

Unstable Slope Management Program for FLMAs

Western Federal Lands



Presented by: Douglas A. Anderson, LG, LEG
FHWA - WFL - Engineering Geologist



U.S. Department of Transportation
Federal Highway Administration





Project Conducted by:

Western Federal Lands



FHWA - Western Federal Lands
Douglas A. Anderson, L.E.G.
Engineering Geologist
360-619-7958
douglas.a.anderson@dot.gov

Phase 1



ADOT&PF
David Stanley and Barry Benko
Chief Engineering Geologists



LANDSLIDE
TECHNOLOGY
A DIVISION OF CORNFORTH CONSULTANTS

Phase 2



WTI - Montana State University
Eli Cuelho, P.E. & Laura Fay, P.E.
Principal Investigators

DASC
D.A. Stanley Consulting

FLMA Stakeholders



U.S. Department of Transportation
Federal Highway Administration



Paul D. Thompson

Types of Unstable Slopes

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Goals of USMP

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Risk Reduction, ↓ Maintenance, and ↑ Resiliency

- Proactively prioritize and manage unstable slopes on roads and trails for project selection
- Includes soil, rock, and thaw-unstable slopes
- Developed for low AADTs and has a rural context for hazard and risk ratings
- Includes risks to natural and cultural resources
- Utilizes existing, proven unstable slope systems (RHRS, WSDOT USMS, ADOT&PF USMP)





Goals of USMP continued...

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Risk Reduction, ↓ Maintenance, and ↑ Resiliency

- Generate one standard set of criteria
- Provides efficient field survey process (App)
- Provide methods to monitor and track deterioration to prioritize preventative maintenance
- Develop program elements that are scalable and flexible to meet departments/agencies differing missions and data availability



USMP Program Step-by-Step “6 Steps to Success”

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1. Evaluate transportation system use and needs; target USMP implementation
2. Rate identified transportation corridors based on maintenance input
3. Prioritize Rated Slopes
4. Develop conceptual designs and estimates by geotechnical specialist for highly rated slopes only
5. Evaluate benefit-costs and reprioritize rated slopes for proactive project selection
6. Track slopes in USMP; watching for trends of deterioration that require proactive risk reduction intervention





USMP Website

Western Federal Lands

Unstable Slope Management Program



US Army Corps
of Engineers.



About

Map

Slope Rating Form

New Slope Event Form

Maintenance Form

QRA

Account

Logout

USMP Website: <http://usmp.info/client.php>

Username: level1@email.com

Password: level1





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USMP for FLMA Website Map Functionality

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- Shows an overview of rated sites
 - Landslides 
 - Rockfalls 
 - Color separates good, fair, and poor scores



Low score

High score

- Users can zoom and pan around to different management areas

A screenshot of the USMP for FLMA Website Map Functionality interface. The browser address bar shows the URL https://usmp.info/client/map.php. The page title is "Stable Slope Management Program". The navigation menu includes "Map", "Slope Rating Form", "New Slope Event Form", "Maintenance Form", "QRA", "Account", and "Logout". Below the menu is a search bar with a dropdown menu for "Select Search and Reporting Option", a "Reset" button, and a link "Right click on the Map to Add a new form". The main content is a map showing a road with several colored markers representing rated sites. A legend titled "Rating" is visible on the right side of the map, listing categories: Rockfall-Good (green), Rockfall-Fair (yellow), Rockfall-Poor (red), Landslide-Good (green), Landslide-Fair (yellow), Landslide-Poor (red), Preliminary rating fair to poor (yellow circle), and Preliminary rating Good (green circle). The map also shows various geographical features like "Icicle Ridge", "Leavenworth Ski Hill", "Leavenworth", "Cashmere Mountain", "Stuart And Colchuck Lake Trailheads", and "Dragon Tail Peak".



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Map Functionality

Clicking on a site brings up a pop-up

- Allows for a quick overview of the site
- Includes a carousel with five photos from the most recent edit
- Has links to:
 - A history of site form edits
 - All site photos
 - All files uploaded

Unstable Slope Management Program

Map Slope Rating Form New Slope Event Form Maintenance Form QRA Account Logout

Select Search and Reporting Option [Reset](#) [Right click on the Map to Add a new form](#)

Map Satellite

Site ID: 2102 [Delete Site](#)

Umbrella Agency: FS
Regional Admin: Pacific Northwest Region
Local Admin: Okanogan-Wenatchee National Forest
Coordinates: 47.543, -120.73535
Slope Status: Active
Date: 2017-07-11 07:31:33 Photos Added: 4 Documents Added: 0
Road/Trail Number: 7600
Starting Mile Marker: 5.5 Ending Mile Marker: 5.57
Side: R - FOR USE WITH ROADS WITH MILE MARKERS
Hazard Type: Planar,Wedge
Preliminary Rating: 226
Total Score: 595
Comments: us26; large climbing spot along east edge of outcrop,not on face.
[Add new maintenance form](#)
[Update Rating form, add photos, or add files](#)
[Edit 2017-07-11 07:31:33 Photos Added: 4 Documents Added: 0](#)
[Edit 2017-06-28 21:14:53 Photos Added: 0 Documents Added: 0](#)
Photos:

[View All Site Photos](#)

Rating

- Rockfall-Good
- Rockfall-Fair
- Rockfall-Poor
- Landslide-Good
- Landslide-Fair
- Landslide-Poor
- Preliminary rating fair to poor
- Preliminary rating Good

Map data ©2018 Google 2 km Terms of Use Report a map error





Unstable Slope Rating Form

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Site Information

- Drop-downs agency or other selection
- Several measurements noted here auto-calculate in categories below
- Photos and documents can be uploaded
- Relationship fields provided for existing databases to connect with the USMP for FLMA data

Unstable Slope Management Program

[Map](#) [Slope Rating Form](#) [New Slope Event Form](#) [Maintenance Form](#) [QRA](#) [Account](#) [Logout](#)

Slope Rating Form - Site Information			
Management Area: Select Agency: <input type="text"/> Select State/Region/Territor: <input type="text"/> Select Local/County/Territor: <input type="text"/>	Date: <input type="text" value="2018-01-04 10:52:41"/>	<input type="radio"/> Rockfall <input type="radio"/> Landslide	Hazard Type: Press (ctrl+click) to select more than one <input type="text" value="Planar"/> <input type="text" value="Wedge"/> <input type="text" value="Toppling"/> <input type="text" value="Raveling/Undermining"/>
Road/Trail No: <input type="text"/>	Road/Trail: <input type="text"/>	Road/Trail Class: <input type="text"/>	Rater: <input type="text"/>
Beginning Mile Marker: <input type="text"/>	Ending Mile Marker: <input type="text"/>	Side: <input type="text"/>	Weather: <input type="text" value="Unknown"/>
Begin Coord. Lat/Long: Lat (##.#####): <input type="text"/> Long (-###.#####): <input type="text"/>	End Coord. Lat/Long: Lat (##.#####): <input type="text"/> Long (-###.#####): <input type="text"/>	Datum: <input type="text" value="WGS 84"/>	AADT: <input type="text"/>
Length of Affected Road/Trail (ft): <input type="text"/>	Slope Height (rock)/Axial Length (slide) (ft): <input type="text"/>	Slope Angle (°): <input type="text"/>	
Sight Distance (ft): <input type="text"/>	Usable Roadway/Trail Width (ft): <input type="text"/>	Speed Limit (mph): <input type="text"/>	
Ditch Width Range (ft): <input type="text"/> - <input type="text"/>	Ditch Depth Range (ft): <input type="text"/> - <input type="text"/>	Ditch Slope Range (H:V): <input type="text"/> - <input type="text"/> - <input type="text"/>	Block Size (ft): <input type="text"/> Volume (cy): <input type="text"/>
Annual Rainfall Range (in): <input type="text"/> - <input type="text"/>	Sole Access Route: <input type="text"/>	Mitigation Present: <input type="text"/>	Photos/Documents (up to 10MB): <input type="text"/> <input type="button" value="Browse"/>
Comments: <input style="width: 100%;" type="text"/>			
Alternate database Name: <input type="text"/>		Alternate database ID: <input type="text"/>	
Alternate database Description: <input style="width: 100%;" type="text"/>			



Preliminary Ratings

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- Rapid assessment tool to limit time spent at a good conditioned slope
- Either, three landslide or rockfall hazard rating categories with two risk rating categories required for all unstable slope types

Preliminary Ratings					
Category Rating:	3	9	27	81	Score:
A. Landslide - Roadway Width Affected:	0-5 percent	6-25 percent	26-50 percent	51-100 percent	0
B. Landslide - Slide/Erosion Effects:	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
C. Landslide - Roadway Length Affected:	25 ft	100 ft	225 ft	400 ft	0
D. Rockfall - Ditch Effectiveness: (consider launch features)	Good	Moderate	Limited	No Catchment	0
E. Rockfall - Rockfall History:	Few Falls	Occasional Falls	Many Falls	Constant Falls	0
F. Rockfall - Block Size or Volume per Event:	1ft or 3yd ³	2ft or 6yd ³	3ft or 9yd ³	4ft or 12yd ³	0
G. All - Impact on Use:	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	0
H. All - AADT/Usage/Economic or Recreational Importance (highest rating applies):	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	Use AADT in calculation: <input checked="" type="checkbox"/> 0
Preliminary Rating Landslide Total (A+B+C+G+H):					0
Preliminary Rating Rockfall Total (D+E+F+G+H):					0
Preliminary Rating Good (15-21 pts) Fair (22-161 pts) Poor (>161 pts)					0



Detailed Slope Hazard & Risk Rating Categories

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Slope Hazard Ratings							
Category Rating:	3	9	27	81	Score:		
I. All - Slope Drainage:	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	<input type="text"/>		
J. All - Annual Rainfall:	0-10"	10-30"	30-60"	60"+	<input type="text"/>		
K. All - Slope Height (Rockfall) / Axial Length of slide (Landslide):	25ft	50ft	75ft	100ft	<input type="text"/>		
Select One Unstable Slope Type	Landslides / Erosion	L. Thaw Stability:	Unfrozen / Thaw Stable	Slightly Thaw Unstable	Moderately Thaw Unstable	Highly Thaw Unstable	<input type="text"/>
		M. Instability - Related Maint. Frequency:	Every 10 years	Every 5 years	Every 2 years	Every year	<input type="text"/>
		N. Movement History:	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)	<input type="text"/>
Rockfalls	O. Rockfall-Related Maint. Frequency:	Normal, scheduled maintenance	Patrols after every storm event	Routine seasonal patrols	Year round patrols	<input type="text"/>	
	Geological Character Case 1	P. Structural Condition:	favorable	random	Discontinuous adverse	Continuous adverse	<input type="text"/>
		Q. Rock Friction:	Rough / Irregular	Undulating	Planar	Clay infilled / Slickensided	<input type="text"/>
	Geological Character Case 2	R. Structural Condition:	Few differential erosion features	Occasional differential erosion features	Many differential erosion features	Major differential erosion features	<input type="text"/>
		S. Diff. in Erosion Rates:	Small difference	Moderate difference	Large difference	Extreme difference	<input type="text"/>
T. LANDSLIDE HAZARD TOTAL (A+B+C+J+K+L+M+N):					<input type="text"/>		
U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greater of P+Q or R+S)):					<input type="text"/>		

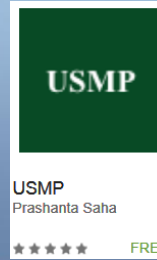
Risk Ratings					
V. Route Width or Trail Width:	36ft 14ft	28ft 10ft	20ft 6ft	12ft 2ft	<input type="text"/>
W. Human Exposure Factor:	12.5% of the time	25% of the time	37.5% of the time	50% of the time	<input type="text"/>
X. % of Decision Sight Distance (Judge avoidance ability on trails):	Adequate, 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"/>
Y. Right of Way (R/W) Impacts (If Left Unattended):	No R/W implications	Minor effects beyond R/W	Private property, no structures affected	Structures, roads, RR, utilities, or Parks affected	<input type="text"/>
Z. Environmental/Cultural Impacts if Left Unattended:	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"/>
AA. Maintenance Complexity:	Routine Effort / In-House	In-House maint. / special project	Specialized equip. / contract	Complex / dangerous effort / location / contract	<input type="text"/>
BB. Event Cost:	\$0-2k	\$2-25k	\$25-100k	>\$100k	<input type="text"/>
CC. Risk Totals (G+H+V+W+X+Y+Z+AA+BB):					<input type="text"/>
TOTAL USMP SCORE: LANDSLIDES (T+CC) OR ROCKFALL (U+CC): Good (<200 pts) Fair (200-400 pts) Poor (>400 pts)					<input type="text"/>

Total USMP Score translates to good, fair, and poor condition for map symbols





USMP “Field” Apps



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- Apps include the rating, new slope event, and maintenance forms (same input categories as online version)
- Android and iOS apps are available at the Google Play Store and on iTunes
- Collect data and photos in offline mode and upload one at a time to the website when back online (very efficient work flow)





Other USMP Products

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- New Slope Event, Maintenance, and QRA Forms
- 40-minute and 9-minute videos that show “How to Rate an Unstable Slope” and “How to Use the USMP Website”
- Training presentations for two-day training course

Unstable Slope Management Program



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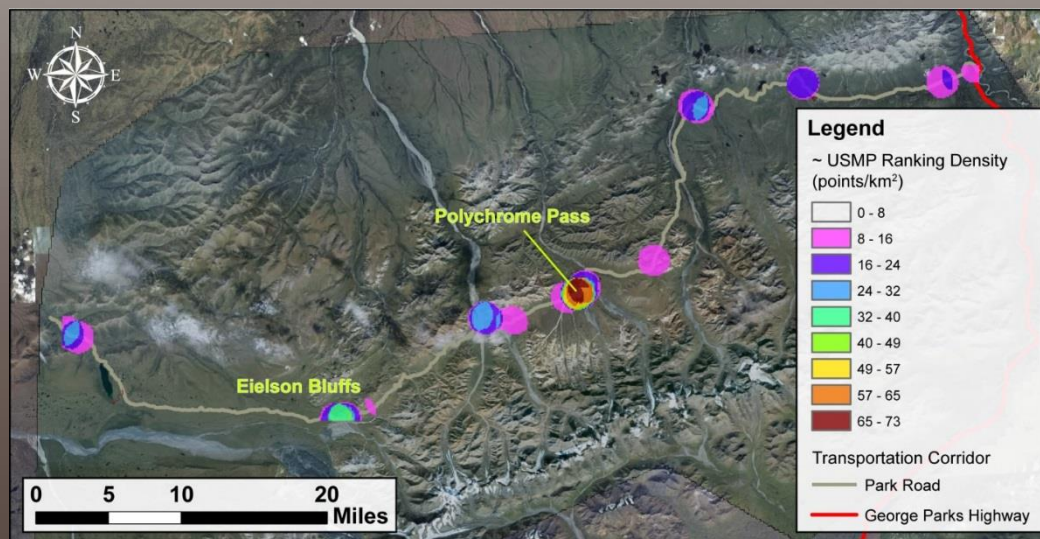
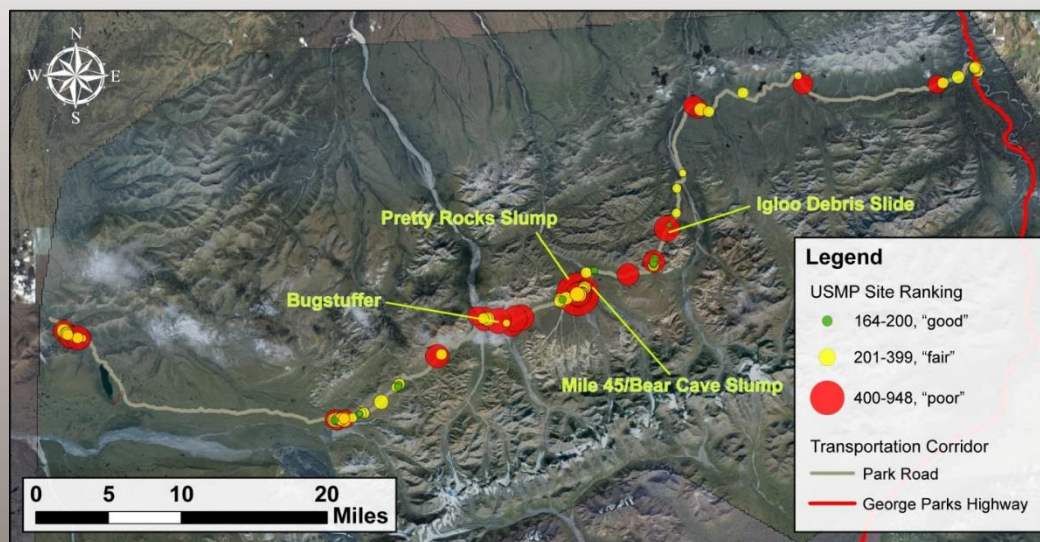




Denali NP Example

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- Step #1 - 92 Mile Denali Park Road
- Significant Park & Regional Asset
- Sole Road Access to Kantishna
- Step #2 - 141 USMP sites rated in 2015-16 (SE);
Zion NP ~\$30/site





Searching and Reporting

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Searching and Reporting

- Search for sites through three-tiered search criteria to funnel search
- Export visible sites as a CSV
- Data can be imported into other databases or GIS programs for analysis

ID	SITE_ID	MGMT_AFRoad	TR/Road	TR/BEGIN_MI	END_MILE	ROAD_OR_S	
22	22	Gifford Pli	FS 25	Level 4	20.63	20.64	R L
26	26	Gifford Pli	FS 25	Level 4	20.87	20.94	R L
33	33	Gifford Pli	FS 25	Level 4	21.3557	21.3991	R L
43	43	Gifford Pli	FS 25	Level 4	22.53	22.76	R L
43	43	Gifford Pli	FS 25	Level 4	22.53	22.76	R L
57	57	Gifford Pli	FS 25	Level 4	24.45	24.48	R L

Unstable Slope Management Program

Map Slope Rating Form New Slope Event Maintenance Form QRA Account Logout

Slope Rating Information Search

Speed Limit (mph) Greater Than 35

AND

Total USMP Score Greater Than 1

AND

Select Site Information

Search on Map

Unstable Slope Management Program

Map Slope Rating Form New Slope Event Maintenance Form QRA Account Logout

Slope Rating Information Search

Speed Limit (mph) Greater Than 35

AND

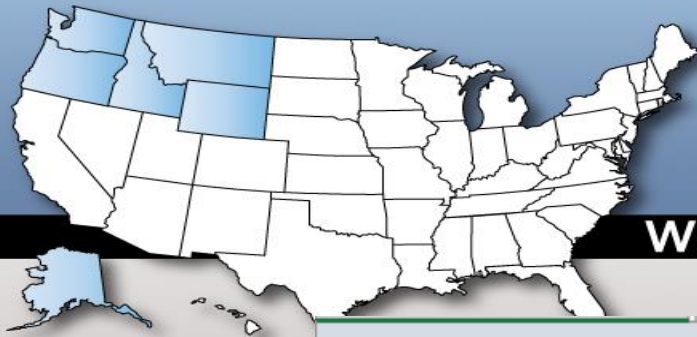
Total USMP Score Greater Than 100

AND

Select Site Information

Search on Map





Step #3 - Denali NP USMP Scores >400

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SITE ID		SITE INFORMATION					HAZARD TOTAL	RISK TOTAL	TOTAL SCORE
DENA SITE NAME	USMP SITE ID [Assigned]	ROAD/TRAIL NO.	BEGIN. MILE MARKER	END. MILE MARKER	SIDE	HAZARD TYPE			
Mile 45.4a - Pretty Rocks Slide	957	10	45.34	45.41	L	Landslide, across road, translational/rotational?	530	418	948
Mile 52.9 - Toklas Bluffs Corner	964	10	52.87	52.96	R	Rockfall, wedge	455	140	595
Mile 50.4 Debris Flow	887	10	50.36	50.40	R	Landslide, debris flow, across road	379	205	583
Mile 51.9 - Bugstuffer	960	10	51.92	51.95	R	Landslide, debris flow, across road	405	170	575
Mile 50.8 - Whoop-te-do	959	10	50.75	50.81	L	Landslide, rotational, mostly below but beginning to come in	316	254	569
Mile 35.2 Debris Flow (bus)	927	10	35.25	35.27	L	Landslide, debris flow, across road	367	195	562
Mile 49.9 Debris Flow	936	10	49.88	49.90	R	Landslide, debris flow, across road	375	186	561
Mile 67.4a - Eagle's Nest Drainage	981	10	67.37	67.41	R	Landslide, debris flow, across road	415	141	556
Mile 57.9 Debris Flow 1990's	889	10	57.88	57.89	R	Landslide, debris flow, across road	330	220	550
Mile 40.1 Debris Flow (more active)	854	10	40.15	40.18	R	Landslide, debris flow, across road	391	139	530
Mile 37.7b - Igloo Debris Slide	980	10	37.72	37.75	R	Landslide, above road, translational	315	199	514
Mile 45.3b - Polychrome Debris Slide	956	10	45.31	45.32	R	Landslide, rotational, above/onto road	281	229	510
Mile 68.2a Bad Rockfall	910	10	68.18	68.23	R	Rockfall, differential erosion from pyroclastic breccia	280	221	500
Mile 44.6b Rockfall	864	10	44.59	44.64	R	Rockfall, wedge	242	241	483
Mile 68.0c Landslide with Hdrains	971	10	68.06	68.08	L	Landslide, below road, rotational	228	238	465
Mile 24.9 - Sanctuary Hill Roadway	799	10	24.90	24.96	R	Landslide, frost-heave, across/in road	322	137	459
Mile 45.2a Rockfall	870	10	45.17	45.21	R	Rockfall, wedge	221	233	454
Mile 45.3a rockfall	933	10	45.27	45.32	R	Rockfall, wedge	214	239	453
Mile 25.2 - Sanctuary Hill	801	10	25.20	25.37	R	Landslide, frost-heave, across/in road	328	116	444
Mile 68.2b Debris Flow 2012	972	10	68.23	68.24	R	Landslide, debris flow, onto road	305	136	440
Mile 67.3 - Eagle's Nest Rockfall	968	10	67.31	67.37	R	Rockfall, indeterminate	254	186	440
Mile 68.2c Rockfall	911	10	68.24	68.26	R	Rockfall, differential erosion from pyroclastic breccia	238	194	432
Mile 53.4 - Toklat Tent	966	912	0.16	0.22	L	Landslide, debris flow potentially across road	280	145	425
Mile 68.1b Rockfall	909	10	68.12	68.18	R	Rockfall, differential erosion from pyroclastic breccia	238	174	412
Mile 67.4b Rockfall	969	10	67.40	67.48	R	Rockfall, indeterminate (some distinct wedge and topple)	245	163	408
Mile 44.8 - Bear Cave Slump	955	10	44.81	44.83	L	Landslide, below road, rotational	198	199	398





Denali NP USMP Process

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Step #4

FLH reviewed USMP ratings and developed conceptual designs and estimates by geotechnical specialists for 26 highly rated slopes > 400 points

Step #5

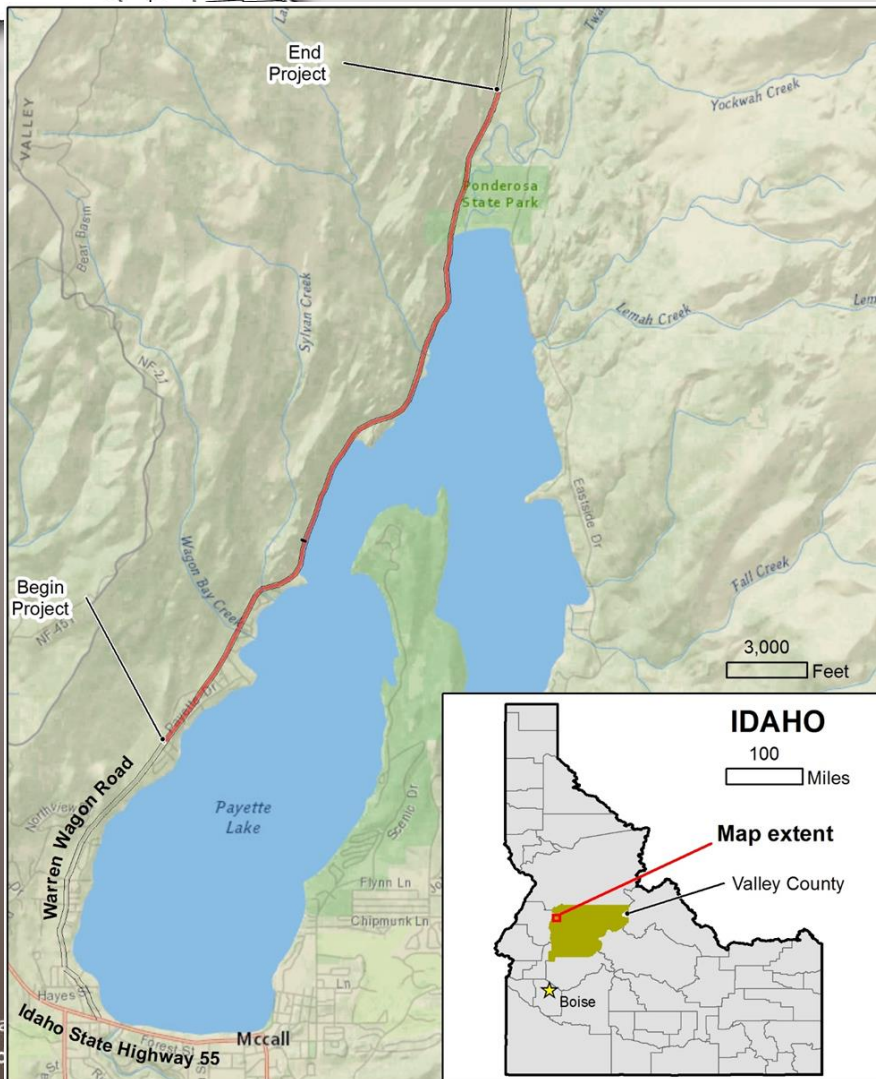
NPS will evaluate benefit-costs and reprioritize rated slopes for proactive project selection and programming (greatest benefit with least cost)

Scheduled for completion in winter 2018-19.



Warren Wagon Road Example Valley County, Idaho

Western Federal Lands



- McCall, Idaho to Payette NF Access (Year-round recreation)
- ~5.5 miles long corridor
- Widening 2-lane roadway to accommodate pedestrian/bike lanes and rebuild pavement to frost free structural section
- USMP (Step #2) 30 rockfall and 6 landslides
- USMP (Step #3) Prioritized Slopes; 8 rockfall and 1 landslide >500 points





Warren Wagon Road Example (USMP Ratings Only Used)

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- Step #4: Conceptual Risk Reduction Designs and Cost Estimates developed for 9 highest rated slopes
- US23 Pictured to right– Highest rated (USMP Rating = 889)
- Goal: Reduce risk of rockfall impacting users and protect the new pavement section; install deep patches for landslides

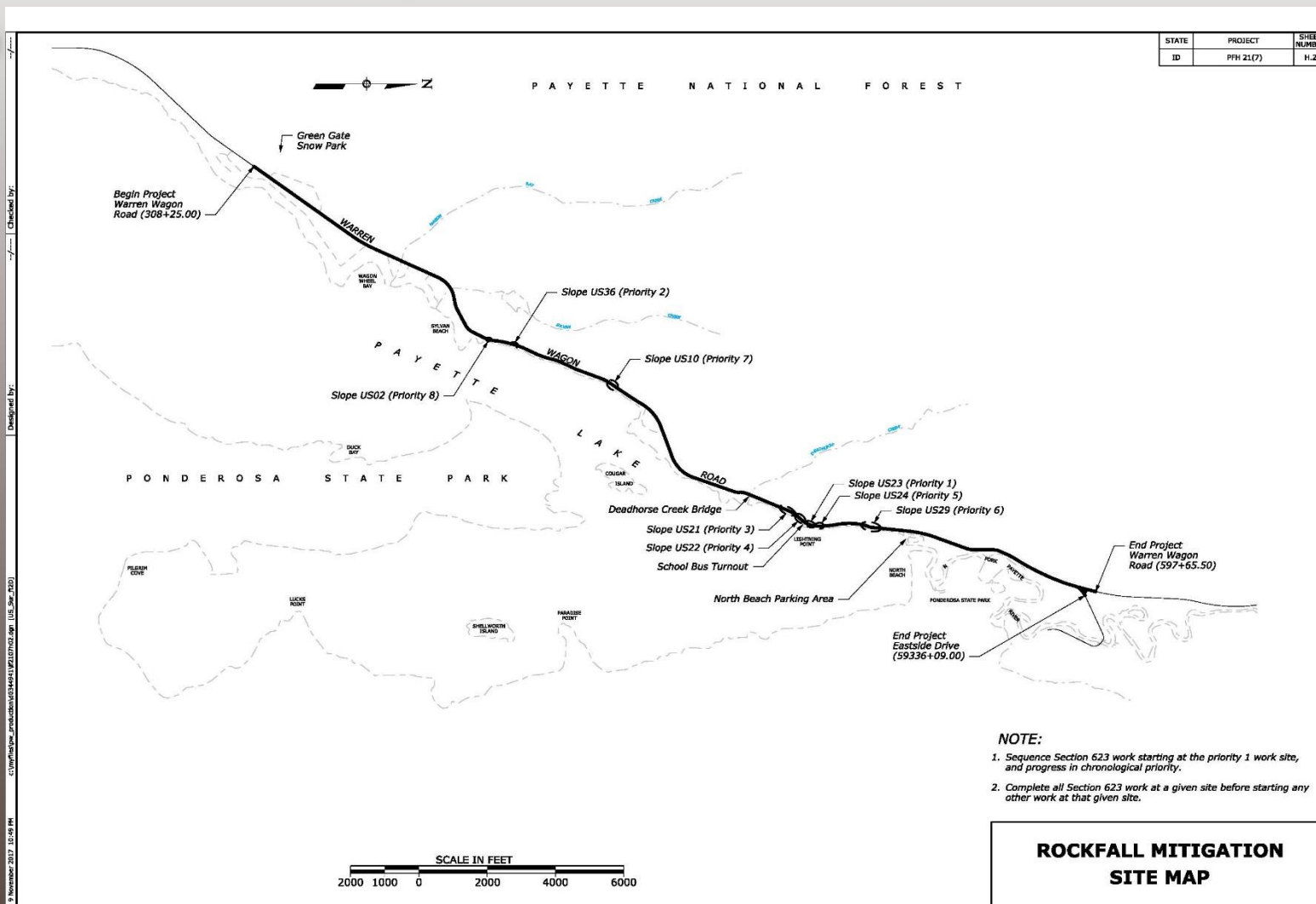




Warren Wagon Road Example

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- **Contract:** Scale top 8 USMP rated rockfall slopes; rock reinforcement in top 3 rated slopes and construction of pinned wire mesh system
- Project Awarded April 2018
- Unstable Slope Construction began in August 2018



Why is this beneficial?

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- Switch from “expensive” reactive practices to more cost effective proactive management with unstable slopes
- Only implement in units/corridors where beneficial
- Minimize rating costs with temporary workforce
- Provides standardized rating scores and processes across department/management units for project selection and programming



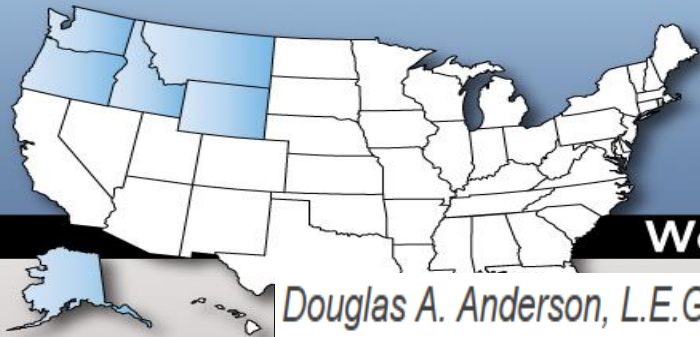
Next Steps



Western Federal Lands

- Manual completed & undergoing publication process (September/October 2018)
- Western Transportation Institute funded to maintain the USMP until March 2020
- **For FLH Partners:** Develop an annual maintenance agreement with FLMAs to house the USMP behind a federal firewall
- **For FHWA Partners:** Make the USMP for FLMA available on the FHWA website for downloading; accompanied by a system architecture document





Contacts, Links, Questions

Western Federal Lands

Douglas A. Anderson, L.E.G. • WFLHD – Engineering Geologist • Office: [360-619-7958](tel:360-619-7958) • Email: douglas.a.anderson@dot.gov

Eric Bilderback, PhD • National Park Service – Geomorphologist • Office: [303-969-2154](tel:303-969-2154) • Email: eric_bilderback@nps.gov



Website and App:

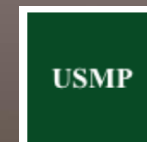
<https://usmp.info/client/map.php>

Username:

level1@email.com

Password:

level1



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***** FREE



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