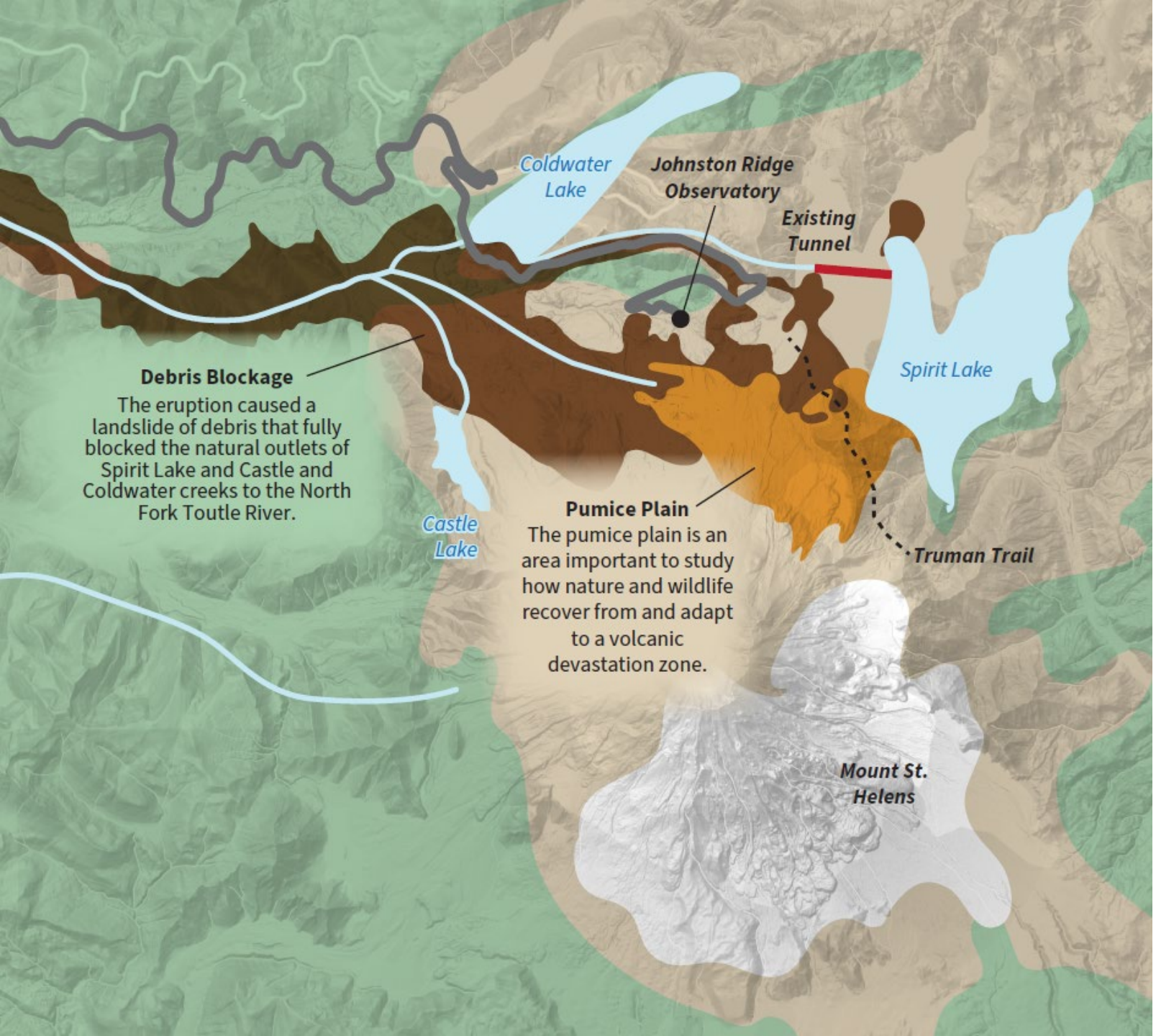
March 26, 2025

SPIRIT LAKE OUTFLOW SAFETY IMPROVEMENT PROJECT

Virtual Public Meeting No. 3

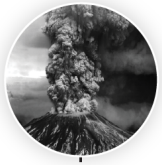
Opening Remarks

USDA FOREST SERVICE



Spirit Lake Outflow Safety Improvement Project at Mount St. Helens National Volcanic Monument

History of the Spirit Lake Outflow Tunnel



1980: Mount St. Helens erupts, causing widespread damage and loss of 57 lives. Blast debris blocks the outlet to Spirit Lake, and the lake can no longer drain.

1982: Impounded waters of Spirit Lake rise dangerously and FEMA fears a catastrophic flood from a potential breach of the debris blockage is imminent. The US Army Corps of Engineers (Army Corps) deploys barge-mounted pumps to remove water from the lake.

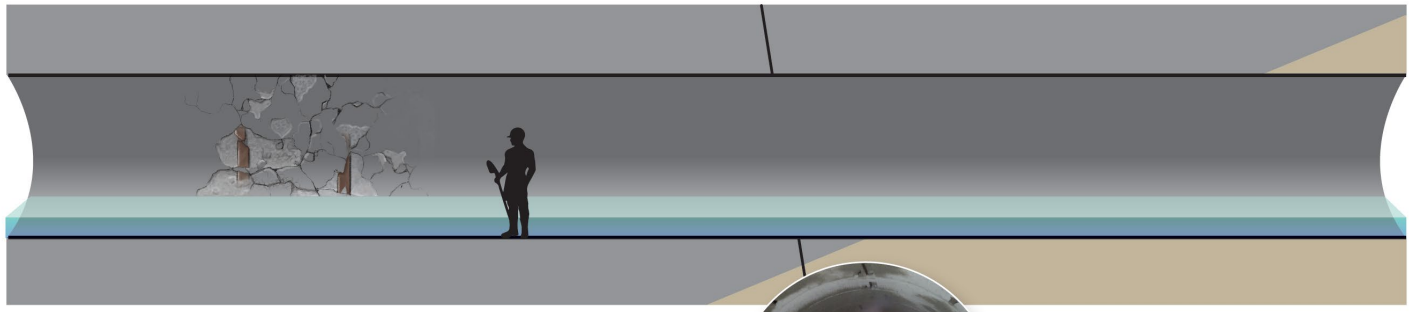
1989: The Army Corps builds a sediment retention structure on the North Fork Toutle River to counteract ongoing sedimentation in the area's rivers by slowing the flow of water to allow debris to settle rather than be carried downstream.

1985: A tunnel is bored through Harry's Ridge to create a new outlet for Spirit Lake water. This addresses the immediate dangers of the lake overflov release of the debris block downstream communities

1995 & 1996: Major tunnel repairs are required for two consecutive years. During these efforts, Spirit Lake is unable to discharge. Rising water levels approach the maximum safe operating levels where pressure on the natural debris blockage increases, and creates concern about potential future tunnel failure and the downstream consequences.

2016: Major tunnel repairs noted during annual inspections are addressed. As in 1995 and 1996, Spirit Lake water levels approach maximum safe operating levels while repairs are underway.

2021: The U.S. Forest Service (USFS), Gifford Pinchot National Forest is seeking a long-term solution to managing Spirit Lake water levels. As the responsible agency, the Forest Service must address the consequences of the aging tunnel, and a single lake outlet.



1995/1996:
Large sections of shotcrete had pulled away from the tunnel walls and the floor had heaved and cracked. Some supportive ribs had buckled.

2015/2016:
Significant floor heave from high ground pressure reduced the tunnel diameter from 11 feet to 7 feet, restricting flow capacity.

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Congress of the United States
Washington, DC 20510

May 7, 2015

The Honorable Tom Tidwell
Chief
U.S. Forest Service
1400 Independence Ave. S.W.
Washington, D.C. 20250

The Honorable Jo-Ellen Darcy
Assistant Secretary of the Army (Civil Works)
U.S. Army Corps of Engineers
108 Army Pentagon
Washington, D.C. 20310-0108

The Honorable Suzette Kimball
Director (Acting)
U.S. Geological Survey
12201 Sunrise Valley Drive
Reston, VA 20192

Dear Chief Tidwell, Assistant Secretary Darcy, and Director Kimball:

We write with serious concern regarding the state of the Spirit Lake Tunnel, located on the Gifford Pinchot National Forest in our home state of Washington. We understand that the tunnel is in significant need of renovation and repair and we wish to ensure federal agencies are doing everything in their power to prevent a structural failure, including communicating their needs to Congress. Complete failure of this tunnel in the shadow of Mount St. Helens could be catastrophic to Washington state on multiple levels.

While the tunnel is located on land managed by the U.S. Forest Service (USFS) and is operated and maintained by the USFS, it was constructed by the U.S. Army Corps of Engineers (Army Corps). Using funds provided by the USFS, the Army Corps has provided inspection and repair work on the tunnel throughout its existence, and the U.S. Geological Survey (USGS) has monitored seismic activity in the region at the Cascades Volcano Observatory.

Spirit Lake tunnel operating again

Andre Stepankowsky andre@tdn.com Mar 15, 2016 0

1 of 2

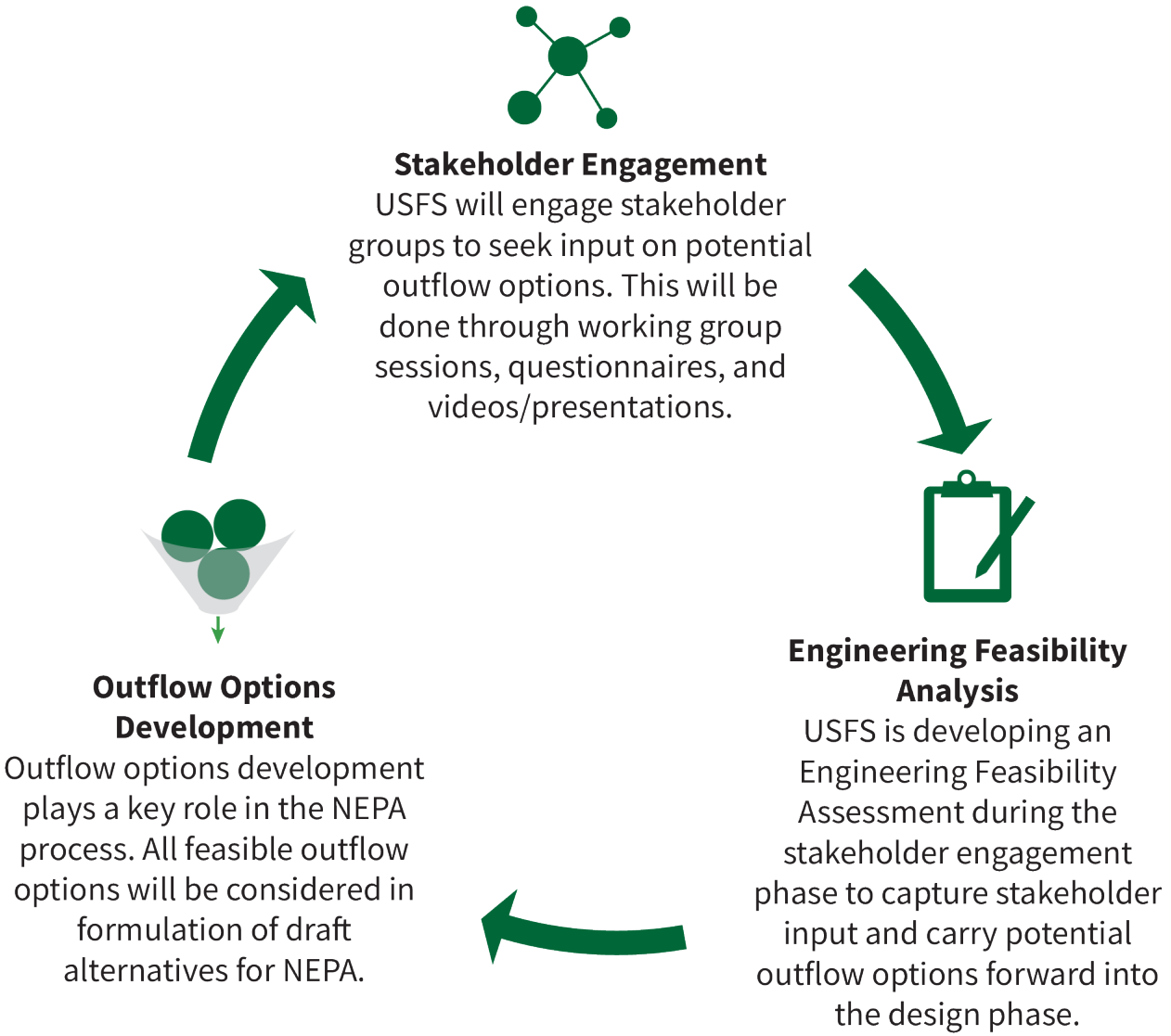
Failure of Wash. volcano runoff could be catastrophic

Kyle Iboshi KGW Staff

Published 7:20 p.m. ET May 14, 2015

Spirit Lake Tunnel *Kyle Iboshi, KGW*

The Enhanced Outreach Process



Stakeholder Engagement
USFS will engage stakeholder groups to seek input on potential outflow options. This will be done through working group sessions, questionnaires, and videos/presentations.

Engineering Feasibility Analysis
USFS is developing an Engineering Feasibility Assessment during the stakeholder engagement phase to capture stakeholder input and carry potential outflow options forward into the design phase.

Outflow Options Development
Outflow options development plays a key role in the NEPA process. All feasible outflow options will be considered in formulation of draft alternatives for NEPA.

USFS and the local Collaborative Group have hosted many discussions, identified values, and explored ideas and solutions in the years and months leading up to NEPA. This is an iterative process which relies on continued engagement with stakeholders. All these efforts will inform NEPA compliance documentation and USFS decision-making.

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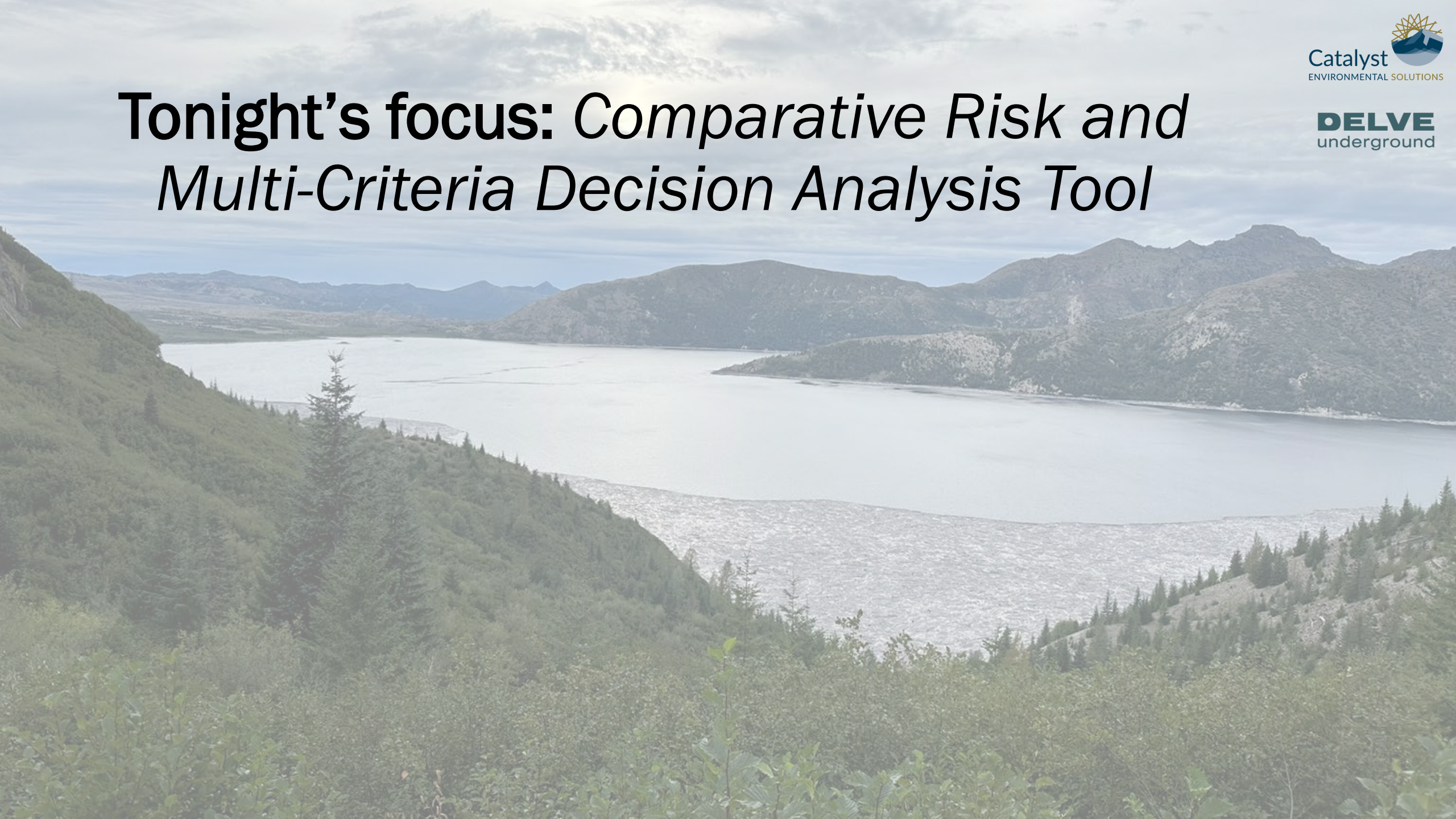
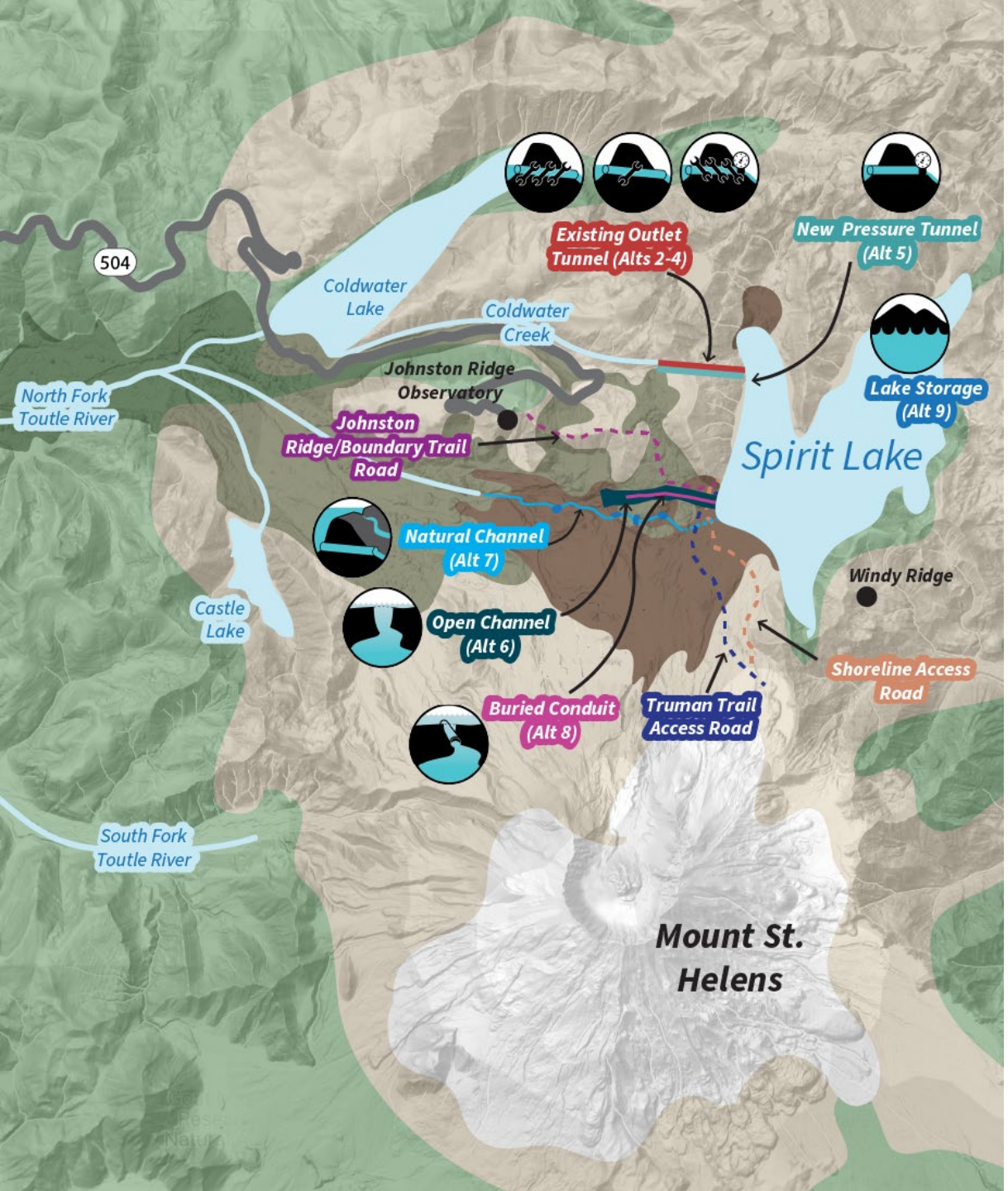
Tonight's focus: *Comparative Risk and Multi-Criteria Decision Analysis Tool*





Lake Level Control

A **Preferred Alternative(s)** have not yet been selected for the project; however, the lake level control options shown here will be analyzed to identify a preferred alternative (for NEPA) which will be a combination of the below alternatives or components of alternatives. For example, rehabilitating the existing tunnel through the ridge could be combined with a buried conduit in the pumice plain as the redundant measure.

Harry's Ridge Tunnel Options			
			
Alt 2 Full Repair of Existing Tunnel	Alt 3 Minor Repair of Existing Tunnel	Alt 4 Convert Existing Tunnel to Pressurized System	Alt 5 New Pressurized Tunnel

Pumice Plain Outlet Options			Lake Storage Option
			
Alt 6 Mechanically Excavated Open Channel	Alt 7 Facilitate Natural Channel Formation	Alt 8 Buried Conduit within the Debris Blockage	Alt 9 Lake Storage

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Examples of Engineered Structures

Temporary pump station in the early 1980s

Tunnel repair 2016

Example buried conduit installation

Example heavy haul road

Illustrative AI rendering of concrete lined channel

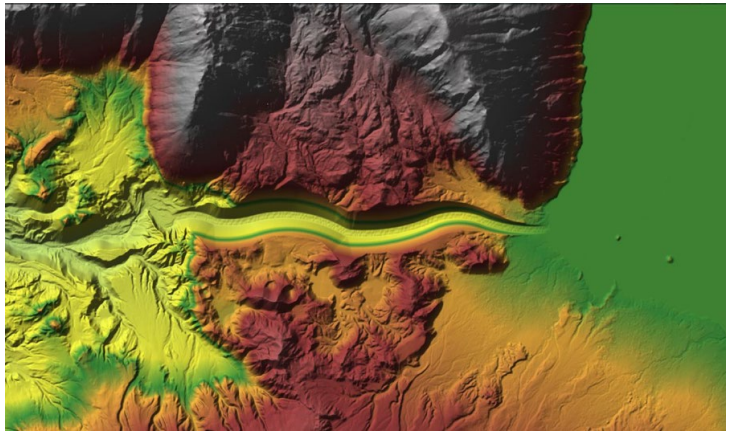
The Truman Trail (center) during operation of the pumping pipeline in the early 1980s

Example new tunnel construction

Example access road from a distance

Tunnel boring machine

Example access road through Pumice Plain



Terrain of the potential open channel using LiDAR data

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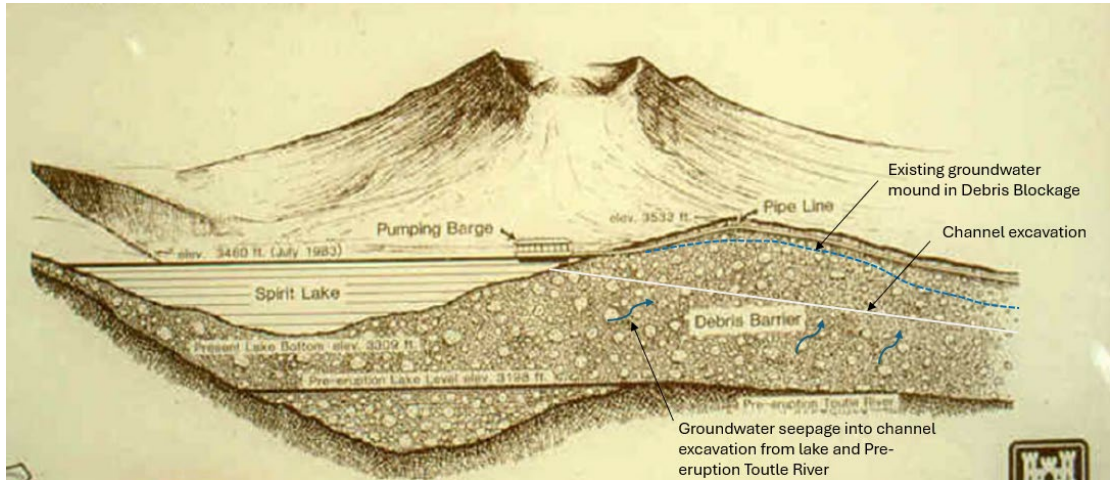
Outflow Option Summary: Combinations after screening evaluations

Paired Option ID	Primary Lake Level Control Measure	Redundant Lake Level Control Feature	Natural and Nature Based Habitat Channel Development Compatibility
A	Open channel which maintains Spirit Lake at its current normal lake elevation 3,440 feet Alternative 6	Existing outlet tunnel system rehabilitated to serve as a redundant, back-up outlet Alternative 2 or 3	No
B	Rehabilitate existing tunnel (full repair) and lower intake channel depth Alternative 2	Lake storage considering a lower operating lake level by modifying the existing intake depth Alternative 9	Maybe with alternative water supply source
C	New pressure tunnel parallel to existing tunnel Alternative 5	Existing outlet tunnel system serves as a redundant, back-up outlet Alternative 3	Yes
D	Rehabilitate existing tunnel (full repair) Alternative 2	Buried conduit that serves as an emergency spillway through the debris blockage Alternative 8	Maybe with alternative water supply source or lake water siphon.
E	Convert existing tunnel into a pressure tunnel Alternative 4	Lake storage with consideration of an updated max safe lake level Alternative 9	No
F	New tunnel and intake system parallel to existing tunnel alignment Alternative 5	Lake storage considering a lower operating lake level with new intake and the existing tunnel outlet serving as an emergency outlet Alternative 3 and 9	Yes

Comparative Evaluation of Risk Relative to Baseline

- Identify major hazards that impact project objectives and assess the relative impact amongst alternatives
- “Hazards” are events which are uncertain to occur but would negatively affect the Project if they did occur
- “Risk” = (Probability of Hazard) x (Severity of Hazard Consequence)

SR 504 Landslide Washout. Photo Credit: WSDOT



Risk of Different Hazard Types

Operational Risk – Vulnerability to seismic, volcanic, and hydrogeologic impacts

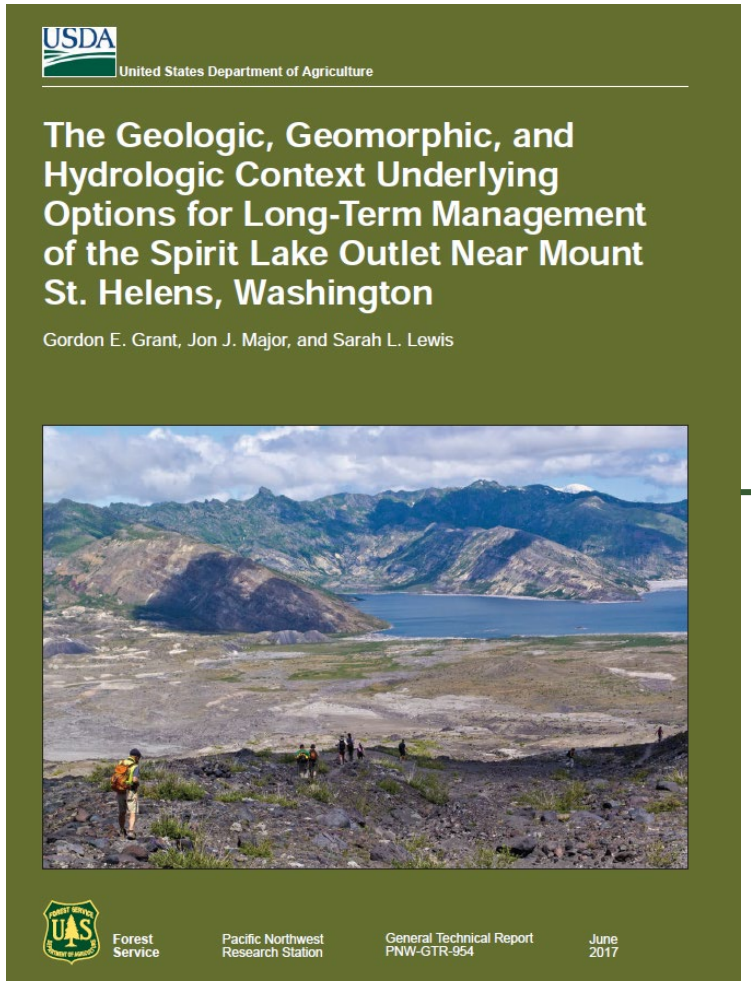
Construction Risk – Unanticipated subsurface and groundwater impacts (offsite and onsite)

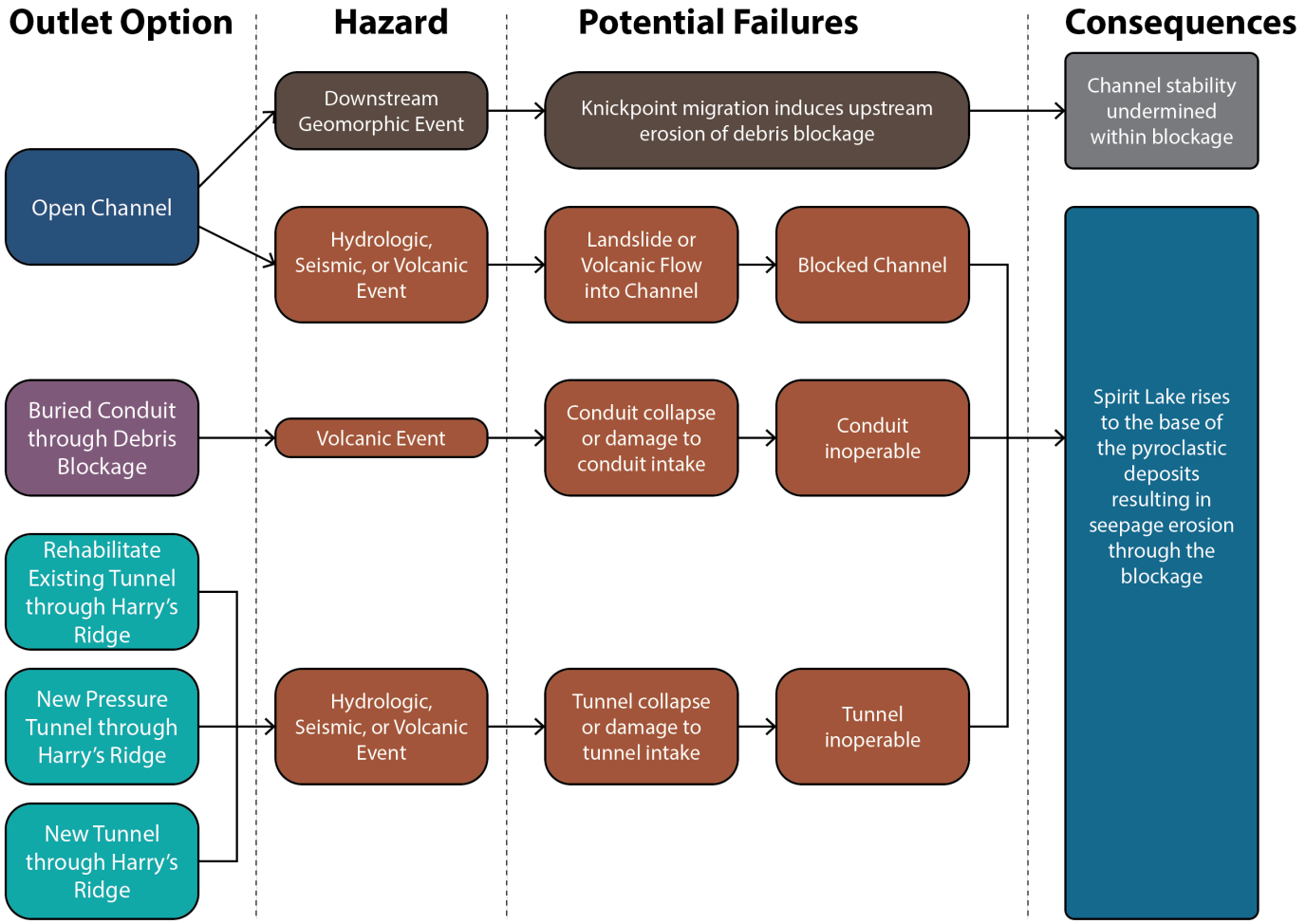
Environmental – Permanent disturbance to landscape and watershed

Sediment Mobilization – Downstream impacts from sediment mobilization for large outflows

Operational Risk

2017 Risk Evaluation: USACE methods for Potential Failure Mode Assessment, augmented by consequence analysis and expert opinion





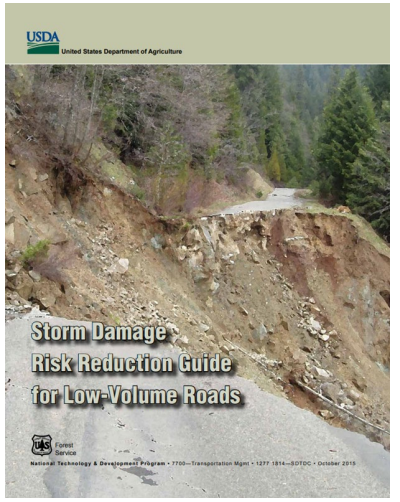
Natural Hazards (Operational)

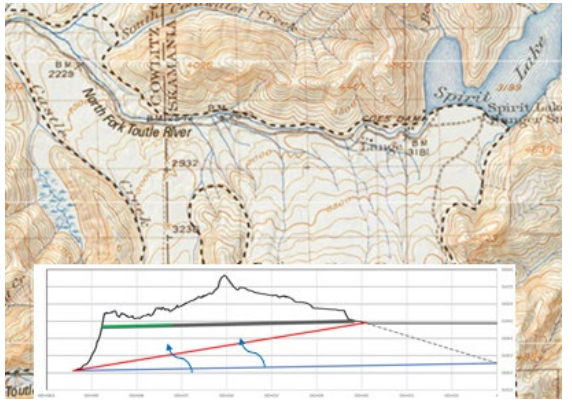
- Landslides triggered by large hydrologic event blocks an outflow which leads to rising lake level and subsequent debris flow through the blockage
- Landslides triggered by a large seismic event blocks an outflow which leads to rising lake level and subsequent debris flow through the blockage
- Lahar event blocks an outflow channel which leads to rising lake level and subsequent debris flow through the channel blockage
- Seismic ground deformations damage an outflow structure, temporarily reducing outlet capacity until repairs can be made
- Knick point initiating mass movements during large hydrologic event that extends upstream into the debris blockage.

SR 504 Damage (Photo Credit WSDOT)

Construction

- Unanticipated site conditions or unstable terrain delays construction and requires extensive modification to construction methods, design and extended project duration.
- Rare hydrologic event floods the construction work area requiring worker evacuation and extensive remediation of work sites afterwards.
- Groundwater induced excavation instability due to artesian groundwater pressures that are influenced by lake level requiring extensive groundwater pumping or modification to construction methods to cut-off groundwater
- Impeded offsite access routes





Ground Disturbance

- Site disturbance during construction exceeds impacts assumed in EIS
- Scale of construction access road infrastructure across Pumice Plain
- Contamination from fuel and oils spills from construction equipment require significant cleanup efforts
- Excavated material disposal quantities exceeds capacity of designated disposal sites requiring alternative disposal sites and configurations

Sediment Mobilization

- Excessive sediment mobilization during construction
- Sediment mobilization exceeds baseline sediment loads
- Sediment loading during large hydrologic events inundates SRS before future SRS modifications are implemented
- Difficult to measure and monitor sediment mobilization

USACE Sediment Retention Structure on the North Fork Toutle River (Photo Credit: USACE)

Risk Evaluation

Risk level matrix and acceptance criteria

Consequence if risk event occurs	1 - Improbable Conceivable but not expected to occur <10%	2 - Unlikely Not expected but possible 11% -25%	3 - Possible May occur occasionally 26%-50%	4 - Probable Will probably occur >51%
4 - Intolerable "Could result in disaster"	4	8	12	16
3 - Undesirable "Serious impact and long-term effect"	3	6	9	12
2 - Tolerable "Impacts are felt but have minimum long-term effect	2	4	6	8
1 - Acceptable Minimal damage or no long-term effect	1	2	3	4

Extreme

Disruptive

Controlled

Likelihood the risk event will occur

Risk Level	Acceptance Criteria
Extreme	Action is required. Exposure to this level of risk should be avoided.
Disruptive	Investigations and interventions are needed. Exposure to this level of risk should only continue with active monitoring and contingency plans that are reviewed and updated regularly.
Controlled	Exposure to this level of risk is acceptable with limited monitoring.

“No Action” Baseline Case

Risk Category	Assessment Metric	Impact	Likelihood	Risk Level
Operational Risk	Outlet damaged and adverse downstream impacts	**4**	**3**	**12**
Construction Risk	Construction safety and impact of extended construction durations	**3**	**3**	**9**
Ground Disturbance	Permanent disturbance to landscape and watershed	**1**	**2**	**2**
Sediment Mobilization	Increase sediment loads beyond background levels	**1**	**1**	**1**
Impact, likelihood, scoring, and risk levels are indicated in Figure 7-1**.**				

Risk Level Comparison *(for illustrative purposes, work-in-progress)*

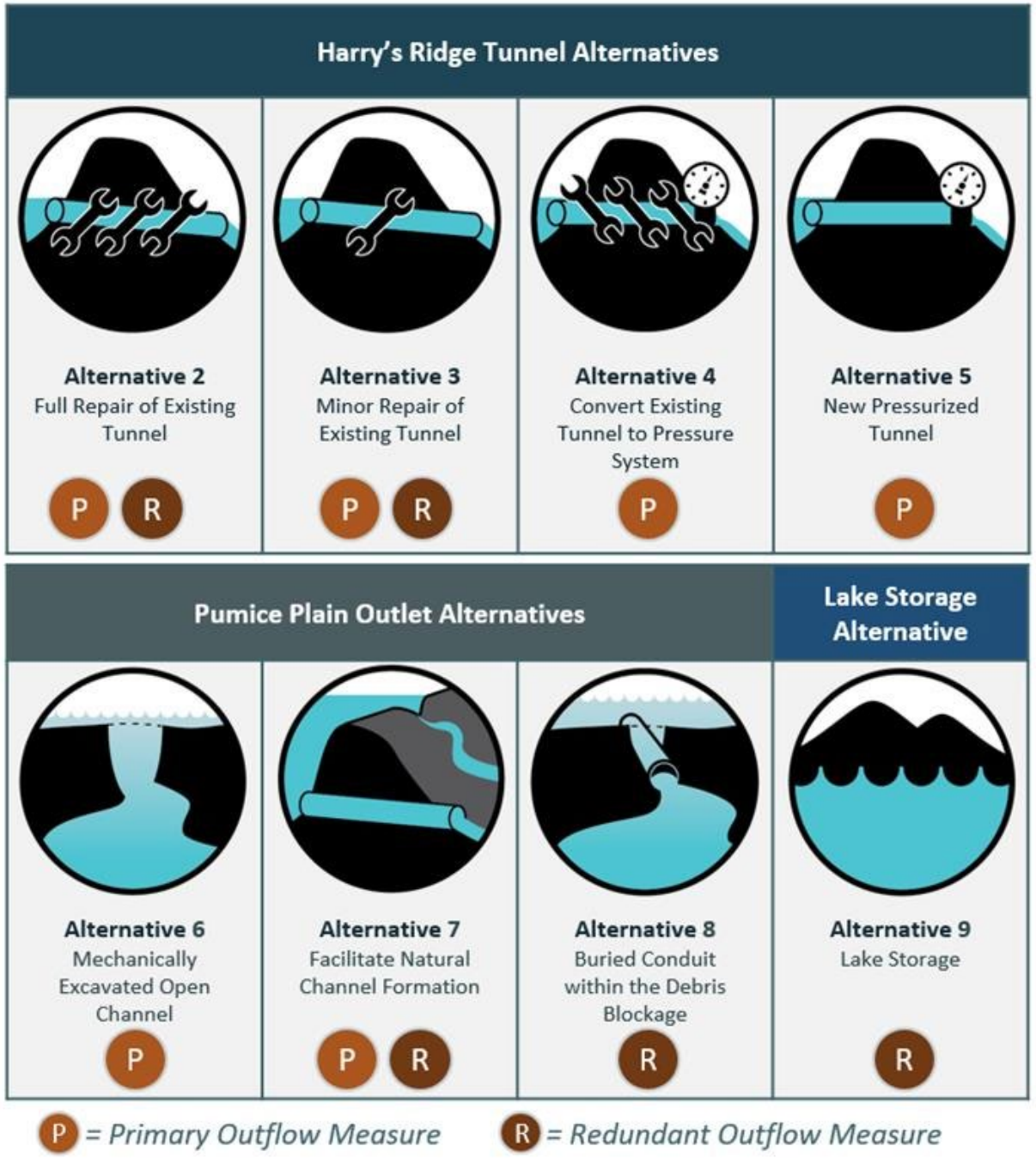
Risk Category	No Action	A Alt 6 Open Channel + Alt 2/3 Repaired Tunnel	B Alt 2 Full Tunnel Repair + Alt 9 Lake Storage	C* Alt 5 New Pressure Tunnel + Alt 3 Minor Repair of Existing Tunnel	D Alt 2 Full Repair of Existing Tunnel + Alt 8 Buried Conduit	E Alt 4 Convert Existing Tunnel to Pressure Tunnel + Alt 9 Lake Storage	F* Alt 5 New Pressure Tunnel + Alt 3 Minor Repair of Existing Tunnel and Alt 9 Lake Storage
Operational	**12**	**12**	**6**	**2**	**9**	**4**	**2**
Construction	**9**	**16**	**6**	**4**	**9**	**4**	**6**
Ground Disturbance	**2**	**12**	**6**	**4**	**12**	**4**	**6**
Sediment Mobilization	**1**	**16**	**2**	**2**	**9**	**2**	**2**

* **Compatible with Natural Habitat Channel Development Alternative 7**

Multi-Criteria Decision Analysis (MCDA) Tool

Alternatives, to be formed as:

- Primary
- Redundant
- Access



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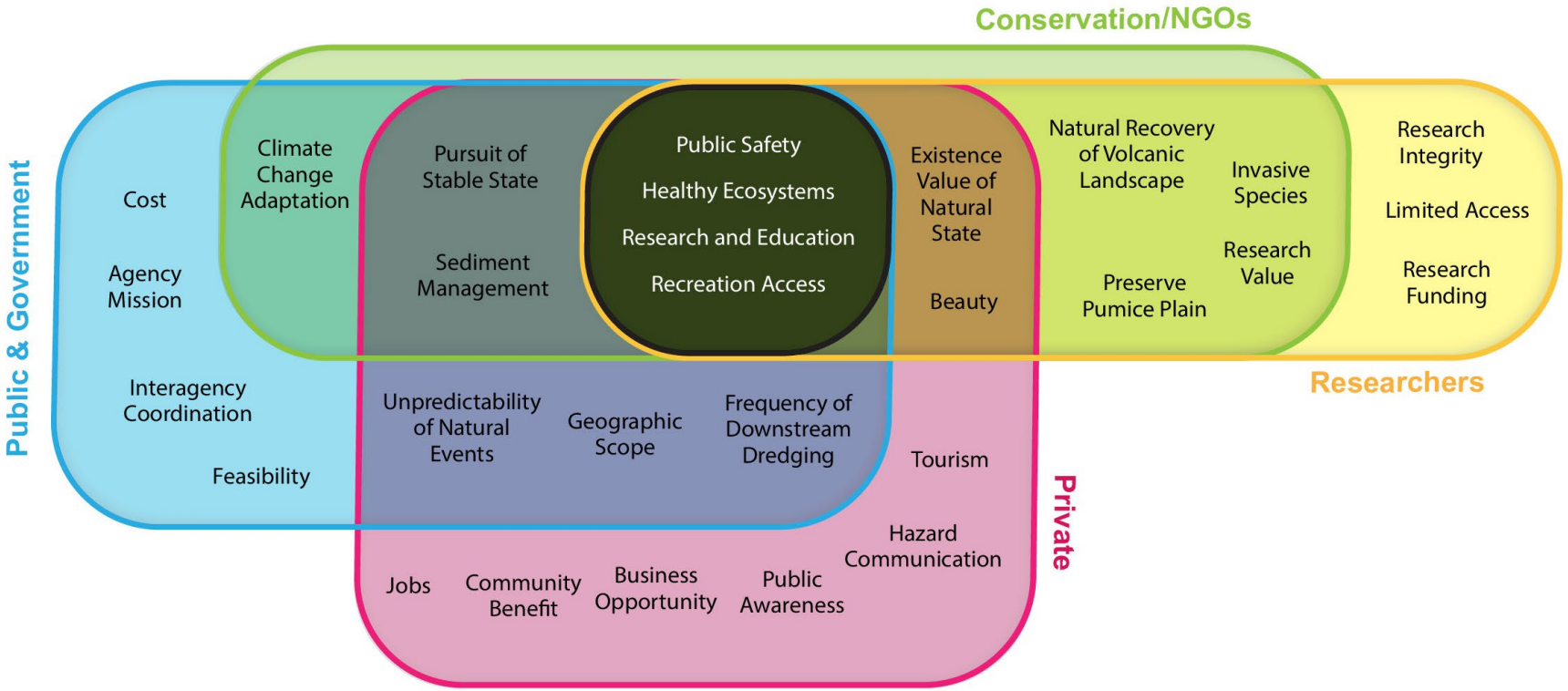
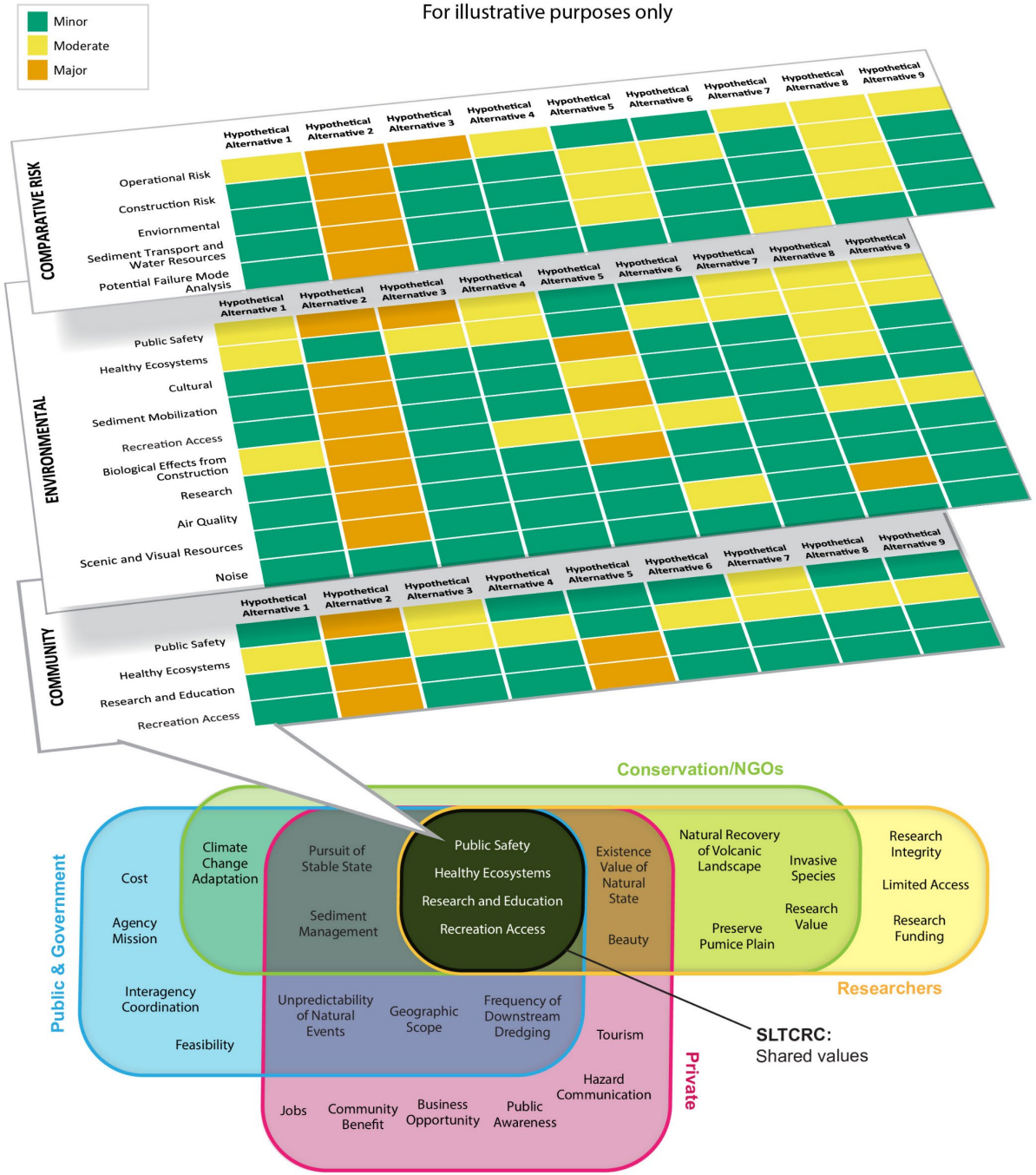
MCDA Tool Integrates Values and Issues Across Several Dimensions:

- Community Dimension
- Risk Dimension
- Environmental Dimension



Bringing it Together: *For Illustrative Purposes Only, Work in Progress*

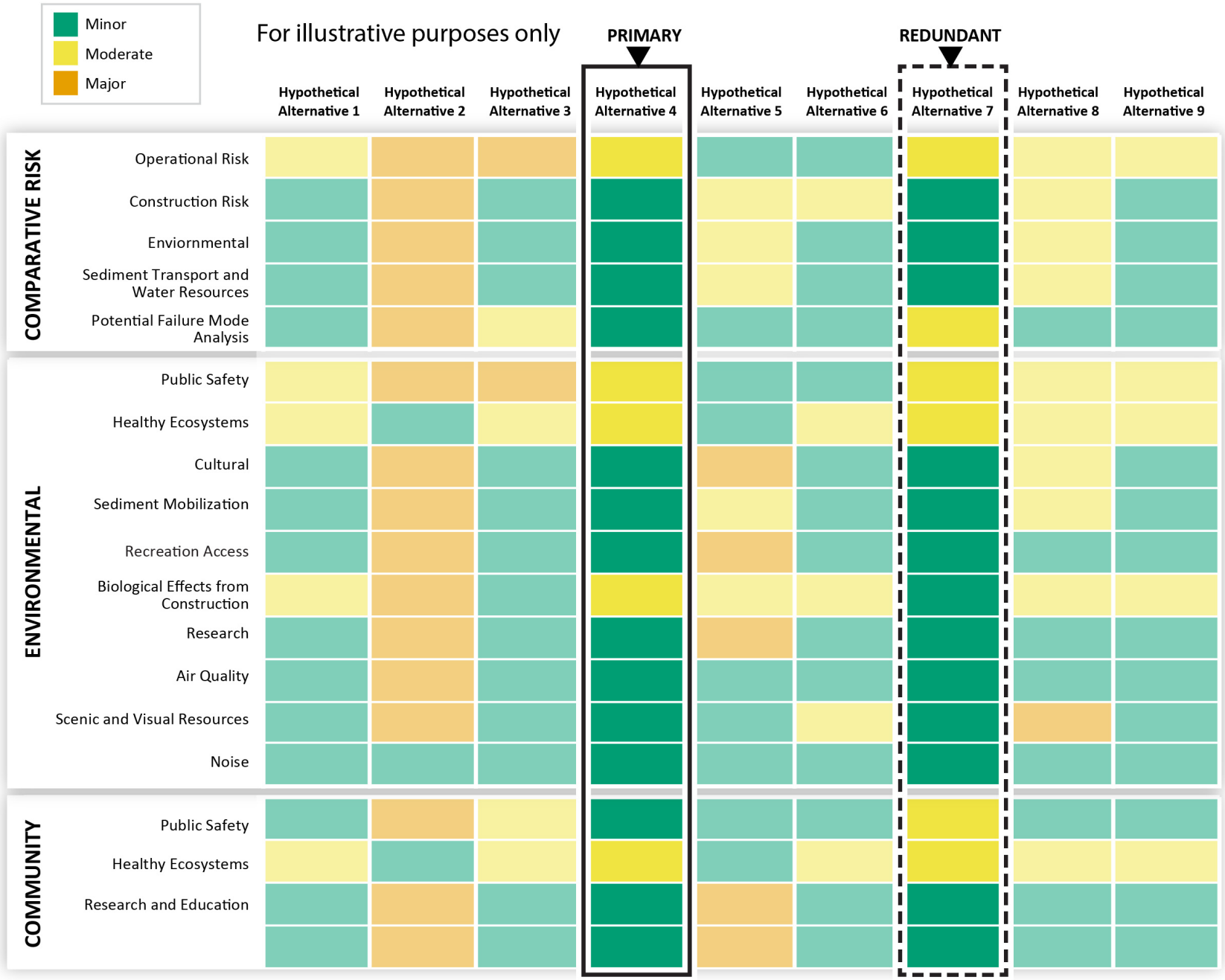
- Weighting Factors
- Overlaying risks within dimensions for each Alternative



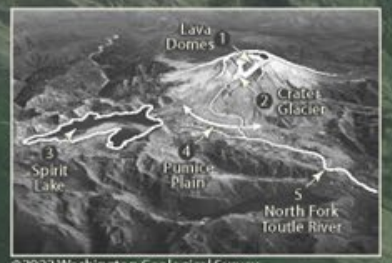
MCDA Tool Illustration

For Illustrative Purposes Only, Work in Progress

- Consider combinations of Primary and Redundant
- Illustrate all dimensions
- Different stakeholders would weight different factors higher and lower

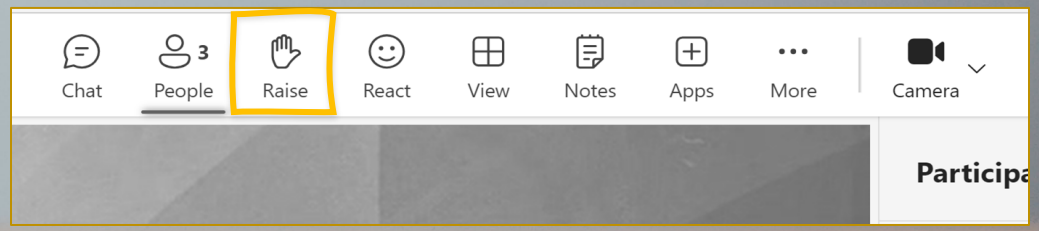


Thank You!



Questions or comments? Let's talk.

Raise your hand in Teams!



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Spirit Lake Outflow Safety Improvement Project Webpage:

https://www.fs.usda.gov/detailfull/giffordpinchot/landmanagement/?cid=fseprd1004094