USMP Rating Form - Slope Hazard Rating

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Relative Hazard Evaluation

SITE INFORMATION

ITALICIZED DATA CATEGORIES REQUIRED FOR FULL RATING

Management Area				**Date**
Hazard Type	**Rockfall** Planar | Wedge | Topple Ravelling | Rock Avalanche Indeterminate Rock Failures | Differential. Erosion		**Landslide** Above, Below, or Across Route Translational | Rotational | Debris Flow Shallow slump | Erosional Failure	
Road/Trail No.	○ Trail ○ Road	**Road/Trail Class**		**Rater**
Beginning Mile Marker		**Ending Marker**	**Side**	**Weather**
Begin Coord. Lat. Long.	**End Coord.** Lat. Long.	**Datum**		**AADT**
Length of Affected Road/Trail (ft)		***Slope Height (rock) /Axial Length (slide) (ft)***		**Slope Angle (°)**
Sight Distance (ft)		***Roadway/Trail Width (ft)***		***Speed Limit (mph)***
Ditch Width (ft) RANGE	**Ditch Depth (ft)** RANGE	**Ditch Slope (H:V)** RANGE		***Blk Size (ft)/Volume (cy)***
Annual Rainfall (in) RANGE	**Sole Access Route** □ Yes □ No	**Fixes Present** □ Yes □ No		**Photo # Range**
Comments				

PRELIMINARY RATING

Category Rating	3	9	27	81	Score
A. Landslide – Roadway Width Affected	0-5 Percent	6-25 Percent	26-50 Percent	51-100 Percent	
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 yrs	2-inch offset or 12-inch deposit/ mod. erosion impacting travel annually	4-inch offset or 24-inch deposit/ severe erosion impacting travel consistently	
C. Landslide – Roadway Length Affected	25 ft	100 ft	225 ft	400 ft	CALC
D. Rockfall – Ditch Effectiveness (consider launch features)	Good	Moderate	Limited	No Catchment	
E. Rockfall – Rockfall History	Few Falls	Occasional Falls	Many Falls	Constant Falls	
F. Rockfall – Block Size or Volume per Event	1 ft or 3 yd³	2 ft or 6 yd³	3 ft or 9 yd³	4 ft or 12 yd³	CALC
G. All - Impact on Use	Full use continues with minor delay	Partial use remains Use modification required, short (3 mi/30 min.) detour available	Use is blocked – long (>30 min) detour available or less than 1 day closure	Use is blocked – no detour available or closure longer than 1 week	
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	CALC FOR AADT ONLY
				LANDSLIDES TOTAL (A+B+C+G+H)	CALC
				ROCKFALL TOTAL (D+E+F+G+H)	CALC

Preliminary Rating Good (15-21 pts) | Fair (22-161 pts)| Poor (>161 pts)
Sites rated as **Fair** or **Poor** receive detailed evaluation (complete back page)

FLMA - Unstable Slope Management Program Field Rating Form
Prepared by: Landslide Technology, WFLHD, USDA FS, BLM, BIA and NPS

Rev 1.04 (July 24, 2015)

SLOPE HAZARD RATING

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. 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	
J. All - Annual Rainfall				0-10"	10-30"	30-60"	60"+	
K. All - Slope Height / Axial length of slide				25 ft	50 ft	75 ft	100 ft	CALC
Select One Unstable Slope Type: Landslides/ Erosion (add A, B, C)	**L. Thaw Stability (Cold Climates)**			Unfrozen/Thaw Stable	Slightly Thaw Unstable	Moderately Thaw Unstable	Highly Thaw Unstable	
	M. Instability-Related Maint. Frequency			Every 10 years	Every 5 years	Every 2 years	Every year	
	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)	
Rockfalls (add D, E, F)	**O. Rockfall-Related Maint. Frequency**			Normal, scheduled maintenance	Patrols after every storm events	Routine seasonal patrols	Year-round patrols	
	Geologic Character	Case 1	**P. Structural Condition**	Discontinuous Favorable	Discontinuous Random	Discontinuous Adverse	Continuous Adverse	
			Q. Rock Friction	Rough/ Irregular	Undulating	Planar	Clay infilled/ Slickensided	
		Case 2	**R. Structural Condition**	Few differential erosion features	Occasional differential erosion features	Many differential erosion features	Major differential erosion features	
			S. Diff. in Erosion Rates	Small difference	Moderate difference	Large difference	Extreme difference	
							T. LANDSLIDE HAZARD TOTAL (A+B+C+I+J+K+L+M+N)	CALC
							U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greatest of P+Q or R+S))	CALC

RISK RATING

V. Route Width or Trail Width	36 ft 14 ft	28 ft 10 ft	20 ft 6 ft	12 ft 2 ft	CALC
W. Human Exposure Factor	12.5% of the time	25% of the time	37.5% of the time	50% of the time	CALC if AADT avail
X. % of Decision Sight Distance (Judge avoidance ability on trails)	Adequate, 100% of low design value	Moderate, 80% of low design value	Limited, 60% of low design value	Very Limited, 40% of low design value	CALC for roads
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	
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	
AA. Maintenance Complexity	Routine Effort/In-House	In-house maint./ special project	Specialized equip./ contract	Complex/ dangerous effort /location/contract	
BB. Event Cost	$0-2k	$2-25k	$25-100k	>$100k	
				CC. RISK TOTALS: (G+H+V+W+X+Y+Z+AA+BB)	CALC
				TOTAL USMP SCORE: LANDSLIDES (T+CC) OR ROCKFALL (U+CC)	CALC

FLMA - Unstable Slope Management Program Field Rating Form
Prepared by: Landslide Technology, WFLHD, USDA FS, BLM, BIA and NPS

Rev 1.04 (July 3, 2015)

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Select One Unstable Slope Type	Landslides/ Erosion (add A, B, C)	L. Thaw Stability (Cold Climates)			Unfrozen/Thaw Stable	Slightly Thaw Unstable	Moderately Thaw Unstable	Highly Thaw Unstable	
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	Rockfalls (add D, E, F)	O. Rockfall-Related Maint. Frequency			Normal, scheduled maintenance	Patrols after every storm events	Routine seasonal patrols	Year-round patrols	
		Geologic Character	Case 1	P. Structural Condition	Discontinuous Favorable	Discontinuous Random	Discontinuous Adverse	Continuous Adverse	
				Q. Rock Friction	Rough/ Irregular	Undulating	Planar	Clay infilled/ Slickensided	
			Case 2	R. Structural Condition	Few differential erosion features	Occasional differential erosion features	Many differential erosion features	Major differential erosion features	
				S. Diff. in Erosion Rates	Small difference	Moderate difference	Large difference	Extreme difference	
T. LANDSLIDE HAZARD TOTAL (A+B+C+I+J+K+L+M+N)									CALC
U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greatest of P+Q or R+S))									CALC

Slope Types

- Hazard Criteria for Landslides
  - Thaw Stability (permafrost, ice lens melting)
  - How often is movement requiring maint.?
  - How much & often is movement occurring?
- Hazard Criteria for Rockfall
  - How often is maint. required to visit the slope?
  - How bad is the slope's geology?
- Common Hazard Factors (both slope types)
  - Water (ability to drain), water (precip.), and hazard size

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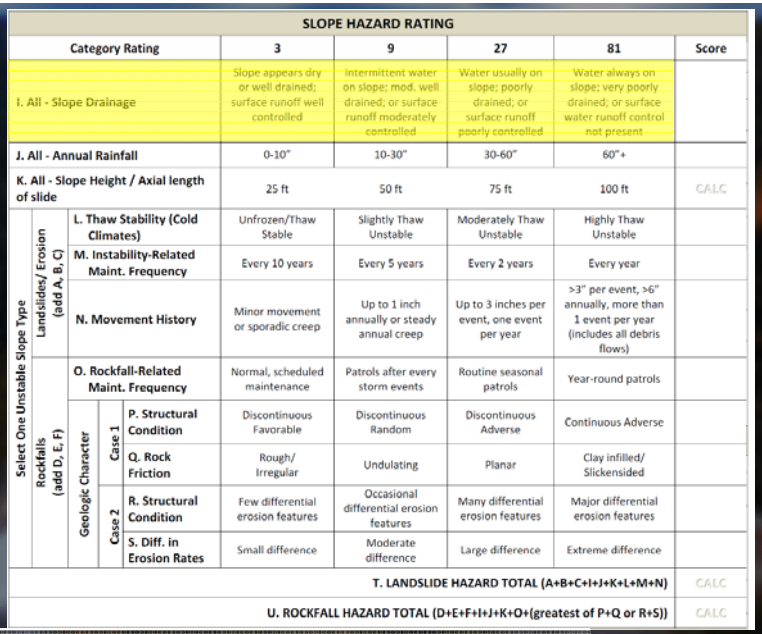
U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greatest of P+Q or R+S))								CALC

I. All - Slope Drainage

- Ability for the materials to be free draining.
  - Results may vary by the time of the year, check for slope staining



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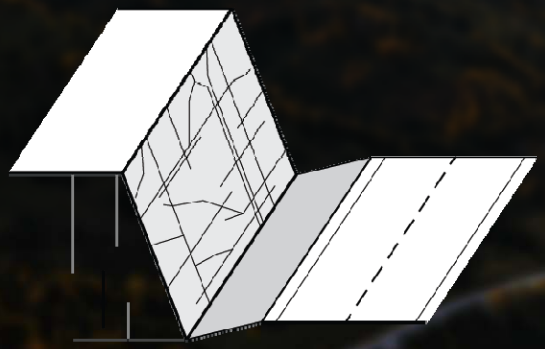
U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greatest of P+Q or R+S))									CALC

3 points Well Drained. Slope appears dry or well drained; surface runoff well controlled; slope is dry hours after rain events.

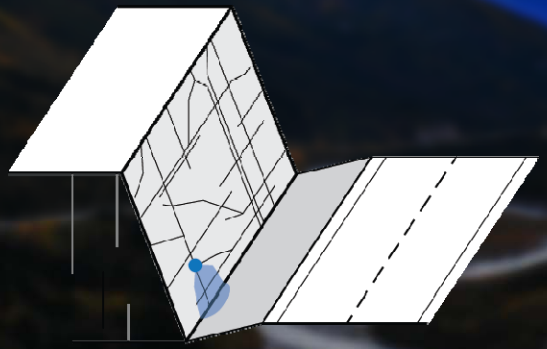
9 points Moderately Well Drained. Water is intermittently on slope; moderately well drained; surface runoff moderately controlled; slope is dry days after rain events.

27 points Moderately Poorly Drained. Water usually on slope; poorly drained; surface runoff poorly controlled; slope is still wet a week or two following rain events, but may dry during prolonged dry spells.

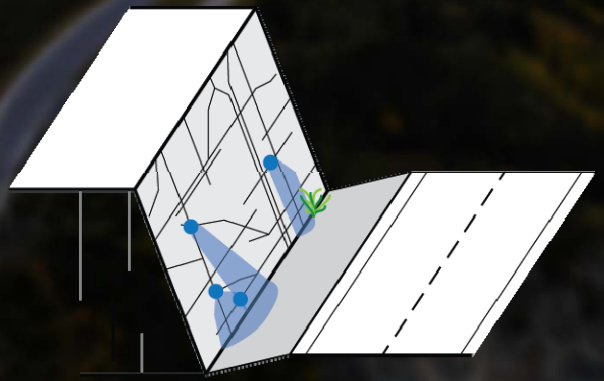
81 points Poorly Drained. Water always on slope; very poorly drained; or surface water runoff control not present.



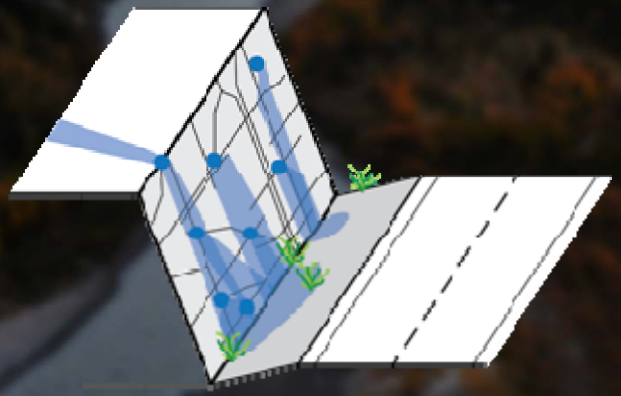
Well Drained



Moderately Well Drained

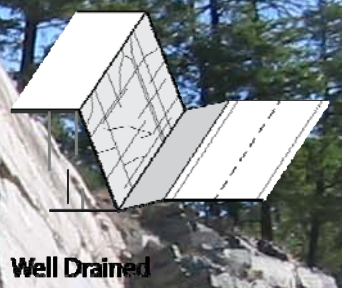


Moderately Poorly Drained



Poorly Drained

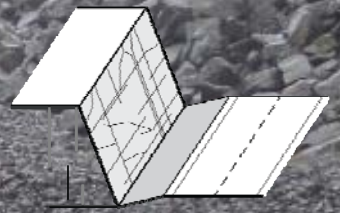
I. AII – Slope Drainage



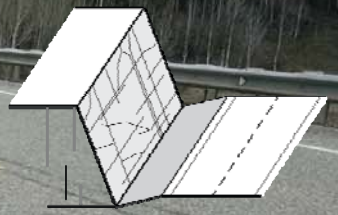
- Slope appears dry or well drained
- No water staining

I. AII – Slope Drainage

- Drains facilitating drainage



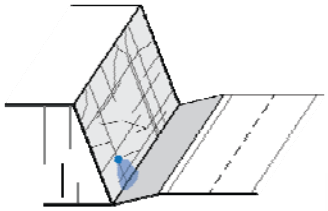
I. All – Slope Drainage



Well Drained

- Surface drainage well controlled

I. AII – Slope Drainage

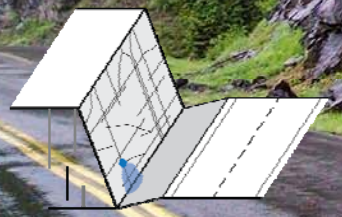


Moderately Well Drained

- Slope is mostly dry or well drained
- Minor water staining, vegetation growth

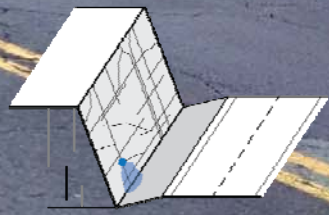
I. AII – Slope Drainage

- Slope is mostly dry or well drained
- Some water staining, vegetation growth



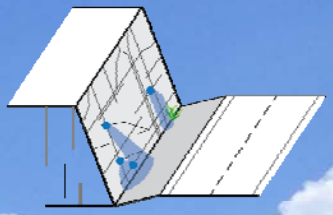
I. All – Slope Drainage

- Culvert drains the creek
- Embankment settles/slides slowly
- Likely no drainage layer under fill



Moderately Well Drained

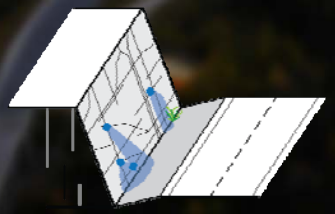
I. All – Slope Drainage



- Slope exhibits signs of poor drainage
- Drainage issues not continuous

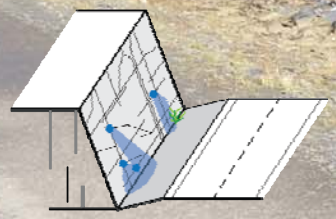
I. All – Slope Drainage

- Surface water poorly controlled, directs sheet flow to slide



I. AII – Slope Drainage

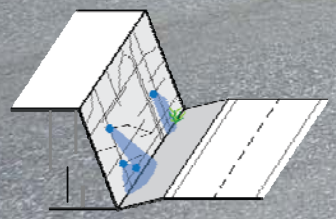
- Water on lower half of rock slope



Moderately Poorly Drained

I. All – Slope Drainage

- Water on rock slope, saturates embankment, corrodes and fails wall

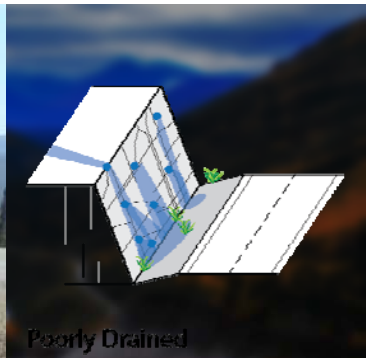


Moderately Poorly Drained

2015/04/06

I. AII – Slope Drainage

- Standing water above embankment



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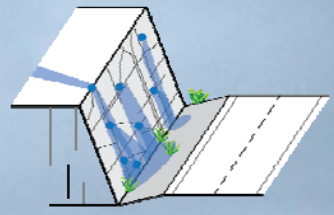
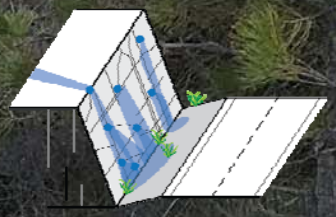


- Surface water control not present/effective

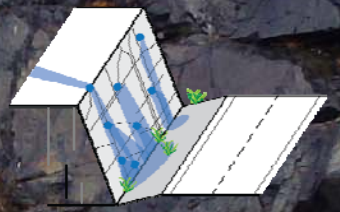
I. AII – Slope Drainage

- Sag ponds high in a large landslide



I. AII – Slope Drainage

- Many drainage features all over slope



I. AII – Slope Drainage

- Difficult to predict

I. All – Slope Drainage

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I. AII – Slope Drainage

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J. All – Annual Rainfall

3 points	0-10 inches of rain annually
9 points	10-30 inches of rain annually
27 points	30-60 inches of rain annually
81 points	60+ inches of rain annually

SLOPE HAZARD RATING						
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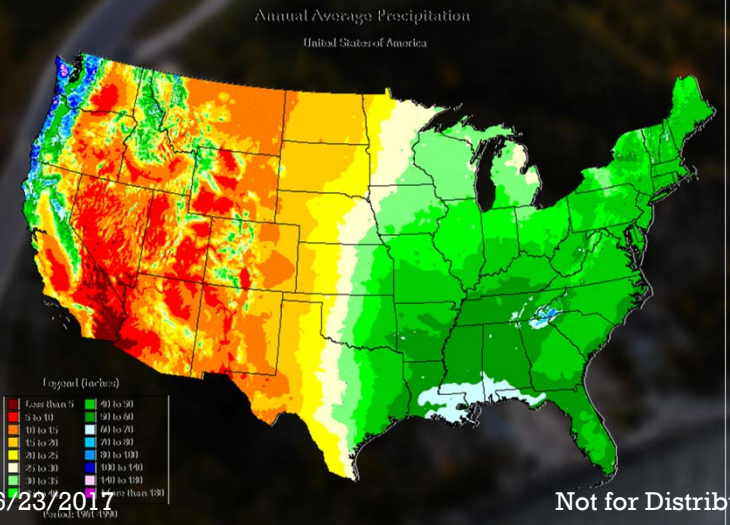

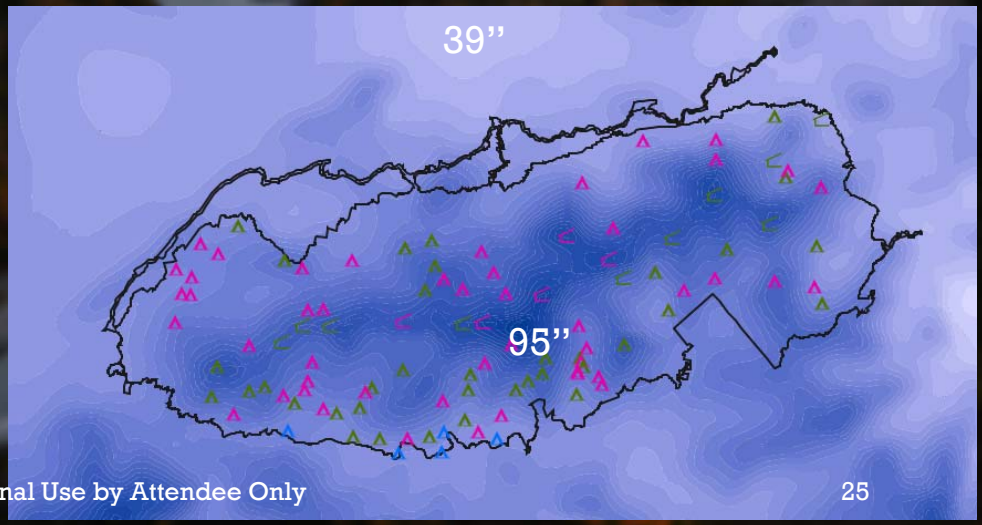

K. All – Slope Height

- Height recorded in Site Information
- <u>Calculated</u>

3 points	25 feet
9 points	50 feet
27 points	75 feet
81 points	100 feet

$$Score = 3^x \ (\max 100);$$

$$x = \frac{slope\ height\ or\ axial\ length}{25}$$

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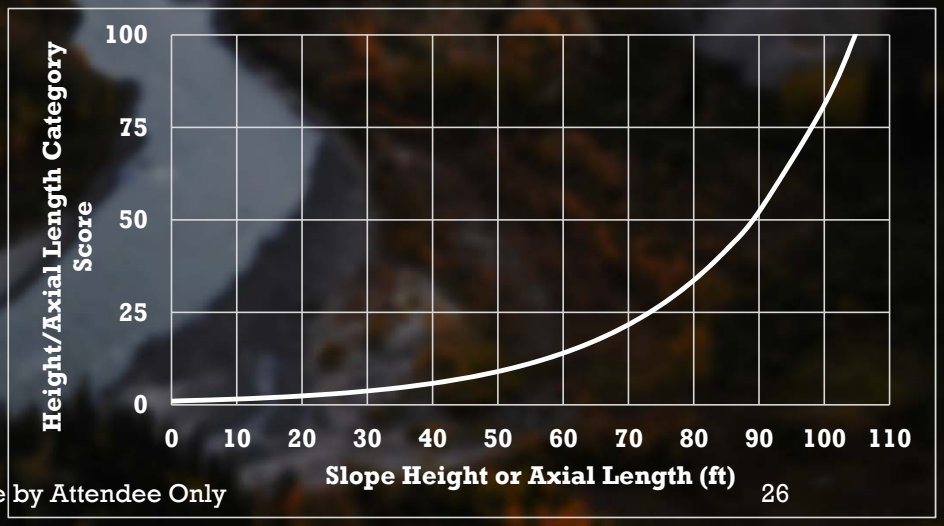
Select One Unstable Slope Type: Landslides/ Erosion (add A, B, C)	L. Thaw Stability (Cold Climates)		Unfrozen/Thaw Stable	Slightly Thaw Unstable	Moderately Thaw Unstable	Highly Thaw Unstable	
	M. Instability-Related Maint. Frequency		Every 10 years	Every 5 years	Every 2 years	Every year	
	N. Movement 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)	
Rockfalls (add D, E, F)	O. Rockfall-Related Maint. Frequency		Normal, scheduled maintenance	Patrols after every storm events	Routine seasonal patrols	Year-round patrols	
Geologic Character	Case 1	P. Structural Condition	Discontinuous Favorable	Discontinuous Random	Discontinuous Adverse	Continuous Adverse	
		Q. Rock Friction	Rough/ Irregular	Undulating	Planar	Clay infilled/ Slickensided	
	Case 2	R. Structural Condition	Few differential erosion features	Occasional differential erosion features	Many differential erosion features	Major differential erosion features	
		S. Diff. in Erosion Rates	Small difference	Moderate difference	Large difference	Extreme difference	
T. LANDSLIDE HAZARD TOTAL (A+B+C+I+J+K+L+M+N)							CALC
U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greatest of P+Q or R+S))							CALC



K. All – Slope Height

$$Score = 3^x \ (\max 100);$$

$$x = \frac{slope\ height\ or\ axial\ length}{25}$$

Example:
Rock slope is measured as 56' high.
What is the score?

$$x = \frac{56}{25} = 2.24$$

$$score = 3^{2.24} = 12\ pts$$

L. LS – Thaw Stability

- Melting permafrost becomes unstable, creating rough and wavy driving surface
- Ice lenses in high elevations in lower 48 may also create issues
- Performance of road a strong indicator

SLOPE HAZARD RATING								
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. 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	
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T. LANDSLIDE HAZARD TOTAL (A+B+C+I+J+K+L+M+N)									CALC
U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greatest of P+Q or R+S))									CALC

If in lower 48 and not in very high elevations, rate as 'Thaw Stable' - 3

L. LS – Thaw Stability

3 points	Unfrozen / Thaw Stable. **Soil may be coarse- or fine-grained**. No ice is visible with the naked eye but if present, it does not occupy space in excess of the original voids. These soils are usually thaw-stable. No thaw unstable slopes should be rated in this category
9 points	Slightly Thaw Unstable. **Soil is coarse-grained**. **Ice occupies space equal to, or in excess of, the original voids.** It is present as crystals or lenses visible with the naked eye. These soils may be thaw-unstable depending on soil density. Few thaw unstable slopes should be rated in this subcategory.
27 points	Moderately Thaw Unstable. **Soil is fine-grained. Ice occupies space equal to, or in excess of the original voids** and is present as crystals or lenses visible with the naked eye. These soils are typically thaw-unstable. Most thaw unstable slopes are rated in this category based on relative performance of the roadway.
81 points	Highly Thaw Unstable. **Soil layers contain significant quantities of ice well in excess of the original void space. The ice is readily visible with the naked eye and is present as large lenses or as separate ice layers.** These materials are highly thaw-unstable. Any embankment sections with characteristics indicating a likelihood or history of rapid failure or severe displacement due to the presence of thaw unstable materials should be rated in this subcategory.

Public ...

LANDSLIDE TECHNOLOGY
A DIVISION OF SOMPORTH CONSULTANTS

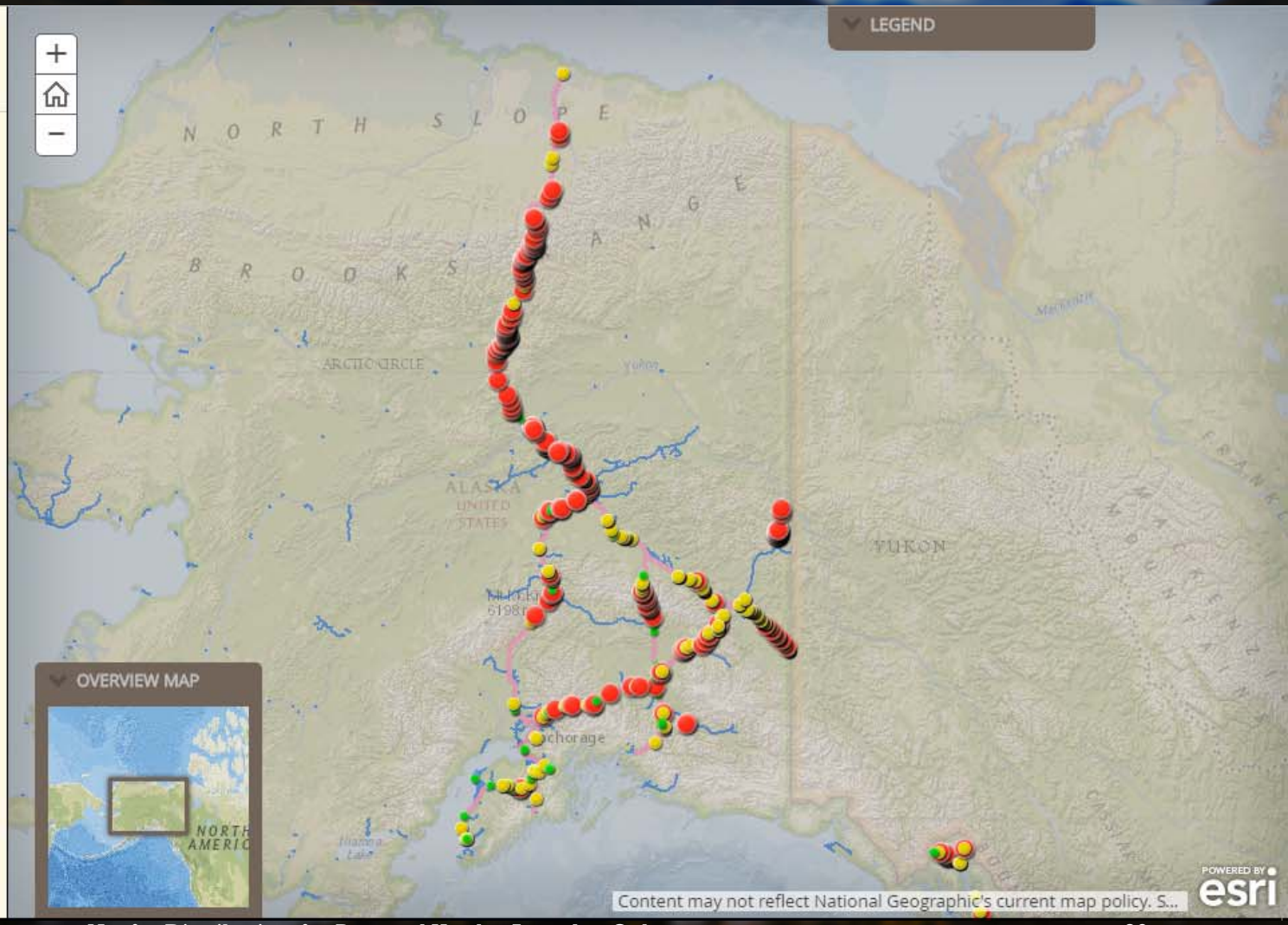
GAM Program Overview

Integrating USMP Unstable Soil Slope and Embankment Assets into GAM

Repeated patching required to address frost heave on the Elliott Highway, MP 48.3. This embankment is in a Poor Condition State due to permafrost-related instability.

The Condition State map of unstable soil slopes and embankments shown at right helped highlight that most of AKDOT&PF's poorly performing soil slopes/embankments are located in the Northern Region, where permafrost impacts are a dominant concern.

The developed Condition States can be directly mapped to TAM's Good/Fair/Poor criteria. The



AASHTO Webinar Map Series

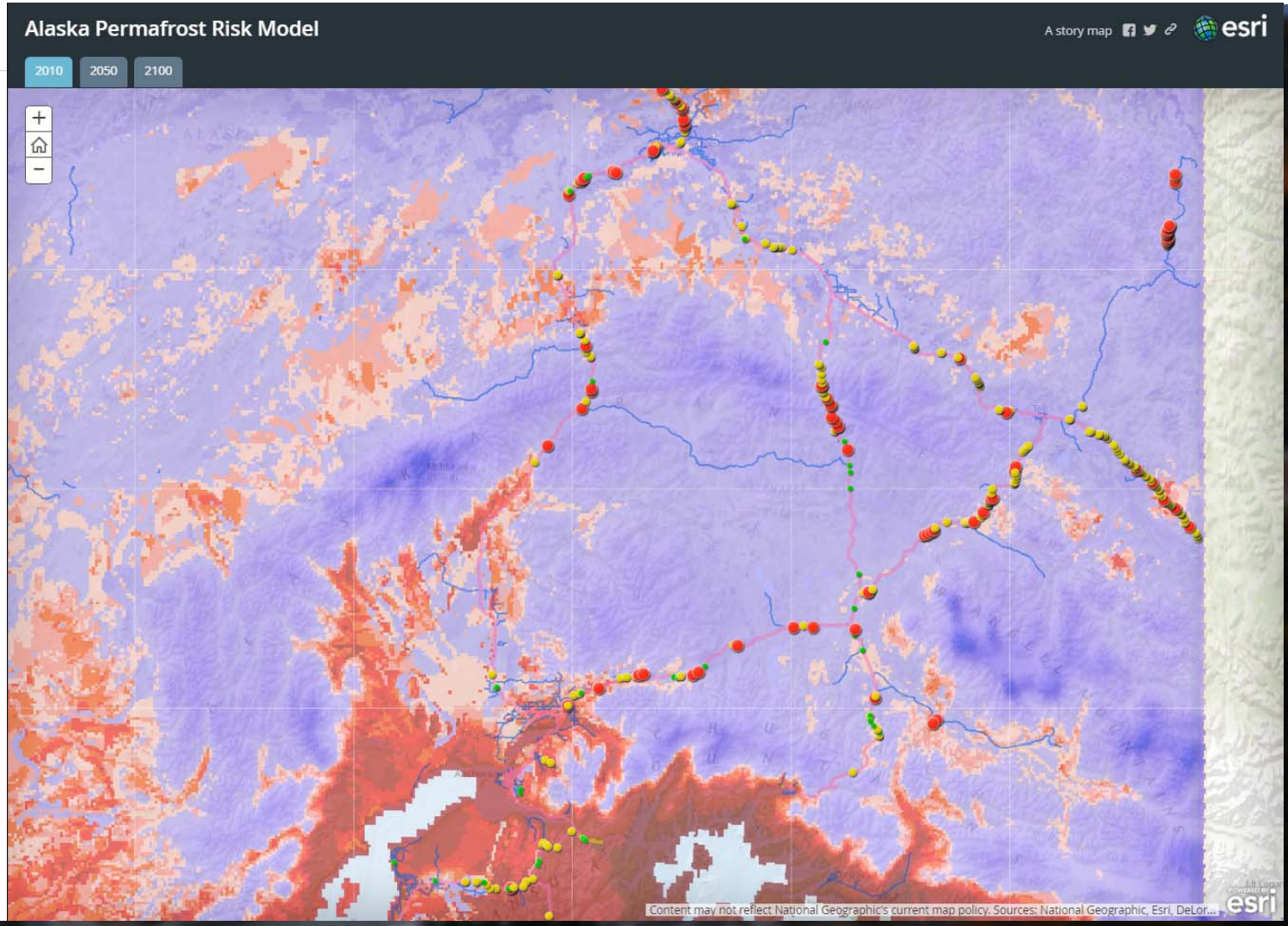
AKDOT&PF Slope, Wall, & Material Site Management

Applying GAM - Incorporating Thawing Permafrost Risks

Thawing permafrost causing embankment damage. Tok Highway, MP 42.

Throughout Alaska, mean average ground temperatures are projected to increase throughout the next century. Work conducted under Dr. Marchenko at the University of Alaska at Fairbanks modeled projected warming of Alaskan soils, and created the Alaska Permafrost Risk Application. When coupled with AKDOT's existing unstable soil slope inventory, this model can help the department predict areas where thawing permafrost will results in increased maintenance requirements and prepare long-term budgets accordingly.

Applying GAM - Combining Activity and Asset Improvement Costs



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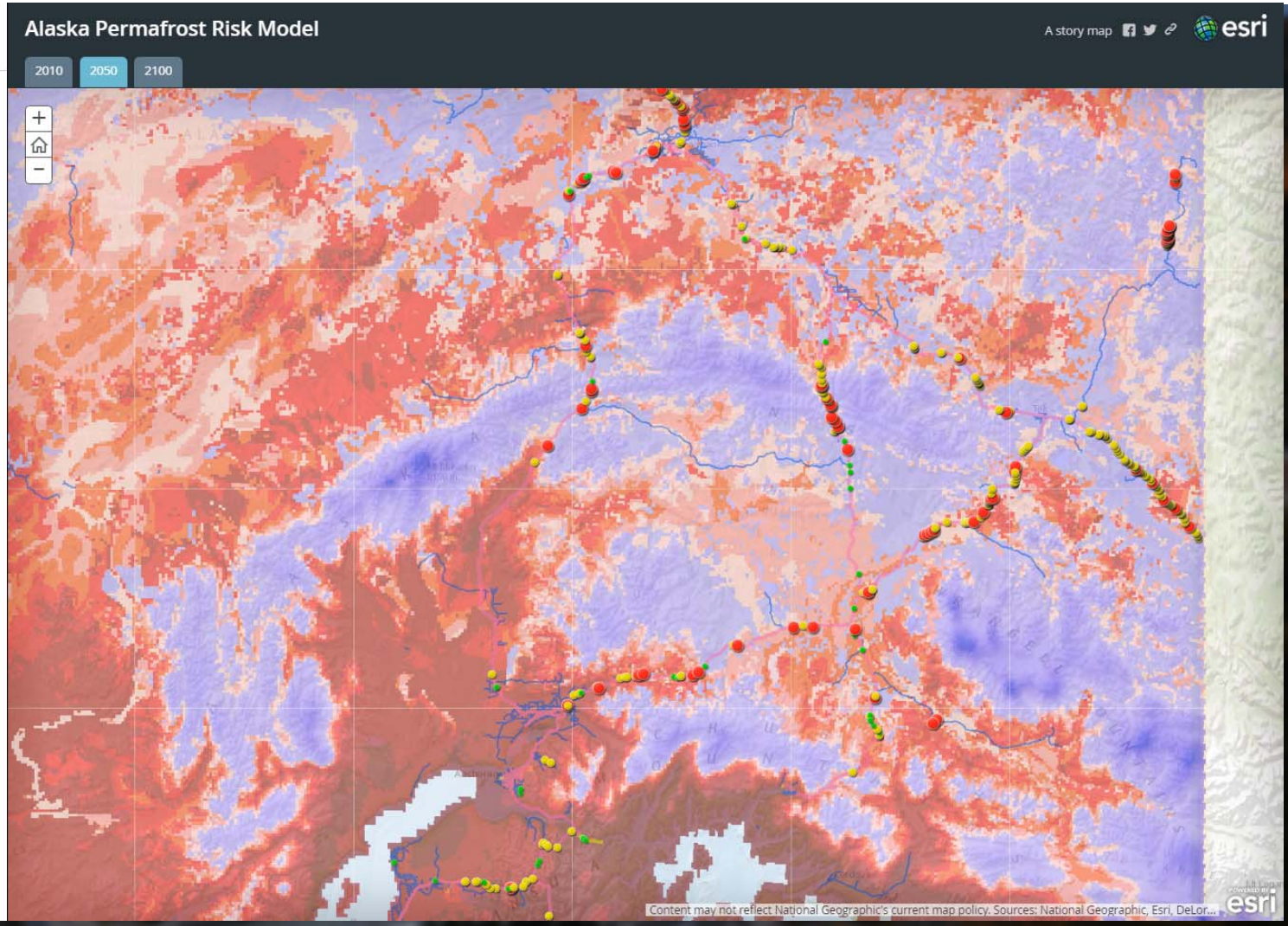

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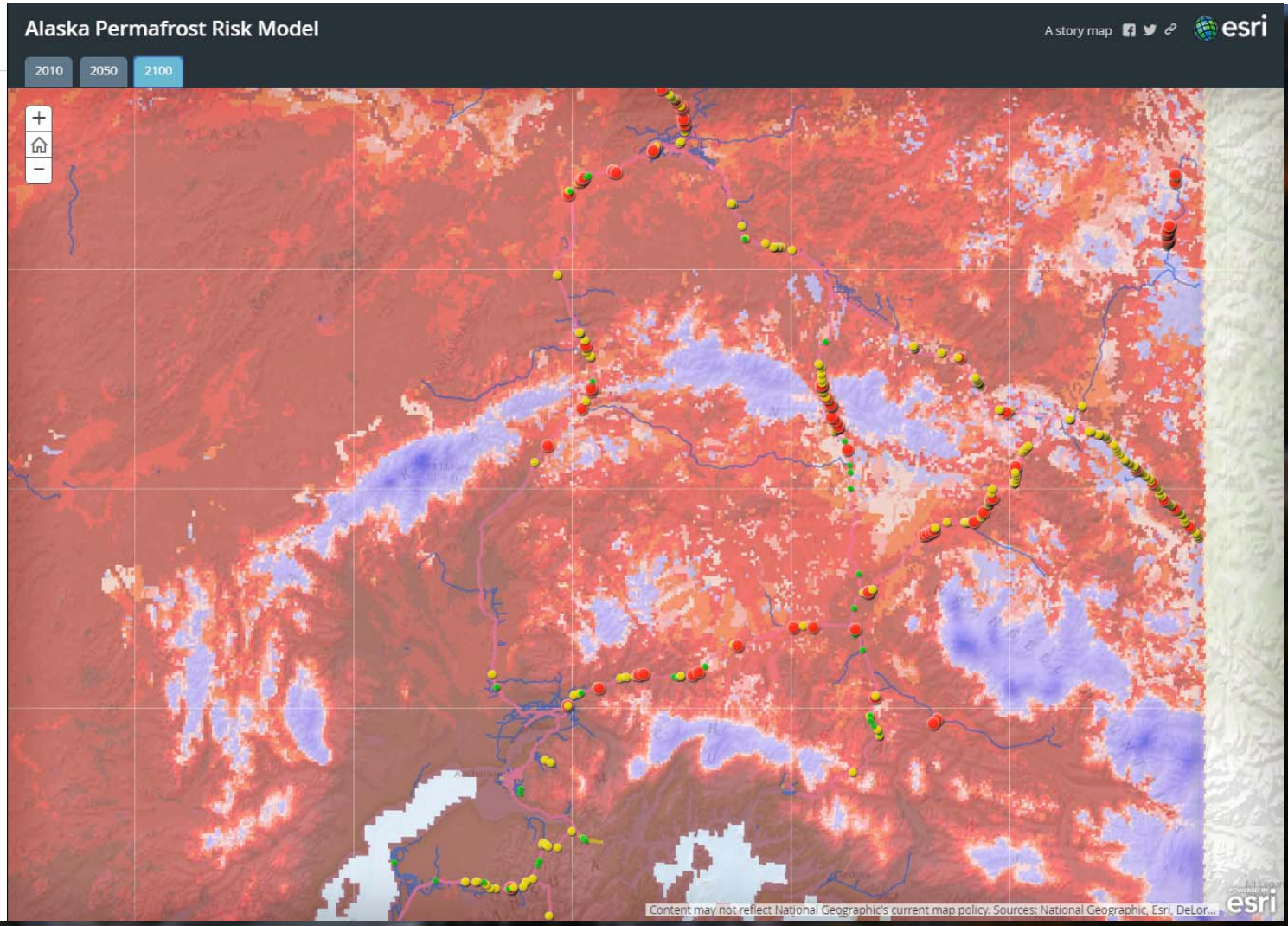

M. LS – Maint. Frequency

- Maintenance Frequency
  - Poses frequent hazard to agency personnel
  - Actions may be deferred, increasing hazard to public
  - Costs increase
  - May have to make judgements when records don't exist
  - Category marks both escalating efforts and frequency

SLOPE HAZARD RATING							
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. 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	
J. All - Annual Rainfall				0-10"	10-30"	30-60"	60"+	
K. All - Slope Height / Axial length of slide				25 ft	50 ft	75 ft	100 ft	CALC
Select One Unstable Slope Type	Landslides/ Erosion (add A, B, C)	L. Thaw Stability (Cold Climates)		Unfrozen/Thaw Stable	Slightly Thaw Unstable	Moderately Thaw Unstable	Highly Thaw Unstable	
		M. Instability-Related Maint. Frequency		Every 10 years	Every 5 years	Every 2 years	Every year	
		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)	
	Rockfalls (add D, E, F)	O. Rockfall-Related Maint. Frequency		Normal, scheduled maintenance	Patrols after every storm events	Routine seasonal patrols	Year-round patrols	
		Geologic Character	Case 1 P. Structural Condition	Discontinuous Favorable	Discontinuous Random	Discontinuous Adverse	Continuous Adverse	
			Case 1 Q. Rock Friction	Rough/ Irregular	Undulating	Planar	Clay infilled/ Slickensided	
			Case 2 R. Structural Condition	Few differential erosion features	Occasional differential erosion features	Many differential erosion features	Major differential erosion features	
			Case 2 S. Diff. in Erosion Rates	Small difference	Moderate difference	Large difference	Extreme difference	
T. LANDSLIDE HAZARD TOTAL (A+B+C+I+J+K+L+M+N)								CALC
U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greatest of P+Q or R+S))								CALC

M. LS – Maint. Frequency

3 points	Every 10 years. Events requiring maintenance intervention are relatively rare or nonrecurring and/or the repair activities can typically be completed using standard equipment with minimal impacts to traffic flow.
9 points	Every 5 years. Maintenance intervention is required occasionally and/or the repair activities can usually be completed in less than a day using standard equipment but traffic flow is reduced and flagging is required.
27 points	Every 2 years. Maintenance action is routinely required and/or the repair activities require non-standard equipment or more than one day to complete; or the traffic flow is significantly impeded for more than a day and flagging is required.
81 points	Every year. Maintenance is required one or more times per year or wherever major events have occurred requiring several days to restore traffic. This category also applies if an outside contractor is required.

N. LS – Movement History

- Movement rate per event and their frequency relate to public hazard
- High rates more likely to create unanticipated roadway conditions, increasing public hazard
- Involve maintenance personnel, if possible, as it is difficult to accurately assess rates from single visit

SLOPE HAZARD RATING							
Category Rating				3	9	27	81	Score
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U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greatest of P+Q or R+S))								CALC

N. LS – Movement History

3 points	Minor movement or sporadic creep. The rate of movement is low and non-continuous. Pavement disturbance is minor on an annual basis and maintenance requirements are minimal and carried out as a scheduled activity.
9 points	Up to 1 inch annually or steady annual creep. The rate of movement is low but continuous. Roadway maintenance is routinely required to avoid road closures but maintenance action can generally be on a scheduled basis.
27 points	Up to 3 inches per event, one event per year. The rate of movement is moderately high. Events occurring more than twice a year that require immediate and unscheduled maintenance are a persistent maintenance problem.
81 points	>3 inches per event, >6 inches annually, or more than 1 event per year (includes all debris flows). The rate of movement is high with significant roadway disturbance developing quickly. Aggressive, unscheduled maintenance intervention is required to maintain traffic flow and correct unsafe conditions.

O. RF – Maint. Frequency

- Indicator of rockfall activity and long-term costs
- Indicates relative hazard to the public
- If your agency does not patrol for rockfall, use judgement informed by maintenance experience, when possible

SLOPE HAZARD RATING								
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. 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	
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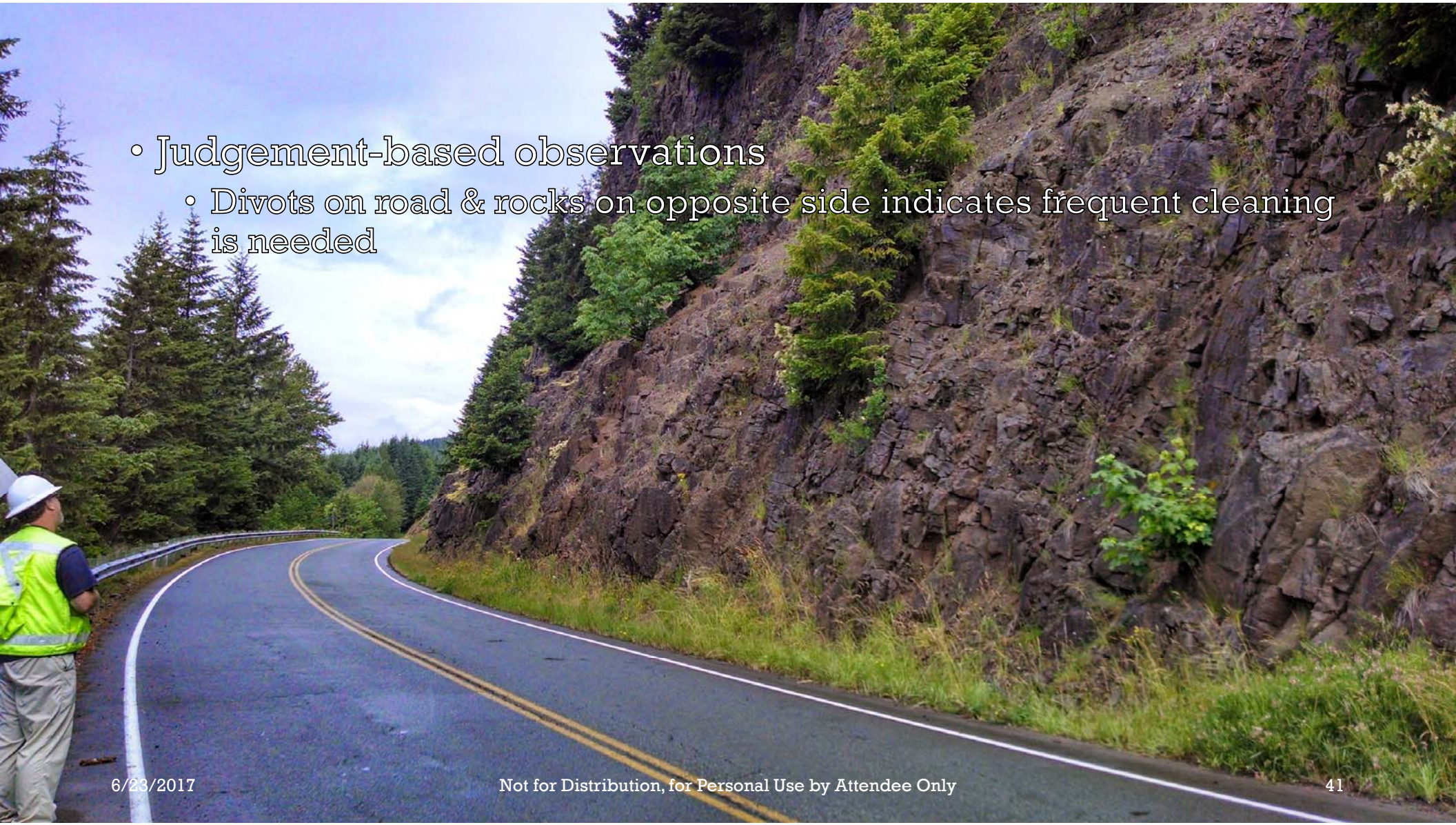
U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greatest of P+Q or R+S))									CALC

- Judgement-based observations
  - The excavator was being mobilized, again.



P., Q., R., S. RF – Geologic Character

- One of two categories
- Case 1
  - Occur as a result of movement along joints/faults/foliation/bedding/fractures - discontinuities
  - Typically hard rock
- Case 2
  - Differential erosion or oversteepening is the primary failure mode
  - Typically bedded soft rock, glacial till, talus

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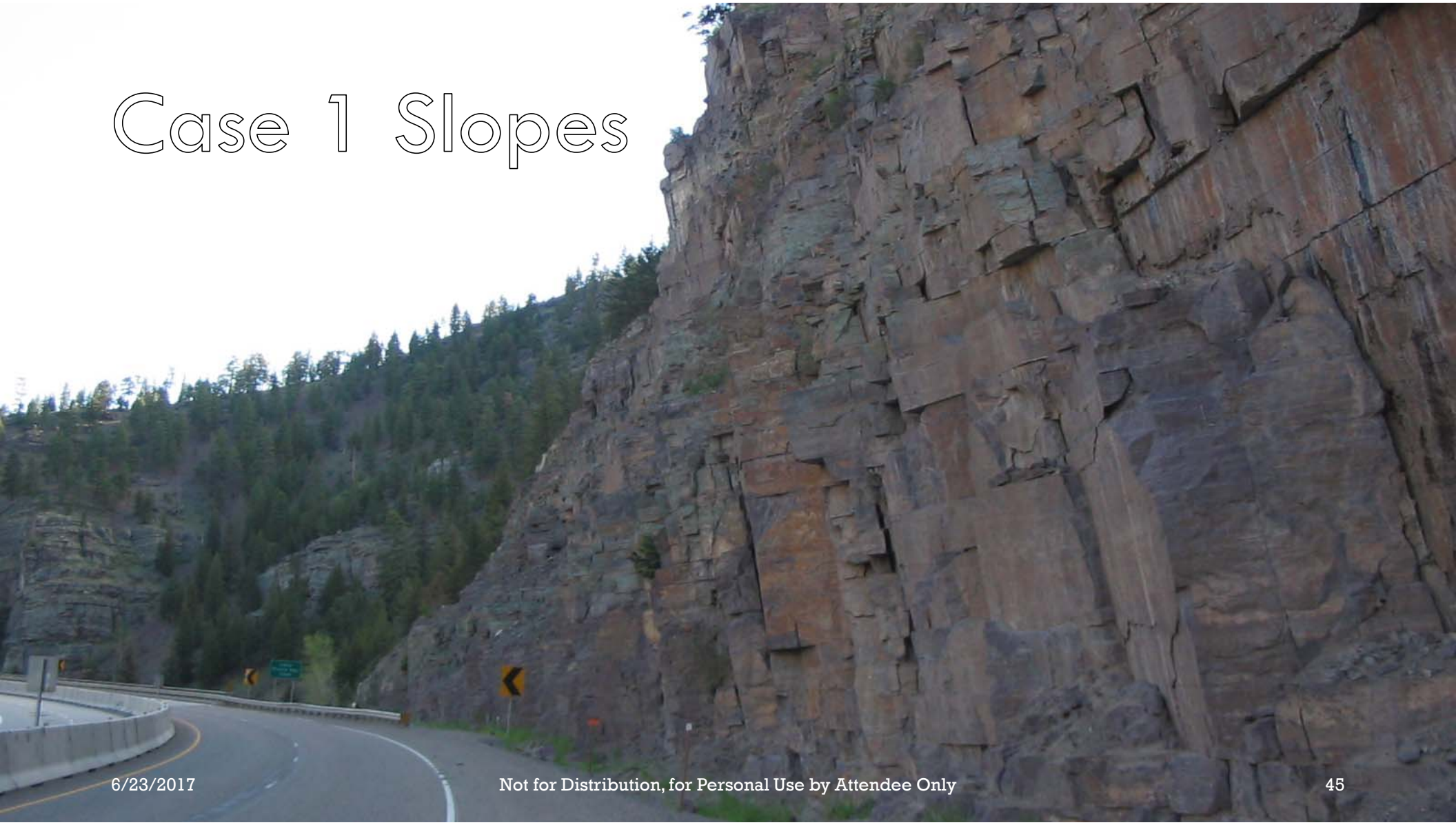
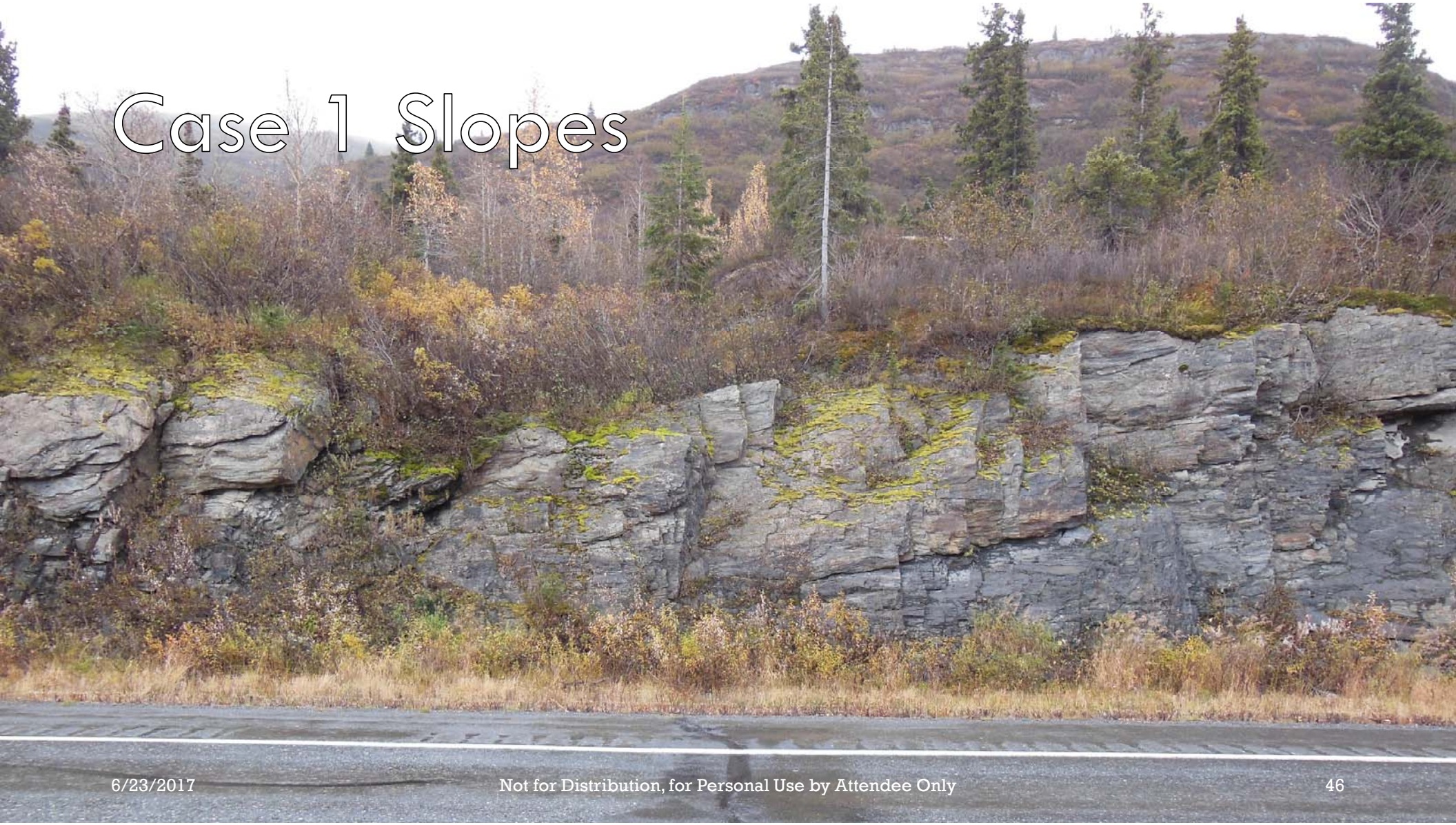
U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greatest of P+Q or R+S))								CALC

Both failure modes present? Uncertain? Rate both and high score combination 'wins'.

Case 1 Slopes



Case 1 Slopes



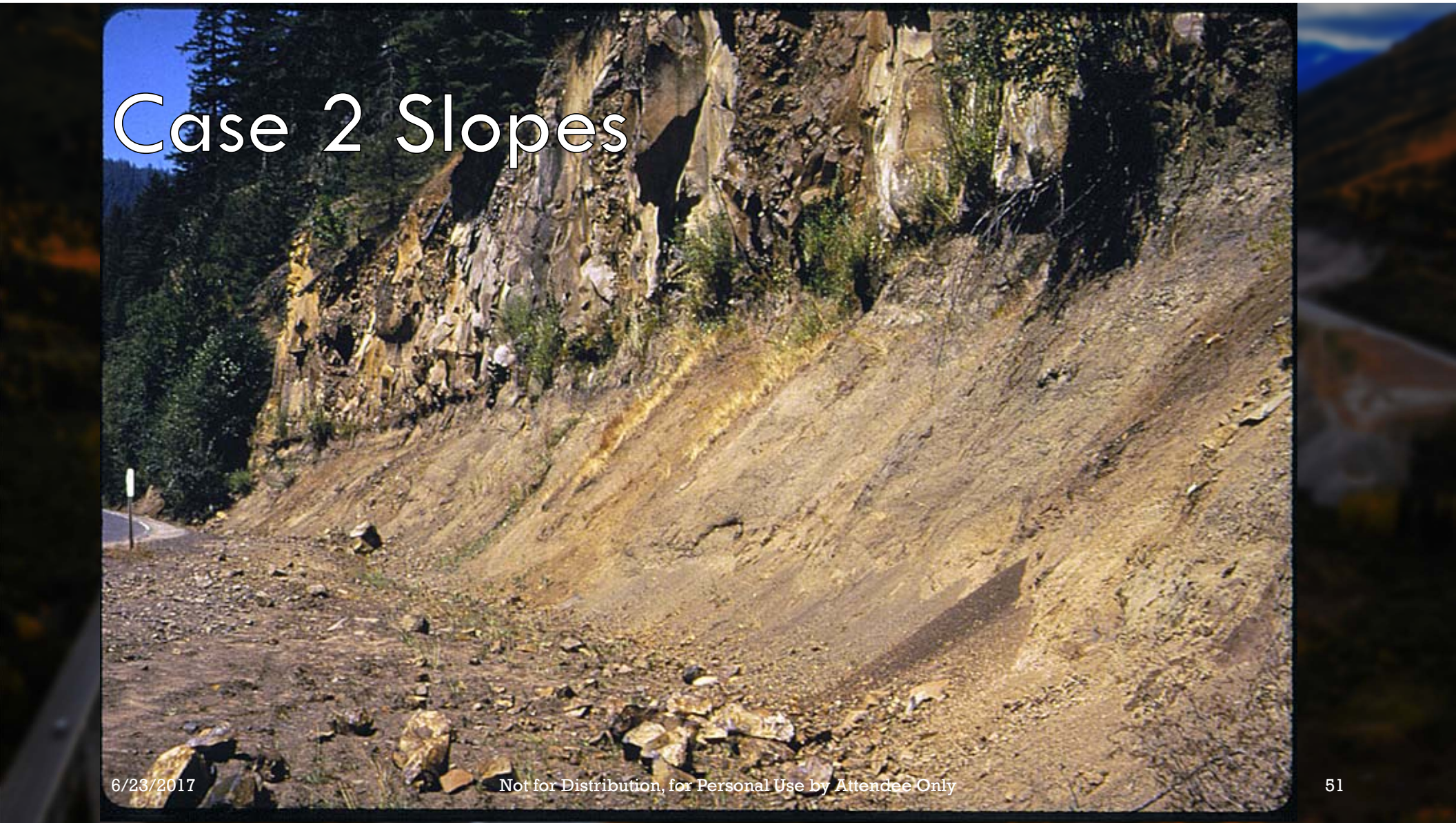
Case 1 Slopes

Case 1 Slopes

Case 2 Slopes

Case 2 Slopes

Case 2 Slopes



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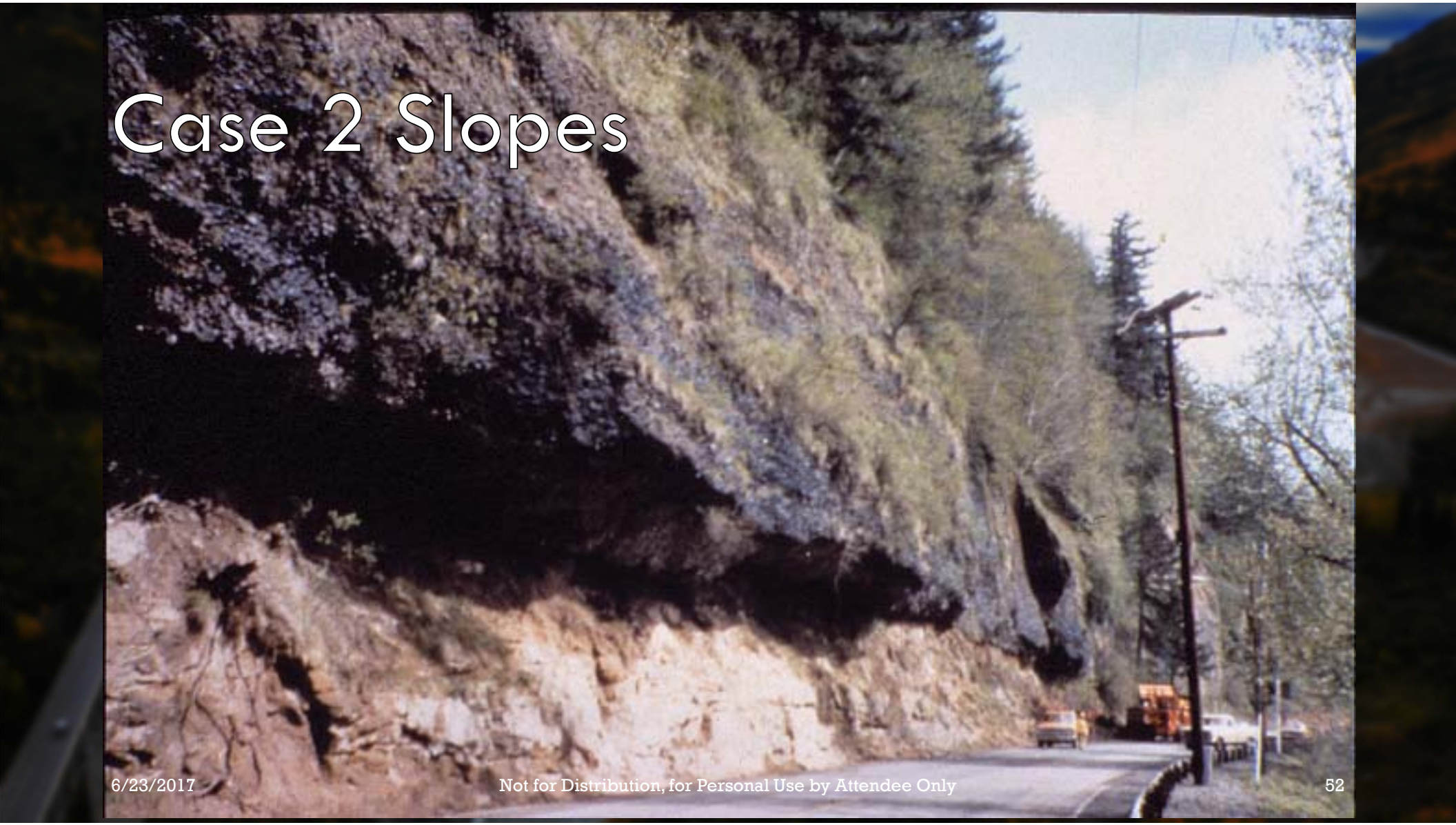

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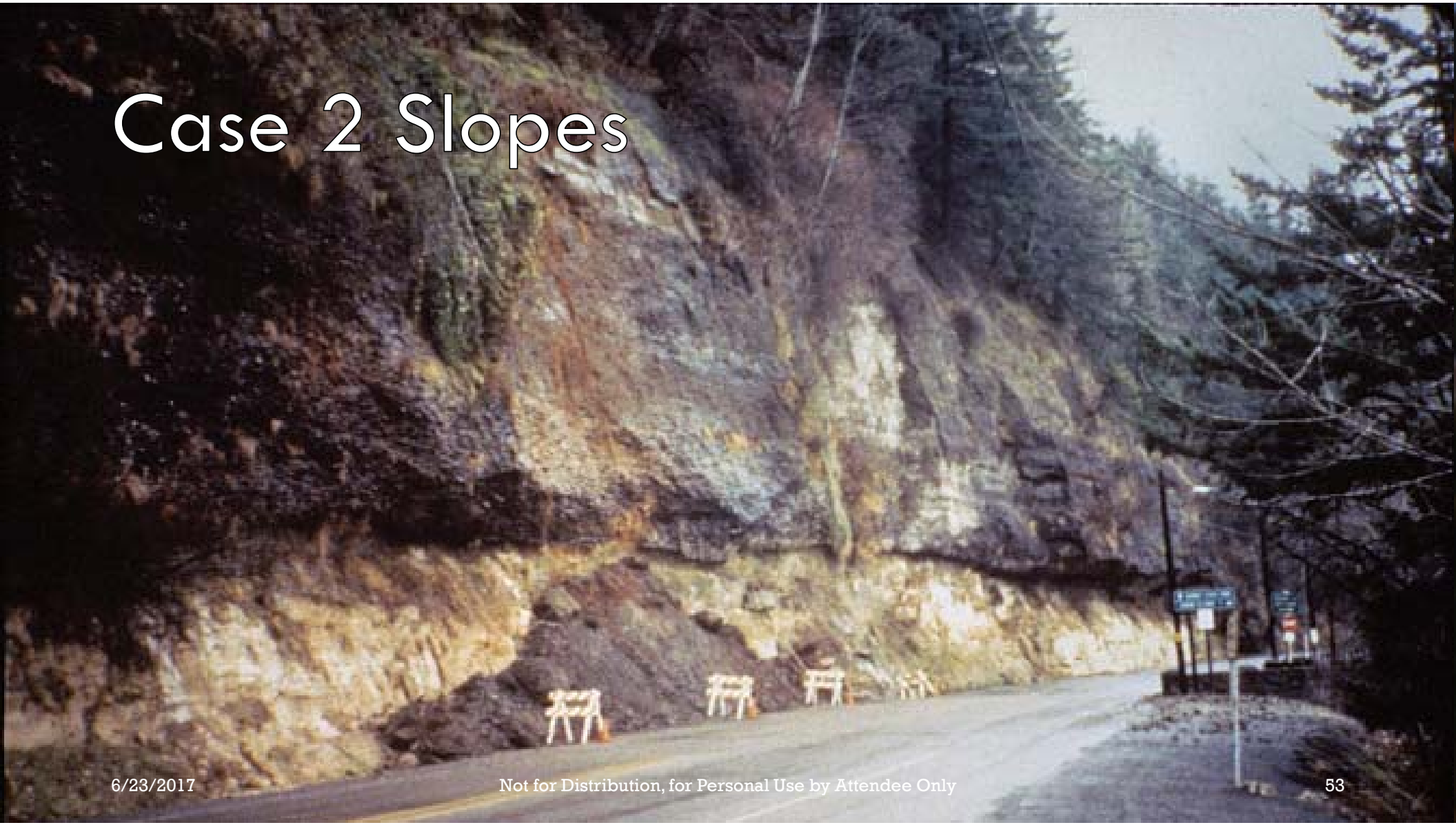

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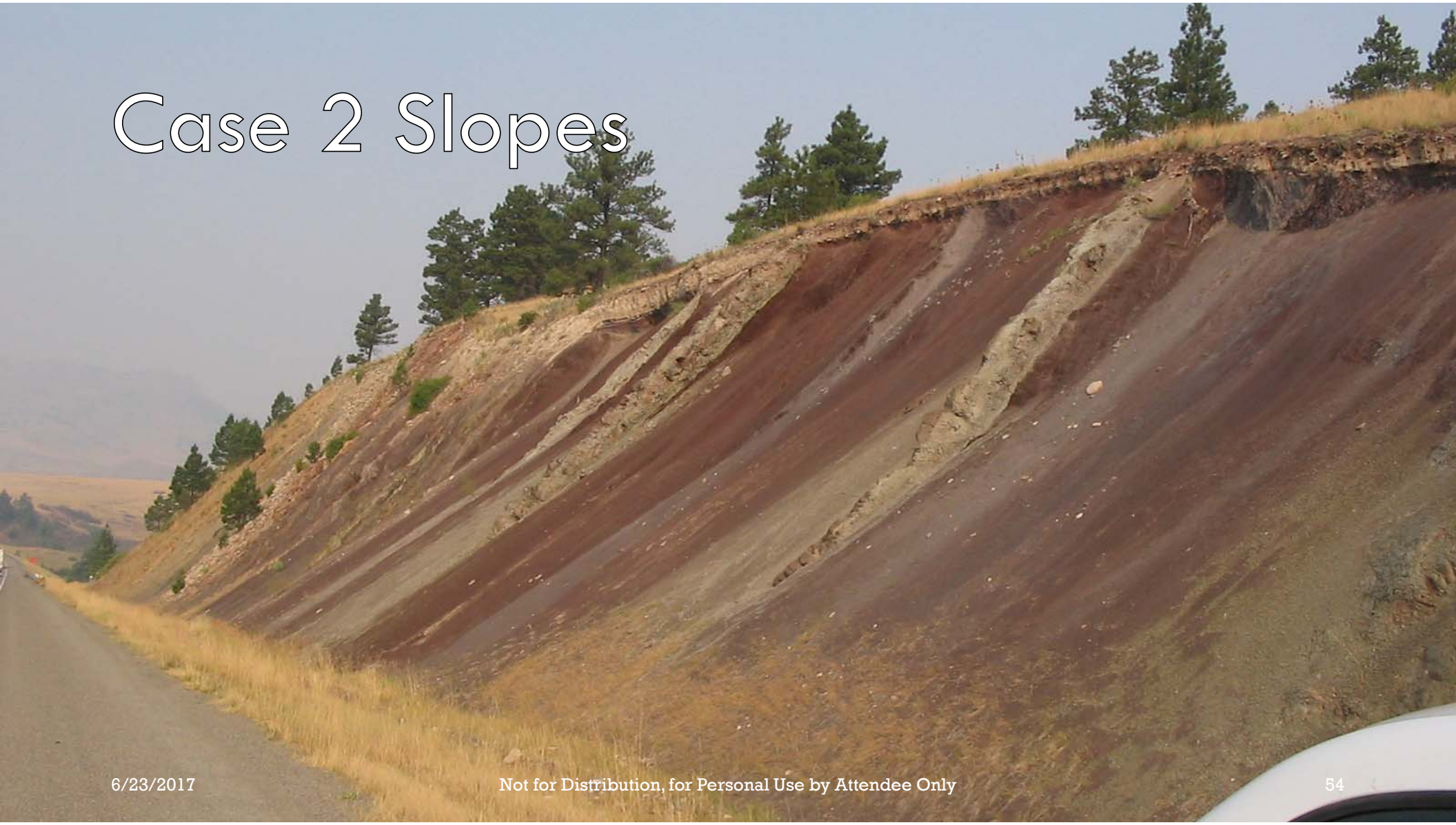
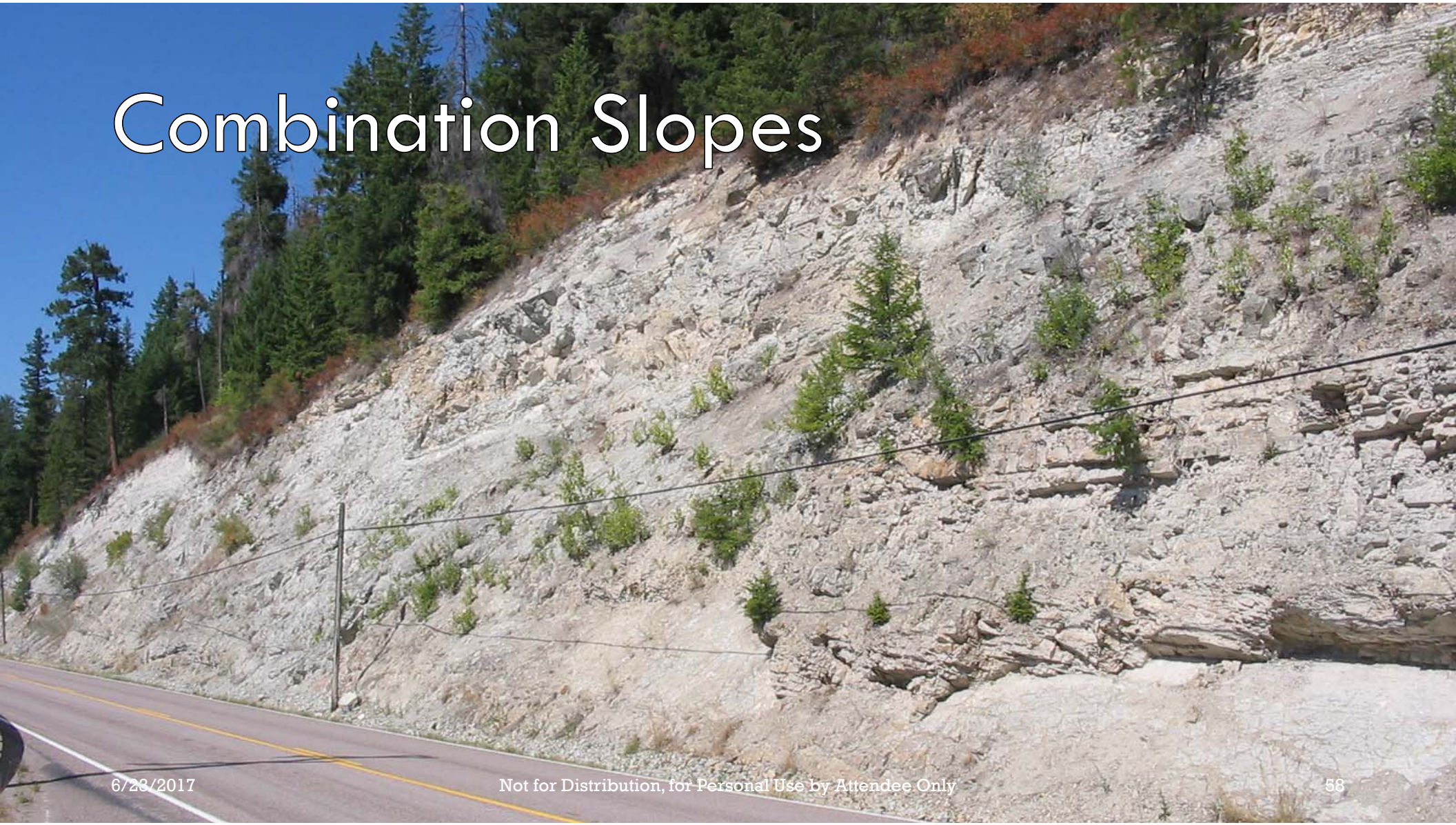


Case 2 Slopes

Case 2 Slopes

Combination Slopes

Combination Slopes



Combination Slopes

Combination Slopes

P. RF – C1 Structural Condition

- Discontinuities control failures in hard rock
- Orientation and persistence factor into rockfall potential, volume, and size

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Category Rating				3	9	27	81	Score
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U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greatest of P+Q or R+S))								CALC

3 points Joints with favorable orientations. Slope contains jointed rock with no adversely oriented joints.

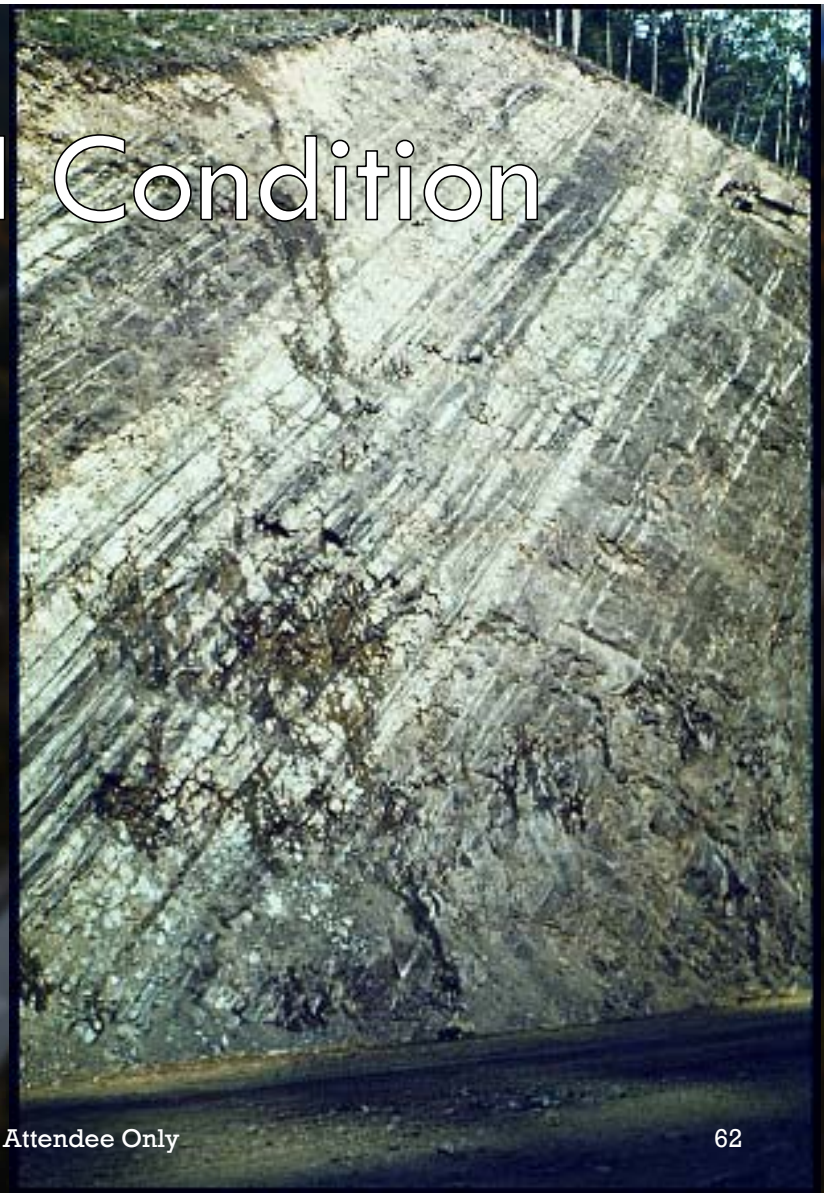
9 points Joints with random (both favorable and unfavorable) orientations. Slope contains randomly oriented joints creating a variable pattern. The slope is likely to have some scattered blocks with adversely oriented joints, but no dominant adverse pattern is present.

27 points Joints w/ Adverse Orientations - Discontinuous. Rock slope exhibits a prominent joint pattern with an adverse orientation. These features have less than 10 feet of continuous length.

81 points Joints w/ Adverse Orientations - Continuous. Rock slope exhibits a dominant joint pattern with an adverse orientation and a length greater than 10 feet.

P. RF – C1 Structural Condition

- **Favorable**
  - **Continuous foliations dip favorably**

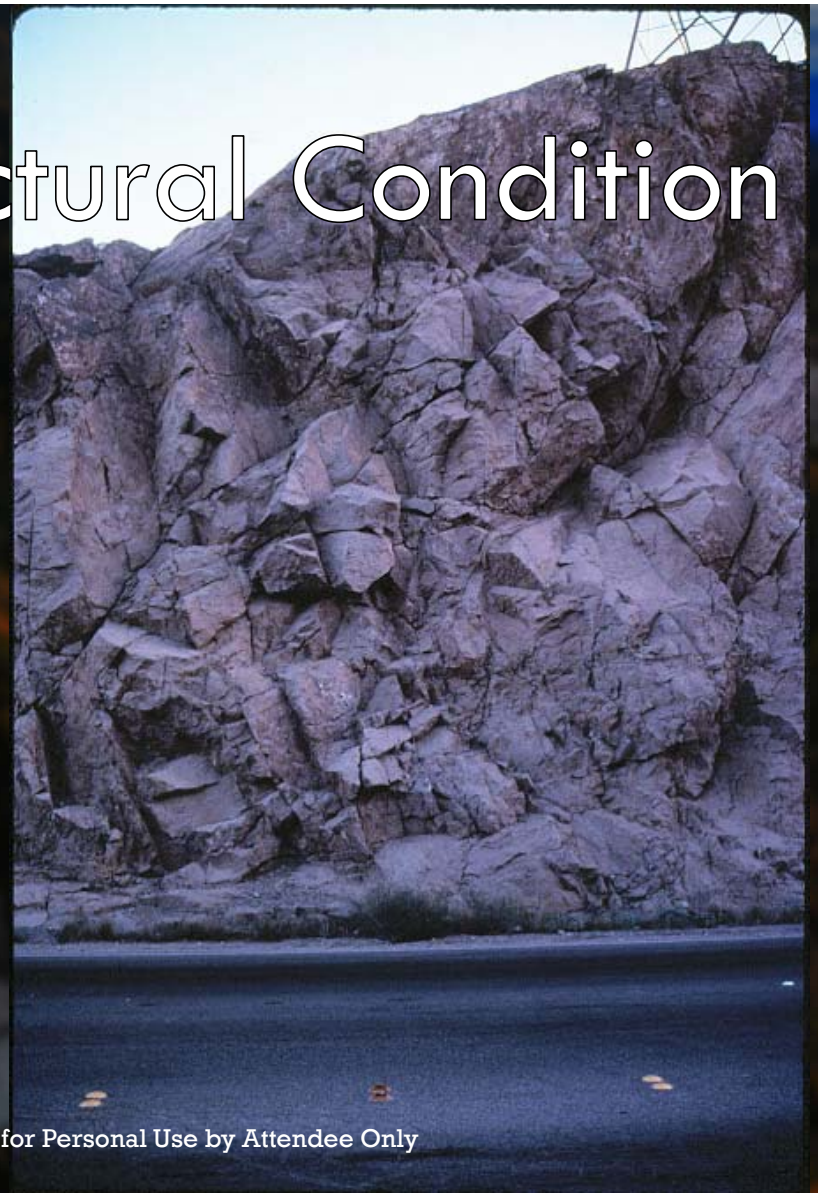


P. RF – C1 Structural Condition

- **Favorable**
  - **Continuous faults // to face**
  - **Bedding favorable**

P. RF – C1 Structural Condition

- **Random**



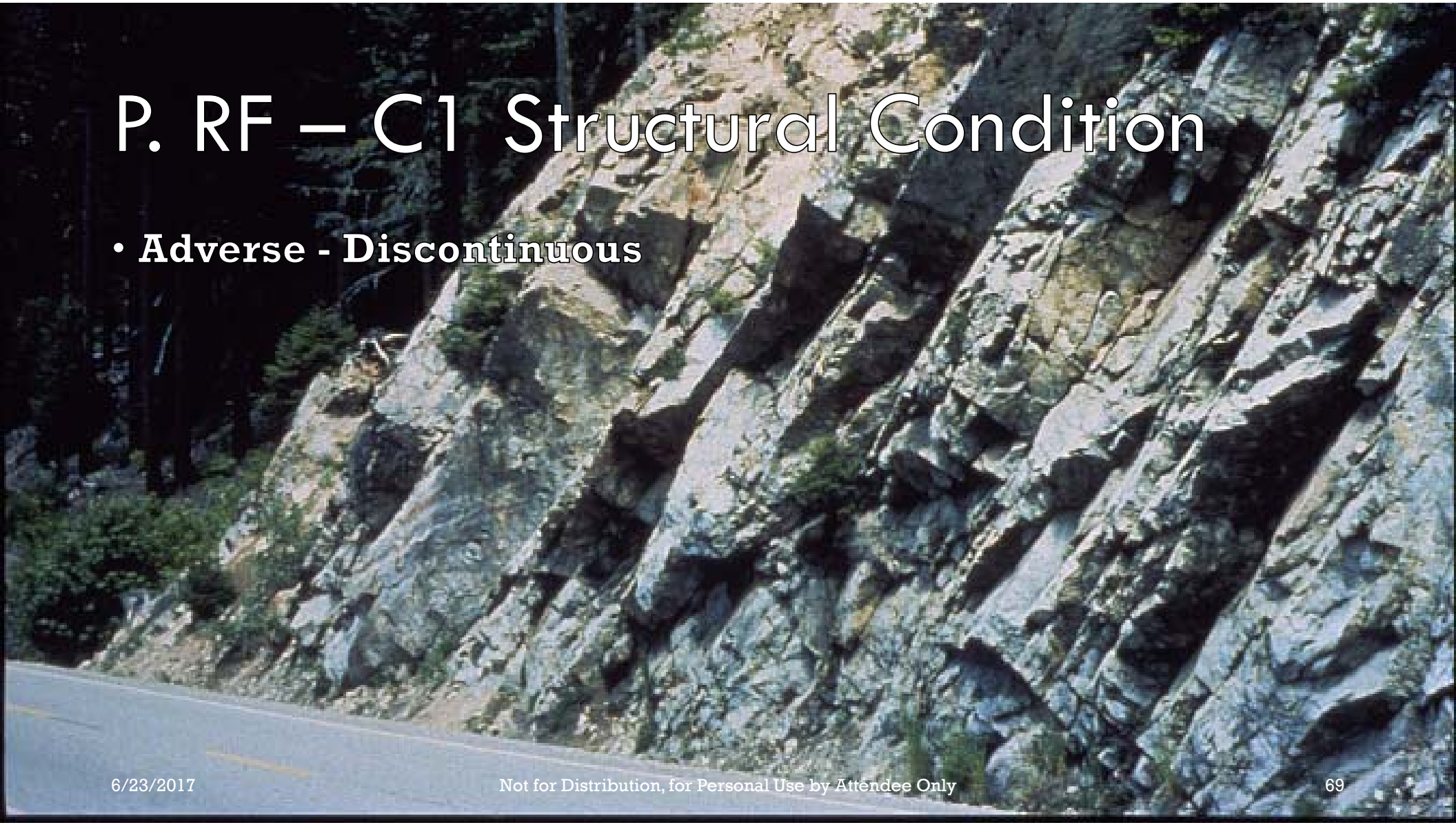
P. RF – C1 Structural Condition

- Random

P. RF – C1 Structural Condition

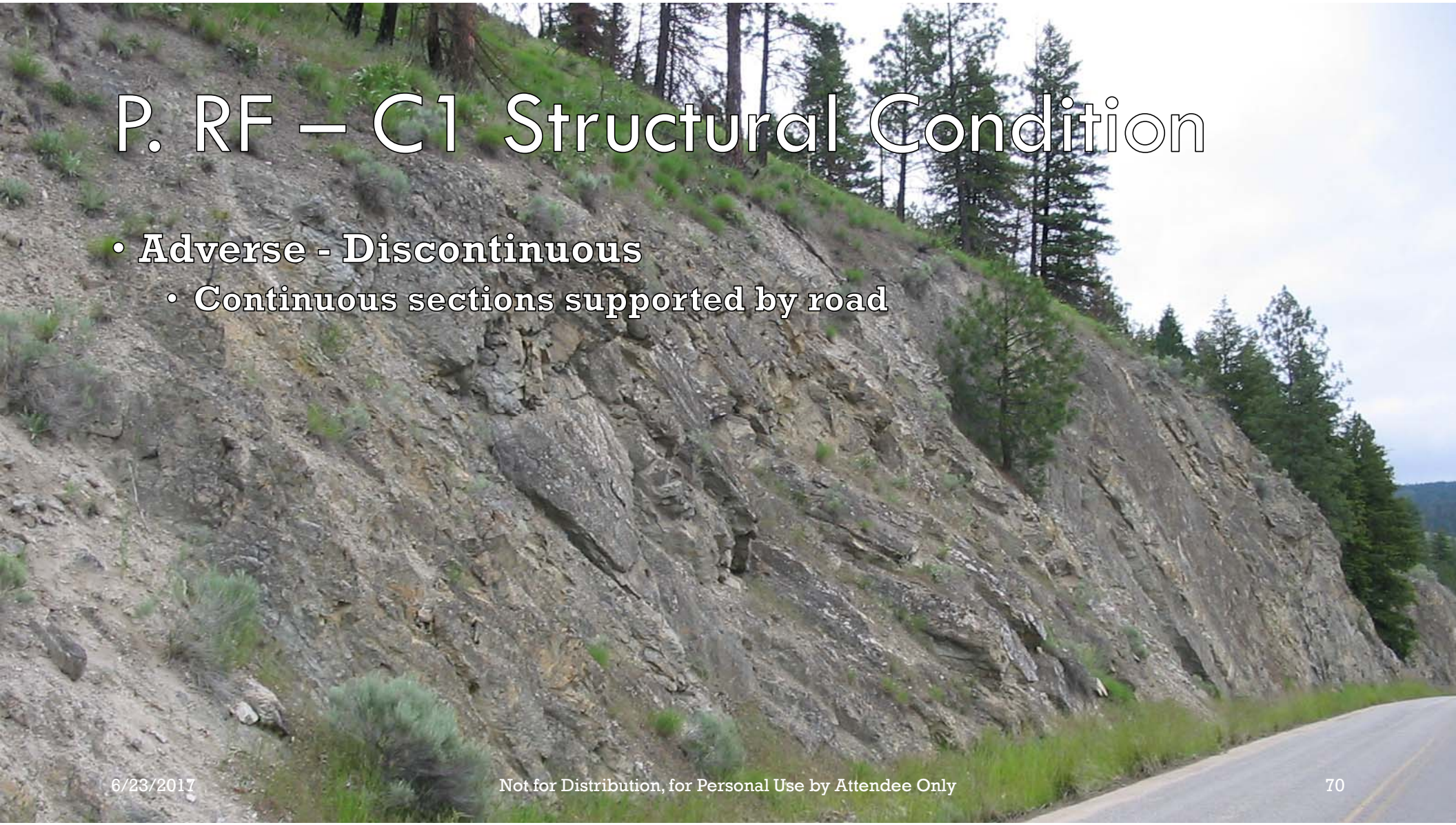
- **Random**

P. RF – C1 Structural Condition



- **Adverse - Discontinuous**

P. RF – C1 Structural Condition



- **Adverse - Discontinuous**
  - **Continuous sections supported by road**

P. RF – C1 Structural Condition

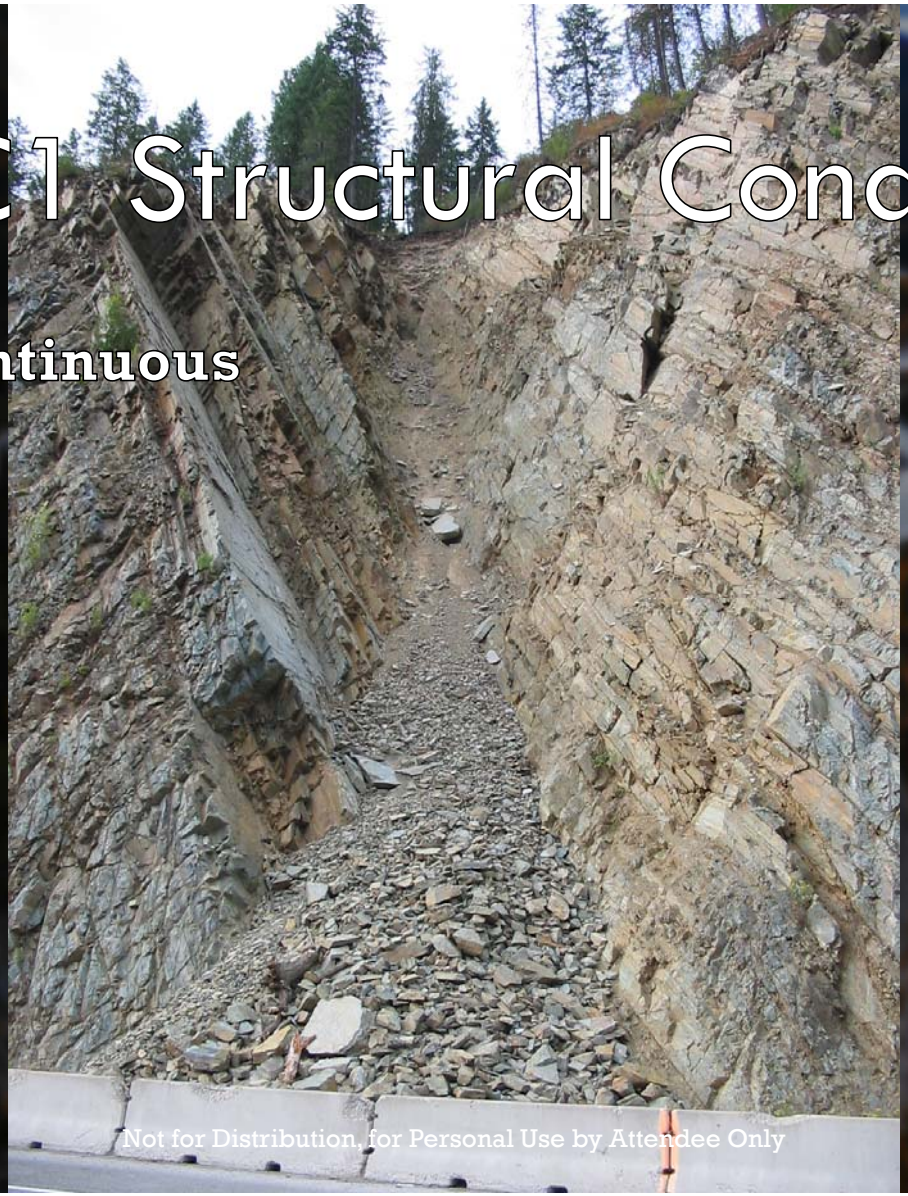
- **Adverse - Discontinuous**
- **Continuous sections not adverse**

P. RF – C1 Structural Condition

- **Adverse - Continuous**

P. RF – C1 Structural Condition

- **Adverse - Continuous**



P. RF – C1 Structural Condition

- **Adverse - Continuous**

P. RF – C1 Structural Condition

- **Adverse - Continuous**

P. RF – C1 Structural Condition

- **Adverse - Continuous**

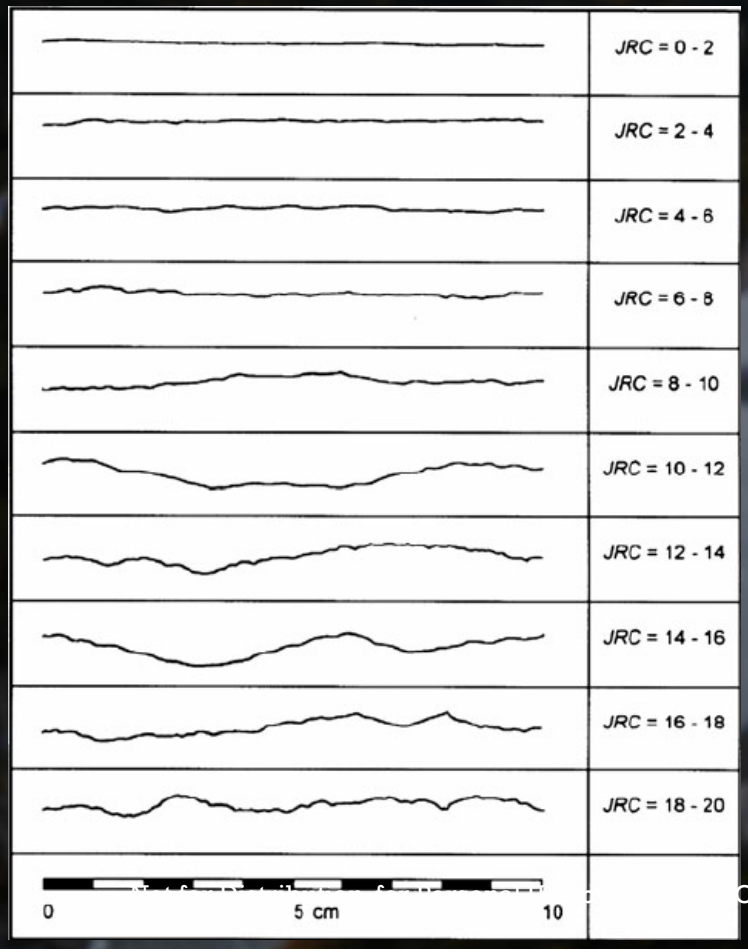
Q. RF – C1 Rock Friction

- High friction to low friction
- Can be difficult to judge
  - Roughly corresponds to JRC (Joint Roughness Coefficient), Joint Aperture, Weathering, Infilling

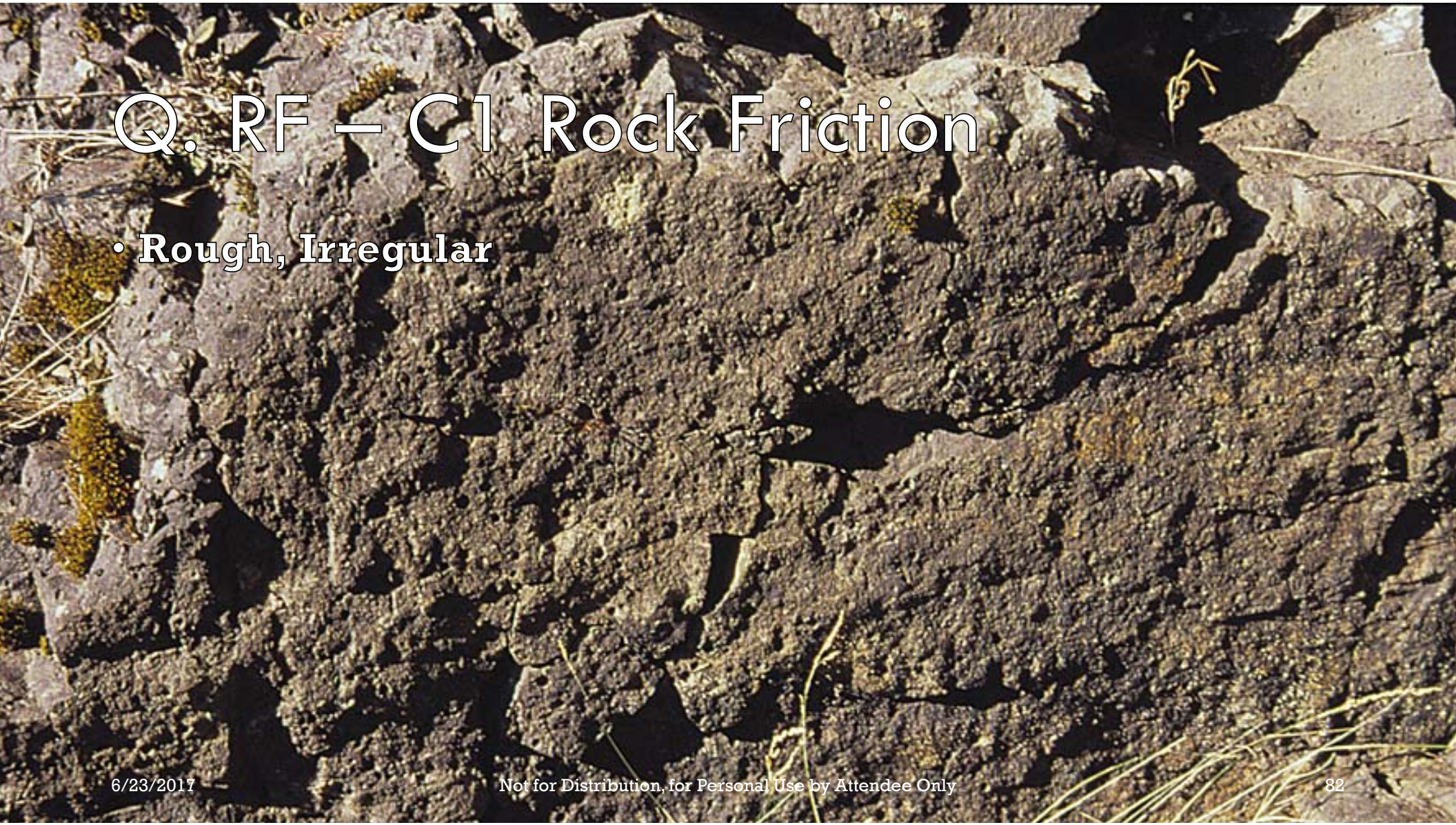
SLOPE HAZARD RATING						
Category Rating			3	9	27	81	Score
I. All - Slope Drainage			Slope appears dry or well drained; surface runoff well controlled	Intermittent water on slope; mod. well drained; or surface runoff moderately controlled	Water usually on slope; poorly drained; or surface runoff poorly controlled	Water always on slope; very poorly drained; or surface water runoff control not present	
J. All - Annual Rainfall			0-10"	10-30"	30-60"	60"+	
K. All - Slope Height / Axial length of slide			25 ft	50 ft	75 ft	100 ft	CALC
Select One Unstable Slope Type: Landslides/ Erosion (add A, B, C)	L. Thaw Stability (Cold Climates)		Unfrozen/Thaw Stable	Slightly Thaw Unstable	Moderately Thaw Unstable	Highly Thaw Unstable	
	M. Instability-Related Maint. Frequency		Every 10 years	Every 5 years	Every 2 years	Every year	
	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)	
Rockfalls (add D, E, F)	O. Rockfall-Related Maint. Frequency		Normal, scheduled maintenance	Patrols after every storm events	Routine seasonal patrols	Year-round patrols	
Geologic Character	Case 1	P. Structural Condition	Discontinuous Favorable	Discontinuous Random	Discontinuous Adverse	Continuous Adverse	
		Q. Rock Friction	Rough/ Irregular	Undulating	Planar	Clay infilled/ Slickensided	
	Case 2	R. Structural Condition	Few differential erosion features	Occasional differential erosion features	Many differential erosion features	Major differential erosion features	
		S. Diff. in Erosion Rates	Small difference	Moderate difference	Large difference	Extreme difference	
T. LANDSLIDE HAZARD TOTAL (A+B+C+I+J+K+L+M+N)							CALC
U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greatest of P+Q or R+S))							CALC

3 points	Rough. Irregular. The surface of the joints are rough and the joint planes are irregular enough to cause interlocking.
9 points	Undulating Macro. Rough but without the interlocking ability.
27 points	Planar. Macro smooth and micro rough joint surfaces. Friction is derived strictly from the roughness of the rock surface.
81 points	Clay Infilling, Open, or Slickensides. Low friction materials separate the rock surfaces, negating any micro or macro roughness of the joint surfaces. Slickensided joints also have a lower friction angle, and belong in this category.

Q. RF – C1 Rock Friction



27 . . . . 9 3

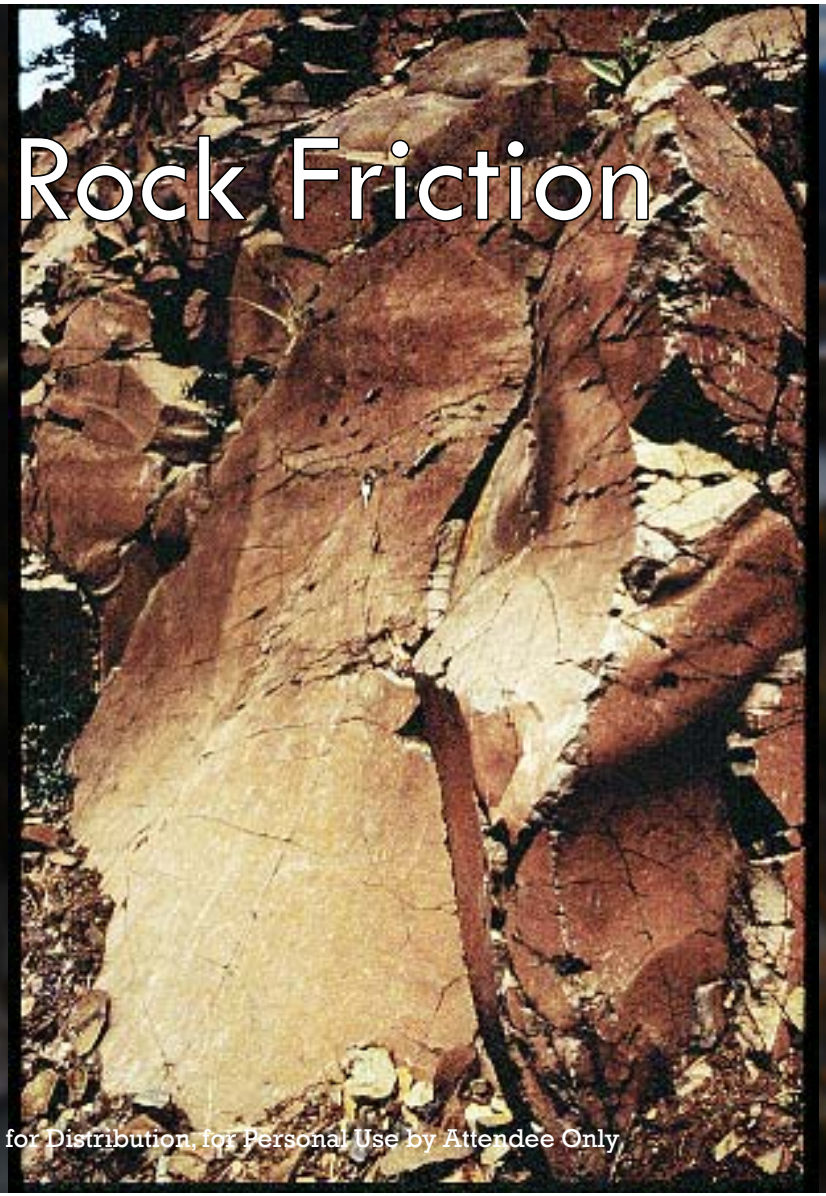


Q. RF – C1 Rock Friction

- **Rough, Irregular**

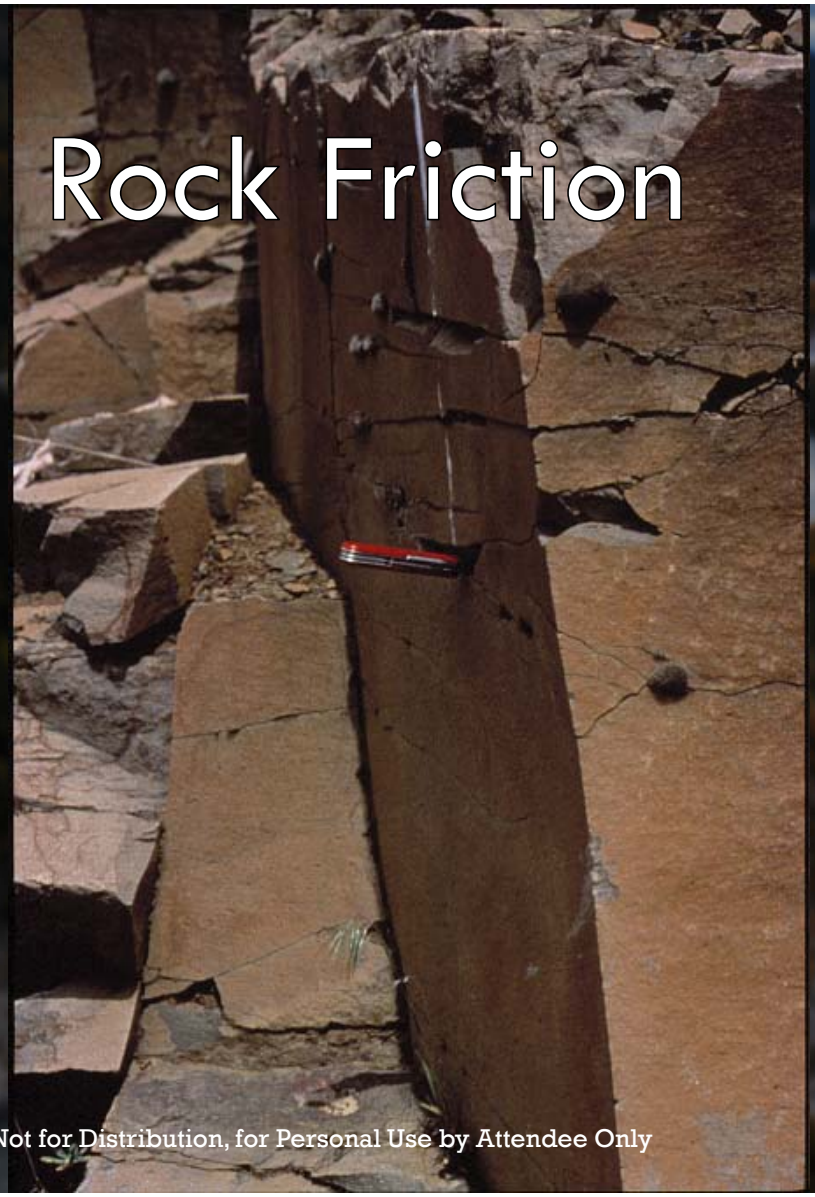
Q. RF – C1 Rock Friction

- **Undulating**
  - **Frequently in basalt columns, stress relief joints**



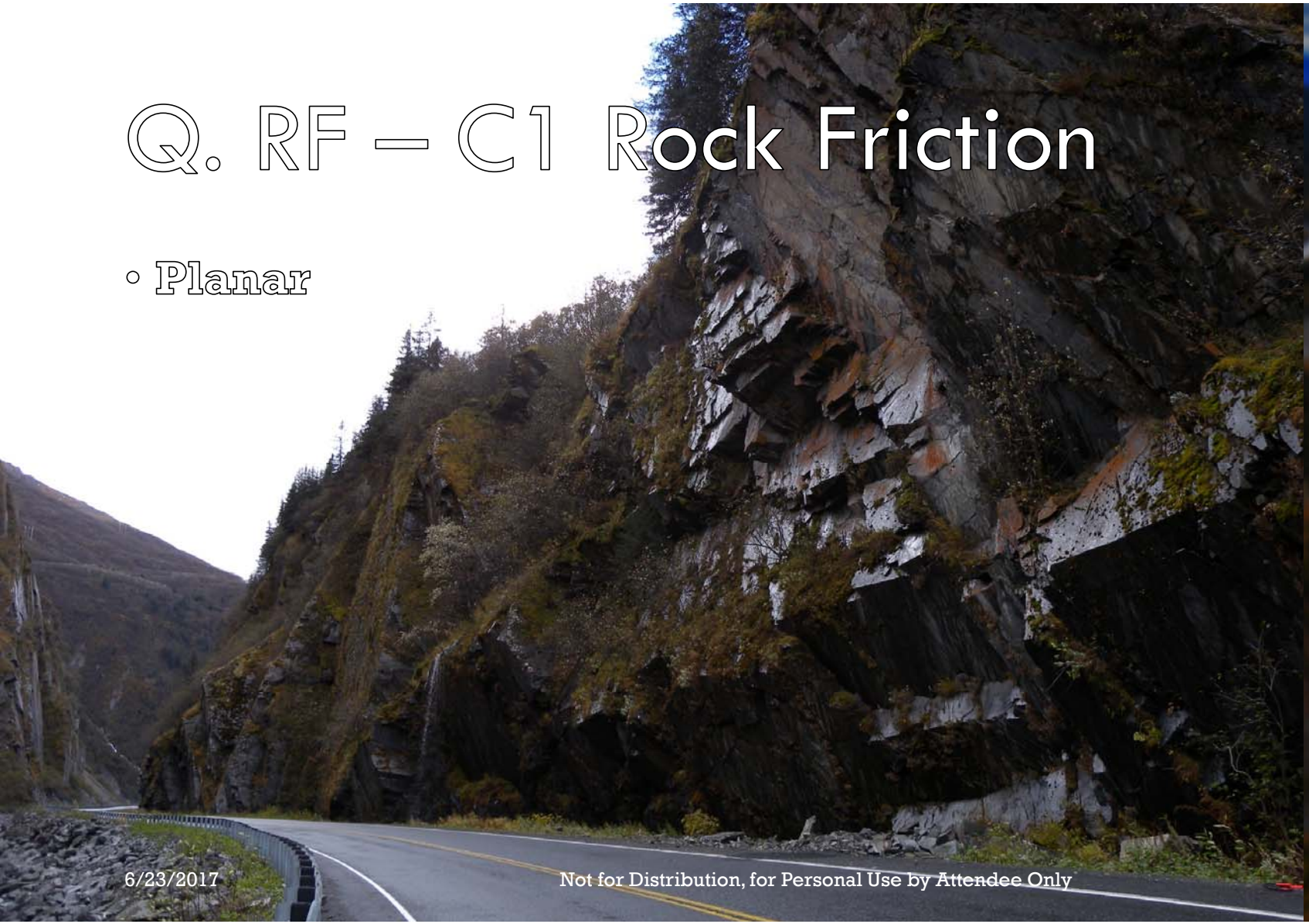
Q. RF – C1 Rock Friction

- **Planar**



Q. RF – C1 Rock Friction

- Planar



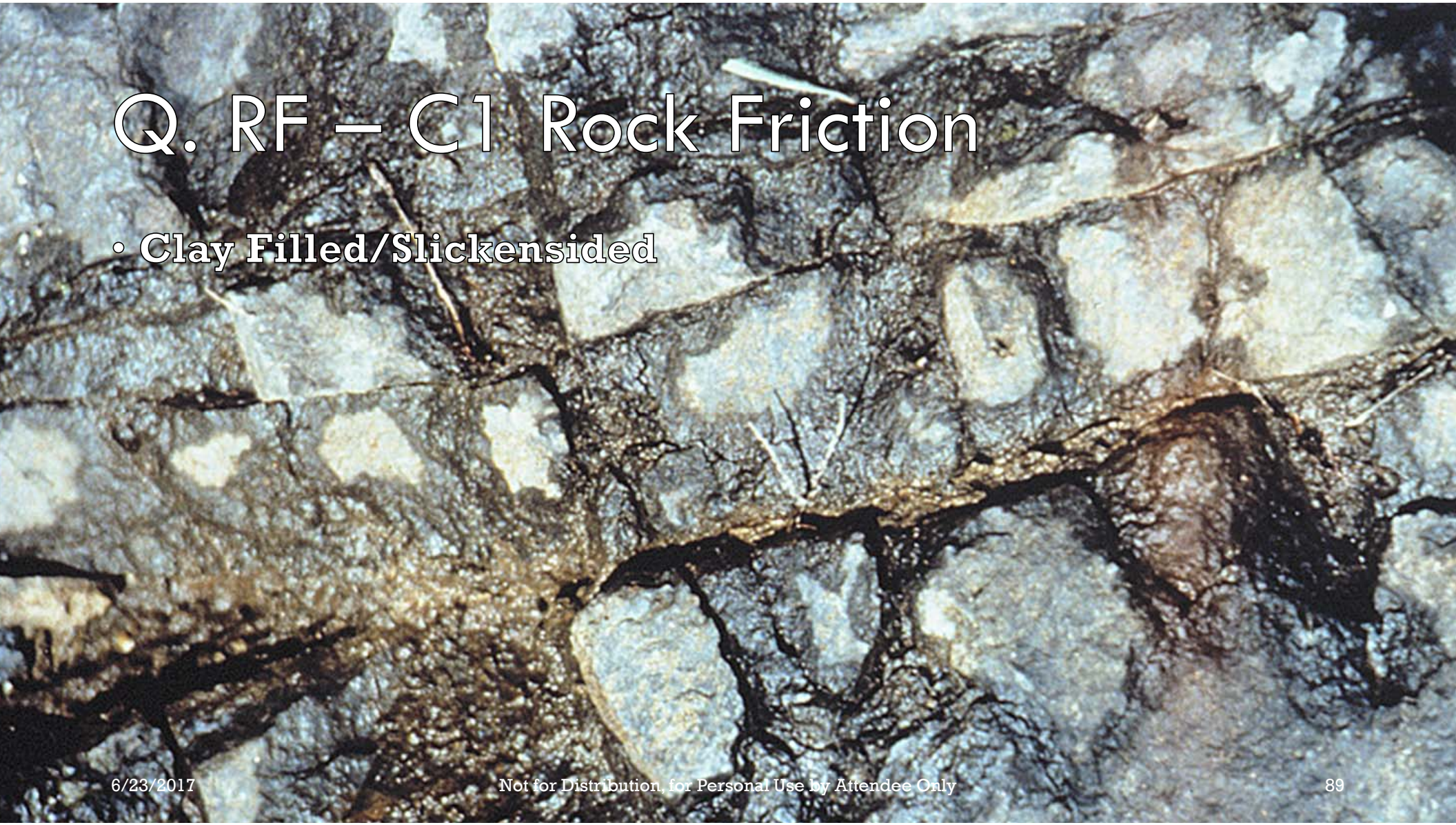
Q. RF – C1 Rock Friction

- **Planar**

Q. RF – C1 Rock Friction

- **Planar**

Q. RF – C1 Rock Friction



- **Clay Filled/Slickensided**

R. RF – C2 Structural Condition

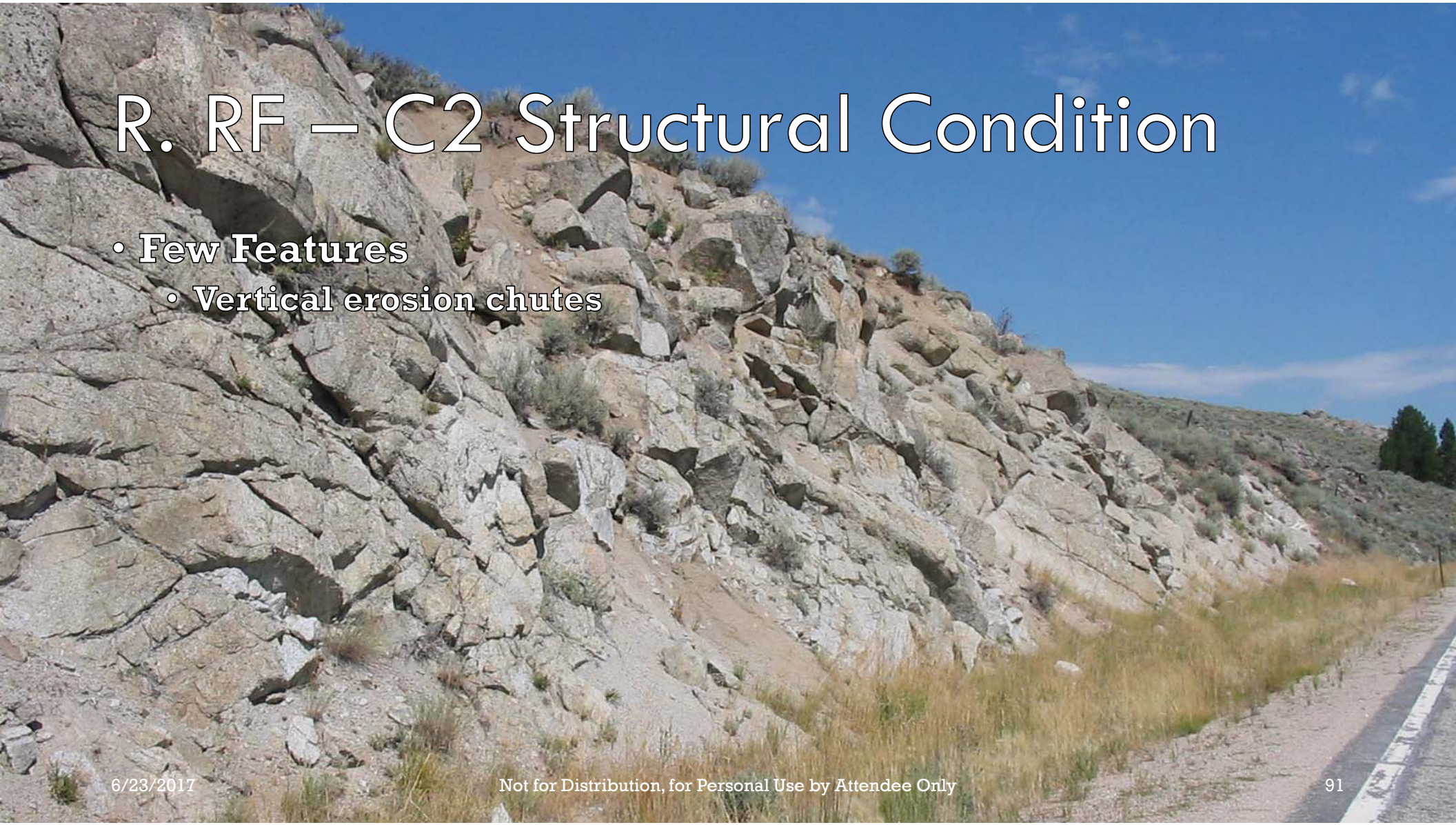
- Common in
  - Layered units
  - Easily erodible
  - Highly variable (breccias, conglomerates, limestone w/ dissolution features, till, etc.)

SLOPE HAZARD RATING

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. 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	
J. All - Annual Rainfall				0-10"	10-30"	30-60"	60"+	
K. All - Slope Height / Axial length of slide				25 ft	50 ft	75 ft	100 ft	CALC
Select One Unstable Slope Type: Landslides/ Erosion (add A, B, C)	L. Thaw Stability (Cold Climates)			Unfrozen/Thaw Stable	Slightly Thaw Unstable	Moderately Thaw Unstable	Highly Thaw Unstable	
	M. Instability-Related Maint. Frequency			Every 10 years	Every 5 years	Every 2 years	Every year	
	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)	
Rockfalls (add D, E, F)	O. Rockfall-Related Maint. Frequency			Normal, scheduled maintenance	Patrols after every storm events	Routine seasonal patrols	Year-round patrols	
	Geologic Character	Case 1	P. Structural Condition	Discontinuous Favorable	Discontinuous Random	Discontinuous Adverse	Continuous Adverse	
			Q. Rock Friction	Rough/ Irregular	Undulating	Planar	Clay infilled/ Slickensided	
		Case 2	R. Structural Condition	Few differential erosion features	Occasional differential erosion features	Many differential erosion features	Major differential erosion features	
			S. Diff. in Erosion Rates	Small difference	Moderate difference	Large difference	Extreme difference	
T. LANDSLIDE HAZARD TOTAL (A+B+C+I+J+K+L+M+N)								CALC
U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greatest of P+Q or R+S))								CALC

3 points	Few Differential Erosion Features. Minor differential erosion features that are not distributed throughout the slope.
9 points	Occasional Differential Erosion Features. Minor differential erosion features that are widely distributed throughout the slope.
27 points	Many Differential Erosion Features. Differential erosion features that are large and numerous throughout the slope
81 points	Major Differential Erosion Features. Severe cases such as dangerous erosion-created overhangs, or significantly oversteepened soil/rock slopes or talus slopes.

R. RF – C2 Structural Condition



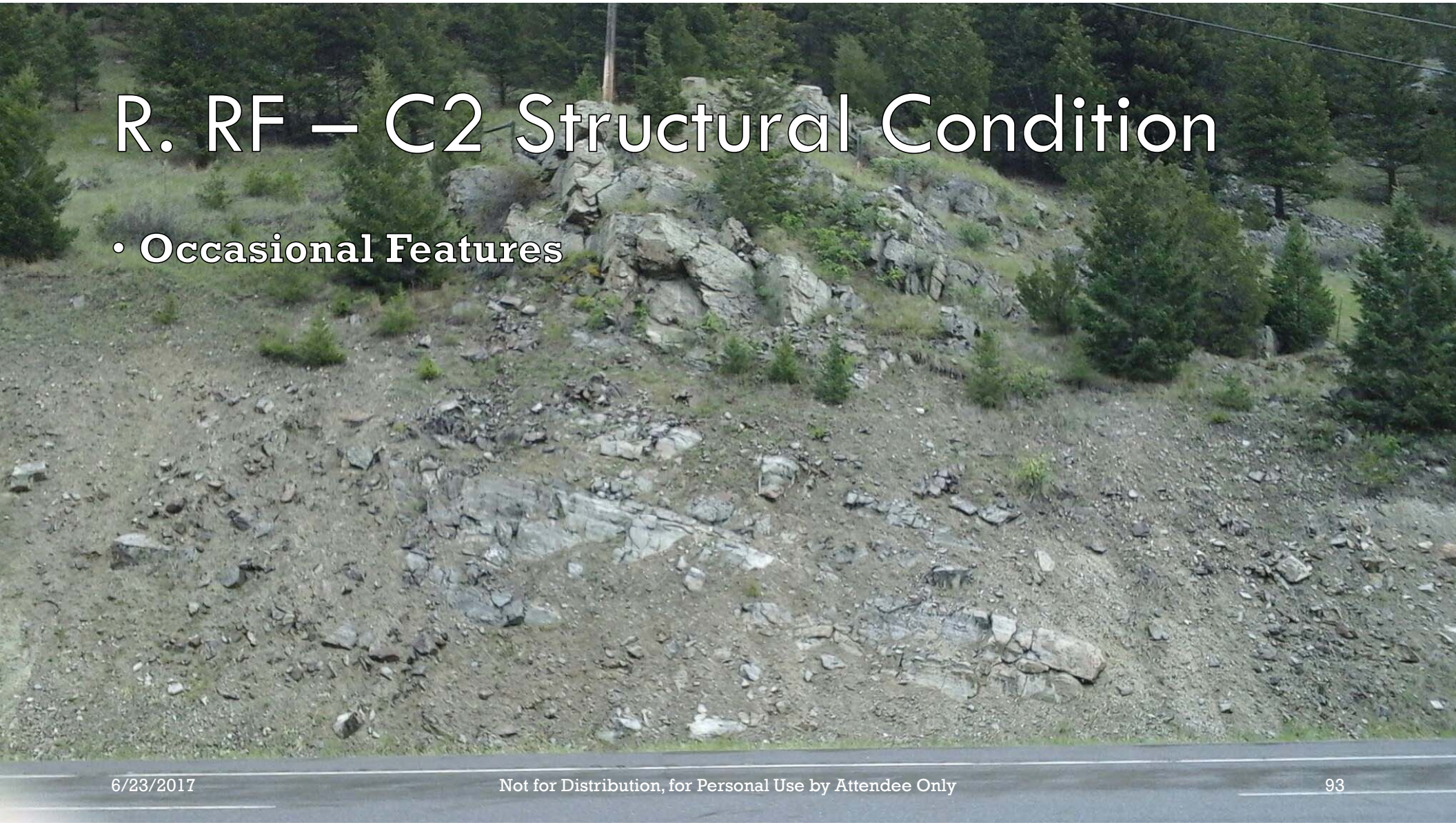
- **Few Features**
  - **Vertical erosion chutes**

R. RF – C2 Structural Condition

- Few Features
  - Blocks in matrix

R. RF – C2 Structural Condition

- **Occasional Features**



R. RF – C2 Structural Condition

- **Occasional Features**

R. RF – C2 Structural Condition

- **Many Features**

R. RF – C2 Structural Condition

- **Many Features**

R. RF – C2 Structural Condition

- **Many Features**

R. RF – C2 Structural Condition

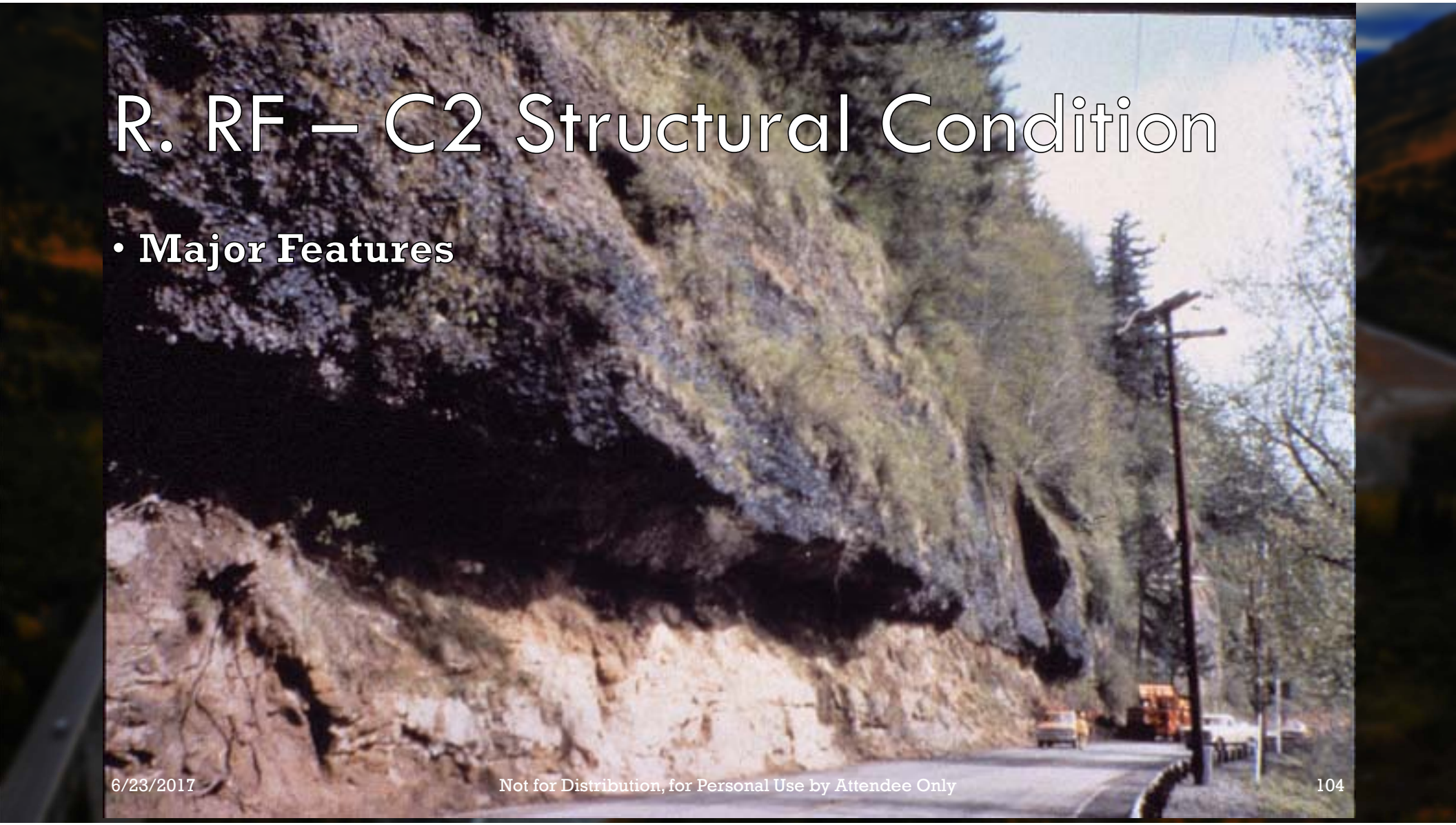
- **Major Features**

R. RF – C2 Structural Condition

- **Major Features**

R. RF – C2 Structural Condition

- **Major Features**

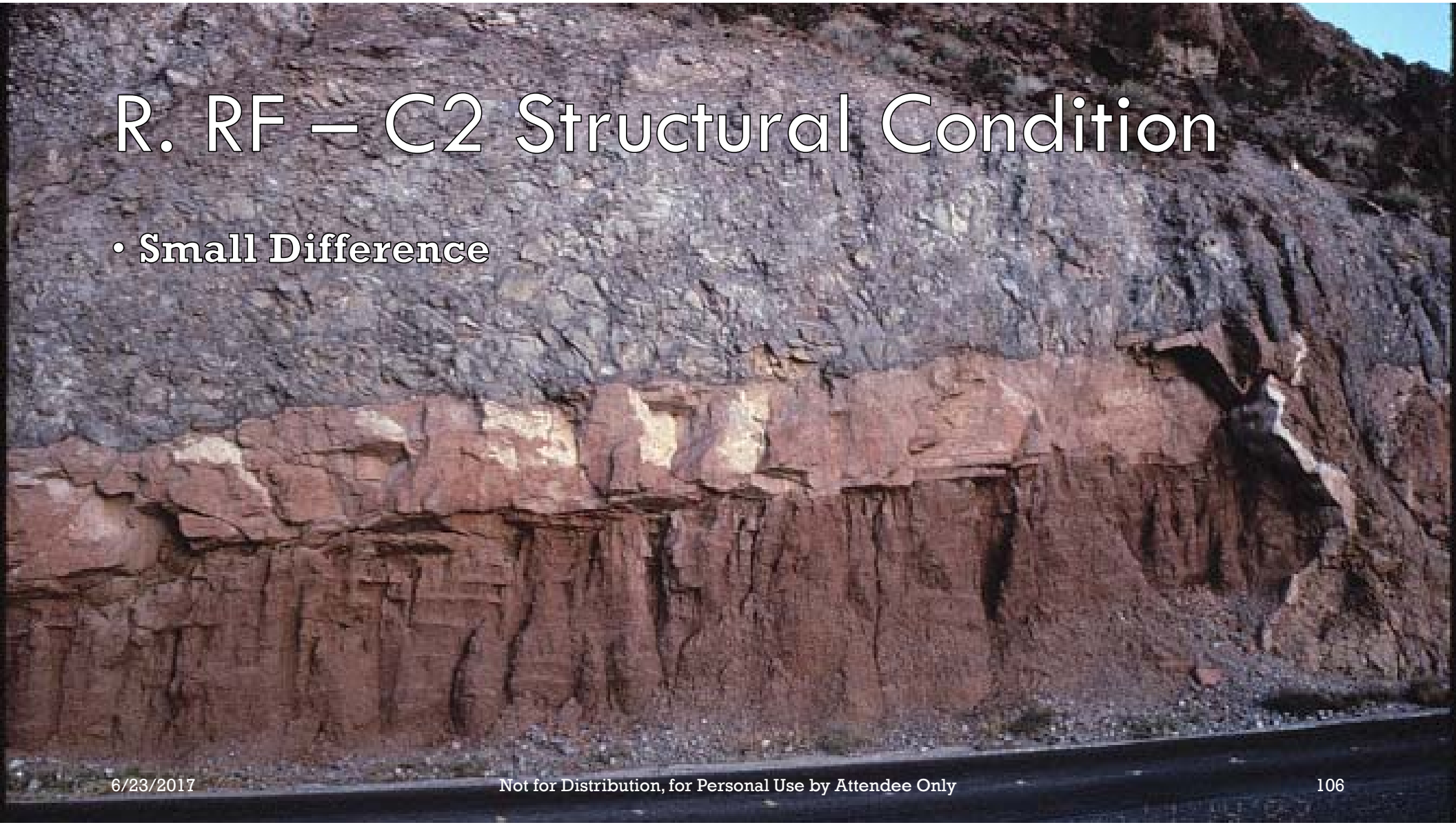


S. RF – C2 Rate Difference

SLOPE HAZARD RATING						
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. 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	
J. All - Annual Rainfall			0-10"	10-30"	30-60"	60"+	
K. All - Slope Height / Axial length of slide			25 ft	50 ft	75 ft	100 ft	CALC
Select One Unstable Slope Type: Landslides/ Erosion (add A, B, C)	L. Thaw Stability (Cold Climates)		Unfrozen/Thaw Stable	Slightly Thaw Unstable	Moderately Thaw Unstable	Highly Thaw Unstable	
	M. Instability-Related Maint. Frequency		Every 10 years	Every 5 years	Every 2 years	Every year	
	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)	
Rockfalls (add D, E, F)	O. Rockfall-Related Maint. Frequency		Normal, scheduled maintenance	Patrols after every storm events	Routine seasonal patrols	Year-round patrols	
Geologic Character	Case 1	P. Structural Condition	Discontinuous Favorable	Discontinuous Random	Discontinuous Adverse	Continuous Adverse	
		Q. Rock Friction	Rough/ Irregular	Undulating	Planar	Clay infilled/ Slickensided	
	Case 2	R. Structural Condition	Few differential erosion features	Occasional differential erosion features	Many differential erosion features	Major differential erosion features	
		S. Diff. in Erosion Rates	Small difference	Moderate difference	Large difference	Extreme difference	
T. LANDSLIDE HAZARD TOTAL (A+B+C+I+J+K+L+M+N)							CALC
U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greatest of P+Q or R+S))							CALC

3 points	Small Difference. Erosion features take many years to develop. Slopes that are near equilibrium with their environment are covered by this category..
9 points	Moderate Difference. The difference in erosion rates allows erosion features to develop over a period of a few years.
27 points	Large Difference. The difference in erosion rates allows noticeable changes in the slope to develop annually
81 points	Extreme Difference. The difference in erosion rates allows rapid and continuous development of erosion features..

R. RF – C2 Structural Condition



- **Small Difference**

R. RF – C2 Structural Condition

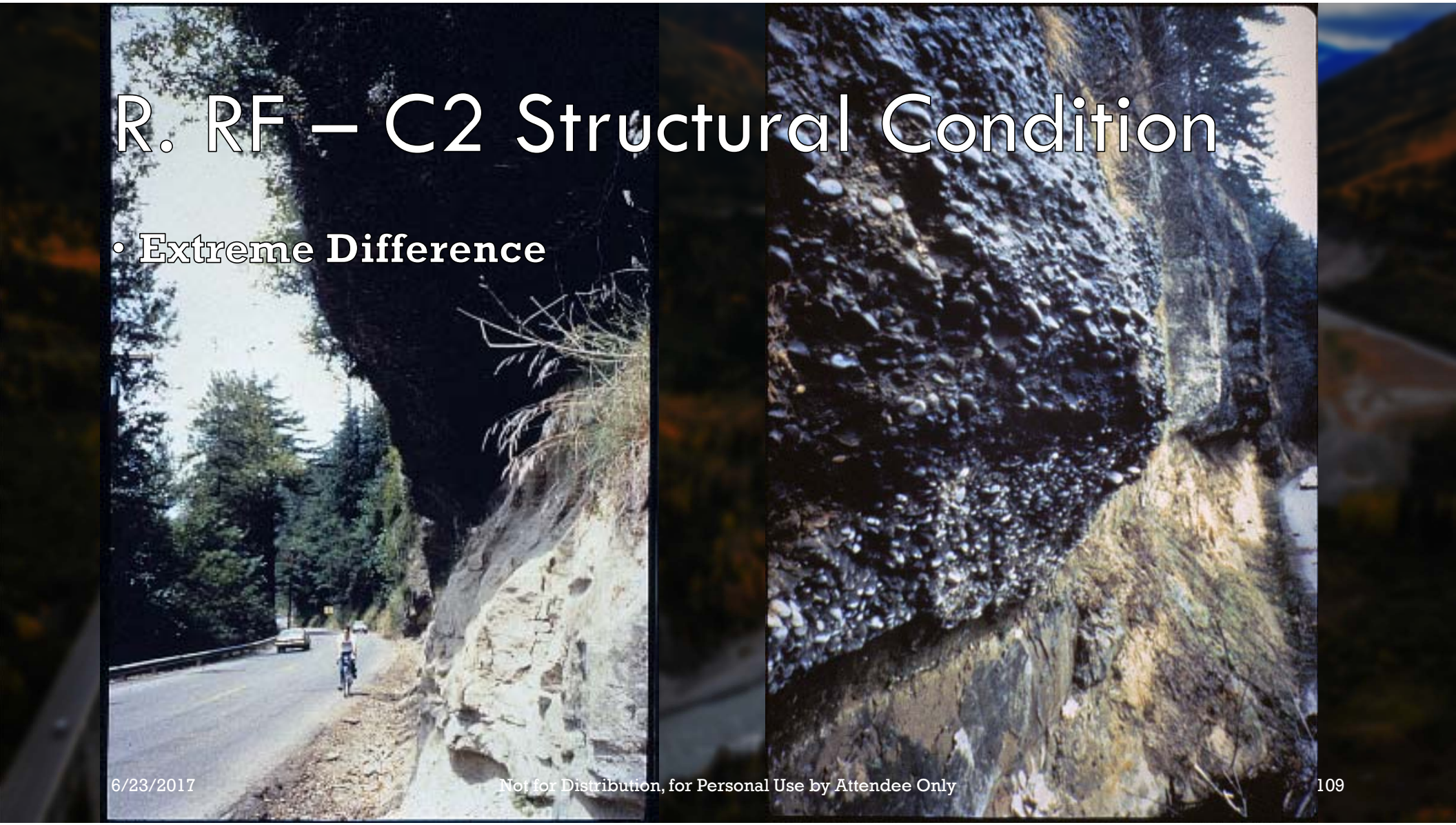
- **Moderate Difference**

R. RF – C2 Structural Condition

- **Large Difference**

R. RF – C2 Structural Condition

- **Extreme Difference**



Total Hazard Scores

- For Landslides: add categories A, B, C (first page), I, J, K, L, M, N
- For Rockfall, add categories, D, E, F (first page), I, J, K, O, & max of (P+Q *or* R+S)

- Progress onto next round of ratings…Risk Ratings

SLOPE HAZARD RATING								
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. 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	
J. All - Annual Rainfall					0-10"	10-30"	30-60"	60"+	
K. All - Slope Height / Axial length of slide					25 ft	50 ft	75 ft	100 ft	CALC
Select One Unstable Slope Type	Landslides/ Erosion (add A, B, C)	L. Thaw Stability (Cold Climates)			Unfrozen/Thaw Stable	Slightly Thaw Unstable	Moderately Thaw Unstable	Highly Thaw Unstable	
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T. LANDSLIDE HAZARD TOTAL (A+B+C+I+J+K+L+M+N)									CALC
U. ROCKFALL HAZARD TOTAL (D+E+F+I+J+K+O+(greatest of P+Q or R+S))									CALC