



**Geotechnical Report No. UT-NX-USMP-20-01**

# **ZION NATIONAL PARK UNSTABLE SLOPE ASSESSMENT REPORT**

## **Phase II Conceptual Design Priority Slope Locations**

**Route 0010 Zion-Mt. Carmel Highway  
Route 0011 Zion Canyon Scenic Drive  
Route 0407 Oak Creek Residence Road  
Route 0408 Oak Creek Residence Spur Road  
Route 0412 Concessionaire/Dorm Access Road**



**Federal Lands Highway  
"Commitment to Excellence"**

**Washington County, Utah  
November 2020**

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### APPENDIX B – USMP Conceptual Design Forms (Phase II Assessment)

Presented in order by Route/Location (corresponding to order in Table 3-1)

### APPENDIX C – USMP Rating Sheets (from Phase I Assessment) and Site Photographs

Presented in order by Route/Location (corresponding to order in Table 3-1)

# 1 INTRODUCTION AND BACKGROUND

This report summarizes the results of Federal Lands Highway Division's (FLHD) preliminary assessment of the priority unstable slopes in Zion National Park (ZION), Utah. The Unstable Slope Management Program for Federal Land Management agencies (USMP) (January 2019) was utilized for this assessment. The purpose of the assessment was to verify the ratings for those unstable slopes rated higher than 400 points for current conditions and develop conceptual level risk reduction and/or full mitigation alternatives with geotechnical cost estimates. This work will provide ZION with information that will be needed to develop benefit/cost analyses for each unstable slope site and allow the Park to consider the alternatives for each site when more than one is provided. In depth benefit/cost analysis could further prioritize unstable slopes for risk reduction work however, the conceptual risk reduction alternatives provide an opportunity to schedule risk reduction work along with other facility maintenance or as standalone projects using the initial USMP prioritization.

The Unstable Slope Management Program at ZION follows a roadmap of six steps to initiate and maintain the program, which are listed below along with the status of each step to date. This asset management process represents a cycle that can repeated programmatically at a Park-wide level or at a specific individual site. Performing this work involves an integrated approach between the Park as the asset owner/ decision maker, National Park Service (NPS) technical assistance through the Geologic Resources Division (GRD), and FLHD technical assistance through an interagency agreement. This report presents the results of step four in the following process:

1. Evaluate transportation system use and needs (USMP implementation)
  - *Performed by ZION with NPS GRD technical assistance in 2016*
2. Rate targeted transportation corridors based on maintenance input (USMP initial ratings)
  - *Performed by Geoscientist-in-the-Park (GIP) program in 2016-2017 with NPS GRD technical assistance (Phase I: USMP Initial Ratings entered in electronic USMP Database)*
3. Prioritize Initial USMP rated slopes
  - *Performed by ZION with NPS GRD technical assistance in September 2018*
  - *Criteria for "poorly rated slopes" = all ZION USMP-rated slopes greater than "400"*
4. Develop conceptual designs and estimates by geotechnical professional for "poorly rated slopes"
  - *Performed by FLH with NPS GRD technical assistance with ZION input in October 2018 (field work)*
  - *Pine Creek Housing Rockfall Hazard Report (2019); ZION identified as highest priority 3 sites and need for immediate action*
  - ***This Phase II Conceptual Design Report (November 2020)***
5. Reprioritize slopes for proactive project selection and programming, benefit/cost analyst or another logical project prioritization.
  - *Monitoring at Pine Creek Residential Area initiated Spring 2019 by ZION with NPS technical assistance*
  - *Other USMP rated areas –not started*
6. Track unstable slope in living USMP system; watch for trends of deterioration that require proactive risk reduction intervention (USMP maintenance and incident forms)
  - *Not started*

FLHD evaluated a total of 25 unstable slopes within ZION using the USMP located along six main routes in ZION, designated according to the Roadway Inventory Program (RIP) (FHWA, 2018) as the following:

- Route 0010 Zion-Mt. Carmel Highway
- Route 0011 Zion Canyon Scenic Drive
- Route 0407 Oak Creek Residence Road
- Route 0408 Oak Creek Residence Spur Road
- Route 0412 Concessionaire/Dorm Access Road
- Route 0404 Pine Creek Residential Road (under separate cover FLHD, 2019)

These general Park areas evaluated in ZION are presented in Figure 1-1 and site-specific locations are presented on more detailed route maps in Appendix A: USMP Priority Site Location Maps. Three sites are not included in this report and were presented under separate cover due to immediate concerns regarding rockfall hazards above residences in the December 2019 Zion USMP Pine Creek Housing Rockfall Hazard Report (FLHD, 2019). The December 2019 report presents a detailed overview of the rockfall hazards and risks and the applicability of risk reduction and mitigation alternatives for USMP Sites 950, 976, and 991.

Priority sites evaluated were rated greater than 400 and identified as high occupancy transportation facilities or buildings for housing or work. Site observations were conducted following an on-site coordination and planning meeting with NPS personnel responsible for the maintenance and oversight of the sites during the week of October 22, 2018. Information regarding unstable slope history, frequency, and size of unstable slope events was gathered during this meeting and during a preliminary drive-through of the sites. This data informed and influenced the validation and updating, if necessary, of the USMP ratings for the unstable slopes.

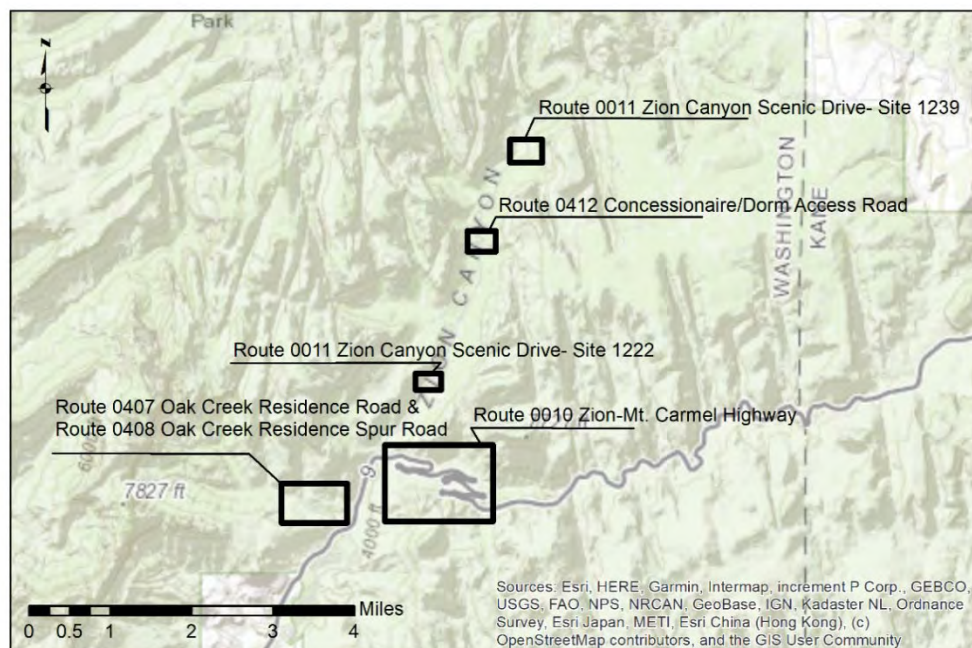


**Figure 1-1** General Location Map of USMP High Priority Sites Assessed.

## 2 GEOLOGY AND ROCKFALL IN ZION

Regionally, bedrock mapped within the project area includes a variety of Early to Middle Jurassic (160 to 200 million years ago (Ma)) sedimentary rocks associated with Zion Canyon, per the Geologic Map of the Kanab Quadrangle, Kane & Washington County, Utah (Doelling, 2008). Geologic formations, listed from youngest to oldest from the surface down, are Carmel (Jc), Temple Cap Sandstone (Jt), Navajo Sandstone (Jn), Kayenta (Jk) and Moenave (JTRmo). These formations generally consist of sandstone, siltstone and mudstone beds ranging in color from whitish gray to brown and red. Sandstones in the canyon are typically massive, cross-bedded, and cliff formers with varying amounts of interbedded siltstone and mudstone rock. Faulting and fracturing of the bedrock is attributed to thrust faulting during the mountain-building Sevier Orogeny about 120 to 80 Ma.

Surface soils are quaternary (10,000 years ago to 2 Ma) talus and colluvium, undifferentiated mass-movement (Qmsc), eolian (Qes) and alluvial (Qa) deposits. Undifferentiated mass-movement deposits can include landslide, slump, colluvium, and talus deposits. Talus is associated with upslope bedrock while colluvium and is generally described as poorly sorted, coarse angular blocks on steep slopes with fine-grained sand infilling. Eolian deposits are described as windblown, poorly graded, fine to medium grained sand with scattered sandstone blocks derived from Navajo Sandstone with some minor localized alluvial gravels. Alluvial deposits are described as sand with lenses of silt and gravel deposited in stream beds, washes, and floodplains.

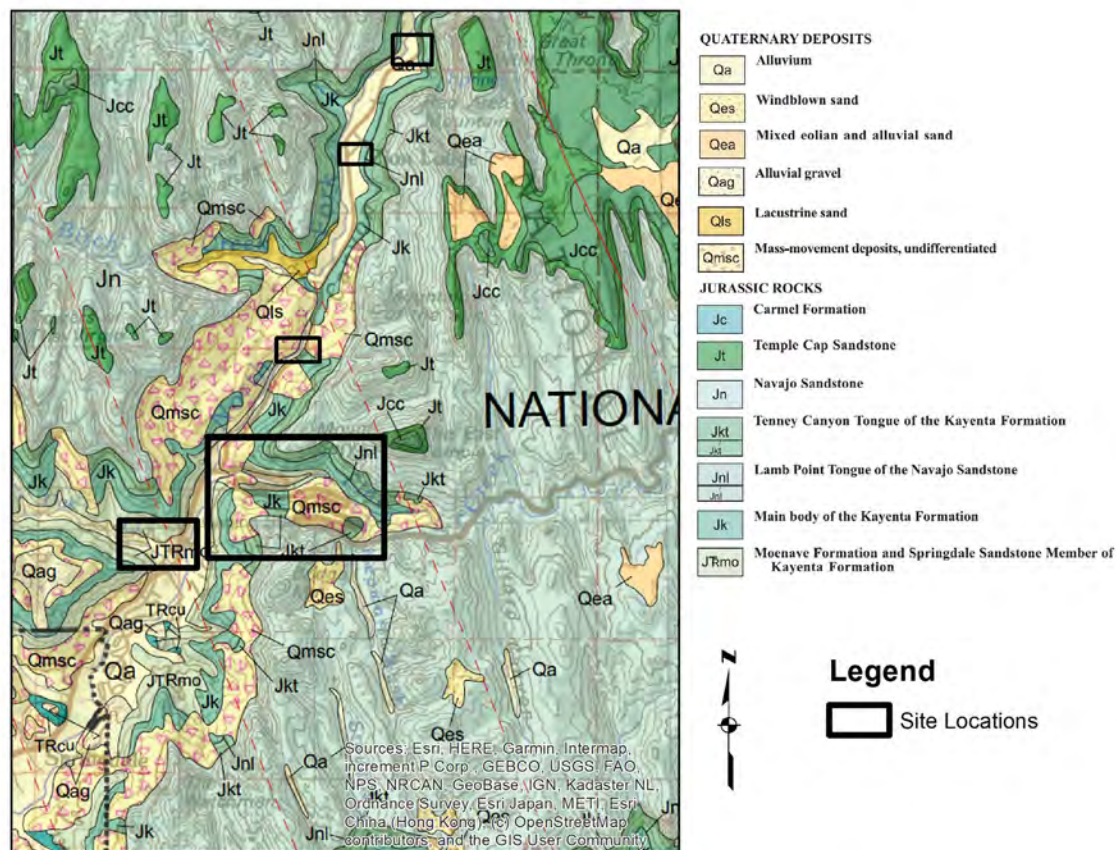


**Figure 2-1** Geologic Map of Zion Canyon (Doelling, 2008).

## **2.1 SITE SPECIFIC GEOLOGY AND ROCKFALL HAZARDS**

Rockfall and landslides exist throughout ZION but pose the greatest hazard and the highest risk potential when above roadways and occupied buildings. Bedrock exposures, both massive outcrops and differentially eroding overhangs, are the leading contributors to rockfall in the Zion valley; however, unidentified mass-movement deposits also produce regular rockfall. The combination of joint systems in the more resistant and stronger bedrock formations create structurally controlled unstable slopes that include planar, wedge and toppling type failures.

### **2.1.1 ROUTE 0010 ZION-MT. CARMEL HIGHWAY**

Geologic conditions along the Mount Carmel Highway, also locally known as the Switchbacks, is generally consistent with geologic conditions described above. The Kayenta Formation is present and is periodically exposed from the base of the canyon to the tunnel elevation, and is typically the formation producing rockfall. The Navajo Formation lies above the Kayenta Formation and is generally in line with the highway and can also produce rockfall. Formations and associated rockfall outside of reported and documented rockfall source areas along the Park road corridors were not evaluated. Most of the Kayenta Formation is a red to reddish-brown sandstone, siltstone, and claystone. Sandstone members within the Kayenta Formation are generally massive, horizontally bedded and jointed. Siltstone and Claystone members are generally horizontally bedded, thinly laminated, and are highly susceptible to erosion when exposed at the surface to moisture. The primary rockfall mechanism associated with the Kayenta is differential erosion of the siltstone and mudstone layers beneath and within the sandstone outcrops, leading to toppling failures of unsupported sandstone beds. A secondary rockfall mechanism is caused by joint systems, which form the rock structural release planes of sandstone blocks, including wedge-type failures. Rockfall resulting from differential erosion of the cut slope can range in size from 1 to 40 feet in dimension with Park personnel observations of previous rockfall exceeding 40 feet long by 20 feet high by 20 feet wide in size.



**Figure 2-2** Representative Zion-Mt. Carmel Highway Switchbacks with Bedrock Differential Erosion and Rockfall Debris in Unpaved Ditches.

In addition to rockfall resulting from bedrock failure, landslide deposits and benched canyon walls contain boulders in colluvium overburden (block-in-matrix) materials. These materials are mapped as undifferentiated mass-movement deposits. Colluvium overburden found throughout the switchbacks ranges from fine-grained sands to coarse gravels and cobbles. Boulders suspended in colluvium, as block-in-matrix, will remain until the underlying, finer-grained material erodes enough to free, or destabilize the boulder. These colluvium are both highly susceptible to erosion and can easily erode over several precipitation events. It is not uncommon for a rockfall event to destabilize other portions of the slope, especially in block-in-matrix sections, which can precipitate further rockfall events.



**Figure 2-3** Representative Zion-Mt. Carmel Highway Switchbacks where Block-in-Matrix Colluvium is above Thinly Interbedded Siltstone, Mudstone, and Sandstone Prone to Differential Erosion.

Landslides have also been noted within the switchbacks, notably at 'Carl's Bend' and the "Nevada Switchback". Landslides encompass a variety of downslope movements of earth materials, such as soil, rock, and vegetation, driven by gravity. The landslides evaluated are shallow failures that reside on top of a much larger prehistoric landslide occurring within steep terrain. Landslides can be triggered by both natural phenomena and by human activities. Inherent weakness in the landslide deposits can combine with a triggering event; such as, a heavy precipitation event to cause failures. Triggers from human activities can be associated with road and trail construction, such as changes in slope, loading, and drainage. Specifically, changes in drainage patterns can increase erosion and deliver surface water to susceptible areas, largely impacting the stability of the slope. These landslides consist of large boulders mixed with clay, silt, sand, gravel, and cobbles, generally have poor drainage, and can be identified by lateral movement and vertical subsidence with arcuate shaped cracks in the pavement. Hummocky terrain and sometimes wet vegetation and stark changes in vegetation are an indication of these landslide deposit features.



**Figure 2-4** Arcuate Shaped Road Distress at "Carl's Bend" Landslide Area.

### 2.1.2 ROUTE 0011 ZION CANYON SCENIC DRIVE

Site 1222 is located on Zion Canyon Scenic Drive, in deposits from the approximately 4.8-thousand-year-old Sentinel rock avalanche (Castleton et al., 2016). The site consists of a landslide deposit on a curve in the road across the Virgin River from a 1995 landslide, also in Sentinel rock avalanche deposits, that pushed the river toward the Scenic Drive. Block-in-matrix slopes are mixed and heterogeneous formations of hard blocks embedded within a weaker matrix. The block-in-matrix on site consists of large sandstone blocks suspended in a silty to gravelly matrix. The primary rock failure mechanism is differential erosion of the weaker siltstone/mudstone or unconsolidated rock avalanche debris underlying the sandstone blocks, which can create toppling-type failures. Boulders within block-in-matrix will become mobilized when the finer grained materials erode, and the boulders have no more confinement to hold them in place.



**Figure 2-5** Block-in-Matrix Landslide Material at Site 1222.



**Figure 2-6** Ditch Before (left) and Recently After (right) Cleaning at Site 1222.

### **2.1.3 ROUTE 0407 OAK CREEK RESIDENCE ROAD & ROUTE 0408 OAK CREEK RESIDENCE SPUR ROAD**

Sites 1431 and 1435 are associated with RIP Route 0408, Oak Creek Residence Spur Road and Route 0407, Oak Creek Residence Road, respectively. Residences at both sites are located directly below colluvium (block-in-matrix) slopes. Block-in-matrix slopes are mixed, heterogeneous formations of hard blocks embedded within a weaker matrix. These slopes consist of large sandstone blocks suspended in a silty to gravelly matrix. Kayenta and Navajo Formations outcrop above the colluvium slope generally consisting of interbedded siltstone/ mudstone and sandstone. The bedrock outcrops are source areas for boulders within the block-in-matrix slope, but the potential for direct rockfall from the outcrops was not evaluated. The primary potential failure mechanism is differential erosion of the soils undermining the sandstone boulders, leading to toppling of the boulders. Generally, soil erosion and failures occur during or directly after precipitation events. Evaluations at both sites identified sandstone boulders up the slope from the residences that are undermined and may pose a rockfall hazard. Figures 2-7 and 2-8 show the undermined boulder at Site 1435.



**Figure 2-7** View of Site 1435 Boulder from the Residence Below.



**Figure 2-8** Sandstone Boulder Above the Residence at Site 1435.



**Figure 2-9** View Above the Sandstone Boulder Looking Down at the Residence at Site 1431.



**Figure 2-10** View from Below of the Undermined Sandstone Boulder at Site 1431.

#### 2.1.4 ROUTE 0412 CONCESSIONAIRE/DORM ACCESS ROAD

The geologic outcrops above this site are similar to the rockfall-producing outcrops in Rockville, Utah, approximately five miles south of Springdale, Utah. Since 2007, several documented rock fall events in Rockville have impacted residences, causing fatalities. The Rockville fatalities resulted from a December 12, 2013 rockfall event estimated to be 2,700 tons in size hitting a house. Prior to this, another rockfall event on February 10, 2010, estimated to be 450 tons, fell onto a house, resulting in no injuries or fatalities. The Utah Geological Survey identified the source of both rockfall events as the Shinarump Conglomerate Member of the Chinle Formation which underlies the Moenave Formation.

Kayenta Formation outcrops directly above the dorm and maintenance shed near the Zion Lodge. These outcrops have the same predisposition to be a source for rockfall, as mentioned above.



**Figure 2-11** Cliff-Forming Outcrop in the Upper Right of the Photo is the Rockfall Source Behind the Dormitory and Maintenance Shop near Zion Lodge.

### 3 USMP RATINGS

The unstable slopes along transportation corridors and facilities were evaluated using the Unstable Slope Management Program for FLMA (USMP). The USMP is a performance-based geotechnical asset management evaluation tool for unstable slopes along roads and trails. It is designed to give Federal Land managers a decision support tool that increases understanding of the location and performance of their slope assets, helps to proactively plan preventative maintenance and funding requests to improve transportation corridor resiliency to closures that impact mobility and access, and provides support for responding to litigation and/or claims related to unstable slopes. It evaluates unstable slopes based on a variety of factors, including roadway characteristics, slope failure type and severity, maintenance frequency and complexity, and risk factors associated with human exposure, maintenance costs, and right-of-way, environmental, and cultural impacts. The USMP assigns a total score to an unstable slope based on these rockfall hazard and risk-related factors.

Unstable slopes in this assessment with temporarily or permanently occupied facilities have been given the highest human exposure factor USMP rating. Areas with high occupancy transportation facilities or buildings for housing or work rate higher than some road adjacent slope, recognizing the increased risk of higher human occupation.

Unstable slopes outside of the previously defined facility corridors are not included in the conceptual design assessment of the higher rated slopes as this study focused on known unstable slope ratings scoring higher than 400 points. It is important to note that potential unstable slopes and known unstable slopes outside the immediate transportation corridors and building facilities selected by the Park are not part of the USMP. ZION has unstable slope (rockfall and landslide) hazards and risks throughout a park characterized by steep slopes, cliffs, and canyons, where high erosion rates have contributed to the natural beauty of the area.

The following table presents the USMP rating for the selected unstable slopes surveyed by FLH for Phase II work presented in this report, presented in order by mile point along each route. As supporting documentation, the details of the Phase I initial USMP slope ratings are presented in Appendix C supplemented with more recent photographs taken during the Phase II site visit.

**Table 3-1** ZION Highest Rated USMP Slopes (Not Including Pine Creek Residences), Listed in Order by Route Location and Facility Name.

| SITE                        | ROUTE NUMBER/<br>NAME                   | LOCATION<br>Mile Points |      | TYPE OF<br>UNSTABLE<br>SLOPE | SLOPE<br>HEIGHT<br>(Ft) | SLOPE<br>ANGLE<br>(Degrees) | LENGTH<br>AFFECTED<br>(Ft) | TOTAL<br>USMP<br>SCORE |
|-----------------------------|-----------------------------------------|-------------------------|------|------------------------------|-------------------------|-----------------------------|----------------------------|------------------------|
| 997 <sup>1</sup><br>(997A)  | 0010/<br>Zion- Mt. Carmel Hwy           | 1.83                    | 1.91 | Rock                         | 140                     | 40                          | 407                        | 795                    |
| 5123 <sup>1</sup><br>(997B) | 0010/<br>Zion- Mt. Carmel Hwy           | 1.91                    | 1.95 | Rock                         | 136                     | 50                          | 190                        | 796                    |
| 5124 <sup>1</sup><br>(997C) | 0010/<br>Zion- Mt. Carmel Hwy           | 1.95                    | 2.02 | Rock                         | 128                     | 52                          | 190                        | 884                    |
| 1000                        | 0010/<br>Zion- Mt. Carmel Hwy           | 1.99                    | 2.07 | Rock                         | 120                     | 88                          | 393                        | 786                    |
| 1002                        | 0010/<br>Zion- Mt. Carmel Hwy           | 2.14                    | 2.19 | Rock                         | 55                      | 90                          | 300                        | 685                    |
| 1004                        | 0010/<br>Zion- Mt. Carmel Hwy           | 2.19                    | 2.27 | Rock                         | 90                      | 75                          | 325                        | 594                    |
| 1006                        | 0010/<br>Zion- Mt. Carmel Hwy           | 2.27                    | 2.36 | Rock                         | 73                      | 90                          | 465                        | 621                    |
| 1124                        | 0010/<br>Zion- Mt. Carmel Hwy           | 2.56                    | 2.60 | Rock                         | 22                      | 63                          | 145                        | 479                    |
| 1125                        | 0010/<br>Zion- Mt. Carmel Hwy           | 2.61                    | 2.71 | Rock                         | 40                      | 58                          | 510                        | 514                    |
| 1127                        | 0010/<br>Zion- Mt. Carmel Hwy           | 2.71                    | 2.77 | Rock                         | 54                      | 53                          | 197                        | 435                    |
| 1129                        | 0010/<br>Zion- Mt. Carmel Hwy           | 2.79                    | 2.93 | Rock                         | 96                      | 42                          | 587                        | 546                    |
| 1130                        | 0010/<br>Zion- Mt. Carmel Hwy           | 2.93                    | 2.94 | Rock                         | 37                      | 70                          | 71                         | 457                    |
| 1131                        | 0010/<br>Zion- Mt. Carmel Hwy           | 2.94                    | 3.07 | Rock                         | 33                      | 38                          | 388                        | 422                    |
| 1134                        | 0010/<br>Zion- Mt. Carmel Hwy           | 3.38                    | 3.43 | Rock                         | 84                      | 39                          | 286                        | 484                    |
| 1145                        | 0010/<br>Zion- Mt. Carmel Hwy           | 4.26                    | 4.30 | Rock                         | 62                      | 43                          | 208                        | 473                    |
| 1150                        | 0010/<br>Zion- Mt. Carmel Hwy           | 4.71                    | 4.76 | Rock                         | 60                      | 45                          | 221                        | 437                    |
| 5104 <sup>2</sup><br>(New)  | 0010/<br>Zion- Mt. Carmel Hwy           | 3.26                    | 3.32 | Landslide                    | 516                     | 13                          | 267                        | 547                    |
| 1222                        | 0011/<br>Zion Canyon Scenic Drive       | 0.90                    | 0.98 | Landslide                    | 75                      | 50                          | 420                        | 505                    |
| 1239                        | 0011/<br>Zion Canyon Scenic Drive       | 3.60                    | 3.75 | Rock                         | 60                      | 50                          | 800                        | 489                    |
| 1435                        | 0407/<br>Oak Creek Residence Rd         | 0.23                    | 0.23 | Rock                         | 83                      | 31                          | 300                        | 827                    |
| 1431                        | 0408/ Oak Creek<br>Residence Spur Rd    | 0.15                    | 0.15 | Rock                         | 48                      | 25                          | 98                         | 784                    |
| 1234                        | 0412/ Concessionaire/<br>Dorm Access Rd | 0.20                    | 0.20 | Rock                         | 145                     | 40                          | 621                        | 870                    |

Table Notes:

- (1) Site 997 was split into 3 sections during this site visit and the new sites were added to the USMP  
 (2) Site 1504 was added during this site visit

## 4 ROCKFALL CONCEPTUAL DESIGN ALTERNATIVES

FLH assessed the unstable slopes to develop preliminary conceptual designs for rockfall and landslide hazards. Recommendations are generally divided into three options:

1. Monitoring,
2. Temporary Risk Reduction - Scaling, and
3. Mitigation- Rockfall Stabilization.

Treatment constraints resulting from NPS permitting or clearance requirements were considered when risk reduction and full mitigation recommendations were described. Recommendations described below are general and not prescriptive for every site. The Conceptual Design forms in Appendix B should be referenced for site specific alternatives and recommendations. All conceptual alternatives require some level of maintenance or inspection to operate for the intended design life.

### 4.1 MONITORING

Park monitoring of unstable slopes provides a temporary risk reduction, in that it provides the potential to find deterioration in conditions before slope failure, but monitoring is labor intensive and is seldom a long-term solution for risk reduction. For features, such as perceived unstable rocks, potential movement can be either individually measured (direct) or monitored remotely (indirect). The level of monitoring for an unstable slope can range from annual inspections to periodic remote sensing scans (surveys and photogrammetry) to continual measurement of displacement cracks. Depending on the scale of the problem, monitoring needs will be dictated by the size of the unstable feature, accessibility to monitoring locations, and the site-specific risk tolerance.

Direct monitoring is generally recommended for features that are clearly identified, accessible, with potentially high consequence of impacting a park roadway or structure. Based on this assessment, no specific locations were identified for direct monitoring. While there is a variety of monitoring instruments available, displacement transducers or slope inclinometers are the most typical instrument used to directly monitor unstable rock slopes. Crackmeter displacement transducers are used to span cracks on the ground. Readings can be downloaded to a datalogger, which is remotely accessed or manually downloaded. Currently there is an active crackmeter monitoring of large unstable rocks located above the Pine Creek residences within ZION. Although no new locations were identified during this assessment at other priority locations where it would be feasible to install crackmeters, the Park should consider this option if future needs arise.

Indirect monitoring technology is continually improving for remote monitoring systems using laser or radar change detection and for unmanned aerial vehicle (UAV) aircraft used as monitoring platforms. Laser or radar change detection can have high resolution and can monitor over varying time periods, as frequent as continuous or once every several years. Ground-based laser or radar scanning can be limited by viewing angle, unlike a more complete UAV scan, but is effective and can be part of a self-contained monitoring and/or alarmed system. Another remote monitoring

option to consider is the use of periodic photographs or photographic models (photogrammetry) to monitor possible changes to the slope over the course of a time period in order to establish if movement is occurring. For example, Utah Geologic Survey has recently provided UAV photogrammetric scans of rockfall and geohazard trail sites to ZION. This data can be time intensive to collect/ process and costly, but could provide a valuable comparison of larger areas to determine more active zones that should be inspected more often. Seven locations in the lower Route 0010/Zion-Mt. Carmel Highway switchbacks were identified as potential locations where the park could perform ground-based laser or radar scanning due to open lines of sight (997A, 997B, 997C, 1000, 1002, 1004, and 1006). Costs for this work were included in these conceptual design forms and the Park should consider the value of performing this more detailed monitoring to assist with proactively managing their road and trail assets. Processing of the data and differential comparisons may require technical assistance from NPS experts or contractors.

Monitoring also includes maintaining the USMP database of known unstable slopes in ZION. It is recommended that events affecting rated slopes be noted in the USMP and the slope are revisited for potential re-rating on a three- to five-year schedule. Tracking new geotechnical events can be recorded in the USMP “New Slope Event” form and maintenance activities can be tracked in the USMP “Maintenance Tracking” form. The Park can use the USMP to collect inventory and condition data about sites to support analysis and decision-making.

## **4.2 TEMPORARY RISK REDUCTION- SCALING**

Scaling is the process of removing loose, or potentially unstable material that might dislodge or influence the trajectory of other falling rock. Typical methods used to perform scaling are by hand tools and/or with heavy equipment, and while not typical, small trim blasts are used occasionally. Scaling is used as a temporary stabilization or risk reduction measure, because it is effective for a period of 1 to 10 years, depending on site climatic conditions. Because it enhances site safety, scaling is routinely included with other mitigation efforts for public roads such as new rock excavation, rock reinforcement or draped mesh. In most cases a geotechnical engineer or engineering geologist will indicate areas that require scaling in the roadway project limits. In all cases, scaling should be observed by the geotechnical specialist and controlled to prevent the scaling activities from digging too deep, or creating a worse problem than previously existed. A critical aspect of a scaling operation is ensuring the selected method of scaling is capable of achieving the desired results, based on the rock size, traffic control needs, facility protection measures, and accessibility to reach all portions of the slope.

Hand scaling is the most common form of scaling. Workers rappel from the top of slope or work out of a supported platform and use hand tools to dislodge loose rocks, working as they clean the slope down to the bottom. Hand tools such as pry bars and air bags are typically used to move rocks (Figure 4-1). Mechanical scaling is used on larger slopes, or to augment hand-scaling operations. This process uses long-reach excavators with hydraulic hammers. Targeted, heavy equipment scaling methods are robust and can remove a lot of loose material quickly; therefore, it is typical to have hand scaling methods follow behind the heavy machinery with mechanical scaling to clean up the loose material on the slope.



**Figure 4-1** Typical Hand Scaling Setup (Colorado National Monument, from CFLHD).

To protect the roadway and downslope of the roadway embankment during scaling, movable flexible rockfall fences are needed when roadway closures are not planned. These temporary protection devices are generally moved with standard earthwork equipment and may be anchored to the ground to resist overturning during an impact (Figure 4-2). Roadway closures during low visitation periods could greatly reduce the cost of scaling projects.



**Figure 4-2** Typical Roadside, Movable Flexible Rockfall Fence (from WFLHD).

## **4.3 MITIGATION- ROCKFALL STABILIZATION AND PROTECTION OPTIONS**

### **4.3.1 ROCK REINFORCEMENT (BOLTING & DOWELS)**

Rock scaling is typically performed prior to installing rock reinforcement, for safety of the construction operations and to assure completed reinforcement is not jeopardized by falling material. As scaling progresses it may expose large, unstable stacked rocks supported by keystones holding the stack in place. For unstable rocks too large to remove, either rock bolts or dowels can be installed. Rock bolts apply a tensioned load to detached blocks which pulls them back down into the rock face. Rock bolts can be used to reinforce critical keystone blocks supporting unstable slopes above. Alternatively, untensioned dowels hold an unstable block of rock to the slope and are fully grouted. This prevents further loosening of the unstable rock mass.



**Figure 4-3** Before and After Camouflaged Rock Reinforcement (Colorado National Monument, from CFLHD).

Actively tensioned rock bolt anchors and passive rock dowels are the most common type of internal stabilization methods. Both are cold rolled, all-thread steel bars or cables that are installed in drilled holes and bonded to the rock mass by cement grout. Tensioned bolts can be installed in two-stages, with the first stage grouted and cured, the anchor tested and loaded, and then the second stage grouting is brought to the surface. Once completed the anchor can be flush cut. Completed bolts can be camouflaged with colored grout that matches the surrounding rock. Dowels that have been fully grouted into strong rock can also be cut flush and camouflaged. Tie-back cable anchors are options for stabilizing very large rock masses but because they are typically used for very high loading, require large concrete reaction frames to prevent a localized punching failure from occurring, and they could not be hidden or camouflaged well, we did not feel that this met the aesthetic values for ZION.

#### 4.3.2 TRIM BLASTING

Trim Blasting, a method of controlled blasting sometimes referred to as cushion blasting, uses explosives (lightly loaded holes filled with crushed stone) to remove unstable blocks, or problematic benches and portions of an unstable slope. A properly designed trim blast will break up the rock being removed into small enough pieces to be handled, loaded, and removed from the site with little to no back-break and fracturing of the rock face that remains. Trim blasting is often used with scaling and rock reinforcement, if necessary.



**Figure 4-4** Hand Drilling for Trim Blasting on a Fractured Slope (from Matcon).

#### 4.3.3 SHOTCRETE EROSION CONTROL

Shotcrete is used as a form of erosion control for rock outcrops with differential weathering or oversteepened soil slopes. Differential weathering occurs in slopes composed of different natural materials. This could be a rock slope in sedimentary rock with layered shales and sandstone, or in volcanic rocks with beds of hard lava rock overlying softer ash. Differential weathering also occurs in slopes with blocks of harder rock in a matrix of less resistant material, such as in glacial or landslide deposits. In all cases the less resistant material will weather at a faster rate, creating overhangs in the more resistant rock which can then be released as rockfall. Shotcrete can also be used to protect against erosion on oversteepened soil slopes.

By applying a shotcrete face to these erodible materials, the intent is to stop or significantly slow the rate of erosion which can provide a longer design life for the engineered cut slope or slope mitigation. Shotcrete can be combined with rock reinforcement to provide greater confinement or combined with the ditch hardening option to create an encapsulated slope base. Anytime shotcrete is applied to a slope a sufficient drainage system must be included so no water is trapped behind the facing.

Shotcrete can range in appearance from unfinished condition to a specialty colored and sculpted finish. Depending on the level of effort to achieve the desired end result, the cost and time required to obtain the shotcrete finish varies widely.



**Figure 4-5** Example of Sculpted and Colored Shotcrete (Yosemite National Park, from CFLHD).

#### 4.3.4 ROCKFALL PROTECTION FENCE

Rockfall fences are large steel barriers designed to stop high-energy rockfall impacts. These barriers are utilized along mountain corridor highways where rockfall is common but there is no room to move traffic away from the hazard. In these corridors, rockfall fences are typically installed on slopes in order to minimize the rockfall energy and to prevent rock from reaching the highway. Fence sizes vary but can range from 10 to 30-feet tall, and use a variety of steel wire or cable barriers as a net to catch rocks. As shown in Figure 4-5 a typical ring net (looped wire) barrier includes a secondary wire mesh backing to stop smaller rocks from passing through the larger diameter rings.



**Figure 4-6** Example of a Ring-Net Flexible Barrier (from Andrew et al., 2011).

Regular inspection of rockfall barriers is required to check for damage to the netting, friction brakes, and the anchor posts. Rockfall impacts to any barrier must be cleared, and repair or replacement of the barrier quickly performed to ensure the system is fully operational.



**Figure 4-7** Rockfall Fence behind Zion Lodge.

Rockfall barriers are designed based on impact energy and, therefore, the size and volume of rock that can be retained depends on many variables. One large rockfall event can overload a barrier, but more commonly, barriers capture small rockfall events which can build up debris. Either scenario will require regular maintenance checks and repairs.

#### 4.3.5 PAVED DITCH

Roadside ditches are typically designed only for drainage, but in unstable slope areas, they also serve as an important impact zone and retention area for eroded debris. In ZION, unpaved ditches can lead to increased erosion of weak mudstone/shale units and undercutting of harder sandstone units, leading to differential erosion (the main rockfall cause in the Park). Paved ditches prevent infiltration of water so all runoff is directed to the drainage outlets, which may need to be upsized to handle additional water volume.

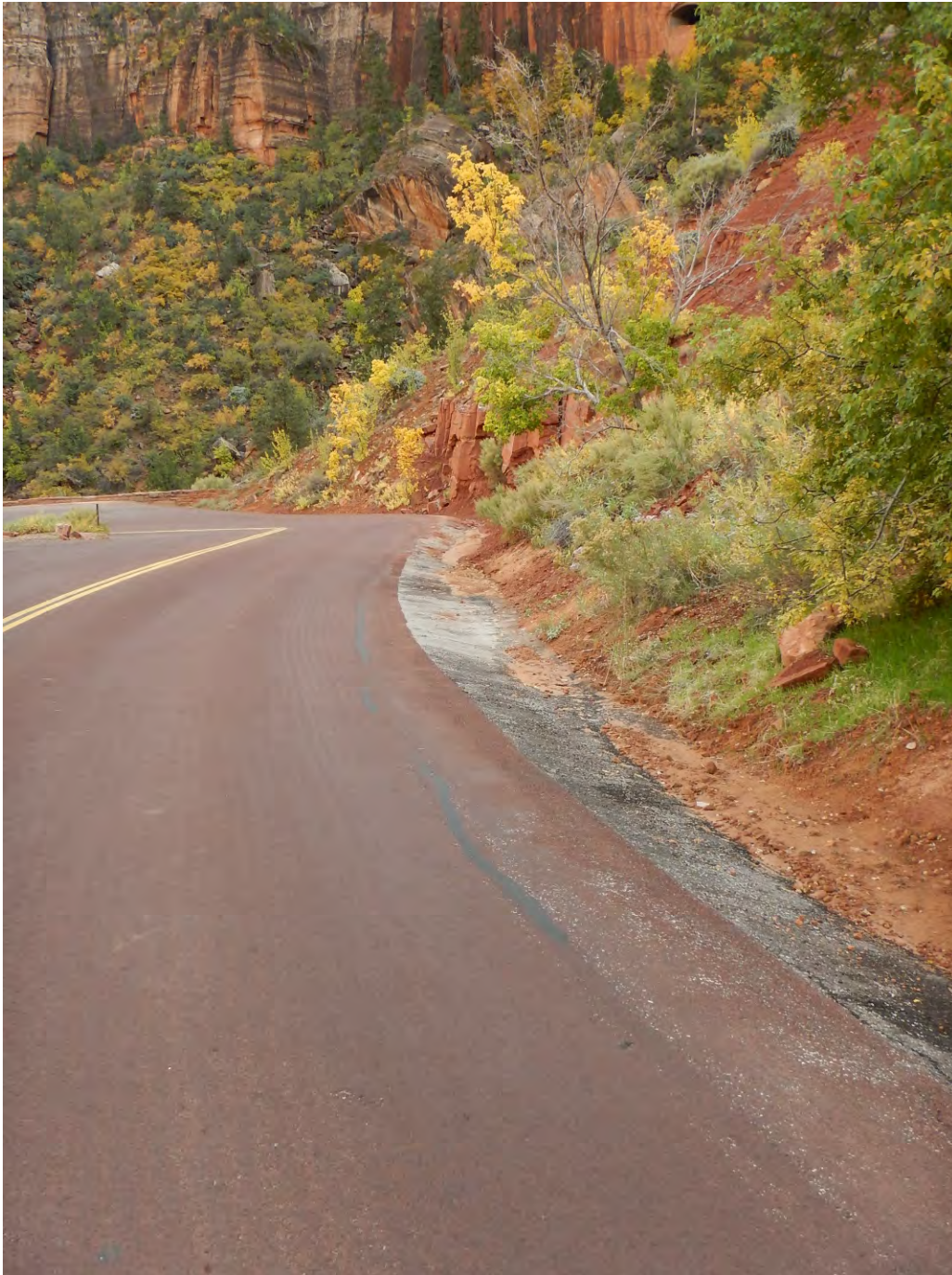


**Figure 4-8** Example of Paved Ditch from Site 1145.

#### **4.3.6 DRAPED OR PINNED WIRE MESH**

A draped system consists of high tensile wire mesh suspended by anchors at the top of the slope and hung loose at the bottom to allow rocks to drop into the ditch. These systems are generally self-cleaning, as they drop the rocks out at the bottom and therefore typically do not need to be cleared of debris. They are designed to protect against raveling-type rockfall that involves small-volume slope failures or blocks up to about 2 feet (Figure 4-9). Larger rocks up to 5 feet can be contained by a 5/16<sup>th</sup>-inch cable net system which can be combined with mesh.



**Figure 4-9** Example of Draped Mesh Rock Cut with Differential Weathering (from Arndt, 2016).

Pinned wire mesh systems consist of wire mesh that is anchored to the rock face in a grid pattern across the entire face. These systems work to largely inhibit erosion and contain rockfall. While unpinned drapery systems are meant to contain small rocks or channel larger rocks safely down a slope, a pinned mesh system is intended to reinforce a slope face and, if possible, prevent rocks from ever detaching and falling. The mesh used in an anchored system is stronger than that used for a drapery, and its fastening method consists of closely spaced rock dowels with plates that anchor the mesh to the slope. Placement of erosion control fabric behind the mesh can provide an area for small shrubs and grasses to become established when the slope consists of soils and rock mixtures (Figure 4-10).



**Figure 4-10** Example of Pinned Wire Mesh Slope (WSDOT).

## 5 ESTIMATED COSTS

Preliminary conceptual designs for risk reduction and/or full mitigation were developed for all 22 slopes presented in this report. Preliminary assumptions were made regarding dimensions and engineering analysis corresponding to each conceptual design option. Details of each conceptual design and geotechnical cost estimates are on the Conceptual Design forms in Appendix B for each site and summarized below in Table 5-1. **These cost estimates are for the geotechnical work items only and don't represent a complete design and construction cost estimate.** Costs for items such as project engineering (PE)/plan preparation, construction engineering (CE)/oversight, and other associated construction (CN) costs (e.g. mobilization, traffic control, contractor QA/QC, erosion protection, surveying, inspection), are not included.

Each site was evaluated individually, but there could be cost savings of 15-25% in grouping the monitoring activities from each route due to reduced mobilization and economy of greater quantity for sites located in close proximity, such as in the Zion-Mt. Carmel switchbacks. In the same manner, cost savings of 10-20% may be realized when grouping scaling or mitigation work.

**Table 5-1** Summary of Preliminary Estimated Costs for Rockfall Risk Reduction Conceptual Designs at Park Priority Locations, Listed in order by USMP Score (Highest to Lowest).

| Rank | SITE        | ROUTE NUMBER/NAME                   | Conceptual Design Options |                   |                                                | TOTAL USMP SCORE |
|------|-------------|-------------------------------------|---------------------------|-------------------|------------------------------------------------|------------------|
|      |             |                                     | Monitoring \$/year        | Risk Reduction    | Mitigation                                     |                  |
| 1    | 5124 (997C) | 0010/Zion- Mt. Carmel Hwy           | \$9,000                   | \$236,000         | \$335,260                                      | 884              |
| 2    | 1234        | 0412/Concessionaire/ Dorm Access Rd | \$5,000                   | \$1,322,000       | None <sup>1</sup>                              | 870              |
| 3    | 1435        | 0407/Oak Creek Residence Road       | \$7,600                   | None <sup>2</sup> | \$71,250 <sup>3</sup>                          | 827              |
| 4    | 5123 (997B) | 0010/Zion- Mt. Carmel Hwy           | \$9,000                   | \$175,000         | \$290,800                                      | 796              |
| 5    | 997 (997A)  | 0010/Zion- Mt. Carmel Hwy           | \$9,000                   | \$236,000         | \$568,200                                      | 795              |
| 6    | 1000        | 0010/Zion- Mt. Carmel Hwy           | \$9,000                   | \$236,000         | \$541,135                                      | 786              |
| 7    | 1431        | 0408/Oak Creek Residence Spur Road  | \$7,600                   | None <sup>2</sup> | \$45,000 <sup>3</sup><br>\$56,000 <sup>4</sup> | 784              |
| 8    | 1002        | 0010/Zion- Mt. Carmel Hwy           | \$9,000                   | \$202,000         | \$985,500                                      | 685              |
| 9    | 1006        | 0010/Zion- Mt. Carmel Hwy           | \$9,000                   | \$323,000         | \$487,750                                      | 621              |
| 10   | 1004        | 0010/Zion- Mt. Carmel Hwy           | \$9,000                   | \$202,000         | \$342,000                                      | 594              |
| 11   | 5104 (New)  | 0010/Zion- Mt. Carmel Hwy           | \$15,000                  | \$70,900          | \$255,850                                      | 547              |
| 12   | 1129        | 0010/Zion- Mt. Carmel Hwy           | \$5,000                   | \$316,000         | \$551,750                                      | 546              |
| 13   | 1125        | 0010/Zion- Mt. Carmel Hwy           | \$5,000                   | \$286,000         | None <sup>5</sup>                              | 514              |
| 14   | 1222        | 0011/Zion Canyon Scenic Drive       | \$5,000                   | \$194,000         | \$878,000                                      | 505              |
| 15   | 1239        | 0011/Zion Canyon Scenic Drive       | \$5,000                   | \$434,000         | \$794,000                                      | 489              |
| 16   | 1134        | 0010/Zion- Mt. Carmel Hwy           | \$5,000                   | \$139,000         | None <sup>5</sup>                              | 484              |
| 17   | 1124        | 0010/Zion- Mt. Carmel Hwy           | \$5,000                   | \$122,000         | \$149,500                                      | 479              |
| 18   | 1145        | 0010/Zion- Mt. Carmel Hwy           | \$5,000                   | \$154,000         | \$386,500                                      | 473              |
| 19   | 1130        | 0010/Zion- Mt. Carmel Hwy           | \$5,000                   | \$97,000          | \$102,250                                      | 457              |
| 20   | 1150        | 0010/Zion- Mt. Carmel Hwy           | \$5,000                   | \$280,000         | None <sup>5</sup>                              | 437              |
| 21   | 1127        | 0010/Zion- Mt. Carmel Hwy           | \$5,000                   | \$202,000         | \$287,000                                      | 435              |
| 22   | 1131        | 0010/Zion- Mt. Carmel Hwy           | \$5,000                   | \$200,000         | None <sup>5</sup>                              | 422              |

Table Notes: (1) Rockfall fence at this location is considered a risk reduction, not mitigation option

(2) No risk reduction option developed for Oak Creek Residential area

(3) Concrete buttress mitigation option

(4) Rock removal mitigation option

(5) No feasible mitigation option identified at some locations

## 6 NEXT USMP STEPS

The development of a working USMP for ZION has achieved the first four key steps as previously discussed in the Introduction Section of this report: (1) evaluation, (2) rating, (3) initial prioritization, and this report presents (4) the development of conceptual designs and estimates for priority sites up to the tunnel on Route 0010 Zion-Mt. Carmel Highway, up to MP 3.75 on Route 0011 Zion Canyon Scenic Drive, and at all facility and residential locations in Zion Canyon. The next USMP steps are to evaluate benefit/costs of the mitigation concepts and prioritize slopes for proactive project selection and programming (Step 5 previously discussed in the Section 1: Introduction). Then, ZION can track unstable slopes in the USMP database system, watching for trends of deterioration that require proactive risk reduction intervention (Step 6 previously discussed in Section 1: Introduction). This last step includes periodic USMP re-ratings, maintenance tracking forms, and new slope event incident forms.

Please let us know if FLHD can assist with any site specific or other corridor USMP ratings or assessments as ZION works through the benefit-cost analysis, prioritization of projects, or emergency rockfall or landslide events.

## 7 LIMITATIONS

A detailed site investigation with the purpose of evaluating rockfall and subsurface conditions was not performed as a part of the USMP study. Interpretation of surface and subsurface conditions is based on limited field reconnaissance and reviewing maps or images of soil and rock outcrops. The Conceptual Design section of this report includes interpretations and recommendations developed by the Government in the process of preparing the preliminary conceptual design risk reduction options. These interpretations are intended to support the Park's efforts for planning and requesting funds as a decision support tool when weighing all other facility needs. The information contained in this report is not intended for final design or construction.

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Prepared by:

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**Marilyn Dodson, P.E., Lead Geotechnical Engineer  
FHWA Central Federal Lands Highway Division**

Cc:

Douglas A. Anderson, Engineering Geologist, FHWA Western Federal Lands Highway Division  
Eric Bilderback, PhD., Geomorphologist, National Park Service, Geologic Resources Division

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## **APPENDIX A**

### **USMP Priority Site Location Maps**

Figure A-1: Route 0010 Zion-Mt. Carmel Highway, Location of Evaluated Unstable Slopes (Google Earth, 2020).

Figure A-2: Route 0011 Zion Canyon Scenic Drive, Locations of Evaluated Unstable Slopes, Site 1222 near Sentinel Slide (left), and Site 1239 past the Grotto (right) (Google Earth, 2020).

Figure A-3: Routes 0407 and 0408 Oak Creek Residence Road and Spur Road, Locations of Evaluated Unstable Slopes: Site 1435 (left), and Site 1431 (right) (Google Earth, 2020).

Figure A-4: Route 0412 Concessionaire/ Dorm Access Road near Zion Lodge, Locations of Evaluated Unstable Slopes; Site 1234 (Google Earth, 2020).



Figure A-1: Route 0010 Zion- Mt. Carmel Highway, Locations of Evaluated Unstable Slopes (Google Earth, 2020).

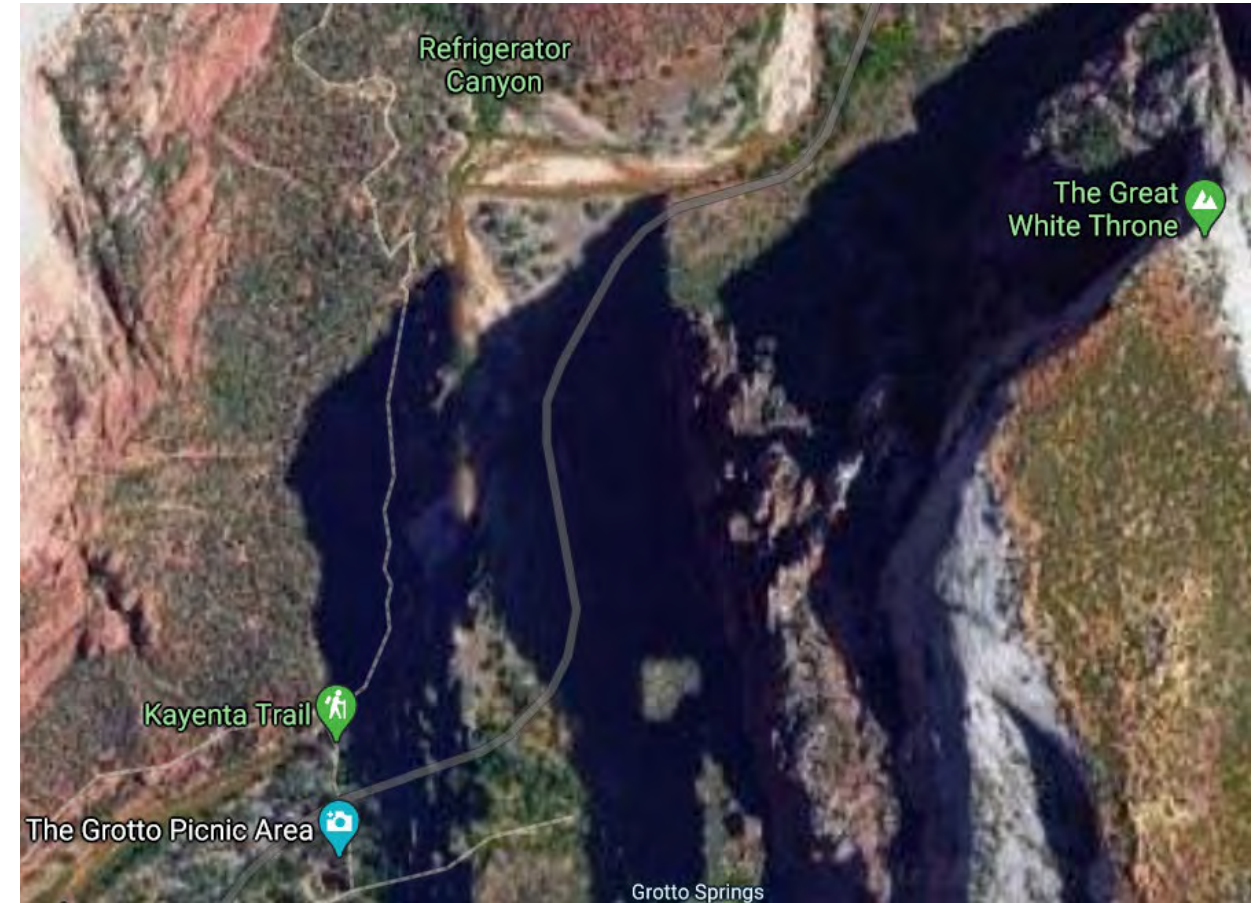


Figure A-2: Route 0011 Zion Canyon Scenic Drive, Locations of Evaluated Unstable Slopes; Site 1222 near Sentinel Slide (left), and Site 1239 past the Grotto (Right)(Google Earth, 2020).



Figure A-3: Routes 0407 and 0408 Oak Creek Residence Road and Spur Road, Locations of Evaluated Unstable Slopes; Site 1435 (left), and Site 1431 (right)(Google Earth, 2020).



Figure A-4: Route 0412 Concessionaire/ Dorm Access Road near Zion Lodge, Locations of Evaluated Unstable Slopes; Site 1234 (Google Earth, 2020).

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## **APPENDIX B**

### **USMP Conceptual Design Forms (Phase II Assessment)**

**Presented in order by Route/Location  
(corresponding to order presented in Table 3-1)**

# **Zion National Park Unstable Slope Corridor Assessment**

**SITE:** 997A

**Evaluated By:** DAA/MDD

**Date:** 10/26/2018

**Agency:** NPS

**Region:** Intermountain Region

**Park:** ZION

**Road (RIP Route No.):** 0010 – Zion-Mt Carmel Highway

**Side of Centerline:** Left

**Beginning:** 1.83

**Ending:** 1.91

**Numerical Rating:** 795

## **Problem Definition/ Description:**

This unstable slope extends approximately 407 feet long from MP 1.83 to MP 1.19, with a maximum evaluated slope height of 140 feet. Evaluated rockfall source areas consist of a massive, cliff-forming sandstone member of the Kayenta Formation overlying a siltstone/ mudstone member of the Kayenta Formation outcropping at the road elevation. The Navajo Formation lies above the Kayenta Formation and is generally in line with the highway and can also produce rockfall. Formations and associated rockfall outside of reported and documented rockfall source areas along the Park road corridors were not evaluated. Rock outcrops in the source area are horizontally bedded and cross-jointed, which results in variable sized rockfall blocks ranging from approximately 1 to 15-foot cubes. The primary potential failure mechanism is differential erosion of the weaker siltstones/ mudstones underlying the sandstone, which can create topple failure. In combination, common secondary failure mechanisms due to the release planes created by structural discontinuities, such as joints and fractures, include direct sliding and wedge failures. Coarse colluvial material perched along the slope can also be reactivated by precipitation or rockfall masses from the cliff-forming sandstone above them. Patches in the lane closest to the face and pits in the second lane are evidence of previous events at this site. Fresh rock faces on exposed outcrops indicate recent failures.

## **Problem Correction:**

### **Option 1 – Monitoring:**

As discussed in the main report, monitoring by the Park is always an option at this unstable slope location, but it is a temporary risk reduction method, not a long-term mitigation measure. Installation of direct monitoring devices, such as extensometers, at specific locations is unfeasible at this site due to difficult access locations and the large number and extents of the fracturing. Instead, a ground-based survey could produce models that could be processed for change detection between surveys. It is also recommended to re-rate the slope on a 3- to 5-year basis or after significant precipitation events to determine if there are any significant changes in the unstable slope conditions.

USMP “New Slope Event” and “Maintenance Tracking” forms can be used to easily record new information.

**Option 2 – Temporary Risk Reduction-Scaling:** Temporary risk reduction of the hazard from this unstable slope will require slope scaling to remove loose rock, large unstable blocks, and colluvial material. The slope scaling efforts will need to be repeated on 5 to 10 year intervals to maintain the same level of risk reduction. The use of air-bags may be required in some areas with larger boulders or tight fracturing. During scaling operations, the road might sustain damage from debris impacts even with the use of plates to protect the roadway and would be ideally planned in advanced coordination with resurfacing or other pavement repair work. Rock will also need to be prevented from falling outside of the roadway embankment area or into Pine Creek with the use of a temporary roadside rockfall catchment fences. It was assumed for this conceptual design that these issues could be addressed within the debris removal item.

**Option 3 – Mitigation – Rockfall Stabilization:** Preliminary site evaluation indicates a combination of stabilization methods could best protect the roadway from typical rockfall events that includes scaling, rock stabilization (bolting/dowels), shotcrete erosion control, and ditch paving.

**Scaling:** As described above in Option 2, mitigation of this unstable slope will require slope scaling to remove loose rock, large unstable blocks, and colluvial material.

**Trim Blasting:** Small localized blasts may be recommended if large blocks cannot be scaled or reasonably bolted.

**Rock Stabilization:** Strategic bolting and/or doweling should follow the scaling to secure large unstable rock features in the cliff. Two-stage grouted bolts would be appropriate to retain larger blocks that have potential to detach and fall into the roadway. The aesthetics of the rock reinforcement can be improved by cutting off the heads of the bolts and/or dowels, and then applying colored grout over top. Final bolt and/or dowel design and locations will need further evaluation at the time of a planned project to account for any changes in the slope conditions and planned access to the slopes.

**Shotcrete Erosion Control:** Following the rock stabilization, erosion prevention measures could protect the roadway from typical rockfall events caused by differential erosion. Applying shotcrete to siltstone and mudstone members, would slow the erosion of the siltstone and mudstone members of the Kayenta, and thus prevent undermining the sandstone member above. Shotcrete would be colored and sculpted to blend into the exposed outcrops in a context sensitive manner to minimize visual impacts.

**Ditch Paving:** Ditch maintenance, including regular cleaning of debris, is imperative to minimalizing roadway debris. Ditch armoring (paving) is also recommended to reduce erosion of weaker mudstone/shale units by transporting water away from the base of the rock slopes and prevent undercutting during regular ditch maintenance activities.

The conceptual design cost estimate is for the geotechnical work items only and doesn't represent a complete design and construction cost estimate.

## **Geotechnical Estimating Factors:**

### **Option 1 - Monitoring**

| <b>Item</b>                        | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|------------------------------------|-------------|---------------|------------------|-------------------|
| Park Ground-Based Survey (1/yr)    | Each        | 1             | \$ 1,000         | \$ 1,000          |
| Survey Processing & Report (1/yr)  | Each        | 1             | \$ 3,000         | \$ 3,000          |
| Park Monitoring (ad hoc/yr)        | Each        | 1             | \$ 1,000         | \$ 1,000          |
| Park Re-Rating (3 to5 yr interval) | Each        | 1             | \$ 4,000         | \$ 4,000          |

**Option 1 Total Estimated Costs** **\$ 9,000**

### **Option 2 - Temporary Risk Reduction- Scaling**

| <b>Item</b>               | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|---------------------------|-------------|---------------|------------------|-------------------|
| Final Geotechnical Design | Lump Sum    | 1             | \$ 20,000        | \$ 20,000         |
| Scaling                   | Scaler Hour | 500           | \$ 300           | \$ 150,000        |
| Movable Rockfall Fence    | Lump Sum    | 1             | \$ 50,000        | \$ 50,000         |
| Debris Removal            | Cubic Yd    | 400           | \$ 40            | \$ 16,000         |

**Option 2 Total Estimated Costs** **\$ 236,000**

### **Option 3 - Mitigation-Rockfall Stabilization**

| <b>Item</b>                             | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|-----------------------------------------|-------------|---------------|------------------|-------------------|
| Final Geotechnical Design               | Lump Sum    | 1             | \$ 30,000        | \$ 30,000         |
| Scaling                                 | Scaler Hour | 500           | \$ 300           | \$ 150,000        |
| Movable Rockfall Fence                  | Lump Sum    | 1             | \$ 50,000        | \$ 50,000         |
| Debris Removal                          | Cubic Yd    | 400           | \$ 40            | \$ 16,000         |
| Trim Blasting/Rock Excavation           | Cubic Yd    | 30            | \$ 200           | \$ 6,000          |
| Rock Reinforcement Installation (Bolts) | Lineal Foot | 1300          | \$ 175           | \$ 227,500        |
| Shotcrete Erosion Control               | Sq Yard     | 200           | \$ 300           | \$ 60,000         |
| Paved Ditch                             | Lineal Foot | 410           | \$ 70            | \$ 28,700         |

**Option 3 Total Estimated Costs** **\$ 568,200**

## **Zion National Park Unstable Slope Corridor Assessment**

**SITE:** 997B/ 5123

**Evaluated By:** DAA/MDD

**Date:** 10-25-2018

**Agency:** NPS

**Region:** Intermountain Region

**Park:** ZION

**Road (RIP Route No.):** Mt Carmel Hwy (0010)

**Side of Centerline:** Left (RIP) north side

**Beginning:** 1.91

**Ending:** 1.95

**Numerical Rating:** 796

### **Problem Definition/ Description:**

This unstable slope extends approximately 190 feet long from MP 1.91 to MP 1.95, with a maximum evaluated slope height of 136 feet. Evaluated rockfall source areas consist of a massive, cliff-forming sandstone member interbedded with and overlying a siltstone/ mudstone member of the Kayenta Formation. The Navajo Formation lies above the Kayenta Formation and is generally in line with the highway and can also produce rockfall. Formations and associated rockfall outside of reported and documented rockfall source areas along the Park road corridors were not evaluated. Rock outcrops in the source area are horizontally bedded and cross-jointed, which results in variable sized rockfall blocks ranging from approximately 1 to 20-foot cubes. The primary potential failure mechanism is differential erosion of the weaker siltstones/ mudstones underlying the sandstone, which can create topple failure. In combination, common secondary failure mechanisms due to the release planes created by structural discontinuities, such as joints and fractures, include wedge failures. The siltstone/ mudstone member of the Kayenta is weathered and covered by coarse colluvial material. This colluvium perched along the slope can also be reactivated by precipitation or rockfall masses from the cliff-forming sandstone above them. Impact marks were documented in both lanes, small rocks were noted in the ditch from recent failures, and larger blocks were noted in the shoulder on the south side of the road.

### **Problem Correction:**

**Option 1 – Monitoring:** As discussed in the main report, monitoring by the Park is always an option at this unstable slope location, but it is a temporary risk reduction method, not a long-term mitigation measure. Installation of direct monitoring devices, such as extensometers, at specific locations is unfeasible at this site due to difficult access locations and the large number and extents of the fracturing. Instead, a ground-based survey could produce models that could be processed for change detection between surveys. It is also recommended to re-rate the slope on a 3- to 5-year basis or after significant precipitation events to determine if there are any significant changes in the

unstable slope conditions. USMP “New Slope Event” and “Maintenance Tracking” forms can be used to easily record new information.

**Option 2 – Temporary Risk Reduction-Scaling:** Temporary risk reduction of the hazard from this unstable slope will require slope scaling to remove loose rock, large unstable blocks, and colluvial material. The slope scaling efforts will need to be repeated on 5 to 10 year intervals to maintain the same level of risk reduction. The use of air-bags may be required in some areas with larger boulders or tight fracturing. During scaling operations, the road might sustain damage from debris impacts even with the use of plates to protect the roadway and would be ideally planned in advanced coordination with resurfacing or other pavement repair work. Rock will also need to be prevented from falling outside of the roadway embankment area or into Pine Creek with the use of temporary roadside rockfall fences.

**Option 3 – Mitigation – Rockfall Stabilization:** Preliminary site evaluation indicates a combination of stabilization methods could best protect the roadway from typical rockfall events that includes scaling, rock stabilization (bolting/dowels), and ditch paving.

**Scaling:** As described above in Option 2, mitigation of this unstable slope will require slope scaling to remove loose rock, large unstable blocks, and colluvial material.

**Rock Stabilization:** Strategic bolting and/or doweling should follow the scaling to secure large unstable rock features in the cliff. Two-stage grouted bolts would be appropriate to retain larger blocks that have potential to detach and fall into the roadway. The aesthetics of the rock reinforcement can be improved by cutting off the heads of the bolts and/or dowels, and then applying colored grout over top. Final bolt and/or dowel design and locations will need further evaluation at the time of a planned project to account for any changes in the slope conditions and planned access to the slopes.

**Ditch Paving:** Ditch maintenance, including regular cleaning of debris, is imperative to minimalizing roadway debris. Ditch armoring (paving) is also recommended to reduce erosion of weaker mudstone/shale units by transporting water away from the base of the rock slopes and prevent undercutting during regular ditch maintenance activities.

The conceptual design cost estimate is for the geotechnical work items only and doesn’t represent a complete design and construction cost estimate.

## **Geotechnical Estimating Factors:**

### **Option 1 - Monitoring**

| Item                                | Unit | Amount | Unit Cost | Total Cost |
|-------------------------------------|------|--------|-----------|------------|
| Park Ground-Based Survey (1/yr)     | Each | 1      | \$ 1,000  | \$ 1,000   |
| Survey Processing & Report (1/year) | Each | 1      | \$ 3,000  | \$ 3,000   |
| Park Monitoring (ad hoc/year)       | Each | 1      | \$ 1,000  | \$ 1,000   |
| Park Re-Rating (3 to 5 yr interval) | Each | 1      | \$ 4,000  | \$ 4,000   |

**Option 1 Total Estimated Costs** **\$ 9,000**

### **Option 2 - Temporary Risk Reduction- Scaling**

| Item                      | Unit        | Amount | Unit Cost | Total Cost |
|---------------------------|-------------|--------|-----------|------------|
| Final Geotechnical Design | Lump Sum    | 1      | \$ 15,000 | \$ 15,000  |
| Scaling                   | Scaler Hour | 300    | \$ 300    | \$ 90,000  |
| Movable Rockfall Fence    | Lump Sum    | 1      | \$ 50,000 | \$ 50,000  |
| Debris Removal            | Cubic Yd    | 500    | \$ 40     | \$ 20,000  |

**Option 2 Total Estimated Costs** **\$ 175,000**

### **Option 3 - Mitigation-Rockfall Stabilization**

| Item                                    | Unit        | Amount | Unit Cost | Total Cost |
|-----------------------------------------|-------------|--------|-----------|------------|
| Final Geotechnical Design               | Lump Sum    | 1      | \$ 30,000 | \$ 30,000  |
| Scaling                                 | Scaler Hour | 300    | \$ 300    | \$ 90,000  |
| Movable Rockfall Fence                  | Lump Sum    | 1      | \$ 50,000 | \$ 50,000  |
| Debris Removal                          | Cubic Yd    | 500    | \$ 40     | \$ 20,000  |
| Rock Reinforcement Installation (Bolts) | Lineal Foot | 500    | \$ 175    | \$ 87,500  |
| Paved Ditch                             | Lineal Foot | 190    | \$ 70     | \$ 13,300  |

**Option 3 Total Estimated Costs** **\$ 290,800**

## **Zion National Park Unstable Slope Corridor Assessment**

**SITE:** 5124 (997C)

**Evaluated By:** DAA/MDD

**Date:** 10-25-2018

**Agency:** NPS

**Region:** Intermountain Region

**Park:** ZION

**Road (RIP Route No.):** Mt Carmel Hwy (0010)

**Side of Centerline:** Left (RIP) north side

**Beginning:** 1.95

**Ending:** 2.02

**Numerical Rating:** 884

### **Problem Definition/ Description:**

This unstable slope extends approximately 318 feet long from MP 1.97 to MP 2.02, with a maximum evaluated slope height of 128 feet. Evaluated rockfall source areas consist of a massive, cliff-forming sandstone member of the Kayenta Formation interbedded with a siltstone/ mudstone member, and a slope covered in colluvium. The Navajo Formation lies above the Kayenta Formation and is generally in line with the highway and can also produce rockfall. Formations and associated rockfall outside of reported and documented rockfall source areas along the Park road corridors were not evaluated. Rock outcrops in the source area are horizontally bedded and cross-jointed, which results in variable sized rockfall blocks ranging from approximately 1 to 10-foot cubes. The primary potential failure mechanism is differential erosion of the weaker siltstones/ mudstones underlying the sandstone, which can create topple failure. In combination, common secondary failure mechanisms due to the release planes created by structural discontinuities, such as joints and fractures, include direct sliding and wedge failures. Coarse colluvium perched along the slope can also be reactivated by precipitation or rockfall masses from the cliff-forming sandstone above them. Patches in the road, blocks across the road, small rocks in the ditch, and fresh rock faces on exposed outcrops indicate recent failures.

### **Problem Correction:**

**Option 1 – Monitoring:** As discussed in the main report, monitoring by the Park is always an option at this unstable slope location, but it is a temporary risk reduction method, not a long-term mitigation measure. Installation of direct monitoring devices, such as extensometers, at specific locations is unfeasible at this site due to difficult access locations and the large number and extents of the fracturing. Instead, a ground-based survey could produce models that could be processed for change detection between surveys. It is also recommended to re-rate the slope on a 3- to 5-year basis or after significant precipitation events to determine if there are any significant changes in the

unstable slope conditions. USMP “New Slope Event” and “Maintenance Tracking” forms can be used to easily record new information.

**Option 2 – Temporary Risk Reduction-Scaling:** Temporary risk reduction of the hazard from this unstable slope will require slope scaling to remove loose rock, large unstable blocks, and colluvial material. The slope scaling efforts will need to be repeated on 5 to 10 year intervals to maintain the same level of risk reduction. The use of air-bags may be required in some areas with larger boulders or tight fracturing. During scaling operations, the road might sustain damage from debris impacts even with the use of plates to protect the roadway and would be ideally planned in advanced coordination with resurfacing or other pavement repair work. Rock will also need to be prevented from falling outside of the roadway embankment area or into Pine Creek with the use of temporary movable roadside rockfall fences.

**Option 3 – Mitigation – Rockfall Stabilization:** Preliminary site evaluation indicates a combination of stabilization methods could best protect the roadway from typical rockfall events that includes scaling, rock stabilization (bolting/dowels), and ditch paving.

**Scaling:** As described above in Option 2, mitigation of this unstable slope will require slope scaling to remove loose rock, large unstable blocks, and colluvial material.

**Rock Stabilization:** Strategic bolting and/or doweling should follow the scaling to secure large unstable rock features in the cliff. Two-stage grouted bolts would be appropriate to retain larger blocks that have potential to detach and fall into the roadway. The aesthetics of the rock reinforcement can be improved by cutting off the heads of the bolts and/or dowels, and then applying colored grout over top. Final bolt and/or dowel design and locations will need further evaluation at the time of a planned project to account for any changes in the slope conditions and planned access to the slopes.

**Trim Blasting:** Small localized blasts maybe recommended if large blocks cannot be scaled or reasonably bolted.

**Ditch Paving:** Ditch maintenance, including regular cleaning of debris, is imperative to minimalizing roadway debris. Ditch armoring (paving) is also recommended to reduce erosion of weaker mudstone/shale units by transporting water away from the base of the rock slopes and prevent undercutting during regular ditch maintenance activities.

The conceptual design cost estimate is for the geotechnical work items only and doesn’t represent a complete design and construction cost estimate.

## **Geotechnical Estimating Factors:**

### **Option 1 - Monitoring**

| <b>Item</b>                           | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|---------------------------------------|-------------|---------------|------------------|-------------------|
| Park Ground-Based Survey (1/year)     | Each        | 1             | \$ 1,000         | \$ 1,000          |
| Survey Processing & Report (1/yr)     | Each        | 1             | \$ 3,000         | \$ 3,000          |
| Park Monitoring (ad hoc/year)         | Each        | 1             | \$ 1,000         | \$ 1,000          |
| Park Re-Rating (3 to 5 yr interval)   | Each        | 1             | \$ 4,000         | \$ 4,000          |
| <b>Option 1 Total Estimated Costs</b> |             |               |                  | <b>\$ 9,000</b>   |

### **Option 2 - Temporary Risk Reduction- Scaling**

| <b>Item</b>                           | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|---------------------------------------|-------------|---------------|------------------|-------------------|
| Final Geotechnical Design             | Lump Sum    | 1             | \$ 20,000        | \$ 20,000         |
| Scaling                               | Scaler Hour | 500           | \$ 300           | \$ 150,000        |
| Movable Rockfall Fence                | Lump Sum    | 1             | \$ 50,000        | \$ 50,000         |
| Debris Removal                        | Cubic Yd    | 400           | \$ 40            | \$ 16,000         |
| <b>Option 2 Total Estimated Costs</b> |             |               |                  | <b>\$ 236,000</b> |

### **Option 3 - Mitigation-Rockfall Stabilization**

| <b>Item</b>                             | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|-----------------------------------------|-------------|---------------|------------------|-------------------|
| Final Geotechnical Design               | Lump Sum    | 1             | \$ 30,000        | \$ 30,000         |
| Scaling                                 | Scaler Hour | 600           | \$ 300           | \$ 180,000        |
| Movable Rockfall Fence                  | Lump Sum    | 1             | \$ 50,000        | \$ 50,000         |
| Debris Removal                          | Cubic Yd    | 300           | \$ 40            | \$ 12,000         |
| Rock Reinforcement Installation (Bolts) | Lineal Foot | 200           | \$ 175           | \$ 35,000         |
| Paved Ditch                             | Lineal Foot | 318           | \$ 70            | \$ 22,260         |
| Trim Blasting/ Rock Excavation          | Cubic Yd    | 30            | \$ 200           | \$ 6,000          |
| <b>Option 3 Total Estimated Costs</b>   |             |               |                  | <b>\$ 335,260</b> |

## **Zion National Park Unstable Slope Corridor Assessment**

**SITE:** 1000

**Evaluated By:** DAA/MDD

**Date:** 10-25-2018

**Agency:** NPS

**Region:** Intermountain Region

**Park:** ZION

**Road (RIP Route No.):** Mt Carmel Hwy (0010)

**Side of Centerline:** North

**Beginning MP:** 1.99

**Ending MP:** 2.07

**Numerical Rating:** 786

### **Problem Definition/ Description:**

This unstable slope extends approximately 393 feet long from MP 1.99 to MP 2.07, with a maximum evaluated slope height of 120 feet. The evaluated rockfall source area consists of a massive, cliff-forming sandstone member interbedded and overlying a siltstone/ mudstone member of the Kayenta Formation. The Navajo Formation lies above the Kayenta Formation and is generally in line with the highway and can also produce rockfall. Formations and associated rockfall outside of reported and documented rockfall source areas along the Park road corridors were not evaluated. Rock outcrops in the source area are horizontally bedded and cross-jointed, which results in variable sized rockfall blocks ranging from approximately 1 to 15-foot cubes. The primary potential failure mechanism is differential erosion of the weaker siltstone/ mudstone underlying the sandstone, which can create topple failure. A common secondary mechanism is the failure of release planes created by structural discontinuities, such as joints and fractures, which are persistent in this location and allow for wedge failures. Generally, rockfall events occur during or after precipitation events. Evidence of previous rockfall events can be seen in the roadway as impact marks in the road and rocks in the ditch.

### **Problem Correction:**

**Option 1 – Monitoring:** As discussed in the main report, monitoring by the Park is always an option at this unstable slope location, but it is a temporary risk reduction method, not a long-term mitigation measure. Installation of direct monitoring devices, such as extensometers, at specific locations is unfeasible at this site due to difficult access locations and the large number and extents of the fracturing. Instead, a ground-based survey could produce models that could be processed for change detection between surveys. It is also recommended to re-rate the slope on a 3- to 5-year basis or after significant precipitation events to determine if there are any significant changes in the unstable slope conditions. USMP “New Slope Event” and “Maintenance Tracking” forms can be used to easily record new information.

**Option 2 – Temporary Risk Reduction-Scaling:** Temporary risk reduction of the hazard from this unstable slope will require slope scaling to remove loose rock, large unstable blocks, and colluvial material. The slope scaling efforts will need to be repeated on 5 to 10 year intervals to maintain the same level of risk reduction. The use of air-bags may be required in some areas with larger boulders or tight fracturing. During scaling operations, the road might sustain damage from debris impacts even with the use of plates to protect the roadway and would be ideally planned in advanced coordination with resurfacing or other pavement repair work. Rock will also need to be prevented from falling outside the roadway embankment area or into Pine Creek with the use of temporary movable roadside rockfall fences.

**Option 3 – Mitigation – Rockfall Stabilization:** Preliminary site evaluation indicates a combination of stabilization methods could best protect the roadway from typical rockfall events that includes scaling, rock stabilization (bolting/dowels), shotcrete erosion control, and ditch paving.

**Scaling:** As described above in Option 2, mitigation of this unstable slope will require slope scaling to remove loose rock, large unstable blocks, and colluvial material.

**Trim Blasting:** Small localized blasts may be recommended if large blocks cannot be scaled or reasonably bolted.

**Rock Stabilization:** Strategic bolting and/or doweling should follow the scaling to secure large unstable rock features in the cliff. Two-stage grouted bolts would be appropriate to retain larger blocks that have potential to detach and fall into the roadway. The aesthetics of the rock reinforcement can be improved by cutting off the heads of the bolts and/or dowels, and then applying colored grout over top. Final bolt and/or dowel design and locations will need further evaluation at the time of a planned project to account for any changes in the slope conditions and planned access to the slopes.

**Shotcrete Erosion Control:** Following the rock stabilization, erosion prevention measures could protect the roadway from typical rockfall events caused by differential erosion. Applying shotcrete to siltstone and mudstone members, would slow the erosion of the siltstone and mudstone members of the Kayenta, and thus prevent undermining the sandstone member above. Shotcrete would be colored and sculpted to blend into the exposed outcrops in a context sensitive manner to minimize visual impacts.

**Ditch Paving:** Ditch maintenance, including regular cleaning of debris, is imperative to minimalizing roadway debris. Ditch armoring (paving) is also recommended to reduce erosion of weaker mudstone/shale units by transporting water away from the base of the rock slopes and prevent undercutting during regular ditch maintenance activities.

The conceptual design cost estimate is for the geotechnical work items only and doesn't represent a complete design and construction cost estimate.

## **Geotechnical Estimating Factors:**

### **Option 1 - Monitoring**

| <b>Item</b>                         | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|-------------------------------------|-------------|---------------|------------------|-------------------|
| Park Ground-Based Survey (1/yr)     | Each        | 1             | \$ 1,000         | \$ 1,000          |
| Survey Processing & Report (1/yr)   | Each        | 1             | \$ 3,000         | \$ 3,000          |
| Park Monitoring (ad hoc/yr)         | Each        | 1             | \$ 1,000         | \$ 1,000          |
| Park Re-Rating (3 to 5 yr interval) | Each        | 1             | \$ 4,000         | \$ 4,000          |

**Option 1 Total Estimated Costs** **\$ 9,000**

### **Option 2 - Temporary Risk Reduction- Scaling**

| <b>Item</b>               | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|---------------------------|-------------|---------------|------------------|-------------------|
| Final Geotechnical Design | Lump Sum    | 1             | \$ 20,000        | \$ 20,000         |
| Scaling                   | Scaler Hour | 500           | \$ 300           | \$ 150,000        |
| Movable Rockfall Fence    | Lump Sum    | 1             | \$ 50,000        | \$ 50,000         |
| Debris Removal            | Cubic Yd    | 400           | \$ 40            | \$ 16,000         |

**Option 2 Total Estimated Costs** **\$ 236,000**

### **Option 3 - Mitigation-Rockfall Stabilization**

| <b>Item</b>                             | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|-----------------------------------------|-------------|---------------|------------------|-------------------|
| Final Geotechnical Design               | Lump Sum    | 1             | \$ 20,000        | \$ 20,000         |
| Rock Reinforcement Installation (Bolts) | Lineal Foot | 975           | \$ 175           | \$ 170,625        |
| Scaling                                 | Scaler Hour | 500           | \$ 300           | \$ 150,000        |
| Movable Rockfall Fence                  | Lump Sum    | 1             | \$ 50,000        | \$ 50,000         |
| Trim Blasting/ Rock Excavation          | Cubic Yd    | 30            | \$ 200           | \$ 6,000          |
| Shotcrete Erosion Control               | Square Yd   | 190           | \$ 300           | \$ 57,000         |
| Paved Ditch                             | Lineal Foot | 393           | \$ 70            | \$ 27,510         |
| Debris Removal                          | Cubic Yd    | 1500          | \$ 40            | \$ 60,000         |

**Option 3 Total Estimated Costs** **\$ 541,135**

## **Zion National Park Unstable Slope Corridor Assessment**

**SITE:** 1002

**Evaluated By:** DAA/MDD

**Date:** 10-25-2018

**Agency:** NPS

**Region:** Intermountain Region

**Park:** ZION

**Road (RIP Route No.):** Mt Carmel Hwy (0010)

**Side of Centerline:** South (Left RIP)

**Beginning:** 2.14

**Ending:** 2.19

**Numerical Rating:** 685

### **Problem Definition/ Description:**

This unstable slope extends approximately 300 feet long from MP 2.14 to MP 2.19, with a maximum evaluated slope height of 55 feet. Evaluated rockfall source areas consist of a massive, cliff-forming sandstone member of the Kayenta Formation overlying a siltstone/ mudstone member of the Kayenta Formation outcropping at the road elevation. The Navajo Formation lies above the Kayenta Formation and is generally in line with the highway and can also produce rockfall. Formations and associated rockfall outside of reported and documented rockfall source areas along the Park road corridors were not evaluated. Rock outcrops in the source area are horizontally bedded and cross-jointed, which results in variable sized rockfall blocks ranging from approximately 1 to 20-foot cubes. The primary potential failure mechanism is differential erosion of the weaker siltstone/ mudstones underlying the sandstone, which can create tension cracks in overlying sandstone leading to toppling failures of the massive sandstone units. In combination, common secondary failure mechanisms due to the release planes created by structural discontinuities, such as joints and fractures, include direct sliding and wedge failures. Generally, failures occur during or directly after precipitation events. This location experiences precipitation drainage over overhanging sandstone cliffs above the road. Previous events, such as the 2013 and 2015 rockfall events, have largely impacted the road, requiring repairs. Large boulders, ranging from 2 to 15 feet, can also be seen in the ditch from previous events.

### **Problem Correction:**

**Option 1 – Monitoring:** As discussed in the main report, monitoring by the Park is always an option at this unstable slope location, but it is a temporary risk reduction method, not a long-term mitigation measure. Installation of direct monitoring devices, such as extensometers, at specific locations is unfeasible at this site due to difficult access locations and the large number and extents of the fracturing. Instead, a ground-based survey could produce models that could be processed for change detection between surveys. It is also recommended to re-rate the slope on a 3- to 5-year basis or after

significant precipitation events to determine if there are any significant changes in the unstable slope conditions. USMP “New Slope Event” and “Maintenance Tracking” forms can be used to easily record new information.

**Option 2 – Temporary Risk Reduction-Scaling:** Temporary risk reduction of the hazard from this unstable slope will require slope scaling to remove loose rock, large unstable blocks, and colluvial material. The slope scaling efforts will need to be repeated on 5 to 10 year intervals to maintain the same level of risk reduction. The use of air-bags may be required in some areas with larger boulders or tight fracturing. During scaling operations, the road might sustain damage from debris impacts even with the use of plates to protect the roadway and would be ideally planned in advanced coordination with resurfacing or other pavement repair work. Rock will also need to be prevented from falling outside of the roadway embankment area or into Pine Creek or impacting Pine Creek Sandstone Arch Bridge with the use of temporary movable roadside rockfall fences. Cleanout behind the dry-stacked retaining wall at the top of the cutslope drainage area will need to be cleaned out using scaling hours, as shown below (Photograph 1002A).

**Option 3 – Mitigation – Rockfall Stabilization:** Preliminary site evaluation indicates a combination of stabilization methods could best protect the roadway from typical rockfall events that includes scaling, rock stabilization (bolting/dowels), shotcrete erosion control, and ditch paving.

**Scaling:** As described above in Option 2, mitigation of this unstable slope will require slope scaling to remove loose rock, large unstable blocks, and colluvial material.

**Rock Stabilization:** Strategic bolting and/or doweling should follow the scaling to secure large unstable rock features in the cliff. Two-stage grouted bolts would be appropriate to retain larger blocks that have potential to detach and fall into the roadway. The aesthetics of the rock reinforcement can be improved by cutting off the heads of the bolts and/or dowels, and then applying colored grout over top. Final bolt and/or dowel design and locations will need further evaluation at the time of a planned project to account for any changes in the slope conditions and planned access to the slopes.

**Shotcrete Erosion Control:** Following the rock stabilization, erosion prevention measures could protect the roadway from typical rockfall events caused by differential erosion. Applying shotcrete to siltstone and mudstone members would slow the erosion of the siltstone and mudstone members of the Kayenta, and thus prevent undermining the sandstone member above. Shotcrete would be colored and sculpted to blend into the exposed outcrops in a context sensitive manner to minimize visual impacts.

**Ditch Paving:** Ditch maintenance, including regular cleaning of debris, is imperative to minimalizing roadway debris. Ditch armoring (paving) is also recommended to reduce erosion of weaker mudstone/shale units by transporting water away from the base of the rock slopes and prevent undercutting during regular ditch maintenance activities.

The conceptual design cost estimate is for the geotechnical work items only and doesn't represent a complete design and construction cost estimate.

## **Geotechnical Estimating Factors:**

### **Option 1 - Monitoring**

| Item                                | Unit | Amount | Unit Cost | Total Cost |
|-------------------------------------|------|--------|-----------|------------|
| Park Ground-Based Survey (1/yr)     | Each | 1      | \$ 1,000  | \$ 1,000   |
| Survey Processing & Report (1/yr)   | Each | 1      | \$ 3,000  | \$ 3,000   |
| Park Monitoring (ad hoc/year)       | Each | 1      | \$ 1,000  | \$ 1,000   |
| Park Re-Rating (3 to 5 yr interval) | Each | 1      | \$ 4,000  | \$ 4,000   |

**Option 1 Total Estimated Costs** **\$ 9,000**

### **Option 2 - Temporary Risk Reduction- Scaling**

| Item                      | Unit        | Amount | Unit Cost | Total Cost |
|---------------------------|-------------|--------|-----------|------------|
| Final Geotechnical Design | Lump Sum    | 1      | \$ 20,000 | \$ 20,000  |
| Scaling                   | Scaler Hour | 400    | \$ 300    | \$ 120,000 |
| Movable Rockfall Fence    | Lump Sum    | 1      | \$ 50,000 | \$ 50,000  |
| Debris Removal            | Cubic Yd    | 300    | \$ 40     | \$ 12,000  |

**Option 2 Total Estimated Costs** **\$ 202,000**

### **Option 3 - Mitigation-Rockfall Stabilization**

| Item                                    | Unit        | Amount | Unit Cost | Total Cost |
|-----------------------------------------|-------------|--------|-----------|------------|
| Final Geotechnical Design               | Lump Sum    | 1      | \$ 30,000 | \$ 30,000  |
| Scaling                                 | Scaler Hour | 400    | \$ 300    | \$ 120,000 |
| Movable Rockfall Fence                  | Lump Sum    | 1      | \$ 50,000 | \$ 50,000  |
| Debris Removal                          | Cubic Yd    | 300    | \$ 40     | \$ 12,000  |
| Rock Reinforcement Installation (Bolts) | Lineal Foot | 700    | \$ 175    | \$ 122,500 |
| Shotcrete Erosion Control               | Sq Yard     | 2100   | \$ 300    | \$ 630,000 |
| Paved Ditch                             | Lineal Foot | 300    | \$ 70     | \$ 21,000  |

**Option 3 Total Estimated Costs** **\$ 985,500**



**Photograph 1002A: Scaling would include cleanout of the drainage channel at the top of the cut slope and the dry-stacked retaining wall (check dam) at the top of the slope.**

## **Zion National Park Unstable Slope Corridor Assessment**

**SITE:** 1004

**Evaluated By:** DAA/MDD

**Date:** 10-25-2018

**Agency:** NPS

**Region:** Intermountain Region

**Park:** ZION

**Road (RIP Route No.):** Mt Carmel Hwy (0010)

**Side of Centerline:** South (Left RIP)

**Beginning:** 2.19

**Ending:** 2.27

**Numerical Rating:** 594

### **Problem Definition/ Description:**

This unstable slope extends approximately 325 feet long from MP 2.19 to MP 2.27, with a maximum evaluated slope height of 55 feet. The evaluated rockfall source area consists of a massive, cliff-forming sandstone member of the Kayenta Formation interbedded with a siltstone/ mudstone member of the Kayenta Formation. The Navajo Formation lies above the Kayenta Formation and is generally in line with the highway and can also produce rockfall. Formations and associated rockfall outside of reported and documented rockfall source areas along the Park road corridors were not evaluated. Rock outcrops in the source area are horizontally bedded and cross-jointed, which results in variable sized rockfall blocks ranging from approximately 1 to 20-foot cubes. The primary potential failure mechanism is differential erosion of the weaker siltstone/ mudstones interbedded with the sandstone, which can create tension cracks in overlying sandstone leading to toppling failures of the massive sandstone units. In combination, common secondary failure mechanisms due to the release planes created by structural discontinuities, such as joints and fractures, include wedge failures. Generally, failures occur during or directly after precipitation events. This location is directly in line with two culvert dropouts from the above road. Water from these drainages can specifically impact the stability of inline rocks. Large boulders, ranging from 2 to 10 feet, can also be seen in the ditch from previous events.

### **Problem Correction:**

**Option 1 – Monitoring System:** As discussed in the main report, monitoring by the Park is always an option at this unstable slope location, but it is a temporary risk reduction method, not a long-term mitigation measure. Installation of direct monitoring devices, such as extensometers, at specific locations is unfeasible at this site due to difficult access locations and the large number and extents of the fracturing. Instead, a ground-based survey could produce models that could be processed for change detection between surveys. It is also recommended to re-rate the slope on a 3- to 5-year basis or after significant precipitation events to determine if there are any significant changes in

the unstable slope conditions. USMP “New Slope Event” and “Maintenance Tracking” forms can be used to easily record new information.

**Option 2 – Temporary Risk Reduction-Scaling:** Temporary risk reduction of the hazard from this unstable slope will require slope scaling to remove loose rock, large unstable blocks, and colluvial material. The slope scaling efforts will need to be repeated on 5 to 10 year intervals to maintain the same level of risk reduction. The use of air-bags may be required in some areas with larger boulders or tight fracturing. During scaling operations, the road might sustain damage from debris impacts even with the use of plates to protect the roadway and would be ideally planned in advanced coordination with resurfacing or other pavement repair work. Rock will also need to be prevented from falling outside the roadway embankment or into Pine Creek with the use of temporary movable roadside rockfall fences.

**Option 3 – Mitigation – Rockfall Stabilization:** Preliminary site evaluation indicates a combination of stabilization methods could best protect the roadway from typical rockfall events that includes scaling, rock stabilization (bolting/dowels), ditch paving, and drainage resiliency.

**Scaling:** As described above in Option 2, mitigation of this unstable slope will require slope scaling to remove loose rock, large unstable blocks, and colluvial material.

**Rock Stabilization:** Strategic bolting and/or doweling should follow the scaling to secure large unstable rock features in the cliff. Two-stage grouted bolts would be appropriate to retain larger blocks that have potential to detach and fall into the roadway. The aesthetics of the rock reinforcement can be improved by cutting off the heads of the bolts and/or dowels, and then applying colored grout over top. Final bolt and/or dowel design and locations will need further evaluation at the time of a planned project to account for any changes in the slope conditions and planned access to the slopes.

**Ditch Paving:** Ditch maintenance, including regular cleaning of debris, is imperative to minimalizing roadway debris. Ditch armoring (paving) is also recommended to reduce erosion of weaker mudstone/shale units by transporting water away from the base of the rock slopes and prevent undercutting during regular ditch maintenance activities.

**Drainage Resiliency:** Drainage channels have formed as a result of water output from the switchback culverts above. These drainages have incised into the slope. It is recommended to armor one drainage channel with a hardened cleanout area (extra paved ditch distance assumed for estimate) and with a riprap rundown at a second location, as shown below in Photographs 1004-A and 1004-B.

The conceptual design cost estimate is for the geotechnical work items only and doesn’t represent a complete design and construction cost estimate.

## **Geotechnical Estimating Factors:**

### **Option 1 - Monitoring**

| <b>Item</b>                         | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|-------------------------------------|-------------|---------------|------------------|-------------------|
| Park Ground-Based Survey (1/yr)     | Each        | 1             | \$ 1,000         | \$ 1,000          |
| Survey Processing & Report (1/yr)   | Each        | 1             | \$ 3,000         | \$ 3,000          |
| Park Monitoring (ad hoc/year)       | Each        | 1             | \$ 1,000         | \$ 1,000          |
| Park Re-Rating (3 to 5 yr interval) | Each        | 1             | \$ 4,000         | \$ 4,000          |

**Option 1 Total Estimated Costs** **\$ 9,000**

### **Option 2 - Temporary Risk Reduction- Scaling**

| <b>Item</b>            | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|------------------------|-------------|---------------|------------------|-------------------|
| Geotechnical Design    | Lump Sum    | 1             | \$ 20,000        | \$ 20,000         |
| Scaling                | Scaler Hour | 400           | \$ 300           | \$ 120,000        |
| Movable Rockfall Fence | Lump Sum    | 1             | \$ 50,000        | \$ 50,000         |
| Debris Removal         | Cubic Yd    | 300           | \$ 40            | \$ 12,000         |

**Option 2 Total Estimated Costs** **\$ 202,000**

### **Option 3 - Mitigation-Rockfall Stabilization**

| <b>Item</b>                             | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|-----------------------------------------|-------------|---------------|------------------|-------------------|
| Final Geotechnical Design               | Lump Sum    | 1             | \$ 30,000        | \$ 30,000         |
| Scaling                                 | Scaler Hour | 500           | \$ 300           | \$ 150,000        |
| Movable Rockfall Fence                  | Lump Sum    | 1             | \$ 50,000        | \$ 50,000         |
| Debris Removal                          | Cubic Yd    | 350           | \$ 40            | \$ 14,000         |
| Rock Reinforcement Installation (Bolts) | Lineal Foot | 400           | \$ 175           | \$ 70,000         |
| Paved Ditch                             | Lineal Foot | 325           | \$ 70            | \$ 22,750         |
| Riprap Rundown                          | Cubic Yd    | 30            | \$ 175           | \$ 5,250          |

**Option 3 Total Estimated Costs** **\$ 342,000**



Photograph 1004-A: Drainage 1 from switchback culvert outlet at top of cutslope from upper switchback retaining wall. Recommended hardened basin for easier debris cleanout and reduction of undercutting erosion at the base of the slope.



Photograph 1004-B: Drainage 2 from switchback culvert outlet in upper retaining wall at top of cutslope. Recommended riprap rundown for reduction of undercutting erosion at the base of the slope.

## **Zion National Park Unstable Slope Corridor Assessment**

**SITE:** 1006

**Evaluated By:** DAA/MDD

**Date:** 10-25-2018

**Agency:** NPS

**Region:** Intermountain Region

**Park:** ZION

**Road (RIP Route No.):** Mt Carmel Hwy (0010)

**Side of Centerline:** South (Left RIP)

**Beginning:** 2.27

**Ending:** 2.36

**Numerical Rating:** 621

### **Problem Definition/ Description:**

This unstable slope extends approximately 465 feet long from MP 2.27 to MP 2.36, with a maximum evaluated slope height of 73 feet. The evaluated rockfall source area consists of a massive, cliff-forming sandstone member of the Kayenta Formation interbedded with a siltstone/ mudstone member of the Kayenta Formation. The Navajo Formation lies above the Kayenta Formation and is generally in line with the highway and can also produce rockfall. Formations and associated rockfall outside of reported and documented rockfall source areas along the Park road corridors were not evaluated. Rock outcrops in the source area are horizontally bedded and cross-jointed, which results in variable sized rockfall blocks ranging from approximately 1 to 20-foot cubes. The primary potential failure mechanism is differential erosion of the weaker siltstone/ mudstone underlying the sandstone, which can create tension cracks in overlying sandstone, leading to toppling failures of the massive sandstone units. In combination, common secondary failure mechanisms due to the release planes created by structural discontinuities, such as joints and fractures, include wedge failures and the toppling of the large pillars of rock. Generally, failures occur during or directly after precipitation events.

### **Problem Correction:**

**Option 1 – Monitoring:** As discussed in the main report, monitoring by the Park is always an option at this unstable slope location, but it is a temporary risk reduction method, not a long-term mitigation measure. Installation of direct monitoring devices, such as extensometers, at specific locations is unfeasible at this site due to difficult access locations and the large number and extents of the fracturing. Instead, a ground-based survey could produce models that could be processed for change detection between surveys. It is also recommended to re-rate the slope on a 3- to 5-year basis or after significant precipitation events to determine if there are any significant changes in the unstable slope conditions. USMP “New Slope Event” and “Maintenance Tracking” forms can be used to easily record new information.

**Option 2 – Temporary Risk Reduction-Scaling:** Temporary risk reduction of the hazard from this unstable slope will require slope scaling to remove loose rock, large unstable blocks and spires, and colluvial material on and above the cut. The slope scaling efforts will need to be repeated on 5 to 10 year intervals to maintain the same level of risk reduction. The use of air-bags may be required in some areas with larger boulders or tight fracturing. During scaling operations, the road might sustain damage from debris impacts even with the use of plates to protect the roadway and would be ideally planned in advanced coordination with resurfacing or other pavement repair work. Rock will also need to be prevented from falling outside of the roadway embankment or into Pine Creek with the use of temporary movable roadside rockfall fences.

**Option 3 – Mitigation – Rockfall Stabilization:** Preliminary site evaluation indicates a combination of stabilization methods could best protect the roadway from typical rockfall events that includes scaling, trim blasting, and rock stabilization (bolting/dowels),

**Scaling:** As described above in Option 2, mitigation of this unstable slope will require slope scaling to remove loose rock, large unstable blocks and spires, and colluvial material.

**Trim Blasting:** A trim blast shot may be utilized to remove larger blocks of rock that cannot be scaled or reasonably bolted.

**Rock Stabilization:** Strategic bolting and/or doweling should follow the scaling to secure large unstable rock features in the cliff. Two-stage grouted bolts would be appropriate to retain larger blocks that have potential to detach and fall into the roadway. The aesthetics of the rock reinforcement can be improved by cutting off the heads of the bolts and/or dowels, and then applying colored grout over top. Final bolt and/or dowel design and locations will need further evaluation at the time of a planned project to account for any changes in the slope conditions and planned access to the slopes.

The conceptual design cost estimate is for the geotechnical work items only and doesn't represent a complete design and construction cost estimate.

## **Geotechnical Estimating Factors:**

### **Option 1 - Monitoring**

| <b>Item</b>                         | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|-------------------------------------|-------------|---------------|------------------|-------------------|
| Park Ground-Based Survey (1/yr)     | Each        | 1             | \$ 1,000         | \$ 1,000          |
| Survey Processing & Report (1/yr)   | Each        | 1             | \$ 3,000         | \$ 3,000          |
| Park Monitoring (ad hoc/yr)         | Each        | 1             | \$ 1,000         | \$ 1,000          |
| Park Re-Rating (3 to 5 yr interval) | Each        | 1             | \$ 4,000         | \$ 4,000          |

**Option 1 Total Estimated Costs** **\$ 9,000**

### **Option 2 - Temporary Risk Reduction- Scaling**

| <b>Item</b>               | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|---------------------------|-------------|---------------|------------------|-------------------|
| Final Geotechnical Design | Lump Sum    | 1             | \$ 20,000        | \$ 20,000         |
| Scaling                   | Scaler Hour | 650           | \$ 300           | \$ 195,000        |
| Movable Rockfall Fence    | Lump Sum    | 1             | \$ 50,000        | \$ 50,000         |
| Debris Removal            | Cubic Yd    | 1450          | \$ 40            | \$ 58,000         |

**Option 2 Total Estimated Costs** **\$ 323,000**

### **Option 3 - Mitigation-Rockfall Stabilization**

| <b>Item</b>                             | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|-----------------------------------------|-------------|---------------|------------------|-------------------|
| Final Geotechnical Design               | Lump Sum    | 1             | \$ 30,000        | \$ 30,000         |
| Scaling                                 | Scaler Hour | 650           | \$ 300           | \$ 195,000        |
| Movable Rockfall Fence                  | Lump Sum    | 1             | \$ 50,000        | \$ 50,000         |
| Debris Removal                          | Cubic Yd    | 1450          | \$ 40            | \$ 58,000         |
| Trim Blasting/Rock Excavation           | Cubic Yd    | 30            | \$ 200           | \$ 6,000          |
| Rock Reinforcement Installation (Bolts) | Lineal Foot | 850           | \$ 175           | \$ 148,750        |

**Option 3 Total Estimated Costs** **\$ 487,750**

## **Zion National Park Unstable Slope Corridor Assessment**

**SITE:** 1124

**Evaluated By:** DAA/MDD

**Date:** 10-24-2018

**Agency:** NPS

**Region:** Intermountain Region

**Park:** ZION

**Road (RIP Route No.):** Mt Carmel Hwy (0010)

**Side of Centerline:** South (Right RIP)

**Beginning:** 2.56

**Ending:** 2.60

**Numerical Rating:** 479

### **Problem Definition/ Description:**

This unstable slope extends approximately 145 feet long from MP 2.56 to MP 2.60, with a maximum evaluated slope height of approximately 63 feet. The evaluated rockfall source area consists of a massive, cliff-forming sandstone member with minor interbedding of a siltstone/ mudstone member of the Kayenta Formation. The Navajo Formation lies above the Kayenta Formation and is generally in line with the highway and can also produce rockfall. Formations and associated rockfall outside of reported and documented rockfall source areas along the Park road corridors were not evaluated. Rock outcrops in the source area are horizontally bedded and cross-jointed, which results in variable sized rockfall blocks ranging from approximately 1 to 10 feet. The primary potential failure mechanism is differential erosion of the weaker siltstone/ mudstones underlying the sandstone, which can create tension cracks in overlying sandstone leading to toppling failures of the massive sandstone units. There is noted differential erosion at the base of the slope, by the ditch line, that may impact the stability of the slope in the future; however, the slope is not currently impacted. Common secondary failure mechanisms due to the release planes created by structural discontinuities, such as joints and fractures, include wedge failures. Generally, failures occur during or directly after precipitation events. Loose boulders and colluvium have also been noted perched on the non-vegetated slopes above the cut that could potentially be reactivated during or after precipitation events. Previous infrequent events have recorded rockfall ranging in 1 to 2 feet in diameter generally landing in the ditch, rarely reaching the roadway.

### **Problem Correction:**

**Option 1 – Monitoring:** As discussed in the main report, monitoring by the Park is always an option at this unstable slope location, but it is a temporary risk reduction method, not a long-term mitigation measure. It is also recommended to rate the slope on a 3- to 5-year basis or after significant precipitation events to determine if there are any significant changes in the unstable slope conditions. USMP “New Slope Event” and “Maintenance Tracking” forms can be used to easily record new information.

**Option 2 – Temporary Risk Reduction-Scaling:** Temporary risk reduction of the hazard from this unstable slope will require slope scaling to remove loose rock, large unstable blocks, and colluvial material. The slope scaling efforts will need to be repeated on 5 to 10 year intervals to maintain the same level of risk reduction. The use of air-bags may be required in some areas with larger boulders or tight fracturing. During scaling operations, the road might sustain damage from debris impacts even with the use of plates to protect the roadway and would be ideally planned in advanced coordination with resurfacing or other pavement repair work. Rock will also need to be prevented from falling and impacting lower sections of Mount Carmel Hwy or into Pine Creek with the use of temporary movable roadside rockfall fences.

**Option 3 – Mitigation – Rockfall Stabilization:** Preliminary site evaluation indicates a combination of stabilization methods could best protect the roadway from typical rockfall events that includes scaling and rock stabilization (bolting/dowels).

Scaling: As described above in Option 2, mitigation of this unstable slope will require slope scaling to remove loose rock, large unstable blocks, and colluvial material.

Rock Stabilization: Strategic bolting and/or doweling should follow the scaling to secure large unstable rock features in the cliff. Two-stage grouted bolts would be appropriate to retain larger blocks that have potential to detach and fall into the roadway. The aesthetics of the rock reinforcement can be improved by cutting off the heads of the bolts and/or dowels, and then applying colored grout over top. Final bolt and/or dowel design and locations will need further evaluation at the time of a planned project to account for any changes in the slope conditions and planned access to the slopes.

The conceptual design cost estimate is for the geotechnical work items only and doesn't represent a complete design and construction cost estimate.

## **Geotechnical Estimating Factors:**

### **Option 1 - Monitoring**

| <b>Item</b>                           | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|---------------------------------------|-------------|---------------|------------------|-------------------|
| Park Monitoring (ad hoc/yr)           | Each        | 1             | \$ 1,000         | \$ 1,000          |
| Park Re-Rating (3 to 5 yr interval)   | Each        | 1             | \$ 4,000         | \$ 4,000          |
| <b>Option 1 Total Estimated Costs</b> |             |               |                  | <b>\$ 5,000</b>   |

### **Option 2 - Temporary Risk Reduction- Scaling**

| <b>Item</b>                           | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|---------------------------------------|-------------|---------------|------------------|-------------------|
| Final Geotechnical Design             | Lump Sum    | 1             | \$ 20,000        | \$ 20,000         |
| Scaling                               | Scaler Hour | 120           | \$ 300           | \$ 36,000         |
| Movable Rockfall Fence                | Lump Sum    | 1             | \$ 50,000        | \$ 50,000         |
| Debris Removal                        | Cubic Yd    | 400           | \$ 40            | \$ 16,000         |
| <b>Option 2 Total Estimated Costs</b> |             |               |                  | <b>\$ 122,000</b> |

### **Option 3 - Mitigation-Rockfall Stabilization**

| <b>Item</b>                             | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|-----------------------------------------|-------------|---------------|------------------|-------------------|
| Final Geotechnical Design               | Lump Sum    | 1             | \$ 30,000        | \$ 30,000         |
| Scaling                                 | Scaler Hour | 120           | \$ 300           | \$ 36,000         |
| Movable Rockfall Fence                  | Lump Sum    | 1             | \$ 50,000        | \$ 50,000         |
| Debris Removal                          | Cubic Yd    | 400           | \$ 40            | \$ 16,000         |
| Rock Reinforcement Installation (Bolts) | Lineal Foot | 100           | \$ 175           | \$ 17,500         |
| <b>Option 3 Total Estimated Costs</b>   |             |               |                  | <b>\$ 149,500</b> |

## **Zion National Park Unstable Slope Corridor Assessment**

**SITE:** 1125

**Evaluated By:** DAA/MDD

**Date:** 10-24-2018

**Agency:** NPS

**Region:** Intermountain Region

**Park:** ZION

**Road (RIP Route No.):** Mt Carmel Hwy (0010)

**Side of Centerline:** South (Right RIP)

**Beginning:** 2.61

**Ending:** 2.71

**Numerical Rating:** 514

### **Problem Definition/ Description:**

This unstable slope extends approximately 510 feet long from MP 2.61 to MP 2.71, with a maximum evaluated slope height of 60 feet. Evaluated rockfall source areas consist of a siltstone/ mudstone member of the Kayenta Formation interbedded with thin beds of a massive, cliff-forming sandstone member of the Kayenta Formation. The Navajo Formation lies above the Kayenta Formation and is generally in line with the highway and can also produce rockfall. Formations and associated rockfall outside of reported and documented rockfall source areas along the Park road corridors were not evaluated. Siltstone/ mudstone outcrops are horizontally bedded and vary from slightly to highly weathered. The siltstone/ mudstone member can outcrop with vertical faces or sloped faces with perched colluvium. Sandstone rock outcrops in the source area are horizontally bedded and cross-jointed, which results in variable sized rockfall blocks ranging from approximately 1 to 20-foot cubes. The primary potential failure mechanism is differential erosion of the weaker siltstone/ mudstones underlying the sandstone, which can create tension cracks in overlying sandstone leading to toppling failures of the massive sandstone units. Failures occur regularly during or directly after precipitation events. Ephemeral alluvial channels and sheet-washing transport sandstone blocks and siltstone fragments down slope. Rocks ranging from 6 inches to 1- foot in diameter, can also be seen in the ditch from previous events and regularly land in the road.

### **Problem Correction:**

**Option 1 – Monitoring:** As discussed in the main report, monitoring by the Park is always an option at this unstable slope location, but it is a temporary risk reduction method, not a long-term mitigation measure. It is also recommended to rate the slope on a 3- to 5-year basis or after significant precipitation events to determine if there are any significant changes in the unstable slope conditions. USMP “New Slope Event” and “Maintenance Tracking” forms can be used to easily record new information.

**Option 2 – Temporary Risk Reduction-Scaling:** Temporary risk reduction of the hazard from this unstable slope will require slope scaling to remove loose rock, large unstable blocks, and colluvial material. The slope scaling and alluvial channels scaling efforts will need to be repeated every year to 5 years, as needed, to maintain the same level of risk reduction. The use of air-bags may be required in some areas with larger boulders or tight fracturing. During scaling operations, the road might sustain damage from debris impacts even with the use of plates to protect the roadway and would be ideally planned in advanced coordination with resurfacing or other pavement repair work. Rock will also need to be prevented from impacting the Mount Carmel Hwy below or from falling into Pine Creek with the use of temporary movable roadside rockfall fences.

No rockfall stabilization option appears feasible at this location due to lack of identifiable unstable rock blocks.

The conceptual design cost estimate is for the geotechnical work items only and doesn't represent a complete design and construction cost estimate.

## **Geotechnical Estimating Factors:**

### **Option 1 - Monitoring**

| Item                                  | Unit | Amount | Unit Cost | Total Cost      |
|---------------------------------------|------|--------|-----------|-----------------|
| Park Monitoring (ad hoc/yr)           | Each | 1      | \$ 1,000  | \$ 1,000        |
| Park Re-Rating (3 to 5 yr interval)   | Each | 1      | \$ 4,000  | \$ 4,000        |
| <b>Option 1 Total Estimated Costs</b> |      |        |           | <b>\$ 5,000</b> |

### **Option 2 - Temporary Risk Reduction- Scaling**

| Item                                  | Unit        | Amount | Unit Cost | Total Cost        |
|---------------------------------------|-------------|--------|-----------|-------------------|
| Final Geotechnical Design             | Lump Sum    | 1      | \$ 20,000 | \$ 20,000         |
| Scaling                               | Scaler Hour | 600    | \$ 300    | \$ 180,000        |
| Movable Rockfall Fence                | Lump Sum    | 1      | \$ 50,000 | \$ 50,000         |
| Debris Removal                        | Cubic Yd    | 900    | \$ 40     | \$ 36,000         |
| <b>Option 2 Total Estimated Costs</b> |             |        |           | <b>\$ 286,000</b> |

# **Zion National Park Unstable Slope Corridor Assessment**

**SITE:** 1127

**Evaluated By:** DAA/MDD

**Date:** 10-24-2018

**Agency:** NPS

**Region:** Intermountain Region

**Park:** ZION

**Road (RIP Route No.):** Mt Carmel Hwy (0010)

**Side of Centerline:** South (Right RIP)

**Beginning:** 2.71

**Ending:** 2.77

**Numerical Rating:** 435

## **Problem Definition/ Description:**

This unstable slope extends approximately 197 feet long from MP 2.71 to MP 2.77, with a maximum evaluated slope height of 54 feet. There are two distinctly different slope characteristics, designated Segment 1 and Segment 2 in this unstable slope area, shown on the attached sketch. For Segment 1, evaluated rockfall source areas consist of a band massive, cliff-forming sandstone member of the Kayenta Formation overlying a siltstone/mudstone member of the Kayenta Formation outcropping at the road elevation. The Navajo Formation lies above the Kayenta Formation and is generally in line with the highway and can also produce rockfall. Formations and associated rockfall outside of reported and documented rockfall source areas along the Park road corridors were not evaluated. Rock outcrops in the source area are horizontally bedded and cross-jointed, which results in variable sized rockfall blocks ranging from approximately 1 to 5-foot cubes. The primary potential failure mechanism in Segment 1 is differential erosion of the weaker siltstone/ mudstones underlying the sandstone, which can create tension cracks in overlying sandstone leading to toppling failures of the massive sandstone units. Large colluvial material overlies the outcropping bedrock and can be reactivated with precipitation events. Segment 2 is comprised of a block-in-matrix partially overlying bedrock and continuing to road level. Segment 2 fails due to the erosion of soils undermining large sandstone blocks. Generally, failures occur during or directly after precipitation events.

## **Problem Correction:**

**Option 1 – Monitoring:** As discussed in the main report, monitoring by the Park is always an option at this unstable slope location, but it is a temporary risk reduction method, not a long-term mitigation measure. It is also recommended to rate the slope on a 3- to 5-year basis or after significant precipitation events to determine if there are any significant changes in the unstable slope conditions. USMP “New Slope Event” and “Maintenance Tracking” forms can be used to easily record new information.

**Option 2 – Temporary Risk Reduction-Scaling:** Temporary risk reduction of the hazard from Segment 1 and Segment 2 will require slope scaling to remove loose rock,

debris in erosion gullies, and overlying colluvial material. The slope scaling efforts will need to be repeated on 1 to 5 year intervals to maintain the same level of risk reduction. The use of air-bags may be required in some areas with larger boulders or tight fracturing. During scaling operations, the road might sustain damage from debris impacts even with the use of plates to protect the roadway and would be ideally planned in advanced coordination with resurfacing or other pavement repair work. Rock will also need to be prevented from falling and impacting Mount Camel Hwy below or from falling into Pine Creek with the use of temporary movable roadside rockfall fences.

**Option 3 – Mitigation – Slope Cut:** Preliminary site evaluation indicates a combination of stabilization methods for Segment 2 could best protect the roadway from typical rockfall events that includes scaling and laying the slope back.

**Scaling:** As described above in Option 2, mitigation of this unstable slope will require slope scaling to remove loose rock, debris from erosion gullies, and overlying colluvial material.

**Slope Cut:** It is recommended to lay Segment 2 of the slope back to an overall slope angle near 1H:1V for a length of approximately 140 feet adjacent to the roadway (Figure 1127A below).

The conceptual design cost estimate is for the geotechnical work items only and doesn't represent a complete design and construction cost estimate.

## **Geotechnical Estimating Factors:**

### **Option 1 - Monitoring**

| Item                                  | Unit | Amount | Unit Cost | Total Cost      |
|---------------------------------------|------|--------|-----------|-----------------|
| Park Monitoring (ad hoc/year)         | Each | 1      | \$ 1,000  | \$ 1,000        |
| Park Re-Rating (3 to 5 yr interval)   | Each | 1      | \$ 4,000  | \$ 4,000        |
| <b>Option 1 Total Estimated Costs</b> |      |        |           | <b>\$ 5,000</b> |

### **Option 2 - Temporary Risk Reduction- Scaling**

| Item                                  | Unit        | Amount | Unit Cost | Total Cost        |
|---------------------------------------|-------------|--------|-----------|-------------------|
| Final Geotechnical Design             | Lump Sum    | 1      | \$ 20,000 | \$ 20,000         |
| Scaling                               | Scaler Hour | 400    | \$ 300    | \$ 120,000        |
| Movable Rockfall Fence                | Lump Sum    | 1      | \$ 50,000 | \$ 50,000         |
| Debris Removal                        | Cubic Yd    | 300    | \$ 40     | \$ 12,000         |
| <b>Option 2 Total Estimated Costs</b> |             |        |           | <b>\$ 202,000</b> |

### **Option 3 - Mitigation-Rockfall Stabilization**

| Item                                  | Unit        | Amount | Unit Cost | Total Cost        |
|---------------------------------------|-------------|--------|-----------|-------------------|
| Final Geotechnical Design             | Lump Sum    | 1      | \$ 30,000 | \$ 30,000         |
| Scaling                               | Scaler Hour | 400    | \$ 300    | \$ 120,000        |
| Movable Rockfall Fence                | Lump Sum    | 1      | \$ 50,000 | \$ 50,000         |
| Debris Removal                        | Cubic Yd    | 300    | \$ 40     | \$ 12,000         |
| Slope Excavation                      | Cubic Yd    | 1000   | \$ 75     | \$ 75,000         |
| <b>Option 3 Total Estimated Costs</b> |             |        |           | <b>\$ 287,000</b> |

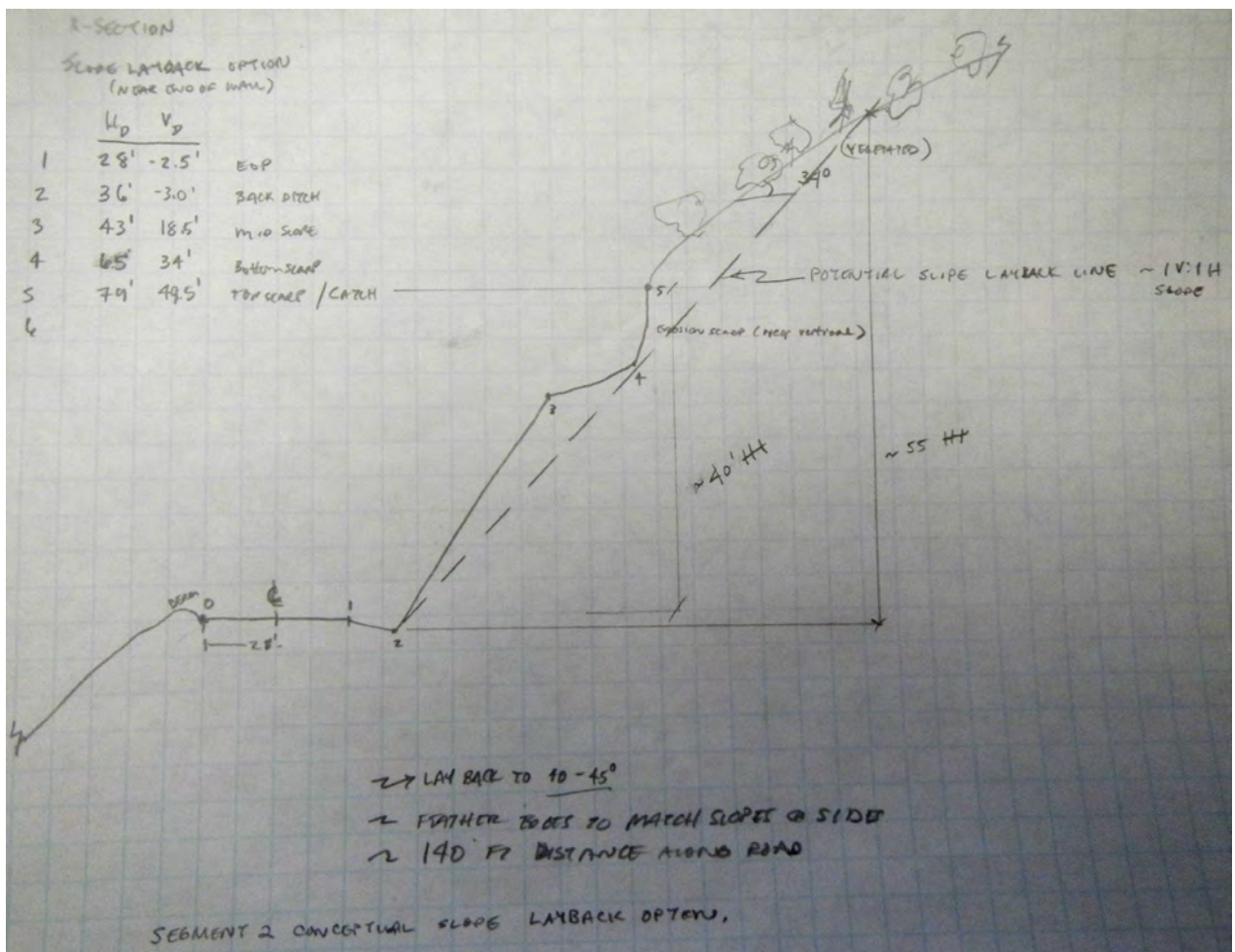


Figure 1127A: Sketch of Segment 2 slope intercept profile and conceptual slope layback.

## **Zion National Park Unstable Slope Corridor Assessment**

**SITE:** 1129

**Evaluated By:** DAA/MDD

**Date:** 10-24-2018

**Agency:** NPS

**Region:** Intermountain Region

**Park:** ZION

**Road (RIP Route No.):** Mt Carmel Hwy (0010)

**Side of Centerline:** South (Right RIP)

**Beginning MP:** 2.79

**Ending MP:** 2.93

**Numerical Rating:** 546

### **Problem Definition/ Description:**

This unstable slope extends approximately 587 feet long from MP 2.79 to MP 2.93, with a maximum evaluated slope height of 96 feet. This slope was divided into three sections for evaluating hazards and mitigation options. The score is representative of the entire slope. Evaluated rockfall source areas consist of a thinly bedded siltstone/ mudstone interbedded with bands of cliff-forming sandstone of the Kayenta Formation. The Navajo Formation lies above the Kayenta Formation and is generally in line with the highway and can also produce rockfall. Formations and associated rockfall outside of reported and documented rockfall source areas along the Park road corridors were not evaluated. Rock outcrops in the source area are horizontally bedded and cross-jointed, which results in variable sized rockfall blocks ranging from approximately 1 to 8-foot blocks. The primary potential failure mechanism is differential erosion of the weaker siltstone/ mudstones underlying the sandstone, which can create tension cracks in overlying sandstone leading to toppling failures of the massive sandstone units. Sections 1 and 3 have sandstone units closer to the road elevation, producing smaller 1 foot blocks regularly. Sandstone outcrops higher in elevation in Section 2 and produces less frequent, larger blocks. Large colluvial material overlies the outcropping bedrock and can be reactivated with precipitation and rockfall events from above outcrops. Alluvial channels through unvegetated slope have been documented in each section. Generally, failures occur during or directly after precipitation events. Historically, this site has produced 6-to 12-inch rockfall regularly, as seen by the impact damage in the road and described by maintenance as “constant rumble” that is sometimes cleaned daily. In the 1990’s, a boulder, approximately 40’x20’x20’, impacted both lanes and closed the road for three days.

### **Problem Correction:**

**Option 1 – Monitoring:** As discussed in the main report, monitoring by the Park is always an option at this unstable slope location, but it is a temporary risk reduction method, not a long-term mitigation measure. It is also recommended to rate the slope on

a 3- to 5-year basis or after significant precipitation events to determine if there are any significant changes in the unstable slope conditions. USMP “New Slope Event” and “Maintenance Tracking” forms can be used to easily record new information.

**Option 2 – Temporary Risk Reduction-Scaling:** Temporary risk reduction of the hazard from all sections will require slope scaling to remove loose rock, debris in erosion gullies, overlying colluvial material, and loose vegetation. The slope scaling efforts will need to be repeated on 10 to 15 year intervals to maintain the same level of risk reduction. The use of air-bags may be required in some areas with larger boulders or tight fracturing. During scaling operations, the road might sustain damage from debris impacts even with the use of plates to protect the roadway and would be ideally planned in advanced coordination with resurfacing or other pavement repair work. Rock will also need to be prevented from falling and impacting Mount Camel Hwy below or from falling into Pine Creek with the use of temporary movable roadside rockfall fences.

**Option 3 – Mitigation – Rockfall Stabilization:** Preliminary site evaluation indicates a combination of stabilization methods could best protect the roadway from typical rockfall events that includes scaling, rock stabilization (bolting/dowels), and ditch paving.

**Scaling:** As described above in Option 2, mitigation of this unstable slope will require slope scaling to remove loose rock, large unstable blocks, colluvial material, and loose vegetation on the cut slope.

**Rock Stabilization:** Strategic bolting and/or doweling should follow the scaling to secure large unstable rock features in the cliff. Two-stage grouted bolts would be appropriate to retain larger blocks that have potential to detach and fall into the roadway. The aesthetics of the rock reinforcement can be improved by cutting off the heads of the bolts and/or dowels, and then applying colored grout over top. Final bolt and/or dowel design and locations will need further evaluation at the time of a planned project to account for any changes in the slope conditions and planned access to the slopes.

**Ditch Paving:** Ditch maintenance, including regular cleaning of debris, is imperative to minimalizing roadway debris. Ditch armoring (paving) is also recommended to reduce erosion of weaker mudstone/shale units by transporting water away from the base of the rock slopes and prevent undercutting during regular ditch maintenance activities.

The conceptual design cost estimate is for the geotechnical work items only and doesn’t represent a complete design and construction cost estimate.

## **Geotechnical Estimating Factors:**

### **Option 1 - Monitoring**

| <b>Item</b>                           | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|---------------------------------------|-------------|---------------|------------------|-------------------|
| Park Monitoring (ad hoc/yr)           | Each        | 1             | \$ 1,000         | \$ 1,000          |
| Park Re-Rating (3 to 5 yr interval)   | Each        | 1             | \$ 4,000         | \$ 4,000          |
| <b>Option 1 Total Estimated Costs</b> |             |               |                  | <b>\$ 5,000</b>   |

### **Option 2 - Temporary Risk Reduction- Scaling**

| <b>Item</b>                           | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|---------------------------------------|-------------|---------------|------------------|-------------------|
| Final Geotechnical Design             | Lump Sum    | 1             | \$ 20,000        | \$ 20,000         |
| Scaling                               | Scaler Hour | 700           | \$ 300           | \$ 210,000        |
| Movable Rockfall Fence                | Lump Sum    | 1             | \$ 50,000        | \$ 50,000         |
| Debris Removal                        | Cubic Yd    | 900           | \$ 40            | \$ 36,000         |
| <b>Option 2 Total Estimated Costs</b> |             |               |                  | <b>\$ 316,000</b> |

### **Option 3 - Mitigation-Rockfall Stabilization**

| <b>Item</b>                             | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|-----------------------------------------|-------------|---------------|------------------|-------------------|
| Final Geotechnical Design               | Lump Sum    | 1             | \$ 30,000        | \$ 30,000         |
| Scaling                                 | Scaler Hour | 700           | \$ 300           | \$ 210,000        |
| Movable Rockfall Fence                  | Lump Sum    | 1             | \$ 50,000        | \$ 50,000         |
| Debris Removal                          | Cubic Yd    | 900           | \$ 40            | \$ 36,000         |
| Rock Reinforcement Installation (Bolts) | Lineal Foot | 1250          | \$ 175.00        | \$ 218,750        |
| Paved Ditch                             | Lineal Foot | 100           | \$ 70.00         | \$ 7,000          |
| <b>Option 3 Total Estimated Costs</b>   |             |               |                  | <b>\$ 551,750</b> |

## **Zion National Park Unstable Slope Corridor Assessment**

**SITE:** 1130

**Evaluated By:** DAA/MDD

**Date:** 10-24-2018

**Agency:** NPS

**Region:** Intermountain Region

**Park:** ZION

**Road (RIP Route No.):** Mt Carmel Hwy (0010)

**Side of Centerline:** South (Right RIP)

**Beginning:** 37.21509, -112.96502  
(MP2.93)

**Ending:** 37.21508, -112.96472 (MP2.94)

**Numerical Rating:** 457

### **Problem Definition/ Description:**

This unstable slope extends approximately 71 feet long, with a maximum evaluated slope height of approximately 37 feet within a large landslide deposit. Rockfall source areas consist of block-in-matrix landslide material with erosional undermining of finer-grained material below larger boulder-sized Kayenta Sandstone blocks, leading to failures. One large sandstone boulder approximately 80-feet wide and 40-feet high represents a large portion of this unstable slope. A portion of this boulder overhangs the ditch and contains an open fracture. Rockfall can also source from the Kayenta and Navajo Sandstones above the landslide area; however, slopes outside areas that have documented impact to the road were not evaluated. Unvegetated alluvial channels have formed around the large sandstone boulder, where landslide material transports down the face of the slope into the ditch. Generally, rockfall occurs during or directly after precipitation events. Historically, this site has produced 3-foot diameter rocks that typically catch in the 7-foot wide ditch and infrequently impact the roadway. Surface drainage from the Poison Ivy Springs flows in the ditch that proceeds down slope to a paved inlet beyond this unstable slope area at adjacent Site 1129.

### **Problem Correction:**

**Option 1 – Monitoring:** As discussed in the main report, monitoring by the Park is always an option at this unstable slope location, but it is a temporary risk reduction method, not a long-term mitigation measure. It is also recommended to rate the slope on a 3- to 5-year basis or after significant precipitation events to determine if there are any significant changes in the unstable slope conditions. USMP “New Slope Event” and “Maintenance Tracking” forms can be used to easily record new information.

**Option 2 – Temporary Risk Reduction-Scaling:** Temporary risk reduction of the hazard from all sections will require slope scaling to remove loose rock, large unstable blocks, colluvial material, and loose vegetation on the cut slope. The slope scaling

efforts will need to be repeated on 10 to 15 year intervals to maintain the same level of risk reduction. The use of air-bags may be required to dislodge larger boulders. During scaling operations, the road might sustain damage from debris impacts even with the use of plates to protect the roadway and would be ideally planned in advanced coordination with resurfacing or other pavement repair work. Rock will also need to be prevented from falling and impacting Mount Camel Highway below or from falling all the way down into Pine Creek at the base of the switchbacks with the use of temporary movable roadside rockfall fences.

**Option 3 – Mitigation – Rockfall Stabilization:** Preliminary site evaluation indicates a combination of stabilization methods could best protect the roadway from typical rockfall events that includes scaling and rock stabilization (bolting/dowels) of the large sandstone block.

**Scaling:** As described above in Option 2, mitigation of this unstable slope will require slope scaling to remove loose rock, large unstable blocks, colluvial material, and loose vegetation on the cut slope.

**Rock Stabilization:** Strategic bolting and/or doweling could follow the scaling to secure the large unstable sandstone block in the middle of this cut slope. Two-stage grouted bolts would be appropriate to retain larger blocks that have potential to detach and fall into the roadway. The aesthetics of the rock reinforcement can be improved by cutting off the heads of the bolts and/or dowels, and then applying colored grout over top. Final bolt and/or dowel design and locations will need further evaluation at the time of a planned project to account for any changes in the slope conditions.

The conceptual design cost estimate is for the geotechnical work items only and doesn't represent a complete design and construction cost estimate.

## **Geotechnical Estimating Factors:**

### **Option 1 - Monitoring**

| <b>Item</b>                           | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|---------------------------------------|-------------|---------------|------------------|-------------------|
| Park Monitoring (ad hoc/yr)           | Each        | 1             | \$ 1,000         | \$ 1,000          |
| Park Re-Rating (3 to 5 yr interval)   | Each        | 1             | \$ 4,000         | \$ 4,000          |
| <b>Option 1 Total Estimated Costs</b> |             |               |                  | <b>\$ 5,000</b>   |

### **Option 2 - Temporary Risk Reduction- Scaling**

| <b>Item</b>                           | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|---------------------------------------|-------------|---------------|------------------|-------------------|
| Final Geotechnical Design             | Lump Sum    | 1             | \$ 15,000        | \$ 15,000         |
| Scaling                               | Scaler Hour | 80            | \$ 300           | \$ 24,000         |
| Movable Rockfall Fence                | Lump Sum    | 1             | \$ 50,000        | \$ 50,000         |
| Debris Removal                        | Cubic Yd    | 200           | \$ 40            | \$ 8,000          |
| <b>Option 2 Total Estimated Costs</b> |             |               |                  | <b>\$ 97,000</b>  |

### **Option 3 - Mitigation-Rockfall Stabilization**

| <b>Item</b>                             | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|-----------------------------------------|-------------|---------------|------------------|-------------------|
| Final Geotechnical Design               | Lump Sum    | 1             | \$ 15,000        | \$ 15,000         |
| Scaling                                 | Scaler Hour | 80            | \$ 300           | \$ 24,000         |
| Movable Rockfall Fence                  | Lump Sum    | 1             | \$ 50,000        | \$ 50,000         |
| Debris Removal                          | Cubic Yd    | 200           | \$ 40            | \$ 8,000          |
| Rock Reinforcement Installation (Bolts) | Lineal Foot | 30            | \$ 175           | \$ 5,250          |
| <b>Option 3 Total Estimated Costs</b>   |             |               |                  | <b>\$ 102,250</b> |

## **Zion National Park Unstable Slope Corridor Assessment**

**SITE:** 1131 (above Poison Ivy Springs)

**Evaluated By:** DAA/MDD

**Date:** 10-24-2018

**Agency:** NPS

**Region:** Intermountain Region

**Park:** ZION

**Road (RIP Route No.):** Mt Carmel Hwy (0010)

**Side of Centerline:** South (Right RIP)

**Beginning:** 2.94

**Ending:** 3.07

**Numerical Rating:** 422

### **Problem Definition/ Description:**

This unstable slope extends approximately 388 feet long from MP 2.94 to MP 3.07, with a maximum evaluated slope height of 40 feet. The unstable slope was split into two segments based on the slope characteristics. Segment 1 extends approximately 250 feet in length and contains a row of inlaid boulders at the base of the cut slope in landslide material, leaving a narrow ditch. Segment 2 extends approximately 140 feet in length and has up to a 9-foot wide rock catchment ditch. Evaluated rockfall source areas consist of a block-in-matrix partially overlying bedrock and continuing to road level. The Navajo Formation lies above the Kayenta Formation and is generally in line with the highway and can also produce rockfall. Formations and associated rockfall outside of reported and documented rockfall source areas along the Park road corridors were not evaluated. Segment 2 fails due to the erosion of soils undermining large sandstone blocks. The loss of support leads to toppling failure. Large colluvial material above the slope can be reactivated with precipitation events. Generally, failures occur during or directly after precipitation events. Large boulders and sand in the ditch indicates recent failures; however, risk of rockfall impacting the travel lanes at this location is reduced due to the wide ditch.

### **Problem Correction:**

**Option 1 – Monitoring:** As discussed in the main report, monitoring by the Park is always an option at this unstable slope location, but it is a temporary risk reduction method, not a long-term mitigation measure. It is also recommended to rate the slope on a 3- to 5-year basis or after significant precipitation events to determine if there are any significant changes in the unstable slope conditions. USMP “New Slope Event” and “Maintenance Tracking” forms can be used to easily record new information.

**Option 2 – Temporary Risk Reduction-Scaling:** Temporary risk reduction of the hazard from Segment 1 and Segment 2 will require slope scaling to remove loose rock, debris in erosion gullies, and overlying colluvial material. It is imperative that the rock inlay at the base of the slope is not removed during scaling efforts. The slope scaling

efforts will need to be repeated on 1 to 5 year intervals to maintain the same level of risk reduction. The use of air-bags may be required in some areas with larger boulders or tight fracturing. During scaling operations, the road might sustain damage from debris impacts even with the use of plates to protect the roadway and would be ideally planned in advanced coordination with resurfacing or other pavement repair work. Rock will also need to be prevented from falling and impacting Mount Camel Hwy below or from falling into Pine Creek with the use of temporary movable roadside rockfall fences.

No rockfall stabilization option appears feasible at this location.

The conceptual design cost estimate is for the geotechnical work items only and doesn't represent a complete design and construction cost estimate.

### **Geotechnical Estimating Factors:**

#### **Option 1 - Monitoring**

| <b>Item</b>                           | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|---------------------------------------|-------------|---------------|------------------|-------------------|
| Park Monitoring (ad hoc/yr)           | Each        | 1             | \$ 1,000         | \$ 1,000          |
| Park Re-Rating (3 to 5 yr interval)   | Each        | 1             | \$ 4,000         | \$ 4,000          |
| <b>Option 1 Total Estimated Costs</b> |             |               |                  | <b>\$ 5,000</b>   |

#### **Option 2 - Temporary Risk Reduction- Scaling**

| <b>Item</b>                           | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|---------------------------------------|-------------|---------------|------------------|-------------------|
| Final Geotechnical Design             | Lump Sum    | 1             | \$ 20,000.00     | \$ 20,000         |
| Scaling                               | Scaler Hour | 400           | \$ 300.00        | \$ 120,000        |
| Movable Rockfall Fence                | Lump Sum    | 1             | \$ 50,000.00     | \$ 50,000         |
| Debris Removal                        | Cubic Yd    | 250           | \$ 40            | \$ 10,000         |
| <b>Option 2 Total Estimated Costs</b> |             |               |                  | <b>\$ 200,000</b> |

## **Zion National Park Unstable Slope Corridor Assessment**

**SITE:** 1134 (Carl's Bend cut slope)

**Evaluated By:** DAA/MDD

**Date:** 10-23-2018

**Agency:** NPS

**Region:** Intermountain Region

**Park:** ZION

**Road (RIP Route No.):** 0010 Zion-Mt. Carmel Highway

**Side of Centerline:** South (left going uphill)

**Beginning MP:** 3.38

**Ending MP:** 3.43

**Numerical Rating:** 484

### **Problem Definition/ Description:**

This unstable slope extends approximately 286 feet long from MP 3.38 to MP 3.43, with a maximum evaluated slope height of 84 feet. Evaluated rockfall source areas consist of a block-in-matrix slope with colluvium in eroded channels. The Navajo Formation lies above the Kayenta Formation and is generally in line with the highway and can also produce rockfall. Formations and associated rockfall outside of reported and documented rockfall source areas along the Park road corridors were not evaluated. The primary potential failure mechanism is the differential erosion of soils undermining large sandstone blocks, average of about 5 feet in diameter. The loss of support leads to toppling failure. Material in alluvial channels can be reactivated with precipitation events, or rockfall events from above. Generally, failures occur during or directly after precipitation events when water channelizes and removes fines supporting boulders. Boulders and sand in the ditch indicates recent failures; however, rocks infrequently impact the road. This area is within a known ancient landslide. Reactivation of this ancient landslide can be triggered by infiltration of heavy precipitation events and human activities.

### **Problem Correction:**

**Option 1 – Monitoring:** As discussed in the main report, monitoring by the Park is always an option at this unstable slope location, but it is a temporary risk reduction method, not a long-term mitigation measure. It is also recommended to rate the slope on a 3- to 5-year basis or after significant precipitation events to determine if there are any significant changes in the unstable slope conditions. USMP “New Slope Event” and “Maintenance Tracking” forms can be used to easily record new information.

**Option 2 – Temporary Risk Reduction-Scaling:** Temporary risk reduction of the hazard will require slope scaling to remove loose rock, debris in alluvial channels, and overlying colluvial material. The slope scaling efforts will need to be repeated on 5 to 10 year intervals to maintain the same level of risk reduction. The use of air-bags may be required in some areas with larger boulders. During scaling operations, the road might

sustain damage from debris impacts even with the use of plates to protect the roadway and would be ideally planned in advanced coordination with resurfacing or other pavement repair work. Rock will also need to be prevented from falling and impacting Mount Camel Hwy below or from falling into Pine Creek with the use of temporary mobile roadside rockfall fences.

The conceptual design cost estimate is for the geotechnical work items only and doesn't represent a complete design and construction cost estimate.

### **Geotechnical Estimating Factors:**

#### **Option 1 - Monitoring**

| <b>Item</b>                           | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|---------------------------------------|-------------|---------------|------------------|-------------------|
| Park Monitoring (ad hoc/yr)           | Each        | 1             | \$ 1,000         | \$ 1,000          |
| Park Re-Rating (3 to 5 yr interval)   | Each        | 1             | \$ 4,000         | \$ 4,000          |
| <b>Option 1 Total Estimated Costs</b> |             |               |                  | <b>\$ 5,000</b>   |

#### **Option 2 - Temporary Risk Reduction- Scaling**

| <b>Item</b>                           | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|---------------------------------------|-------------|---------------|------------------|-------------------|
| Final Geotechnical Design             | Lump Sum    | 1             | \$ 15,000        | \$ 15,000         |
| Scaling                               | Scaler Hour | 200           | \$ 300           | \$ 60,000         |
| Movable Rockfall Fence                | Lump Sum    | 1             | \$ 50,000        | \$ 50,000         |
| Debris Removal                        | Cubic Yd    | 350           | \$ 40            | \$ 14,000         |
| <b>Option 2 Total Estimated Costs</b> |             |               |                  | <b>\$ 139,000</b> |

## **Zion National Park Unstable Slope Corridor Assessment**

**SITE:** 1145 (Nevada Switchback)

**Evaluated By:** DAA/MDD

**Date:** 10-23-2018

**Agency:** NPS

**Region:** Intermountain Region

**Park:** ZION

**Road (RIP Route No.):** Zion 99 – Mt Carmel Hwy (0010) Upper Switchback

**Side of Centerline:** South (left going uphill)

**Beginning MP:** 4.26

**Ending MP:** 4.30

**Numerical Rating:** 473

### **Problem Definition/ Description:**

This unstable slope extends approximately 208 feet long from MP 4.26 to MP 4.30, with a maximum evaluated slope height of approximately 62 feet. The evaluated rockfall source area consists of a siltstone/ mudstone member interbedded and overlying a massive, cliff-forming sandstone member of the Kayenta Formation. The Navajo Formation lies above the Kayenta Formation and is generally in line with the highway and can also produce rockfall. Formations and associated rockfall outside of reported and documented rockfall source areas along the Park road corridors were not evaluated. Rock outcrops in the source area are horizontally bedded and cross-jointed, which results in variable sized rockfall blocks ranging from approximately 1 to 5-foot blocks. The primary potential failure mechanism is differential erosion of the weaker siltstone/ mudstone underlying the sandstone, which can create topple failure. A common secondary mechanism is the unraveling of the siltstone/ mudstone member resulting in large amounts of sediment in the ditch and the release of colluvial material above the cut. Generally, rockfall events occur during or after precipitation events. Rocks and sediment in the ditch continuously need to be cleaned out. This site is also located on a known ancient landslide, and has experienced distress that is indicative of movement. The culvert at this site has been repaired twice in the past 20 years, indicating high sediment transport.

### **Problem Correction:**

**Option 1 – Monitoring:** As discussed in the main report, monitoring by the Park is always an option at this unstable slope location, but it is a temporary risk reduction method, not a long-term mitigation measure. It is also recommended to rate the slope on a 3- to 5-year basis or after significant precipitation events to determine if there are any significant changes in the unstable slope conditions. USMP “New Slope Event” and “Maintenance Tracking” forms can be used to easily record new information.

### **Option 2 – Temporary Risk Reduction – Scaling and Drainage Improvements**

Scaling: Temporary risk reduction of the hazard from this unstable slope will require slope scaling to remove loose rock, large unstable blocks, and colluvial material. The slope scaling efforts will need to be repeated on 5 to 10 year intervals to maintain the same level of risk reduction. The use of air-bags may be required in some areas with larger boulders or tight fracturing. During scaling operations, the road might sustain damage from debris impacts even with the use of plates to protect the roadway and would be ideally planned in advanced coordination with resurfacing or other pavement repair work. Rock will also need to be prevented from falling outside the roadway embankment area with the use of temporary movable roadside rockfall fences. Additionally, drainage improvements are recommended, which would include check dams to slow the velocity of ditch flow and reduce sedimentation.

**Option 3 – Mitigation – Rockfall Stabilization:** Preliminary site evaluation indicates a combination of stabilization methods could best protect the roadway from typical rockfall events that includes scaling and pinned high tensile strength wire mesh.

Scaling: As described above in Option 2, mitigation of this unstable slope will require slope scaling to remove loose rock, large unstable blocks, and colluvial material.

Pinned High Tensile Strength Wire Mesh: A pinned mesh could be used to retain the colluvial and siltstone/ mudstone units. Pinned mesh may form pockets of accumulated material, and can be difficult to clean; however, pinned mesh used on slopes less than 40 degrees may aide in establishing vegetation that can slow the erosion of the siltstone/ mudstone interbedded unit and increase the overall stability of the slope.

The conceptual design cost estimate is for the geotechnical work items only and doesn't represent a complete design and construction cost estimate.

## **Geotechnical Estimating Factors:**

### **Option 1 - Monitoring**

| <b>Item</b>                           | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|---------------------------------------|-------------|---------------|------------------|-------------------|
| Park Monitoring (ad hoc/yr)           | Each        | 1             | \$ 1,000         | \$ 1,000          |
| Park Re-Rating (3 to 5 yr interval)   | Each        | 1             | \$ 4,000         | \$ 4,000          |
| <b>Option 1 Total Estimated Costs</b> |             |               |                  | <b>\$ 5,000</b>   |

### **Option 2 - Temporary Risk Reduction- Scaling**

| <b>Item</b>                           | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|---------------------------------------|-------------|---------------|------------------|-------------------|
| Final Geotechnical Design             | Lump Sum    | 1             | \$ 20,000        | \$ 20,000         |
| Drainage improvements - check dams    | Lump Sum    | 1             | \$ 5,000         | \$ 5,000          |
| Scaling                               | Scaler Hour | 230           | \$ 300           | \$ 69,000         |
| Movable Rockfall Fence                | Lump Sum    | 1             | \$ 50,000        | \$ 50,000         |
| Debris Removal                        | Cubic Yd    | 250           | \$ 40            | \$ 10,000         |
| <b>Option 2 Total Estimated Costs</b> |             |               |                  | <b>\$ 154,000</b> |

### **Option 3 - Mitigation-Rockfall Stabilization**

| <b>Item</b>                           | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|---------------------------------------|-------------|---------------|------------------|-------------------|
| Geotechnical Design                   | Lump Sum    | 1             | \$ 30,000        | \$ 30,000         |
| Pinned Wire Mesh                      | Sq Yd       | 1300          | \$ 175           | \$ 227,500        |
| Scaling                               | Scaler Hour | 230           | \$ 300           | \$ 69,000         |
| Movable Rockfall Fence                | Lump Sum    | 1             | \$ 50,000        | \$ 50,000         |
| Debris Removal                        | Cubic Yd    | 250           | \$ 40            | \$ 10,000         |
| <b>Option 3 Total Estimated Costs</b> |             |               |                  | <b>\$ 386,500</b> |

## **Zion National Park Unstable Slope Corridor Assessment**

**SITE:** 1150 (Water Spring Switchback)

**Evaluated By:** DAA/MDD

**Date:** 10-23-2018

**Agency:** NPS

**Region:** Intermountain Region

**Park:** ZION

**Road (RIP Route No.):** Zion 99 – Mt Carmel Hwy (0010) Upper Switchback

**Side of Centerline:** South (right going uphill)

**Beginning:** 4.71

**Ending:** 4.76

**Numerical Rating:** 437

### **Problem Definition/ Description:**

This unstable slope extends approximately 221 feet long from MP 4.71 to MP 4.76, with a maximum evaluated slope height of approximately 60 feet. The evaluated rockfall source area consists of a massive, cliff-forming sandstone member interbedded a siltstone/ mudstone member of the Kayenta Formation. The Navajo Formation lies above the Kayenta Formation and is generally in line with the highway and can also produce rockfall. Formations and associated rockfall outside of reported and documented rockfall source areas along the Park road corridors were not evaluated. Rock outcrops in the source area are horizontally bedded and cross-jointed, which results in variable sized rockfall blocks ranging from approximately 1- to 6-foot blocks. The primary potential failure mechanism is differential erosion of the weaker siltstone/ mudstone underlying the sandstone, which can create topple failure. A common secondary mechanism is the failure of release planes created by structural discontinuities, such as joints and fractures, which are persistent in this location and allow for wedge failures. There are drainages in the middle and on either end of the site with loose hanging rocks. Seepage was noted in the siltstone/ mudstone units during the site evaluation. Generally, rockfall events occur during or after precipitation events. The ditch size allows for rock catchment, and regularly needs to be cleaned out.

### **Problem Correction:**

**Option 1 – Monitoring:** As discussed in the main report, monitoring by the Park is always an option at this unstable slope location, but it is a temporary risk reduction method, not a long-term mitigation measure. It is also recommended to rate the slope on a 3- to 5-year basis or after significant precipitation events to determine if there are any significant changes in the unstable slope conditions. USMP “New Slope Event” and “Maintenance Tracking” forms can be used to easily record new information.

**Option 2 – Temporary Risk Reduction-Scaling:** Temporary risk reduction of the hazard from this unstable slope will require slope scaling to remove loose rock, large unstable blocks, and colluvial material. The slope scaling efforts will need to be repeated

on 1 to 5 year intervals to maintain the same level of risk reduction. The use of air-bags may be required in some areas with larger boulders or tight fracturing. During scaling operations, the road might sustain damage from debris impacts even with the use of plates to protect the roadway and would be ideally planned in advanced coordination with resurfacing or other pavement repair work. Temporary movable roadside rockfall fences were assumed in the estimate to reduce the risk of debris impacting a travel lane.

The conceptual design cost estimate is for the geotechnical work items only and doesn't represent a complete design and construction cost estimate.

## **Geotechnical Estimating Factors:**

### **Option 1 - Monitoring**

| Item                                  | Unit | Amount | Unit Cost | Total Cost      |
|---------------------------------------|------|--------|-----------|-----------------|
| Park Monitoring (ad hoc/year)         | Each | 1      | \$ 1,000  | \$ 1,000        |
| Park Re-Rating (3 to 5 yr interval)   | Each | 1      | \$ 4,000  | \$ 4,000        |
| <b>Option 1 Total Estimated Costs</b> |      |        |           | <b>\$ 5,000</b> |

### **Option 2 - Temporary Risk Reduction- Scaling**

| Item                                  | Unit        | Amount | Unit Cost | Total Cost        |
|---------------------------------------|-------------|--------|-----------|-------------------|
| Final Geotechnical Design             | Lump Sum    | 1      | \$ 15,000 | \$ 15,000         |
| Scaling                               | Scaler Hour | 650    | \$ 300    | \$ 195,000        |
| Movable Rockfall Fence                | Lump Sum    | 1      | \$ 50,000 | \$ 50,000         |
| Debris Removal                        | Cubic Yd    | 500    | \$ 40     | \$ 20,000         |
| <b>Option 2 Total Estimated Costs</b> |             |        |           | <b>\$ 280,000</b> |

## Zion National Park Unstable Slope Corridor Assessment

**SITE:** 5104 (Landslide at Carl's Bend)

**Evaluated By:** DAA/MDD

**Date:** 10-23-2018

**Agency:** NPS

**Region:** Intermountain Region

**Park:** ZION

**Road (RIP Route No.):** 0010 Zion-Mt. Carmel Highway

**Side of Centerline:** North (RIP-Left)

**Beginning MP:** 3.25

**Ending MP:** 3.32

Numerical Rating: 547

### **Problem Definition/ Description:**

The unstable slope is located from MP 3.25 to MP 3.32 within a known landslide area. This site has experienced distress in the fill slope outboard lane periodically over multiple years. Maintenance has applied asphalt patching to the area, typically across one lane of travel, to expected total depths of up to 4 feet. The length of affected road distance is approximately 267 linear feet and the entire slope/ landslide is approximately 516 feet tall (See attached sketch and photograph in Figures 5104A and 5104B). The initial site visit indicates that the landslide can be divided into two sections, the ancient landslide and a localized active failure. The large ancient landslide does not show evidence of recent movement. This stability is largely dependent on water infiltration and groundwater levels in the overburden material. The smaller, more localized landslide impacts the road more directly, and is highly dependent on precipitation, water infiltration, and groundwater levels. Surface water does not appear to be contained, and water above this area has been noted. Water infiltrating the slope can be contributing to the observed distress. Additionally, this has been investigated in the past as part of previous roadway improvement projects with inclinometers installed in at least 3 locations.

### **Problem Correction:**

**Option 1 – Monitoring:** As discussed in the main report, monitoring by the Park is always an option at this landslide location, but it is a temporary risk reduction method, not a long-term mitigation measure. Re-baselining and starting to periodically read the existing inclinometers is recommended to track movement. It is also recommended to rate the slope on a 3- to 5-year basis or after significant precipitation events to determine if there are any significant changes in the unstable slope conditions. USMP “New Slope Event” and “Maintenance Tracking” forms can be used to easily record new information.

**Option 2 – Temporary Risk Reduction- Drainage Improvements:** Temporary risk reduction of the landslide hazard will require the control and diversion of surface water. Water collecting on the road surface will be directed away from the slide, either by paved ditch or culverts. The two cross culverts will be upsized to accommodate the flow in that area. Four inlets would be improved to capture surface water flow.

**Option 3 – Mitigation:** Permanent repairs could include a deep patch to raft the roadway across the landslide area and a full width underdrain to remove water from the slope. A deep patch is assumed to extend the full width of the roadway (26-feet), extend approximately 6-feet deep with layers of geosynthetic stabilization material spaced vertically at 6 to 9 inches, with full coverage drainage at the backside. A permanent repair would require a full geotechnical investigation, which would include installation of additional inclinometers downslope to develop a profile of the apparent complex landslide and associated movement. This investigation would require environmental clearances and difficult access, followed by at least a one-year monitoring period.

The conceptual design cost estimate is for the geotechnical work items only and doesn't represent a complete design and construction cost estimate.

## **Geotechnical Estimating Factors:**

### **Option 1 - Monitoring**

| Item                                  | Unit | Amount | Unit Cost | Total Cost       |
|---------------------------------------|------|--------|-----------|------------------|
| Inclinometer Monitoring (2/year)      | Each | 2      | \$ 5,000  | \$ 10,000        |
| Park Monitoring (ad hoc/year)         | Each | 1      | \$ 1,000  | \$ 1,000         |
| Park Re-Rating (3 to 5 year interval) | Each | 1      | \$ 4,000  | \$ 4,000         |
| <b>Option 1 Total Estimated Costs</b> |      |        |           | <b>\$ 15,000</b> |

### **Option 2 - Temporary Risk Reduction- Drainage Improvements**

| Item                                  | Unit        | Amount | Unit Cost | Total Cost       |
|---------------------------------------|-------------|--------|-----------|------------------|
| Final Roadway Design                  | Lump Sum    | 1      | \$ 10,000 | \$ 10,000        |
| Surface drainage - Inlet improvements | Each        | 4      | \$ 3,000  | \$ 12,000        |
| New culverts 24-inch                  | Each        | 2      | \$ 15,000 | \$ 30,000        |
| Paved Ditch                           | Lineal Foot | 270    | \$ 70     | \$ 18,900        |
| <b>Option 2 Total Estimated Costs</b> |             |        |           | <b>\$ 70,900</b> |

### **Option 3 - Mitigation - Deep Patch**

| Item                                  | Unit      | Amount | Unit Cost  | Total Cost        |
|---------------------------------------|-----------|--------|------------|-------------------|
| Geotechnical Design                   | Lump Sum  | 1      | \$ 30,000  | \$ 30,000         |
| Standard Underdrain                   | Lineal Ft | 267    | \$ 50      | \$ 13,350         |
| Deep Patch (full width, 6-ft depth)   | CUYD      | 1500   | \$ 75      | \$ 112,500        |
| Geotech Investigation/Monitoring      | Lump Sum  | 1      | \$ 100,000 | \$ 100,000        |
| <b>Option 3 Total Estimated Costs</b> |           |        |            | <b>\$ 255,850</b> |

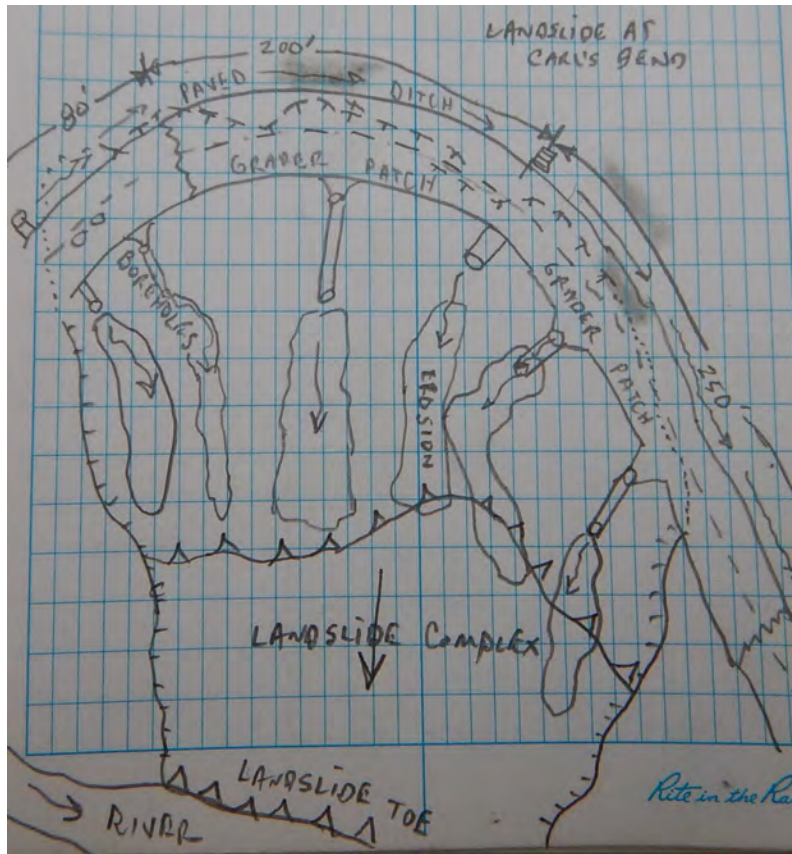


Figure 5104A: Sketch of landslide at Carl's Bend.



Figure 5104B: Photograph of Carl's Bend in large landslide complex.

## **Zion National Park Unstable Slope Corridor Assessment**

**SITE:** 1222 (Cut side across from Sentinel Slide)

**Evaluated By:** DAA/MDD

**Date:** 10-26-2018

**Agency:** NPS

**Region:** Intermountain Region

**Park:** ZION

**Road (RIP Route No.):** 0011 – Zion Canyon Scenic Drive

**Side of Centerline:**

**Beginning MP:** 0.9

**Ending MP:** 0.98

**Numerical Rating:** 505

### **Problem Definition/ Description:**

This unstable slope extends approximately 420 feet long from MP 0.9 to MP 0.98, with a maximum evaluated slope height of approximately 75 feet. Evaluated rockfall source areas consist of a landslide/block-in-matrix material. Sandstone boulders in the source area are variable sized, ranging from approximately 1- to 4-foot diameter. The primary rock failure mechanism is differential erosion of the weaker matrix material, which can create toppling failure of the boulders. Boulders within the block-in-matrix fail due to the erosion of soils, undermining large sandstone blocks, and the loss of support leads to toppling failure. The Navajo Formation lies above the Kayenta Formation and is generally in line with the highway and can also produce rockfall. Formations and associated rockfall outside of reported and documented rockfall source areas along the Park road corridors were not evaluated. Large colluvial material above the slope and the block-in-matrix can be reactivated with precipitation or rockfall events. Generally, rockfall events occur during or after precipitation events. Sediment and 4-foot boulders are regularly cleaned from the ditch 3 to 4 times a year, and this location is considered one of the most active slopes in the Park.

### **Problem Correction:**

**Option 1 – Monitoring:** As discussed in the main report, monitoring by the Park is always an option at this unstable slope location, but it is a temporary risk reduction method, not a long-term mitigation measure. It is also recommended to rate the slope on a 3- to 5-year basis or after significant precipitation events to determine if there are any significant changes in the unstable slope conditions. USMP “New Slope Event” and “Maintenance Tracking” forms can be used to easily record new information.

**Option 2 – Temporary Risk Reduction-Scaling:** Temporary risk reduction of the hazard from all sections will require slope scaling to remove loose rock, debris in erosion gullies, overlying colluvial material, and loose vegetation. The slope scaling efforts will need to be repeated on 5 to 10 year intervals to maintain the same level of risk reduction.

The use of air-bags may be required in some areas with larger boulders or tight fracturing. During scaling operations, the road might sustain damage from debris impacts even with the use of plates to protect the roadway and would be ideally planned in advanced coordination with resurfacing or other pavement repair work. Jersey barriers (colored) would be beneficial in reducing material in the roadway since it is generally fine silt and sands and not usually boulder sized debris. An estimate was included here for temporary movable roadside rockfall catchment fences to help reduce risk of impacting the travel lanes during scaling activities. Reshaping the ditch from flat to inclined will also assist in retention of sediment and rockfall.

**Option 3 – Mitigation – Rockfall Stabilization-Draped Wire Mesh:** Preliminary site evaluation indicates a combination of stabilization methods could best protect the roadway from typical rockfall events that includes scaling, draped wire mesh, and ditch reshaping and paving.

**Scaling:** As described above in Option 2, mitigation of this unstable slope will require slope scaling to remove loose rock, large unstable blocks, colluvial material, and loose vegetation on the cut slope.

**Draped High Tensile Strength Wire Mesh:** Draped mesh is commonly used to control rockfall hazard and erosion of slopes. Before installation, scaling will be required on and above the slope for worker safety and longevity of the system. Fallen rocks and sediment will be guided into the ditch, which will require regular cleaning. Brow clearing and layback will be necessary to anchor the draped mesh.

**Ditch Reconditioning:** Ditch maintenance, including regular cleaning of debris, is imperative to minimalizing roadway debris. Ditch armoring (paving) is also recommended to reduce erosion of weaker units by transporting water away from the base of the rock slopes and prevent undercutting during regular ditch maintenance activities. Reshaping the ditch from flat to inclined will also assist in retention of sediment and rockfall.

The conceptual design cost estimate is for the geotechnical work items only and doesn't represent a complete design and construction cost estimate.

## **Geotechnical Estimating Factors:**

### **Option 1 - Monitoring**

| <b>Item</b>                           | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|---------------------------------------|-------------|---------------|------------------|-------------------|
| Park Monitoring (ad hoc/yr)           | Each        | 1             | \$ 1,000         | \$ 1,000          |
| Park Re-Rating (3 to 5 yr interval)   | Each        | 1             | \$ 4,000         | \$ 4,000          |
| <b>Option 1 Total Estimated Costs</b> |             |               |                  | <b>\$ 5,000</b>   |

### **Option 2 - Temporary Risk Reduction- Scaling and Jersey Barriers**

| <b>Item</b>                           | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|---------------------------------------|-------------|---------------|------------------|-------------------|
| Final Geotechnical Design             | Lump Sum    | 1             | \$ 20,000        | \$ 20,000         |
| Scaling                               | Scaler Hour | 100           | \$ 300           | \$ 30,000         |
| Ditch Reshaping/ Reconditioning       | Linear Ft   | 420           | \$ 50            | \$ 21,000         |
| Jersey Barriers                       | Linear Ft   | 420           | \$ 150           | \$ 63,000         |
| Movable Rockfall Fence                | Lump Sum    | 1             | \$ 50,000        | \$ 50,000         |
| Debris Removal                        | Cubic Yd    | 250           | \$ 40            | \$ 10,000         |
| <b>Option 2 Total Estimated Costs</b> |             |               |                  | <b>\$ 194,000</b> |

### **Option 3 - Mitigation-Rockfall Stabilization- Draped Mesh**

| <b>Item</b>                           | <b>Unit</b> | <b>Amount</b> | <b>Unit Cost</b> | <b>Total Cost</b> |
|---------------------------------------|-------------|---------------|------------------|-------------------|
| Final Geotechnical Design             | Lump Sum    | 1             | \$ 30,000        | \$ 30,000         |
| Scaling                               | Scaler Hour | 1120          | \$ 300           | \$ 336,000        |
| Movable Rockfall Fence                | Lump Sum    | 1             | \$ 50,000        | \$ 50,000         |
| Debris Removal                        | Cubic Yd    | 700           | \$ 40            | \$ 28,000         |
| Ditch Reshaping/ Reconditioning       | Linear Ft   | 420           | \$ 50            | \$ 21,000         |
| Jersey Barriers                       | Linear Ft   | 420           | \$ 150           | \$ 63,000         |
| Draped Wire Mesh                      | Sq Yd       | 2000          | \$ 175           | \$ 350,000        |
| <b>Option 3 Total Estimated Costs</b> |             |               |                  | <b>\$ 878,000</b> |

## **Zion National Park Unstable Slope Corridor Assessment**

**SITE:** 1239 (North of the Grotto)

**Evaluated By:** DAA/MDD

**Date:** 10-26-2018

**Agency:** NPS

**Region:** Intermountain Region

**Park:** ZION

**Road (RIP Route No.):** 0011 – Zion Canyon Scenic Drive

**Side of Centerline:**

**Beginning MP:** 3.6

**Ending:** 3.75

**Numerical Rating:** 489

### **Problem Definition/ Description:**

This unstable slope extends approximately 800 feet long from MP 3.6 to MP 3.75, with a maximum evaluated slope height of approximately 60 feet. Evaluated rockfall source areas consist of a colluvial material overlaying a cliff-forming sandstone member interbedded with a siltstone/ mudstone member of the Kayenta Formation. Rock outcrops in the source area are massive, horizontally bedded and cross-jointed, which results in variable sized rockfall blocks ranging from approximately 1- to 10-foot cubes. The primary potential failure mechanism is differential erosion of the weaker siltstone/ mudstone underlying the sandstone, which can create toppling failure. A large, fractured sandstone boulder sitting on a pedestal of siltstone/ mudstone was noted as a specific area of concern. Minor blast damage along the cut can also release 2- to 3- foot boulders. Boulders within the block-in-matrix fail due to the erosion of soils undermining large sandstone blocks, and the loss of support leads to toppling failure. Slopes outside areas that have documented impact to the road were not evaluated. Large colluvial material above the slope and the block-in-matrix can be reactivated with precipitation or rockfall events. Generally, rockfall events occur during or after precipitation events. Erosional channels above and below the cut were noted during the evaluations and may contribute to rockfall events. Aerial photos show impact marks, sediment and 3-foot boulders are regularly cleaned from the ditch, indicating that the slope is active. Additionally, there are large, open cracks in the sandstone units midslope due to undermining and loss of support, also indicating that large blocks can fall into the ditch and roadway and that this is a highly active area that could frequently experience rockfall.

### **Problem Correction:**

**Option 1 – Monitoring:** As discussed in the main report, monitoring by the Park is always an option at this unstable slope location, but it is a temporary risk reduction method, not a long-term mitigation measure. It is also recommended to rate the slope on a 3- to 5-year basis or after significant precipitation events to determine if there are any significant changes in the unstable slope conditions. USMP “New Slope Event” and “Maintenance Tracking” forms can be used to easily record new information.

**Option 2 – Temporary Risk Reduction-Scaling:** Temporary risk reduction of the hazard from this unstable slope will require slope scaling to remove loose rock, large unstable blocks, and colluvial material. The slope scaling efforts will need to be repeated on 5 to 10 year intervals to maintain the same level of risk reduction. The use of air-bags may be required in some areas with larger boulders or tight fracturing. During scaling operations, the road might sustain damage from debris impacts even with the use of plates to protect the roadway and would be ideally planned in advanced coordination with resurfacing or other pavement repair work. An estimate was included for temporary movable roadside rockfall catchment fences.

**Option 3 – Mitigation – Rockfall Stabilization:** Preliminary site evaluation indicates a combination of stabilization methods could best protect the roadway from typical rockfall events that includes scaling and rock stabilization (bolting/dowels).

Scaling: As described above in Option 2, mitigation of this unstable slope will require slope scaling to remove loose rock, large unstable blocks, and colluvial material.

Rock Stabilization: Strategic bolting and/or doweling should follow the scaling to secure large unstable rock features in the cliff. Two-stage grouted bolts would be appropriate to retain larger blocks that have potential to detach and fall into the roadway. The aesthetics of the rock reinforcement can be improved by cutting off the heads of the bolts and/or dowels, and then applying colored grout over top. Final bolt and/or dowel design and locations will need further evaluation at the time of a planned project to account for any changes in the slope conditions and planned access to the slopes.

The conceptual design cost estimate is for the geotechnical work items only and doesn't represent a complete design and construction cost estimate.

## **Geotechnical Estimating Factors:**

### **Option 1 - Monitoring**

| Item                                | Unit | Amount | Unit Cost | Total Cost |
|-------------------------------------|------|--------|-----------|------------|
| Park Monitoring (ad hoc/yr)         | Each | 1      | \$ 1,000  | \$ 1,000   |
| Park Re-Rating (3 to 5 yr interval) | Each | 1      | \$ 4,000  | \$ 4,000   |

**Option 1 Total Estimated Costs** **\$ 5,000**

### **Option 2 - Temporary Risk Reduction- Scaling**

| Item                      | Unit        | Amount | Unit Cost | Total Cost |
|---------------------------|-------------|--------|-----------|------------|
| Final Geotechnical Design | Lump Sum    | 1      | \$ 20,000 | \$ 20,000  |
| Scaling                   | Scaler Hour | 1120   | \$ 300    | \$ 336,000 |
| Movable Rockfall Fence    | Lump Sum    | 1      | \$ 50,000 | \$ 50,000  |
| Debris Removal            | Cubic Yd    | 700    | \$ 40     | \$ 28,000  |

**Option 2 Total Estimated Costs** **\$ 434,000**

### **Option 3 - Mitigation-Rockfall Stabilization**

| Item                                    | Unit        | Amount | Unit Cost | Total Cost |
|-----------------------------------------|-------------|--------|-----------|------------|
| Final Geotechnical Design               | Lump Sum    | 1      | \$ 30,000 | \$ 30,000  |
| Scaling                                 | Scaler Hour | 1120   | \$ 300    | \$ 336,000 |
| Movable Rockfall Fence                  | Lump Sum    | 1      | \$ 50,000 | \$ 50,000  |
| Debris Removal                          | Cubic Yd    | 700    | \$ 40     | \$ 28,000  |
| Rock Reinforcement Installation (Bolts) | Lineal Foot | 2000   | \$ 175    | \$ 350,000 |

**Option 3 Total Estimated Costs** **\$ 794,000**

## **Zion National Park Unstable Slope Corridor Assessment**

**SITE:** 1435 (Year-round Residence)

**Evaluated By:** DAA/MDD

**Date:** 10-26-2018

**Agency:** NPS

**Region:** Intermountain Region

**Park:** ZION

**Road (RIP Route No.):** 0407 – Oak Creek Drive

**Side of Centerline:** North

**Beginning:** 37.21162, -112.9877

**Ending:** 37.2122, -112.98796

Last residence at west end of route

**Numerical Rating:** 827

### **Problem Definition/ Description:**

This unstable slope extends approximately 300 feet long behind the Oak Creek Residences, with a maximum evaluated slope height of approximately 83 feet. Evaluated rockfall source areas consist of unravelling alluvium/ colluvium slopes with large, loose sandstone boulders. Rockfall can also source from the Moenave Formation, Kayenta Formation and Navajo Sandstone, but formations and associated rockfall outside of reported and documented rockfall source areas along the Park road corridors were not evaluated. The primary potential failure mechanism is differential erosion of the soils undermining the sandstone boulders, leading to toppling of the boulders. Generally, soil erosion and failures occur during or directly after precipitation events. This location does not have a history of events; however, boulders of concern have been identified. One boulder, approximately 9 feet tall, 19 feet wide and 14 feet long, has been identified 55 feet up the slope as a potential threat to the residence below, as shown in the attached sketch. The soil below the boulder has been washed out creating an opening approximately 8.5 feet tall and 6 feet deep. Three boulders ranging from 7 to 10 feet in diameter were identified uphill from the residential garages. The erosion rate of the soil below the boulders above the garage is less than the erosion rate of the soil below the boulder above the residence due to their position on the slope and site-specific drainage of water. These rockfall source areas pose a threat to the residential, historic structure and any occupants. Sketches and photographs of the site are presented in Figures 1435A through 1435D below.

### **Problem Correction:**

**Option 1 – Monitoring:** As discussed in the main report, monitoring by the Park is always an option at this unstable slope location, but it is a temporary risk reduction method, not a long-term mitigation measure. It is also recommended to rate the slope on a 3- to 5-year basis or after significant precipitation events to determine if there are any significant changes in the unstable slope conditions. USMP “New Slope Event” and “Maintenance Tracking” forms can be used to easily record new information.

**Option 2 – Mitigation- Rock Stabilization (Concrete Buttress):** Preliminary site evaluation indicates stabilization of the boulders would result in the best temporary risk reduction of the hazard from this unstable slope. For the boulder above the residence, a reinforced concrete buttress would minimize differential erosion of the soil under the boulder. By applying a reinforced concrete buttress within the undermined area, the supporting soils exposure to precipitation would be limited, slowing the erosion of the soil, thus preventing the undermining of the boulder. A similar buttress has been documented at Site 976 below a pillar in the Pine Creek Housing Area.

For the three boulders above the garage, strategic doweling of the boulders is recommended to secure the unstable rock in place.

The conceptual design cost estimate is for the geotechnical work items only and doesn't represent a complete design and construction cost estimate.

### **Geotechnical Estimating Factors:**

#### **Option 1 - Monitoring**

| Item                                                       | Unit  | Amount | Unit Cost | Total Cost      |
|------------------------------------------------------------|-------|--------|-----------|-----------------|
| Visual monitoring by Park staff<br>(2hrs/month for 1 year) | Hours | 24     | \$ 150    | \$ 3,600        |
| Park Re-Rating (3 to 5 yr interval)                        | Each  | 1      | \$ 4,000  | \$ 4,000        |
| <b>Option 1 Total Estimated Costs</b>                      |       |        |           | <b>\$ 7,600</b> |

#### **Option 2 - Mitigation - Rock Stabilization (Concrete Buttress/ Dowels)**

| Item                                  | Unit        | Amount | Unit Cost | Total Cost       |
|---------------------------------------|-------------|--------|-----------|------------------|
| Final Geotechnical/ Structural Design | Lump Sum    | 1      | \$ 15,000 | \$ 15,000        |
| Structure Concrete (reinforced)       | Cubic Yd    | 15     | \$ 1,000  | \$ 15,000        |
| Rock Reinforcement Install (Dowels)   | Linear Foot | 150    | \$ 175    | \$ 26,250        |
| Site Preparation/ Formwork/ Mob.      | Lump Sum    | 1      | \$ 15,000 | \$ 15,000        |
| <b>Option 2 Total Estimated Costs</b> |             |        |           | <b>\$ 71,250</b> |

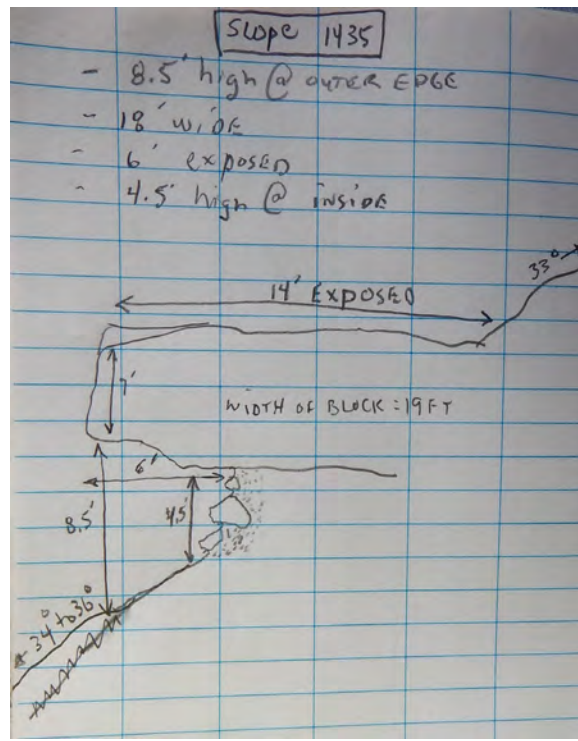


Figure 1435A: Field notes documenting dimensions of the unstable boulder.

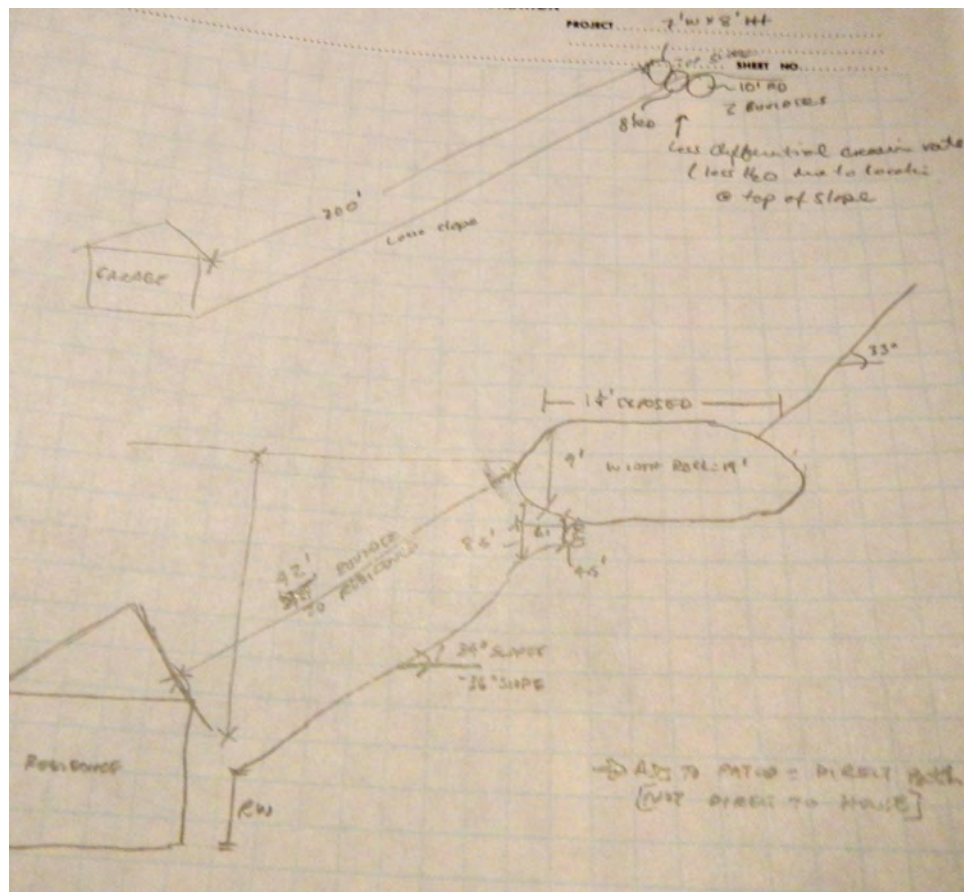


Figure 1435B: Field notes illustrating slope profile of residence and garage rockfall risk.



Figure 1435C: Photograph of slope above residence with unstable boulders.



Figure 1435D: Photograph of slope above garage with unstable boulders.

# **Zion National Park Unstable Slope Corridor Assessment**

**SITE:** 1431 (Dorm)

**Evaluated By:** DAA/MDD

**Date:** 10-26-2018

**Agency:** NPS

**Region:** Intermountain Region

**Park:** ZION

**Road (RIP Route No.):** 0408 – Oak Creek Residence Spur Road

**Side of Centerline:**

**Beginning:** 37.21047, -112.98355

**Ending:** 37.21052, -112.98404

**Numerical Rating:** 784

## **Problem Definition/ Description:**

This unstable slope extends approximately 98 feet long behind the Oak Creek Residence with a maximum evaluated slope height of approximately 48 feet. Evaluated rockfall source areas consist of unravelling alluvium/ colluvium and block-in-matrix slopes with large, loose sandstone boulders. Rockfall can also source from the Moenave Formation, Kayenta Formation and Navajo Sandstone Formations and associated rockfall outside of reported and documented rockfall source areas along the Park road corridors were not evaluated. The primary potential failure mechanism is differential erosion of the soils undermining the sandstone boulders, leading to toppling of the boulders. Generally, soil erosion and failures occur during or directly after precipitation events. This location has a history of small boulders impacting the property and driveway from the trail and slope above; however, one boulder of concern has been identified upslope. The identified boulder is about 60 feet up the slope, approximately 3 feet tall, 11 feet wide and 7 feet long, is not embedded in the slope and is partially perched on a smaller boulder. The soil below the boulder has been eroded out creating an opening approximately 4.5 feet tall and 5.5 feet deep, as shown in the sketch and photograph in Figures 1431A and 1431B below. These rockfall source areas pose a threat to the residential, historic structure and any occupants.

## **Problem Correction:**

**Option 1 – Monitoring:** As discussed in the main report, monitoring by the Park is always an option at this unstable slope location, but it is a temporary risk reduction method, not a long-term mitigation measure. It is also recommended to rate the slope on a 3- to 5-year basis or after significant precipitation events to determine if there are any significant changes in the unstable slope conditions. USMP “New Slope Event” and “Maintenance Tracking” forms can be used to easily record new information.

**Option 2 – Mitigation- Rock Stabilization (Concrete Buttress):** Preliminary site evaluation indicates stabilization of the boulder would result in the best temporary risk reduction of the hazard from this unstable slope. A reinforced concrete buttress would minimize differential erosion of the soil under the boulder. By applying a concrete

buttress within the undermined area, the supporting soils exposure to precipitation would be limited, slowing the erosion of the soil, thus preventing the undermining of the boulder. A similar buttress has been documented at Site 976 below a pillar in the Pine Creek Housing Area.

**Option 3 – Mitigation – Rock Removal:** A second mitigation option would involve the controlled removal of the unstable boulder. Expansion grout or physical scaling with hand tools could loosen the boulder, but the historic residential structure would need to be protected with a temporary catchment system at the base of the slope, such as a temporary rockfall fence or jersey barrier for deflection of moving materials. This option would involve high risk of potentially damaging the patio or historic structure, even if there were no occupants at the time of work.

The conceptual design cost estimate is for the geotechnical work items only and doesn't represent a complete design and construction cost estimate.

### **Geotechnical Estimating Factors:**

#### **Option 1 - Monitoring**

| Item                                                       | Unit  | Amount | Unit Cost | Total Cost      |
|------------------------------------------------------------|-------|--------|-----------|-----------------|
| Visual monitoring by Park staff<br>(2hrs/month for 1 year) | Hours | 24     | \$ 150    | \$ 3,600        |
| Park Re-Rating (3 to 5 year interval)                      | Each  | 1      | \$ 4,000  | \$ 4,000        |
| <b>Option 1 Total Estimated Costs</b>                      |       |        |           | <b>\$ 7,600</b> |

#### **Option 2 - Mitigation - Rock Stabilization (Concrete Buttress)**

| Item                                  | Unit     | Amount | Unit Cost | Total Cost       |
|---------------------------------------|----------|--------|-----------|------------------|
| Final Geotechnical Design/ Assistance | Lump Sum | 1      | \$ 15,000 | \$ 15,000        |
| Concrete                              | Cubic Yd | 15     | \$ 1,000  | \$ 15,000        |
| Site Preparation/ Formwork/ Mob.      | Lump Sum | 1      | \$ 15,000 | \$ 15,000        |
| <b>Option 2 Total Estimated Costs</b> |          |        |           | <b>\$ 45,000</b> |

#### **Option 3 - Mitigation - Rock Removal**

| Item                                  | Unit     | Amount | Unit Cost | Total Cost       |
|---------------------------------------|----------|--------|-----------|------------------|
| Geotechnical Design/ Tech Assistance  | Lump Sum | 1      | \$ 5,000  | \$ 5,000         |
| Movable Rockfall Fence                | Lump Sum | 1      | \$ 50,000 | \$ 50,000        |
| Site Preparation                      | Lump Sum | 1      | \$ 1,000  | \$ 1,000         |
| <b>Option 3 Total Estimated Costs</b> |          |        |           | <b>\$ 56,000</b> |

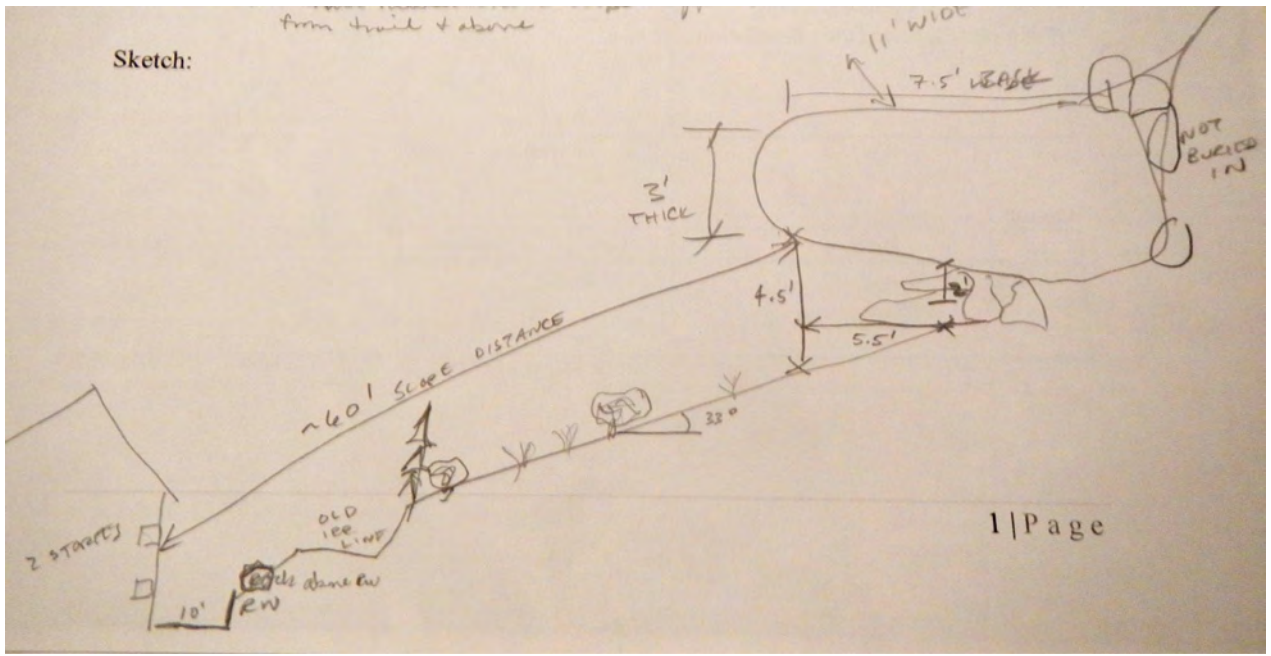


Figure 1431A: Sketch illustrating slope profile of the unstable boulder.



Figure 1431A: Photograph looking downslope from the top of the unstable boulder.

## **Zion National Park Unstable Slope Corridor Assessment**

**SITE:** 1234

**Evaluated By:** EB/DAA/MDD

**Date:** 10-26-2018

**Agency:** NPS

**Region:** Intermountain Region

**Park:** ZION

**Building:** Above park dorm and maintenance shed

**Road (RIP Route No.):** 0412 Concessionaire/Dorm Access Road

**Beginning:** 37.24605, -112.95501

**Ending:** 37.24817, -112.9565

**Numerical Rating:** 870

### **Problem Definition/ Description:**

This unstable slope extends approximately 621 feet long behind the dorm and maintenance shed on RIP Rout 0412, with a maximum evaluated slope height of approximately 145 feet. Evaluated rockfall source areas consist of unravelling alluvium/ colluvium slopes with large, loose sandstone boulders, and outcrops of sandstone interbedded with siltstone/ mudstone of the Kayenta Formation above. Rock outcrops in the source area are horizontally bedded and cross-jointed, which results in variable sized rockfall blocks ranging from approximately 1- to 5-foot cubes. The primary rock potential failure mechanism is differential erosion of the weaker siltstone/ mudstones underlying the sandstone, which can create tension cracks in overlying sandstone leading to toppling failures of the massive sandstone units. In combination, common secondary failure mechanisms due to the release planes created by structural discontinuities, such as joints and fractures, include direct sliding and wedge failures. The primary potential failure mechanism of the colluvium slope is differential erosion of the soils undermining the sandstone boulders, leading to toppling of the boulders. Generally, soil erosion and failures occur during or directly after precipitation events and can also be triggered from an unmarked hiking trail use that accesses the cliffs above the dorms. This location does not have a history of events; however, boulders of concern have been identified and rocks can be heard moving on the slope. As the dorm is occupied at night and the maintenance shop is occupied during the day, this sight has a high human exposure rating.

### **Problem Correction:**

**Option 1 – Monitoring:** As discussed in the main report, monitoring by the Park is always an option at this unstable slope location, but it is a temporary risk reduction method, not a long-term mitigation measure. It is also recommended to rate the slope on a 3- to 5-year basis or after significant precipitation events to determine if there are any significant changes in the unstable slope conditions. USMP “New Slope Event” and “Maintenance Tracking” forms can be used to easily record new information.

**Option 2 – Temporary Risk Reduction – Rockfall Protection (Rockfall Fence):** A detailed site evaluation will be required to determine mitigated options for risk reduction of rockfall hazards. The scale of some rockfall hazards may be too large to feasibly address long-term. Preliminary site evaluation and rockfall analysis indicates rockfall protection measures could protect the residence from typical rockfall events (not the largest event). The unstable slope at this location would likely require a flexible rockfall barrier installed along the entire length of the dorm and maintenance shed, approximately 140 feet. The fence would likely be located upslope of the residence and maintenance shop by at least 25 feet to allow for deformation of rockfall impacts to the system and a clean-out area for maintenance. A preliminary location midslope was identified that would have limited vegetation removal and have a low aesthetic impact. The fence would require annual maintenance to remove captured rocks. Prior to the installation of the fence, large rock features may need to be reinforced and the slope should be safety scaled to remove large boulders that are hazardous to construction personnel and/or beyond the capacity of the fence to stop. During this scaling operation, the residential structure would need to be protected, possibly with a temporary rockfall fence or diversion structure, is included in the conceptual estimate.

The conceptual design cost estimate is for the geotechnical work items only and doesn't represent a complete design and construction cost estimate.

## **Geotechnical Estimating Factors:**

### **Option 1 - Monitoring**

| Item                                  | Unit | Amount | Unit Cost | Total Cost      |
|---------------------------------------|------|--------|-----------|-----------------|
| Park Monitoring (ad hoc/yr)           | Each | 1      | \$ 1,000  | \$ 1,000        |
| Park Re-Rating (3 to 5 yr interval)   | Each | 1      | \$ 4,000  | \$ 4,000        |
| <b>Option 1 Total Estimated Costs</b> |      |        |           | <b>\$ 5,000</b> |

### **Option 2 - Temporary Risk Reduction- Rockfall Fence**

| Item                                   | Unit        | Amount | Unit Cost | Total Cost          |
|----------------------------------------|-------------|--------|-----------|---------------------|
| Final Geotechnical Design              | Lump Sum    | 1      | \$ 20,000 | \$ 20,000           |
| Scaling                                | Scaler Hour | 400    | \$ 300    | \$ 120,000          |
| Movable Rockfall Fence                 | Lump Sum    | 1      | \$ 50,000 | \$ 50,000           |
| Debris Removal                         | Cubic Yd    | 300    | \$ 40     | \$ 12,000           |
| Flexible Rockfall Barrier Materials    | Lineal Foot | 140    | \$ 2,000  | \$ 280,000          |
| Flexible Rockfall Barrier Installation | Lineal Foot | 140    | \$ 6,000  | \$ 840,000          |
| <b>Option 2 Total Estimated Costs</b>  |             |        |           | <b>\$ 1,322,000</b> |

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## **APPENDIX C**

### **USMP Rating Sheets (From Phase I Assessment) and Site Photographs**

**Presented in order by Route/Location  
(corresponding to order presented in Table 3-1)**

**ROUTE 0010/ Zion-Mt. Carmel Hwy**

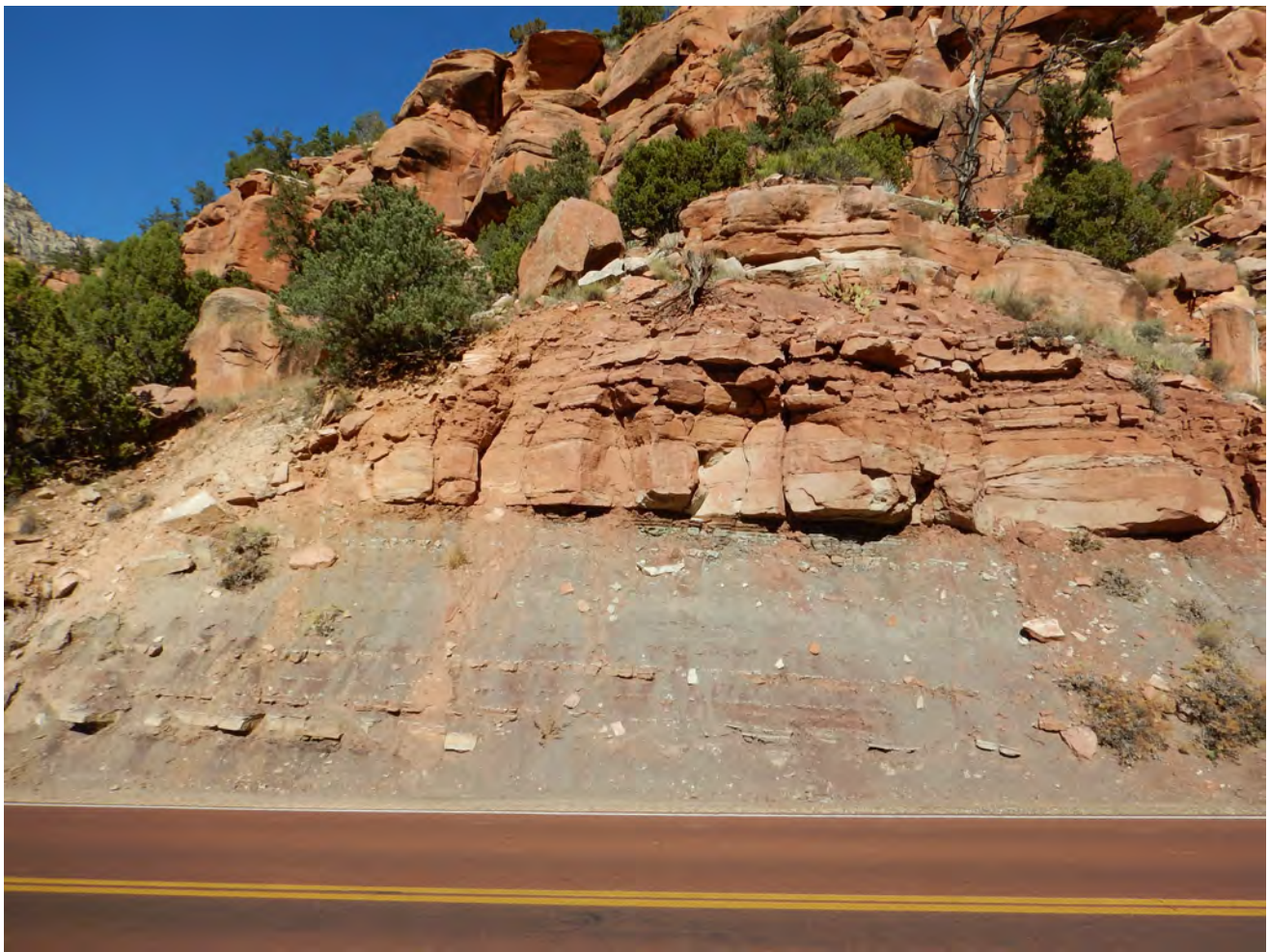
**SITE: 997A**

| Slope Rating Form - Site Information (Rockfall)                                                                                        |                                                             |                                                                                                     |                                                                           |                                                                                                                                                                                                                                                                                                                                             |               |
|----------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| <b>Management Area:</b><br><div>NPS</div> <div>IMR</div> <div>ZION</div>                                                               |                                                             | <b>Date:</b> 2020-02-28 14:19:15<br>Last edit: 2018-10-25 11:25:46<br>Edit ID: 5127<br>Site ID: 997 |                                                                           | <b>Hazard Type:</b> Press (ctrl+click) to select more than one<br><div> <input checked="" type="radio"/> Rockfall<br/> <input type="radio"/> Landslide           </div> <div>             Raveling/Undermining<br/>             Rock Avalanche<br/>             Indeterminate Rock Failures<br/>             Diff. Erosion           </div> |               |
| <b>Road/Trail No:</b> 0                                                                                                                | <b>Road/Trail:</b> R                                        | <b>Road/Trail Class:</b> 0                                                                          | <b>Rater:</b> Justin LaForge                                              |                                                                                                                                                                                                                                                                                                                                             |               |
| <b>Beginning Mile Marker:</b> 0                                                                                                        | <b>Ending Mile Marker:</b> 0                                | <b>Side:</b> N - if road direction r                                                                | <b>Weather:</b> Unknown                                                   |                                                                                                                                                                                                                                                                                                                                             |               |
| <b>Begin Coord. Lat/Long:</b><br>Lat (###.#####): 37.21748292<br>Long (-###.#####): -112.9699522                                       |                                                             | <b>End Coord. Lat/Long:</b><br>Lat (###.#####): 37.21720399<br>Long (-###.#####): -112.96860262     |                                                                           | <b>Datum:</b> WGS 84<br><b>AADT:</b> 8000                                                                                                                                                                                                                                                                                                   |               |
| <b>Length of Affected Road/Trail (ft):</b> 407                                                                                         | <b>Slope Height (rock)/Axial Length (slide) (ft):</b> 140   |                                                                                                     |                                                                           | <b>Slope Angle (°):</b> 40                                                                                                                                                                                                                                                                                                                  |               |
| <b>Sight Distance (ft):</b> 400                                                                                                        | <b>Usable Roadway/Trail Width (ft):</b> 26                  |                                                                                                     |                                                                           | <b>Speed Limit (mph):</b> 35                                                                                                                                                                                                                                                                                                                |               |
| <b>Ditch Width Range (ft):</b> 2 - 12                                                                                                  | <b>Ditch Depth Range (ft):</b> 1 - 1                        | <b>Ditch Slope Range (H:V):</b> 0 : 0 - 0 : 0                                                       |                                                                           | <b>Block Size (ft):</b> 20<br><b>Volume (cy):</b> 0                                                                                                                                                                                                                                                                                         |               |
| <b>Annual Rainfall Range (in):</b> 15 - 16                                                                                             | <b>Sole Access Route:</b> No                                | <b>Mitigation Present:</b> NO                                                                       |                                                                           | <b>Photos/Documents(up to 10MB):</b><br><div>Choose Files</div> No file chosen                                                                                                                                                                                                                                                              |               |
| <b>Comments:</b> Slope split into three slopes, 997, 5123, and 5124. Split by Eric Bilderback on 25-Oct-2018.<br>New Photos- 4021-4024 |                                                             |                                                                                                     |                                                                           |                                                                                                                                                                                                                                                                                                                                             |               |
| <b>Alternate database Name:</b>                                                                                                        |                                                             |                                                                                                     | <b>Alternate database ID:</b>                                             |                                                                                                                                                                                                                                                                                                                                             |               |
| <b>Alternate database Description:</b>                                                                                                 |                                                             |                                                                                                     |                                                                           |                                                                                                                                                                                                                                                                                                                                             |               |
| Preliminary Ratings                                                                                                                    |                                                             |                                                                                                     |                                                                           |                                                                                                                                                                                                                                                                                                                                             |               |
| <b>Category Rating:</b>                                                                                                                | <b>3</b>                                                    | <b>9</b>                                                                                            | <b>27</b>                                                                 | <b>81</b>                                                                                                                                                                                                                                                                                                                                   | <b>Score:</b> |
| <b>A. Landslide - Roadway Width Affected:</b>                                                                                          | 0-5 percent                                                 | 6-25 percent                                                                                        | 26-50 percent                                                             | 51-100 percent                                                                                                                                                                                                                                                                                                                              | 0             |
| <b>B. Landslide - Slide/Erosion Effects:</b>                                                                                           | Visible crack or slight deposit of material / minor erosion | 1 inch offset, or 6-inch deposit of material / major erosion will affect travel in < 5 years        | 2-inch offset or 12-inch deposit / mod. erosion impacting travel annually | 4-inch offset or 24-inch deposit / severe erosion impacting travel consistently                                                                                                                                                                                                                                                             | 0             |
| <b>C. Landslide - Roadway Length Affected:</b>                                                                                         | 25 ft                                                       | 100 ft                                                                                              | 225 ft                                                                    | 400 ft                                                                                                                                                                                                                                                                                                                                      | 0             |
| <b>D. Rockfall - Ditch Effectiveness: (consider launch features)</b>                                                                   | Good                                                        | Moderate                                                                                            | Limited                                                                   | No Catchment                                                                                                                                                                                                                                                                                                                                | 27            |

|                                                                                          |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
|------------------------------------------------------------------------------------------|-----------------------------|---------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------|----|
| <b>E. Rockfall - Rockfall History:</b>                                                   |                             | Few Falls                                               | Occasional Falls                                                                     | Many Falls                                                                                  | Constant Falls                                                              | 3                                                                                       |                                                                                     |                                     |    |
| <b>F. Rockfall - Block Size or Volume per Event:</b>                                     |                             | 1ft or 3yd^3                                            | 2ft or 6yd^3                                                                         | 3ft or 9yd^3                                                                                | 4ft or 12yd^3                                                               | 100                                                                                     |                                                                                     |                                     |    |
| <b>G. All - Impact on Use:</b>                                                           |                             | Full use continues with minor delay                     | Partial use remains Use modification required, short (3mi / 30min.) detour available | Use is blocked - long (>30min.) detour available or less than 1 day closure                 | Use is blocked - no detour available or closure longer than 1 week          | 27                                                                                      |                                                                                     |                                     |    |
| <b>H. All - AADT/Usage/Economic or Recreational Importance (highest rating applies):</b> |                             | 50 Rarely Used Insignificant economic / rec. importance | 200 Occasionally used Minor economic / rec. importance                               | 450 Frequently used Moderate economic / rec. importance                                     | 800 Constantly used Significant economic / rec. importance                  | <b>Use AADT in calculation:</b> <input checked="" type="checkbox"/><br>100              |                                                                                     |                                     |    |
| <b>Preliminary Rating Landslide Total (A+B+C+G+H):</b>                                   |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
| <b>Preliminary Rating Rockfall Total (D+E+F+G+H):</b>                                    |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 257                                                                                     |                                                                                     |                                     |    |
| <b>Preliminary Rating</b> Good (15-21 pts)   Fair (22-161 pts)   Poor (>161 pts)         |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 257                                                                                     |                                                                                     |                                     |    |
| <b>Slope Hazard Ratings</b>                                                              |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
| <b>Category Rating:</b>                                                                  |                             |                                                         | <b>3</b>                                                                             | <b>9</b>                                                                                    | <b>27</b>                                                                   | <b>81</b>                                                                               | <b>Score:</b>                                                                       |                                     |    |
| <b>I. All - Slope Drainage:</b>                                                          |                             |                                                         | Slope appears dry or well drained; surface runoff well controlled                    | Intermittent water on slope; mod. not well drained; or surface runoff moderately controlled | Water usually on slope; poorly drained; or surface runoff poorly controlled | Water always on slope; very poorly drained; or surface water runoff control not present | 3                                                                                   |                                     |    |
| <b>J. All - Annual Rainfall:</b>                                                         |                             |                                                         | 0-10"                                                                                | 10-30"                                                                                      | 30-60"                                                                      | 60"+                                                                                    | 9                                                                                   |                                     |    |
| <b>K. All - Slope Height (Rockfall) / Axial Length of slide (Landslide):</b>             |                             |                                                         | 25ft                                                                                 | 50ft                                                                                        | 75ft                                                                        | 100ft                                                                                   | 100                                                                                 |                                     |    |
| <b>Select One Unstable Slope Type</b>                                                    | <b>Landslides / Erosion</b> | <b>L. Thaw Stability:</b>                               |                                                                                      | Unfrozen / Thaw Stable                                                                      | Slightly Thaw Unstable                                                      | Moderately Thaw Unstable                                                                | Highly Thaw Unstable                                                                | 0                                   |    |
|                                                                                          |                             | <b>M. Instability - Related Maint. Frequency:</b>       |                                                                                      | Every 10 years                                                                              | Every 5 years                                                               | Every 2 years                                                                           | Every year                                                                          | 0                                   |    |
|                                                                                          |                             | <b>N. Movement History:</b>                             |                                                                                      | Minor movement or sporadic creep                                                            | Up to 1 inch annually or steady annual creep                                | Up to 3 inches per event, one event per year                                            | >3" per event, >6" annually, more than 1 event per year (includes all debris flows) | 0                                   |    |
|                                                                                          | <b>Rockfalls</b>            | <b>O. Rockfall-Related Maint. Frequency:</b>            |                                                                                      | Normal, scheduled maintenance                                                               | Patrols after every storm event                                             | Routine seasonal patrols                                                                | Year round patrols                                                                  | 81                                  |    |
|                                                                                          |                             | <b>Geological Character Case 1</b>                      | <b>P. Structural Condition:</b>                                                      |                                                                                             | favorable                                                                   | random                                                                                  | Discontinuous adverse                                                               | Continuous adverse                  | 81 |
|                                                                                          |                             |                                                         | <b>Q. Rock Friction:</b>                                                             |                                                                                             | Rough / Irregular                                                           | Undulating                                                                              | Planar                                                                              | Clay infilled / Slickensided        | 9  |
|                                                                                          |                             | <b>Geological Character Case 2</b>                      |                                                                                      | <b>R. Structural Condition:</b>                                                             | Few differential erosion features                                           | Occasional differential erosion features                                                | Many differential erosion features                                                  | Major differential erosion features | 0  |

|                                                                                                                       |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
|-----------------------------------------------------------------------------------------------------------------------|----------------------------------------|------------------------------------------|---------------------------------------------------------|-----------------------------------------------------|---------------------|------------------|--------------------|-----|
|                                                                                                                       |                                        |                                          | <b>S. Diff. in Erosion Rates:</b>                       | Small difference                                    | Moderate difference | Large difference | Extreme difference | 0   |
| <b>T. LANDSLIDE HAZARD TOTAL (A+B+C+I+J+K+L+M+N):</b>                                                                 |                                        |                                          |                                                         |                                                     |                     |                  |                    | 0   |
| <b>U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greater of P+Q or R+S)):</b>                                              |                                        |                                          |                                                         |                                                     |                     |                  |                    | 485 |
| <b>Risk Ratings</b>                                                                                                   |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
| <b>V. Route Width or Trail Width:</b>                                                                                 | 36ft<br>14ft                           | 28ft<br>10ft                             | 20ft<br>6ft                                             | 12ft<br>2ft                                         | 12                  |                  |                    |     |
| <b>W. Human Exposure Factor:</b>                                                                                      | 12.5% of the time                      | 25% of the time                          | 37.5% of the time                                       | 50% of the time                                     | 100                 |                  |                    |     |
| <b>X. % of Decision Sight Distance (Judge avoidance ability on trails):</b>                                           | Adequate, 100% of the low design value | Moderate, 80% of the low design value    | Limited, 60% of the low design value                    | Very limited, 40% of the low design value           | 11                  |                  |                    |     |
| <b>Y. Right of Way (R/W) Impacts (If Left Unattended):</b>                                                            | No R/W implications                    | Minor effects beyond R/W                 | Private property, no structures affected                | Structures, roads, RR, utilities, or Parks affected | 3                   |                  |                    |     |
| <b>Z. Environmental/Cultural Impacts if Left Unattended:</b>                                                          | None/No Potential to Cause Effects     | Likely to Effect/No Hist. Prop. Affected | Likely to adversely Affect/Finding of No Adverse Effect | Current adverse effects/Adverse Effect              | 3                   |                  |                    |     |
| <b>AA. Maintenance Complexity:</b>                                                                                    | Routine Effort / In-House              | In-House maint. / special project        | Specialized equip. / contract                           | Complex / dangerous effort / location / contract    | 27                  |                  |                    |     |
| <b>BB. Event Cost:</b>                                                                                                | \$0-2k                                 | \$2-25k                                  | \$25-100k                                               | >\$100k                                             | 27                  |                  |                    |     |
| <b>CC. Risk Totals (G+H+V+W+X+Y+Z+AA+BB):</b>                                                                         |                                        |                                          |                                                         |                                                     |                     |                  |                    | 310 |
| <b>TOTAL USMP SCORE: LANDSLIDES (T+CC) OR ROCKFALL (U+CC):</b> Good (<200 pts)   Fair (200-400 pts)   Poor (>400 pts) |                                        |                                          |                                                         |                                                     |                     |                  |                    | 795 |





**SITE: 5123 (997B)**

| Slope Rating Form - Site Information (Rockfall)                                                   |                                                             |                                                                                                      |                                                                           |                                                                                                                         |               |
|---------------------------------------------------------------------------------------------------|-------------------------------------------------------------|------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|---------------|
| <b>Management Area:</b><br><div>NPS</div> <div>IMR</div> <div>ZION</div>                          |                                                             | <b>Date:</b> 2020-02-28 14:45:12<br>Last edit: 2018-10-25 11:34:49<br>Edit ID: 5128<br>Site ID: 5123 |                                                                           | <b>Hazard Type:</b> Press (ctrl+click) to select more than one<br><div> <div>Rockfall</div> <div>Landslide</div> </div> |               |
| <b>Road/Trail No:</b> 9                                                                           |                                                             | <b>Road/Trail:</b> R                                                                                 |                                                                           | <b>Road/Trail Class:</b> 0                                                                                              |               |
| <b>Beginning Mile Marker:</b> 0                                                                   |                                                             | <b>Ending Mile Marker:</b> 0                                                                         |                                                                           | <b>Side:</b> N - if road direction r                                                                                    |               |
| <b>Begin Coord. Lat/Long:</b><br>Lat (###.#####): 37.21719681<br>Long (-###.#####): -112.96857461 |                                                             | <b>End Coord. Lat/Long:</b><br>Lat (###.#####): 37.21707695<br>Long (-###.#####): -112.9679438       |                                                                           | <b>Datum:</b> WGS 84                                                                                                    |               |
| <b>Length of Affected Road/Trail (ft):</b> 190                                                    |                                                             | <b>Slope Height (rock)/Axial Length (slide) (ft):</b> 136                                            |                                                                           | <b>Slope Angle (°):</b> 50                                                                                              |               |
| <b>Sight Distance (ft):</b> 198                                                                   |                                                             | <b>Usable Roadway/Trail Width (ft):</b> 26                                                           |                                                                           | <b>Speed Limit (mph):</b> 35                                                                                            |               |
| <b>Ditch Width Range (ft):</b> 7 - 8                                                              |                                                             | <b>Ditch Depth Range (ft):</b> 0.5 - 0.5                                                             |                                                                           | <b>Ditch Slope Range (H:V):</b> 0 : 0 - 0 : 0                                                                           |               |
| <b>Block Size (ft):</b> 20<br><b>Volume (cy):</b> 0                                               |                                                             | <b>Annual Rainfall Range (in):</b> 15 - 16                                                           |                                                                           | <b>Sole Access Route:</b> No                                                                                            |               |
| <b>Mitigation Present:</b> NO                                                                     |                                                             | <b>Photos/Documents(up to 10MB):</b><br><div>Choose Files</div> No file chosen                       |                                                                           |                                                                                                                         |               |
| <b>Comments:</b> Split from slope 997 on 25-Oct-2018. Photo 4025-4027                             |                                                             |                                                                                                      |                                                                           |                                                                                                                         |               |
| <b>Alternate database Name:</b>                                                                   |                                                             |                                                                                                      | <b>Alternate database ID:</b>                                             |                                                                                                                         |               |
| <b>Alternate database Description:</b>                                                            |                                                             |                                                                                                      |                                                                           |                                                                                                                         |               |
| Preliminary Ratings                                                                               |                                                             |                                                                                                      |                                                                           |                                                                                                                         |               |
| <b>Category Rating:</b>                                                                           | <b>3</b>                                                    | <b>9</b>                                                                                             | <b>27</b>                                                                 | <b>81</b>                                                                                                               | <b>Score:</b> |
| <b>A. Landslide - Roadway Width Affected:</b>                                                     | 0-5 percent                                                 | 6-25 percent                                                                                         | 26-50 percent                                                             | 51-100 percent                                                                                                          | 0             |
| <b>B. Landslide - Slide/Erosion Effects:</b>                                                      | Visible crack or slight deposit of material / minor erosion | 1 inch offset, or 6-inch deposit of material / major erosion will affect travel in < 5 years         | 2-inch offset or 12-inch deposit / mod. erosion impacting travel annually | 4-inch offset or 24-inch deposit / severe erosion impacting travel consistently                                         | 0             |
| <b>C. Landslide - Roadway Length Affected:</b>                                                    | 25 ft                                                       | 100 ft                                                                                               | 225 ft                                                                    | 400 ft                                                                                                                  | 0             |
| <b>D. Rockfall - Ditch Effectiveness: (consider launch features)</b>                              | Good                                                        | Moderate                                                                                             | Limited                                                                   | No Catchment                                                                                                            | 27            |

|                                                                                          |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
|------------------------------------------------------------------------------------------|-----------------------------|---------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------|----|
| <b>E. Rockfall - Rockfall History:</b>                                                   |                             | Few Falls                                               | Occasional Falls                                                                     | Many Falls                                                                                  | Constant Falls                                                              | 3                                                                                       |                                                                                     |                                     |    |
| <b>F. Rockfall - Block Size or Volume per Event:</b>                                     |                             | 1ft or 3yd^3                                            | 2ft or 6yd^3                                                                         | 3ft or 9yd^3                                                                                | 4ft or 12yd^3                                                               | 100                                                                                     |                                                                                     |                                     |    |
| <b>G. All - Impact on Use:</b>                                                           |                             | Full use continues with minor delay                     | Partial use remains Use modification required, short (3mi / 30min.) detour available | Use is blocked - long (>30min.) detour available or less than 1 day closure                 | Use is blocked - no detour available or closure longer than 1 week          | 27                                                                                      |                                                                                     |                                     |    |
| <b>H. All - AADT/Usage/Economic or Recreational Importance (highest rating applies):</b> |                             | 50 Rarely Used Insignificant economic / rec. importance | 200 Occasionally used Minor economic / rec. importance                               | 450 Frequently used Moderate economic / rec. importance                                     | 800 Constantly used Significant economic / rec. importance                  | <b>Use AADT in calculation:</b> <input checked="" type="checkbox"/><br>100              |                                                                                     |                                     |    |
| <b>Preliminary Rating Landslide Total (A+B+C+G+H):</b>                                   |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
| <b>Preliminary Rating Rockfall Total (D+E+F+G+H):</b>                                    |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 257                                                                                     |                                                                                     |                                     |    |
| <b>Preliminary Rating</b> Good (15-21 pts)   Fair (22-161 pts)   Poor (>161 pts)         |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 257                                                                                     |                                                                                     |                                     |    |
| <b>Slope Hazard Ratings</b>                                                              |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
| <b>Category Rating:</b>                                                                  |                             |                                                         | <b>3</b>                                                                             | <b>9</b>                                                                                    | <b>27</b>                                                                   | <b>81</b>                                                                               | <b>Score:</b>                                                                       |                                     |    |
| <b>I. All - Slope Drainage:</b>                                                          |                             |                                                         | Slope appears dry or well drained; surface runoff well controlled                    | Intermittent water on slope; mod. not well drained; or surface runoff moderately controlled | Water usually on slope; poorly drained; or surface runoff poorly controlled | Water always on slope; very poorly drained; or surface water runoff control not present | 3                                                                                   |                                     |    |
| <b>J. All - Annual Rainfall:</b>                                                         |                             |                                                         | 0-10"                                                                                | 10-30"                                                                                      | 30-60"                                                                      | 60"+                                                                                    | 9                                                                                   |                                     |    |
| <b>K. All - Slope Height (Rockfall) / Axial Length of slide (Landslide):</b>             |                             |                                                         | 25ft                                                                                 | 50ft                                                                                        | 75ft                                                                        | 100ft                                                                                   | 100                                                                                 |                                     |    |
| <b>Select One Unstable Slope Type</b>                                                    | <b>Landslides / Erosion</b> | <b>L. Thaw Stability:</b>                               |                                                                                      | Unfrozen / Thaw Stable                                                                      | Slightly Thaw Unstable                                                      | Moderately Thaw Unstable                                                                | Highly Thaw Unstable                                                                | 0                                   |    |
|                                                                                          |                             | <b>M. Instability - Related Maint. Frequency:</b>       |                                                                                      | Every 10 years                                                                              | Every 5 years                                                               | Every 2 years                                                                           | Every year                                                                          | 0                                   |    |
|                                                                                          |                             | <b>N. Movement History:</b>                             |                                                                                      | Minor movement or sporadic creep                                                            | Up to 1 inch annually or steady annual creep                                | Up to 3 inches per event, one event per year                                            | >3" per event, >6" annually, more than 1 event per year (includes all debris flows) | 0                                   |    |
|                                                                                          | <b>Rockfalls</b>            | <b>O. Rockfall-Related Maint. Frequency:</b>            |                                                                                      | Normal, scheduled maintenance                                                               | Patrols after every storm event                                             | Routine seasonal patrols                                                                | Year round patrols                                                                  | 81                                  |    |
|                                                                                          |                             | <b>Geological Character Case 1</b>                      | <b>P. Structural Condition:</b>                                                      |                                                                                             | favorable                                                                   | random                                                                                  | Discontinuous adverse                                                               | Continuous adverse                  | 81 |
|                                                                                          |                             |                                                         | <b>Q. Rock Friction:</b>                                                             |                                                                                             | Rough / Irregular                                                           | Undulating                                                                              | Planar                                                                              | Clay infilled / Slickensided        | 9  |
|                                                                                          |                             | <b>Geological Character Case 2</b>                      |                                                                                      | <b>R. Structural Condition:</b>                                                             | Few differential erosion features                                           | Occasional differential erosion features                                                | Many differential erosion features                                                  | Major differential erosion features | 0  |

|                                                                                                                       |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
|-----------------------------------------------------------------------------------------------------------------------|----------------------------------------|------------------------------------------|---------------------------------------------------------|-----------------------------------------------------|---------------------|------------------|--------------------|-----|
|                                                                                                                       |                                        |                                          | <b>S. Diff. in Erosion Rates:</b>                       | Small difference                                    | Moderate difference | Large difference | Extreme difference | 0   |
| <b>T. LANDSLIDE HAZARD TOTAL (A+B+C+I+J+K+L+M+N):</b>                                                                 |                                        |                                          |                                                         |                                                     |                     |                  |                    | 0   |
| <b>U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greater of P+Q or R+S)):</b>                                              |                                        |                                          |                                                         |                                                     |                     |                  |                    | 485 |
| <b>Risk Ratings</b>                                                                                                   |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
| <b>V. Route Width or Trail Width:</b>                                                                                 | 36ft<br>14ft                           | 28ft<br>10ft                             | 20ft<br>6ft                                             | 12ft<br>2ft                                         | 12                  |                  |                    |     |
| <b>W. Human Exposure Factor:</b>                                                                                      | 12.5% of the time                      | 25% of the time                          | 37.5% of the time                                       | 50% of the time                                     | 20                  |                  |                    |     |
| <b>X. % of Decision Sight Distance (Judge avoidance ability on trails):</b>                                           | Adequate, 100% of the low design value | Moderate, 80% of the low design value    | Limited, 60% of the low design value                    | Very limited, 40% of the low design value           | 92                  |                  |                    |     |
| <b>Y. Right of Way (R/W) Impacts (If Left Unattended):</b>                                                            | No R/W implications                    | Minor effects beyond R/W                 | Private property, no structures affected                | Structures, roads, RR, utilities, or Parks affected | 3                   |                  |                    |     |
| <b>Z. Environmental/Cultural Impacts if Left Unattended:</b>                                                          | None/No Potential to Cause Effects     | Likely to Effect/No Hist. Prop. Affected | Likely to adversely Affect/Finding of No Adverse Effect | Current adverse effects/Adverse Effect              | 3                   |                  |                    |     |
| <b>AA. Maintenance Complexity:</b>                                                                                    | Routine Effort / In-House              | In-House maint. / special project        | Specialized equip. / contract                           | Complex / dangerous effort / location / contract    | 27                  |                  |                    |     |
| <b>BB. Event Cost:</b>                                                                                                | \$0-2k                                 | \$2-25k                                  | \$25-100k                                               | >\$100k                                             | 27                  |                  |                    |     |
| <b>CC. Risk Totals (G+H+V+W+X+Y+Z+AA+BB):</b>                                                                         |                                        |                                          |                                                         |                                                     |                     |                  |                    | 311 |
| <b>TOTAL USMP SCORE: LANDSLIDES (T+CC) OR ROCKFALL (U+CC):</b> Good (<200 pts)   Fair (200-400 pts)   Poor (>400 pts) |                                        |                                          |                                                         |                                                     |                     |                  |                    | 796 |





**SITE: 5124 (997C)**

| Slope Rating Form - Site Information (Rockfall)                                                                                                                                                                                                               |                                                                                                                                                                |                                                                                                                                                                                                                     |                                                                                                                                                                                                                                         |                                                                                                                                                                         |                                                                             |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|
| <b>Management Area:</b><br><div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;">NPS</div> <div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;">IMR</div> <div style="border: 1px solid black; padding: 2px;">ZION</div> | <b>Date:</b> <div style="border: 1px solid black; padding: 2px;">2020-02-28 14:45:59</div><br>Last edit: 2018-10-25 11:36:59<br>Edit ID: 5129<br>Site ID: 5124 | <input checked="" type="radio"/> Rockfall<br><input type="radio"/> Landslide                                                                                                                                        | <b>Hazard Type:</b> Press (ctrl+click) to select more than one<br><div style="border: 1px solid black; padding: 2px;">           Planar<br/>           Wedge<br/>           Toppling<br/>           Raveling/Undermining         </div> |                                                                                                                                                                         |                                                                             |
| <b>Road/Trail No:</b> <div style="border: 1px solid black; padding: 2px;">9</div>                                                                                                                                                                             | <b>Road/Trail:</b> <div style="border: 1px solid black; padding: 2px;">R</div>                                                                                 | <b>Road/Trail Class:</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                | <b>Rater:</b> <div style="border: 1px solid black; padding: 2px;">Eric Bilderback</div>                                                                                                                                                 |                                                                                                                                                                         |                                                                             |
| <b>Beginning Mile Marker:</b><br><div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                  | <b>Ending Mile Marker:</b><br><div style="border: 1px solid black; padding: 2px;">0</div>                                                                      | <b>Side:</b> <div style="border: 1px solid black; padding: 2px;">N - if road direction r</div>                                                                                                                      | <b>Weather:</b> <div style="border: 1px solid black; padding: 2px;">Clear</div>                                                                                                                                                         |                                                                                                                                                                         |                                                                             |
| <b>Begin Coord. Lat/Long:</b><br>Lat (###.#####): <div style="border: 1px solid black; padding: 2px;">37.21700603</div><br>Long (-###.#####): <div style="border: 1px solid black; padding: 2px;">-112.96758033</div>                                         |                                                                                                                                                                | <b>End Coord. Lat/Long:</b><br>Lat (###.#####): <div style="border: 1px solid black; padding: 2px;">37.21689695</div><br>Long (-###.#####): <div style="border: 1px solid black; padding: 2px;">-112.96679405</div> |                                                                                                                                                                                                                                         | <b>Datum:</b> <div style="border: 1px solid black; padding: 2px;">WGS 84</div>                                                                                          | <b>AADT:</b> <div style="border: 1px solid black; padding: 2px;">8000</div> |
| <b>Length of Affected Road/Trail (ft):</b><br><div style="border: 1px solid black; padding: 2px;">318</div>                                                                                                                                                   | <b>Slope Height (rock)/Axial Length (slide) (ft):</b><br><div style="border: 1px solid black; padding: 2px;">128</div>                                         |                                                                                                                                                                                                                     |                                                                                                                                                                                                                                         | <b>Slope Angle (°):</b> <div style="border: 1px solid black; padding: 2px;">52</div>                                                                                    |                                                                             |
| <b>Sight Distance (ft):</b><br><div style="border: 1px solid black; padding: 2px;">190</div>                                                                                                                                                                  | <b>Usable Roadway/Trail Width (ft):</b><br><div style="border: 1px solid black; padding: 2px;">26</div>                                                        |                                                                                                                                                                                                                     |                                                                                                                                                                                                                                         | <b>Speed Limit (mph):</b><br><div style="border: 1px solid black; padding: 2px;">35</div>                                                                               |                                                                             |
| <b>Ditch Width Range (ft):</b><br><div style="border: 1px solid black; padding: 2px;">3-7</div>                                                                                                                                                               | <b>Ditch Depth Range (ft):</b><br><div style="border: 1px solid black; padding: 2px;">0.5-0.5</div>                                                            | <b>Ditch Slope Range (H:V):</b><br><div style="border: 1px solid black; padding: 2px;">0:0-0:0</div>                                                                                                                |                                                                                                                                                                                                                                         | <b>Block Size (ft):</b> <div style="border: 1px solid black; padding: 2px;">20</div><br><b>Volume (cy):</b> <div style="border: 1px solid black; padding: 2px;">0</div> |                                                                             |
| <b>Annual Rainfall Range (in):</b><br><div style="border: 1px solid black; padding: 2px;">15-16</div>                                                                                                                                                         | <b>Sole Access Route:</b> <div style="border: 1px solid black; padding: 2px;">No</div>                                                                         | <b>Mitigation Present:</b> <div style="border: 1px solid black; padding: 2px;">NO</div>                                                                                                                             |                                                                                                                                                                                                                                         | <b>Photos/Documents(up to 10MB):</b><br><div style="border: 1px solid black; padding: 2px;">           Choose Files No file chosen         </div>                       |                                                                             |
| <div style="border: 1px solid black; padding: 5px;">           Split from 997 on 25-Oct-2018. Photo 4028-4030         </div>                                                                                                                                  |                                                                                                                                                                |                                                                                                                                                                                                                     |                                                                                                                                                                                                                                         |                                                                                                                                                                         |                                                                             |
| <b>Comments:</b>                                                                                                                                                                                                                                              |                                                                                                                                                                |                                                                                                                                                                                                                     |                                                                                                                                                                                                                                         |                                                                                                                                                                         |                                                                             |
| <b>Alternate database Name:</b><br><div style="border: 1px solid black; height: 30px; width: 100%;"></div>                                                                                                                                                    |                                                                                                                                                                |                                                                                                                                                                                                                     | <b>Alternate database ID:</b><br><div style="border: 1px solid black; height: 30px; width: 100%;"></div>                                                                                                                                |                                                                                                                                                                         |                                                                             |
| <b>Alternate database Description:</b><br><div style="border: 1px solid black; height: 40px; width: 100%;"></div>                                                                                                                                             |                                                                                                                                                                |                                                                                                                                                                                                                     |                                                                                                                                                                                                                                         |                                                                                                                                                                         |                                                                             |
| Preliminary Ratings                                                                                                                                                                                                                                           |                                                                                                                                                                |                                                                                                                                                                                                                     |                                                                                                                                                                                                                                         |                                                                                                                                                                         |                                                                             |
| Category Rating:                                                                                                                                                                                                                                              | 3                                                                                                                                                              | 9                                                                                                                                                                                                                   | 27                                                                                                                                                                                                                                      | 81                                                                                                                                                                      | Score:                                                                      |
| <b>A. Landslide - Roadway Width Affected:</b>                                                                                                                                                                                                                 | 0-5 percent                                                                                                                                                    | 6-25 percent                                                                                                                                                                                                        | 26-50 percent                                                                                                                                                                                                                           | 51-100 percent                                                                                                                                                          | <div style="border: 1px solid black; padding: 2px;">0</div>                 |
| <b>B. Landslide - Slide/Erosion Effects:</b>                                                                                                                                                                                                                  | Visible crack or slight deposit of material / minor erosion                                                                                                    | 1 inch offset, or 6-inch deposit of material / major erosion will affect travel in < 5 years                                                                                                                        | 2-inch offset or 12-inch deposit / mod. erosion impacting travel annually                                                                                                                                                               | 4-inch offset or 24-inch deposit / severe erosion impacting travel consistently                                                                                         | <div style="border: 1px solid black; padding: 2px;">0</div>                 |
| <b>C. Landslide - Roadway Length Affected:</b>                                                                                                                                                                                                                | 25 ft                                                                                                                                                          | 100 ft                                                                                                                                                                                                              | 225 ft                                                                                                                                                                                                                                  | 400 ft                                                                                                                                                                  | <div style="border: 1px solid black; padding: 2px;">0</div>                 |
| <b>D. Rockfall - Ditch Effectiveness: (consider launch features)</b>                                                                                                                                                                                          | Good                                                                                                                                                           | Moderate                                                                                                                                                                                                            | Limited                                                                                                                                                                                                                                 | No Catchment                                                                                                                                                            | <div style="border: 1px solid black; padding: 2px;">27</div>                |

|                                                                                          |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
|------------------------------------------------------------------------------------------|-----------------------------|---------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------|----|
| <b>E. Rockfall - Rockfall History:</b>                                                   |                             | Few Falls                                               | Occasional Falls                                                                     | Many Falls                                                                                  | Constant Falls                                                              | 3                                                                                       |                                                                                     |                                     |    |
| <b>F. Rockfall - Block Size or Volume per Event:</b>                                     |                             | 1ft or 3yd^3                                            | 2ft or 6yd^3                                                                         | 3ft or 9yd^3                                                                                | 4ft or 12yd^3                                                               | 100                                                                                     |                                                                                     |                                     |    |
| <b>G. All - Impact on Use:</b>                                                           |                             | Full use continues with minor delay                     | Partial use remains Use modification required, short (3mi / 30min.) detour available | Use is blocked - long (>30min.) detour available or less than 1 day closure                 | Use is blocked - no detour available or closure longer than 1 week          | 27                                                                                      |                                                                                     |                                     |    |
| <b>H. All - AADT/Usage/Economic or Recreational Importance (highest rating applies):</b> |                             | 50 Rarely Used Insignificant economic / rec. importance | 200 Occasionally used Minor economic / rec. importance                               | 450 Frequently used Moderate economic / rec. importance                                     | 800 Constantly used Significant economic / rec. importance                  | <b>Use AADT in calculation:</b> <input checked="" type="checkbox"/><br>100              |                                                                                     |                                     |    |
| <b>Preliminary Rating Landslide Total (A+B+C+G+H):</b>                                   |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
| <b>Preliminary Rating Rockfall Total (D+E+F+G+H):</b>                                    |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 257                                                                                     |                                                                                     |                                     |    |
| <b>Preliminary Rating</b> Good (15-21 pts)   Fair (22-161 pts)   Poor (>161 pts)         |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 257                                                                                     |                                                                                     |                                     |    |
| <b>Slope Hazard Ratings</b>                                                              |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
| <b>Category Rating:</b>                                                                  |                             |                                                         | <b>3</b>                                                                             | <b>9</b>                                                                                    | <b>27</b>                                                                   | <b>81</b>                                                                               | <b>Score:</b>                                                                       |                                     |    |
| <b>I. All - Slope Drainage:</b>                                                          |                             |                                                         | Slope appears dry or well drained; surface runoff well controlled                    | Intermittent water on slope; mod. not well drained; or surface runoff moderately controlled | Water usually on slope; poorly drained; or surface runoff poorly controlled | Water always on slope; very poorly drained; or surface water runoff control not present | 3                                                                                   |                                     |    |
| <b>J. All - Annual Rainfall:</b>                                                         |                             |                                                         | 0-10"                                                                                | 10-30"                                                                                      | 30-60"                                                                      | 60"+                                                                                    | 9                                                                                   |                                     |    |
| <b>K. All - Slope Height (Rockfall) / Axial Length of slide (Landslide):</b>             |                             |                                                         | 25ft                                                                                 | 50ft                                                                                        | 75ft                                                                        | 100ft                                                                                   | 100                                                                                 |                                     |    |
| <b>Select One Unstable Slope Type</b>                                                    | <b>Landslides / Erosion</b> | <b>L. Thaw Stability:</b>                               |                                                                                      | Unfrozen / Thaw Stable                                                                      | Slightly Thaw Unstable                                                      | Moderately Thaw Unstable                                                                | Highly Thaw Unstable                                                                | 0                                   |    |
|                                                                                          |                             | <b>M. Instability - Related Maint. Frequency:</b>       |                                                                                      | Every 10 years                                                                              | Every 5 years                                                               | Every 2 years                                                                           | Every year                                                                          | 0                                   |    |
|                                                                                          |                             | <b>N. Movement History:</b>                             |                                                                                      | Minor movement or sporadic creep                                                            | Up to 1 inch annually or steady annual creep                                | Up to 3 inches per event, one event per year                                            | >3" per event, >6" annually, more than 1 event per year (includes all debris flows) | 0                                   |    |
|                                                                                          | <b>Rockfalls</b>            | <b>O. Rockfall-Related Maint. Frequency:</b>            |                                                                                      | Normal, scheduled maintenance                                                               | Patrols after every storm event                                             | Routine seasonal patrols                                                                | Year round patrols                                                                  | 81                                  |    |
|                                                                                          |                             | <b>Geological Character Case 1</b>                      | <b>P. Structural Condition:</b>                                                      |                                                                                             | favorable                                                                   | random                                                                                  | Discontinuous adverse                                                               | Continuous adverse                  | 81 |
|                                                                                          |                             |                                                         | <b>Q. Rock Friction:</b>                                                             |                                                                                             | Rough / Irregular                                                           | Undulating                                                                              | Planar                                                                              | Clay infilled / Slickensided        | 9  |
|                                                                                          |                             | <b>Geological Character Case 2</b>                      |                                                                                      | <b>R. Structural Condition:</b>                                                             | Few differential erosion features                                           | Occasional differential erosion features                                                | Many differential erosion features                                                  | Major differential erosion features | 0  |

|                                                                                                                       |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
|-----------------------------------------------------------------------------------------------------------------------|----------------------------------------|------------------------------------------|---------------------------------------------------------|-----------------------------------------------------|---------------------|------------------|--------------------|-----|
|                                                                                                                       |                                        |                                          | <b>S. Diff. in Erosion Rates:</b>                       | Small difference                                    | Moderate difference | Large difference | Extreme difference | 0   |
| <b>T. LANDSLIDE HAZARD TOTAL (A+B+C+I+J+K+L+M+N):</b>                                                                 |                                        |                                          |                                                         |                                                     |                     |                  |                    | 0   |
| <b>U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greater of P+Q or R+S)):</b>                                              |                                        |                                          |                                                         |                                                     |                     |                  |                    | 485 |
| <b>Risk Ratings</b>                                                                                                   |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
| <b>V. Route Width or Trail Width:</b>                                                                                 | 36ft<br>14ft                           | 28ft<br>10ft                             | 20ft<br>6ft                                             | 12ft<br>2ft                                         | 12                  |                  |                    |     |
| <b>W. Human Exposure Factor:</b>                                                                                      | 12.5% of the time                      | 25% of the time                          | 37.5% of the time                                       | 50% of the time                                     | 100                 |                  |                    |     |
| <b>X. % of Decision Sight Distance (Judge avoidance ability on trails):</b>                                           | Adequate, 100% of the low design value | Moderate, 80% of the low design value    | Limited, 60% of the low design value                    | Very limited, 40% of the low design value           | 100                 |                  |                    |     |
| <b>Y. Right of Way (R/W) Impacts (If Left Unattended):</b>                                                            | No R/W implications                    | Minor effects beyond R/W                 | Private property, no structures affected                | Structures, roads, RR, utilities, or Parks affected | 3                   |                  |                    |     |
| <b>Z. Environmental/Cultural Impacts if Left Unattended:</b>                                                          | None/No Potential to Cause Effects     | Likely to Effect/No Hist. Prop. Affected | Likely to adversely Affect/Finding of No Adverse Effect | Current adverse effects/Adverse Effect              | 3                   |                  |                    |     |
| <b>AA. Maintenance Complexity:</b>                                                                                    | Routine Effort / In-House              | In-House maint. / special project        | Specialized equip. / contract                           | Complex / dangerous effort / location / contract    | 27                  |                  |                    |     |
| <b>BB. Event Cost:</b>                                                                                                | \$0-2k                                 | \$2-25k                                  | \$25-100k                                               | >\$100k                                             | 27                  |                  |                    |     |
| <b>CC. Risk Totals (G+H+V+W+X+Y+Z+AA+BB):</b>                                                                         |                                        |                                          |                                                         |                                                     |                     |                  |                    | 399 |
| <b>TOTAL USMP SCORE: LANDSLIDES (T+CC) OR ROCKFALL (U+CC):</b> Good (<200 pts)   Fair (200-400 pts)   Poor (>400 pts) |                                        |                                          |                                                         |                                                     |                     |                  |                    | 884 |



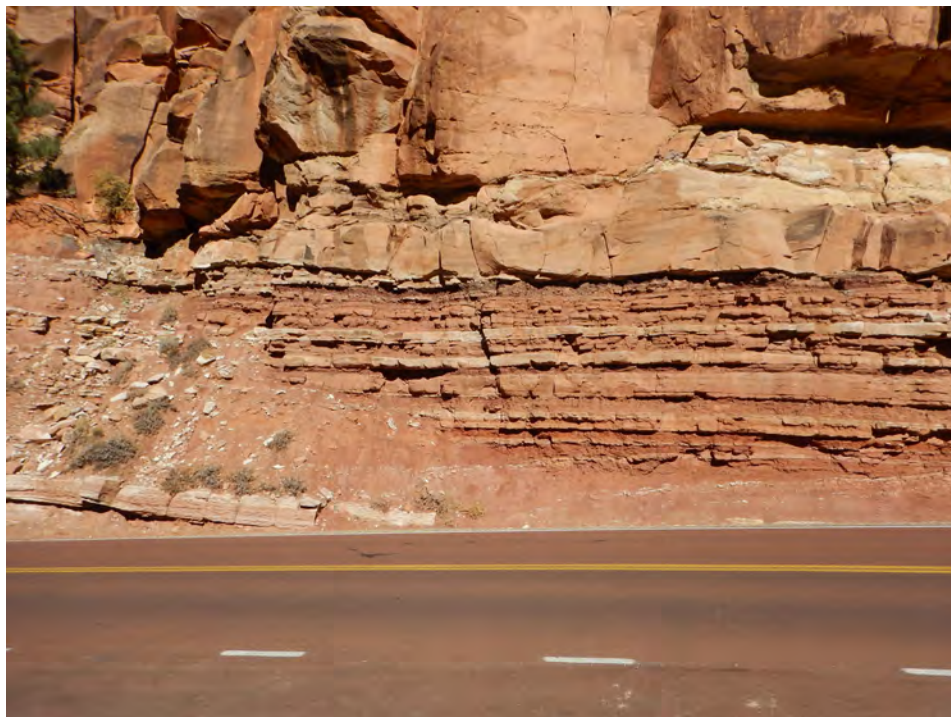


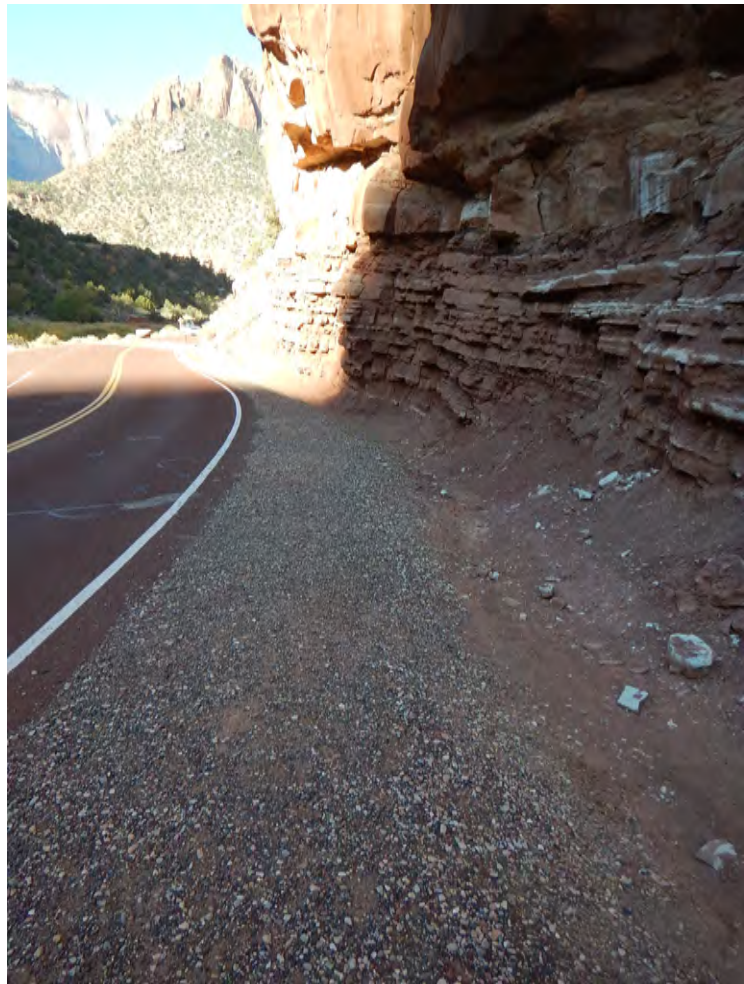
**SITE: 1000**

| Slope Rating Form - Site Information (Rockfall)                                                                                                                                                                                                               |                                                                                                                                                                |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                         |                                                                                                                                                                         |                                                              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|
| <b>Management Area:</b><br><div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;">NPS</div> <div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;">IMR</div> <div style="border: 1px solid black; padding: 2px;">ZION</div> | <b>Date:</b> <div style="border: 1px solid black; padding: 2px;">2020-02-28 14:29:21</div><br>Last edit: 2018-10-18 14:19:07<br>Edit ID: 5021<br>Site ID: 1000 | <input checked="" type="radio"/> Rockfall<br><input type="radio"/> Landslide                                                                                                                                                                                                             | <b>Hazard Type:</b> Press (ctrl+click) to select more than one<br><div style="border: 1px solid black; padding: 2px;">           Planar<br/>           Wedge<br/>           Toppling<br/>           Raveling/Undermining         </div> |                                                                                                                                                                         |                                                              |
| <b>Road/Trail No:</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                             | <b>Road/Trail:</b> <div style="border: 1px solid black; padding: 2px;">R</div>                                                                                 | <b>Road/Trail Class:</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                                                     | <b>Rater:</b> <div style="border: 1px solid black; padding: 2px;">Justin LaForge</div>                                                                                                                                                  |                                                                                                                                                                         |                                                              |
| <b>Beginning Mile Marker:</b><br><div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                  | <b>Ending Mile Marker:</b><br><div style="border: 1px solid black; padding: 2px;">0</div>                                                                      | <b>Side:</b> <div style="border: 1px solid black; padding: 2px;">N - if road direction r</div>                                                                                                                                                                                           | <b>Weather:</b> <div style="border: 1px solid black; padding: 2px;">Clear</div>                                                                                                                                                         |                                                                                                                                                                         |                                                              |
| <b>Begin Coord. Lat/Long:</b><br>Lat (##.#####): <div style="border: 1px solid black; padding: 2px;">37.21694558</div><br>Long (-###.#####): <div style="border: 1px solid black; padding: 2px;">-112.967179511</div>                                         |                                                                                                                                                                | <b>End Coord. Lat/Long:</b><br>Lat (##.#####): <div style="border: 1px solid black; padding: 2px;">37.216805888</div><br>Long (-###.#####): <div style="border: 1px solid black; padding: 2px;">-112.965765757</div>                                                                     |                                                                                                                                                                                                                                         | <b>Datum:</b> <div style="border: 1px solid black; padding: 2px;">WGS 84</div><br><b>AADT:</b> <div style="border: 1px solid black; padding: 2px;">0</div>              |                                                              |
| <b>Length of Affected Road/Trail (ft):</b><br><div style="border: 1px solid black; padding: 2px;">393</div>                                                                                                                                                   | <b>Slope Height (rock)/Axial Length (slide) (ft):</b><br><div style="border: 1px solid black; padding: 2px;">120</div>                                         |                                                                                                                                                                                                                                                                                          | <b>Slope Angle (°):</b> <div style="border: 1px solid black; padding: 2px;">88</div>                                                                                                                                                    |                                                                                                                                                                         |                                                              |
| <b>Sight Distance (ft):</b><br><div style="border: 1px solid black; padding: 2px;">230</div>                                                                                                                                                                  | <b>Usable Roadway/Trail Width (ft):</b><br><div style="border: 1px solid black; padding: 2px;">27</div>                                                        |                                                                                                                                                                                                                                                                                          | <b>Speed Limit (mph):</b><br><div style="border: 1px solid black; padding: 2px;">35</div>                                                                                                                                               |                                                                                                                                                                         |                                                              |
| <b>Ditch Width Range (ft):</b><br><div style="border: 1px solid black; padding: 2px;">4</div> - <div style="border: 1px solid black; padding: 2px;">10</div>                                                                                                  | <b>Ditch Depth Range (ft):</b><br><div style="border: 1px solid black; padding: 2px;">1</div> - <div style="border: 1px solid black; padding: 2px;">3</div>    | <b>Ditch Slope Range (H:V):</b><br><div style="border: 1px solid black; padding: 2px;">0</div> : <div style="border: 1px solid black; padding: 2px;">0</div> - <div style="border: 1px solid black; padding: 2px;">0</div> : <div style="border: 1px solid black; padding: 2px;">0</div> |                                                                                                                                                                                                                                         | <b>Block Size (ft):</b> <div style="border: 1px solid black; padding: 2px;">30</div><br><b>Volume (cy):</b> <div style="border: 1px solid black; padding: 2px;">0</div> |                                                              |
| <b>Annual Rainfall Range (in):</b><br><div style="border: 1px solid black; padding: 2px;">13</div> - <div style="border: 1px solid black; padding: 2px;">13</div>                                                                                             | <b>Sole Access Route:</b> <div style="border: 1px solid black; padding: 2px;">Yes</div>                                                                        | <b>Mitigation Present:</b> <div style="border: 1px solid black; padding: 2px;">NO</div>                                                                                                                                                                                                  |                                                                                                                                                                                                                                         | <b>Photos/Documents(up to 10MB):</b><br><div style="border: 1px solid black; padding: 2px; display: inline-block;">Choose Files</div> No file chosen                    |                                                              |
| <b>Comments:</b> <div style="border: 1px solid black; padding: 5px;">Rockfall recorded here that closed the road in 2015.</div>                                                                                                                               |                                                                                                                                                                |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                         |                                                                                                                                                                         |                                                              |
| <b>Alternate database Name:</b><br><div style="border: 1px solid black; height: 30px;"></div>                                                                                                                                                                 |                                                                                                                                                                |                                                                                                                                                                                                                                                                                          | <b>Alternate database ID:</b><br><div style="border: 1px solid black; height: 30px;"></div>                                                                                                                                             |                                                                                                                                                                         |                                                              |
| <b>Alternate database Description:</b><br><div style="border: 1px solid black; height: 40px;"></div>                                                                                                                                                          |                                                                                                                                                                |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                         |                                                                                                                                                                         |                                                              |
| Preliminary Ratings                                                                                                                                                                                                                                           |                                                                                                                                                                |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                         |                                                                                                                                                                         |                                                              |
| Category Rating:                                                                                                                                                                                                                                              | 3                                                                                                                                                              | 9                                                                                                                                                                                                                                                                                        | 27                                                                                                                                                                                                                                      | 81                                                                                                                                                                      | Score:                                                       |
| <b>A. Landslide - Roadway Width Affected:</b>                                                                                                                                                                                                                 | 0-5 percent                                                                                                                                                    | 6-25 percent                                                                                                                                                                                                                                                                             | 26-50 percent                                                                                                                                                                                                                           | 51-100 percent                                                                                                                                                          | <div style="border: 1px solid black; padding: 2px;">0</div>  |
| <b>B. Landslide - Slide/Erosion Effects:</b>                                                                                                                                                                                                                  | Visible crack or slight deposit of material / minor erosion                                                                                                    | 1 inch offset, or 6-inch deposit of material / major erosion will affect travel in < 5 years                                                                                                                                                                                             | 2-inch offset or 12-inch deposit / mod. erosion impacting travel annually                                                                                                                                                               | 4-inch offset or 24-inch deposit / severe erosion impacting travel consistently                                                                                         | <div style="border: 1px solid black; padding: 2px;">0</div>  |
| <b>C. Landslide - Roadway Length Affected:</b>                                                                                                                                                                                                                | 25 ft                                                                                                                                                          | 100 ft                                                                                                                                                                                                                                                                                   | 225 ft                                                                                                                                                                                                                                  | 400 ft                                                                                                                                                                  | <div style="border: 1px solid black; padding: 2px;">0</div>  |
| <b>D. Rockfall - Ditch Effectiveness: (consider launch features)</b>                                                                                                                                                                                          | Good                                                                                                                                                           | Moderate                                                                                                                                                                                                                                                                                 | Limited                                                                                                                                                                                                                                 | No Catchment                                                                                                                                                            | <div style="border: 1px solid black; padding: 2px;">81</div> |

|                                                                                          |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
|------------------------------------------------------------------------------------------|-----------------------------|---------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------|----|
| <b>E. Rockfall - Rockfall History:</b>                                                   |                             | Few Falls                                               | Occasional Falls                                                                     | Many Falls                                                                                  | Constant Falls                                                              | 3                                                                                       |                                                                                     |                                     |    |
| <b>F. Rockfall - Block Size or Volume per Event:</b>                                     |                             | 1ft or 3yd^3                                            | 2ft or 6yd^3                                                                         | 3ft or 9yd^3                                                                                | 4ft or 12yd^3                                                               | 100                                                                                     |                                                                                     |                                     |    |
| <b>G. All - Impact on Use:</b>                                                           |                             | Full use continues with minor delay                     | Partial use remains Use modification required, short (3mi / 30min.) detour available | Use is blocked - long (>30min.) detour available or less than 1 day closure                 | Use is blocked - no detour available or closure longer than 1 week          | 27                                                                                      |                                                                                     |                                     |    |
| <b>H. All - AADT/Usage/Economic or Recreational Importance (highest rating applies):</b> |                             | 50 Rarely Used Insignificant economic / rec. importance | 200 Occasionally used Minor economic / rec. importance                               | 450 Frequently used Moderate economic / rec. importance                                     | 800 Constantly used Significant economic / rec. importance                  | <b>Use AADT in calculation:</b> <input type="checkbox"/><br>81                          |                                                                                     |                                     |    |
| <b>Preliminary Rating Landslide Total (A+B+C+G+H):</b>                                   |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
| <b>Preliminary Rating Rockfall Total (D+E+F+G+H):</b>                                    |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 292                                                                                     |                                                                                     |                                     |    |
| <b>Preliminary Rating</b> Good (15-21 pts)   Fair (22-161 pts)   Poor (>161 pts)         |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 292                                                                                     |                                                                                     |                                     |    |
| <b>Slope Hazard Ratings</b>                                                              |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
| <b>Category Rating:</b>                                                                  |                             |                                                         | <b>3</b>                                                                             | <b>9</b>                                                                                    | <b>27</b>                                                                   | <b>81</b>                                                                               | <b>Score:</b>                                                                       |                                     |    |
| <b>I. All - Slope Drainage:</b>                                                          |                             |                                                         | Slope appears dry or well drained; surface runoff well controlled                    | Intermittent water on slope; mod. not well drained; or surface runoff moderately controlled | Water usually on slope; poorly drained; or surface runoff poorly controlled | Water always on slope; very poorly drained; or surface water runoff control not present | 3                                                                                   |                                     |    |
| <b>J. All - Annual Rainfall:</b>                                                         |                             |                                                         | 0-10"                                                                                | 10-30"                                                                                      | 30-60"                                                                      | 60"+                                                                                    | 9                                                                                   |                                     |    |
| <b>K. All - Slope Height (Rockfall) / Axial Length of slide (Landslide):</b>             |                             |                                                         | 25ft                                                                                 | 50ft                                                                                        | 75ft                                                                        | 100ft                                                                                   | 100                                                                                 |                                     |    |
| <b>Select One Unstable Slope Type</b>                                                    | <b>Landslides / Erosion</b> | <b>L. Thaw Stability:</b>                               |                                                                                      | Unfrozen / Thaw Stable                                                                      | Slightly Thaw Unstable                                                      | Moderately Thaw Unstable                                                                | Highly Thaw Unstable                                                                | 0                                   |    |
|                                                                                          |                             | <b>M. Instability - Related Maint. Frequency:</b>       |                                                                                      | Every 10 years                                                                              | Every 5 years                                                               | Every 2 years                                                                           | Every year                                                                          | 0                                   |    |
|                                                                                          |                             | <b>N. Movement History:</b>                             |                                                                                      | Minor movement or sporadic creep                                                            | Up to 1 inch annually or steady annual creep                                | Up to 3 inches per event, one event per year                                            | >3" per event, >6" annually, more than 1 event per year (includes all debris flows) | 0                                   |    |
|                                                                                          | <b>Rockfalls</b>            | <b>O. Rockfall-Related Maint. Frequency:</b>            |                                                                                      | Normal, scheduled maintenance                                                               | Patrols after every storm event                                             | Routine seasonal patrols                                                                | Year round patrols                                                                  | 81                                  |    |
|                                                                                          |                             | <b>Geological Character Case 1</b>                      | <b>P. Structural Condition:</b>                                                      |                                                                                             | favorable                                                                   | random                                                                                  | Discontinuous adverse                                                               | Continuous adverse                  | 81 |
|                                                                                          |                             |                                                         | <b>Q. Rock Friction:</b>                                                             |                                                                                             | Rough / Irregular                                                           | Undulating                                                                              | Planar                                                                              | Clay infilled / Slickensided        | 27 |
|                                                                                          |                             | <b>Geological Character Case 2</b>                      |                                                                                      | <b>R. Structural Condition:</b>                                                             | Few differential erosion features                                           | Occasional differential erosion features                                                | Many differential erosion features                                                  | Major differential erosion features | 0  |

|                                                                                                                       |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
|-----------------------------------------------------------------------------------------------------------------------|----------------------------------------|------------------------------------------|---------------------------------------------------------|-----------------------------------------------------|---------------------|------------------|--------------------|-----|
|                                                                                                                       |                                        |                                          | <b>S. Diff. in Erosion Rates:</b>                       | Small difference                                    | Moderate difference | Large difference | Extreme difference | 0   |
| <b>T. LANDSLIDE HAZARD TOTAL (A+B+C+I+J+K+L+M+N):</b>                                                                 |                                        |                                          |                                                         |                                                     |                     |                  |                    | 0   |
| <b>U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greater of P+Q or R+S)):</b>                                              |                                        |                                          |                                                         |                                                     |                     |                  |                    | 539 |
| <b>Risk Ratings</b>                                                                                                   |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
| <b>V. Route Width or Trail Width:</b>                                                                                 | 36ft<br>14ft                           | 28ft<br>10ft                             | 20ft<br>6ft                                             | 12ft<br>2ft                                         | 10                  |                  |                    |     |
| <b>W. Human Exposure Factor:</b>                                                                                      | 12.5% of the time                      | 25% of the time                          | 37.5% of the time                                       | 50% of the time                                     | 3                   |                  |                    |     |
| <b>X. % of Decision Sight Distance (Judge avoidance ability on trails):</b>                                           | Adequate, 100% of the low design value | Moderate, 80% of the low design value    | Limited, 60% of the low design value                    | Very limited, 40% of the low design value           | 66                  |                  |                    |     |
| <b>Y. Right of Way (R/W) Impacts (If Left Unattended):</b>                                                            | No R/W implications                    | Minor effects beyond R/W                 | Private property, no structures affected                | Structures, roads, RR, utilities, or Parks affected | 3                   |                  |                    |     |
| <b>Z. Environmental/Cultural Impacts if Left Unattended:</b>                                                          | None/No Potential to Cause Effects     | Likely to Effect/No Hist. Prop. Affected | Likely to adversely Affect/Finding of No Adverse Effect | Current adverse effects/Adverse Effect              | 3                   |                  |                    |     |
| <b>AA. Maintenance Complexity:</b>                                                                                    | Routine Effort / In-House              | In-House maint. / special project        | Specialized equip. / contract                           | Complex / dangerous effort / location / contract    | 27                  |                  |                    |     |
| <b>BB. Event Cost:</b>                                                                                                | \$0-2k                                 | \$2-25k                                  | \$25-100k                                               | >\$100k                                             | 27                  |                  |                    |     |
| <b>CC. Risk Totals (G+H+V+W+X+Y+Z+AA+BB):</b>                                                                         |                                        |                                          |                                                         |                                                     |                     |                  |                    | 247 |
| <b>TOTAL USMP SCORE: LANDSLIDES (T+CC) OR ROCKFALL (U+CC):</b> Good (<200 pts)   Fair (200-400 pts)   Poor (>400 pts) |                                        |                                          |                                                         |                                                     |                     |                  |                    | 786 |





**SITE: 1002**

| Slope Rating Form - Site Information (Rockfall)                                                                                                                                                                                                               |                                                                                                                                                                |                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                            |                                                                                                                                                                         |                                                                          |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|
| <b>Management Area:</b><br><div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;">NPS</div> <div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;">IMR</div> <div style="border: 1px solid black; padding: 2px;">ZION</div> | <b>Date:</b> <div style="border: 1px solid black; padding: 2px;">2020-02-28 14:31:05</div><br>Last edit: 2018-10-18 14:24:36<br>Edit ID: 5023<br>Site ID: 1002 | <input checked="" type="radio"/> Rockfall<br><input type="radio"/> Landslide                                                                                                                                         | <b>Hazard Type:</b> Press (ctrl+click) to select more than one<br><div style="border: 1px solid black; padding: 2px;">           Raveling/Undermining<br/>           Rock Avalanche<br/>           Indeterminate Rock Failures<br/>           Diff. Erosion         </div> |                                                                                                                                                                         |                                                                          |
| <b>Road/Trail No:</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                             | <b>Road/Trail:</b> <div style="border: 1px solid black; padding: 2px;">R</div>                                                                                 | <b>Road/Trail Class:</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                 | <b>Rater:</b> <div style="border: 1px solid black; padding: 2px;">Justin LaForge</div>                                                                                                                                                                                     |                                                                                                                                                                         |                                                                          |
| <b>Beginning Mile Marker:</b><br><div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                  | <b>Ending Mile Marker:</b><br><div style="border: 1px solid black; padding: 2px;">0</div>                                                                      | <b>Side:</b> <div style="border: 1px solid black; padding: 2px;">S - if road direction r</div>                                                                                                                       | <b>Weather:</b> <div style="border: 1px solid black; padding: 2px;">Clear</div>                                                                                                                                                                                            |                                                                                                                                                                         |                                                                          |
| <b>Begin Coord. Lat/Long:</b><br>Lat (##.#####): <div style="border: 1px solid black; padding: 2px;">37.215903905</div><br>Long (-###.#####): <div style="border: 1px solid black; padding: 2px;">-112.965575861</div>                                        |                                                                                                                                                                | <b>End Coord. Lat/Long:</b><br>Lat (##.#####): <div style="border: 1px solid black; padding: 2px;">37.215700446</div><br>Long (-###.#####): <div style="border: 1px solid black; padding: 2px;">-112.966536385</div> |                                                                                                                                                                                                                                                                            | <b>Datum:</b> <div style="border: 1px solid black; padding: 2px;">WGS 84</div>                                                                                          | <b>AADT:</b> <div style="border: 1px solid black; padding: 2px;">0</div> |
| <b>Length of Affected Road/Trail (ft):</b><br><div style="border: 1px solid black; padding: 2px;">300</div>                                                                                                                                                   | <b>Slope Height (rock)/Axial Length (slide) (ft):</b><br><div style="border: 1px solid black; padding: 2px;">55</div>                                          |                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                            | <b>Slope Angle (°):</b> <div style="border: 1px solid black; padding: 2px;">90</div>                                                                                    |                                                                          |
| <b>Sight Distance (ft):</b><br><div style="border: 1px solid black; padding: 2px;">150</div>                                                                                                                                                                  | <b>Usable Roadway/Trail Width (ft):</b><br><div style="border: 1px solid black; padding: 2px;">26</div>                                                        |                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                            | <b>Speed Limit (mph):</b><br><div style="border: 1px solid black; padding: 2px;">35</div>                                                                               |                                                                          |
| <b>Ditch Width Range (ft):</b><br><div style="border: 1px solid black; padding: 2px;">3-10</div>                                                                                                                                                              | <b>Ditch Depth Range (ft):</b><br><div style="border: 1px solid black; padding: 2px;">2.5-2.5</div>                                                            | <b>Ditch Slope Range (H:V):</b><br><div style="border: 1px solid black; padding: 2px;">0:0-0:0</div>                                                                                                                 |                                                                                                                                                                                                                                                                            | <b>Block Size (ft):</b> <div style="border: 1px solid black; padding: 2px;">20</div><br><b>Volume (cy):</b> <div style="border: 1px solid black; padding: 2px;">0</div> |                                                                          |
| <b>Annual Rainfall Range (in):</b><br><div style="border: 1px solid black; padding: 2px;">13-13</div>                                                                                                                                                         | <b>Sole Access Route:</b> <div style="border: 1px solid black; padding: 2px;">Yes</div>                                                                        | <b>Mitigation Present:</b> <div style="border: 1px solid black; padding: 2px;">NO</div>                                                                                                                              |                                                                                                                                                                                                                                                                            | <b>Photos/Documents(up to 10MB):</b><br><div style="border: 1px solid black; padding: 2px;"> <div>Choose Files</div> <div>No file chosen</div> </div>                   |                                                                          |
| <div style="border: 1px solid black; padding: 5px; min-height: 40px;">           Site of rockfall that closed the road in September of 2015         </div>                                                                                                    |                                                                                                                                                                |                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                            |                                                                                                                                                                         |                                                                          |
| <b>Comments:</b>                                                                                                                                                                                                                                              |                                                                                                                                                                |                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                            |                                                                                                                                                                         |                                                                          |
| <b>Alternate database Name:</b><br><div style="border: 1px solid black; height: 30px; width: 100%;"></div>                                                                                                                                                    |                                                                                                                                                                |                                                                                                                                                                                                                      | <b>Alternate database ID:</b><br><div style="border: 1px solid black; height: 30px; width: 100%;"></div>                                                                                                                                                                   |                                                                                                                                                                         |                                                                          |
| <b>Alternate database Description:</b><br><div style="border: 1px solid black; height: 40px; width: 100%;"></div>                                                                                                                                             |                                                                                                                                                                |                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                            |                                                                                                                                                                         |                                                                          |
| Preliminary Ratings                                                                                                                                                                                                                                           |                                                                                                                                                                |                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                            |                                                                                                                                                                         |                                                                          |
| Category Rating:                                                                                                                                                                                                                                              | 3                                                                                                                                                              | 9                                                                                                                                                                                                                    | 27                                                                                                                                                                                                                                                                         | 81                                                                                                                                                                      | Score:                                                                   |
| <b>A. Landslide - Roadway Width Affected:</b>                                                                                                                                                                                                                 | 0-5 percent                                                                                                                                                    | 6-25 percent                                                                                                                                                                                                         | 26-50 percent                                                                                                                                                                                                                                                              | 51-100 percent                                                                                                                                                          | <div style="border: 1px solid black; padding: 2px;">0</div>              |
| <b>B. Landslide - Slide/Erosion Effects:</b>                                                                                                                                                                                                                  | Visible crack or slight deposit of material / minor erosion                                                                                                    | 1 inch offset, or 6-inch deposit of material / major erosion will affect travel in < 5 years                                                                                                                         | 2-inch offset or 12-inch deposit / mod. erosion impacting travel annually                                                                                                                                                                                                  | 4-inch offset or 24-inch deposit / severe erosion impacting travel consistently                                                                                         | <div style="border: 1px solid black; padding: 2px;">0</div>              |
| <b>C. Landslide - Roadway Length Affected:</b>                                                                                                                                                                                                                | 25 ft                                                                                                                                                          | 100 ft                                                                                                                                                                                                               | 225 ft                                                                                                                                                                                                                                                                     | 400 ft                                                                                                                                                                  | <div style="border: 1px solid black; padding: 2px;">0</div>              |
| <b>D. Rockfall - Ditch Effectiveness: (consider launch features)</b>                                                                                                                                                                                          | Good                                                                                                                                                           | Moderate                                                                                                                                                                                                             | Limited                                                                                                                                                                                                                                                                    | No Catchment                                                                                                                                                            | <div style="border: 1px solid black; padding: 2px;">27</div>             |

|                                                                                          |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                    |                                     |
|------------------------------------------------------------------------------------------|-----------------------------|---------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------------------------------------|-------------------------------------|
| <b>E. Rockfall - Rockfall History:</b>                                                   |                             | Few Falls                                               | Occasional Falls                                                                     | Many Falls                                                                                  | Constant Falls                                                              | 3                                                                                       |                                                                                     |                                    |                                     |
| <b>F. Rockfall - Block Size or Volume per Event:</b>                                     |                             | 1ft or 3yd^3                                            | 2ft or 6yd^3                                                                         | 3ft or 9yd^3                                                                                | 4ft or 12yd^3                                                               | 100                                                                                     |                                                                                     |                                    |                                     |
| <b>G. All - Impact on Use:</b>                                                           |                             | Full use continues with minor delay                     | Partial use remains Use modification required, short (3mi / 30min.) detour available | Use is blocked - long (>30min.) detour available or less than 1 day closure                 | Use is blocked - no detour available or closure longer than 1 week          | 27                                                                                      |                                                                                     |                                    |                                     |
| <b>H. All - AADT/Usage/Economic or Recreational Importance (highest rating applies):</b> |                             | 50 Rarely Used Insignificant economic / rec. importance | 200 Occasionally used Minor economic / rec. importance                               | 450 Frequently used Moderate economic / rec. importance                                     | 800 Constantly used Significant economic / rec. importance                  | <b>Use AADT in calculation:</b> <input type="checkbox"/><br>81                          |                                                                                     |                                    |                                     |
| <b>Preliminary Rating Landslide Total (A+B+C+G+H):</b>                                   |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                    |                                     |
| <b>Preliminary Rating Rockfall Total (D+E+F+G+H):</b>                                    |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 238                                                                                     |                                                                                     |                                    |                                     |
| <b>Preliminary Rating</b> Good (15-21 pts)   Fair (22-161 pts)   Poor (>161 pts)         |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 238                                                                                     |                                                                                     |                                    |                                     |
| <b>Slope Hazard Ratings</b>                                                              |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                    |                                     |
| <b>Category Rating:</b>                                                                  |                             |                                                         | <b>3</b>                                                                             | <b>9</b>                                                                                    | <b>27</b>                                                                   | <b>81</b>                                                                               | <b>Score:</b>                                                                       |                                    |                                     |
| <b>I. All - Slope Drainage:</b>                                                          |                             |                                                         | Slope appears dry or well drained; surface runoff well controlled                    | Intermittent water on slope; mod. not well drained; or surface runoff moderately controlled | Water usually on slope; poorly drained; or surface runoff poorly controlled | Water always on slope; very poorly drained; or surface water runoff control not present | 3                                                                                   |                                    |                                     |
| <b>J. All - Annual Rainfall:</b>                                                         |                             |                                                         | 0-10"                                                                                | 10-30"                                                                                      | 30-60"                                                                      | 60"+                                                                                    | 9                                                                                   |                                    |                                     |
| <b>K. All - Slope Height (Rockfall) / Axial Length of slide (Landslide):</b>             |                             |                                                         | 25ft                                                                                 | 50ft                                                                                        | 75ft                                                                        | 100ft                                                                                   | 11                                                                                  |                                    |                                     |
| <b>Select One Unstable Slope Type</b>                                                    | <b>Landslides / Erosion</b> | <b>L. Thaw Stability:</b>                               |                                                                                      | Unfrozen / Thaw Stable                                                                      | Slightly Thaw Unstable                                                      | Moderately Thaw Unstable                                                                | Highly Thaw Unstable                                                                | 0                                  |                                     |
|                                                                                          |                             | <b>M. Instability - Related Maint. Frequency:</b>       |                                                                                      | Every 10 years                                                                              | Every 5 years                                                               | Every 2 years                                                                           | Every year                                                                          | 0                                  |                                     |
|                                                                                          |                             | <b>N. Movement History:</b>                             |                                                                                      | Minor movement or sporadic creep                                                            | Up to 1 inch annually or steady annual creep                                | Up to 3 inches per event, one event per year                                            | >3" per event, >6" annually, more than 1 event per year (includes all debris flows) | 0                                  |                                     |
|                                                                                          | <b>Rockfalls</b>            | <b>O. Rockfall-Related Maint. Frequency:</b>            |                                                                                      | Normal, scheduled maintenance                                                               | Patrols after every storm event                                             | Routine seasonal patrols                                                                | Year round patrols                                                                  | 81                                 |                                     |
|                                                                                          |                             | <b>Geological Character Case 1</b>                      | <b>P. Structural Condition:</b>                                                      |                                                                                             | favorable                                                                   | random                                                                                  | Discontinuous adverse                                                               | Continuous adverse                 | 81                                  |
|                                                                                          |                             |                                                         | <b>Q. Rock Friction:</b>                                                             |                                                                                             | Rough / Irregular                                                           | Undulating                                                                              | Planar                                                                              | Clay infilled / Slickensided       | 27                                  |
|                                                                                          |                             | <b>Geological Character Case 2</b>                      |                                                                                      | <b>R. Structural Condition:</b>                                                             |                                                                             | Few differential erosion features                                                       | Occasional differential erosion features                                            | Many differential erosion features | Major differential erosion features |

|                                                                                                                       |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
|-----------------------------------------------------------------------------------------------------------------------|----------------------------------------|------------------------------------------|---------------------------------------------------------|-----------------------------------------------------|---------------------|------------------|--------------------|-----|
|                                                                                                                       |                                        |                                          | <b>S. Diff. in Erosion Rates:</b>                       | Small difference                                    | Moderate difference | Large difference | Extreme difference | 0   |
| <b>T. LANDSLIDE HAZARD TOTAL (A+B+C+I+J+K+L+M+N):</b>                                                                 |                                        |                                          |                                                         |                                                     |                     |                  |                    | 0   |
| <b>U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greater of P+Q or R+S)):</b>                                              |                                        |                                          |                                                         |                                                     |                     |                  |                    | 396 |
| <b>Risk Ratings</b>                                                                                                   |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
| <b>V. Route Width or Trail Width:</b>                                                                                 | 36ft<br>14ft                           | 28ft<br>10ft                             | 20ft<br>6ft                                             | 12ft<br>2ft                                         | 12                  |                  |                    |     |
| <b>W. Human Exposure Factor:</b>                                                                                      | 12.5% of the time                      | 25% of the time                          | 37.5% of the time                                       | 50% of the time                                     | 3                   |                  |                    |     |
| <b>X. % of Decision Sight Distance (Judge avoidance ability on trails):</b>                                           | Adequate, 100% of the low design value | Moderate, 80% of the low design value    | Limited, 60% of the low design value                    | Very limited, 40% of the low design value           | 100                 |                  |                    |     |
| <b>Y. Right of Way (R/W) Impacts (If Left Unattended):</b>                                                            | No R/W implications                    | Minor effects beyond R/W                 | Private property, no structures affected                | Structures, roads, RR, utilities, or Parks affected | 9                   |                  |                    |     |
| <b>Z. Environmental/Cultural Impacts if Left Unattended:</b>                                                          | None/No Potential to Cause Effects     | Likely to Effect/No Hist. Prop. Affected | Likely to adversely Affect/Finding of No Adverse Effect | Current adverse effects/Adverse Effect              | 3                   |                  |                    |     |
| <b>AA. Maintenance Complexity:</b>                                                                                    | Routine Effort / In-House              | In-House maint. / special project        | Specialized equip. / contract                           | Complex / dangerous effort / location / contract    | 27                  |                  |                    |     |
| <b>BB. Event Cost:</b>                                                                                                | \$0-2k                                 | \$2-25k                                  | \$25-100k                                               | >\$100k                                             | 27                  |                  |                    |     |
| <b>CC. Risk Totals (G+H+V+W+X+Y+Z+AA+BB):</b>                                                                         |                                        |                                          |                                                         |                                                     |                     |                  |                    | 289 |
| <b>TOTAL USMP SCORE: LANDSLIDES (T+CC) OR ROCKFALL (U+CC):</b> Good (<200 pts)   Fair (200-400 pts)   Poor (>400 pts) |                                        |                                          |                                                         |                                                     |                     |                  |                    | 685 |





**SITE: 1004**

| Slope Rating Form - Site Information (Rockfall)                                                   |                                                             |                                                                                                      |                                                                           |                                                                                                                                                                                                                                                                                                 |               |
|---------------------------------------------------------------------------------------------------|-------------------------------------------------------------|------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| <b>Management Area:</b><br><div>NPS</div> <div>IMR</div> <div>ZION</div>                          |                                                             | <b>Date:</b> 2020-02-28 14:31:30<br>Last edit: 2018-10-18 14:28:34<br>Edit ID: 5024<br>Site ID: 1004 |                                                                           | <b>Hazard Type:</b> Press (ctrl+click) to select more than one<br><div>                         Raveling/Undermining<br/>                         Rock Avalanche<br/>                         Indeterminate Rock Failures<br/>                         Diff. Erosion                     </div> |               |
| <b>Road/Trail No:</b> 0                                                                           | <b>Road/Trail:</b> R                                        | <b>Road/Trail Class:</b> 0                                                                           | <b>Rater:</b> Justin LaForge                                              |                                                                                                                                                                                                                                                                                                 |               |
| <b>Beginning Mile Marker:</b> 0                                                                   | <b>Ending Mile Marker:</b> 0                                | <b>Side:</b> S - if road direction r                                                                 | <b>Weather:</b> Clear                                                     |                                                                                                                                                                                                                                                                                                 |               |
| <b>Begin Coord. Lat/Long:</b><br>Lat (##.#####): 37.215698951<br>Long (-###.#####): -112.96657405 |                                                             | <b>End Coord. Lat/Long:</b><br>Lat (##.#####): 37.215819704<br>Long (-###.#####): -112.967864171     |                                                                           | <b>Datum:</b> WGS 84<br><b>AADT:</b> 0                                                                                                                                                                                                                                                          |               |
| <b>Length of Affected Road/Trail (ft):</b> 325                                                    | <b>Slope Height (rock)/Axial Length (slide) (ft):</b> 90    |                                                                                                      |                                                                           | <b>Slope Angle (°):</b> 75                                                                                                                                                                                                                                                                      |               |
| <b>Sight Distance (ft):</b> 320                                                                   | <b>Usable Roadway/Trail Width (ft):</b> 25                  |                                                                                                      |                                                                           | <b>Speed Limit (mph):</b> 35                                                                                                                                                                                                                                                                    |               |
| <b>Ditch Width Range (ft):</b> 6 - 6                                                              | <b>Ditch Depth Range (ft):</b> 1 - 1                        | <b>Ditch Slope Range (H:V):</b> 0:0 - 0:0                                                            |                                                                           | <b>Block Size (ft):</b> 15<br><b>Volume (cy):</b> 0                                                                                                                                                                                                                                             |               |
| <b>Annual Rainfall Range (in):</b> 13 - 13                                                        | <b>Sole Access Route:</b> Yes                               | <b>Mitigation Present:</b> NO                                                                        |                                                                           | <b>Photos/Documents(up to 10MB):</b><br><div>Choose Files</div> No file chosen                                                                                                                                                                                                                  |               |
| <b>Comments:</b>                                                                                  |                                                             |                                                                                                      |                                                                           |                                                                                                                                                                                                                                                                                                 |               |
| <b>Alternate database Name:</b>                                                                   |                                                             |                                                                                                      | <b>Alternate database ID:</b>                                             |                                                                                                                                                                                                                                                                                                 |               |
| <b>Alternate database Description:</b>                                                            |                                                             |                                                                                                      |                                                                           |                                                                                                                                                                                                                                                                                                 |               |
| Preliminary Ratings                                                                               |                                                             |                                                                                                      |                                                                           |                                                                                                                                                                                                                                                                                                 |               |
| <b>Category Rating:</b>                                                                           | <b>3</b>                                                    | <b>9</b>                                                                                             | <b>27</b>                                                                 | <b>81</b>                                                                                                                                                                                                                                                                                       | <b>Score:</b> |
| <b>A. Landslide - Roadway Width Affected:</b>                                                     | 0-5 percent                                                 | 6-25 percent                                                                                         | 26-50 percent                                                             | 51-100 percent                                                                                                                                                                                                                                                                                  | 0             |
| <b>B. Landslide - Slide/Erosion Effects:</b>                                                      | Visible crack or slight deposit of material / minor erosion | 1 inch offset, or 6-inch deposit of material / major erosion will affect travel in < 5 years         | 2-inch offset or 12-inch deposit / mod. erosion impacting travel annually | 4-inch offset or 24-inch deposit / severe erosion impacting travel consistently                                                                                                                                                                                                                 | 0             |
| <b>C. Landslide - Roadway Length Affected:</b>                                                    | 25 ft                                                       | 100 ft                                                                                               | 225 ft                                                                    | 400 ft                                                                                                                                                                                                                                                                                          | 0             |
| <b>D. Rockfall - Ditch Effectiveness: (consider launch features)</b>                              | Good                                                        | Moderate                                                                                             | Limited                                                                   | No Catchment                                                                                                                                                                                                                                                                                    | 9             |

|                                                                                          |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                    |                                     |
|------------------------------------------------------------------------------------------|-----------------------------|---------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------------------------------------|-------------------------------------|
| <b>E. Rockfall - Rockfall History:</b>                                                   |                             | Few Falls                                               | Occasional Falls                                                                     | Many Falls                                                                                  | Constant Falls                                                              | 3                                                                                       |                                                                                     |                                    |                                     |
| <b>F. Rockfall - Block Size or Volume per Event:</b>                                     |                             | 1ft or 3yd^3                                            | 2ft or 6yd^3                                                                         | 3ft or 9yd^3                                                                                | 4ft or 12yd^3                                                               | 100                                                                                     |                                                                                     |                                    |                                     |
| <b>G. All - Impact on Use:</b>                                                           |                             | Full use continues with minor delay                     | Partial use remains Use modification required, short (3mi / 30min.) detour available | Use is blocked - long (>30min.) detour available or less than 1 day closure                 | Use is blocked - no detour available or closure longer than 1 week          | 27                                                                                      |                                                                                     |                                    |                                     |
| <b>H. All - AADT/Usage/Economic or Recreational Importance (highest rating applies):</b> |                             | 50 Rarely Used Insignificant economic / rec. importance | 200 Occasionally used Minor economic / rec. importance                               | 450 Frequently used Moderate economic / rec. importance                                     | 800 Constantly used Significant economic / rec. importance                  | <b>Use AADT in calculation:</b> <input type="checkbox"/><br>81                          |                                                                                     |                                    |                                     |
| <b>Preliminary Rating Landslide Total (A+B+C+G+H):</b>                                   |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                    |                                     |
| <b>Preliminary Rating Rockfall Total (D+E+F+G+H):</b>                                    |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 220                                                                                     |                                                                                     |                                    |                                     |
| <b>Preliminary Rating</b> Good (15-21 pts)   Fair (22-161 pts)   Poor (>161 pts)         |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 220                                                                                     |                                                                                     |                                    |                                     |
| <b>Slope Hazard Ratings</b>                                                              |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                    |                                     |
| <b>Category Rating:</b>                                                                  |                             |                                                         | <b>3</b>                                                                             | <b>9</b>                                                                                    | <b>27</b>                                                                   | <b>81</b>                                                                               | <b>Score:</b>                                                                       |                                    |                                     |
| <b>I. All - Slope Drainage:</b>                                                          |                             |                                                         | Slope appears dry or well drained; surface runoff well controlled                    | Intermittent water on slope; mod. not well drained; or surface runoff moderately controlled | Water usually on slope; poorly drained; or surface runoff poorly controlled | Water always on slope; very poorly drained; or surface water runoff control not present | 3                                                                                   |                                    |                                     |
| <b>J. All - Annual Rainfall:</b>                                                         |                             |                                                         | 0-10"                                                                                | 10-30"                                                                                      | 30-60"                                                                      | 60"+                                                                                    | 9                                                                                   |                                    |                                     |
| <b>K. All - Slope Height (Rockfall) / Axial Length of slide (Landslide):</b>             |                             |                                                         | 25ft                                                                                 | 50ft                                                                                        | 75ft                                                                        | 100ft                                                                                   | 52                                                                                  |                                    |                                     |
| <b>Select One Unstable Slope Type</b>                                                    | <b>Landslides / Erosion</b> | <b>L. Thaw Stability:</b>                               |                                                                                      | Unfrozen / Thaw Stable                                                                      | Slightly Thaw Unstable                                                      | Moderately Thaw Unstable                                                                | Highly Thaw Unstable                                                                | 0                                  |                                     |
|                                                                                          |                             | <b>M. Instability - Related Maint. Frequency:</b>       |                                                                                      | Every 10 years                                                                              | Every 5 years                                                               | Every 2 years                                                                           | Every year                                                                          | 0                                  |                                     |
|                                                                                          |                             | <b>N. Movement History:</b>                             |                                                                                      | Minor movement or sporadic creep                                                            | Up to 1 inch annually or steady annual creep                                | Up to 3 inches per event, one event per year                                            | >3" per event, >6" annually, more than 1 event per year (includes all debris flows) | 0                                  |                                     |
|                                                                                          | <b>Rockfalls</b>            | <b>O. Rockfall-Related Maint. Frequency:</b>            |                                                                                      | Normal, scheduled maintenance                                                               | Patrols after every storm event                                             | Routine seasonal patrols                                                                | Year round patrols                                                                  | 81                                 |                                     |
|                                                                                          |                             | <b>Geological Character Case 1</b>                      | <b>P. Structural Condition:</b>                                                      |                                                                                             | favorable                                                                   | random                                                                                  | Discontinuous adverse                                                               | Continuous adverse                 | 81                                  |
|                                                                                          |                             |                                                         | <b>Q. Rock Friction:</b>                                                             |                                                                                             | Rough / Irregular                                                           | Undulating                                                                              | Planar                                                                              | Clay infilled / Slickensided       | 27                                  |
|                                                                                          |                             | <b>Geological Character Case 2</b>                      |                                                                                      | <b>R. Structural Condition:</b>                                                             |                                                                             | Few differential erosion features                                                       | Occasional differential erosion features                                            | Many differential erosion features | Major differential erosion features |

|                                                                                                                       |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
|-----------------------------------------------------------------------------------------------------------------------|----------------------------------------|------------------------------------------|---------------------------------------------------------|-----------------------------------------------------|---------------------|------------------|--------------------|-----|
|                                                                                                                       |                                        |                                          | <b>S. Diff. in Erosion Rates:</b>                       | Small difference                                    | Moderate difference | Large difference | Extreme difference | 0   |
| <b>T. LANDSLIDE HAZARD TOTAL (A+B+C+I+J+K+L+M+N):</b>                                                                 |                                        |                                          |                                                         |                                                     |                     |                  |                    | 0   |
| <b>U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greater of P+Q or R+S)):</b>                                              |                                        |                                          |                                                         |                                                     |                     |                  |                    | 419 |
| <b>Risk Ratings</b>                                                                                                   |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
| <b>V. Route Width or Trail Width:</b>                                                                                 | 36ft<br>14ft                           | 28ft<br>10ft                             | 20ft<br>6ft                                             | 12ft<br>2ft                                         | 14                  |                  |                    |     |
| <b>W. Human Exposure Factor:</b>                                                                                      | 12.5% of the time                      | 25% of the time                          | 37.5% of the time                                       | 50% of the time                                     | 3                   |                  |                    |     |
| <b>X. % of Decision Sight Distance (Judge avoidance ability on trails):</b>                                           | Adequate, 100% of the low design value | Moderate, 80% of the low design value    | Limited, 60% of the low design value                    | Very limited, 40% of the low design value           | 26                  |                  |                    |     |
| <b>Y. Right of Way (R/W) Impacts (If Left Unattended):</b>                                                            | No R/W implications                    | Minor effects beyond R/W                 | Private property, no structures affected                | Structures, roads, RR, utilities, or Parks affected | 3                   |                  |                    |     |
| <b>Z. Environmental/Cultural Impacts if Left Unattended:</b>                                                          | None/No Potential to Cause Effects     | Likely to Effect/No Hist. Prop. Affected | Likely to adversely Affect/Finding of No Adverse Effect | Current adverse effects/Adverse Effect              | 3                   |                  |                    |     |
| <b>AA. Maintenance Complexity:</b>                                                                                    | Routine Effort / In-House              | In-House maint. / special project        | Specialized equip. / contract                           | Complex / dangerous effort / location / contract    | 9                   |                  |                    |     |
| <b>BB. Event Cost:</b>                                                                                                | \$0-2k                                 | \$2-25k                                  | \$25-100k                                               | >\$100k                                             | 9                   |                  |                    |     |
| <b>CC. Risk Totals (G+H+V+W+X+Y+Z+AA+BB):</b>                                                                         |                                        |                                          |                                                         |                                                     |                     |                  |                    | 175 |
| <b>TOTAL USMP SCORE: LANDSLIDES (T+CC) OR ROCKFALL (U+CC):</b> Good (<200 pts)   Fair (200-400 pts)   Poor (>400 pts) |                                        |                                          |                                                         |                                                     |                     |                  |                    | 594 |





**SITE: 1006**

| Slope Rating Form - Site Information (Rockfall)                                                                                                                                                                                                               |                                                                                                                                                                |                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                            |                                                                                                                                                                         |                                                              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|
| <b>Management Area:</b><br><div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;">NPS</div> <div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;">IMR</div> <div style="border: 1px solid black; padding: 2px;">ZION</div> | <b>Date:</b> <div style="border: 1px solid black; padding: 2px;">2020-02-28 14:32:23</div><br>Last edit: 2018-10-18 14:33:48<br>Edit ID: 5025<br>Site ID: 1006 | <input checked="" type="radio"/> Rockfall<br><input type="radio"/> Landslide                                                                                                                                         | <b>Hazard Type:</b> Press (ctrl+click) to select more than one<br><div style="border: 1px solid black; padding: 2px;">           Raveling/Undermining<br/>           Rock Avalanche<br/>           Indeterminate Rock Failures<br/>           Diff. Erosion         </div> |                                                                                                                                                                         |                                                              |
| <b>Road/Trail No:</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                             | <b>Road/Trail:</b> <div style="border: 1px solid black; padding: 2px;">R</div>                                                                                 | <b>Road/Trail Class:</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                 | <b>Rater:</b> <div style="border: 1px solid black; padding: 2px;">Justin LaForge</div>                                                                                                                                                                                     |                                                                                                                                                                         |                                                              |
| <b>Beginning Mile Marker:</b><br><div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                  | <b>Ending Mile Marker:</b><br><div style="border: 1px solid black; padding: 2px;">0</div>                                                                      | <b>Side:</b> <div style="border: 1px solid black; padding: 2px;">S - if road direction r</div>                                                                                                                       | <b>Weather:</b> <div style="border: 1px solid black; padding: 2px;">Clear</div>                                                                                                                                                                                            |                                                                                                                                                                         |                                                              |
| <b>Begin Coord. Lat/Long:</b><br>Lat (##.#####): <div style="border: 1px solid black; padding: 2px;">37.215824482</div><br>Long (-###.#####): <div style="border: 1px solid black; padding: 2px;">-112.967889074</div>                                        |                                                                                                                                                                | <b>End Coord. Lat/Long:</b><br>Lat (##.#####): <div style="border: 1px solid black; padding: 2px;">37.215858381</div><br>Long (-###.#####): <div style="border: 1px solid black; padding: 2px;">-112.969468419</div> |                                                                                                                                                                                                                                                                            | <b>Datum:</b> <div style="border: 1px solid black; padding: 2px;">WGS 84</div><br><b>AADT:</b> <div style="border: 1px solid black; padding: 2px;">0</div>              |                                                              |
| <b>Length of Affected Road/Trail (ft):</b><br><div style="border: 1px solid black; padding: 2px;">465</div>                                                                                                                                                   | <b>Slope Height (rock)/Axial Length (slide) (ft):</b><br><div style="border: 1px solid black; padding: 2px;">73</div>                                          |                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                            | <b>Slope Angle (°):</b> <div style="border: 1px solid black; padding: 2px;">90</div>                                                                                    |                                                              |
| <b>Sight Distance (ft):</b><br><div style="border: 1px solid black; padding: 2px;">320</div>                                                                                                                                                                  | <b>Usable Roadway/Trail Width (ft):</b><br><div style="border: 1px solid black; padding: 2px;">25</div>                                                        |                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                            | <b>Speed Limit (mph):</b><br><div style="border: 1px solid black; padding: 2px;">35</div>                                                                               |                                                              |
| <b>Ditch Width Range (ft):</b><br><div style="border: 1px solid black; padding: 2px;">2-5</div>                                                                                                                                                               | <b>Ditch Depth Range (ft):</b><br><div style="border: 1px solid black; padding: 2px;">1.5-1.5</div>                                                            | <b>Ditch Slope Range (H:V):</b><br><div style="border: 1px solid black; padding: 2px;">0:0-0:0</div>                                                                                                                 |                                                                                                                                                                                                                                                                            | <b>Block Size (ft):</b> <div style="border: 1px solid black; padding: 2px;">20</div><br><b>Volume (cy):</b> <div style="border: 1px solid black; padding: 2px;">0</div> |                                                              |
| <b>Annual Rainfall Range (in):</b><br><div style="border: 1px solid black; padding: 2px;">13-13</div>                                                                                                                                                         | <b>Sole Access Route:</b> <div style="border: 1px solid black; padding: 2px;">Yes</div>                                                                        | <b>Mitigation Present:</b> <div style="border: 1px solid black; padding: 2px;">NO</div>                                                                                                                              |                                                                                                                                                                                                                                                                            | <b>Photos/Documents(up to 10MB):</b><br><div style="border: 1px solid black; padding: 2px;"> <div>Choose Files</div> <div>No file chosen</div> </div>                   |                                                              |
| <div style="border: 1px solid black; padding: 5px; min-height: 40px;">           Some of slope is overhanging road, some boulders are partially disconnected from slop.         </div>                                                                        |                                                                                                                                                                |                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                            |                                                                                                                                                                         |                                                              |
| <b>Comments:</b>                                                                                                                                                                                                                                              |                                                                                                                                                                |                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                            |                                                                                                                                                                         |                                                              |
| <b>Alternate database Name:</b><br><div style="border: 1px solid black; height: 30px; width: 100%;"></div>                                                                                                                                                    |                                                                                                                                                                |                                                                                                                                                                                                                      | <b>Alternate database ID:</b><br><div style="border: 1px solid black; height: 30px; width: 100%;"></div>                                                                                                                                                                   |                                                                                                                                                                         |                                                              |
| <b>Alternate database Description:</b><br><div style="border: 1px solid black; height: 40px; width: 100%;"></div>                                                                                                                                             |                                                                                                                                                                |                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                            |                                                                                                                                                                         |                                                              |
| Preliminary Ratings                                                                                                                                                                                                                                           |                                                                                                                                                                |                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                            |                                                                                                                                                                         |                                                              |
| Category Rating:                                                                                                                                                                                                                                              | 3                                                                                                                                                              | 9                                                                                                                                                                                                                    | 27                                                                                                                                                                                                                                                                         | 81                                                                                                                                                                      | Score:                                                       |
| <b>A. Landslide - Roadway Width Affected:</b>                                                                                                                                                                                                                 | 0-5 percent                                                                                                                                                    | 6-25 percent                                                                                                                                                                                                         | 26-50 percent                                                                                                                                                                                                                                                              | 51-100 percent                                                                                                                                                          | <div style="border: 1px solid black; padding: 2px;">0</div>  |
| <b>B. Landslide - Slide/Erosion Effects:</b>                                                                                                                                                                                                                  | Visible crack or slight deposit of material / minor erosion                                                                                                    | 1 inch offset, or 6-inch deposit of material / major erosion will affect travel in < 5 years                                                                                                                         | 2-inch offset or 12-inch deposit / mod. erosion impacting travel annually                                                                                                                                                                                                  | 4-inch offset or 24-inch deposit / severe erosion impacting travel consistently                                                                                         | <div style="border: 1px solid black; padding: 2px;">0</div>  |
| <b>C. Landslide - Roadway Length Affected:</b>                                                                                                                                                                                                                | 25 ft                                                                                                                                                          | 100 ft                                                                                                                                                                                                               | 225 ft                                                                                                                                                                                                                                                                     | 400 ft                                                                                                                                                                  | <div style="border: 1px solid black; padding: 2px;">0</div>  |
| <b>D. Rockfall - Ditch Effectiveness: (consider launch features)</b>                                                                                                                                                                                          | Good                                                                                                                                                           | Moderate                                                                                                                                                                                                             | Limited                                                                                                                                                                                                                                                                    | No Catchment                                                                                                                                                            | <div style="border: 1px solid black; padding: 2px;">27</div> |

|                                                                                          |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
|------------------------------------------------------------------------------------------|-----------------------------|---------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------|----|
| <b>E. Rockfall - Rockfall History:</b>                                                   |                             | Few Falls                                               | Occasional Falls                                                                     | Many Falls                                                                                  | Constant Falls                                                              | 3                                                                                       |                                                                                     |                                     |    |
| <b>F. Rockfall - Block Size or Volume per Event:</b>                                     |                             | 1ft or 3yd^3                                            | 2ft or 6yd^3                                                                         | 3ft or 9yd^3                                                                                | 4ft or 12yd^3                                                               | 100                                                                                     |                                                                                     |                                     |    |
| <b>G. All - Impact on Use:</b>                                                           |                             | Full use continues with minor delay                     | Partial use remains Use modification required, short (3mi / 30min.) detour available | Use is blocked - long (>30min.) detour available or less than 1 day closure                 | Use is blocked - no detour available or closure longer than 1 week          | 27                                                                                      |                                                                                     |                                     |    |
| <b>H. All - AADT/Usage/Economic or Recreational Importance (highest rating applies):</b> |                             | 50 Rarely Used Insignificant economic / rec. importance | 200 Occasionally used Minor economic / rec. importance                               | 450 Frequently used Moderate economic / rec. importance                                     | 800 Constantly used Significant economic / rec. importance                  | <b>Use AADT in calculation:</b> <input type="checkbox"/><br>81                          |                                                                                     |                                     |    |
| <b>Preliminary Rating Landslide Total (A+B+C+G+H):</b>                                   |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
| <b>Preliminary Rating Rockfall Total (D+E+F+G+H):</b>                                    |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 238                                                                                     |                                                                                     |                                     |    |
| <b>Preliminary Rating</b> Good (15-21 pts)   Fair (22-161 pts)   Poor (>161 pts)         |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 238                                                                                     |                                                                                     |                                     |    |
| <b>Slope Hazard Ratings</b>                                                              |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
| <b>Category Rating:</b>                                                                  |                             |                                                         | <b>3</b>                                                                             | <b>9</b>                                                                                    | <b>27</b>                                                                   | <b>81</b>                                                                               | <b>Score:</b>                                                                       |                                     |    |
| <b>I. All - Slope Drainage:</b>                                                          |                             |                                                         | Slope appears dry or well drained; surface runoff well controlled                    | Intermittent water on slope; mod. not well drained; or surface runoff moderately controlled | Water usually on slope; poorly drained; or surface runoff poorly controlled | Water always on slope; very poorly drained; or surface water runoff control not present | 3                                                                                   |                                     |    |
| <b>J. All - Annual Rainfall:</b>                                                         |                             |                                                         | 0-10"                                                                                | 10-30"                                                                                      | 30-60"                                                                      | 60"+                                                                                    | 9                                                                                   |                                     |    |
| <b>K. All - Slope Height (Rockfall) / Axial Length of slide (Landslide):</b>             |                             |                                                         | 25ft                                                                                 | 50ft                                                                                        | 75ft                                                                        | 100ft                                                                                   | 25                                                                                  |                                     |    |
| <b>Select One Unstable Slope Type</b>                                                    | <b>Landslides / Erosion</b> | <b>L. Thaw Stability:</b>                               |                                                                                      | Unfrozen / Thaw Stable                                                                      | Slightly Thaw Unstable                                                      | Moderately Thaw Unstable                                                                | Highly Thaw Unstable                                                                | 0                                   |    |
|                                                                                          |                             | <b>M. Instability - Related Maint. Frequency:</b>       |                                                                                      | Every 10 years                                                                              | Every 5 years                                                               | Every 2 years                                                                           | Every year                                                                          | 0                                   |    |
|                                                                                          |                             | <b>N. Movement History:</b>                             |                                                                                      | Minor movement or sporadic creep                                                            | Up to 1 inch annually or steady annual creep                                | Up to 3 inches per event, one event per year                                            | >3" per event, >6" annually, more than 1 event per year (includes all debris flows) | 0                                   |    |
|                                                                                          | <b>Rockfalls</b>            | <b>O. Rockfall-Related Maint. Frequency:</b>            |                                                                                      | Normal, scheduled maintenance                                                               | Patrols after every storm event                                             | Routine seasonal patrols                                                                | Year round patrols                                                                  | 81                                  |    |
|                                                                                          |                             | <b>Geological Character Case 1</b>                      | <b>P. Structural Condition:</b>                                                      |                                                                                             | favorable                                                                   | random                                                                                  | Discontinuous adverse                                                               | Continuous adverse                  | 81 |
|                                                                                          |                             |                                                         | <b>Q. Rock Friction:</b>                                                             |                                                                                             | Rough / Irregular                                                           | Undulating                                                                              | Planar                                                                              | Clay infilled / Slickensided        | 27 |
|                                                                                          |                             | <b>Geological Character Case 2</b>                      |                                                                                      | <b>R. Structural Condition:</b>                                                             | Few differential erosion features                                           | Occasional differential erosion features                                                | Many differential erosion features                                                  | Major differential erosion features | 0  |

|                                                                                                                       |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
|-----------------------------------------------------------------------------------------------------------------------|----------------------------------------|------------------------------------------|---------------------------------------------------------|-----------------------------------------------------|---------------------|------------------|--------------------|-----|
|                                                                                                                       |                                        |                                          | <b>S. Diff. in Erosion Rates:</b>                       | Small difference                                    | Moderate difference | Large difference | Extreme difference | 0   |
| <b>T. LANDSLIDE HAZARD TOTAL (A+B+C+I+J+K+L+M+N):</b>                                                                 |                                        |                                          |                                                         |                                                     |                     |                  |                    | 0   |
| <b>U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greater of P+Q or R+S)):</b>                                              |                                        |                                          |                                                         |                                                     |                     |                  |                    | 410 |
| <b>Risk Ratings</b>                                                                                                   |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
| <b>V. Route Width or Trail Width:</b>                                                                                 | 36ft<br>14ft                           | 28ft<br>10ft                             | 20ft<br>6ft                                             | 12ft<br>2ft                                         | 14                  |                  |                    |     |
| <b>W. Human Exposure Factor:</b>                                                                                      | 12.5% of the time                      | 25% of the time                          | 37.5% of the time                                       | 50% of the time                                     | 3                   |                  |                    |     |
| <b>X. % of Decision Sight Distance (Judge avoidance ability on trails):</b>                                           | Adequate, 100% of the low design value | Moderate, 80% of the low design value    | Limited, 60% of the low design value                    | Very limited, 40% of the low design value           | 26                  |                  |                    |     |
| <b>Y. Right of Way (R/W) Impacts (If Left Unattended):</b>                                                            | No R/W implications                    | Minor effects beyond R/W                 | Private property, no structures affected                | Structures, roads, RR, utilities, or Parks affected | 3                   |                  |                    |     |
| <b>Z. Environmental/Cultural Impacts if Left Unattended:</b>                                                          | None/No Potential to Cause Effects     | Likely to Effect/No Hist. Prop. Affected | Likely to adversely Affect/Finding of No Adverse Effect | Current adverse effects/Adverse Effect              | 3                   |                  |                    |     |
| <b>AA. Maintenance Complexity:</b>                                                                                    | Routine Effort / In-House              | In-House maint. / special project        | Specialized equip. / contract                           | Complex / dangerous effort / location / contract    | 27                  |                  |                    |     |
| <b>BB. Event Cost:</b>                                                                                                | \$0-2k                                 | \$2-25k                                  | \$25-100k                                               | >\$100k                                             | 27                  |                  |                    |     |
| <b>CC. Risk Totals (G+H+V+W+X+Y+Z+AA+BB):</b>                                                                         |                                        |                                          |                                                         |                                                     |                     |                  |                    | 211 |
| <b>TOTAL USMP SCORE: LANDSLIDES (T+CC) OR ROCKFALL (U+CC):</b> Good (<200 pts)   Fair (200-400 pts)   Poor (>400 pts) |                                        |                                          |                                                         |                                                     |                     |                  |                    | 621 |





**SITE: 1124**

| Slope Rating Form - Site Information (Rockfall)                                                                                                                                                                                                               |                                                                                                                                                                |                                                                                                                                                                                                             |                                                                                                                                                                                                                                                             |                                                                                                                                                            |                                                              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|
| <b>Management Area:</b><br><div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;">NPS</div> <div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;">IMR</div> <div style="border: 1px solid black; padding: 2px;">ZION</div> | <b>Date:</b> <div style="border: 1px solid black; padding: 2px;">2020-02-28 14:33:08</div><br>Last edit: 2018-10-18 15:20:58<br>Edit ID: 5035<br>Site ID: 1124 | <input checked="" type="radio"/> Rockfall<br><input type="radio"/> Landslide                                                                                                                                | <b>Hazard Type:</b> Press (ctrl+click) to select more than one<br><div style="border: 1px solid black; padding: 2px;">           Planar<br/>           Wedge<br/>           Toppling<br/>           Raveling/Undermining         </div>                     |                                                                                                                                                            |                                                              |
| <b>Road/Trail No:</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                             | <b>Road/Trail:</b> <div style="border: 1px solid black; padding: 2px;">R</div>                                                                                 | <b>Road/Trail Class:</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                        | <b>Rater:</b> <div style="border: 1px solid black; padding: 2px;">Justin LaForge</div>                                                                                                                                                                      |                                                                                                                                                            |                                                              |
| <b>Beginning Mile Marker:</b><br><div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                  | <b>Ending Mile Marker:</b><br><div style="border: 1px solid black; padding: 2px;">0</div>                                                                      | <b>Side:</b> <div style="border: 1px solid black; padding: 2px;">S - if road direction r</div>                                                                                                              | <b>Weather:</b> <div style="border: 1px solid black; padding: 2px;">Clear</div>                                                                                                                                                                             |                                                                                                                                                            |                                                              |
| <b>Begin Coord. Lat/Long:</b><br>Lat (##.#####): <div style="border: 1px solid black; padding: 2px;">37.21597</div><br>Long (-###.#####): <div style="border: 1px solid black; padding: 2px;">-112.97101</div>                                                |                                                                                                                                                                | <b>End Coord. Lat/Long:</b><br>Lat (##.#####): <div style="border: 1px solid black; padding: 2px;">37.21564</div><br>Long (-###.#####): <div style="border: 1px solid black; padding: 2px;">-112.9705</div> |                                                                                                                                                                                                                                                             | <b>Datum:</b> <div style="border: 1px solid black; padding: 2px;">WGS 84</div><br><b>AADT:</b> <div style="border: 1px solid black; padding: 2px;">1</div> |                                                              |
| <b>Length of Affected Road/Trail (ft):</b><br><div style="border: 1px solid black; padding: 2px;">145</div>                                                                                                                                                   | <b>Slope Height (rock)/Axial Length (slide) (ft):</b><br><div style="border: 1px solid black; padding: 2px;">22</div>                                          |                                                                                                                                                                                                             | <b>Slope Angle (°):</b> <div style="border: 1px solid black; padding: 2px;">63</div>                                                                                                                                                                        |                                                                                                                                                            |                                                              |
| <b>Sight Distance (ft):</b><br><div style="border: 1px solid black; padding: 2px;">96</div>                                                                                                                                                                   | <b>Usable Roadway/Trail Width (ft):</b><br><div style="border: 1px solid black; padding: 2px;">26</div>                                                        |                                                                                                                                                                                                             | <b>Speed Limit (mph):</b><br><div style="border: 1px solid black; padding: 2px;">35</div>                                                                                                                                                                   |                                                                                                                                                            |                                                              |
| <b>Ditch Width Range (ft):</b><br><div style="border: 1px solid black; padding: 2px;">5 - 5</div>                                                                                                                                                             | <b>Ditch Depth Range (ft):</b><br><div style="border: 1px solid black; padding: 2px;">2 - 2</div>                                                              | <b>Ditch Slope Range (H:V):</b><br><div style="border: 1px solid black; padding: 2px;">0 : 0 - 0 : 0</div>                                                                                                  | <b>Block Size (ft):</b> <div style="border: 1px solid black; padding: 2px;">6</div><br><b>Volume (cy):</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                      |                                                                                                                                                            |                                                              |
| <b>Annual Rainfall Range (in):</b><br><div style="border: 1px solid black; padding: 2px;">13 - 13</div>                                                                                                                                                       | <b>Sole Access Route:</b> <div style="border: 1px solid black; padding: 2px;">Yes</div>                                                                        | <b>Mitigation Present:</b> <div style="border: 1px solid black; padding: 2px;">NO</div>                                                                                                                     | <b>Photos/Documents(up to 10MB):</b><br><div style="border: 1px solid black; padding: 2px; display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 2px; margin-right: 5px;">Choose Files</div> <div>No file chosen</div> </div> |                                                                                                                                                            |                                                              |
| <div style="border: 1px solid black; padding: 5px; min-height: 40px;">           Springdale sandstone         </div>                                                                                                                                          |                                                                                                                                                                |                                                                                                                                                                                                             |                                                                                                                                                                                                                                                             |                                                                                                                                                            |                                                              |
| <b>Comments:</b>                                                                                                                                                                                                                                              |                                                                                                                                                                |                                                                                                                                                                                                             |                                                                                                                                                                                                                                                             |                                                                                                                                                            |                                                              |
| <b>Alternate database Name:</b><br><div style="border: 1px solid black; height: 30px; width: 100%;"></div>                                                                                                                                                    |                                                                                                                                                                |                                                                                                                                                                                                             | <b>Alternate database ID:</b><br><div style="border: 1px solid black; height: 30px; width: 100%;"></div>                                                                                                                                                    |                                                                                                                                                            |                                                              |
| <b>Alternate database Description:</b><br><div style="border: 1px solid black; height: 40px; width: 100%;"></div>                                                                                                                                             |                                                                                                                                                                |                                                                                                                                                                                                             |                                                                                                                                                                                                                                                             |                                                                                                                                                            |                                                              |
| Preliminary Ratings                                                                                                                                                                                                                                           |                                                                                                                                                                |                                                                                                                                                                                                             |                                                                                                                                                                                                                                                             |                                                                                                                                                            |                                                              |
| Category Rating:                                                                                                                                                                                                                                              | 3                                                                                                                                                              | 9                                                                                                                                                                                                           | 27                                                                                                                                                                                                                                                          | 81                                                                                                                                                         | Score:                                                       |
| <b>A. Landslide - Roadway Width Affected:</b>                                                                                                                                                                                                                 | 0-5 percent                                                                                                                                                    | 6-25 percent                                                                                                                                                                                                | 26-50 percent                                                                                                                                                                                                                                               | 51-100 percent                                                                                                                                             | <div style="border: 1px solid black; padding: 2px;">0</div>  |
| <b>B. Landslide - Slide/Erosion Effects:</b>                                                                                                                                                                                                                  | Visible crack or slight deposit of material / minor erosion                                                                                                    | 1 inch offset, or 6-inch deposit of material / major erosion will affect travel in < 5 years                                                                                                                | 2-inch offset or 12-inch deposit / mod. erosion impacting travel annually                                                                                                                                                                                   | 4-inch offset or 24-inch deposit / severe erosion impacting travel consistently                                                                            | <div style="border: 1px solid black; padding: 2px;">0</div>  |
| <b>C. Landslide - Roadway Length Affected:</b>                                                                                                                                                                                                                | 25 ft                                                                                                                                                          | 100 ft                                                                                                                                                                                                      | 225 ft                                                                                                                                                                                                                                                      | 400 ft                                                                                                                                                     | <div style="border: 1px solid black; padding: 2px;">0</div>  |
| <b>D. Rockfall - Ditch Effectiveness: (consider launch features)</b>                                                                                                                                                                                          | Good                                                                                                                                                           | Moderate                                                                                                                                                                                                    | Limited                                                                                                                                                                                                                                                     | No Catchment                                                                                                                                               | <div style="border: 1px solid black; padding: 2px;">27</div> |

|                                                                                          |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
|------------------------------------------------------------------------------------------|-----------------------------|---------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------|----|
| <b>E. Rockfall - Rockfall History:</b>                                                   |                             | Few Falls                                               | Occasional Falls                                                                     | Many Falls                                                                                  | Constant Falls                                                              | 9                                                                                       |                                                                                     |                                     |    |
| <b>F. Rockfall - Block Size or Volume per Event:</b>                                     |                             | 1ft or 3yd^3                                            | 2ft or 6yd^3                                                                         | 3ft or 9yd^3                                                                                | 4ft or 12yd^3                                                               | 100                                                                                     |                                                                                     |                                     |    |
| <b>G. All - Impact on Use:</b>                                                           |                             | Full use continues with minor delay                     | Partial use remains Use modification required, short (3mi / 30min.) detour available | Use is blocked - long (>30min.) detour available or less than 1 day closure                 | Use is blocked - no detour available or closure longer than 1 week          | 27                                                                                      |                                                                                     |                                     |    |
| <b>H. All - AADT/Usage/Economic or Recreational Importance (highest rating applies):</b> |                             | 50 Rarely Used Insignificant economic / rec. importance | 200 Occasionally used Minor economic / rec. importance                               | 450 Frequently used Moderate economic / rec. importance                                     | 800 Constantly used Significant economic / rec. importance                  | <b>Use AADT in calculation:</b> <input type="checkbox"/><br>81                          |                                                                                     |                                     |    |
| <b>Preliminary Rating Landslide Total (A+B+C+G+H):</b>                                   |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 244                                                                                     |                                                                                     |                                     |    |
| <b>Preliminary Rating Rockfall Total (D+E+F+G+H):</b>                                    |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 244                                                                                     |                                                                                     |                                     |    |
| <b>Preliminary Rating</b> Good (15-21 pts)   Fair (22-161 pts)   Poor (>161 pts)         |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 244                                                                                     |                                                                                     |                                     |    |
| <b>Slope Hazard Ratings</b>                                                              |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
| <b>Category Rating:</b>                                                                  |                             |                                                         | <b>3</b>                                                                             | <b>9</b>                                                                                    | <b>27</b>                                                                   | <b>81</b>                                                                               | <b>Score:</b>                                                                       |                                     |    |
| <b>I. All - Slope Drainage:</b>                                                          |                             |                                                         | Slope appears dry or well drained; surface runoff well controlled                    | Intermittent water on slope; mod. not well drained; or surface runoff moderately controlled | Water usually on slope; poorly drained; or surface runoff poorly controlled | Water always on slope; very poorly drained; or surface water runoff control not present | 3                                                                                   |                                     |    |
| <b>J. All - Annual Rainfall:</b>                                                         |                             |                                                         | 0-10"                                                                                | 10-30"                                                                                      | 30-60"                                                                      | 60"+                                                                                    | 9                                                                                   |                                     |    |
| <b>K. All - Slope Height (Rockfall) / Axial Length of slide (Landslide):</b>             |                             |                                                         | 25ft                                                                                 | 50ft                                                                                        | 75ft                                                                        | 100ft                                                                                   | 3                                                                                   |                                     |    |
| <b>Select One Unstable Slope Type</b>                                                    | <b>Landslides / Erosion</b> | <b>L. Thaw Stability:</b>                               |                                                                                      | Unfrozen / Thaw Stable                                                                      | Slightly Thaw Unstable                                                      | Moderately Thaw Unstable                                                                | Highly Thaw Unstable                                                                | 0                                   |    |
|                                                                                          |                             | <b>M. Instability - Related Maint. Frequency:</b>       |                                                                                      | Every 10 years                                                                              | Every 5 years                                                               | Every 2 years                                                                           | Every year                                                                          | 0                                   |    |
|                                                                                          |                             | <b>N. Movement History:</b>                             |                                                                                      | Minor movement or sporadic creep                                                            | Up to 1 inch annually or steady annual creep                                | Up to 3 inches per event, one event per year                                            | >3" per event, >6" annually, more than 1 event per year (includes all debris flows) | 0                                   |    |
|                                                                                          | <b>Rockfalls</b>            | <b>O. Rockfall-Related Maint. Frequency:</b>            |                                                                                      | Normal, scheduled maintenance                                                               | Patrols after every storm event                                             | Routine seasonal patrols                                                                | Year round patrols                                                                  | 27                                  |    |
|                                                                                          |                             | <b>Geological Character Case 1</b>                      | <b>P. Structural Condition:</b>                                                      |                                                                                             | favorable                                                                   | random                                                                                  | Discontinuous adverse                                                               | Continuous adverse                  | 27 |
|                                                                                          |                             |                                                         | <b>Q. Rock Friction:</b>                                                             |                                                                                             | Rough / Irregular                                                           | Undulating                                                                              | Planar                                                                              | Clay infilled / Slickensided        | 9  |
|                                                                                          |                             | <b>Geological Character Case 2</b>                      |                                                                                      | <b>R. Structural Condition:</b>                                                             | Few differential erosion features                                           | Occasional differential erosion features                                                | Many differential erosion features                                                  | Major differential erosion features | 0  |

|                                                                                                                       |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
|-----------------------------------------------------------------------------------------------------------------------|----------------------------------------|------------------------------------------|---------------------------------------------------------|-----------------------------------------------------|---------------------|------------------|--------------------|-----|
|                                                                                                                       |                                        |                                          | <b>S. Diff. in Erosion Rates:</b>                       | Small difference                                    | Moderate difference | Large difference | Extreme difference | 0   |
| <b>T. LANDSLIDE HAZARD TOTAL (A+B+C+I+J+K+L+M+N):</b>                                                                 |                                        |                                          |                                                         |                                                     |                     |                  |                    | 0   |
| <b>U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greater of P+Q or R+S)):</b>                                              |                                        |                                          |                                                         |                                                     |                     |                  |                    | 232 |
| <b>Risk Ratings</b>                                                                                                   |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
| <b>V. Route Width or Trail Width:</b>                                                                                 | 36ft<br>14ft                           | 28ft<br>10ft                             | 20ft<br>6ft                                             | 12ft<br>2ft                                         | 12                  |                  |                    |     |
| <b>W. Human Exposure Factor:</b>                                                                                      | 12.5% of the time                      | 25% of the time                          | 37.5% of the time                                       | 50% of the time                                     | 3                   |                  |                    |     |
| <b>X. % of Decision Sight Distance (Judge avoidance ability on trails):</b>                                           | Adequate, 100% of the low design value | Moderate, 80% of the low design value    | Limited, 60% of the low design value                    | Very limited, 40% of the low design value           | 100                 |                  |                    |     |
| <b>Y. Right of Way (R/W) Impacts (If Left Unattended):</b>                                                            | No R/W implications                    | Minor effects beyond R/W                 | Private property, no structures affected                | Structures, roads, RR, utilities, or Parks affected | 3                   |                  |                    |     |
| <b>Z. Environmental/Cultural Impacts if Left Unattended:</b>                                                          | None/No Potential to Cause Effects     | Likely to Effect/No Hist. Prop. Affected | Likely to adversely Affect/Finding of No Adverse Effect | Current adverse effects/Adverse Effect              | 3                   |                  |                    |     |
| <b>AA. Maintenance Complexity:</b>                                                                                    | Routine Effort / In-House              | In-House maint. / special project        | Specialized equip. / contract                           | Complex / dangerous effort / location / contract    | 9                   |                  |                    |     |
| <b>BB. Event Cost:</b>                                                                                                | \$0-2k                                 | \$2-25k                                  | \$25-100k                                               | >\$100k                                             | 9                   |                  |                    |     |
| <b>CC. Risk Totals (G+H+V+W+X+Y+Z+AA+BB):</b>                                                                         |                                        |                                          |                                                         |                                                     |                     |                  |                    | 247 |
| <b>TOTAL USMP SCORE: LANDSLIDES (T+CC) OR ROCKFALL (U+CC):</b> Good (<200 pts)   Fair (200-400 pts)   Poor (>400 pts) |                                        |                                          |                                                         |                                                     |                     |                  |                    | 479 |



# SITE: 1125

| Slope Rating Form - Site Information (Rockfall)                                            |                                                             |                                                                                                      |                                                                           |                                                                                                                         |               |
|--------------------------------------------------------------------------------------------|-------------------------------------------------------------|------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|---------------|
| <b>Management Area:</b><br><div>NPS</div> <div>IMR</div> <div>ZION</div>                   |                                                             | <b>Date:</b> 2020-02-28 14:34:17<br>Last edit: 2018-10-18 15:26:40<br>Edit ID: 5036<br>Site ID: 1125 |                                                                           | <b>Hazard Type:</b> Press (ctrl+click) to select more than one<br><div> <div>Rockfall</div> <div>Landslide</div> </div> |               |
| <b>Road/Trail No:</b> 0                                                                    |                                                             | <b>Road/Trail:</b> R                                                                                 |                                                                           | <b>Road/Trail Class:</b> 0                                                                                              |               |
| <b>Beginning Mile Marker:</b> 0                                                            |                                                             | <b>Ending Mile Marker:</b> 0                                                                         |                                                                           | <b>Side:</b> S - if road direction r                                                                                    |               |
| <b>Begin Coord. Lat/Long:</b><br>Lat (##.#####): 37.21556<br>Long (-###.#####): -112.97043 |                                                             | <b>End Coord. Lat/Long:</b><br>Lat (##.#####): 37.21563<br>Long (-###.#####): -112.96875             |                                                                           | <b>Datum:</b> WGS 84                                                                                                    |               |
| <b>Length of Affected Road/Trail (ft):</b> 510                                             |                                                             | <b>Slope Height (rock)/Axial Length (slide) (ft):</b> 40                                             |                                                                           | <b>Slope Angle (°):</b> 58                                                                                              |               |
| <b>Sight Distance (ft):</b> 245                                                            |                                                             | <b>Usable Roadway/Trail Width (ft):</b> 24                                                           |                                                                           | <b>Speed Limit (mph):</b> 35                                                                                            |               |
| <b>Ditch Width Range (ft):</b> 5 - 5                                                       |                                                             | <b>Ditch Depth Range (ft):</b> 2 - 2                                                                 |                                                                           | <b>Ditch Slope Range (H:V):</b> 0 : 0 - 0 : 0                                                                           |               |
| <b>Block Size (ft):</b> 30<br><b>Volume (cy):</b> 0                                        |                                                             | <b>Annual Rainfall Range (in):</b> 13 - 13                                                           |                                                                           | <b>Sole Access Route:</b> Yes                                                                                           |               |
| <b>Mitigation Present:</b> YES                                                             |                                                             | <b>Photos/Documents(up to 10MB):</b><br><div>Choose Files</div> No file chosen                       |                                                                           |                                                                                                                         |               |
| <b>Comments:</b> Some reinforcement between road and slope; culvert present                |                                                             |                                                                                                      |                                                                           |                                                                                                                         |               |
| <b>Alternate database Name:</b>                                                            |                                                             |                                                                                                      | <b>Alternate database ID:</b>                                             |                                                                                                                         |               |
| <b>Alternate database Description:</b>                                                     |                                                             |                                                                                                      |                                                                           |                                                                                                                         |               |
| Preliminary Ratings                                                                        |                                                             |                                                                                                      |                                                                           |                                                                                                                         |               |
| <b>Category Rating:</b>                                                                    | <b>3</b>                                                    | <b>9</b>                                                                                             | <b>27</b>                                                                 | <b>81</b>                                                                                                               | <b>Score:</b> |
| <b>A. Landslide - Roadway Width Affected:</b>                                              | 0-5 percent                                                 | 6-25 percent                                                                                         | 26-50 percent                                                             | 51-100 percent                                                                                                          | 0             |
| <b>B. Landslide - Slide/Erosion Effects:</b>                                               | Visible crack or slight deposit of material / minor erosion | 1 inch offset, or 6-inch deposit of material / major erosion will affect travel in < 5 years         | 2-inch offset or 12-inch deposit / mod. erosion impacting travel annually | 4-inch offset or 24-inch deposit / severe erosion impacting travel consistently                                         | 0             |
| <b>C. Landslide - Roadway Length Affected:</b>                                             | 25 ft                                                       | 100 ft                                                                                               | 225 ft                                                                    | 400 ft                                                                                                                  | 0             |
| <b>D. Rockfall - Ditch Effectiveness: (consider launch features)</b>                       | Good                                                        | Moderate                                                                                             | Limited                                                                   | No Catchment                                                                                                            | 27            |

|                                                                                          |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
|------------------------------------------------------------------------------------------|-----------------------------|---------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------|----|
| <b>E. Rockfall - Rockfall History:</b>                                                   |                             | Few Falls                                               | Occasional Falls                                                                     | Many Falls                                                                                  | Constant Falls                                                              | 27                                                                                      |                                                                                     |                                     |    |
| <b>F. Rockfall - Block Size or Volume per Event:</b>                                     |                             | 1ft or 3yd^3                                            | 2ft or 6yd^3                                                                         | 3ft or 9yd^3                                                                                | 4ft or 12yd^3                                                               | 100                                                                                     |                                                                                     |                                     |    |
| <b>G. All - Impact on Use:</b>                                                           |                             | Full use continues with minor delay                     | Partial use remains Use modification required, short (3mi / 30min.) detour available | Use is blocked - long (>30min.) detour available or less than 1 day closure                 | Use is blocked - no detour available or closure longer than 1 week          | 9                                                                                       |                                                                                     |                                     |    |
| <b>H. All - AADT/Usage/Economic or Recreational Importance (highest rating applies):</b> |                             | 50 Rarely Used Insignificant economic / rec. importance | 200 Occasionally used Minor economic / rec. importance                               | 450 Frequently used Moderate economic / rec. importance                                     | 800 Constantly used Significant economic / rec. importance                  | <b>Use AADT in calculation:</b> <input type="checkbox"/><br>81                          |                                                                                     |                                     |    |
| <b>Preliminary Rating Landslide Total (A+B+C+G+H):</b>                                   |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
| <b>Preliminary Rating Rockfall Total (D+E+F+G+H):</b>                                    |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 244                                                                                     |                                                                                     |                                     |    |
| <b>Preliminary Rating</b> Good (15-21 pts)   Fair (22-161 pts)   Poor (>161 pts)         |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 90                                                                                      |                                                                                     |                                     |    |
| <b>Slope Hazard Ratings</b>                                                              |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
| <b>Category Rating:</b>                                                                  |                             |                                                         | <b>3</b>                                                                             | <b>9</b>                                                                                    | <b>27</b>                                                                   | <b>81</b>                                                                               | <b>Score:</b>                                                                       |                                     |    |
| <b>I. All - Slope Drainage:</b>                                                          |                             |                                                         | Slope appears dry or well drained; surface runoff well controlled                    | Intermittent water on slope; mod. not well drained; or surface runoff moderately controlled | Water usually on slope; poorly drained; or surface runoff poorly controlled | Water always on slope; very poorly drained; or surface water runoff control not present | 3                                                                                   |                                     |    |
| <b>J. All - Annual Rainfall:</b>                                                         |                             |                                                         | 0-10"                                                                                | 10-30"                                                                                      | 30-60"                                                                      | 60"+                                                                                    | 9                                                                                   |                                     |    |
| <b>K. All - Slope Height (Rockfall) / Axial Length of slide (Landslide):</b>             |                             |                                                         | 25ft                                                                                 | 50ft                                                                                        | 75ft                                                                        | 100ft                                                                                   | 6                                                                                   |                                     |    |
| <b>Select One Unstable Slope Type</b>                                                    | <b>Landslides / Erosion</b> | <b>L. Thaw Stability:</b>                               |                                                                                      | Unfrozen / Thaw Stable                                                                      | Slightly Thaw Unstable                                                      | Moderately Thaw Unstable                                                                | Highly Thaw Unstable                                                                | 0                                   |    |
|                                                                                          |                             | <b>M. Instability - Related Maint. Frequency:</b>       |                                                                                      | Every 10 years                                                                              | Every 5 years                                                               | Every 2 years                                                                           | Every year                                                                          | 0                                   |    |
|                                                                                          |                             | <b>N. Movement History:</b>                             |                                                                                      | Minor movement or sporadic creep                                                            | Up to 1 inch annually or steady annual creep                                | Up to 3 inches per event, one event per year                                            | >3" per event, >6" annually, more than 1 event per year (includes all debris flows) | 0                                   |    |
|                                                                                          | <b>Rockfalls</b>            | <b>O. Rockfall-Related Maint. Frequency:</b>            |                                                                                      | Normal, scheduled maintenance                                                               | Patrols after every storm event                                             | Routine seasonal patrols                                                                | Year round patrols                                                                  | 81                                  |    |
|                                                                                          |                             | <b>Geological Character Case 1</b>                      | <b>P. Structural Condition:</b>                                                      |                                                                                             | favorable                                                                   | random                                                                                  | Discontinuous adverse                                                               | Continuous adverse                  | 27 |
|                                                                                          |                             |                                                         | <b>Q. Rock Friction:</b>                                                             |                                                                                             | Rough / Irregular                                                           | Undulating                                                                              | Planar                                                                              | Clay infilled / Slickensided        | 27 |
|                                                                                          |                             | <b>Geological Character Case 2</b>                      | <b>R. Structural Condition:</b>                                                      |                                                                                             | Few differential erosion features                                           | Occasional differential erosion features                                                | Many differential erosion features                                                  | Major differential erosion features | 0  |

|                                                                                                                       |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
|-----------------------------------------------------------------------------------------------------------------------|----------------------------------------|------------------------------------------|---------------------------------------------------------|-----------------------------------------------------|---------------------|------------------|--------------------|-----|
|                                                                                                                       |                                        |                                          | <b>S. Diff. in Erosion Rates:</b>                       | Small difference                                    | Moderate difference | Large difference | Extreme difference | 0   |
| <b>T. LANDSLIDE HAZARD TOTAL (A+B+C+I+J+K+L+M+N):</b>                                                                 |                                        |                                          |                                                         |                                                     |                     |                  |                    | 0   |
| <b>U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greater of P+Q or R+S)):</b>                                              |                                        |                                          |                                                         |                                                     |                     |                  |                    | 307 |
| <b>Risk Ratings</b>                                                                                                   |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
| <b>V. Route Width or Trail Width:</b>                                                                                 | 36ft<br>14ft                           | 28ft<br>10ft                             | 20ft<br>6ft                                             | 12ft<br>2ft                                         | 16                  |                  |                    |     |
| <b>W. Human Exposure Factor:</b>                                                                                      | 12.5% of the time                      | 25% of the time                          | 37.5% of the time                                       | 50% of the time                                     | 3                   |                  |                    |     |
| <b>X. % of Decision Sight Distance (Judge avoidance ability on trails):</b>                                           | Adequate, 100% of the low design value | Moderate, 80% of the low design value    | Limited, 60% of the low design value                    | Very limited, 40% of the low design value           | 56                  |                  |                    |     |
| <b>Y. Right of Way (R/W) Impacts (If Left Unattended):</b>                                                            | No R/W implications                    | Minor effects beyond R/W                 | Private property, no structures affected                | Structures, roads, RR, utilities, or Parks affected | 3                   |                  |                    |     |
| <b>Z. Environmental/Cultural Impacts if Left Unattended:</b>                                                          | None/No Potential to Cause Effects     | Likely to Effect/No Hist. Prop. Affected | Likely to adversely Affect/Finding of No Adverse Effect | Current adverse effects/Adverse Effect              | 3                   |                  |                    |     |
| <b>AA. Maintenance Complexity:</b>                                                                                    | Routine Effort / In-House              | In-House maint. / special project        | Specialized equip. / contract                           | Complex / dangerous effort / location / contract    | 9                   |                  |                    |     |
| <b>BB. Event Cost:</b>                                                                                                | \$0-2k                                 | \$2-25k                                  | \$25-100k                                               | >\$100k                                             | 27                  |                  |                    |     |
| <b>CC. Risk Totals (G+H+V+W+X+Y+Z+AA+BB):</b>                                                                         |                                        |                                          |                                                         |                                                     |                     |                  |                    | 207 |
| <b>TOTAL USMP SCORE: LANDSLIDES (T+CC) OR ROCKFALL (U+CC):</b> Good (<200 pts)   Fair (200-400 pts)   Poor (>400 pts) |                                        |                                          |                                                         |                                                     |                     |                  |                    | 514 |





**SITE: 1127**

| Slope Rating Form - Site Information (Rockfall)                                            |                                                             |                                                                                                      |                                                                           |                                                                                                                                                                                                                                       |               |
|--------------------------------------------------------------------------------------------|-------------------------------------------------------------|------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| <b>Management Area:</b><br><div>NPS</div> <div>IMR</div> <div>ZION</div>                   |                                                             | <b>Date:</b> 2020-02-28 14:35:24<br>Last edit: 2018-10-19 08:25:34<br>Edit ID: 5038<br>Site ID: 1127 |                                                                           | <b>Hazard Type:</b> Press (ctrl+click) to select more than one<br><div>             Raveling/Undermining<br/>             Rock Avalanche<br/>             Indeterminate Rock Failures<br/>             Diff. Erosion           </div> |               |
| <b>Road/Trail No:</b> 0                                                                    | <b>Road/Trail:</b> R                                        | <b>Road/Trail Class:</b> 0                                                                           | <b>Rater:</b> Justin LaForge                                              |                                                                                                                                                                                                                                       |               |
| <b>Beginning Mile Marker:</b> 0                                                            | <b>Ending Mile Marker:</b> 0                                | <b>Side:</b> S - if road direction r                                                                 | <b>Weather:</b> Clear                                                     |                                                                                                                                                                                                                                       |               |
| <b>Begin Coord. Lat/Long:</b><br>Lat (##.#####): 37.21563<br>Long (-###.#####): -112.97043 |                                                             | <b>End Coord. Lat/Long:</b><br>Lat (##.#####): 37.21531<br>Long (-###.#####): -112.96776             |                                                                           | <b>Datum:</b> WGS 84<br><b>AADT:</b> 1                                                                                                                                                                                                |               |
| <b>Length of Affected Road/Trail (ft):</b> 197                                             | <b>Slope Height (rock)/Axial Length (slide) (ft):</b> 54    |                                                                                                      |                                                                           | <b>Slope Angle (°):</b> 53                                                                                                                                                                                                            |               |
| <b>Sight Distance (ft):</b> 200                                                            | <b>Usable Roadway/Trail Width (ft):</b> 30                  |                                                                                                      |                                                                           | <b>Speed Limit (mph):</b> 35                                                                                                                                                                                                          |               |
| <b>Ditch Width Range (ft):</b> 0 - 0                                                       | <b>Ditch Depth Range (ft):</b> 0 - 0                        | <b>Ditch Slope Range (H:V):</b> 0 : 0 - 0 : 0                                                        |                                                                           | <b>Block Size (ft):</b> 4<br><b>Volume (cy):</b> 0                                                                                                                                                                                    |               |
| <b>Annual Rainfall Range (in):</b> 13 - 13                                                 | <b>Sole Access Route:</b> Yes                               | <b>Mitigation Present:</b> NO                                                                        |                                                                           | <b>Photos/Documents(up to 10MB):</b><br><div>Choose Files</div> No file chosen                                                                                                                                                        |               |
| <b>Comments:</b>                                                                           |                                                             |                                                                                                      |                                                                           |                                                                                                                                                                                                                                       |               |
| <b>Alternate database Name:</b>                                                            |                                                             |                                                                                                      | <b>Alternate database ID:</b>                                             |                                                                                                                                                                                                                                       |               |
| <b>Alternate database Description:</b>                                                     |                                                             |                                                                                                      |                                                                           |                                                                                                                                                                                                                                       |               |
| Preliminary Ratings                                                                        |                                                             |                                                                                                      |                                                                           |                                                                                                                                                                                                                                       |               |
| <b>Category Rating:</b>                                                                    | <b>3</b>                                                    | <b>9</b>                                                                                             | <b>27</b>                                                                 | <b>81</b>                                                                                                                                                                                                                             | <b>Score:</b> |
| <b>A. Landslide - Roadway Width Affected:</b>                                              | 0-5 percent                                                 | 6-25 percent                                                                                         | 26-50 percent                                                             | 51-100 percent                                                                                                                                                                                                                        | 0             |
| <b>B. Landslide - Slide/Erosion Effects:</b>                                               | Visible crack or slight deposit of material / minor erosion | 1 inch offset, or 6-inch deposit of material / major erosion will affect travel in < 5 years         | 2-inch offset or 12-inch deposit / mod. erosion impacting travel annually | 4-inch offset or 24-inch deposit / severe erosion impacting travel consistently                                                                                                                                                       | 0             |
| <b>C. Landslide - Roadway Length Affected:</b>                                             | 25 ft                                                       | 100 ft                                                                                               | 225 ft                                                                    | 400 ft                                                                                                                                                                                                                                | 0             |
| <b>D. Rockfall - Ditch Effectiveness: (consider launch features)</b>                       | Good                                                        | Moderate                                                                                             | Limited                                                                   | No Catchment                                                                                                                                                                                                                          | 9             |

|                                                                                          |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
|------------------------------------------------------------------------------------------|-----------------------------|---------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------|----|
| <b>E. Rockfall - Rockfall History:</b>                                                   |                             | Few Falls                                               | Occasional Falls                                                                     | Many Falls                                                                                  | Constant Falls                                                              | 27                                                                                      |                                                                                     |                                     |    |
| <b>F. Rockfall - Block Size or Volume per Event:</b>                                     |                             | 1ft or 3yd^3                                            | 2ft or 6yd^3                                                                         | 3ft or 9yd^3                                                                                | 4ft or 12yd^3                                                               | 81                                                                                      |                                                                                     |                                     |    |
| <b>G. All - Impact on Use:</b>                                                           |                             | Full use continues with minor delay                     | Partial use remains Use modification required, short (3mi / 30min.) detour available | Use is blocked - long (>30min.) detour available or less than 1 day closure                 | Use is blocked - no detour available or closure longer than 1 week          | 9                                                                                       |                                                                                     |                                     |    |
| <b>H. All - AADT/Usage/Economic or Recreational Importance (highest rating applies):</b> |                             | 50 Rarely Used Insignificant economic / rec. importance | 200 Occasionally used Minor economic / rec. importance                               | 450 Frequently used Moderate economic / rec. importance                                     | 800 Constantly used Significant economic / rec. importance                  | <b>Use AADT in calculation:</b> <input type="checkbox"/><br>81                          |                                                                                     |                                     |    |
| <b>Preliminary Rating Landslide Total (A+B+C+G+H):</b>                                   |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
| <b>Preliminary Rating Rockfall Total (D+E+F+G+H):</b>                                    |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 207                                                                                     |                                                                                     |                                     |    |
| <b>Preliminary Rating</b> Good (15-21 pts)   Fair (22-161 pts)   Poor (>161 pts)         |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 90                                                                                      |                                                                                     |                                     |    |
| <b>Slope Hazard Ratings</b>                                                              |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
| <b>Category Rating:</b>                                                                  |                             |                                                         | <b>3</b>                                                                             | <b>9</b>                                                                                    | <b>27</b>                                                                   | <b>81</b>                                                                               | <b>Score:</b>                                                                       |                                     |    |
| <b>I. All - Slope Drainage:</b>                                                          |                             |                                                         | Slope appears dry or well drained; surface runoff well controlled                    | Intermittent water on slope; mod. not well drained; or surface runoff moderately controlled | Water usually on slope; poorly drained; or surface runoff poorly controlled | Water always on slope; very poorly drained; or surface water runoff control not present | 3                                                                                   |                                     |    |
| <b>J. All - Annual Rainfall:</b>                                                         |                             |                                                         | 0-10"                                                                                | 10-30"                                                                                      | 30-60"                                                                      | 60"+                                                                                    | 9                                                                                   |                                     |    |
| <b>K. All - Slope Height (Rockfall) / Axial Length of slide (Landslide):</b>             |                             |                                                         | 25ft                                                                                 | 50ft                                                                                        | 75ft                                                                        | 100ft                                                                                   | 11                                                                                  |                                     |    |
| <b>Select One Unstable Slope Type</b>                                                    | <b>Landslides / Erosion</b> | <b>L. Thaw Stability:</b>                               |                                                                                      | Unfrozen / Thaw Stable                                                                      | Slightly Thaw Unstable                                                      | Moderately Thaw Unstable                                                                | Highly Thaw Unstable                                                                | 0                                   |    |
|                                                                                          |                             | <b>M. Instability - Related Maint. Frequency:</b>       |                                                                                      | Every 10 years                                                                              | Every 5 years                                                               | Every 2 years                                                                           | Every year                                                                          | 0                                   |    |
|                                                                                          |                             | <b>N. Movement History:</b>                             |                                                                                      | Minor movement or sporadic creep                                                            | Up to 1 inch annually or steady annual creep                                | Up to 3 inches per event, one event per year                                            | >3" per event, >6" annually, more than 1 event per year (includes all debris flows) | 0                                   |    |
|                                                                                          | <b>Rockfalls</b>            | <b>O. Rockfall-Related Maint. Frequency:</b>            |                                                                                      | Normal, scheduled maintenance                                                               | Patrols after every storm event                                             | Routine seasonal patrols                                                                | Year round patrols                                                                  | 27                                  |    |
|                                                                                          |                             | <b>Geological Character Case 1</b>                      | <b>P. Structural Condition:</b>                                                      |                                                                                             | favorable                                                                   | random                                                                                  | Discontinuous adverse                                                               | Continuous adverse                  | 0  |
|                                                                                          |                             |                                                         | <b>Q. Rock Friction:</b>                                                             |                                                                                             | Rough / Irregular                                                           | Undulating                                                                              | Planar                                                                              | Clay infilled / Slickensided        | 0  |
|                                                                                          |                             | <b>Geological Character Case 2</b>                      | <b>R. Structural Condition:</b>                                                      |                                                                                             | Few differential erosion features                                           | Occasional differential erosion features                                                | Many differential erosion features                                                  | Major differential erosion features | 27 |

|                                                                                                                       |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
|-----------------------------------------------------------------------------------------------------------------------|----------------------------------------|------------------------------------------|---------------------------------------------------------|-----------------------------------------------------|---------------------|------------------|--------------------|-----|
|                                                                                                                       |                                        |                                          | <b>S. Diff. in Erosion Rates:</b>                       | Small difference                                    | Moderate difference | Large difference | Extreme difference | 27  |
| <b>T. LANDSLIDE HAZARD TOTAL (A+B+C+I+J+K+L+M+N):</b>                                                                 |                                        |                                          |                                                         |                                                     |                     |                  |                    | 0   |
| <b>U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greater of P+Q or R+S)):</b>                                              |                                        |                                          |                                                         |                                                     |                     |                  |                    | 221 |
| <b>Risk Ratings</b>                                                                                                   |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
| <b>V. Route Width or Trail Width:</b>                                                                                 | 36ft<br>14ft                           | 28ft<br>10ft                             | 20ft<br>6ft                                             | 12ft<br>2ft                                         | 7                   |                  |                    |     |
| <b>W. Human Exposure Factor:</b>                                                                                      | 12.5% of the time                      | 25% of the time                          | 37.5% of the time                                       | 50% of the time                                     | 3                   |                  |                    |     |
| <b>X. % of Decision Sight Distance (Judge avoidance ability on trails):</b>                                           | Adequate, 100% of the low design value | Moderate, 80% of the low design value    | Limited, 60% of the low design value                    | Very limited, 40% of the low design value           | 90                  |                  |                    |     |
| <b>Y. Right of Way (R/W) Impacts (If Left Unattended):</b>                                                            | No R/W implications                    | Minor effects beyond R/W                 | Private property, no structures affected                | Structures, roads, RR, utilities, or Parks affected | 3                   |                  |                    |     |
| <b>Z. Environmental/Cultural Impacts if Left Unattended:</b>                                                          | None/No Potential to Cause Effects     | Likely to Effect/No Hist. Prop. Affected | Likely to adversely Affect/Finding of No Adverse Effect | Current adverse effects/Adverse Effect              | 3                   |                  |                    |     |
| <b>AA. Maintenance Complexity:</b>                                                                                    | Routine Effort / In-House              | In-House maint. / special project        | Specialized equip. / contract                           | Complex / dangerous effort / location / contract    | 9                   |                  |                    |     |
| <b>BB. Event Cost:</b>                                                                                                | \$0-2k                                 | \$2-25k                                  | \$25-100k                                               | >\$100k                                             | 9                   |                  |                    |     |
| <b>CC. Risk Totals (G+H+V+W+X+Y+Z+AA+BB):</b>                                                                         |                                        |                                          |                                                         |                                                     |                     |                  |                    | 214 |
| <b>TOTAL USMP SCORE: LANDSLIDES (T+CC) OR ROCKFALL (U+CC):</b> Good (<200 pts)   Fair (200-400 pts)   Poor (>400 pts) |                                        |                                          |                                                         |                                                     |                     |                  |                    | 435 |





**SITE: 1129**

| Slope Rating Form - Site Information (Rockfall)                                                                                                                                                                                                               |                                                                                                                                                                |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                             |                                                                          |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|
| <b>Management Area:</b><br><div style="border: 1px solid black; padding: 2px; margin-bottom: 2px;">NPS</div> <div style="border: 1px solid black; padding: 2px; margin-bottom: 2px;">IMR</div> <div style="border: 1px solid black; padding: 2px;">ZION</div> | <b>Date:</b> <div style="border: 1px solid black; padding: 2px;">2020-02-28 14:35:55</div><br>Last edit: 2018-10-19 08:32:19<br>Edit ID: 5040<br>Site ID: 1129 | <input checked="" type="radio"/> Rockfall<br><input type="radio"/> Landslide                                                                                                                                                                                                             | <b>Hazard Type:</b> Press (ctrl+click) to select more than one<br><div style="border: 1px solid black; padding: 2px;">           Planar<br/>           Wedge<br/>           Toppling<br/>           Raveling/Undermining         </div> |                                                                                                                                                                                                                                                             |                                                                          |
| <b>Road/Trail No:</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                             | <b>Road/Trail:</b> <div style="border: 1px solid black; padding: 2px;">R</div>                                                                                 | <b>Road/Trail Class:</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                                                     | <b>Rater:</b> <div style="border: 1px solid black; padding: 2px;">Justin LaForge</div>                                                                                                                                                  |                                                                                                                                                                                                                                                             |                                                                          |
| <b>Beginning Mile Marker:</b><br><div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                  | <b>Ending Mile Marker:</b><br><div style="border: 1px solid black; padding: 2px;">0</div>                                                                      | <b>Side:</b> <div style="border: 1px solid black; padding: 2px;">S - if road direction r</div>                                                                                                                                                                                           | <b>Weather:</b> <div style="border: 1px solid black; padding: 2px;">Clear</div>                                                                                                                                                         |                                                                                                                                                                                                                                                             |                                                                          |
| <b>Begin Coord. Lat/Long:</b><br>Lat (##.#####): <div style="border: 1px solid black; padding: 2px;">37.21523</div><br>Long (-###.#####): <div style="border: 1px solid black; padding: 2px;">-112.96729</div>                                                |                                                                                                                                                                | <b>End Coord. Lat/Long:</b><br>Lat (##.#####): <div style="border: 1px solid black; padding: 2px;">37.21509</div><br>Long (-###.#####): <div style="border: 1px solid black; padding: 2px;">-112.96502</div>                                                                             |                                                                                                                                                                                                                                         | <b>Datum:</b> <div style="border: 1px solid black; padding: 2px;">WGS 84</div>                                                                                                                                                                              | <b>AADT:</b> <div style="border: 1px solid black; padding: 2px;">1</div> |
| <b>Length of Affected Road/Trail (ft):</b> <div style="border: 1px solid black; padding: 2px;">587</div>                                                                                                                                                      | <b>Slope Height (rock)/Axial Length (slide) (ft):</b> <div style="border: 1px solid black; padding: 2px;">96</div>                                             |                                                                                                                                                                                                                                                                                          | <b>Slope Angle (°):</b> <div style="border: 1px solid black; padding: 2px;">42</div>                                                                                                                                                    |                                                                                                                                                                                                                                                             |                                                                          |
| <b>Sight Distance (ft):</b> <div style="border: 1px solid black; padding: 2px;">130</div>                                                                                                                                                                     | <b>Usable Roadway/Trail Width (ft):</b> <div style="border: 1px solid black; padding: 2px;">25</div>                                                           |                                                                                                                                                                                                                                                                                          | <b>Speed Limit (mph):</b> <div style="border: 1px solid black; padding: 2px;">35</div>                                                                                                                                                  |                                                                                                                                                                                                                                                             |                                                                          |
| <b>Ditch Width Range (ft):</b><br><div style="border: 1px solid black; padding: 2px;">3</div> - <div style="border: 1px solid black; padding: 2px;">3</div>                                                                                                   | <b>Ditch Depth Range (ft):</b><br><div style="border: 1px solid black; padding: 2px;">1</div> - <div style="border: 1px solid black; padding: 2px;">1</div>    | <b>Ditch Slope Range (H:V):</b><br><div style="border: 1px solid black; padding: 2px;">0</div> : <div style="border: 1px solid black; padding: 2px;">0</div> - <div style="border: 1px solid black; padding: 2px;">0</div> : <div style="border: 1px solid black; padding: 2px;">0</div> |                                                                                                                                                                                                                                         | <b>Block Size (ft):</b> <div style="border: 1px solid black; padding: 2px;">8</div><br><b>Volume (cy):</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                      |                                                                          |
| <b>Annual Rainfall Range (in):</b><br><div style="border: 1px solid black; padding: 2px;">13</div> - <div style="border: 1px solid black; padding: 2px;">13</div>                                                                                             | <b>Sole Access Route:</b> <div style="border: 1px solid black; padding: 2px;">Yes</div>                                                                        | <b>Mitigation Present:</b> <div style="border: 1px solid black; padding: 2px;">NO</div>                                                                                                                                                                                                  |                                                                                                                                                                                                                                         | <b>Photos/Documents(up to 10MB):</b><br><div style="border: 1px solid black; padding: 2px; display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 2px; margin-right: 5px;">Choose Files</div> <div>No file chosen</div> </div> |                                                                          |
| <b>Comments:</b> <div style="border: 1px solid black; padding: 5px; min-height: 30px;">Large boulders upslope</div>                                                                                                                                           |                                                                                                                                                                |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                             |                                                                          |
| <b>Alternate database Name:</b><br><div style="border: 1px solid black; height: 30px;"></div>                                                                                                                                                                 |                                                                                                                                                                |                                                                                                                                                                                                                                                                                          | <b>Alternate database ID:</b><br><div style="border: 1px solid black; height: 30px;"></div>                                                                                                                                             |                                                                                                                                                                                                                                                             |                                                                          |
| <b>Alternate database Description:</b><br><div style="border: 1px solid black; height: 30px;"></div>                                                                                                                                                          |                                                                                                                                                                |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                             |                                                                          |
| Preliminary Ratings                                                                                                                                                                                                                                           |                                                                                                                                                                |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                             |                                                                          |
| Category Rating:                                                                                                                                                                                                                                              | 3                                                                                                                                                              | 9                                                                                                                                                                                                                                                                                        | 27                                                                                                                                                                                                                                      | 81                                                                                                                                                                                                                                                          | Score:                                                                   |
| <b>A. Landslide - Roadway Width Affected:</b>                                                                                                                                                                                                                 | 0-5 percent                                                                                                                                                    | 6-25 percent                                                                                                                                                                                                                                                                             | 26-50 percent                                                                                                                                                                                                                           | 51-100 percent                                                                                                                                                                                                                                              | <div style="border: 1px solid black; padding: 2px;">0</div>              |
| <b>B. Landslide - Slide/Erosion Effects:</b>                                                                                                                                                                                                                  | Visible crack or slight deposit of material / minor erosion                                                                                                    | 1 inch offset, or 6-inch deposit of material / major erosion will affect travel in < 5 years                                                                                                                                                                                             | 2-inch offset or 12-inch deposit / mod. erosion impacting travel annually                                                                                                                                                               | 4-inch offset or 24-inch deposit / severe erosion impacting travel consistently                                                                                                                                                                             | <div style="border: 1px solid black; padding: 2px;">0</div>              |
| <b>C. Landslide - Roadway Length Affected:</b>                                                                                                                                                                                                                | 25 ft                                                                                                                                                          | 100 ft                                                                                                                                                                                                                                                                                   | 225 ft                                                                                                                                                                                                                                  | 400 ft                                                                                                                                                                                                                                                      | <div style="border: 1px solid black; padding: 2px;">0</div>              |
| <b>D. Rockfall - Ditch Effectiveness: (consider launch features)</b>                                                                                                                                                                                          | Good                                                                                                                                                           | Moderate                                                                                                                                                                                                                                                                                 | Limited                                                                                                                                                                                                                                 | No Catchment                                                                                                                                                                                                                                                | <div style="border: 1px solid black; padding: 2px;">27</div>             |

|                                                                                          |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
|------------------------------------------------------------------------------------------|-----------------------------|---------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------|----|
| <b>E. Rockfall - Rockfall History:</b>                                                   |                             | Few Falls                                               | Occasional Falls                                                                     | Many Falls                                                                                  | Constant Falls                                                              | 27                                                                                      |                                                                                     |                                     |    |
| <b>F. Rockfall - Block Size or Volume per Event:</b>                                     |                             | 1ft or 3yd^3                                            | 2ft or 6yd^3                                                                         | 3ft or 9yd^3                                                                                | 4ft or 12yd^3                                                               | 100                                                                                     |                                                                                     |                                     |    |
| <b>G. All - Impact on Use:</b>                                                           |                             | Full use continues with minor delay                     | Partial use remains Use modification required, short (3mi / 30min.) detour available | Use is blocked - long (>30min.) detour available or less than 1 day closure                 | Use is blocked - no detour available or closure longer than 1 week          | 9                                                                                       |                                                                                     |                                     |    |
| <b>H. All - AADT/Usage/Economic or Recreational Importance (highest rating applies):</b> |                             | 50 Rarely Used Insignificant economic / rec. importance | 200 Occasionally used Minor economic / rec. importance                               | 450 Frequently used Moderate economic / rec. importance                                     | 800 Constantly used Significant economic / rec. importance                  | <b>Use AADT in calculation:</b> <input type="checkbox"/><br>81                          |                                                                                     |                                     |    |
| <b>Preliminary Rating Landslide Total (A+B+C+G+H):</b>                                   |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 90                                                                                      |                                                                                     |                                     |    |
| <b>Preliminary Rating Rockfall Total (D+E+F+G+H):</b>                                    |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 244                                                                                     |                                                                                     |                                     |    |
| <b>Preliminary Rating</b> Good (15-21 pts)   Fair (22-161 pts)   Poor (>161 pts)         |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 90                                                                                      |                                                                                     |                                     |    |
| <b>Slope Hazard Ratings</b>                                                              |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
| <b>Category Rating:</b>                                                                  |                             |                                                         | <b>3</b>                                                                             | <b>9</b>                                                                                    | <b>27</b>                                                                   | <b>81</b>                                                                               | <b>Score:</b>                                                                       |                                     |    |
| <b>I. All - Slope Drainage:</b>                                                          |                             |                                                         | Slope appears dry or well drained; surface runoff well controlled                    | Intermittent water on slope; mod. not well drained; or surface runoff moderately controlled | Water usually on slope; poorly drained; or surface runoff poorly controlled | Water always on slope; very poorly drained; or surface water runoff control not present | 3                                                                                   |                                     |    |
| <b>J. All - Annual Rainfall:</b>                                                         |                             |                                                         | 0-10"                                                                                | 10-30"                                                                                      | 30-60"                                                                      | 60"+                                                                                    | 9                                                                                   |                                     |    |
| <b>K. All - Slope Height (Rockfall) / Axial Length of slide (Landslide):</b>             |                             |                                                         | 25ft                                                                                 | 50ft                                                                                        | 75ft                                                                        | 100ft                                                                                   | 68                                                                                  |                                     |    |
| <b>Select One Unstable Slope Type</b>                                                    | <b>Landslides / Erosion</b> | <b>L. Thaw Stability:</b>                               |                                                                                      | Unfrozen / Thaw Stable                                                                      | Slightly Thaw Unstable                                                      | Moderately Thaw Unstable                                                                | Highly Thaw Unstable                                                                | 0                                   |    |
|                                                                                          |                             | <b>M. Instability - Related Maint. Frequency:</b>       |                                                                                      | Every 10 years                                                                              | Every 5 years                                                               | Every 2 years                                                                           | Every year                                                                          | 0                                   |    |
|                                                                                          |                             | <b>N. Movement History:</b>                             |                                                                                      | Minor movement or sporadic creep                                                            | Up to 1 inch annually or steady annual creep                                | Up to 3 inches per event, one event per year                                            | >3" per event, >6" annually, more than 1 event per year (includes all debris flows) | 0                                   |    |
|                                                                                          | <b>Rockfalls</b>            | <b>O. Rockfall-Related Maint. Frequency:</b>            |                                                                                      | Normal, scheduled maintenance                                                               | Patrols after every storm event                                             | Routine seasonal patrols                                                                | Year round patrols                                                                  | 27                                  |    |
|                                                                                          |                             | <b>Geological Character Case 1</b>                      | <b>P. Structural Condition:</b>                                                      |                                                                                             | favorable                                                                   | random                                                                                  | Discontinuous adverse                                                               | Continuous adverse                  | 0  |
|                                                                                          |                             |                                                         | <b>Q. Rock Friction:</b>                                                             |                                                                                             | Rough / Irregular                                                           | Undulating                                                                              | Planar                                                                              | Clay infilled / Slickensided        | 0  |
|                                                                                          |                             | <b>Geological Character Case 2</b>                      | <b>R. Structural Condition:</b>                                                      |                                                                                             | Few differential erosion features                                           | Occasional differential erosion features                                                | Many differential erosion features                                                  | Major differential erosion features | 27 |

|                                                                                                                       |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
|-----------------------------------------------------------------------------------------------------------------------|----------------------------------------|------------------------------------------|---------------------------------------------------------|-----------------------------------------------------|---------------------|------------------|--------------------|-----|
|                                                                                                                       |                                        |                                          | <b>S. Diff. in Erosion Rates:</b>                       | Small difference                                    | Moderate difference | Large difference | Extreme difference | 27  |
| <b>T. LANDSLIDE HAZARD TOTAL (A+B+C+I+J+K+L+M+N):</b>                                                                 |                                        |                                          |                                                         |                                                     |                     |                  |                    | 0   |
| <b>U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greater of P+Q or R+S)):</b>                                              |                                        |                                          |                                                         |                                                     |                     |                  |                    | 315 |
| <b>Risk Ratings</b>                                                                                                   |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
| <b>V. Route Width or Trail Width:</b>                                                                                 | 36ft<br>14ft                           | 28ft<br>10ft                             | 20ft<br>6ft                                             | 12ft<br>2ft                                         | 14                  |                  |                    |     |
| <b>W. Human Exposure Factor:</b>                                                                                      | 12.5% of the time                      | 25% of the time                          | 37.5% of the time                                       | 50% of the time                                     | 3                   |                  |                    |     |
| <b>X. % of Decision Sight Distance (Judge avoidance ability on trails):</b>                                           | Adequate, 100% of the low design value | Moderate, 80% of the low design value    | Limited, 60% of the low design value                    | Very limited, 40% of the low design value           | 100                 |                  |                    |     |
| <b>Y. Right of Way (R/W) Impacts (If Left Unattended):</b>                                                            | No R/W implications                    | Minor effects beyond R/W                 | Private property, no structures affected                | Structures, roads, RR, utilities, or Parks affected | 3                   |                  |                    |     |
| <b>Z. Environmental/Cultural Impacts if Left Unattended:</b>                                                          | None/No Potential to Cause Effects     | Likely to Effect/No Hist. Prop. Affected | Likely to adversely Affect/Finding of No Adverse Effect | Current adverse effects/Adverse Effect              | 3                   |                  |                    |     |
| <b>AA. Maintenance Complexity:</b>                                                                                    | Routine Effort / In-House              | In-House maint. / special project        | Specialized equip. / contract                           | Complex / dangerous effort / location / contract    | 9                   |                  |                    |     |
| <b>BB. Event Cost:</b>                                                                                                | \$0-2k                                 | \$2-25k                                  | \$25-100k                                               | >\$100k                                             | 9                   |                  |                    |     |
| <b>CC. Risk Totals (G+H+V+W+X+Y+Z+AA+BB):</b>                                                                         |                                        |                                          |                                                         |                                                     |                     |                  |                    | 231 |
| <b>TOTAL USMP SCORE: LANDSLIDES (T+CC) OR ROCKFALL (U+CC):</b> Good (<200 pts)   Fair (200-400 pts)   Poor (>400 pts) |                                        |                                          |                                                         |                                                     |                     |                  |                    | 546 |





**SITE: 1130**

| Slope Rating Form - Site Information (Rockfall)                                                                                                                                                                                                               |                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                             |                                                                                 |                                                              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|--------------------------------------------------------------|
| <b>Management Area:</b><br><div style="border: 1px solid black; padding: 2px; margin-bottom: 2px;">NPS</div> <div style="border: 1px solid black; padding: 2px; margin-bottom: 2px;">IMR</div> <div style="border: 1px solid black; padding: 2px;">ZION</div> | <b>Date:</b> <div style="border: 1px solid black; padding: 2px;">2020-02-28 14:36:22</div><br>Last edit: 2018-10-19 08:35:50<br>Edit ID: 5041<br>Site ID: 1130                                               | <input checked="" type="radio"/> Rockfall<br><input type="radio"/> Landslide                                                                                                                                                                                                             | <b>Hazard Type:</b> Press (ctrl+click) to select more than one<br><div style="border: 1px solid black; padding: 2px;">           Planar<br/>           Wedge<br/>           Toppling<br/>           Raveling/Undermining         </div>                     |                                                                                 |                                                              |
| <b>Road/Trail No:</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                             | <b>Road/Trail:</b> <div style="border: 1px solid black; padding: 2px;">R</div>                                                                                                                               | <b>Road/Trail Class:</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                                                     | <b>Rater:</b> <div style="border: 1px solid black; padding: 2px;">Justin LaForge</div>                                                                                                                                                                      |                                                                                 |                                                              |
| <b>Beginning Mile Marker:</b><br><div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                  | <b>Ending Mile Marker:</b><br><div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                    | <b>Side:</b> <div style="border: 1px solid black; padding: 2px;">S - if road direction r</div>                                                                                                                                                                                           | <b>Weather:</b> <div style="border: 1px solid black; padding: 2px;">Clear</div>                                                                                                                                                                             |                                                                                 |                                                              |
| <b>Begin Coord. Lat/Long:</b><br>Lat (##.#####): <div style="border: 1px solid black; padding: 2px;">37.21509</div><br>Long (-###.#####): <div style="border: 1px solid black; padding: 2px;">-112.96502</div>                                                | <b>End Coord. Lat/Long:</b><br>Lat (##.#####): <div style="border: 1px solid black; padding: 2px;">37.21508</div><br>Long (-###.#####): <div style="border: 1px solid black; padding: 2px;">-112.96472</div> | <b>Datum:</b> <div style="border: 1px solid black; padding: 2px;">WGS 84</div>                                                                                                                                                                                                           | <b>AADT:</b> <div style="border: 1px solid black; padding: 2px;">1</div>                                                                                                                                                                                    |                                                                                 |                                                              |
| <b>Length of Affected Road/Trail (ft):</b> <div style="border: 1px solid black; padding: 2px;">71</div>                                                                                                                                                       | <b>Slope Height (rock)/Axial Length (slide) (ft):</b> <div style="border: 1px solid black; padding: 2px;">37</div>                                                                                           |                                                                                                                                                                                                                                                                                          | <b>Slope Angle (°):</b> <div style="border: 1px solid black; padding: 2px;">70</div>                                                                                                                                                                        |                                                                                 |                                                              |
| <b>Sight Distance (ft):</b><br><div style="border: 1px solid black; padding: 2px;">213</div>                                                                                                                                                                  | <b>Usable Roadway/Trail Width (ft):</b> <div style="border: 1px solid black; padding: 2px;">27</div>                                                                                                         |                                                                                                                                                                                                                                                                                          | <b>Speed Limit (mph):</b><br><div style="border: 1px solid black; padding: 2px;">35</div>                                                                                                                                                                   |                                                                                 |                                                              |
| <b>Ditch Width Range (ft):</b><br><div style="border: 1px solid black; padding: 2px;">7</div> - <div style="border: 1px solid black; padding: 2px;">7</div>                                                                                                   | <b>Ditch Depth Range (ft):</b><br><div style="border: 1px solid black; padding: 2px;">1</div> - <div style="border: 1px solid black; padding: 2px;">1</div>                                                  | <b>Ditch Slope Range (H:V):</b><br><div style="border: 1px solid black; padding: 2px;">0</div> : <div style="border: 1px solid black; padding: 2px;">0</div> - <div style="border: 1px solid black; padding: 2px;">0</div> : <div style="border: 1px solid black; padding: 2px;">0</div> | <b>Block Size (ft):</b> <div style="border: 1px solid black; padding: 2px;">30</div><br><b>Volume (cy):</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                     |                                                                                 |                                                              |
| <b>Annual Rainfall Range (in):</b><br><div style="border: 1px solid black; padding: 2px;">13</div> - <div style="border: 1px solid black; padding: 2px;">13</div>                                                                                             | <b>Sole Access Route:</b> <div style="border: 1px solid black; padding: 2px;">Yes</div>                                                                                                                      | <b>Mitigation Present:</b> <div style="border: 1px solid black; padding: 2px;">NO</div>                                                                                                                                                                                                  | <b>Photos/Documents(up to 10MB):</b><br><div style="border: 1px solid black; padding: 2px; display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 2px; margin-right: 5px;">Choose Files</div> <div>No file chosen</div> </div> |                                                                                 |                                                              |
| <b>Comments:</b> <div style="border: 1px solid black; padding: 5px;">Big Navajo sandstone blocks upslope</div>                                                                                                                                                |                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                             |                                                                                 |                                                              |
| <b>Alternate database Name:</b><br><div style="border: 1px solid black; height: 30px;"></div>                                                                                                                                                                 |                                                                                                                                                                                                              | <b>Alternate database ID:</b><br><div style="border: 1px solid black; height: 30px;"></div>                                                                                                                                                                                              |                                                                                                                                                                                                                                                             |                                                                                 |                                                              |
| <b>Alternate database Description:</b><br><div style="border: 1px solid black; height: 30px;"></div>                                                                                                                                                          |                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                             |                                                                                 |                                                              |
| Preliminary Ratings                                                                                                                                                                                                                                           |                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                             |                                                                                 |                                                              |
| Category Rating:                                                                                                                                                                                                                                              | 3                                                                                                                                                                                                            | 9                                                                                                                                                                                                                                                                                        | 27                                                                                                                                                                                                                                                          | 81                                                                              | Score:                                                       |
| <b>A. Landslide - Roadway Width Affected:</b>                                                                                                                                                                                                                 | 0-5 percent                                                                                                                                                                                                  | 6-25 percent                                                                                                                                                                                                                                                                             | 26-50 percent                                                                                                                                                                                                                                               | 51-100 percent                                                                  | <div style="border: 1px solid black; padding: 2px;">0</div>  |
| <b>B. Landslide - Slide/Erosion Effects:</b>                                                                                                                                                                                                                  | Visible crack or slight deposit of material / minor erosion                                                                                                                                                  | 1 inch offset, or 6-inch deposit of material / major erosion will affect travel in < 5 years                                                                                                                                                                                             | 2-inch offset or 12-inch deposit / mod. erosion impacting travel annually                                                                                                                                                                                   | 4-inch offset or 24-inch deposit / severe erosion impacting travel consistently | <div style="border: 1px solid black; padding: 2px;">0</div>  |
| <b>C. Landslide - Roadway Length Affected:</b>                                                                                                                                                                                                                | 25 ft                                                                                                                                                                                                        | 100 ft                                                                                                                                                                                                                                                                                   | 225 ft                                                                                                                                                                                                                                                      | 400 ft                                                                          | <div style="border: 1px solid black; padding: 2px;">0</div>  |
| <b>D. Rockfall - Ditch Effectiveness: (consider launch features)</b>                                                                                                                                                                                          | Good                                                                                                                                                                                                         | Moderate                                                                                                                                                                                                                                                                                 | Limited                                                                                                                                                                                                                                                     | No Catchment                                                                    | <div style="border: 1px solid black; padding: 2px;">27</div> |

|                                                                                          |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
|------------------------------------------------------------------------------------------|-----------------------------|---------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------|----|
| <b>E. Rockfall - Rockfall History:</b>                                                   |                             | Few Falls                                               | Occasional Falls                                                                     | Many Falls                                                                                  | Constant Falls                                                              | 9                                                                                       |                                                                                     |                                     |    |
| <b>F. Rockfall - Block Size or Volume per Event:</b>                                     |                             | 1ft or 3yd^3                                            | 2ft or 6yd^3                                                                         | 3ft or 9yd^3                                                                                | 4ft or 12yd^3                                                               | 100                                                                                     |                                                                                     |                                     |    |
| <b>G. All - Impact on Use:</b>                                                           |                             | Full use continues with minor delay                     | Partial use remains Use modification required, short (3mi / 30min.) detour available | Use is blocked - long (>30min.) detour available or less than 1 day closure                 | Use is blocked - no detour available or closure longer than 1 week          | 27                                                                                      |                                                                                     |                                     |    |
| <b>H. All - AADT/Usage/Economic or Recreational Importance (highest rating applies):</b> |                             | 50 Rarely Used Insignificant economic / rec. importance | 200 Occasionally used Minor economic / rec. importance                               | 450 Frequently used Moderate economic / rec. importance                                     | 800 Constantly used Significant economic / rec. importance                  | <b>Use AADT in calculation:</b> <input type="checkbox"/><br>81                          |                                                                                     |                                     |    |
| <b>Preliminary Rating Landslide Total (A+B+C+G+H):</b>                                   |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 244                                                                                     |                                                                                     |                                     |    |
| <b>Preliminary Rating Rockfall Total (D+E+F+G+H):</b>                                    |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 244                                                                                     |                                                                                     |                                     |    |
| <b>Preliminary Rating</b> Good (15-21 pts)   Fair (22-161 pts)   Poor (>161 pts)         |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 244                                                                                     |                                                                                     |                                     |    |
| <b>Slope Hazard Ratings</b>                                                              |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
| <b>Category Rating:</b>                                                                  |                             |                                                         | <b>3</b>                                                                             | <b>9</b>                                                                                    | <b>27</b>                                                                   | <b>81</b>                                                                               | <b>Score:</b>                                                                       |                                     |    |
| <b>I. All - Slope Drainage:</b>                                                          |                             |                                                         | Slope appears dry or well drained; surface runoff well controlled                    | Intermittent water on slope; mod. not well drained; or surface runoff moderately controlled | Water usually on slope; poorly drained; or surface runoff poorly controlled | Water always on slope; very poorly drained; or surface water runoff control not present | 3                                                                                   |                                     |    |
| <b>J. All - Annual Rainfall:</b>                                                         |                             |                                                         | 0-10"                                                                                | 10-30"                                                                                      | 30-60"                                                                      | 60"+                                                                                    | 9                                                                                   |                                     |    |
| <b>K. All - Slope Height (Rockfall) / Axial Length of slide (Landslide):</b>             |                             |                                                         | 25ft                                                                                 | 50ft                                                                                        | 75ft                                                                        | 100ft                                                                                   | 5                                                                                   |                                     |    |
| <b>Select One Unstable Slope Type</b>                                                    | <b>Landslides / Erosion</b> | <b>L. Thaw Stability:</b>                               |                                                                                      | Unfrozen / Thaw Stable                                                                      | Slightly Thaw Unstable                                                      | Moderately Thaw Unstable                                                                | Highly Thaw Unstable                                                                | 0                                   |    |
|                                                                                          |                             | <b>M. Instability - Related Maint. Frequency:</b>       |                                                                                      | Every 10 years                                                                              | Every 5 years                                                               | Every 2 years                                                                           | Every year                                                                          | 0                                   |    |
|                                                                                          |                             | <b>N. Movement History:</b>                             |                                                                                      | Minor movement or sporadic creep                                                            | Up to 1 inch annually or steady annual creep                                | Up to 3 inches per event, one event per year                                            | >3" per event, >6" annually, more than 1 event per year (includes all debris flows) | 0                                   |    |
|                                                                                          | <b>Rockfalls</b>            | <b>O. Rockfall-Related Maint. Frequency:</b>            |                                                                                      | Normal, scheduled maintenance                                                               | Patrols after every storm event                                             | Routine seasonal patrols                                                                | Year round patrols                                                                  | 27                                  |    |
|                                                                                          |                             | <b>Geological Character Case 1</b>                      | <b>P. Structural Condition:</b>                                                      |                                                                                             | favorable                                                                   | random                                                                                  | Discontinuous adverse                                                               | Continuous adverse                  | 0  |
|                                                                                          |                             |                                                         | <b>Q. Rock Friction:</b>                                                             |                                                                                             | Rough / Irregular                                                           | Undulating                                                                              | Planar                                                                              | Clay infilled / Slickensided        | 0  |
|                                                                                          |                             | <b>Geological Character Case 2</b>                      |                                                                                      | <b>R. Structural Condition:</b>                                                             | Few differential erosion features                                           | Occasional differential erosion features                                                | Many differential erosion features                                                  | Major differential erosion features | 27 |

|                                                                                                                       |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
|-----------------------------------------------------------------------------------------------------------------------|----------------------------------------|------------------------------------------|---------------------------------------------------------|-----------------------------------------------------|---------------------|------------------|--------------------|-----|
|                                                                                                                       |                                        |                                          | <b>S. Diff. in Erosion Rates:</b>                       | Small difference                                    | Moderate difference | Large difference | Extreme difference | 27  |
| <b>T. LANDSLIDE HAZARD TOTAL (A+B+C+I+J+K+L+M+N):</b>                                                                 |                                        |                                          |                                                         |                                                     |                     |                  |                    | 0   |
| <b>U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greater of P+Q or R+S)):</b>                                              |                                        |                                          |                                                         |                                                     |                     |                  |                    | 234 |
| <b>Risk Ratings</b>                                                                                                   |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
| <b>V. Route Width or Trail Width:</b>                                                                                 | 36ft<br>14ft                           | 28ft<br>10ft                             | 20ft<br>6ft                                             | 12ft<br>2ft                                         | 10                  |                  |                    |     |
| <b>W. Human Exposure Factor:</b>                                                                                      | 12.5% of the time                      | 25% of the time                          | 37.5% of the time                                       | 50% of the time                                     | 3                   |                  |                    |     |
| <b>X. % of Decision Sight Distance (Judge avoidance ability on trails):</b>                                           | Adequate, 100% of the low design value | Moderate, 80% of the low design value    | Limited, 60% of the low design value                    | Very limited, 40% of the low design value           | 78                  |                  |                    |     |
| <b>Y. Right of Way (R/W) Impacts (If Left Unattended):</b>                                                            | No R/W implications                    | Minor effects beyond R/W                 | Private property, no structures affected                | Structures, roads, RR, utilities, or Parks affected | 3                   |                  |                    |     |
| <b>Z. Environmental/Cultural Impacts if Left Unattended:</b>                                                          | None/No Potential to Cause Effects     | Likely to Effect/No Hist. Prop. Affected | Likely to adversely Affect/Finding of No Adverse Effect | Current adverse effects/Adverse Effect              | 3                   |                  |                    |     |
| <b>AA. Maintenance Complexity:</b>                                                                                    | Routine Effort / In-House              | In-House maint. / special project        | Specialized equip. / contract                           | Complex / dangerous effort / location / contract    | 9                   |                  |                    |     |
| <b>BB. Event Cost:</b>                                                                                                | \$0-2k                                 | \$2-25k                                  | \$25-100k                                               | >\$100k                                             | 9                   |                  |                    |     |
| <b>CC. Risk Totals (G+H+V+W+X+Y+Z+AA+BB):</b>                                                                         |                                        |                                          |                                                         |                                                     |                     |                  |                    | 223 |
| <b>TOTAL USMP SCORE: LANDSLIDES (T+CC) OR ROCKFALL (U+CC):</b> Good (<200 pts)   Fair (200-400 pts)   Poor (>400 pts) |                                        |                                          |                                                         |                                                     |                     |                  |                    | 457 |





**SITE: 1131**

| Slope Rating Form - Site Information (Rockfall)                                            |                                                             |                                                                                                      |                                                                           |                                                                                                                                                                                   |        |
|--------------------------------------------------------------------------------------------|-------------------------------------------------------------|------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| <b>Management Area:</b><br><div>NPS</div> <div>IMR</div> <div>ZION</div>                   |                                                             | <b>Date:</b> 2020-02-28 14:37:53<br>Last edit: 2018-10-19 08:39:45<br>Edit ID: 5042<br>Site ID: 1131 |                                                                           | <b>Hazard Type:</b> Press (ctrl+click) to select more than one<br><div> <input checked="" type="radio"/> Rockfall<br/> <input type="radio"/> Landslide                     </div> |        |
| <b>Road/Trail No:</b> 0                                                                    |                                                             | <b>Road/Trail:</b> R                                                                                 |                                                                           | <b>Road/Trail Class:</b> 0                                                                                                                                                        |        |
| <b>Beginning Mile Marker:</b> 0                                                            |                                                             | <b>Ending Mile Marker:</b> 0                                                                         |                                                                           | <b>Side:</b> S - if road direction r                                                                                                                                              |        |
| <b>Begin Coord. Lat/Long:</b><br>Lat (##.#####): 37.21508<br>Long (-###.#####): -112.96464 |                                                             | <b>End Coord. Lat/Long:</b><br>Lat (##.#####): 37.21543<br>Long (-###.#####): -112.96317             |                                                                           | <b>Datum:</b> WGS 84                                                                                                                                                              |        |
| <b>Length of Affected Road/Trail (ft):</b> 388                                             |                                                             | <b>Slope Height (rock)/Axial Length (slide) (ft):</b> 33                                             |                                                                           | <b>Slope Angle (°):</b> 38                                                                                                                                                        |        |
| <b>Sight Distance (ft):</b> 125                                                            |                                                             | <b>Usable Roadway/Trail Width (ft):</b> 25                                                           |                                                                           | <b>Speed Limit (mph):</b> 35                                                                                                                                                      |        |
| <b>Ditch Width Range (ft):</b> 0.5 - 0.5                                                   |                                                             | <b>Ditch Depth Range (ft):</b> 0 - 0                                                                 |                                                                           | <b>Ditch Slope Range (H:V):</b> 0:0 - 0:0                                                                                                                                         |        |
| <b>Block Size (ft):</b> 6                                                                  |                                                             | <b>Volume (cy):</b> 0                                                                                |                                                                           |                                                                                                                                                                                   |        |
| <b>Annual Rainfall Range (in):</b> 13 - 13                                                 |                                                             | <b>Sole Access Route:</b> Yes                                                                        |                                                                           | <b>Mitigation Present:</b> NO                                                                                                                                                     |        |
| <b>Photos/Documents(up to 10MB):</b><br><div>Choose Files</div> No file chosen             |                                                             |                                                                                                      |                                                                           |                                                                                                                                                                                   |        |
| <b>Comments:</b> Vegetated. raveling or boulders from landslide deposits                   |                                                             |                                                                                                      |                                                                           |                                                                                                                                                                                   |        |
| <b>Alternate database Name:</b>                                                            |                                                             |                                                                                                      | <b>Alternate database ID:</b>                                             |                                                                                                                                                                                   |        |
| <b>Alternate database Description:</b>                                                     |                                                             |                                                                                                      |                                                                           |                                                                                                                                                                                   |        |
| Preliminary Ratings                                                                        |                                                             |                                                                                                      |                                                                           |                                                                                                                                                                                   |        |
| Category Rating:                                                                           | 3                                                           | 9                                                                                                    | 27                                                                        | 81                                                                                                                                                                                | Score: |
| <b>A. Landslide - Roadway Width Affected:</b>                                              | 0-5 percent                                                 | 6-25 percent                                                                                         | 26-50 percent                                                             | 51-100 percent                                                                                                                                                                    | 0      |
| <b>B. Landslide - Slide/Erosion Effects:</b>                                               | Visible crack or slight deposit of material / minor erosion | 1 inch offset, or 6-inch deposit of material / major erosion will affect travel in < 5 years         | 2-inch offset or 12-inch deposit / mod. erosion impacting travel annually | 4-inch offset or 24-inch deposit / severe erosion impacting travel consistently                                                                                                   | 0      |
| <b>C. Landslide - Roadway Length Affected:</b>                                             | 25 ft                                                       | 100 ft                                                                                               | 225 ft                                                                    | 400 ft                                                                                                                                                                            | 0      |
| <b>D. Rockfall - Ditch Effectiveness: (consider launch features)</b>                       | Good                                                        | Moderate                                                                                             | Limited                                                                   | No Catchment                                                                                                                                                                      | 27     |

|                                                                                          |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |   |
|------------------------------------------------------------------------------------------|-----------------------------|---------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------|---|
| <b>E. Rockfall - Rockfall History:</b>                                                   |                             | Few Falls                                               | Occasional Falls                                                                     | Many Falls                                                                                  | Constant Falls                                                              | 9                                                                                       |                                                                                     |                                     |   |
| <b>F. Rockfall - Block Size or Volume per Event:</b>                                     |                             | 1ft or 3yd^3                                            | 2ft or 6yd^3                                                                         | 3ft or 9yd^3                                                                                | 4ft or 12yd^3                                                               | 100                                                                                     |                                                                                     |                                     |   |
| <b>G. All - Impact on Use:</b>                                                           |                             | Full use continues with minor delay                     | Partial use remains Use modification required, short (3mi / 30min.) detour available | Use is blocked - long (>30min.) detour available or less than 1 day closure                 | Use is blocked - no detour available or closure longer than 1 week          | 3                                                                                       |                                                                                     |                                     |   |
| <b>H. All - AADT/Usage/Economic or Recreational Importance (highest rating applies):</b> |                             | 50 Rarely Used Insignificant economic / rec. importance | 200 Occasionally used Minor economic / rec. importance                               | 450 Frequently used Moderate economic / rec. importance                                     | 800 Constantly used Significant economic / rec. importance                  | <b>Use AADT in calculation:</b> <input type="checkbox"/><br>81                          |                                                                                     |                                     |   |
| <b>Preliminary Rating Landslide Total (A+B+C+G+H):</b>                                   |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |   |
| <b>Preliminary Rating Rockfall Total (D+E+F+G+H):</b>                                    |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 220                                                                                     |                                                                                     |                                     |   |
| <b>Preliminary Rating</b> Good (15-21 pts)   Fair (22-161 pts)   Poor (>161 pts)         |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 84                                                                                      |                                                                                     |                                     |   |
| <b>Slope Hazard Ratings</b>                                                              |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |   |
| <b>Category Rating:</b>                                                                  |                             |                                                         | <b>3</b>                                                                             | <b>9</b>                                                                                    | <b>27</b>                                                                   | <b>81</b>                                                                               | <b>Score:</b>                                                                       |                                     |   |
| <b>I. All - Slope Drainage:</b>                                                          |                             |                                                         | Slope appears dry or well drained; surface runoff well controlled                    | Intermittent water on slope; mod. not well drained; or surface runoff moderately controlled | Water usually on slope; poorly drained; or surface runoff poorly controlled | Water always on slope; very poorly drained; or surface water runoff control not present | 3                                                                                   |                                     |   |
| <b>J. All - Annual Rainfall:</b>                                                         |                             |                                                         | 0-10"                                                                                | 10-30"                                                                                      | 30-60"                                                                      | 60"+                                                                                    | 9                                                                                   |                                     |   |
| <b>K. All - Slope Height (Rockfall) / Axial Length of slide (Landslide):</b>             |                             |                                                         | 25ft                                                                                 | 50ft                                                                                        | 75ft                                                                        | 100ft                                                                                   | 4                                                                                   |                                     |   |
| <b>Select One Unstable Slope Type</b>                                                    | <b>Landslides / Erosion</b> | <b>L. Thaw Stability:</b>                               |                                                                                      | Unfrozen / Thaw Stable                                                                      | Slightly Thaw Unstable                                                      | Moderately Thaw Unstable                                                                | Highly Thaw Unstable                                                                | 0                                   |   |
|                                                                                          |                             | <b>M. Instability - Related Maint. Frequency:</b>       |                                                                                      | Every 10 years                                                                              | Every 5 years                                                               | Every 2 years                                                                           | Every year                                                                          | 0                                   |   |
|                                                                                          |                             | <b>N. Movement History:</b>                             |                                                                                      | Minor movement or sporadic creep                                                            | Up to 1 inch annually or steady annual creep                                | Up to 3 inches per event, one event per year                                            | >3" per event, >6" annually, more than 1 event per year (includes all debris flows) | 0                                   |   |
|                                                                                          | <b>Rockfalls</b>            | <b>O. Rockfall-Related Maint. Frequency:</b>            |                                                                                      | Normal, scheduled maintenance                                                               | Patrols after every storm event                                             | Routine seasonal patrols                                                                | Year round patrols                                                                  | 9                                   |   |
|                                                                                          |                             | <b>Geological Character Case 1</b>                      | <b>P. Structural Condition:</b>                                                      |                                                                                             | favorable                                                                   | random                                                                                  | Discontinuous adverse                                                               | Continuous adverse                  | 0 |
|                                                                                          |                             |                                                         | <b>Q. Rock Friction:</b>                                                             |                                                                                             | Rough / Irregular                                                           | Undulating                                                                              | Planar                                                                              | Clay infilled / Slickensided        | 0 |
|                                                                                          |                             | <b>Geological Character Case 2</b>                      | <b>R. Structural Condition:</b>                                                      |                                                                                             | Few differential erosion features                                           | Occasional differential erosion features                                                | Many differential erosion features                                                  | Major differential erosion features | 9 |

|                                                                                                                       |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
|-----------------------------------------------------------------------------------------------------------------------|----------------------------------------|------------------------------------------|---------------------------------------------------------|-----------------------------------------------------|---------------------|------------------|--------------------|-----|
|                                                                                                                       |                                        |                                          | <b>S. Diff. in Erosion Rates:</b>                       | Small difference                                    | Moderate difference | Large difference | Extreme difference | 27  |
| <b>T. LANDSLIDE HAZARD TOTAL (A+B+C+I+J+K+L+M+N):</b>                                                                 |                                        |                                          |                                                         |                                                     |                     |                  |                    | 0   |
| <b>U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greater of P+Q or R+S)):</b>                                              |                                        |                                          |                                                         |                                                     |                     |                  |                    | 197 |
| <b>Risk Ratings</b>                                                                                                   |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
| <b>V. Route Width or Trail Width:</b>                                                                                 | 36ft<br>14ft                           | 28ft<br>10ft                             | 20ft<br>6ft                                             | 12ft<br>2ft                                         | 14                  |                  |                    |     |
| <b>W. Human Exposure Factor:</b>                                                                                      | 12.5% of the time                      | 25% of the time                          | 37.5% of the time                                       | 50% of the time                                     | 3                   |                  |                    |     |
| <b>X. % of Decision Sight Distance (Judge avoidance ability on trails):</b>                                           | Adequate, 100% of the low design value | Moderate, 80% of the low design value    | Limited, 60% of the low design value                    | Very limited, 40% of the low design value           | 100                 |                  |                    |     |
| <b>Y. Right of Way (R/W) Impacts (If Left Unattended):</b>                                                            | No R/W implications                    | Minor effects beyond R/W                 | Private property, no structures affected                | Structures, roads, RR, utilities, or Parks affected | 3                   |                  |                    |     |
| <b>Z. Environmental/Cultural Impacts if Left Unattended:</b>                                                          | None/No Potential to Cause Effects     | Likely to Effect/No Hist. Prop. Affected | Likely to adversely Affect/Finding of No Adverse Effect | Current adverse effects/Adverse Effect              | 3                   |                  |                    |     |
| <b>AA. Maintenance Complexity:</b>                                                                                    | Routine Effort / In-House              | In-House maint. / special project        | Specialized equip. / contract                           | Complex / dangerous effort / location / contract    | 9                   |                  |                    |     |
| <b>BB. Event Cost:</b>                                                                                                | \$0-2k                                 | \$2-25k                                  | \$25-100k                                               | >\$100k                                             | 9                   |                  |                    |     |
| <b>CC. Risk Totals (G+H+V+W+X+Y+Z+AA+BB):</b>                                                                         |                                        |                                          |                                                         |                                                     |                     |                  |                    | 225 |
| <b>TOTAL USMP SCORE: LANDSLIDES (T+CC) OR ROCKFALL (U+CC):</b> Good (<200 pts)   Fair (200-400 pts)   Poor (>400 pts) |                                        |                                          |                                                         |                                                     |                     |                  |                    | 422 |





**SITE: 1134**

| Slope Rating Form - Site Information (Rockfall)                                                                                                                                                                                                               |                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                             |                                                                                 |                                                             |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|-------------------------------------------------------------|
| <b>Management Area:</b><br><div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;">NPS</div> <div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;">IMR</div> <div style="border: 1px solid black; padding: 2px;">ZION</div> | <b>Date:</b> <div style="border: 1px solid black; padding: 2px;">2020-02-28 14:36:46</div><br>Last edit: 2018-10-19 08:42:12<br>Edit ID: 5043<br>Site ID: 1134                                               | <input checked="" type="radio"/> Rockfall<br><input type="radio"/> Landslide                                                                                                                                                                                                             | <b>Hazard Type:</b> Press (ctrl+click) to select more than one<br><div style="border: 1px solid black; padding: 2px;">           Planar<br/>           Wedge<br/>           Toppling<br/>           Raveling/Undermining         </div>                     |                                                                                 |                                                             |
| <b>Road/Trail No:</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                             | <b>Road/Trail:</b> <div style="border: 1px solid black; padding: 2px;">R</div>                                                                                                                               | <b>Road/Trail Class:</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                                                     | <b>Rater:</b> <div style="border: 1px solid black; padding: 2px;">Justin LaForge</div>                                                                                                                                                                      |                                                                                 |                                                             |
| <b>Beginning Mile Marker:</b><br><div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                  | <b>Ending Mile Marker:</b><br><div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                    | <b>Side:</b> <div style="border: 1px solid black; padding: 2px;">S - if road direction r</div>                                                                                                                                                                                           | <b>Weather:</b> <div style="border: 1px solid black; padding: 2px;">Clear</div>                                                                                                                                                                             |                                                                                 |                                                             |
| <b>Begin Coord. Lat/Long:</b><br>Lat (##.#####): <div style="border: 1px solid black; padding: 2px;">37.21412</div><br>Long (-###.#####): <div style="border: 1px solid black; padding: 2px;">-112.95773</div>                                                | <b>End Coord. Lat/Long:</b><br>Lat (##.#####): <div style="border: 1px solid black; padding: 2px;">37.21422</div><br>Long (-###.#####): <div style="border: 1px solid black; padding: 2px;">-112.85866</div> | <b>Datum:</b> <div style="border: 1px solid black; padding: 2px;">WGS 84</div>                                                                                                                                                                                                           | <b>AADT:</b> <div style="border: 1px solid black; padding: 2px;">1</div>                                                                                                                                                                                    |                                                                                 |                                                             |
| <b>Length of Affected Road/Trail (ft):</b> <div style="border: 1px solid black; padding: 2px;">286</div>                                                                                                                                                      | <b>Slope Height (rock)/Axial Length (slide) (ft):</b> <div style="border: 1px solid black; padding: 2px;">84</div>                                                                                           |                                                                                                                                                                                                                                                                                          | <b>Slope Angle (°):</b> <div style="border: 1px solid black; padding: 2px;">39</div>                                                                                                                                                                        |                                                                                 |                                                             |
| <b>Sight Distance (ft):</b> <div style="border: 1px solid black; padding: 2px;">145</div>                                                                                                                                                                     | <b>Usable Roadway/Trail Width (ft):</b> <div style="border: 1px solid black; padding: 2px;">24</div>                                                                                                         |                                                                                                                                                                                                                                                                                          | <b>Speed Limit (mph):</b> <div style="border: 1px solid black; padding: 2px;">35</div>                                                                                                                                                                      |                                                                                 |                                                             |
| <b>Ditch Width Range (ft):</b><br><div style="border: 1px solid black; padding: 2px;">7.5</div> - <div style="border: 1px solid black; padding: 2px;">7.5</div>                                                                                               | <b>Ditch Depth Range (ft):</b><br><div style="border: 1px solid black; padding: 2px;">1.5</div> - <div style="border: 1px solid black; padding: 2px;">1.5</div>                                              | <b>Ditch Slope Range (H:V):</b><br><div style="border: 1px solid black; padding: 2px;">0</div> : <div style="border: 1px solid black; padding: 2px;">0</div> - <div style="border: 1px solid black; padding: 2px;">0</div> : <div style="border: 1px solid black; padding: 2px;">0</div> | <b>Block Size (ft):</b> <div style="border: 1px solid black; padding: 2px;">5</div><br><b>Volume (cy):</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                      |                                                                                 |                                                             |
| <b>Annual Rainfall Range (in):</b><br><div style="border: 1px solid black; padding: 2px;">13</div> - <div style="border: 1px solid black; padding: 2px;">13</div>                                                                                             | <b>Sole Access Route:</b> <div style="border: 1px solid black; padding: 2px;">Yes</div>                                                                                                                      | <b>Mitigation Present:</b> <div style="border: 1px solid black; padding: 2px;">NO</div>                                                                                                                                                                                                  | <b>Photos/Documents(up to 10MB):</b><br><div style="border: 1px solid black; padding: 2px; display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 2px; margin-right: 5px;">Choose Files</div> <div>No file chosen</div> </div> |                                                                                 |                                                             |
| <b>Comments:</b> <div style="border: 1px solid black; padding: 5px; margin-left: 20px;">Large (30ft)boulder on slope</div>                                                                                                                                    |                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                             |                                                                                 |                                                             |
| <b>Alternate database Name:</b><br><div style="border: 1px solid black; height: 30px; margin-top: 5px;"></div>                                                                                                                                                |                                                                                                                                                                                                              | <b>Alternate database ID:</b><br><div style="border: 1px solid black; height: 30px; margin-top: 5px;"></div>                                                                                                                                                                             |                                                                                                                                                                                                                                                             |                                                                                 |                                                             |
| <b>Alternate database Description:</b><br><div style="border: 1px solid black; height: 40px; margin-top: 5px;"></div>                                                                                                                                         |                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                             |                                                                                 |                                                             |
| Preliminary Ratings                                                                                                                                                                                                                                           |                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                             |                                                                                 |                                                             |
| Category Rating:                                                                                                                                                                                                                                              | 3                                                                                                                                                                                                            | 9                                                                                                                                                                                                                                                                                        | 27                                                                                                                                                                                                                                                          | 81                                                                              | Score:                                                      |
| <b>A. Landslide - Roadway Width Affected:</b>                                                                                                                                                                                                                 | 0-5 percent                                                                                                                                                                                                  | 6-25 percent                                                                                                                                                                                                                                                                             | 26-50 percent                                                                                                                                                                                                                                               | 51-100 percent                                                                  | <div style="border: 1px solid black; padding: 2px;">0</div> |
| <b>B. Landslide - Slide/Erosion Effects:</b>                                                                                                                                                                                                                  | Visible crack or slight deposit of material / minor erosion                                                                                                                                                  | 1 inch offset, or 6-inch deposit of material / major erosion will affect travel in < 5 years                                                                                                                                                                                             | 2-inch offset or 12-inch deposit / mod. erosion impacting travel annually                                                                                                                                                                                   | 4-inch offset or 24-inch deposit / severe erosion impacting travel consistently | <div style="border: 1px solid black; padding: 2px;">0</div> |
| <b>C. Landslide - Roadway Length Affected:</b>                                                                                                                                                                                                                | 25 ft                                                                                                                                                                                                        | 100 ft                                                                                                                                                                                                                                                                                   | 225 ft                                                                                                                                                                                                                                                      | 400 ft                                                                          | <div style="border: 1px solid black; padding: 2px;">0</div> |
| <b>D. Rockfall - Ditch Effectiveness: (consider launch features)</b>                                                                                                                                                                                          | Good                                                                                                                                                                                                         | Moderate                                                                                                                                                                                                                                                                                 | Limited                                                                                                                                                                                                                                                     | No Catchment                                                                    | <div style="border: 1px solid black; padding: 2px;">9</div> |

|                                                                                          |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
|------------------------------------------------------------------------------------------|-----------------------------|---------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------|----|
| <b>E. Rockfall - Rockfall History:</b>                                                   |                             | Few Falls                                               | Occasional Falls                                                                     | Many Falls                                                                                  | Constant Falls                                                              | 27                                                                                      |                                                                                     |                                     |    |
| <b>F. Rockfall - Block Size or Volume per Event:</b>                                     |                             | 1ft or 3yd^3                                            | 2ft or 6yd^3                                                                         | 3ft or 9yd^3                                                                                | 4ft or 12yd^3                                                               | 100                                                                                     |                                                                                     |                                     |    |
| <b>G. All - Impact on Use:</b>                                                           |                             | Full use continues with minor delay                     | Partial use remains Use modification required, short (3mi / 30min.) detour available | Use is blocked - long (>30min.) detour available or less than 1 day closure                 | Use is blocked - no detour available or closure longer than 1 week          | 3                                                                                       |                                                                                     |                                     |    |
| <b>H. All - AADT/Usage/Economic or Recreational Importance (highest rating applies):</b> |                             | 50 Rarely Used Insignificant economic / rec. importance | 200 Occasionally used Minor economic / rec. importance                               | 450 Frequently used Moderate economic / rec. importance                                     | 800 Constantly used Significant economic / rec. importance                  | <b>Use AADT in calculation:</b> <input type="checkbox"/><br>81                          |                                                                                     |                                     |    |
| <b>Preliminary Rating Landslide Total (A+B+C+G+H):</b>                                   |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
| <b>Preliminary Rating Rockfall Total (D+E+F+G+H):</b>                                    |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 220                                                                                     |                                                                                     |                                     |    |
| <b>Preliminary Rating</b> Good (15-21 pts)   Fair (22-161 pts)   Poor (>161 pts)         |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 84                                                                                      |                                                                                     |                                     |    |
| <b>Slope Hazard Ratings</b>                                                              |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
| <b>Category Rating:</b>                                                                  |                             |                                                         | <b>3</b>                                                                             | <b>9</b>                                                                                    | <b>27</b>                                                                   | <b>81</b>                                                                               | <b>Score:</b>                                                                       |                                     |    |
| <b>I. All - Slope Drainage:</b>                                                          |                             |                                                         | Slope appears dry or well drained; surface runoff well controlled                    | Intermittent water on slope; mod. not well drained; or surface runoff moderately controlled | Water usually on slope; poorly drained; or surface runoff poorly controlled | Water always on slope; very poorly drained; or surface water runoff control not present | 3                                                                                   |                                     |    |
| <b>J. All - Annual Rainfall:</b>                                                         |                             |                                                         | 0-10"                                                                                | 10-30"                                                                                      | 30-60"                                                                      | 60"+                                                                                    | 9                                                                                   |                                     |    |
| <b>K. All - Slope Height (Rockfall) / Axial Length of slide (Landslide):</b>             |                             |                                                         | 25ft                                                                                 | 50ft                                                                                        | 75ft                                                                        | 100ft                                                                                   | 40                                                                                  |                                     |    |
| <b>Select One Unstable Slope Type</b>                                                    | <b>Landslides / Erosion</b> | <b>L. Thaw Stability:</b>                               |                                                                                      | Unfrozen / Thaw Stable                                                                      | Slightly Thaw Unstable                                                      | Moderately Thaw Unstable                                                                | Highly Thaw Unstable                                                                | 0                                   |    |
|                                                                                          |                             | <b>M. Instability - Related Maint. Frequency:</b>       |                                                                                      | Every 10 years                                                                              | Every 5 years                                                               | Every 2 years                                                                           | Every year                                                                          | 0                                   |    |
|                                                                                          |                             | <b>N. Movement History:</b>                             |                                                                                      | Minor movement or sporadic creep                                                            | Up to 1 inch annually or steady annual creep                                | Up to 3 inches per event, one event per year                                            | >3" per event, >6" annually, more than 1 event per year (includes all debris flows) | 0                                   |    |
|                                                                                          | <b>Rockfalls</b>            | <b>O. Rockfall-Related Maint. Frequency:</b>            |                                                                                      | Normal, scheduled maintenance                                                               | Patrols after every storm event                                             | Routine seasonal patrols                                                                | Year round patrols                                                                  | 27                                  |    |
|                                                                                          |                             | <b>Geological Character Case 1</b>                      | <b>P. Structural Condition:</b>                                                      |                                                                                             | favorable                                                                   | random                                                                                  | Discontinuous adverse                                                               | Continuous adverse                  | 0  |
|                                                                                          |                             |                                                         | <b>Q. Rock Friction:</b>                                                             |                                                                                             | Rough / Irregular                                                           | Undulating                                                                              | Planar                                                                              | Clay infilled / Slickensided        | 0  |
|                                                                                          |                             | <b>Geological Character Case 2</b>                      | <b>R. Structural Condition:</b>                                                      |                                                                                             | Few differential erosion features                                           | Occasional differential erosion features                                                | Many differential erosion features                                                  | Major differential erosion features | 27 |

|                                                                                                                       |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
|-----------------------------------------------------------------------------------------------------------------------|----------------------------------------|------------------------------------------|---------------------------------------------------------|-----------------------------------------------------|---------------------|------------------|--------------------|-----|
|                                                                                                                       |                                        |                                          | <b>S. Diff. in Erosion Rates:</b>                       | Small difference                                    | Moderate difference | Large difference | Extreme difference | 27  |
| <b>T. LANDSLIDE HAZARD TOTAL (A+B+C+I+J+K+L+M+N):</b>                                                                 |                                        |                                          |                                                         |                                                     |                     |                  |                    | 0   |
| <b>U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greater of P+Q or R+S)):</b>                                              |                                        |                                          |                                                         |                                                     |                     |                  |                    | 269 |
| <b>Risk Ratings</b>                                                                                                   |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
| <b>V. Route Width or Trail Width:</b>                                                                                 | 36ft<br>14ft                           | 28ft<br>10ft                             | 20ft<br>6ft                                             | 12ft<br>2ft                                         | 16                  |                  |                    |     |
| <b>W. Human Exposure Factor:</b>                                                                                      | 12.5% of the time                      | 25% of the time                          | 37.5% of the time                                       | 50% of the time                                     | 3                   |                  |                    |     |
| <b>X. % of Decision Sight Distance (Judge avoidance ability on trails):</b>                                           | Adequate, 100% of the low design value | Moderate, 80% of the low design value    | Limited, 60% of the low design value                    | Very limited, 40% of the low design value           | 100                 |                  |                    |     |
| <b>Y. Right of Way (R/W) Impacts (If Left Unattended):</b>                                                            | No R/W implications                    | Minor effects beyond R/W                 | Private property, no structures affected                | Structures, roads, RR, utilities, or Parks affected | 3                   |                  |                    |     |
| <b>Z. Environmental/Cultural Impacts if Left Unattended:</b>                                                          | None/No Potential to Cause Effects     | Likely to Effect/No Hist. Prop. Affected | Likely to adversely Affect/Finding of No Adverse Effect | Current adverse effects/Adverse Effect              | 3                   |                  |                    |     |
| <b>AA. Maintenance Complexity:</b>                                                                                    | Routine Effort / In-House              | In-House maint. / special project        | Specialized equip. / contract                           | Complex / dangerous effort / location / contract    | 3                   |                  |                    |     |
| <b>BB. Event Cost:</b>                                                                                                | \$0-2k                                 | \$2-25k                                  | \$25-100k                                               | >\$100k                                             | 3                   |                  |                    |     |
| <b>CC. Risk Totals (G+H+V+W+X+Y+Z+AA+BB):</b>                                                                         |                                        |                                          |                                                         |                                                     |                     |                  |                    | 215 |
| <b>TOTAL USMP SCORE: LANDSLIDES (T+CC) OR ROCKFALL (U+CC):</b> Good (<200 pts)   Fair (200-400 pts)   Poor (>400 pts) |                                        |                                          |                                                         |                                                     |                     |                  |                    | 484 |



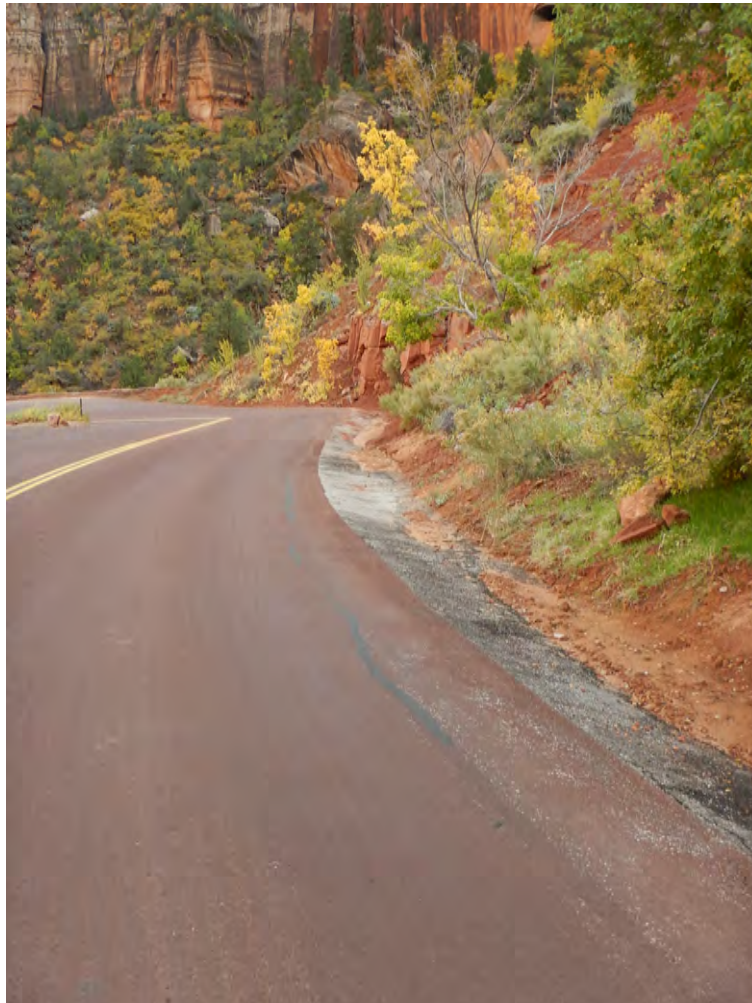


**SITE: 1145**

| Slope Rating Form - Site Information (Rockfall)                                                                                                                                                                                                               |                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                            |                                                                                 |                                                             |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|-------------------------------------------------------------|
| <b>Management Area:</b><br><div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;">NPS</div> <div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;">IMR</div> <div style="border: 1px solid black; padding: 2px;">ZION</div> | <b>Date:</b> <div style="border: 1px solid black; padding: 2px;">2020-02-28 14:39:24</div><br>Last edit: 2018-10-19 08:50:45<br>Edit ID: 5046<br>Site ID: 1145                                               | <input checked="" type="radio"/> Rockfall<br><input type="radio"/> Landslide                                                                                                                                                                                                             | <b>Hazard Type:</b> Press (ctrl+click) to select more than one<br><div style="border: 1px solid black; padding: 2px;">           Raveling/Undermining<br/>           Rock Avalanche<br/>           Indeterminate Rock Failures<br/>           Diff. Erosion         </div> |                                                                                 |                                                             |
| <b>Road/Trail No:</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                             | <b>Road/Trail:</b> <div style="border: 1px solid black; padding: 2px;">R</div>                                                                                                                               | <b>Road/Trail Class:</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                                                     | <b>Rater:</b> <div style="border: 1px solid black; padding: 2px;">Justin LaForge</div>                                                                                                                                                                                     |                                                                                 |                                                             |
| <b>Beginning Mile Marker:</b><br><div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                  | <b>Ending Mile Marker:</b><br><div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                    | <b>Side:</b> <div style="border: 1px solid black; padding: 2px;">S - if road direction r</div>                                                                                                                                                                                           | <b>Weather:</b> <div style="border: 1px solid black; padding: 2px;">Clear</div>                                                                                                                                                                                            |                                                                                 |                                                             |
| <b>Begin Coord. Lat/Long:</b><br>Lat (##.#####): <div style="border: 1px solid black; padding: 2px;">37.21182</div><br>Long (-###.#####): <div style="border: 1px solid black; padding: 2px;">-112.95618</div>                                                | <b>End Coord. Lat/Long:</b><br>Lat (##.#####): <div style="border: 1px solid black; padding: 2px;">37.21198</div><br>Long (-###.#####): <div style="border: 1px solid black; padding: 2px;">-112.95683</div> | <b>Datum:</b> <div style="border: 1px solid black; padding: 2px;">WGS 84</div>                                                                                                                                                                                                           | <b>AADT:</b> <div style="border: 1px solid black; padding: 2px;">1</div>                                                                                                                                                                                                   |                                                                                 |                                                             |
| <b>Length of Affected Road/Trail (ft):</b> <div style="border: 1px solid black; padding: 2px;">208</div>                                                                                                                                                      | <b>Slope Height (rock)/Axial Length (slide) (ft):</b> <div style="border: 1px solid black; padding: 2px;">62</div>                                                                                           |                                                                                                                                                                                                                                                                                          | <b>Slope Angle (°):</b> <div style="border: 1px solid black; padding: 2px;">43</div>                                                                                                                                                                                       |                                                                                 |                                                             |
| <b>Sight Distance (ft):</b> <div style="border: 1px solid black; padding: 2px;">130</div>                                                                                                                                                                     | <b>Usable Roadway/Trail Width (ft):</b> <div style="border: 1px solid black; padding: 2px;">43</div>                                                                                                         |                                                                                                                                                                                                                                                                                          | <b>Speed Limit (mph):</b> <div style="border: 1px solid black; padding: 2px;">35</div>                                                                                                                                                                                     |                                                                                 |                                                             |
| <b>Ditch Width Range (ft):</b><br><div style="border: 1px solid black; padding: 2px;">5</div> - <div style="border: 1px solid black; padding: 2px;">5</div>                                                                                                   | <b>Ditch Depth Range (ft):</b><br><div style="border: 1px solid black; padding: 2px;">1</div> - <div style="border: 1px solid black; padding: 2px;">1</div>                                                  | <b>Ditch Slope Range (H:V):</b><br><div style="border: 1px solid black; padding: 2px;">0</div> : <div style="border: 1px solid black; padding: 2px;">0</div> - <div style="border: 1px solid black; padding: 2px;">0</div> : <div style="border: 1px solid black; padding: 2px;">0</div> | <b>Block Size (ft):</b> <div style="border: 1px solid black; padding: 2px;">2</div><br><b>Volume (cy):</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                     |                                                                                 |                                                             |
| <b>Annual Rainfall Range (in):</b><br><div style="border: 1px solid black; padding: 2px;">13</div> - <div style="border: 1px solid black; padding: 2px;">13</div>                                                                                             | <b>Sole Access Route:</b> <div style="border: 1px solid black; padding: 2px;">Yes</div>                                                                                                                      | <b>Mitigation Present:</b> <div style="border: 1px solid black; padding: 2px;">NO</div>                                                                                                                                                                                                  | <b>Photos/Documents(up to 10MB):</b><br><div style="border: 1px solid black; padding: 2px; display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 2px; margin-right: 5px;">Choose Files</div> <div>No file chosen</div> </div>                |                                                                                 |                                                             |
| <b>Comments:</b> <div style="border: 1px solid black; padding: 5px;">Spring ~30 upslope</div>                                                                                                                                                                 |                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                            |                                                                                 |                                                             |
| <b>Alternate database Name:</b><br><div style="border: 1px solid black; height: 30px;"></div>                                                                                                                                                                 |                                                                                                                                                                                                              | <b>Alternate database ID:</b><br><div style="border: 1px solid black; height: 30px;"></div>                                                                                                                                                                                              |                                                                                                                                                                                                                                                                            |                                                                                 |                                                             |
| <b>Alternate database Description:</b><br><div style="border: 1px solid black; height: 40px;"></div>                                                                                                                                                          |                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                            |                                                                                 |                                                             |
| Preliminary Ratings                                                                                                                                                                                                                                           |                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                            |                                                                                 |                                                             |
| Category Rating:                                                                                                                                                                                                                                              | 3                                                                                                                                                                                                            | 9                                                                                                                                                                                                                                                                                        | 27                                                                                                                                                                                                                                                                         | 81                                                                              | Score:                                                      |
| <b>A. Landslide - Roadway Width Affected:</b>                                                                                                                                                                                                                 | 0-5 percent                                                                                                                                                                                                  | 6-25 percent                                                                                                                                                                                                                                                                             | 26-50 percent                                                                                                                                                                                                                                                              | 51-100 percent                                                                  | <div style="border: 1px solid black; padding: 2px;">0</div> |
| <b>B. Landslide - Slide/Erosion Effects:</b>                                                                                                                                                                                                                  | Visible crack or slight deposit of material / minor erosion                                                                                                                                                  | 1 inch offset, or 6-inch deposit of material / major erosion will affect travel in < 5 years                                                                                                                                                                                             | 2-inch offset or 12-inch deposit / mod. erosion impacting travel annually                                                                                                                                                                                                  | 4-inch offset or 24-inch deposit / severe erosion impacting travel consistently | <div style="border: 1px solid black; padding: 2px;">0</div> |
| <b>C. Landslide - Roadway Length Affected:</b>                                                                                                                                                                                                                | 25 ft                                                                                                                                                                                                        | 100 ft                                                                                                                                                                                                                                                                                   | 225 ft                                                                                                                                                                                                                                                                     | 400 ft                                                                          | <div style="border: 1px solid black; padding: 2px;">0</div> |
| <b>D. Rockfall - Ditch Effectiveness: (consider launch features)</b>                                                                                                                                                                                          | Good                                                                                                                                                                                                         | Moderate                                                                                                                                                                                                                                                                                 | Limited                                                                                                                                                                                                                                                                    | No Catchment                                                                    | <div style="border: 1px solid black; padding: 2px;">9</div> |

|                                                                                          |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |   |
|------------------------------------------------------------------------------------------|-----------------------------|---------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------|---|
| <b>E. Rockfall - Rockfall History:</b>                                                   |                             | Few Falls                                               | Occasional Falls                                                                     | Many Falls                                                                                  | Constant Falls                                                              | 81                                                                                      |                                                                                     |                                     |   |
| <b>F. Rockfall - Block Size or Volume per Event:</b>                                     |                             | 1ft or 3yd^3                                            | 2ft or 6yd^3                                                                         | 3ft or 9yd^3                                                                                | 4ft or 12yd^3                                                               | 9                                                                                       |                                                                                     |                                     |   |
| <b>G. All - Impact on Use:</b>                                                           |                             | Full use continues with minor delay                     | Partial use remains Use modification required, short (3mi / 30min.) detour available | Use is blocked - long (>30min.) detour available or less than 1 day closure                 | Use is blocked - no detour available or closure longer than 1 week          | 3                                                                                       |                                                                                     |                                     |   |
| <b>H. All - AADT/Usage/Economic or Recreational Importance (highest rating applies):</b> |                             | 50 Rarely Used Insignificant economic / rec. importance | 200 Occasionally used Minor economic / rec. importance                               | 450 Frequently used Moderate economic / rec. importance                                     | 800 Constantly used Significant economic / rec. importance                  | <b>Use AADT in calculation:</b> <input type="checkbox"/><br>81                          |                                                                                     |                                     |   |
| <b>Preliminary Rating Landslide Total (A+B+C+G+H):</b>                                   |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |   |
| <b>Preliminary Rating Rockfall Total (D+E+F+G+H):</b>                                    |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 183                                                                                     |                                                                                     |                                     |   |
| <b>Preliminary Rating</b> Good (15-21 pts)   Fair (22-161 pts)   Poor (>161 pts)         |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 84                                                                                      |                                                                                     |                                     |   |
| <b>Slope Hazard Ratings</b>                                                              |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |   |
| <b>Category Rating:</b>                                                                  |                             |                                                         | <b>3</b>                                                                             | <b>9</b>                                                                                    | <b>27</b>                                                                   | <b>81</b>                                                                               | <b>Score:</b>                                                                       |                                     |   |
| <b>I. All - Slope Drainage:</b>                                                          |                             |                                                         | Slope appears dry or well drained; surface runoff well controlled                    | Intermittent water on slope; mod. not well drained; or surface runoff moderately controlled | Water usually on slope; poorly drained; or surface runoff poorly controlled | Water always on slope; very poorly drained; or surface water runoff control not present | 27                                                                                  |                                     |   |
| <b>J. All - Annual Rainfall:</b>                                                         |                             |                                                         | 0-10"                                                                                | 10-30"                                                                                      | 30-60"                                                                      | 60"+                                                                                    | 9                                                                                   |                                     |   |
| <b>K. All - Slope Height (Rockfall) / Axial Length of slide (Landslide):</b>             |                             |                                                         | 25ft                                                                                 | 50ft                                                                                        | 75ft                                                                        | 100ft                                                                                   | 15                                                                                  |                                     |   |
| <b>Select One Unstable Slope Type</b>                                                    | <b>Landslides / Erosion</b> | <b>L. Thaw Stability:</b>                               |                                                                                      | Unfrozen / Thaw Stable                                                                      | Slightly Thaw Unstable                                                      | Moderately Thaw Unstable                                                                | Highly Thaw Unstable                                                                | 0                                   |   |
|                                                                                          |                             | <b>M. Instability - Related Maint. Frequency:</b>       |                                                                                      | Every 10 years                                                                              | Every 5 years                                                               | Every 2 years                                                                           | Every year                                                                          | 0                                   |   |
|                                                                                          |                             | <b>N. Movement History:</b>                             |                                                                                      | Minor movement or sporadic creep                                                            | Up to 1 inch annually or steady annual creep                                | Up to 3 inches per event, one event per year                                            | >3" per event, >6" annually, more than 1 event per year (includes all debris flows) | 0                                   |   |
|                                                                                          | <b>Rockfalls</b>            | <b>O. Rockfall-Related Maint. Frequency:</b>            |                                                                                      | Normal, scheduled maintenance                                                               | Patrols after every storm event                                             | Routine seasonal patrols                                                                | Year round patrols                                                                  | 81                                  |   |
|                                                                                          |                             | <b>Geological Character Case 1</b>                      | <b>P. Structural Condition:</b>                                                      |                                                                                             | favorable                                                                   | random                                                                                  | Discontinuous adverse                                                               | Continuous adverse                  | 0 |
|                                                                                          |                             |                                                         | <b>Q. Rock Friction:</b>                                                             |                                                                                             | Rough / Irregular                                                           | Undulating                                                                              | Planar                                                                              | Clay infilled / Slickensided        | 0 |
|                                                                                          |                             | <b>Geological Character Case 2</b>                      | <b>R. Structural Condition:</b>                                                      |                                                                                             | Few differential erosion features                                           | Occasional differential erosion features                                                | Many differential erosion features                                                  | Major differential erosion features | 9 |

|                                                                                                                       |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
|-----------------------------------------------------------------------------------------------------------------------|----------------------------------------|------------------------------------------|---------------------------------------------------------|-----------------------------------------------------|---------------------|------------------|--------------------|-----|
|                                                                                                                       |                                        |                                          | <b>S. Diff. in Erosion Rates:</b>                       | Small difference                                    | Moderate difference | Large difference | Extreme difference | 27  |
| <b>T. LANDSLIDE HAZARD TOTAL (A+B+C+I+J+K+L+M+N):</b>                                                                 |                                        |                                          |                                                         |                                                     |                     |                  |                    | 0   |
| <b>U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greater of P+Q or R+S)):</b>                                              |                                        |                                          |                                                         |                                                     |                     |                  |                    | 267 |
| <b>Risk Ratings</b>                                                                                                   |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
| <b>V. Route Width or Trail Width:</b>                                                                                 | 36ft<br>14ft                           | 28ft<br>10ft                             | 20ft<br>6ft                                             | 12ft<br>2ft                                         | 1                   |                  |                    |     |
| <b>W. Human Exposure Factor:</b>                                                                                      | 12.5% of the time                      | 25% of the time                          | 37.5% of the time                                       | 50% of the time                                     | 3                   |                  |                    |     |
| <b>X. % of Decision Sight Distance (Judge avoidance ability on trails):</b>                                           | Adequate, 100% of the low design value | Moderate, 80% of the low design value    | Limited, 60% of the low design value                    | Very limited, 40% of the low design value           | 100                 |                  |                    |     |
| <b>Y. Right of Way (R/W) Impacts (If Left Unattended):</b>                                                            | No R/W implications                    | Minor effects beyond R/W                 | Private property, no structures affected                | Structures, roads, RR, utilities, or Parks affected | 3                   |                  |                    |     |
| <b>Z. Environmental/Cultural Impacts if Left Unattended:</b>                                                          | None/No Potential to Cause Effects     | Likely to Effect/No Hist. Prop. Affected | Likely to adversely Affect/Finding of No Adverse Effect | Current adverse effects/Adverse Effect              | 3                   |                  |                    |     |
| <b>AA. Maintenance Complexity:</b>                                                                                    | Routine Effort / In-House              | In-House maint. / special project        | Specialized equip. / contract                           | Complex / dangerous effort / location / contract    | 9                   |                  |                    |     |
| <b>BB. Event Cost:</b>                                                                                                | \$0-2k                                 | \$2-25k                                  | \$25-100k                                               | >\$100k                                             | 3                   |                  |                    |     |
| <b>CC. Risk Totals (G+H+V+W+X+Y+Z+AA+BB):</b>                                                                         |                                        |                                          |                                                         |                                                     |                     |                  |                    | 206 |
| <b>TOTAL USMP SCORE: LANDSLIDES (T+CC) OR ROCKFALL (U+CC):</b> Good (<200 pts)   Fair (200-400 pts)   Poor (>400 pts) |                                        |                                          |                                                         |                                                     |                     |                  |                    | 473 |





**SITE: 1150**

| Slope Rating Form - Site Information (Rockfall)                                            |                                                             |                                                                                                          |                                                                           |                                                                                                                                                                                                                                       |               |
|--------------------------------------------------------------------------------------------|-------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| <b>Management Area:</b><br><div>NPS</div> <div>IMR</div> <div>ZION</div>                   |                                                             | <b>Date:</b> 2020-02-28 14:39:56<br><br>Last edit: 2018-10-19 08:55:10<br>Edit ID: 5047<br>Site ID: 1150 |                                                                           | <b>Hazard Type:</b> Press (ctrl+click) to select more than one<br><div>             Raveling/Undermining<br/>             Rock Avalanche<br/>             Indeterminate Rock Failures<br/>             Diff. Erosion           </div> |               |
| <b>Road/Trail No:</b> 0                                                                    | <b>Road/Trail:</b> R                                        | <b>Road/Trail Class:</b> 0                                                                               | <b>Rater:</b> Justin LaForge                                              |                                                                                                                                                                                                                                       |               |
| <b>Beginning Mile Marker:</b><br>0                                                         | <b>Ending Mile Marker:</b><br>0                             | <b>Side:</b> S - if road direction r                                                                     | <b>Weather:</b> Clear                                                     |                                                                                                                                                                                                                                       |               |
| <b>Begin Coord. Lat/Long:</b><br>Lat (##.#####): 37.21273<br>Long (-###.#####): -112.96401 |                                                             | <b>End Coord. Lat/Long:</b><br>Lat (##.#####): 37.21238<br>Long (-###.#####): -112.96345                 |                                                                           | <b>Datum:</b> WGS 84<br><br><b>AADT:</b> 1                                                                                                                                                                                            |               |
| <b>Length of Affected Road/Trail (ft):</b> 221                                             | <b>Slope Height (rock)/Axial Length (slide) (ft):</b> 60    |                                                                                                          |                                                                           | <b>Slope Angle (°):</b> 45                                                                                                                                                                                                            |               |
| <b>Sight Distance (ft):</b> 125                                                            | <b>Usable Roadway/Trail Width (ft):</b> 25                  |                                                                                                          |                                                                           | <b>Speed Limit (mph):</b> 35                                                                                                                                                                                                          |               |
| <b>Ditch Width Range (ft):</b> 16 - 16                                                     | <b>Ditch Depth Range (ft):</b> 0.5 - 0.5                    | <b>Ditch Slope Range (H:V):</b> 0 : 0 - 0 : 0                                                            |                                                                           | <b>Block Size (ft):</b> 3<br><b>Volume (cy):</b> 0                                                                                                                                                                                    |               |
| <b>Annual Rainfall Range (in):</b> 13 - 13                                                 | <b>Sole Access Route:</b> Yes                               | <b>Mitigation Present:</b> NO                                                                            |                                                                           | <b>Photos/Documents(up to 10MB):</b><br><div>Choose Files</div> No file chosen                                                                                                                                                        |               |
| <b>Comments:</b> Springs obvious in slope. Close to base of Navajo Sandstone.              |                                                             |                                                                                                          |                                                                           |                                                                                                                                                                                                                                       |               |
| <b>Alternate database Name:</b>                                                            |                                                             |                                                                                                          | <b>Alternate database ID:</b>                                             |                                                                                                                                                                                                                                       |               |
| <b>Alternate database Description:</b>                                                     |                                                             |                                                                                                          |                                                                           |                                                                                                                                                                                                                                       |               |
| Preliminary Ratings                                                                        |                                                             |                                                                                                          |                                                                           |                                                                                                                                                                                                                                       |               |
| <b>Category Rating:</b>                                                                    | <b>3</b>                                                    | <b>9</b>                                                                                                 | <b>27</b>                                                                 | <b>81</b>                                                                                                                                                                                                                             | <b>Score:</b> |
| <b>A. Landslide - Roadway Width Affected:</b>                                              | 0-5 percent                                                 | 6-25 percent                                                                                             | 26-50 percent                                                             | 51-100 percent                                                                                                                                                                                                                        | 0             |
| <b>B. Landslide - Slide/Erosion Effects:</b>                                               | Visible crack or slight deposit of material / minor erosion | 1 inch offset, or 6-inch deposit of material / major erosion will affect travel in < 5 years             | 2-inch offset or 12-inch deposit / mod. erosion impacting travel annually | 4-inch offset or 24-inch deposit / severe erosion impacting travel consistently                                                                                                                                                       | 0             |
| <b>C. Landslide - Roadway Length Affected:</b>                                             | 25 ft                                                       | 100 ft                                                                                                   | 225 ft                                                                    | 400 ft                                                                                                                                                                                                                                | 0             |
| <b>D. Rockfall - Ditch Effectiveness: (consider launch features)</b>                       | Good                                                        | Moderate                                                                                                 | Limited                                                                   | No Catchment                                                                                                                                                                                                                          | 9             |

|                                                                                          |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                    |                                     |
|------------------------------------------------------------------------------------------|-----------------------------|---------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------------------------------------|-------------------------------------|
| <b>E. Rockfall - Rockfall History:</b>                                                   |                             | Few Falls                                               | Occasional Falls                                                                     | Many Falls                                                                                  | Constant Falls                                                              | 9                                                                                       |                                                                                     |                                    |                                     |
| <b>F. Rockfall - Block Size or Volume per Event:</b>                                     |                             | 1ft or 3yd^3                                            | 2ft or 6yd^3                                                                         | 3ft or 9yd^3                                                                                | 4ft or 12yd^3                                                               | 27                                                                                      |                                                                                     |                                    |                                     |
| <b>G. All - Impact on Use:</b>                                                           |                             | Full use continues with minor delay                     | Partial use remains Use modification required, short (3mi / 30min.) detour available | Use is blocked - long (>30min.) detour available or less than 1 day closure                 | Use is blocked - no detour available or closure longer than 1 week          | 9                                                                                       |                                                                                     |                                    |                                     |
| <b>H. All - AADT/Usage/Economic or Recreational Importance (highest rating applies):</b> |                             | 50 Rarely Used Insignificant economic / rec. importance | 200 Occasionally used Minor economic / rec. importance                               | 450 Frequently used Moderate economic / rec. importance                                     | 800 Constantly used Significant economic / rec. importance                  | <b>Use AADT in calculation:</b> <input type="checkbox"/><br>81                          |                                                                                     |                                    |                                     |
| <b>Preliminary Rating Landslide Total (A+B+C+G+H):</b>                                   |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                    |                                     |
| <b>Preliminary Rating Rockfall Total (D+E+F+G+H):</b>                                    |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 135                                                                                     |                                                                                     |                                    |                                     |
| <b>Preliminary Rating</b> Good (15-21 pts)   Fair (22-161 pts)   Poor (>161 pts)         |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 90                                                                                      |                                                                                     |                                    |                                     |
| <b>Slope Hazard Ratings</b>                                                              |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                    |                                     |
| <b>Category Rating:</b>                                                                  |                             |                                                         | <b>3</b>                                                                             | <b>9</b>                                                                                    | <b>27</b>                                                                   | <b>81</b>                                                                               | <b>Score:</b>                                                                       |                                    |                                     |
| <b>I. All - Slope Drainage:</b>                                                          |                             |                                                         | Slope appears dry or well drained; surface runoff well controlled                    | Intermittent water on slope; mod. not well drained; or surface runoff moderately controlled | Water usually on slope; poorly drained; or surface runoff poorly controlled | Water always on slope; very poorly drained; or surface water runoff control not present | 3                                                                                   |                                    |                                     |
| <b>J. All - Annual Rainfall:</b>                                                         |                             |                                                         | 0-10"                                                                                | 10-30"                                                                                      | 30-60"                                                                      | 60"+                                                                                    | 9                                                                                   |                                    |                                     |
| <b>K. All - Slope Height (Rockfall) / Axial Length of slide (Landslide):</b>             |                             |                                                         | 25ft                                                                                 | 50ft                                                                                        | 75ft                                                                        | 100ft                                                                                   | 14                                                                                  |                                    |                                     |
| <b>Select One Unstable Slope Type</b>                                                    | <b>Landslides / Erosion</b> | <b>L. Thaw Stability:</b>                               |                                                                                      | Unfrozen / Thaw Stable                                                                      | Slightly Thaw Unstable                                                      | Moderately Thaw Unstable                                                                | Highly Thaw Unstable                                                                | 0                                  |                                     |
|                                                                                          |                             | <b>M. Instability - Related Maint. Frequency:</b>       |                                                                                      | Every 10 years                                                                              | Every 5 years                                                               | Every 2 years                                                                           | Every year                                                                          | 0                                  |                                     |
|                                                                                          |                             | <b>N. Movement History:</b>                             |                                                                                      | Minor movement or sporadic creep                                                            | Up to 1 inch annually or steady annual creep                                | Up to 3 inches per event, one event per year                                            | >3" per event, >6" annually, more than 1 event per year (includes all debris flows) | 0                                  |                                     |
|                                                                                          | <b>Rockfalls</b>            | <b>O. Rockfall-Related Maint. Frequency:</b>            |                                                                                      | Normal, scheduled maintenance                                                               | Patrols after every storm event                                             | Routine seasonal patrols                                                                | Year round patrols                                                                  | 27                                 |                                     |
|                                                                                          |                             | <b>Geological Character Case 1</b>                      | <b>P. Structural Condition:</b>                                                      |                                                                                             | favorable                                                                   | random                                                                                  | Discontinuous adverse                                                               | Continuous adverse                 | 0                                   |
|                                                                                          |                             |                                                         | <b>Q. Rock Friction:</b>                                                             |                                                                                             | Rough / Irregular                                                           | Undulating                                                                              | Planar                                                                              | Clay infilled / Slickensided       | 0                                   |
|                                                                                          |                             | <b>Geological Character Case 2</b>                      |                                                                                      | <b>R. Structural Condition:</b>                                                             |                                                                             | Few differential erosion features                                                       | Occasional differential erosion features                                            | Many differential erosion features | Major differential erosion features |

|                                                                                                                       |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
|-----------------------------------------------------------------------------------------------------------------------|----------------------------------------|------------------------------------------|---------------------------------------------------------|-----------------------------------------------------|---------------------|------------------|--------------------|-----|
|                                                                                                                       |                                        |                                          | <b>S. Diff. in Erosion Rates:</b>                       | Small difference                                    | Moderate difference | Large difference | Extreme difference | 81  |
| <b>T. LANDSLIDE HAZARD TOTAL (A+B+C+I+J+K+L+M+N):</b>                                                                 |                                        |                                          |                                                         |                                                     |                     |                  |                    | 0   |
| <b>U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greater of P+Q or R+S)):</b>                                              |                                        |                                          |                                                         |                                                     |                     |                  |                    | 206 |
| <b>Risk Ratings</b>                                                                                                   |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
| <b>V. Route Width or Trail Width:</b>                                                                                 | 36ft<br>14ft                           | 28ft<br>10ft                             | 20ft<br>6ft                                             | 12ft<br>2ft                                         | 14                  |                  |                    |     |
| <b>W. Human Exposure Factor:</b>                                                                                      | 12.5% of the time                      | 25% of the time                          | 37.5% of the time                                       | 50% of the time                                     | 3                   |                  |                    |     |
| <b>X. % of Decision Sight Distance (Judge avoidance ability on trails):</b>                                           | Adequate, 100% of the low design value | Moderate, 80% of the low design value    | Limited, 60% of the low design value                    | Very limited, 40% of the low design value           | 100                 |                  |                    |     |
| <b>Y. Right of Way (R/W) Impacts (If Left Unattended):</b>                                                            | No R/W implications                    | Minor effects beyond R/W                 | Private property, no structures affected                | Structures, roads, RR, utilities, or Parks affected | 3                   |                  |                    |     |
| <b>Z. Environmental/Cultural Impacts if Left Unattended:</b>                                                          | None/No Potential to Cause Effects     | Likely to Effect/No Hist. Prop. Affected | Likely to adversely Affect/Finding of No Adverse Effect | Current adverse effects/Adverse Effect              | 3                   |                  |                    |     |
| <b>AA. Maintenance Complexity:</b>                                                                                    | Routine Effort / In-House              | In-House maint. / special project        | Specialized equip. / contract                           | Complex / dangerous effort / location / contract    | 9                   |                  |                    |     |
| <b>BB. Event Cost:</b>                                                                                                | \$0-2k                                 | \$2-25k                                  | \$25-100k                                               | >\$100k                                             | 9                   |                  |                    |     |
| <b>CC. Risk Totals (G+H+V+W+X+Y+Z+AA+BB):</b>                                                                         |                                        |                                          |                                                         |                                                     |                     |                  |                    | 231 |
| <b>TOTAL USMP SCORE: LANDSLIDES (T+CC) OR ROCKFALL (U+CC):</b> Good (<200 pts)   Fair (200-400 pts)   Poor (>400 pts) |                                        |                                          |                                                         |                                                     |                     |                  |                    | 437 |



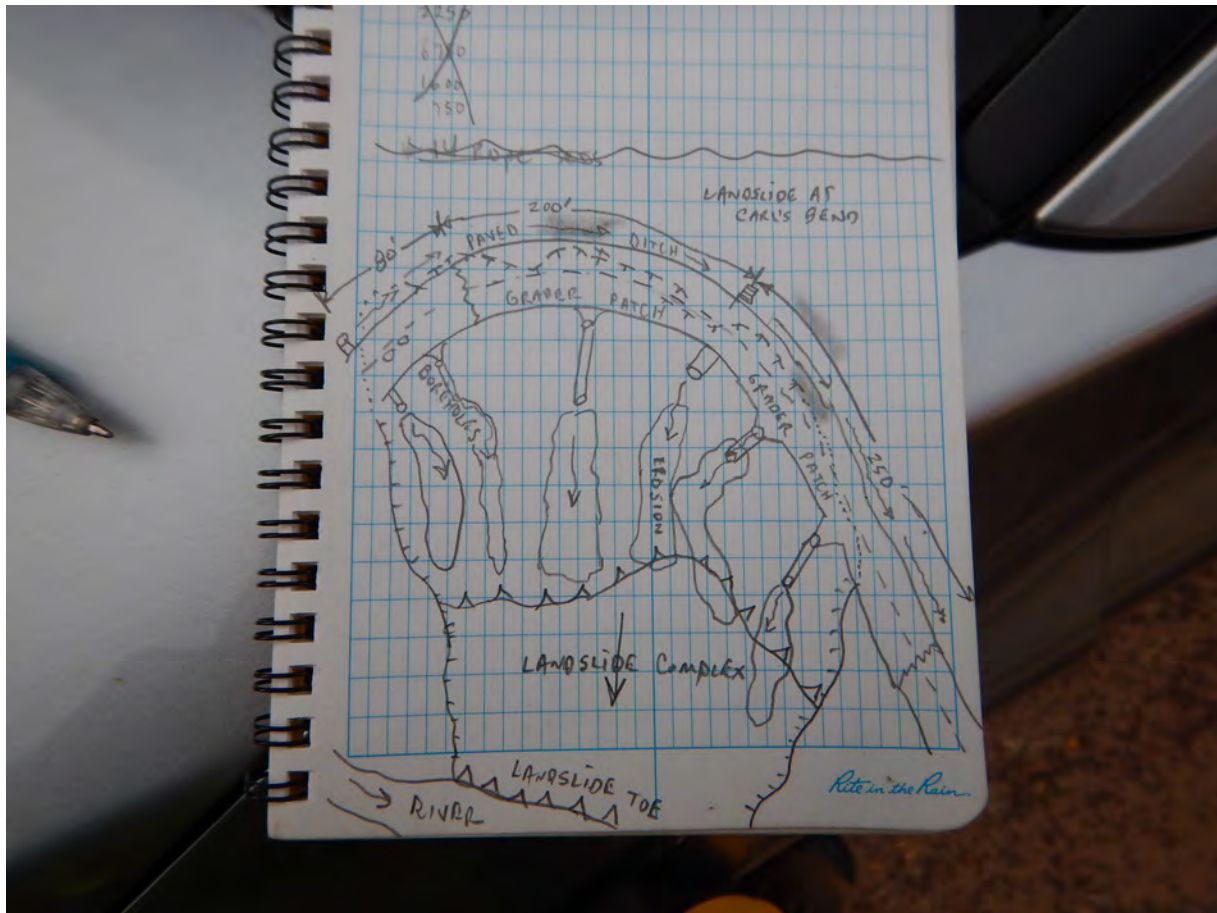


**SITE: 5104**

| Slope Rating Form - Site Information (Landslide)                                                                                                                                                                                                              |                                                                                                                                                                |                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                 |                                                                                                                                                                        |                                                              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|
| <b>Management Area:</b><br><div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;">NPS</div> <div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;">IMR</div> <div style="border: 1px solid black; padding: 2px;">ZION</div> | <b>Date:</b> <div style="border: 1px solid black; padding: 2px;">2020-02-28 14:44:35</div><br>Last edit: 2018-10-23 20:47:35<br>Edit ID: 5104<br>Site ID: 5104 | <input type="radio"/> Rockfall<br><input checked="" type="radio"/> Landslide                                                                                                                                       | <b>Hazard Type:</b> Press (ctrl+click) to select more than one<br><div style="border: 1px solid black; padding: 2px;">           Translational<br/>           Rotational<br/>           Debris Flow<br/>           Shallow Slump         </div> |                                                                                                                                                                        |                                                              |
| <b>Road/Trail No:</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                             | <b>Road/Trail:</b> <div style="border: 1px solid black; padding: 2px;">R</div>                                                                                 | <b>Road/Trail Class:</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                               | <b>Rater:</b> <div style="border: 1px solid black; padding: 2px;">Robyn Henderek</div>                                                                                                                                                          |                                                                                                                                                                        |                                                              |
| <b>Beginning Mile Marker:</b><br><div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                  | <b>Ending Mile Marker:</b><br><div style="border: 1px solid black; padding: 2px;">0</div>                                                                      | <b>Side:</b> <div style="border: 1px solid black; padding: 2px;">N - if road direction r</div>                                                                                                                     | <b>Weather:</b> <div style="border: 1px solid black; padding: 2px;">Clear</div>                                                                                                                                                                 |                                                                                                                                                                        |                                                              |
| <b>Begin Coord. Lat/Long:</b><br>Lat (##.#####): <div style="border: 1px solid black; padding: 2px;">37.21490979</div><br>Long (-###.#####): <div style="border: 1px solid black; padding: 2px;">-112.95955867</div>                                          |                                                                                                                                                                | <b>End Coord. Lat/Long:</b><br>Lat (##.#####): <div style="border: 1px solid black; padding: 2px;">37.21457139</div><br>Long (-###.#####): <div style="border: 1px solid black; padding: 2px;">-112.95863064</div> |                                                                                                                                                                                                                                                 | <b>Datum:</b> <div style="border: 1px solid black; padding: 2px;">WGS 84</div><br><b>AADT:</b> <div style="border: 1px solid black; padding: 2px;">10000</div>         |                                                              |
| <b>Length of Affected Road/Trail (ft):</b><br><div style="border: 1px solid black; padding: 2px;">267</div>                                                                                                                                                   | <b>Slope Height (rock)/Axial Length (slide) (ft):</b><br><div style="border: 1px solid black; padding: 2px;">516</div>                                         |                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                 | <b>Slope Angle (°):</b> <div style="border: 1px solid black; padding: 2px;">13</div>                                                                                   |                                                              |
| <b>Sight Distance (ft):</b><br><div style="border: 1px solid black; padding: 2px;">225</div>                                                                                                                                                                  | <b>Usable Roadway/Trail Width (ft):</b><br><div style="border: 1px solid black; padding: 2px;">27</div>                                                        |                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                 | <b>Speed Limit (mph):</b><br><div style="border: 1px solid black; padding: 2px;">35</div>                                                                              |                                                              |
| <b>Ditch Width Range (ft):</b><br><div style="border: 1px solid black; padding: 2px;">0-0</div>                                                                                                                                                               | <b>Ditch Depth Range (ft):</b><br><div style="border: 1px solid black; padding: 2px;">0-0</div>                                                                | <b>Ditch Slope Range (H:V):</b><br><div style="border: 1px solid black; padding: 2px;">0:0-0:0</div>                                                                                                               |                                                                                                                                                                                                                                                 | <b>Block Size (ft):</b> <div style="border: 1px solid black; padding: 2px;">0</div><br><b>Volume (cy):</b> <div style="border: 1px solid black; padding: 2px;">0</div> |                                                              |
| <b>Annual Rainfall Range (in):</b><br><div style="border: 1px solid black; padding: 2px;">13-16</div>                                                                                                                                                         | <b>Sole Access Route:</b> <div style="border: 1px solid black; padding: 2px;">No</div>                                                                         | <b>Mitigation Present:</b> <div style="border: 1px solid black; padding: 2px;">NO</div>                                                                                                                            |                                                                                                                                                                                                                                                 | <b>Photos/Documents(up to 10MB):</b><br><div style="border: 1px solid black; padding: 2px;"> <div>Choose Files</div> <div>No file chosen</div> </div>                  |                                                              |
| <b>Comments:</b> Down the hill from Carl's Turn. Approximately three events in 20 years. About 2 inches of road offset at the head scarp per event. Road offset occurs at the center line.                                                                    |                                                                                                                                                                |                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                 |                                                                                                                                                                        |                                                              |
| <b>Alternate database Name:</b><br><div style="border: 1px solid black; height: 30px;"></div>                                                                                                                                                                 |                                                                                                                                                                |                                                                                                                                                                                                                    | <b>Alternate database ID:</b><br><div style="border: 1px solid black; height: 30px;"></div>                                                                                                                                                     |                                                                                                                                                                        |                                                              |
| <b>Alternate database Description:</b><br><div style="border: 1px solid black; height: 40px;"></div>                                                                                                                                                          |                                                                                                                                                                |                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                 |                                                                                                                                                                        |                                                              |
| Preliminary Ratings                                                                                                                                                                                                                                           |                                                                                                                                                                |                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                 |                                                                                                                                                                        |                                                              |
| Category Rating:                                                                                                                                                                                                                                              | 3                                                                                                                                                              | 9                                                                                                                                                                                                                  | 27                                                                                                                                                                                                                                              | 81                                                                                                                                                                     | Score:                                                       |
| <b>A. Landslide - Roadway Width Affected:</b>                                                                                                                                                                                                                 | 0-5 percent                                                                                                                                                    | 6-25 percent                                                                                                                                                                                                       | 26-50 percent                                                                                                                                                                                                                                   | 51-100 percent                                                                                                                                                         | <div style="border: 1px solid black; padding: 2px;">27</div> |
| <b>B. Landslide - Slide/Erosion Effects:</b>                                                                                                                                                                                                                  | Visible crack or slight deposit of material / minor erosion                                                                                                    | 1 inch offset, or 6-inch deposit of material / major erosion will affect travel in < 5 years                                                                                                                       | 2-inch offset or 12-inch deposit / mod. erosion impacting travel annually                                                                                                                                                                       | 4-inch offset or 24-inch deposit / severe erosion impacting travel consistently                                                                                        | <div style="border: 1px solid black; padding: 2px;">27</div> |
| <b>C. Landslide - Roadway Length Affected:</b>                                                                                                                                                                                                                | 25 ft                                                                                                                                                          | 100 ft                                                                                                                                                                                                             | 225 ft                                                                                                                                                                                                                                          | 400 ft                                                                                                                                                                 | <div style="border: 1px solid black; padding: 2px;">36</div> |
| <b>D. Rockfall - Ditch Effectiveness: (consider launch features)</b>                                                                                                                                                                                          | Good                                                                                                                                                           | Moderate                                                                                                                                                                                                           | Limited                                                                                                                                                                                                                                         | No Catchment                                                                                                                                                           | <div style="border: 1px solid black; padding: 2px;">0</div>  |

|                                                                                          |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |   |
|------------------------------------------------------------------------------------------|-----------------------------|---------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------|---|
| <b>E. Rockfall - Rockfall History:</b>                                                   |                             | Few Falls                                               | Occasional Falls                                                                     | Many Falls                                                                                  | Constant Falls                                                              | 0                                                                                       |                                                                                     |                                     |   |
| <b>F. Rockfall - Block Size or Volume per Event:</b>                                     |                             | 1ft or 3yd^3                                            | 2ft or 6yd^3                                                                         | 3ft or 9yd^3                                                                                | 4ft or 12yd^3                                                               | 0                                                                                       |                                                                                     |                                     |   |
| <b>G. All - Impact on Use:</b>                                                           |                             | Full use continues with minor delay                     | Partial use remains Use modification required, short (3mi / 30min.) detour available | Use is blocked - long (>30min.) detour available or less than 1 day closure                 | Use is blocked - no detour available or closure longer than 1 week          | 9                                                                                       |                                                                                     |                                     |   |
| <b>H. All - AADT/Usage/Economic or Recreational Importance (highest rating applies):</b> |                             | 50 Rarely Used Insignificant economic / rec. importance | 200 Occasionally used Minor economic / rec. importance                               | 450 Frequently used Moderate economic / rec. importance                                     | 800 Constantly used Significant economic / rec. importance                  | <b>Use AADT in calculation:</b> <input checked="" type="checkbox"/><br>100              |                                                                                     |                                     |   |
| <b>Preliminary Rating Landslide Total (A+B+C+G+H):</b>                                   |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 199                                                                                     |                                                                                     |                                     |   |
| <b>Preliminary Rating Rockfall Total (D+E+F+G+H):</b>                                    |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |   |
| <b>Preliminary Rating</b> Good (15-21 pts)   Fair (22-161 pts)   Poor (>161 pts)         |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 199                                                                                     |                                                                                     |                                     |   |
| <b>Slope Hazard Ratings</b>                                                              |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |   |
| <b>Category Rating:</b>                                                                  |                             |                                                         | <b>3</b>                                                                             | <b>9</b>                                                                                    | <b>27</b>                                                                   | <b>81</b>                                                                               | <b>Score:</b>                                                                       |                                     |   |
| <b>I. All - Slope Drainage:</b>                                                          |                             |                                                         | Slope appears dry or well drained; surface runoff well controlled                    | Intermittent water on slope; mod. not well drained; or surface runoff moderately controlled | Water usually on slope; poorly drained; or surface runoff poorly controlled | Water always on slope; very poorly drained; or surface water runoff control not present | 9                                                                                   |                                     |   |
| <b>J. All - Annual Rainfall:</b>                                                         |                             |                                                         | 0-10"                                                                                | 10-30"                                                                                      | 30-60"                                                                      | 60"+                                                                                    | 9                                                                                   |                                     |   |
| <b>K. All - Slope Height (Rockfall) / Axial Length of slide (Landslide):</b>             |                             |                                                         | 25ft                                                                                 | 50ft                                                                                        | 75ft                                                                        | 100ft                                                                                   | 100                                                                                 |                                     |   |
| <b>Select One Unstable Slope Type</b>                                                    | <b>Landslides / Erosion</b> | <b>L. Thaw Stability:</b>                               |                                                                                      | Unfrozen / Thaw Stable                                                                      | Slightly Thaw Unstable                                                      | Moderately Thaw Unstable                                                                | Highly Thaw Unstable                                                                | 3                                   |   |
|                                                                                          |                             | <b>M. Instability - Related Maint. Frequency:</b>       |                                                                                      | Every 10 years                                                                              | Every 5 years                                                               | Every 2 years                                                                           | Every year                                                                          | 9                                   |   |
|                                                                                          |                             | <b>N. Movement History:</b>                             |                                                                                      | Minor movement or sporadic creep                                                            | Up to 1 inch annually or steady annual creep                                | Up to 3 inches per event, one event per year                                            | >3" per event, >6" annually, more than 1 event per year (includes all debris flows) | 9                                   |   |
|                                                                                          | <b>Rockfalls</b>            | <b>O. Rockfall-Related Maint. Frequency:</b>            |                                                                                      | Normal, scheduled maintenance                                                               | Patrols after every storm event                                             | Routine seasonal patrols                                                                | Year round patrols                                                                  | 0                                   |   |
|                                                                                          |                             | <b>Geological Character Case 1</b>                      | <b>P. Structural Condition:</b>                                                      |                                                                                             | favorable                                                                   | random                                                                                  | Discontinuous adverse                                                               | Continuous adverse                  | 0 |
|                                                                                          |                             |                                                         | <b>Q. Rock Friction:</b>                                                             |                                                                                             | Rough / Irregular                                                           | Undulating                                                                              | Planar                                                                              | Clay infilled / Slickensided        | 0 |
|                                                                                          |                             | <b>Geological Character Case 2</b>                      |                                                                                      | <b>R. Structural Condition:</b>                                                             | Few differential erosion features                                           | Occasional differential erosion features                                                | Many differential erosion features                                                  | Major differential erosion features | 0 |

|                                                                                                                       |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
|-----------------------------------------------------------------------------------------------------------------------|----------------------------------------|------------------------------------------|---------------------------------------------------------|-----------------------------------------------------|---------------------|------------------|--------------------|-----|
|                                                                                                                       |                                        |                                          | <b>S. Diff. in Erosion Rates:</b>                       | Small difference                                    | Moderate difference | Large difference | Extreme difference | 0   |
| <b>T. LANDSLIDE HAZARD TOTAL (A+B+C+I+J+K+L+M+N):</b>                                                                 |                                        |                                          |                                                         |                                                     |                     |                  |                    | 229 |
| <b>U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greater of P+Q or R+S)):</b>                                              |                                        |                                          |                                                         |                                                     |                     |                  |                    | 0   |
| <b>Risk Ratings</b>                                                                                                   |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
| <b>V. Route Width or Trail Width:</b>                                                                                 | 36ft<br>14ft                           | 28ft<br>10ft                             | 20ft<br>6ft                                             | 12ft<br>2ft                                         | 10                  |                  |                    |     |
| <b>W. Human Exposure Factor:</b>                                                                                      | 12.5% of the time                      | 25% of the time                          | 37.5% of the time                                       | 50% of the time                                     | 100                 |                  |                    |     |
| <b>X. % of Decision Sight Distance (Judge avoidance ability on trails):</b>                                           | Adequate, 100% of the low design value | Moderate, 80% of the low design value    | Limited, 60% of the low design value                    | Very limited, 40% of the low design value           | 69                  |                  |                    |     |
| <b>Y. Right of Way (R/W) Impacts (If Left Unattended):</b>                                                            | No R/W implications                    | Minor effects beyond R/W                 | Private property, no structures affected                | Structures, roads, RR, utilities, or Parks affected | 3                   |                  |                    |     |
| <b>Z. Environmental/Cultural Impacts if Left Unattended:</b>                                                          | None/No Potential to Cause Effects     | Likely to Effect/No Hist. Prop. Affected | Likely to adversely Affect/Finding of No Adverse Effect | Current adverse effects/Adverse Effect              | 9                   |                  |                    |     |
| <b>AA. Maintenance Complexity:</b>                                                                                    | Routine Effort / In-House              | In-House maint. / special project        | Specialized equip. / contract                           | Complex / dangerous effort / location / contract    | 9                   |                  |                    |     |
| <b>BB. Event Cost:</b>                                                                                                | \$0-2k                                 | \$2-25k                                  | \$25-100k                                               | >\$100k                                             | 9                   |                  |                    |     |
| <b>CC. Risk Totals (G+H+V+W+X+Y+Z+AA+BB):</b>                                                                         |                                        |                                          |                                                         |                                                     |                     |                  |                    | 318 |
| <b>TOTAL USMP SCORE: LANDSLIDES (T+CC) OR ROCKFALL (U+CC):</b> Good (<200 pts)   Fair (200-400 pts)   Poor (>400 pts) |                                        |                                          |                                                         |                                                     |                     |                  |                    | 547 |





## **ROUTE 0011/ Zion Canyon Scenic Drive**

**SITE: 1222**

| Slope Rating Form - Site Information (Rockfall)                                                                                                                                                                                                               |                                                                                                                                                                |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                             |                                                                                 |                                                                          |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|--------------------------------------------------------------------------|
| <b>Management Area:</b><br><div style="border: 1px solid black; padding: 2px; margin-bottom: 2px;">NPS</div> <div style="border: 1px solid black; padding: 2px; margin-bottom: 2px;">IMR</div> <div style="border: 1px solid black; padding: 2px;">ZION</div> | <b>Date:</b> <div style="border: 1px solid black; padding: 2px;">2020-02-28 14:41:12</div><br>Last edit: 2018-10-19 10:02:29<br>Edit ID: 5051<br>Site ID: 1222 | <input checked="" type="radio"/> Rockfall<br><input type="radio"/> Landslide                                                                                                                                                                                                             | <b>Hazard Type:</b> Press (ctrl+click) to select more than one<br><div style="border: 1px solid black; padding: 2px;">           Planar<br/>           Wedge<br/>           Toppling<br/>           Raveling/Undermining         </div>                     |                                                                                 |                                                                          |
| <b>Road/Trail No:</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                             | <b>Road/Trail:</b> <div style="border: 1px solid black; padding: 2px;">R</div>                                                                                 | <b>Road/Trail Class:</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                                                     | <b>Rater:</b> <div style="border: 1px solid black; padding: 2px;">Justin LaForge</div>                                                                                                                                                                      |                                                                                 |                                                                          |
| <b>Beginning Mile Marker:</b><br><div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                  | <b>Ending Mile Marker:</b><br><div style="border: 1px solid black; padding: 2px;">0</div>                                                                      | <b>Side:</b> <div style="border: 1px solid black; padding: 2px;">E - if road direction r</div>                                                                                                                                                                                           | <b>Weather:</b> <div style="border: 1px solid black; padding: 2px;">Clear</div>                                                                                                                                                                             |                                                                                 |                                                                          |
| <b>Begin Coord. Lat/Long:</b><br>Lat (##.#####): <div style="border: 1px solid black; padding: 2px;">37.22741</div><br>Long (-###.#####): <div style="border: 1px solid black; padding: 2px;">-112.9669</div>                                                 |                                                                                                                                                                | <b>End Coord. Lat/Long:</b><br>Lat (##.#####): <div style="border: 1px solid black; padding: 2px;">37.22829</div><br>Long (-###.#####): <div style="border: 1px solid black; padding: 2px;">-112.96597</div>                                                                             |                                                                                                                                                                                                                                                             | <b>Datum:</b> <div style="border: 1px solid black; padding: 2px;">WGS 84</div>  | <b>AADT:</b> <div style="border: 1px solid black; padding: 2px;">1</div> |
| <b>Length of Affected Road/Trail (ft):</b> <div style="border: 1px solid black; padding: 2px;">420</div>                                                                                                                                                      | <b>Slope Height (rock)/Axial Length (slide) (ft):</b> <div style="border: 1px solid black; padding: 2px;">65</div>                                             |                                                                                                                                                                                                                                                                                          | <b>Slope Angle (°):</b> <div style="border: 1px solid black; padding: 2px;">50</div>                                                                                                                                                                        |                                                                                 |                                                                          |
| <b>Sight Distance (ft):</b> <div style="border: 1px solid black; padding: 2px;">150</div>                                                                                                                                                                     | <b>Usable Roadway/Trail Width (ft):</b> <div style="border: 1px solid black; padding: 2px;">31</div>                                                           |                                                                                                                                                                                                                                                                                          | <b>Speed Limit (mph):</b> <div style="border: 1px solid black; padding: 2px;">35</div>                                                                                                                                                                      |                                                                                 |                                                                          |
| <b>Ditch Width Range (ft):</b><br><div style="border: 1px solid black; padding: 2px;">13</div> - <div style="border: 1px solid black; padding: 2px;">13</div>                                                                                                 | <b>Ditch Depth Range (ft):</b><br><div style="border: 1px solid black; padding: 2px;">1</div> - <div style="border: 1px solid black; padding: 2px;">1</div>    | <b>Ditch Slope Range (H:V):</b><br><div style="border: 1px solid black; padding: 2px;">0</div> : <div style="border: 1px solid black; padding: 2px;">0</div> - <div style="border: 1px solid black; padding: 2px;">0</div> : <div style="border: 1px solid black; padding: 2px;">0</div> | <b>Block Size (ft):</b> <div style="border: 1px solid black; padding: 2px;">10</div><br><b>Volume (cy):</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                     |                                                                                 |                                                                          |
| <b>Annual Rainfall Range (in):</b><br><div style="border: 1px solid black; padding: 2px;">13</div> - <div style="border: 1px solid black; padding: 2px;">13</div>                                                                                             | <b>Sole Access Route:</b> <div style="border: 1px solid black; padding: 2px;">Yes</div>                                                                        | <b>Mitigation Present:</b> <div style="border: 1px solid black; padding: 2px;">NO</div>                                                                                                                                                                                                  | <b>Photos/Documents(up to 10MB):</b><br><div style="border: 1px solid black; padding: 2px; display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 2px; margin-right: 5px;">Choose Files</div> <div>No file chosen</div> </div> |                                                                                 |                                                                          |
| <b>Comments:</b>                                                                                                                                                                                                                                              |                                                                                                                                                                |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                             |                                                                                 |                                                                          |
| <b>Alternate database Name:</b><br><div style="border: 1px solid black; height: 20px;"></div>                                                                                                                                                                 |                                                                                                                                                                |                                                                                                                                                                                                                                                                                          | <b>Alternate database ID:</b><br><div style="border: 1px solid black; height: 20px;"></div>                                                                                                                                                                 |                                                                                 |                                                                          |
| <b>Alternate database Description:</b><br><div style="border: 1px solid black; height: 40px;"></div>                                                                                                                                                          |                                                                                                                                                                |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                             |                                                                                 |                                                                          |
| Preliminary Ratings                                                                                                                                                                                                                                           |                                                                                                                                                                |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                             |                                                                                 |                                                                          |
| Category Rating:                                                                                                                                                                                                                                              | 3                                                                                                                                                              | 9                                                                                                                                                                                                                                                                                        | 27                                                                                                                                                                                                                                                          | 81                                                                              | Score:                                                                   |
| <b>A. Landslide - Roadway Width Affected:</b>                                                                                                                                                                                                                 | 0-5 percent                                                                                                                                                    | 6-25 percent                                                                                                                                                                                                                                                                             | 26-50 percent                                                                                                                                                                                                                                               | 51-100 percent                                                                  | <div style="border: 1px solid black; padding: 2px;">0</div>              |
| <b>B. Landslide - Slide/Erosion Effects:</b>                                                                                                                                                                                                                  | Visible crack or slight deposit of material / minor erosion                                                                                                    | 1 inch offset, or 6-inch deposit of material / major erosion will affect travel in < 5 years                                                                                                                                                                                             | 2-inch offset or 12-inch deposit / mod. erosion impacting travel annually                                                                                                                                                                                   | 4-inch offset or 24-inch deposit / severe erosion impacting travel consistently | <div style="border: 1px solid black; padding: 2px;">0</div>              |
| <b>C. Landslide - Roadway Length Affected:</b>                                                                                                                                                                                                                | 25 ft                                                                                                                                                          | 100 ft                                                                                                                                                                                                                                                                                   | 225 ft                                                                                                                                                                                                                                                      | 400 ft                                                                          | <div style="border: 1px solid black; padding: 2px;">0</div>              |
| <b>D. Rockfall - Ditch Effectiveness: (consider launch features)</b>                                                                                                                                                                                          | Good                                                                                                                                                           | Moderate                                                                                                                                                                                                                                                                                 | Limited                                                                                                                                                                                                                                                     | No Catchment                                                                    | <div style="border: 1px solid black; padding: 2px;">9</div>              |

|                                                                                          |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
|------------------------------------------------------------------------------------------|-----------------------------|---------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------|----|
| <b>E. Rockfall - Rockfall History:</b>                                                   |                             | Few Falls                                               | Occasional Falls                                                                     | Many Falls                                                                                  | Constant Falls                                                              | 81                                                                                      |                                                                                     |                                     |    |
| <b>F. Rockfall - Block Size or Volume per Event:</b>                                     |                             | 1ft or 3yd^3                                            | 2ft or 6yd^3                                                                         | 3ft or 9yd^3                                                                                | 4ft or 12yd^3                                                               | 100                                                                                     |                                                                                     |                                     |    |
| <b>G. All - Impact on Use:</b>                                                           |                             | Full use continues with minor delay                     | Partial use remains Use modification required, short (3mi / 30min.) detour available | Use is blocked - long (>30min.) detour available or less than 1 day closure                 | Use is blocked - no detour available or closure longer than 1 week          | 3                                                                                       |                                                                                     |                                     |    |
| <b>H. All - AADT/Usage/Economic or Recreational Importance (highest rating applies):</b> |                             | 50 Rarely Used Insignificant economic / rec. importance | 200 Occasionally used Minor economic / rec. importance                               | 450 Frequently used Moderate economic / rec. importance                                     | 800 Constantly used Significant economic / rec. importance                  | <b>Use AADT in calculation:</b> <input type="checkbox"/><br>81                          |                                                                                     |                                     |    |
| <b>Preliminary Rating Landslide Total (A+B+C+G+H):</b>                                   |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
| <b>Preliminary Rating Rockfall Total (D+E+F+G+H):</b>                                    |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 274                                                                                     |                                                                                     |                                     |    |
| <b>Preliminary Rating</b> Good (15-21 pts)   Fair (22-161 pts)   Poor (>161 pts)         |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 84                                                                                      |                                                                                     |                                     |    |
| <b>Slope Hazard Ratings</b>                                                              |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
| <b>Category Rating:</b>                                                                  |                             |                                                         | <b>3</b>                                                                             | <b>9</b>                                                                                    | <b>27</b>                                                                   | <b>81</b>                                                                               | <b>Score:</b>                                                                       |                                     |    |
| <b>I. All - Slope Drainage:</b>                                                          |                             |                                                         | Slope appears dry or well drained; surface runoff well controlled                    | Intermittent water on slope; mod. not well drained; or surface runoff moderately controlled | Water usually on slope; poorly drained; or surface runoff poorly controlled | Water always on slope; very poorly drained; or surface water runoff control not present | 3                                                                                   |                                     |    |
| <b>J. All - Annual Rainfall:</b>                                                         |                             |                                                         | 0-10"                                                                                | 10-30"                                                                                      | 30-60"                                                                      | 60"+                                                                                    | 9                                                                                   |                                     |    |
| <b>K. All - Slope Height (Rockfall) / Axial Length of slide (Landslide):</b>             |                             |                                                         | 25ft                                                                                 | 50ft                                                                                        | 75ft                                                                        | 100ft                                                                                   | 17                                                                                  |                                     |    |
| <b>Select One Unstable Slope Type</b>                                                    | <b>Landslides / Erosion</b> | <b>L. Thaw Stability:</b>                               |                                                                                      | Unfrozen / Thaw Stable                                                                      | Slightly Thaw Unstable                                                      | Moderately Thaw Unstable                                                                | Highly Thaw Unstable                                                                | 0                                   |    |
|                                                                                          |                             | <b>M. Instability - Related Maint. Frequency:</b>       |                                                                                      | Every 10 years                                                                              | Every 5 years                                                               | Every 2 years                                                                           | Every year                                                                          | 0                                   |    |
|                                                                                          |                             | <b>N. Movement History:</b>                             |                                                                                      | Minor movement or sporadic creep                                                            | Up to 1 inch annually or steady annual creep                                | Up to 3 inches per event, one event per year                                            | >3" per event, >6" annually, more than 1 event per year (includes all debris flows) | 0                                   |    |
|                                                                                          | <b>Rockfalls</b>            | <b>O. Rockfall-Related Maint. Frequency:</b>            |                                                                                      | Normal, scheduled maintenance                                                               | Patrols after every storm event                                             | Routine seasonal patrols                                                                | Year round patrols                                                                  | 27                                  |    |
|                                                                                          |                             | <b>Geological Character Case 1</b>                      | <b>P. Structural Condition:</b>                                                      |                                                                                             | favorable                                                                   | random                                                                                  | Discontinuous adverse                                                               | Continuous adverse                  | 0  |
|                                                                                          |                             |                                                         | <b>Q. Rock Friction:</b>                                                             |                                                                                             | Rough / Irregular                                                           | Undulating                                                                              | Planar                                                                              | Clay infilled / Slickensided        | 0  |
|                                                                                          |                             | <b>Geological Character Case 2</b>                      | <b>R. Structural Condition:</b>                                                      |                                                                                             | Few differential erosion features                                           | Occasional differential erosion features                                                | Many differential erosion features                                                  | Major differential erosion features | 27 |

|                                                                                                                       |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
|-----------------------------------------------------------------------------------------------------------------------|----------------------------------------|------------------------------------------|---------------------------------------------------------|-----------------------------------------------------|---------------------|------------------|--------------------|-----|
|                                                                                                                       |                                        |                                          | <b>S. Diff. in Erosion Rates:</b>                       | Small difference                                    | Moderate difference | Large difference | Extreme difference | 27  |
| <b>T. LANDSLIDE HAZARD TOTAL (A+B+C+I+J+K+L+M+N):</b>                                                                 |                                        |                                          |                                                         |                                                     |                     |                  |                    | 0   |
| <b>U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greater of P+Q or R+S)):</b>                                              |                                        |                                          |                                                         |                                                     |                     |                  |                    | 300 |
| <b>Risk Ratings</b>                                                                                                   |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
| <b>V. Route Width or Trail Width:</b>                                                                                 | 36ft<br>14ft                           | 28ft<br>10ft                             | 20ft<br>6ft                                             | 12ft<br>2ft                                         | 6                   |                  |                    |     |
| <b>W. Human Exposure Factor:</b>                                                                                      | 12.5% of the time                      | 25% of the time                          | 37.5% of the time                                       | 50% of the time                                     | 3                   |                  |                    |     |
| <b>X. % of Decision Sight Distance (Judge avoidance ability on trails):</b>                                           | Adequate, 100% of the low design value | Moderate, 80% of the low design value    | Limited, 60% of the low design value                    | Very limited, 40% of the low design value           | 100                 |                  |                    |     |
| <b>Y. Right of Way (R/W) Impacts (If Left Unattended):</b>                                                            | No R/W implications                    | Minor effects beyond R/W                 | Private property, no structures affected                | Structures, roads, RR, utilities, or Parks affected | 3                   |                  |                    |     |
| <b>Z. Environmental/Cultural Impacts if Left Unattended:</b>                                                          | None/No Potential to Cause Effects     | Likely to Effect/No Hist. Prop. Affected | Likely to adversely Affect/Finding of No Adverse Effect | Current adverse effects/Adverse Effect              | 3                   |                  |                    |     |
| <b>AA. Maintenance Complexity:</b>                                                                                    | Routine Effort / In-House              | In-House maint. / special project        | Specialized equip. / contract                           | Complex / dangerous effort / location / contract    | 3                   |                  |                    |     |
| <b>BB. Event Cost:</b>                                                                                                | \$0-2k                                 | \$2-25k                                  | \$25-100k                                               | >\$100k                                             | 3                   |                  |                    |     |
| <b>CC. Risk Totals (G+H+V+W+X+Y+Z+AA+BB):</b>                                                                         |                                        |                                          |                                                         |                                                     |                     |                  |                    | 205 |
| <b>TOTAL USMP SCORE: LANDSLIDES (T+CC) OR ROCKFALL (U+CC):</b> Good (<200 pts)   Fair (200-400 pts)   Poor (>400 pts) |                                        |                                          |                                                         |                                                     |                     |                  |                    | 505 |





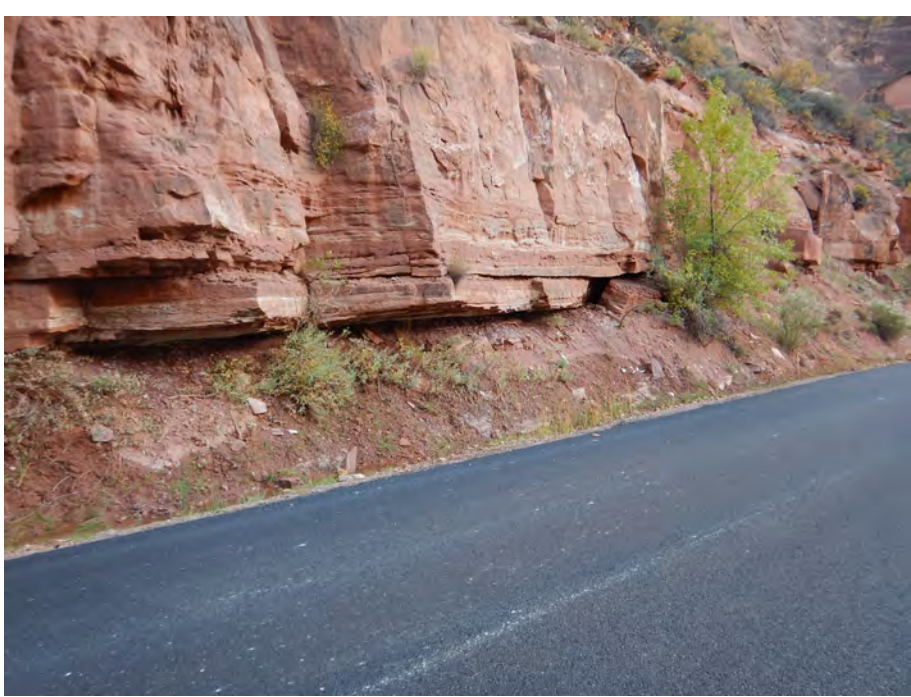
**SITE: 1239**

| Slope Rating Form - Site Information (Rockfall)                                                                                                                                                                                                               |                                                                                                                                                                |                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                            |                                                                                                                                                            |                                                              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|
| <b>Management Area:</b><br><div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;">NPS</div> <div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;">IMR</div> <div style="border: 1px solid black; padding: 2px;">ZION</div> | <b>Date:</b> <div style="border: 1px solid black; padding: 2px;">2020-02-28 14:42:26</div><br>Last edit: 2018-10-19 11:18:36<br>Edit ID: 5060<br>Site ID: 1239 | <input checked="" type="radio"/> Rockfall<br><input type="radio"/> Landslide                                                                                                                                 | <b>Hazard Type:</b> Press (ctrl+click) to select more than one<br><div style="border: 1px solid black; padding: 2px;">           Raveling/Undermining<br/>           Rock Avalanche<br/>           Indeterminate Rock Failures<br/>           Diff. Erosion         </div> |                                                                                                                                                            |                                                              |
| <b>Road/Trail No:</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                             | <b>Road/Trail:</b> <div style="border: 1px solid black; padding: 2px;">R</div>                                                                                 | <b>Road/Trail Class:</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                         | <b>Rater:</b> <div style="border: 1px solid black; padding: 2px;">Justin LaForge</div>                                                                                                                                                                                     |                                                                                                                                                            |                                                              |
| <b>Beginning Mile Marker:</b><br><div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                  | <b>Ending Mile Marker:</b><br><div style="border: 1px solid black; padding: 2px;">0</div>                                                                      | <b>Side:</b> <div style="border: 1px solid black; padding: 2px;">E - if road direction r</div>                                                                                                               | <b>Weather:</b> <div style="border: 1px solid black; padding: 2px;">Clear</div>                                                                                                                                                                                            |                                                                                                                                                            |                                                              |
| <b>Begin Coord. Lat/Long:</b><br>Lat (##.#####): <div style="border: 1px solid black; padding: 2px;">37.26077</div><br>Long (-###.#####): <div style="border: 1px solid black; padding: 2px;">-112.94907</div>                                                |                                                                                                                                                                | <b>End Coord. Lat/Long:</b><br>Lat (##.#####): <div style="border: 1px solid black; padding: 2px;">37.26402</div><br>Long (-###.#####): <div style="border: 1px solid black; padding: 2px;">-112.94923</div> |                                                                                                                                                                                                                                                                            | <b>Datum:</b> <div style="border: 1px solid black; padding: 2px;">WGS 84</div><br><b>AADT:</b> <div style="border: 1px solid black; padding: 2px;">1</div> |                                                              |
| <b>Length of Affected Road/Trail (ft):</b><br><div style="border: 1px solid black; padding: 2px;">839</div>                                                                                                                                                   | <b>Slope Height (rock)/Axial Length (slide) (ft):</b><br><div style="border: 1px solid black; padding: 2px;">36</div>                                          |                                                                                                                                                                                                              | <b>Slope Angle (°):</b> <div style="border: 1px solid black; padding: 2px;">46</div>                                                                                                                                                                                       |                                                                                                                                                            |                                                              |
| <b>Sight Distance (ft):</b><br><div style="border: 1px solid black; padding: 2px;">110</div>                                                                                                                                                                  | <b>Usable Roadway/Trail Width (ft):</b><br><div style="border: 1px solid black; padding: 2px;">25</div>                                                        |                                                                                                                                                                                                              | <b>Speed Limit (mph):</b><br><div style="border: 1px solid black; padding: 2px;">35</div>                                                                                                                                                                                  |                                                                                                                                                            |                                                              |
| <b>Ditch Width Range (ft):</b><br><div style="border: 1px solid black; padding: 2px;">1-1</div>                                                                                                                                                               | <b>Ditch Depth Range (ft):</b><br><div style="border: 1px solid black; padding: 2px;">0-0</div>                                                                | <b>Ditch Slope Range (H:V):</b><br><div style="border: 1px solid black; padding: 2px;">0:0-0:0</div>                                                                                                         | <b>Block Size (ft):</b> <div style="border: 1px solid black; padding: 2px;">7</div><br><b>Volume (cy):</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                     |                                                                                                                                                            |                                                              |
| <b>Annual Rainfall Range (in):</b><br><div style="border: 1px solid black; padding: 2px;">13-13</div>                                                                                                                                                         | <b>Sole Access Route:</b> <div style="border: 1px solid black; padding: 2px;">Yes</div>                                                                        | <b>Mitigation Present:</b> <div style="border: 1px solid black; padding: 2px;">NO</div>                                                                                                                      | <b>Photos/Documents(up to 10MB):</b><br><div style="border: 1px solid black; padding: 2px; display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 2px; margin-right: 5px;">Choose Files</div> <div>No file chosen</div> </div>                |                                                                                                                                                            |                                                              |
| <b>Comments:</b> <div style="border: 1px solid black; padding: 5px; min-height: 30px;">Water/spring on slope</div>                                                                                                                                            |                                                                                                                                                                |                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                            |                                                                                                                                                            |                                                              |
| <b>Alternate database Name:</b><br><div style="border: 1px solid black; height: 30px;"></div>                                                                                                                                                                 |                                                                                                                                                                |                                                                                                                                                                                                              | <b>Alternate database ID:</b><br><div style="border: 1px solid black; height: 30px;"></div>                                                                                                                                                                                |                                                                                                                                                            |                                                              |
| <b>Alternate database Description:</b><br><div style="border: 1px solid black; height: 30px;"></div>                                                                                                                                                          |                                                                                                                                                                |                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                            |                                                                                                                                                            |                                                              |
| Preliminary Ratings                                                                                                                                                                                                                                           |                                                                                                                                                                |                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                            |                                                                                                                                                            |                                                              |
| Category Rating:                                                                                                                                                                                                                                              | 3                                                                                                                                                              | 9                                                                                                                                                                                                            | 27                                                                                                                                                                                                                                                                         | 81                                                                                                                                                         | Score:                                                       |
| <b>A. Landslide - Roadway Width Affected:</b>                                                                                                                                                                                                                 | 0-5 percent                                                                                                                                                    | 6-25 percent                                                                                                                                                                                                 | 26-50 percent                                                                                                                                                                                                                                                              | 51-100 percent                                                                                                                                             | <div style="border: 1px solid black; padding: 2px;">0</div>  |
| <b>B. Landslide - Slide/Erosion Effects:</b>                                                                                                                                                                                                                  | Visible crack or slight deposit of material / minor erosion                                                                                                    | 1 inch offset, or 6-inch deposit of material / major erosion will affect travel in < 5 years                                                                                                                 | 2-inch offset or 12-inch deposit / mod. erosion impacting travel annually                                                                                                                                                                                                  | 4-inch offset or 24-inch deposit / severe erosion impacting travel consistently                                                                            | <div style="border: 1px solid black; padding: 2px;">0</div>  |
| <b>C. Landslide - Roadway Length Affected:</b>                                                                                                                                                                                                                | 25 ft                                                                                                                                                          | 100 ft                                                                                                                                                                                                       | 225 ft                                                                                                                                                                                                                                                                     | 400 ft                                                                                                                                                     | <div style="border: 1px solid black; padding: 2px;">0</div>  |
| <b>D. Rockfall - Ditch Effectiveness: (consider launch features)</b>                                                                                                                                                                                          | Good                                                                                                                                                           | Moderate                                                                                                                                                                                                     | Limited                                                                                                                                                                                                                                                                    | No Catchment                                                                                                                                               | <div style="border: 1px solid black; padding: 2px;">27</div> |

|                                                                                          |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
|------------------------------------------------------------------------------------------|-----------------------------|---------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------|----|
| <b>E. Rockfall - Rockfall History:</b>                                                   |                             | Few Falls                                               | Occasional Falls                                                                     | Many Falls                                                                                  | Constant Falls                                                              | 27                                                                                      |                                                                                     |                                     |    |
| <b>F. Rockfall - Block Size or Volume per Event:</b>                                     |                             | 1ft or 3yd^3                                            | 2ft or 6yd^3                                                                         | 3ft or 9yd^3                                                                                | 4ft or 12yd^3                                                               | 100                                                                                     |                                                                                     |                                     |    |
| <b>G. All - Impact on Use:</b>                                                           |                             | Full use continues with minor delay                     | Partial use remains Use modification required, short (3mi / 30min.) detour available | Use is blocked - long (>30min.) detour available or less than 1 day closure                 | Use is blocked - no detour available or closure longer than 1 week          | 9                                                                                       |                                                                                     |                                     |    |
| <b>H. All - AADT/Usage/Economic or Recreational Importance (highest rating applies):</b> |                             | 50 Rarely Used Insignificant economic / rec. importance | 200 Occasionally used Minor economic / rec. importance                               | 450 Frequently used Moderate economic / rec. importance                                     | 800 Constantly used Significant economic / rec. importance                  | <b>Use AADT in calculation:</b> <input type="checkbox"/><br>81                          |                                                                                     |                                     |    |
| <b>Preliminary Rating Landslide Total (A+B+C+G+H):</b>                                   |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
| <b>Preliminary Rating Rockfall Total (D+E+F+G+H):</b>                                    |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 244                                                                                     |                                                                                     |                                     |    |
| <b>Preliminary Rating</b> Good (15-21 pts)   Fair (22-161 pts)   Poor (>161 pts)         |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 90                                                                                      |                                                                                     |                                     |    |
| <b>Slope Hazard Ratings</b>                                                              |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
| <b>Category Rating:</b>                                                                  |                             |                                                         | <b>3</b>                                                                             | <b>9</b>                                                                                    | <b>27</b>                                                                   | <b>81</b>                                                                               | <b>Score:</b>                                                                       |                                     |    |
| <b>I. All - Slope Drainage:</b>                                                          |                             |                                                         | Slope appears dry or well drained; surface runoff well controlled                    | Intermittent water on slope; mod. not well drained; or surface runoff moderately controlled | Water usually on slope; poorly drained; or surface runoff poorly controlled | Water always on slope; very poorly drained; or surface water runoff control not present | 9                                                                                   |                                     |    |
| <b>J. All - Annual Rainfall:</b>                                                         |                             |                                                         | 0-10"                                                                                | 10-30"                                                                                      | 30-60"                                                                      | 60"+                                                                                    | 9                                                                                   |                                     |    |
| <b>K. All - Slope Height (Rockfall) / Axial Length of slide (Landslide):</b>             |                             |                                                         | 25ft                                                                                 | 50ft                                                                                        | 75ft                                                                        | 100ft                                                                                   | 5                                                                                   |                                     |    |
| <b>Select One Unstable Slope Type</b>                                                    | <b>Landslides / Erosion</b> | <b>L. Thaw Stability:</b>                               |                                                                                      | Unfrozen / Thaw Stable                                                                      | Slightly Thaw Unstable                                                      | Moderately Thaw Unstable                                                                | Highly Thaw Unstable                                                                | 0                                   |    |
|                                                                                          |                             | <b>M. Instability - Related Maint. Frequency:</b>       |                                                                                      | Every 10 years                                                                              | Every 5 years                                                               | Every 2 years                                                                           | Every year                                                                          | 0                                   |    |
|                                                                                          |                             | <b>N. Movement History:</b>                             |                                                                                      | Minor movement or sporadic creep                                                            | Up to 1 inch annually or steady annual creep                                | Up to 3 inches per event, one event per year                                            | >3" per event, >6" annually, more than 1 event per year (includes all debris flows) | 0                                   |    |
|                                                                                          | <b>Rockfalls</b>            | <b>O. Rockfall-Related Maint. Frequency:</b>            |                                                                                      | Normal, scheduled maintenance                                                               | Patrols after every storm event                                             | Routine seasonal patrols                                                                | Year round patrols                                                                  | 27                                  |    |
|                                                                                          |                             | <b>Geological Character Case 1</b>                      | <b>P. Structural Condition:</b>                                                      |                                                                                             | favorable                                                                   | random                                                                                  | Discontinuous adverse                                                               | Continuous adverse                  | 27 |
|                                                                                          |                             |                                                         | <b>Q. Rock Friction:</b>                                                             |                                                                                             | Rough / Irregular                                                           | Undulating                                                                              | Planar                                                                              | Clay infilled / Slickensided        | 9  |
|                                                                                          |                             | <b>Geological Character Case 2</b>                      | <b>R. Structural Condition:</b>                                                      |                                                                                             | Few differential erosion features                                           | Occasional differential erosion features                                                | Many differential erosion features                                                  | Major differential erosion features | 0  |

|                                                                                                                       |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
|-----------------------------------------------------------------------------------------------------------------------|----------------------------------------|------------------------------------------|---------------------------------------------------------|-----------------------------------------------------|---------------------|------------------|--------------------|-----|
|                                                                                                                       |                                        |                                          | <b>S. Diff. in Erosion Rates:</b>                       | Small difference                                    | Moderate difference | Large difference | Extreme difference | 0   |
| <b>T. LANDSLIDE HAZARD TOTAL (A+B+C+I+J+K+L+M+N):</b>                                                                 |                                        |                                          |                                                         |                                                     |                     |                  |                    | 0   |
| <b>U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greater of P+Q or R+S)):</b>                                              |                                        |                                          |                                                         |                                                     |                     |                  |                    | 258 |
| <b>Risk Ratings</b>                                                                                                   |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
| <b>V. Route Width or Trail Width:</b>                                                                                 | 36ft<br>14ft                           | 28ft<br>10ft                             | 20ft<br>6ft                                             | 12ft<br>2ft                                         | 14                  |                  |                    |     |
| <b>W. Human Exposure Factor:</b>                                                                                      | 12.5% of the time                      | 25% of the time                          | 37.5% of the time                                       | 50% of the time                                     | 3                   |                  |                    |     |
| <b>X. % of Decision Sight Distance (Judge avoidance ability on trails):</b>                                           | Adequate, 100% of the low design value | Moderate, 80% of the low design value    | Limited, 60% of the low design value                    | Very limited, 40% of the low design value           | 100                 |                  |                    |     |
| <b>Y. Right of Way (R/W) Impacts (If Left Unattended):</b>                                                            | No R/W implications                    | Minor effects beyond R/W                 | Private property, no structures affected                | Structures, roads, RR, utilities, or Parks affected | 3                   |                  |                    |     |
| <b>Z. Environmental/Cultural Impacts if Left Unattended:</b>                                                          | None/No Potential to Cause Effects     | Likely to Effect/No Hist. Prop. Affected | Likely to adversely Affect/Finding of No Adverse Effect | Current adverse effects/Adverse Effect              | 3                   |                  |                    |     |
| <b>AA. Maintenance Complexity:</b>                                                                                    | Routine Effort / In-House              | In-House maint. / special project        | Specialized equip. / contract                           | Complex / dangerous effort / location / contract    | 9                   |                  |                    |     |
| <b>BB. Event Cost:</b>                                                                                                | \$0-2k                                 | \$2-25k                                  | \$25-100k                                               | >\$100k                                             | 9                   |                  |                    |     |
| <b>CC. Risk Totals (G+H+V+W+X+Y+Z+AA+BB):</b>                                                                         |                                        |                                          |                                                         |                                                     |                     |                  |                    | 231 |
| <b>TOTAL USMP SCORE: LANDSLIDES (T+CC) OR ROCKFALL (U+CC):</b> Good (<200 pts)   Fair (200-400 pts)   Poor (>400 pts) |                                        |                                          |                                                         |                                                     |                     |                  |                    | 489 |





## **ROUTE 0407/ Oak Creek Residence Rd**

**SITE: 1435**

| Slope Rating Form - Site Information (Rockfall)                                                                                                                                                                                                               |                                                                                                                                                                |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                            |                                                                                 |                                                                          |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|--------------------------------------------------------------------------|
| <b>Management Area:</b><br><div style="border: 1px solid black; padding: 2px; margin-bottom: 2px;">NPS</div> <div style="border: 1px solid black; padding: 2px; margin-bottom: 2px;">IMR</div> <div style="border: 1px solid black; padding: 2px;">ZION</div> | <b>Date:</b> <div style="border: 1px solid black; padding: 2px;">2020-02-28 14:43:43</div><br>Last edit: 2018-10-19 14:25:55<br>Edit ID: 5094<br>Site ID: 1435 | <input checked="" type="radio"/> Rockfall<br><input type="radio"/> Landslide                                                                                                                                                                                                             | <b>Hazard Type:</b> Press (ctrl+click) to select more than one<br><div style="border: 1px solid black; padding: 2px;">           Raveling/Undermining<br/>           Rock Avalanche<br/>           Indeterminate Rock Failures<br/>           Diff. Erosion         </div> |                                                                                 |                                                                          |
| <b>Road/Trail No:</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                             | <b>Road/Trail:</b> <div style="border: 1px solid black; padding: 2px;">R</div>                                                                                 | <b>Road/Trail Class:</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                                                     | <b>Rater:</b> <div style="border: 1px solid black; padding: 2px;">Justin LaForge</div>                                                                                                                                                                                     |                                                                                 |                                                                          |
| <b>Beginning Mile Marker:</b><br><div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                  | <b>Ending Mile Marker:</b><br><div style="border: 1px solid black; padding: 2px;">0</div>                                                                      | <b>Side:</b> <div style="border: 1px solid black; padding: 2px;">N - if road direction r</div>                                                                                                                                                                                           | <b>Weather:</b> <div style="border: 1px solid black; padding: 2px;">Clear</div>                                                                                                                                                                                            |                                                                                 |                                                                          |
| <b>Begin Coord. Lat/Long:</b><br>Lat (##.#####): <div style="border: 1px solid black; padding: 2px;">37.21162</div><br>Long (-###.#####): <div style="border: 1px solid black; padding: 2px;">-112.9877</div>                                                 |                                                                                                                                                                | <b>End Coord. Lat/Long:</b><br>Lat (##.#####): <div style="border: 1px solid black; padding: 2px;">37.2122</div><br>Long (-###.#####): <div style="border: 1px solid black; padding: 2px;">-112.98796</div>                                                                              |                                                                                                                                                                                                                                                                            | <b>Datum:</b> <div style="border: 1px solid black; padding: 2px;">WGS 84</div>  | <b>AADT:</b> <div style="border: 1px solid black; padding: 2px;">1</div> |
| <b>Length of Affected Road/Trail (ft):</b> <div style="border: 1px solid black; padding: 2px;">300</div>                                                                                                                                                      | <b>Slope Height (rock)/Axial Length (slide) (ft):</b> <div style="border: 1px solid black; padding: 2px;">83</div>                                             |                                                                                                                                                                                                                                                                                          | <b>Slope Angle (°):</b> <div style="border: 1px solid black; padding: 2px;">31</div>                                                                                                                                                                                       |                                                                                 |                                                                          |
| <b>Sight Distance (ft):</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                       | <b>Usable Roadway/Trail Width (ft):</b> <div style="border: 1px solid black; padding: 2px;">100</div>                                                          |                                                                                                                                                                                                                                                                                          | <b>Speed Limit (mph):</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                                      |                                                                                 |                                                                          |
| <b>Ditch Width Range (ft):</b><br><div style="border: 1px solid black; padding: 2px;">0</div> - <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                   | <b>Ditch Depth Range (ft):</b><br><div style="border: 1px solid black; padding: 2px;">0</div> - <div style="border: 1px solid black; padding: 2px;">0</div>    | <b>Ditch Slope Range (H:V):</b><br><div style="border: 1px solid black; padding: 2px;">0</div> : <div style="border: 1px solid black; padding: 2px;">0</div> - <div style="border: 1px solid black; padding: 2px;">0</div> : <div style="border: 1px solid black; padding: 2px;">0</div> | <b>Block Size (ft):</b> <div style="border: 1px solid black; padding: 2px;">20</div><br><b>Volume (cy):</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                    |                                                                                 |                                                                          |
| <b>Annual Rainfall Range (in):</b><br><div style="border: 1px solid black; padding: 2px;">13</div> - <div style="border: 1px solid black; padding: 2px;">13</div>                                                                                             | <b>Sole Access Route:</b> <div style="border: 1px solid black; padding: 2px;">Yes</div>                                                                        | <b>Mitigation Present:</b> <div style="border: 1px solid black; padding: 2px;">NO</div>                                                                                                                                                                                                  | <b>Photos/Documents(up to 10MB):</b><br><div style="border: 1px solid black; padding: 2px; display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 2px; margin-right: 5px;">Choose Files</div> <div>No file chosen</div> </div>                |                                                                                 |                                                                          |
| <b>Comments:</b> Oak Creek housing                                                                                                                                                                                                                            |                                                                                                                                                                |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                            |                                                                                 |                                                                          |
| <b>Alternate database Name:</b><br><div style="border: 1px solid black; height: 30px;"></div>                                                                                                                                                                 |                                                                                                                                                                |                                                                                                                                                                                                                                                                                          | <b>Alternate database ID:</b><br><div style="border: 1px solid black; height: 30px;"></div>                                                                                                                                                                                |                                                                                 |                                                                          |
| <b>Alternate database Description:</b>                                                                                                                                                                                                                        |                                                                                                                                                                |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                            |                                                                                 |                                                                          |
| Preliminary Ratings                                                                                                                                                                                                                                           |                                                                                                                                                                |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                            |                                                                                 |                                                                          |
| Category Rating:                                                                                                                                                                                                                                              | 3                                                                                                                                                              | 9                                                                                                                                                                                                                                                                                        | 27                                                                                                                                                                                                                                                                         | 81                                                                              | Score:                                                                   |
| <b>A. Landslide - Roadway Width Affected:</b>                                                                                                                                                                                                                 | 0-5 percent                                                                                                                                                    | 6-25 percent                                                                                                                                                                                                                                                                             | 26-50 percent                                                                                                                                                                                                                                                              | 51-100 percent                                                                  | <div style="border: 1px solid black; padding: 2px;">0</div>              |
| <b>B. Landslide - Slide/Erosion Effects:</b>                                                                                                                                                                                                                  | Visible crack or slight deposit of material / minor erosion                                                                                                    | 1 inch offset, or 6-inch deposit of material / major erosion will affect travel in < 5 years                                                                                                                                                                                             | 2-inch offset or 12-inch deposit / mod. erosion impacting travel annually                                                                                                                                                                                                  | 4-inch offset or 24-inch deposit / severe erosion impacting travel consistently | <div style="border: 1px solid black; padding: 2px;">0</div>              |
| <b>C. Landslide - Roadway Length Affected:</b>                                                                                                                                                                                                                | 25 ft                                                                                                                                                          | 100 ft                                                                                                                                                                                                                                                                                   | 225 ft                                                                                                                                                                                                                                                                     | 400 ft                                                                          | <div style="border: 1px solid black; padding: 2px;">0</div>              |
| <b>D. Rockfall - Ditch Effectiveness: (consider launch features)</b>                                                                                                                                                                                          | Good                                                                                                                                                           | Moderate                                                                                                                                                                                                                                                                                 | Limited                                                                                                                                                                                                                                                                    | No Catchment                                                                    | <div style="border: 1px solid black; padding: 2px;">9</div>              |

|                                                                                          |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                    |                                     |
|------------------------------------------------------------------------------------------|-----------------------------|---------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------------------------------------|-------------------------------------|
| <b>E. Rockfall - Rockfall History:</b>                                                   |                             | Few Falls                                               | Occasional Falls                                                                     | Many Falls                                                                                  | Constant Falls                                                              | 3                                                                                       |                                                                                     |                                    |                                     |
| <b>F. Rockfall - Block Size or Volume per Event:</b>                                     |                             | 1ft or 3yd^3                                            | 2ft or 6yd^3                                                                         | 3ft or 9yd^3                                                                                | 4ft or 12yd^3                                                               | 100                                                                                     |                                                                                     |                                    |                                     |
| <b>G. All - Impact on Use:</b>                                                           |                             | Full use continues with minor delay                     | Partial use remains Use modification required, short (3mi / 30min.) detour available | Use is blocked - long (>30min.) detour available or less than 1 day closure                 | Use is blocked - no detour available or closure longer than 1 week          | 81                                                                                      |                                                                                     |                                    |                                     |
| <b>H. All - AADT/Usage/Economic or Recreational Importance (highest rating applies):</b> |                             | 50 Rarely Used Insignificant economic / rec. importance | 200 Occasionally used Minor economic / rec. importance                               | 450 Frequently used Moderate economic / rec. importance                                     | 800 Constantly used Significant economic / rec. importance                  | <b>Use AADT in calculation:</b> <input type="checkbox"/><br>81                          |                                                                                     |                                    |                                     |
| <b>Preliminary Rating Landslide Total (A+B+C+G+H):</b>                                   |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                    |                                     |
| <b>Preliminary Rating Rockfall Total (D+E+F+G+H):</b>                                    |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 274                                                                                     |                                                                                     |                                    |                                     |
| <b>Preliminary Rating</b> Good (15-21 pts)   Fair (22-161 pts)   Poor (>161 pts)         |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 274                                                                                     |                                                                                     |                                    |                                     |
| <b>Slope Hazard Ratings</b>                                                              |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                    |                                     |
| <b>Category Rating:</b>                                                                  |                             |                                                         | <b>3</b>                                                                             | <b>9</b>                                                                                    | <b>27</b>                                                                   | <b>81</b>                                                                               | <b>Score:</b>                                                                       |                                    |                                     |
| <b>I. All - Slope Drainage:</b>                                                          |                             |                                                         | Slope appears dry or well drained; surface runoff well controlled                    | Intermittent water on slope; mod. not well drained; or surface runoff moderately controlled | Water usually on slope; poorly drained; or surface runoff poorly controlled | Water always on slope; very poorly drained; or surface water runoff control not present | 3                                                                                   |                                    |                                     |
| <b>J. All - Annual Rainfall:</b>                                                         |                             |                                                         | 0-10"                                                                                | 10-30"                                                                                      | 30-60"                                                                      | 60"+                                                                                    | 9                                                                                   |                                    |                                     |
| <b>K. All - Slope Height (Rockfall) / Axial Length of slide (Landslide):</b>             |                             |                                                         | 25ft                                                                                 | 50ft                                                                                        | 75ft                                                                        | 100ft                                                                                   | 38                                                                                  |                                    |                                     |
| <b>Select One Unstable Slope Type</b>                                                    | <b>Landslides / Erosion</b> | <b>L. Thaw Stability:</b>                               |                                                                                      | Unfrozen / Thaw Stable                                                                      | Slightly Thaw Unstable                                                      | Moderately Thaw Unstable                                                                | Highly Thaw Unstable                                                                | 0                                  |                                     |
|                                                                                          |                             | <b>M. Instability - Related Maint. Frequency:</b>       |                                                                                      | Every 10 years                                                                              | Every 5 years                                                               | Every 2 years                                                                           | Every year                                                                          | 0                                  |                                     |
|                                                                                          |                             | <b>N. Movement History:</b>                             |                                                                                      | Minor movement or sporadic creep                                                            | Up to 1 inch annually or steady annual creep                                | Up to 3 inches per event, one event per year                                            | >3" per event, >6" annually, more than 1 event per year (includes all debris flows) | 0                                  |                                     |
|                                                                                          | <b>Rockfalls</b>            | <b>O. Rockfall-Related Maint. Frequency:</b>            |                                                                                      | Normal, scheduled maintenance                                                               | Patrols after every storm event                                             | Routine seasonal patrols                                                                | Year round patrols                                                                  | 3                                  |                                     |
|                                                                                          |                             | <b>Geological Character Case 1</b>                      | <b>P. Structural Condition:</b>                                                      |                                                                                             | favorable                                                                   | random                                                                                  | Discontinuous adverse                                                               | Continuous adverse                 | 0                                   |
|                                                                                          |                             |                                                         | <b>Q. Rock Friction:</b>                                                             |                                                                                             | Rough / Irregular                                                           | Undulating                                                                              | Planar                                                                              | Clay infilled / Slickensided       | 0                                   |
|                                                                                          |                             | <b>Geological Character Case 2</b>                      |                                                                                      | <b>R. Structural Condition:</b>                                                             |                                                                             | Few differential erosion features                                                       | Occasional differential erosion features                                            | Many differential erosion features | Major differential erosion features |

|                                                                                                                       |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
|-----------------------------------------------------------------------------------------------------------------------|----------------------------------------|------------------------------------------|---------------------------------------------------------|-----------------------------------------------------|---------------------|------------------|--------------------|-----|
|                                                                                                                       |                                        |                                          | <b>S. Diff. in Erosion Rates:</b>                       | Small difference                                    | Moderate difference | Large difference | Extreme difference | 27  |
| <b>T. LANDSLIDE HAZARD TOTAL (A+B+C+I+J+K+L+M+N):</b>                                                                 |                                        |                                          |                                                         |                                                     |                     |                  |                    | 0   |
| <b>U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greater of P+Q or R+S)):</b>                                              |                                        |                                          |                                                         |                                                     |                     |                  |                    | 219 |
| <b>Risk Ratings</b>                                                                                                   |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
| <b>V. Route Width or Trail Width:</b>                                                                                 | 36ft<br>14ft                           | 28ft<br>10ft                             | 20ft<br>6ft                                             | 12ft<br>2ft                                         | 0                   |                  |                    |     |
| <b>W. Human Exposure Factor:</b>                                                                                      | 12.5% of the time                      | 25% of the time                          | 37.5% of the time                                       | 50% of the time                                     | 100                 |                  |                    |     |
| <b>X. % of Decision Sight Distance (Judge avoidance ability on trails):</b>                                           | Adequate, 100% of the low design value | Moderate, 80% of the low design value    | Limited, 60% of the low design value                    | Very limited, 40% of the low design value           | 100                 |                  |                    |     |
| <b>Y. Right of Way (R/W) Impacts (If Left Unattended):</b>                                                            | No R/W implications                    | Minor effects beyond R/W                 | Private property, no structures affected                | Structures, roads, RR, utilities, or Parks affected | 81                  |                  |                    |     |
| <b>Z. Environmental/Cultural Impacts if Left Unattended:</b>                                                          | None/No Potential to Cause Effects     | Likely to Effect/No Hist. Prop. Affected | Likely to adversely Affect/Finding of No Adverse Effect | Current adverse effects/Adverse Effect              | 3                   |                  |                    |     |
| <b>AA. Maintenance Complexity:</b>                                                                                    | Routine Effort / In-House              | In-House maint. / special project        | Specialized equip. / contract                           | Complex / dangerous effort / location / contract    | 81                  |                  |                    |     |
| <b>BB. Event Cost:</b>                                                                                                | \$0-2k                                 | \$2-25k                                  | \$25-100k                                               | >\$100k                                             | 81                  |                  |                    |     |
| <b>CC. Risk Totals (G+H+V+W+X+Y+Z+AA+BB):</b>                                                                         |                                        |                                          |                                                         |                                                     |                     |                  |                    | 608 |
| <b>TOTAL USMP SCORE: LANDSLIDES (T+CC) OR ROCKFALL (U+CC):</b> Good (<200 pts)   Fair (200-400 pts)   Poor (>400 pts) |                                        |                                          |                                                         |                                                     |                     |                  |                    | 827 |





## **ROUTE 0408/ Oak Creek Residence Spur Rd**

**SITE: 1431**

| Slope Rating Form - Site Information (Rockfall)                                                                                                                                                                                                               |                                                                                                                                                                |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                             |                                                                          |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|
| <b>Management Area:</b><br><div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;">NPS</div> <div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;">IMR</div> <div style="border: 1px solid black; padding: 2px;">ZION</div> | <b>Date:</b> <div style="border: 1px solid black; padding: 2px;">2020-02-28 14:43:08</div><br>Last edit: 2018-10-19 14:23:01<br>Edit ID: 5093<br>Site ID: 1431 | <input checked="" type="radio"/> Rockfall<br><input type="radio"/> Landslide                                                                                                                                                                                                             | <b>Hazard Type:</b> Press (ctrl+click) to select more than one<br><div style="border: 1px solid black; padding: 2px;">           Raveling/Undermining<br/>           Rock Avalanche<br/>           Indeterminate Rock Failures<br/>           Diff. Erosion         </div> |                                                                                                                                                                                                                                                             |                                                                          |
| <b>Road/Trail No:</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                             | <b>Road/Trail:</b> <div style="border: 1px solid black; padding: 2px;">R</div>                                                                                 | <b>Road/Trail Class:</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                                                     | <b>Rater:</b> <div style="border: 1px solid black; padding: 2px;">Justin LaForge</div>                                                                                                                                                                                     |                                                                                                                                                                                                                                                             |                                                                          |
| <b>Beginning Mile Marker:</b><br><div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                  | <b>Ending Mile Marker:</b><br><div style="border: 1px solid black; padding: 2px;">0</div>                                                                      | <b>Side:</b> <div style="border: 1px solid black; padding: 2px;">N - if road direction r</div>                                                                                                                                                                                           | <b>Weather:</b> <div style="border: 1px solid black; padding: 2px;">Clear</div>                                                                                                                                                                                            |                                                                                                                                                                                                                                                             |                                                                          |
| <b>Begin Coord. Lat/Long:</b><br>Lat (##.#####): <div style="border: 1px solid black; padding: 2px;">37.21047</div><br>Long (-###.#####): <div style="border: 1px solid black; padding: 2px;">-112.98355</div>                                                |                                                                                                                                                                | <b>End Coord. Lat/Long:</b><br>Lat (##.#####): <div style="border: 1px solid black; padding: 2px;">37.21052</div><br>Long (-###.#####): <div style="border: 1px solid black; padding: 2px;">-112.98404</div>                                                                             |                                                                                                                                                                                                                                                                            | <b>Datum:</b> <div style="border: 1px solid black; padding: 2px;">WGS 84</div>                                                                                                                                                                              | <b>AADT:</b> <div style="border: 1px solid black; padding: 2px;">1</div> |
| <b>Length of Affected Road/Trail (ft):</b> <div style="border: 1px solid black; padding: 2px;">98</div>                                                                                                                                                       | <b>Slope Height (rock)/Axial Length (slide) (ft):</b> <div style="border: 1px solid black; padding: 2px;">48</div>                                             |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                            | <b>Slope Angle (°):</b> <div style="border: 1px solid black; padding: 2px;">25</div>                                                                                                                                                                        |                                                                          |
| <b>Sight Distance (ft):</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                       | <b>Usable Roadway/Trail Width (ft):</b> <div style="border: 1px solid black; padding: 2px;">32</div>                                                           |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                            | <b>Speed Limit (mph):</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                       |                                                                          |
| <b>Ditch Width Range (ft):</b><br><div style="border: 1px solid black; padding: 2px;">0</div> - <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                   | <b>Ditch Depth Range (ft):</b><br><div style="border: 1px solid black; padding: 2px;">0</div> - <div style="border: 1px solid black; padding: 2px;">0</div>    | <b>Ditch Slope Range (H:V):</b><br><div style="border: 1px solid black; padding: 2px;">0</div> : <div style="border: 1px solid black; padding: 2px;">0</div> - <div style="border: 1px solid black; padding: 2px;">0</div> : <div style="border: 1px solid black; padding: 2px;">0</div> |                                                                                                                                                                                                                                                                            | <b>Block Size (ft):</b> <div style="border: 1px solid black; padding: 2px;">5</div><br><b>Volume (cy):</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                      |                                                                          |
| <b>Annual Rainfall Range (in):</b><br><div style="border: 1px solid black; padding: 2px;">13</div> - <div style="border: 1px solid black; padding: 2px;">13</div>                                                                                             | <b>Sole Access Route:</b> <div style="border: 1px solid black; padding: 2px;">Yes</div>                                                                        | <b>Mitigation Present:</b> <div style="border: 1px solid black; padding: 2px;">NO</div>                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                            | <b>Photos/Documents(up to 10MB):</b><br><div style="border: 1px solid black; padding: 2px; display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 2px; margin-right: 5px;">Choose Files</div> <div>No file chosen</div> </div> |                                                                          |
| <b>Comments:</b> Oak Creek housing                                                                                                                                                                                                                            |                                                                                                                                                                |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                             |                                                                          |
| <b>Alternate database Name:</b><br><div style="border: 1px solid black; height: 30px;"></div>                                                                                                                                                                 |                                                                                                                                                                |                                                                                                                                                                                                                                                                                          | <b>Alternate database ID:</b><br><div style="border: 1px solid black; height: 30px;"></div>                                                                                                                                                                                |                                                                                                                                                                                                                                                             |                                                                          |
| <b>Alternate database Description:</b>                                                                                                                                                                                                                        |                                                                                                                                                                |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                             |                                                                          |
| Preliminary Ratings                                                                                                                                                                                                                                           |                                                                                                                                                                |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                             |                                                                          |
| Category Rating:                                                                                                                                                                                                                                              | 3                                                                                                                                                              | 9                                                                                                                                                                                                                                                                                        | 27                                                                                                                                                                                                                                                                         | 81                                                                                                                                                                                                                                                          | Score:                                                                   |
| <b>A. Landslide - Roadway Width Affected:</b>                                                                                                                                                                                                                 | 0-5 percent                                                                                                                                                    | 6-25 percent                                                                                                                                                                                                                                                                             | 26-50 percent                                                                                                                                                                                                                                                              | 51-100 percent                                                                                                                                                                                                                                              | <div style="border: 1px solid black; padding: 2px;">0</div>              |
| <b>B. Landslide - Slide/Erosion Effects:</b>                                                                                                                                                                                                                  | Visible crack or slight deposit of material / minor erosion                                                                                                    | 1 inch offset, or 6-inch deposit of material / major erosion will affect travel in < 5 years                                                                                                                                                                                             | 2-inch offset or 12-inch deposit / mod. erosion impacting travel annually                                                                                                                                                                                                  | 4-inch offset or 24-inch deposit / severe erosion impacting travel consistently                                                                                                                                                                             | <div style="border: 1px solid black; padding: 2px;">0</div>              |
| <b>C. Landslide - Roadway Length Affected:</b>                                                                                                                                                                                                                | 25 ft                                                                                                                                                          | 100 ft                                                                                                                                                                                                                                                                                   | 225 ft                                                                                                                                                                                                                                                                     | 400 ft                                                                                                                                                                                                                                                      | <div style="border: 1px solid black; padding: 2px;">0</div>              |
| <b>D. Rockfall - Ditch Effectiveness: (consider launch features)</b>                                                                                                                                                                                          | Good                                                                                                                                                           | Moderate                                                                                                                                                                                                                                                                                 | Limited                                                                                                                                                                                                                                                                    | No Catchment                                                                                                                                                                                                                                                | <div style="border: 1px solid black; padding: 2px;">9</div>              |

|                                                                                          |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |   |
|------------------------------------------------------------------------------------------|-----------------------------|---------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------|---|
| <b>E. Rockfall - Rockfall History:</b>                                                   |                             | Few Falls                                               | Occasional Falls                                                                     | Many Falls                                                                                  | Constant Falls                                                              | 3                                                                                       |                                                                                     |                                     |   |
| <b>F. Rockfall - Block Size or Volume per Event:</b>                                     |                             | 1ft or 3yd^3                                            | 2ft or 6yd^3                                                                         | 3ft or 9yd^3                                                                                | 4ft or 12yd^3                                                               | 100                                                                                     |                                                                                     |                                     |   |
| <b>G. All - Impact on Use:</b>                                                           |                             | Full use continues with minor delay                     | Partial use remains Use modification required, short (3mi / 30min.) detour available | Use is blocked - long (>30min.) detour available or less than 1 day closure                 | Use is blocked - no detour available or closure longer than 1 week          | 81                                                                                      |                                                                                     |                                     |   |
| <b>H. All - AADT/Usage/Economic or Recreational Importance (highest rating applies):</b> |                             | 50 Rarely Used Insignificant economic / rec. importance | 200 Occasionally used Minor economic / rec. importance                               | 450 Frequently used Moderate economic / rec. importance                                     | 800 Constantly used Significant economic / rec. importance                  | <b>Use AADT in calculation:</b> <input type="checkbox"/><br>81                          |                                                                                     |                                     |   |
| <b>Preliminary Rating Landslide Total (A+B+C+G+H):</b>                                   |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |   |
| <b>Preliminary Rating Rockfall Total (D+E+F+G+H):</b>                                    |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 274                                                                                     |                                                                                     |                                     |   |
| <b>Preliminary Rating</b> Good (15-21 pts)   Fair (22-161 pts)   Poor (>161 pts)         |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 274                                                                                     |                                                                                     |                                     |   |
| <b>Slope Hazard Ratings</b>                                                              |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |   |
| <b>Category Rating:</b>                                                                  |                             |                                                         | <b>3</b>                                                                             | <b>9</b>                                                                                    | <b>27</b>                                                                   | <b>81</b>                                                                               | <b>Score:</b>                                                                       |                                     |   |
| <b>I. All - Slope Drainage:</b>                                                          |                             |                                                         | Slope appears dry or well drained; surface runoff well controlled                    | Intermittent water on slope; mod. not well drained; or surface runoff moderately controlled | Water usually on slope; poorly drained; or surface runoff poorly controlled | Water always on slope; very poorly drained; or surface water runoff control not present | 3                                                                                   |                                     |   |
| <b>J. All - Annual Rainfall:</b>                                                         |                             |                                                         | 0-10"                                                                                | 10-30"                                                                                      | 30-60"                                                                      | 60"+                                                                                    | 9                                                                                   |                                     |   |
| <b>K. All - Slope Height (Rockfall) / Axial Length of slide (Landslide):</b>             |                             |                                                         | 25ft                                                                                 | 50ft                                                                                        | 75ft                                                                        | 100ft                                                                                   | 8                                                                                   |                                     |   |
| <b>Select One Unstable Slope Type</b>                                                    | <b>Landslides / Erosion</b> | <b>L. Thaw Stability:</b>                               |                                                                                      | Unfrozen / Thaw Stable                                                                      | Slightly Thaw Unstable                                                      | Moderately Thaw Unstable                                                                | Highly Thaw Unstable                                                                | 0                                   |   |
|                                                                                          |                             | <b>M. Instability - Related Maint. Frequency:</b>       |                                                                                      | Every 10 years                                                                              | Every 5 years                                                               | Every 2 years                                                                           | Every year                                                                          | 0                                   |   |
|                                                                                          |                             | <b>N. Movement History:</b>                             |                                                                                      | Minor movement or sporadic creep                                                            | Up to 1 inch annually or steady annual creep                                | Up to 3 inches per event, one event per year                                            | >3" per event, >6" annually, more than 1 event per year (includes all debris flows) | 0                                   |   |
|                                                                                          | <b>Rockfalls</b>            | <b>O. Rockfall-Related Maint. Frequency:</b>            |                                                                                      | Normal, scheduled maintenance                                                               | Patrols after every storm event                                             | Routine seasonal patrols                                                                | Year round patrols                                                                  | 3                                   |   |
|                                                                                          |                             | <b>Geological Character Case 1</b>                      | <b>P. Structural Condition:</b>                                                      |                                                                                             | favorable                                                                   | random                                                                                  | Discontinuous adverse                                                               | Continuous adverse                  | 0 |
|                                                                                          |                             |                                                         | <b>Q. Rock Friction:</b>                                                             |                                                                                             | Rough / Irregular                                                           | Undulating                                                                              | Planar                                                                              | Clay infilled / Slickensided        | 0 |
|                                                                                          |                             | <b>Geological Character Case 2</b>                      | <b>R. Structural Condition:</b>                                                      |                                                                                             | Few differential erosion features                                           | Occasional differential erosion features                                                | Many differential erosion features                                                  | Major differential erosion features | 9 |

|                                                                                                                       |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
|-----------------------------------------------------------------------------------------------------------------------|----------------------------------------|------------------------------------------|---------------------------------------------------------|-----------------------------------------------------|---------------------|------------------|--------------------|-----|
|                                                                                                                       |                                        |                                          | <b>S. Diff. in Erosion Rates:</b>                       | Small difference                                    | Moderate difference | Large difference | Extreme difference | 27  |
| <b>T. LANDSLIDE HAZARD TOTAL (A+B+C+I+J+K+L+M+N):</b>                                                                 |                                        |                                          |                                                         |                                                     |                     |                  |                    | 0   |
| <b>U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greater of P+Q or R+S)):</b>                                              |                                        |                                          |                                                         |                                                     |                     |                  |                    | 171 |
| <b>Risk Ratings</b>                                                                                                   |                                        |                                          |                                                         |                                                     |                     |                  |                    |     |
| <b>V. Route Width or Trail Width:</b>                                                                                 | 36ft<br>14ft                           | 28ft<br>10ft                             | 20ft<br>6ft                                             | 12ft<br>2ft                                         | 5                   |                  |                    |     |
| <b>W. Human Exposure Factor:</b>                                                                                      | 12.5% of the time                      | 25% of the time                          | 37.5% of the time                                       | 50% of the time                                     | 100                 |                  |                    |     |
| <b>X. % of Decision Sight Distance (Judge avoidance ability on trails):</b>                                           | Adequate, 100% of the low design value | Moderate, 80% of the low design value    | Limited, 60% of the low design value                    | Very limited, 40% of the low design value           | 100                 |                  |                    |     |
| <b>Y. Right of Way (R/W) Impacts (If Left Unattended):</b>                                                            | No R/W implications                    | Minor effects beyond R/W                 | Private property, no structures affected                | Structures, roads, RR, utilities, or Parks affected | 81                  |                  |                    |     |
| <b>Z. Environmental/Cultural Impacts if Left Unattended:</b>                                                          | None/No Potential to Cause Effects     | Likely to Effect/No Hist. Prop. Affected | Likely to adversely Affect/Finding of No Adverse Effect | Current adverse effects/Adverse Effect              | 3                   |                  |                    |     |
| <b>AA. Maintenance Complexity:</b>                                                                                    | Routine Effort / In-House              | In-House maint. / special project        | Specialized equip. / contract                           | Complex / dangerous effort / location / contract    | 81                  |                  |                    |     |
| <b>BB. Event Cost:</b>                                                                                                | \$0-2k                                 | \$2-25k                                  | \$25-100k                                               | >\$100k                                             | 81                  |                  |                    |     |
| <b>CC. Risk Totals (G+H+V+W+X+Y+Z+AA+BB):</b>                                                                         |                                        |                                          |                                                         |                                                     |                     |                  |                    | 613 |
| <b>TOTAL USMP SCORE: LANDSLIDES (T+CC) OR ROCKFALL (U+CC):</b> Good (<200 pts)   Fair (200-400 pts)   Poor (>400 pts) |                                        |                                          |                                                         |                                                     |                     |                  |                    | 784 |





**ROUTE 0412/ Concessionaire/Dorm Access Rd**

**SITE: 1234**

| Slope Rating Form - Site Information (Rockfall)                                                                                                                                                                                                               |                                                                                                                                                                |                                                                                                                                                                                                             |                                                                                                                                                                                                                                                             |                                                                                 |                                                                          |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|--------------------------------------------------------------------------|
| <b>Management Area:</b><br><div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;">NPS</div> <div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;">IMR</div> <div style="border: 1px solid black; padding: 2px;">ZION</div> | <b>Date:</b> <div style="border: 1px solid black; padding: 2px;">2020-02-28 14:41:42</div><br>Last edit: 2018-10-19 10:16:54<br>Edit ID: 5056<br>Site ID: 1234 | <input checked="" type="radio"/> Rockfall<br><input type="radio"/> Landslide                                                                                                                                | <b>Hazard Type:</b> Press (ctrl+click) to select more than one<br><div style="border: 1px solid black; padding: 2px;">           Planar<br/>           Wedge<br/>           Toppling<br/>           Raveling/Undermining         </div>                     |                                                                                 |                                                                          |
| <b>Road/Trail No:</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                             | <b>Road/Trail:</b> <div style="border: 1px solid black; padding: 2px;">R</div>                                                                                 | <b>Road/Trail Class:</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                        | <b>Rater:</b> <div style="border: 1px solid black; padding: 2px;">Justin LaForge</div>                                                                                                                                                                      |                                                                                 |                                                                          |
| <b>Beginning Mile Marker:</b><br><div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                  | <b>Ending Mile Marker:</b><br><div style="border: 1px solid black; padding: 2px;">0</div>                                                                      | <b>Side:</b> <div style="border: 1px solid black; padding: 2px;">E - if road direction r</div>                                                                                                              | <b>Weather:</b> <div style="border: 1px solid black; padding: 2px;">Clear</div>                                                                                                                                                                             |                                                                                 |                                                                          |
| <b>Begin Coord. Lat/Long:</b><br>Lat (##.#####): <div style="border: 1px solid black; padding: 2px;">37.24605</div><br>Long (-###.#####): <div style="border: 1px solid black; padding: 2px;">-112.95501</div>                                                |                                                                                                                                                                | <b>End Coord. Lat/Long:</b><br>Lat (##.#####): <div style="border: 1px solid black; padding: 2px;">37.24817</div><br>Long (-###.#####): <div style="border: 1px solid black; padding: 2px;">-112.9565</div> |                                                                                                                                                                                                                                                             | <b>Datum:</b> <div style="border: 1px solid black; padding: 2px;">WGS 84</div>  | <b>AADT:</b> <div style="border: 1px solid black; padding: 2px;">1</div> |
| <b>Length of Affected Road/Trail (ft):</b> <div style="border: 1px solid black; padding: 2px;">621</div>                                                                                                                                                      | <b>Slope Height (rock)/Axial Length (slide) (ft):</b> <div style="border: 1px solid black; padding: 2px;">145</div>                                            |                                                                                                                                                                                                             | <b>Slope Angle (°):</b> <div style="border: 1px solid black; padding: 2px;">40</div>                                                                                                                                                                        |                                                                                 |                                                                          |
| <b>Sight Distance (ft):</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                       | <b>Usable Roadway/Trail Width (ft):</b> <div style="border: 1px solid black; padding: 2px;">100</div>                                                          |                                                                                                                                                                                                             | <b>Speed Limit (mph):</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                                                                                                       |                                                                                 |                                                                          |
| <b>Ditch Width Range (ft):</b><br><div style="border: 1px solid black; padding: 2px;">0 - 0</div>                                                                                                                                                             | <b>Ditch Depth Range (ft):</b><br><div style="border: 1px solid black; padding: 2px;">0 - 0</div>                                                              | <b>Ditch Slope Range (H:V):</b><br><div style="border: 1px solid black; padding: 2px;">0 : 0 - 0 : 0</div>                                                                                                  | <b>Block Size (ft):</b> <div style="border: 1px solid black; padding: 2px;">4</div><br><b>Volume (cy):</b> <div style="border: 1px solid black; padding: 2px;">0</div>                                                                                      |                                                                                 |                                                                          |
| <b>Annual Rainfall Range (in):</b><br><div style="border: 1px solid black; padding: 2px;">13 - 13</div>                                                                                                                                                       | <b>Sole Access Route:</b> <div style="border: 1px solid black; padding: 2px;">Yes</div>                                                                        | <b>Mitigation Present:</b> <div style="border: 1px solid black; padding: 2px;">NO</div>                                                                                                                     | <b>Photos/Documents(up to 10MB):</b><br><div style="border: 1px solid black; padding: 2px; display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 2px; margin-right: 5px;">Choose Files</div> <div>No file chosen</div> </div> |                                                                                 |                                                                          |
| <b>Comments:</b> Slope is above trailer park, maintenance building, housing.                                                                                                                                                                                  |                                                                                                                                                                |                                                                                                                                                                                                             |                                                                                                                                                                                                                                                             |                                                                                 |                                                                          |
| <b>Alternate database Name:</b><br><div style="border: 1px solid black; height: 30px;"></div>                                                                                                                                                                 |                                                                                                                                                                |                                                                                                                                                                                                             | <b>Alternate database ID:</b><br><div style="border: 1px solid black; height: 30px;"></div>                                                                                                                                                                 |                                                                                 |                                                                          |
| <b>Alternate database Description:</b>                                                                                                                                                                                                                        |                                                                                                                                                                |                                                                                                                                                                                                             |                                                                                                                                                                                                                                                             |                                                                                 |                                                                          |
| Preliminary Ratings                                                                                                                                                                                                                                           |                                                                                                                                                                |                                                                                                                                                                                                             |                                                                                                                                                                                                                                                             |                                                                                 |                                                                          |
| Category Rating:                                                                                                                                                                                                                                              | 3                                                                                                                                                              | 9                                                                                                                                                                                                           | 27                                                                                                                                                                                                                                                          | 81                                                                              | Score:                                                                   |
| <b>A. Landslide - Roadway Width Affected:</b>                                                                                                                                                                                                                 | 0-5 percent                                                                                                                                                    | 6-25 percent                                                                                                                                                                                                | 26-50 percent                                                                                                                                                                                                                                               | 51-100 percent                                                                  | <div style="border: 1px solid black; padding: 2px;">0</div>              |
| <b>B. Landslide - Slide/Erosion Effects:</b>                                                                                                                                                                                                                  | Visible crack or slight deposit of material / minor erosion                                                                                                    | 1 inch offset, or 6-inch deposit of material / major erosion will affect travel in < 5 years                                                                                                                | 2-inch offset or 12-inch deposit / mod. erosion impacting travel annually                                                                                                                                                                                   | 4-inch offset or 24-inch deposit / severe erosion impacting travel consistently | <div style="border: 1px solid black; padding: 2px;">0</div>              |
| <b>C. Landslide - Roadway Length Affected:</b>                                                                                                                                                                                                                | 25 ft                                                                                                                                                          | 100 ft                                                                                                                                                                                                      | 225 ft                                                                                                                                                                                                                                                      | 400 ft                                                                          | <div style="border: 1px solid black; padding: 2px;">0</div>              |
| <b>D. Rockfall - Ditch Effectiveness: (consider launch features)</b>                                                                                                                                                                                          | Good                                                                                                                                                           | Moderate                                                                                                                                                                                                    | Limited                                                                                                                                                                                                                                                     | No Catchment                                                                    | <div style="border: 1px solid black; padding: 2px;">9</div>              |

|                                                                                          |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
|------------------------------------------------------------------------------------------|-----------------------------|---------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------|----|
| <b>E. Rockfall - Rockfall History:</b>                                                   |                             | Few Falls                                               | Occasional Falls                                                                     | Many Falls                                                                                  | Constant Falls                                                              | 3                                                                                       |                                                                                     |                                     |    |
| <b>F. Rockfall - Block Size or Volume per Event:</b>                                     |                             | 1ft or 3yd^3                                            | 2ft or 6yd^3                                                                         | 3ft or 9yd^3                                                                                | 4ft or 12yd^3                                                               | 81                                                                                      |                                                                                     |                                     |    |
| <b>G. All - Impact on Use:</b>                                                           |                             | Full use continues with minor delay                     | Partial use remains Use modification required, short (3mi / 30min.) detour available | Use is blocked - long (>30min.) detour available or less than 1 day closure                 | Use is blocked - no detour available or closure longer than 1 week          | 81                                                                                      |                                                                                     |                                     |    |
| <b>H. All - AADT/Usage/Economic or Recreational Importance (highest rating applies):</b> |                             | 50 Rarely Used Insignificant economic / rec. importance | 200 Occasionally used Minor economic / rec. importance                               | 450 Frequently used Moderate economic / rec. importance                                     | 800 Constantly used Significant economic / rec. importance                  | <b>Use AADT in calculation:</b> <input type="checkbox"/><br>81                          |                                                                                     |                                     |    |
| <b>Preliminary Rating Landslide Total (A+B+C+G+H):</b>                                   |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
| <b>Preliminary Rating Rockfall Total (D+E+F+G+H):</b>                                    |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 255                                                                                     |                                                                                     |                                     |    |
| <b>Preliminary Rating</b> Good (15-21 pts)   Fair (22-161 pts)   Poor (>161 pts)         |                             |                                                         |                                                                                      |                                                                                             |                                                                             | 255                                                                                     |                                                                                     |                                     |    |
| <b>Slope Hazard Ratings</b>                                                              |                             |                                                         |                                                                                      |                                                                                             |                                                                             |                                                                                         |                                                                                     |                                     |    |
| <b>Category Rating:</b>                                                                  |                             |                                                         | <b>3</b>                                                                             | <b>9</b>                                                                                    | <b>27</b>                                                                   | <b>81</b>                                                                               | <b>Score:</b>                                                                       |                                     |    |
| <b>I. All - Slope Drainage:</b>                                                          |                             |                                                         | Slope appears dry or well drained; surface runoff well controlled                    | Intermittent water on slope; mod. not well drained; or surface runoff moderately controlled | Water usually on slope; poorly drained; or surface runoff poorly controlled | Water always on slope; very poorly drained; or surface water runoff control not present | 3                                                                                   |                                     |    |
| <b>J. All - Annual Rainfall:</b>                                                         |                             |                                                         | 0-10"                                                                                | 10-30"                                                                                      | 30-60"                                                                      | 60"+                                                                                    | 9                                                                                   |                                     |    |
| <b>K. All - Slope Height (Rockfall) / Axial Length of slide (Landslide):</b>             |                             |                                                         | 25ft                                                                                 | 50ft                                                                                        | 75ft                                                                        | 100ft                                                                                   | 100                                                                                 |                                     |    |
| <b>Select One Unstable Slope Type</b>                                                    | <b>Landslides / Erosion</b> | <b>L. Thaw Stability:</b>                               |                                                                                      | Unfrozen / Thaw Stable                                                                      | Slightly Thaw Unstable                                                      | Moderately Thaw Unstable                                                                | Highly Thaw Unstable                                                                | 0                                   |    |
|                                                                                          |                             | <b>M. Instability - Related Maint. Frequency:</b>       |                                                                                      | Every 10 years                                                                              | Every 5 years                                                               | Every 2 years                                                                           | Every year                                                                          | 0                                   |    |
|                                                                                          |                             | <b>N. Movement History:</b>                             |                                                                                      | Minor movement or sporadic creep                                                            | Up to 1 inch annually or steady annual creep                                | Up to 3 inches per event, one event per year                                            | >3" per event, >6" annually, more than 1 event per year (includes all debris flows) | 0                                   |    |
|                                                                                          | <b>Rockfalls</b>            | <b>O. Rockfall-Related Maint. Frequency:</b>            |                                                                                      | Normal, scheduled maintenance                                                               | Patrols after every storm event                                             | Routine seasonal patrols                                                                | Year round patrols                                                                  | 3                                   |    |
|                                                                                          |                             | <b>Geological Character Case 1</b>                      | <b>P. Structural Condition:</b>                                                      |                                                                                             | favorable                                                                   | random                                                                                  | Discontinuous adverse                                                               | Continuous adverse                  | 27 |
|                                                                                          |                             |                                                         | <b>Q. Rock Friction:</b>                                                             |                                                                                             | Rough / Irregular                                                           | Undulating                                                                              | Planar                                                                              | Clay infilled / Slickensided        | 9  |
|                                                                                          |                             | <b>Geological Character Case 2</b>                      | <b>R. Structural Condition:</b>                                                      |                                                                                             | Few differential erosion features                                           | Occasional differential erosion features                                                | Many differential erosion features                                                  | Major differential erosion features | 0  |

|                                                                                                                       |                                        |                                          |                                                         |                                                     |                                  |                  |                    |                                  |
|-----------------------------------------------------------------------------------------------------------------------|----------------------------------------|------------------------------------------|---------------------------------------------------------|-----------------------------------------------------|----------------------------------|------------------|--------------------|----------------------------------|
|                                                                                                                       |                                        |                                          | <b>S. Diff. in Erosion Rates:</b>                       | Small difference                                    | Moderate difference              | Large difference | Extreme difference | <input type="text" value="0"/>   |
| <b>T. LANDSLIDE HAZARD TOTAL (A+B+C+I+J+K+L+M+N):</b>                                                                 |                                        |                                          |                                                         |                                                     |                                  |                  |                    | <input type="text" value="0"/>   |
| <b>U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greater of P+Q or R+S)):</b>                                              |                                        |                                          |                                                         |                                                     |                                  |                  |                    | <input type="text" value="262"/> |
| <b>Risk Ratings</b>                                                                                                   |                                        |                                          |                                                         |                                                     |                                  |                  |                    |                                  |
| <b>V. Route Width or Trail Width:</b>                                                                                 | 36ft<br>14ft                           | 28ft<br>10ft                             | 20ft<br>6ft                                             | 12ft<br>2ft                                         | <input type="text" value="0"/>   |                  |                    |                                  |
| <b>W. Human Exposure Factor:</b>                                                                                      | 12.5% of the time                      | 25% of the time                          | 37.5% of the time                                       | 50% of the time                                     | <input type="text" value="100"/> |                  |                    |                                  |
| <b>X. % of Decision Sight Distance (Judge avoidance ability on trails):</b>                                           | Adequate, 100% of the low design value | Moderate, 80% of the low design value    | Limited, 60% of the low design value                    | Very limited, 40% of the low design value           | <input type="text" value="100"/> |                  |                    |                                  |
| <b>Y. Right of Way (R/W) Impacts (If Left Unattended):</b>                                                            | No R/W implications                    | Minor effects beyond R/W                 | Private property, no structures affected                | Structures, roads, RR, utilities, or Parks affected | <input type="text" value="81"/>  |                  |                    |                                  |
| <b>Z. Environmental/Cultural Impacts if Left Unattended:</b>                                                          | None/No Potential to Cause Effects     | Likely to Effect/No Hist. Prop. Affected | Likely to adversely Affect/Finding of No Adverse Effect | Current adverse effects/Adverse Effect              | <input type="text" value="3"/>   |                  |                    |                                  |
| <b>AA. Maintenance Complexity:</b>                                                                                    | Routine Effort / In-House              | In-House maint. / special project        | Specialized equip. / contract                           | Complex / dangerous effort / location / contract    | <input type="text" value="81"/>  |                  |                    |                                  |
| <b>BB. Event Cost:</b>                                                                                                | \$0-2k                                 | \$2-25k                                  | \$25-100k                                               | >\$100k                                             | <input type="text" value="81"/>  |                  |                    |                                  |
| <b>CC. Risk Totals (G+H+V+W+X+Y+Z+AA+BB):</b>                                                                         |                                        |                                          |                                                         |                                                     |                                  |                  |                    | <input type="text" value="608"/> |
| <b>TOTAL USMP SCORE: LANDSLIDES (T+CC) OR ROCKFALL (U+CC):</b> Good (<200 pts)   Fair (200-400 pts)   Poor (>400 pts) |                                        |                                          |                                                         |                                                     |                                  |                  |                    | <input type="text" value="870"/> |



