WASHINGTON STATE UNIVERSITY
Energy Program

Pumped Storage Hydropower Siting Information Study

PSH Siting Topics: Wildlife & Habitat, Geology, Access, and more

WSU Energy Program

October 31, 2024

How to Access Captions/Como Ver Subtítulos

- Option 1: In the meeting controls toolbar, click the **Show Captions** icon CC
- Opción 1: Desde la barra de herramientas, haga clic en el símbolo **Ver Subtítulos** CC

- Option 2: Follow the URL: https://rossstrategic.spf.io/z/7kDnw. The URL will open a separate window and you can select a caption language. The captioning will appear in this separate window.
- Opción 2: Para ver a los subtítulos en español sigue la URL: https://rossstrategic.spf.io/z/3ihjU. Si sigue esta URL, abrirá una ventana nueva donde tendrá la opción de subtítulos en español. Los subtítulos aparecerán en esta ventana nueva.

Escanea el código QR para acceder a los subtítulos

Scan the QR code for captions

Welcome and a few reminders…

- This meeting is being recorded and will be available on the study website—along with the slides and a meeting summary
- Please remain muted unless you are speaking
- As needed, please rename yourself with your affiliation or workplace in Zoom
- Attendees will be able to chat everyone in the meeting
  - If you are experiencing technical issues, please chat directly to "hosts and panelists" (or email to hsherrow@rossstrategic.com).
- To ask questions or join discussion, please use the "raise your hand" button to indicate you would like to speak; chat can also be used for Q&A
- Please be respectful of this process. Allow everyone the chance to speak and listen actively to understand others' views

WSU Energy Program

- Self-supporting department within Washington State University based in Olympia
- Other programs: green transportation education and outreach, community solar, Washington state energy codes (residential) support, community energy efficiency, emerging technologies, and more

WSU Energy Program website: https://www.energy.wsu.edu

WSU PSH Siting Study Team

- Karen Janowitz

WASHINGTON STATE UNIVERSITY
Energy Program

- Terri Parr

WASHINGTON STATE UNIVERSITY

- Tom Beierle
- Susan Hayman
- Hogan Sherrow

ROSS STRATEGIC

- Jeff Boyce

Meridian Environmental, Inc.

Today's Meeting Objectives

- Understand key pumped storage hydropower (PSH) impacts and opportunities related to terrestrial ecology, geology and soils, air quality, noise, viewshed, traditional cultural access, recreation, and public access
- Hear from attendees and promote discussion about the above topics
- Provide project update and overview of topics for upcoming PSH study meetings

Agenda Overview

9:30 – 9:45 AM	**Welcome and Quick Ice Breaker**
9:45 – 9:55 AM	**Study Overview and Update**
9:55 – 10:20 AM	**Wildlife and Habitat**
10:20 – 10:40 AM	**Geology and Soils**
10:40 – 11:10 AM	**Breakout Sessions: Terrestrial Ecology, Geology, and Soils**
11:10 – 11:20 AM	***Break***
11:20 – 11:45 AM	**Air Quality, Noise, Viewshed, and Access**
11:35 AM – 12:15 PM	**Breakout Sessions: Air Quality, Noise, Viewshed, and Access**
12:15 – 12:25 PM	**Breakout Session Highlights**
12:25 – 12:30 PM	**Next Steps, Wrap up, and Adjourn**

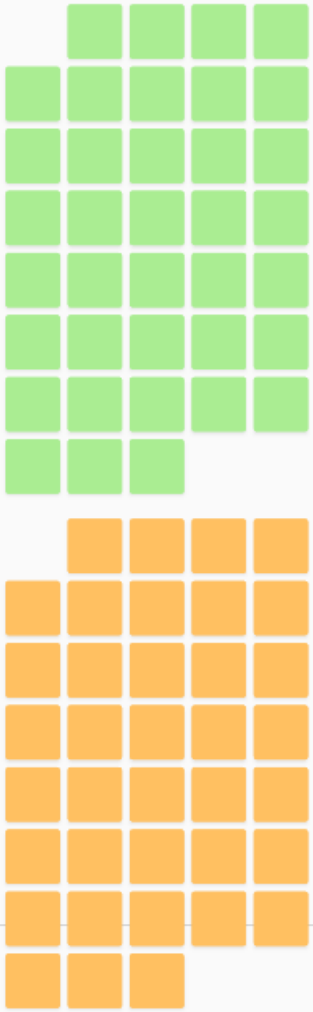
Quick Icebreaker—Using Mural

- Mural is brainstorming software that allows people to share ideas through the use of virtual post-its and whiteboard
- Follow the link for mural and use the virtual post-it's to answer a question

Fall is in the Air!

Post-its

Please write your answers and ideas on the post--its and put them under the appropriate topic.



What is your favorite Halloween decoration?

What is your go-to Halloween costume?

See an example

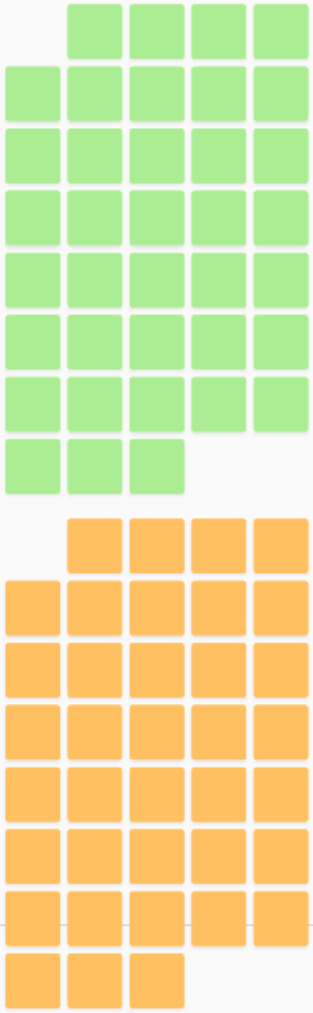
To zoom in or out, use the wheel on your mouse or adjust the zoom percentage with the -/+ tool in the lower right corner of your screen

TB

20%

Fall is in the Air!

Post-its
Please write your answers and ideas on the post--its and put them under the appropriate topic.



What is your favorite Halloween decoration?

What is your go-to Halloween costume?

Click and drag a sticky note from the blank notes beside the board or double click on the place you want to add a note

Once you place a sticky note, add text by double-clicking and starting to type

See an example

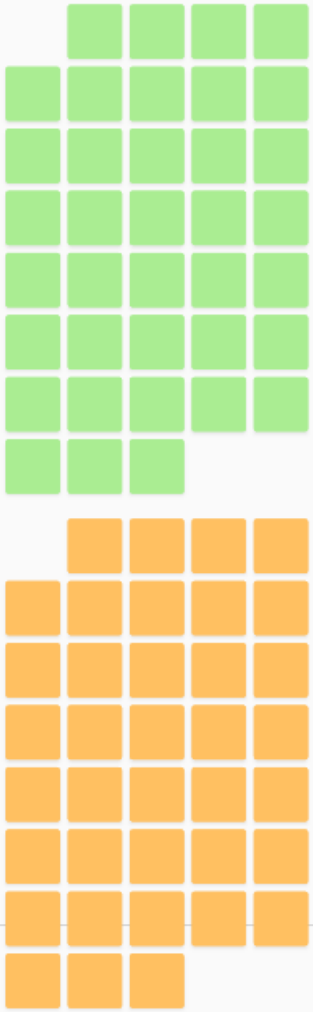
TB

20%

Fall is in the Air!

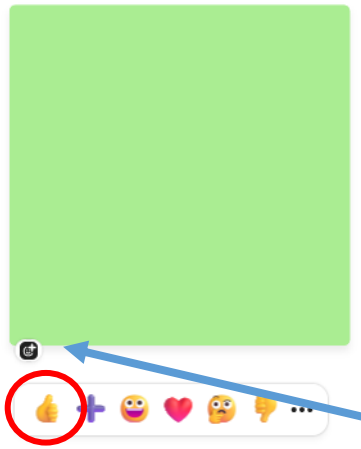
Post-its

Please write your answers and ideas on the post--its and put them under the appropriate topic.



What is your favorite Halloween decoration?

What is your go-to Halloween costume?



If you agree with someone else's note, hover over the lower left corner, click, and pick a "thumbs up" reaction

See an example

TB

20%

Icebreaker Question

- *What is your favorite Halloween decoration?*
- *What is your go-to Halloween costume?*

- Copy-paste link from Zoom chat box into an internet browser
- Keep Zoom and Mural open simultaneously
- Add your name (or remain anonymous) & click "Enter as a visitor"

Study Overview and Update

Karen Janowitz, WSU Energy Program

PSH Siting Study Goal

Identify and understand issues and interests of federally recognized Tribes, agencies, and various stakeholders related to **areas where pumped storage hydro might be sited**.

No specific PSH projects are being promoted or sited in this study.

Section 306 of House Bill 1216 (2023) on Clean Energy Project Siting:

https://lawfilesext.leg.wa.gov/biennium/2023-24/Pdf/Bills/Session%20Laws/House/1216-S2.SL.pdf?q=20240327114612

Why a PSH Siting Study?

- Support goal of Clean Energy Transformation Act (CETA) (SB 5116, 2019)
- Explore PSH, which is an existing proven technology, long-duration, and provides grid reliability
- Understand issues concerning PSH siting to work towards avoiding impacts and disputes

Pumped Storage Hydro Siting Study Process

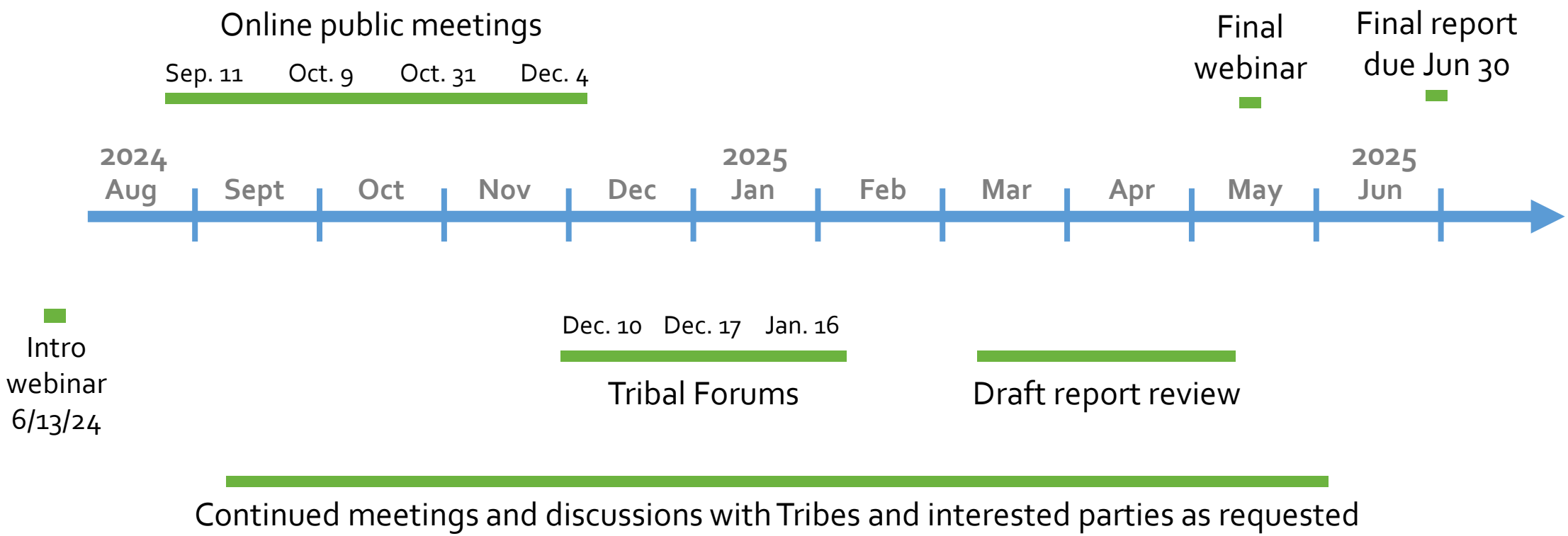
- PSH research
- Outreach, Engagement, Meetings, Webinars
  - Provide information on PSH
  - **Provide opportunities to hear from you**
- Mapping *(requested in legislative bill)*
  - Develop map based on participant input (no sensitive information) along with dataset of theoretical closed-loop PSH locations from National Renewable Energy Laboratory (NREL)*
- Final report – due June 30, 2025

*https://www.nrel.gov/docs/fy22osti/81277.pdf

Engagement

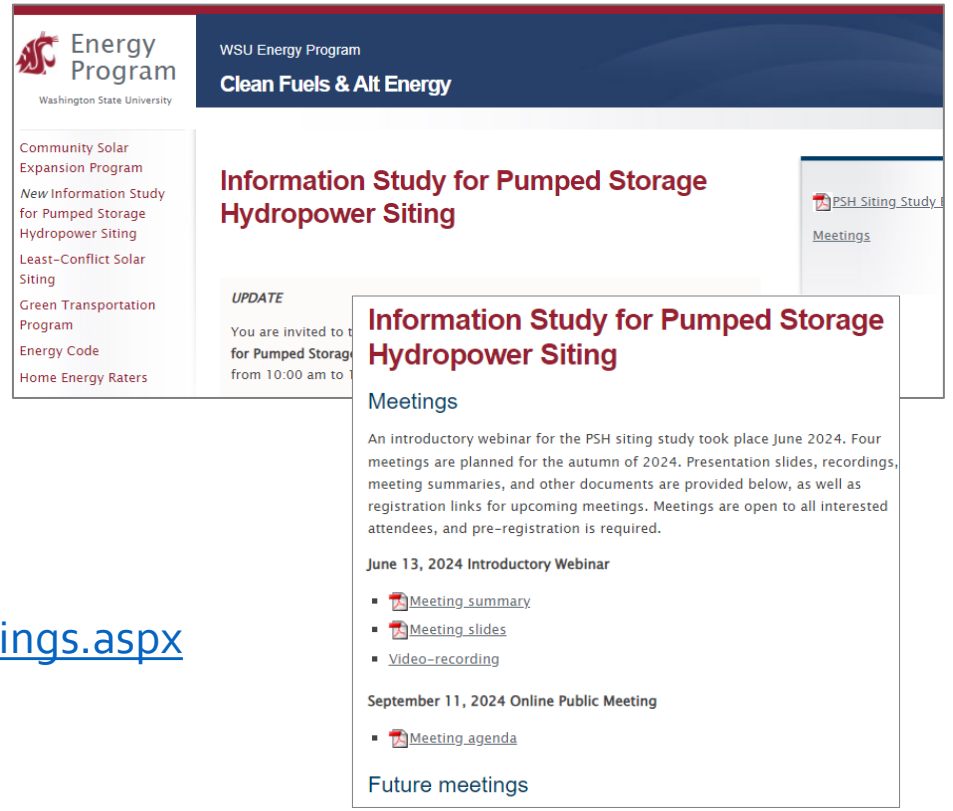
- Next statewide online public meeting
  - December 4, 2024 – 9:30 AM to 12:30 PM Pacific Time
    - Permitting and licensing
    - Other pumped storage and mechanical/gravity-based technologies
- Tribal engagement
  - Three Forums for Tribal leaders and staffs
  - Attendance and discussion at Tribal conventions & conferences
  - Further outreach and meetings
- Further engagement
  - We welcome the opportunity to hear from you individually or in groups

Timeline *(subject to change)*



WSU PSH Website and Email List

WSU Energy Program PSH Siting Study Webpages:
https://www.energy.wsu.edu/CleanFuelsAltEnergy/PSHSiting.aspx



PSH Siting Study Meeting Webpage:

- Meeting summary
- Meeting video-recording
- Meeting slides

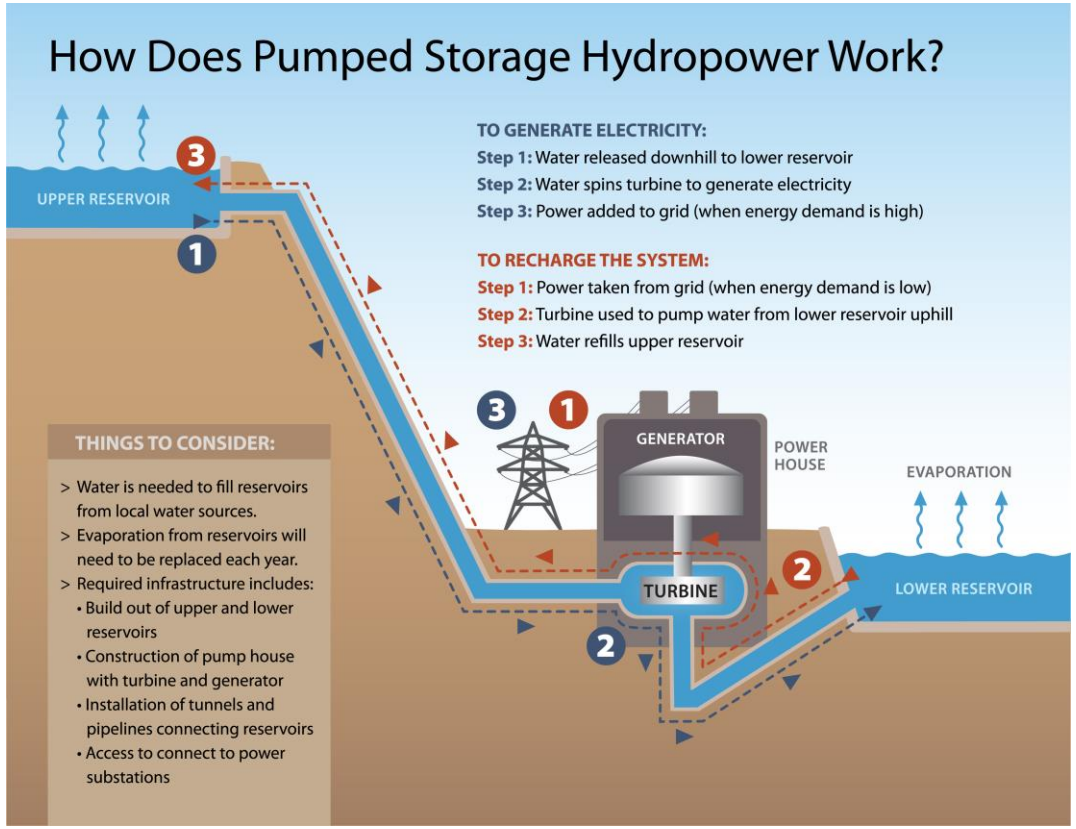
https://www.energy.wsu.edu/CleanFuelsAltEnergy/PSHSiting/Meetings.aspx

Sign up for the email distribution list:
https://www.energy.wsu.edu/CleanFuelsAltEnergy/PSHSiting/PHSSitingEmailRegistration.aspx

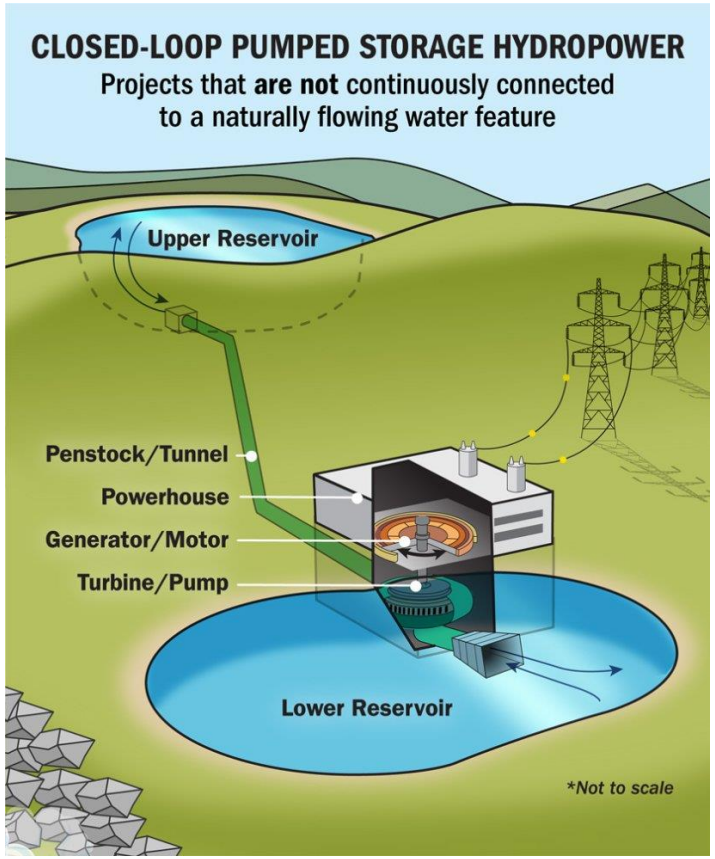
What is Pumped Storage Hydropower?

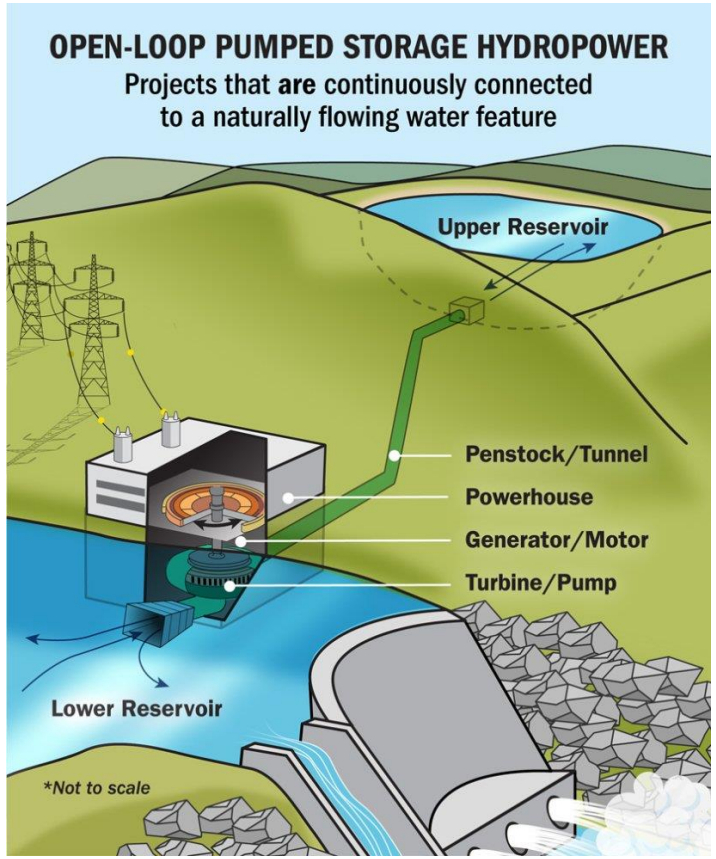
- "Water battery"
- Long-duration energy storage technology
- Stores energy in an upper reservoir, generates energy when water flows to a lower reservoir

This study focuses on closed-loop, where reservoirs are not connected to any existing water bodies



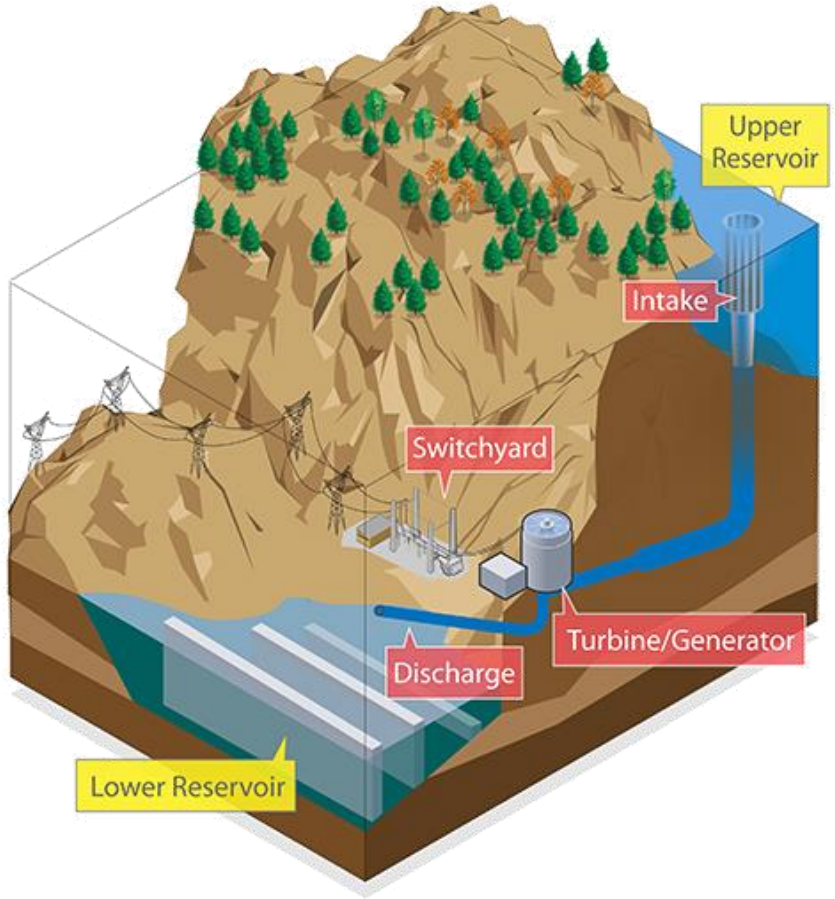
Closed-Loop PSH and Open-Loop PSH





U.S. Dept of Energy, 2019

PSH Benefits & Drawbacks



- Benefits
  - Provides over 90% of U.S. energy storage capacity
  - Supports grid reliability
  - Balances electricity supply and demand
  - Systems last long – has lower life-cycle cost than other methods
- Drawbacks
  - Siting may be difficult
    - Potential impacts include to land use, environment, Traditional cultural resources
  - Needs water to initially fill closed-loop reservoirs, and "top" off
  - Long construction period, expensive construction costs
  - Long, extensive permitting and licensing process

Questions?

Pumped Storage Hydropower (PSH) Impacts to Wildlife and Habitat in WA

Emily Grabowsky (she/her)

Solar and Wind Energy Biologist, WDFW

31 October 2024

Washington Department of FISH & WILDLIFE

Agenda

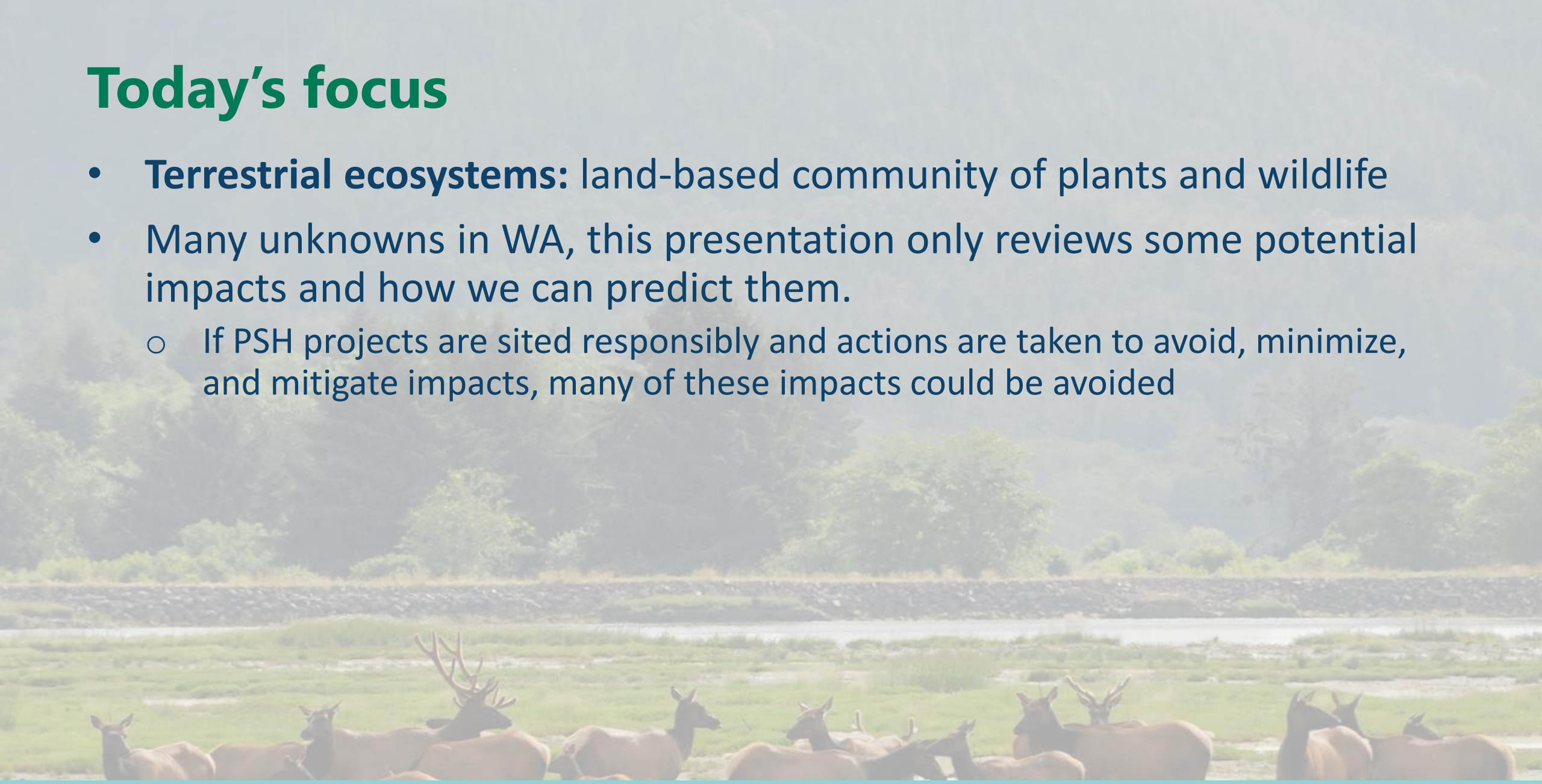
How will PSH impact wildlife and habitats in Washington?

Let's explore:

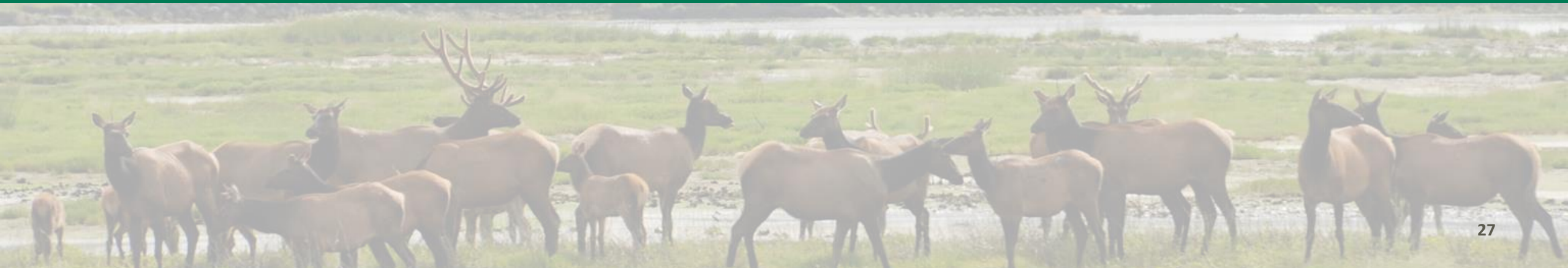
- Common impacts from large-scale development
- How WDFW approaches these impacts
- Tools available to predict impacts

Today's focus

- **Terrestrial ecosystems:** land-based community of plants and wildlife
- Many unknowns in WA, this presentation only reviews some potential impacts and how we can predict them.
  - If PSH projects are sited responsibly and actions are taken to avoid, minimize, and mitigate impacts, many of these impacts could be avoided



Impacts to WA Wildlife



Large-scale Development Impacts

Development Types:

- Housing
- Roads/highways
- Renewable energy

Impacts:

- Habitat loss
  - Movement corridors
  - Resources
- Disturbance
- Mortality

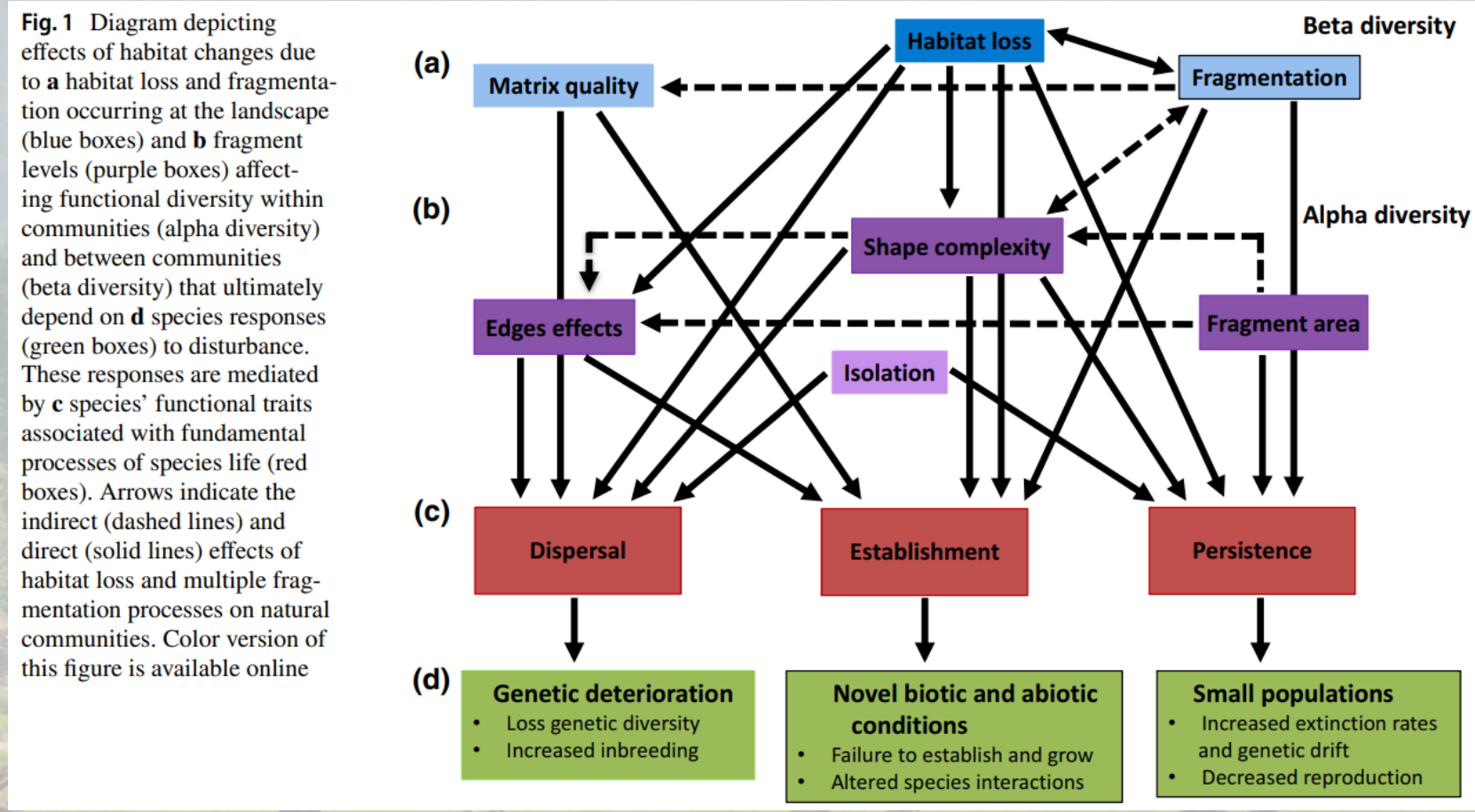


Fig. 1 Diagram depicting effects of habitat changes due to **a** habitat loss and fragmentation occurring at the landscape (blue boxes) and **b** fragment levels (purple boxes) affecting functional diversity within communities (alpha diversity) and between communities (beta diversity) that ultimately depend on **d** species responses (green boxes) to disturbance. These responses are mediated by **c** species' functional traits associated with fundamental processes of species life (red boxes). Arrows indicate the indirect (dashed lines) and direct (solid lines) effects of habitat loss and multiple fragmentation processes on natural communities. Color version of this figure is available online

Zambrano, Jenny & Garzón López, Carol Ximena & Yeager, Lauren & Fortunel, Claire & Cordeiro, Norbert & Beckman, Noelle. (2019). The effects of habitat loss and fragmentation on plant functional traits and functional diversity: what do we know so far?. Oecologia. 191. 10.1007/s00442-019-04505-x.

Large-scale Development Impacts

Development Types:

- Housing
- Roads/highways
- Renewable energy

Impacts:

- **Habitat loss**
  - Movement corridors
  - Resources
- Disturbance
- Mortality

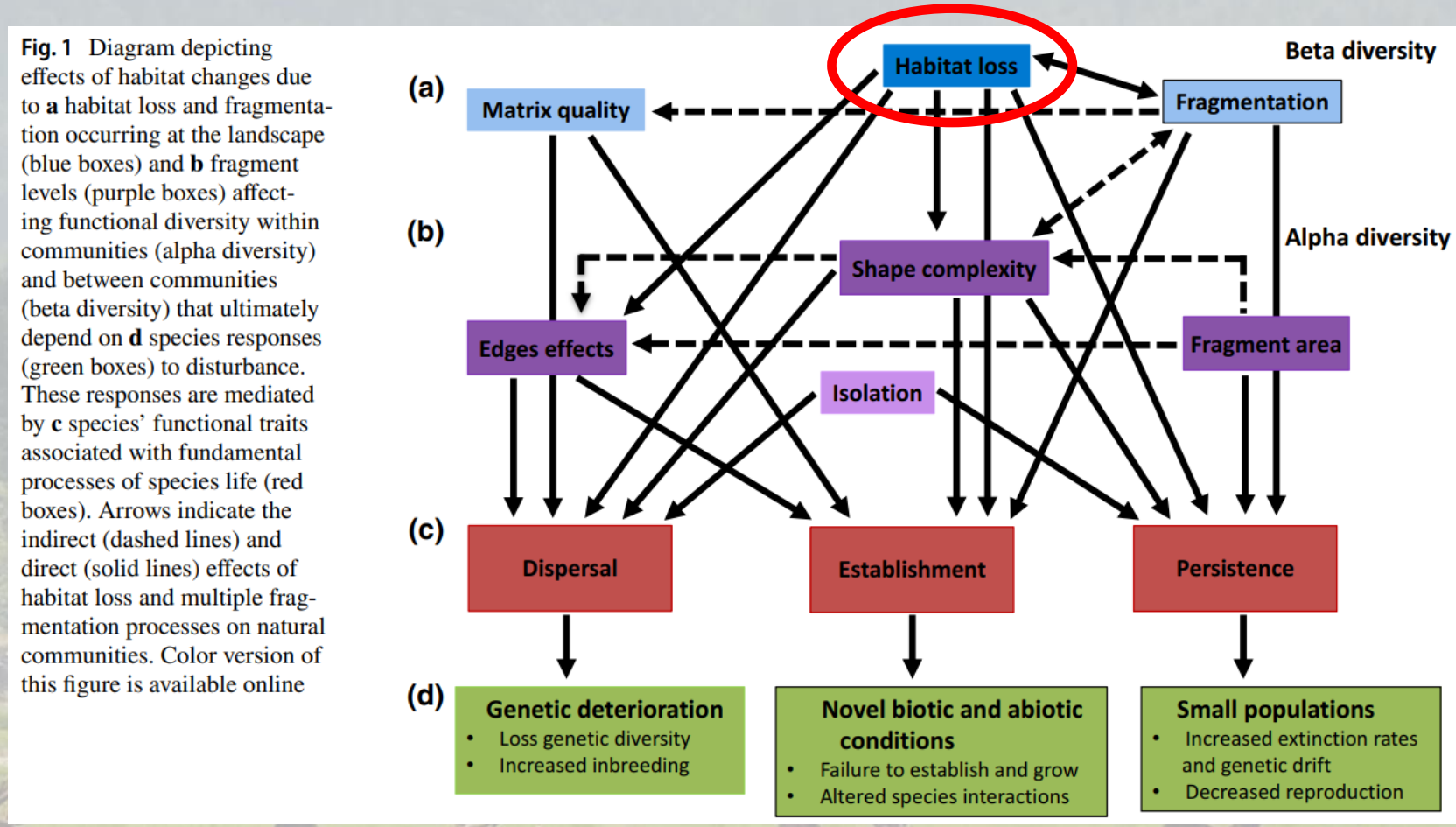


Fig. 1 Diagram depicting effects of habitat changes due to **a** habitat loss and fragmentation occurring at the landscape (blue boxes) and **b** fragment levels (purple boxes) affecting functional diversity within communities (alpha diversity) and between communities (beta diversity) that ultimately depend on **d** species responses (green boxes) to disturbance. These responses are mediated by **c** species' functional traits associated with fundamental processes of species life (red boxes). Arrows indicate the indirect (dashed lines) and direct (solid lines) effects of habitat loss and multiple fragmentation processes on natural communities. Color version of this figure is available online

Zambrano, Jenny & Garzón López, Carol Ximena & Yeager, Lauren & Fortunel, Claire & Cordeiro, Norbert & Beckman, Noelle. (2019). The effects of habitat loss and fragmentation on plant functional traits and functional diversity: what do we know so far?. Oecologia. 191. 10.1007/s00442-019-04505-x.

Habitat Loss and effects on wildlife

Types of habitat loss

- Fragmentation
- Movement barriers/ loss of connectivity
- Increased edge habitat

Ecological consequences

- Loss of resources/displacement
  - Foraging
  - Nesting/breeding
  - Overwintering
- Disease
- Loss of genetic diversity
- Establishment of invasives

How does this translate to PSH?

Impacts:

- Habitat loss- Large scale vegetation removal and excavation
  - Movement corridors
  - Resources

- Disturbance- from equipment (from construction AND operation)
  - Abandoned nests/burrows
  - Avoidance of nearby habitat

- Mortality- construction equipment, vehicle traffic, entrapment

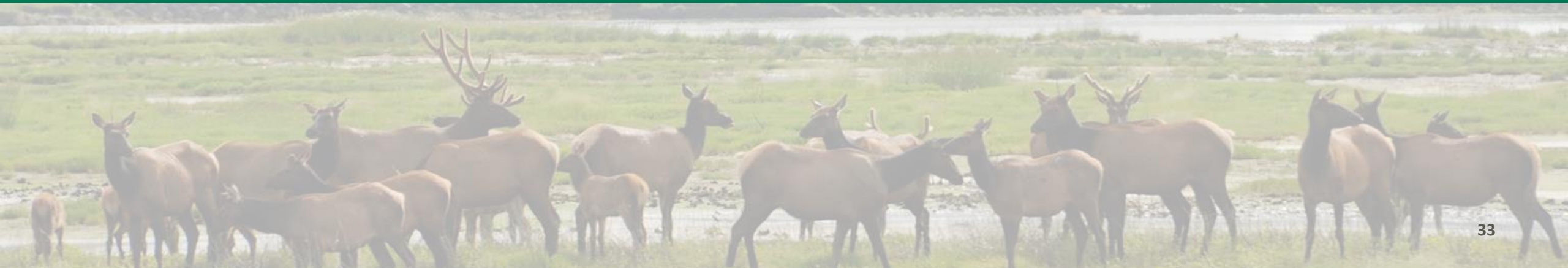
*Long term: unstable populations, increased disease, establishment of non-native and invasive species

Impact Example

Ferruginous Hawk

Photo by Jesse Watson; Watson, Robert W Davies, and Patrick S Kolar "CONTRASTING HOME RANGE CHARACTERISTICS AND PREY OF SYMPATRIC HAWKS (BUTEO SPP) NESTING IN THE UPPER COLUMBIA RIVER BASIN," Northwestern Naturalist 104(1), 37-47, (23 February 2023). https://doi.org/10.1898/NWN22-07

Assessing Impacts



WDFW's Role in PSH

WDFW is non-regulatory in terms of renewable energy development, including PSH.

*This DOES NOT include projects that require Hydrolytic Project Approval (HPA), this is strictly from a terrestrial habitats and species perspective.

Photo by Emily Grabowsky

Photo by WDFW

Photo by WDFW

Evaluating impacts on project sites

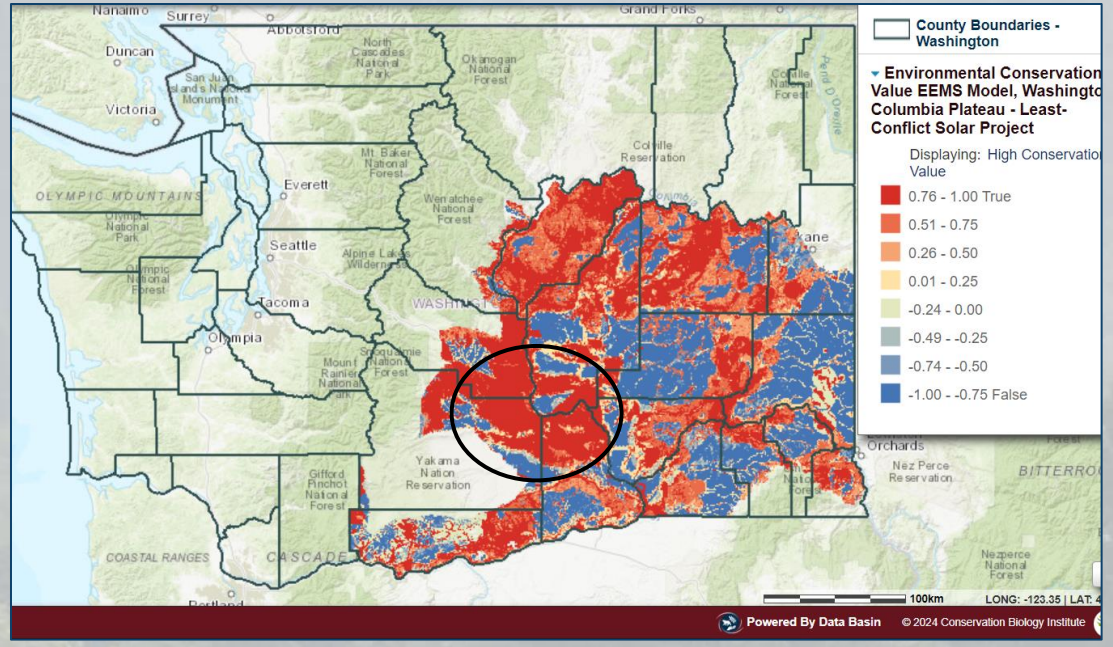
- Early and frequent communication with project proponents
  - Beginning during site selection phase
- Use of reliable scientific resources
  - Priority Habitats and Species (PHS) database Priority Habitats and Species (PHS) | Washington Department of Fish & Wildlife
  - Washington Shrubsteppe Restoration and Resiliency Initiative (WSRRI) Washington Shrubsteppe Restoration and Resiliency Initiative | Washington Department of Fish & Wildlife
  - Arid Lands Initiative (ALI) Arid Lands Initiative |
  - Least Conflict Solar Siting tools (LCSS) Columbia Plateau Least-Conflict Solar Siting Gateway (databasin.org)
  - Washington Habitat Connectivity Action Plan (coming 2025!) Washington Habitat Connectivity Action Plan | Washington Department of Fish & Wildlife
  - Peer reviewed literature
  - Gray literature
  - Expert opinion

Evaluating impacts, caveats

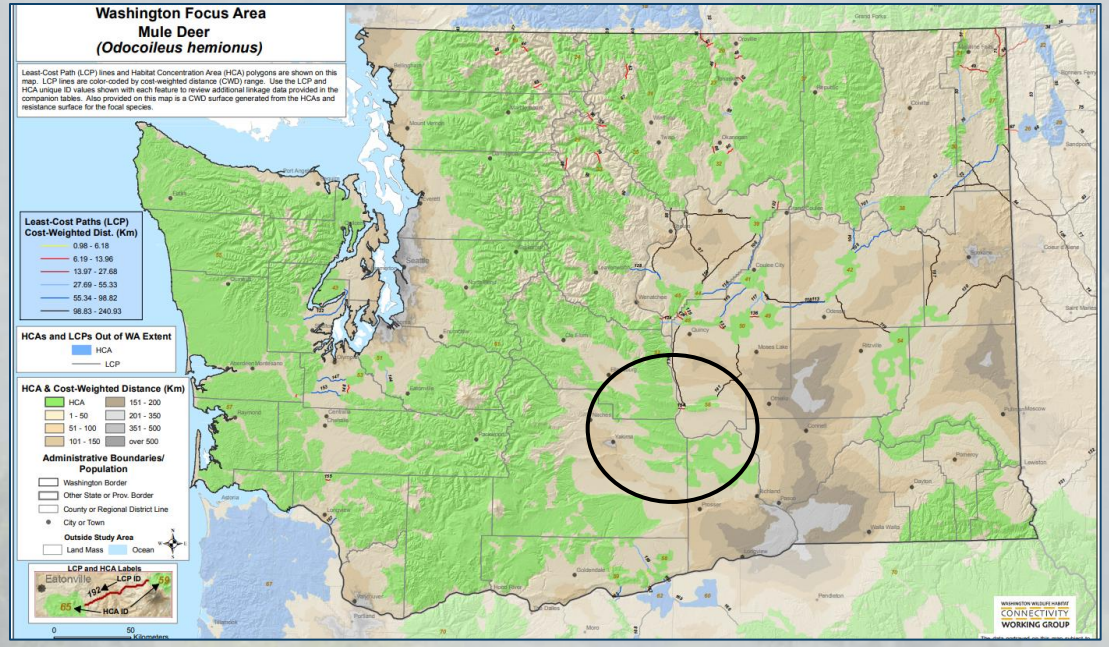
These data mapping tools are almost always created using presence-only data

- Many areas across WA have not been surveyed
- Field surveys needed to verify habitats and wildlife on each site

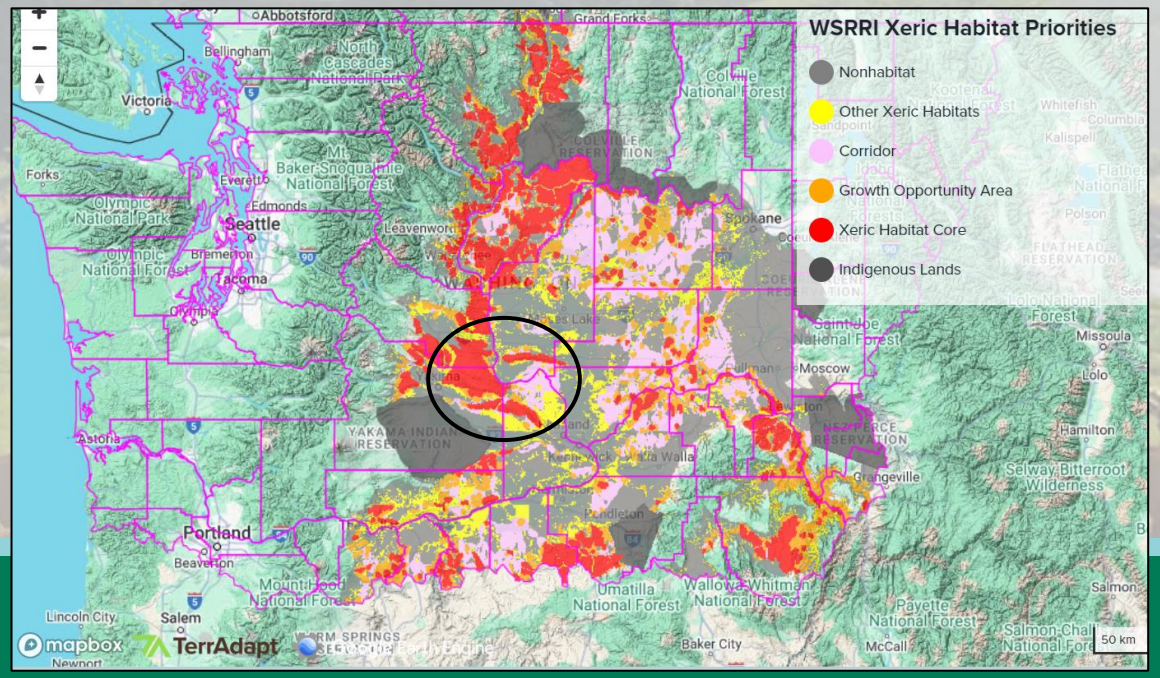
LCSS: Conservation Value map



ALI: Least cost pathways between mule deer habitat.

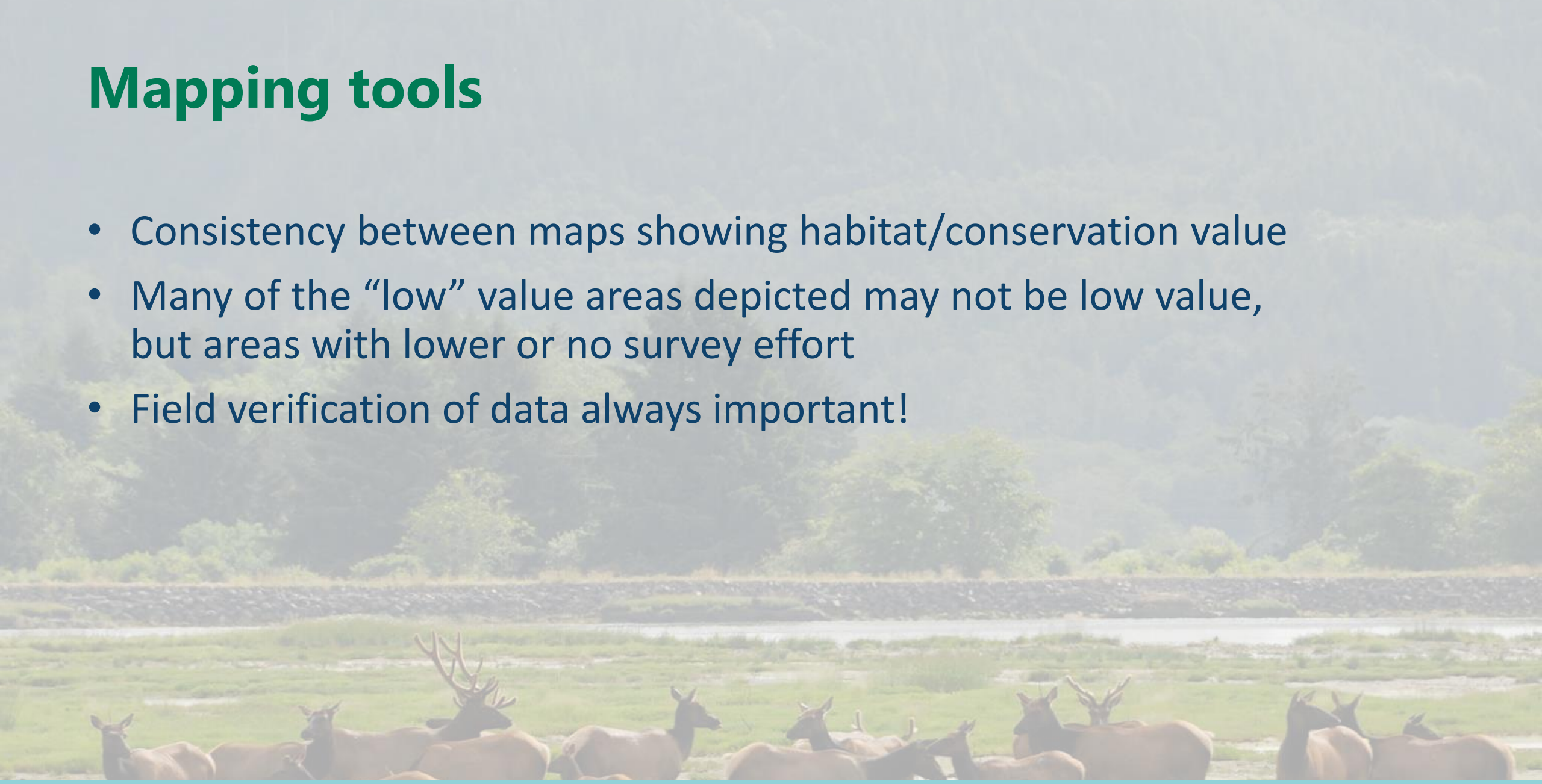


WSRRI: Xeric Habitat Priorities



Mapping tools

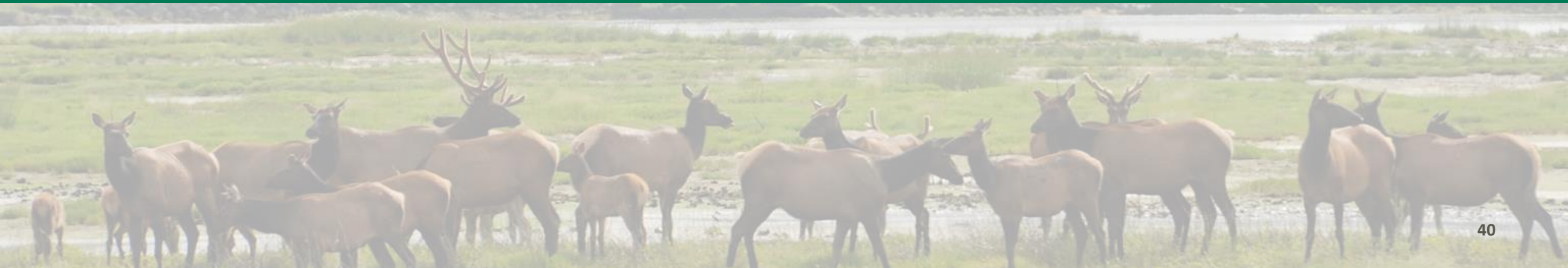
- Consistency between maps showing habitat/conservation value
- Many of the “low” value areas depicted may not be low value, but areas with lower or no survey effort
- Field verification of data always important!



Summary

- Any large-scale development has potential to result in impacts to wildlife and habitats, PSH likely similar
- These are not the only wildlife impacts! Input from Tribes vital.
  - Resources considered important to state agencies might be different from Tribes
- We have tools to guide us!
  - Limitations with all tools and modeling products
  - Field verification essential
- Many unknowns in WA, this presentation only reviews some potential impacts and how we can predict them.
  - If PSH projects are sited responsibly and actions are taken to avoid, minimize, and mitigate impacts, many of these impacts could be avoided

Questions?



Geology and Soil Considerations for Pumped Storage Developments

Mike Manwaring, PG
Regional Sector Lead, Energy
Michael.Manwaring@stantec.com

Stantec

Stantec's History in Pumped Storage

Global PSH Experience:

> 17,500 MW of Constructed PSH

> 17,000 MW of Refurbished PSH

Engineer-of-Record:

- Last two U.S. PSH projects built:
  - ✓ 40 MW Lake Hodges (California)
  - ✓ 1,035 MW Rocky Mountain (Georgia)
- Largest PSH plant in the world
  - ✓ 3,003 MW Bath County (Virginia)

Bath County PSH, Virginia

Geological/Geotechnical Site Characterization

What is the goal for geologic and geotechnical studies?

1. Understand potential project impacts (development and operations)
2. Manage risk and understand potential costs (known unknowns)

Studies designed to develop site-specific knowledge to:

- ✓ Evaluate site conditions (similar to environmental, cultural studies)
- ✓ Develop baseline understand of hydrology and geology
- ✓ Support preparation of engineering design
- ✓ Support construction cost estimates

Rocky Mountain PSH
Rome, Georgia

Owner: Oglethorpe Power

Commissioned at 848 MW (1995)

Upgraded to 1,035 (2011)

3 x 365 MW Units Each

Most recent large-scale PSH built

Understanding Geologic Conditions

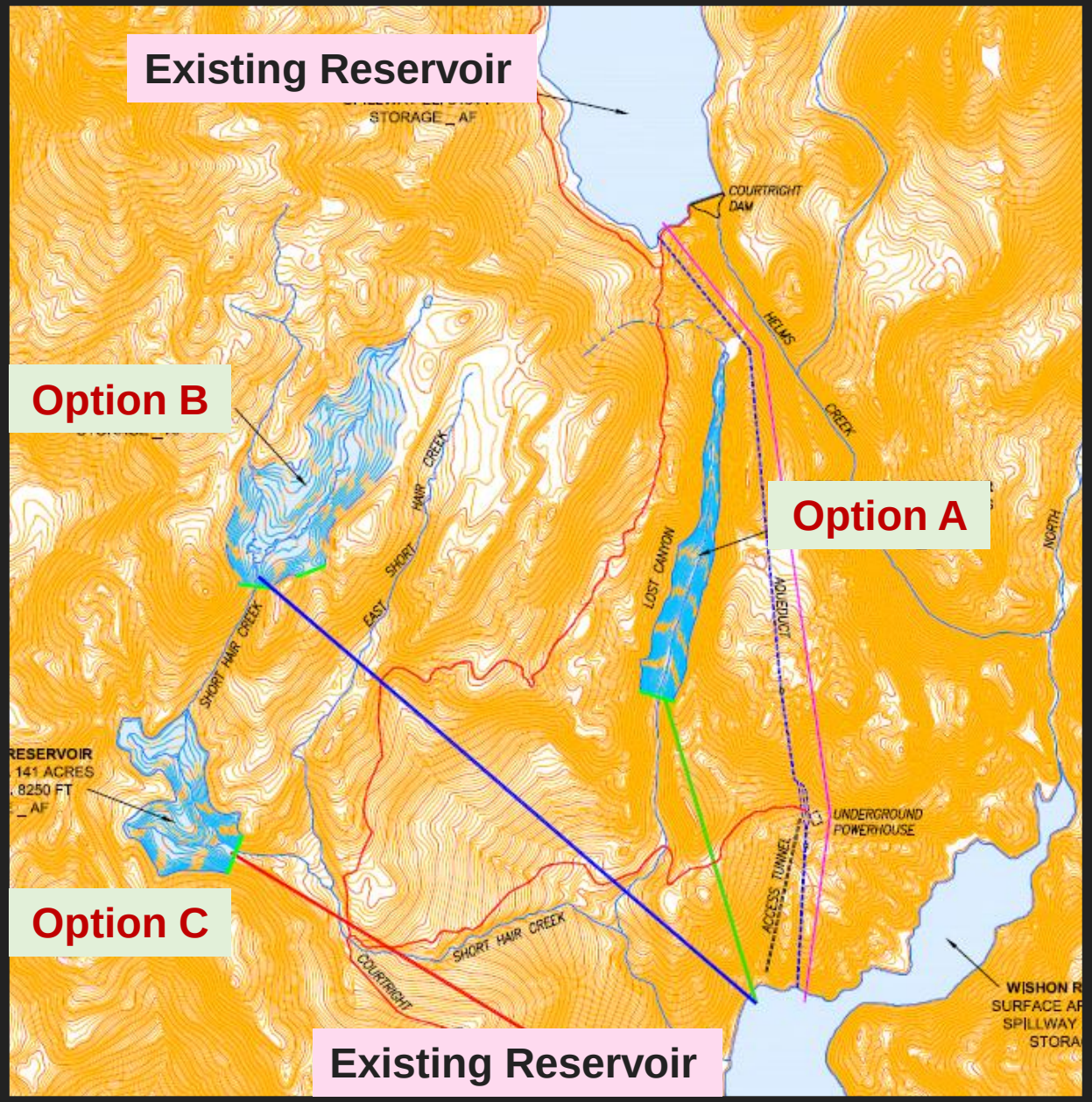
Data Collection Sources

- Previous studies → geologic mapping → geotechnical drilling & geophysics

What is the information used for?

- Regional geologic conditions: seismotectonic (faults, earthquakes)
- Regional Hydrology – water resources (example: CLPSH & mines)
  - Water supply/make-up water, reservoir fill, water quality constraints
- Surface Conditions – seepage, landslides, liquefaction, shoreline erosion
  - Dams type, inlet/outlet design, liner type, reservoirs capacity
- Underground Conditions – rock type, fractures & faults
  - Tunnel installation technique, liner type, surge chambers need

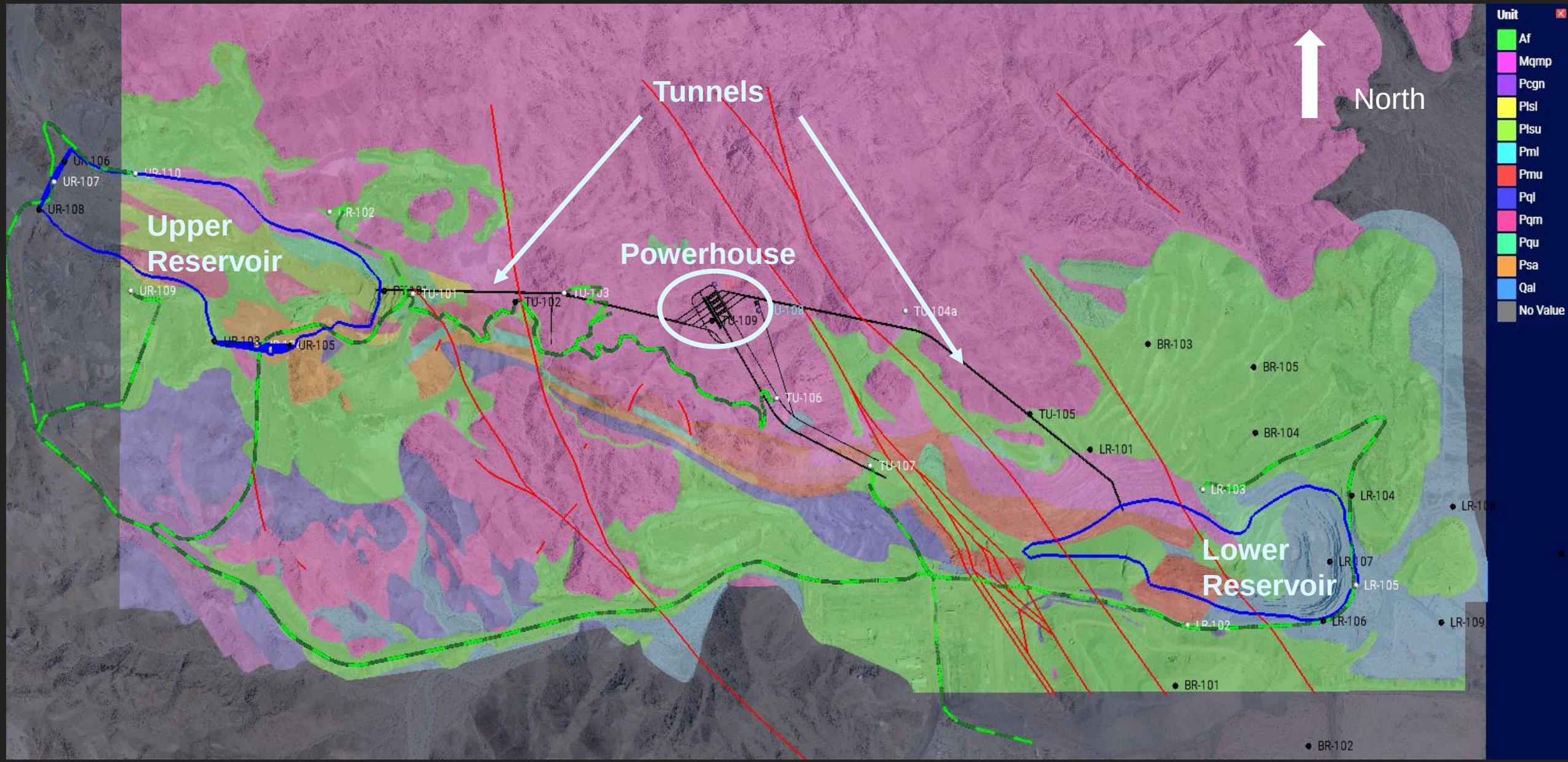
Example #1 - Geologic Mapping for Pumped Storage Project



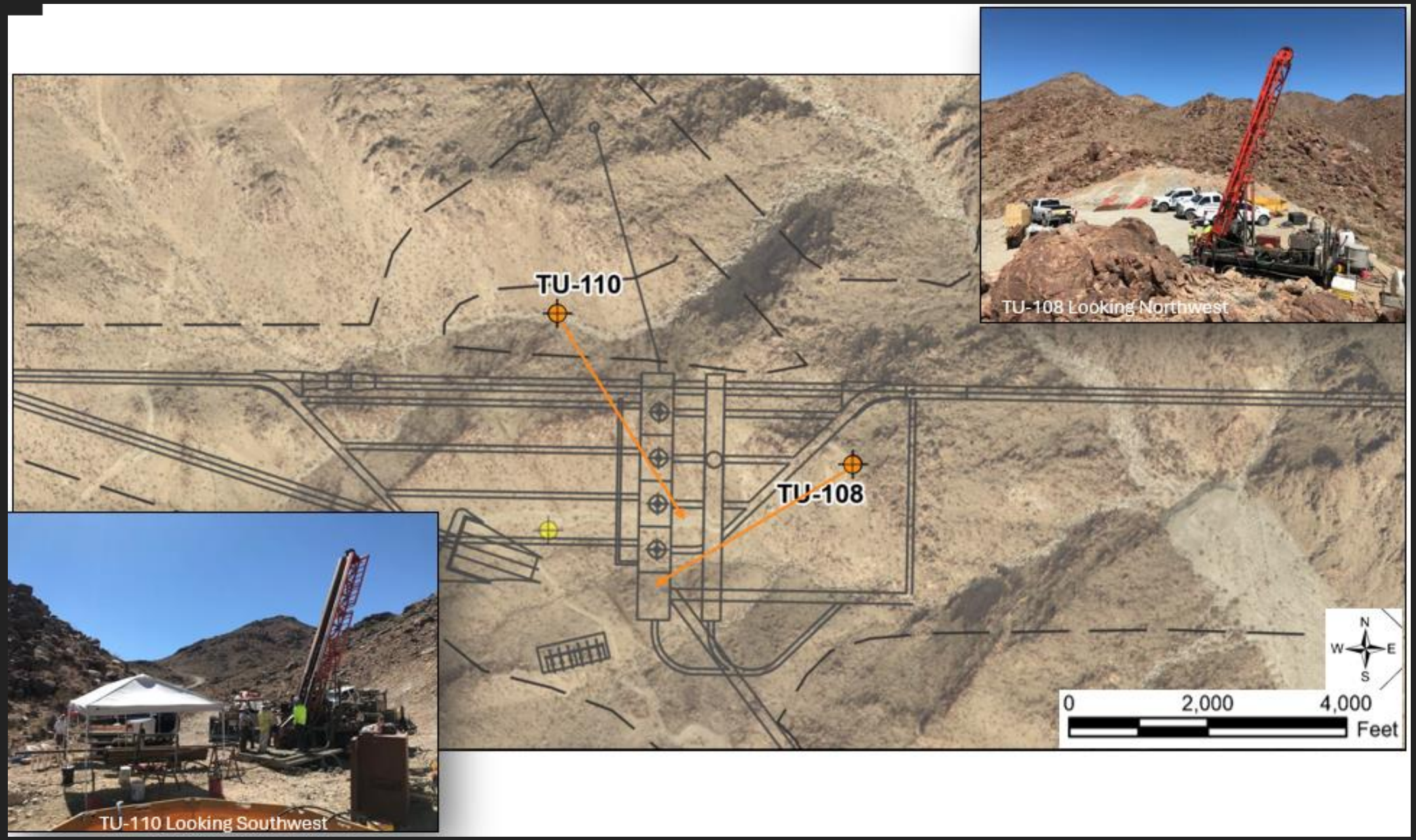
Example Project Mapping:

- Geologists/engineers identified three potential new reservoirs that could be developed as Upper Reservoir to partner with an Existing Lower Reservoir
- **Map** surface area: faults, rock type, soil type, dam site locations, water drainage area, distance to t-lines and other infrastructure

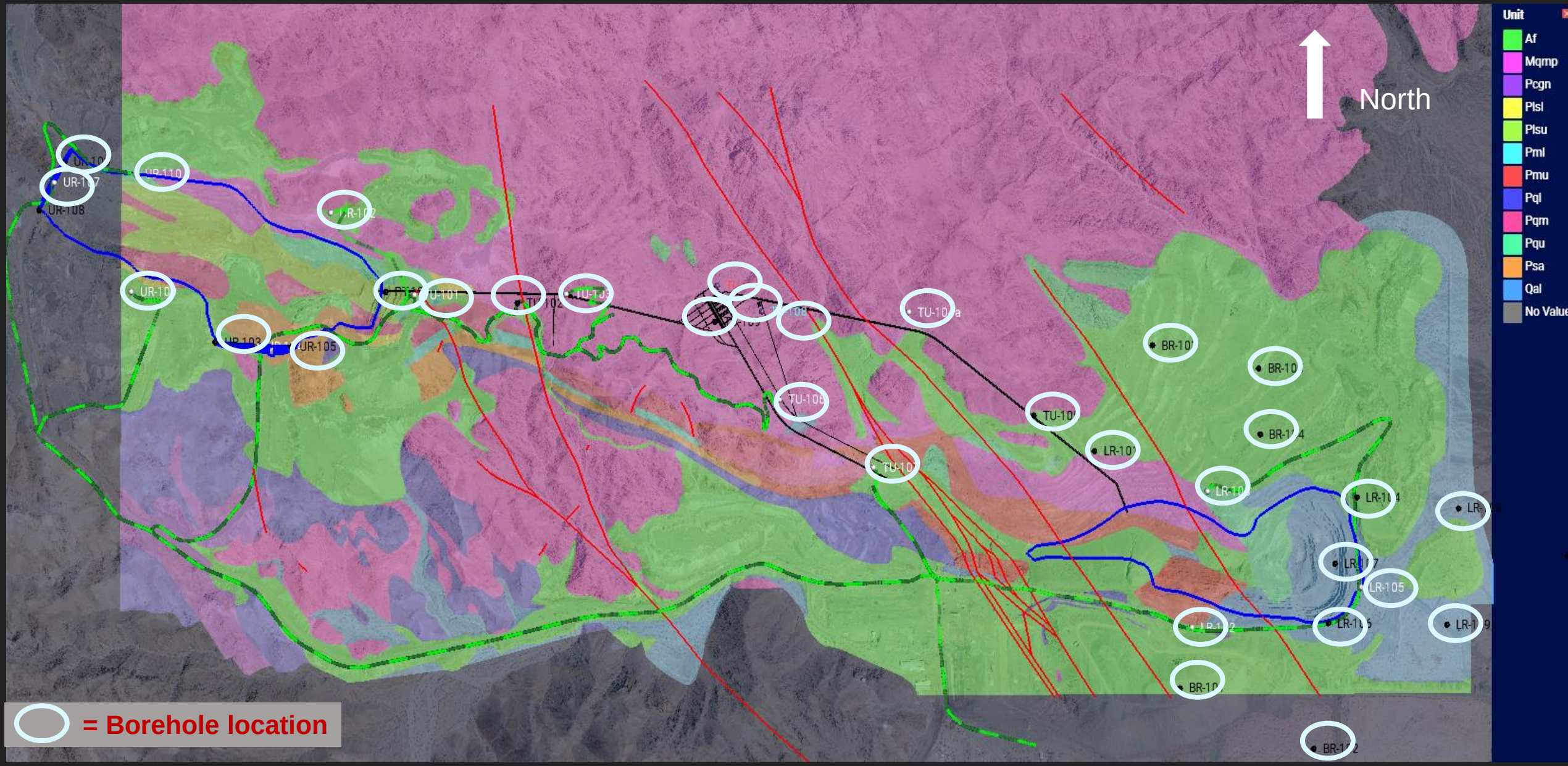
Example #2 – Geotechnical Investigations for PSH Project



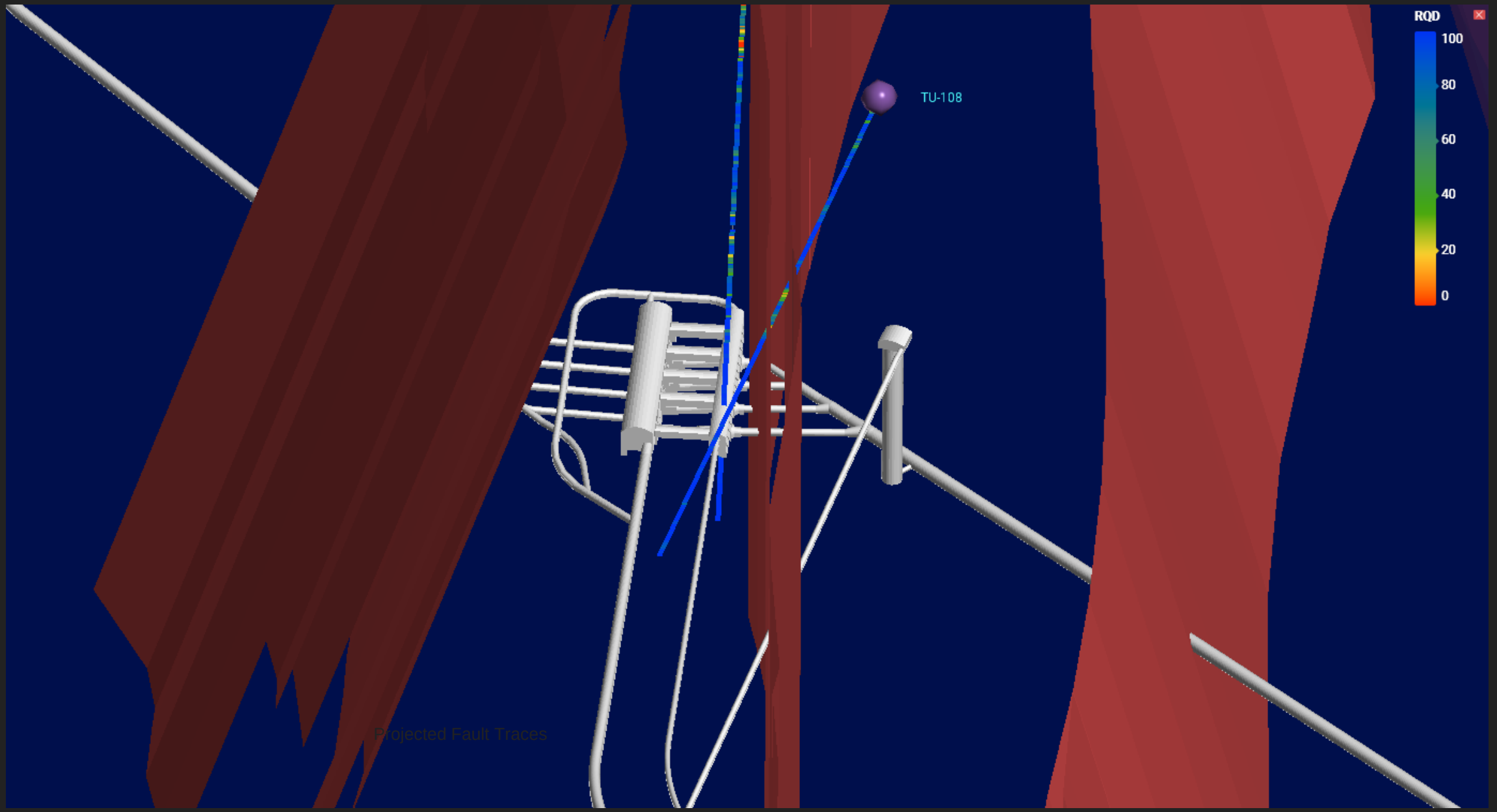
Example #2 – Geotechnical Investigations for PSH Project



Example #2 – Geotechnical Investigations for PSH Project

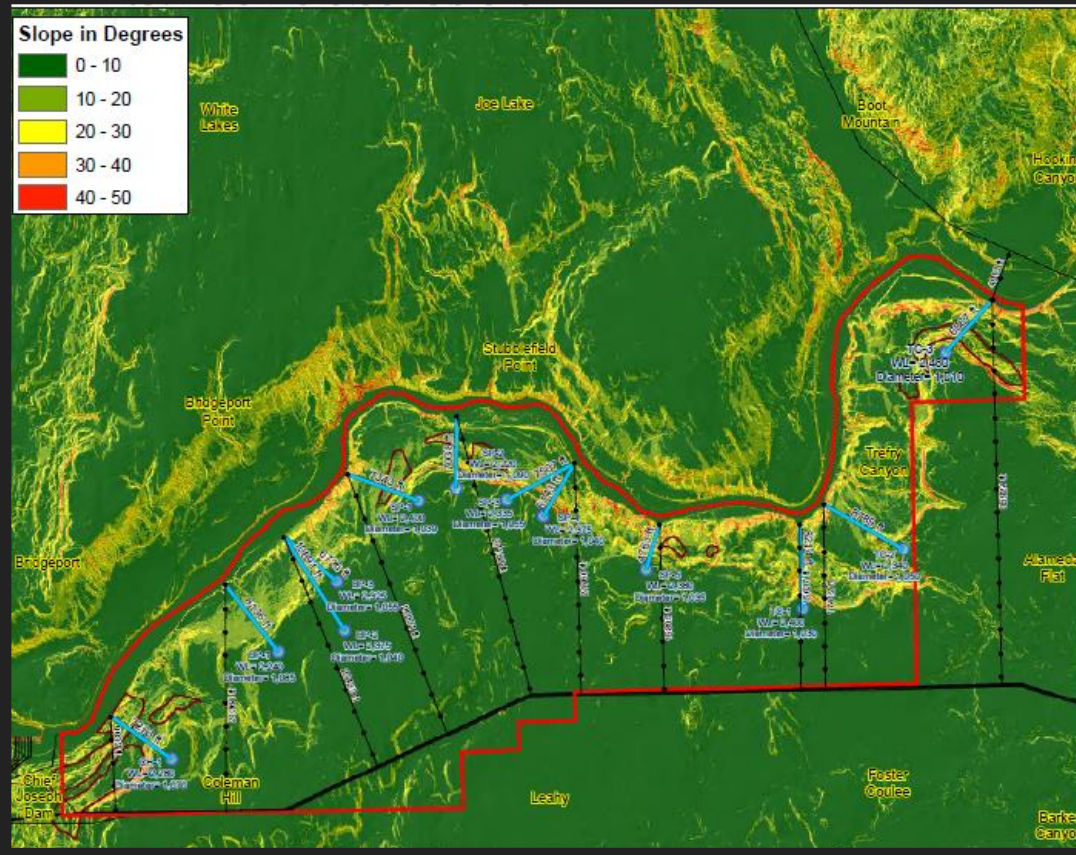


Example #2 – Geotechnical Investigation: Powerhouse Results



What Geology Makes for a Good PSH Site?

- ✓ High topographic relief between UR & LR
- ✓ “Known” geology & hydrology
- ✓ Sound, unfractured rock (caverns, tunnels)
- ✓ Stable slopes (landslides & shoreline erosion
- ✓ Low permeable soils (infiltration / make-up water)
- ✓ Abundant “source materials” for aggregate
- ✓ Minimal potential for environmental, cultural, or economic impacts
- ✓ Proximity to transmission lines



Washington State PSH Siting Study

Questions?

Geology and Soil Considerations for Pumped Storage Developments

Mike Manwaring, PG
Regional Sector Lead, Energy
Michael.Manwaring@stantec.com

Stantec

Discussion of Terrestrial Ecology, Geology, and Soils
Breakout Sessions

Breakout Sessions

- 25-minute facilitated discussions, each covering:
  - Terrestrial Ecology
  - Geology and Soils
- Participants will be randomly assigned to breakout groups

- Discussion questions:
  - *What potential PSH impacts related to terrestrial ecology and geology & soils concern you most?*
  - *What should PSH projects do to improve outcomes with respect to these topics?*

Back to Mural!

- When shared by the facilitator, click on the Mural link in Zoom chat or copy and paste it into an internet browser
- Keep Zoom and Mural open simultaneously
- Add your name (or remain anonymous) & click “Enter as a visitor”

Breakout Sessions

Returning around 11:10 PM

Break

Returning at 11:20 AM

Washington State University Energy Program
Information Study for Pumped Storage Hydropower Siting

October 31, 2024

Land Use Considerations – Air, Aesthetics, and Access

Maryalice Fischer
Certification Program Director

LOW IMPACT HYDROPOWER INSTITUTE

Low Impact Hydropower Institute

Our Vision: We envision a world where hydropower puts people and the environment first.

Our Mission: We recognize and support hydropower that prioritizes environmental, recreational, historical, and cultural resource protection.

We do this by defining and certifying Low Impact Hydropower using rigorous science-based criteria and public input; providing education and outreach; and structuring our organization to integrate and evolve with community, conservation, and hydropower interests.

https://lowimpacthydro.org/frequently-asked-questions/

LIHI's Low Impact Pumped Storage Definition Project

LIHI is leveraging this time-limited opportunity to influence PSH development and proactively address its impacts.

Project goal is to (if possible) develop a comprehensive, informed, science- and knowledge-based low impact definition that can guide PSH development and inform regulators, communities, and policy makers.

LIHI Low Impact Pumped Storage Definition Project

- Convened volunteer multidisciplinary Advisory Group and subject matter experts to develop low impact PSH definition using dialogue, information sharing, research, and public input.
- Biweekly meetings and deep dives into 11 potential impact categories:

Engagement	Aquatic Ecology
Socio-economics	Water Quality
Cultural and Historic	Water Quantity and Availability
Terrestrial Ecology	Geology and Soils
Land Use and Aesthetics	Air Quality and Noise
Recreational, Public, and Traditional Cultural Access	

- Discussion of issues, concerns, and what could be considered “low impact”
- Iterative approach to drafting low impact definition – draft, review, revise

https://lowimpacthydro.org/defining-low-impact-pumped-storage-hydropower/

Land Use Impacts

- Clearing and inundation of large land areas
- Competing land uses, potential conflicts
- Compatibility with existing management and development plans
- Sensitive, protected, or sacred lands
- Impacts on terrestrial habitats and species, recreation, access, and aesthetics
- Impacts on traditional cultural wealth and traditional land uses
- Increased fire risk from transmission lines
- Potential dam failure, overtopping, flooding

Siting Considerations

- Engage early and often with Tribes, local communities and governments
- Avoid sensitive, sacred areas
- Utilize already developed sites if possible
- Site and design to minimize footprint and accommodate pre-existing uses
- Develop wildfire risk assessment and mitigation plans
- Conduct impact assessment for dam failure, design to minimize impacts, and install redundant monitoring systems

Air Quality and Noise

- Emissions from fugitive dust, blasting, and concrete or asphalt batching operations
- Increased vehicle air emissions
- GHG emissions - embedded in materials, energy used for pumping, methane from reservoir inundation

  (https://www.nrel.gov/water/life-cycle-assessment-closed-loop-pumped-storage-hydropower-facilities.html)

- Construction noise from vehicles, equipment, batching operations
- Operational noise from warning sirens, pumping, generation, and transmission operations

Source: https://gosmartbricks.com/5-ways-to-reduce-air-pollution-at-construction-site/

- **Consider the impacts on wildlife and recreational enjoyment, as well as on local community**
- **Hard to avoid these impacts, but Best Management Practices can minimize them**

Visual and Aesthetic Resources

- Disturbance to visual character of local landscape from construction and project structures
- Impacts on larger viewshed from structures, reservoirs, fencing, transmission lines
- Impacts on visual access to culturally important or sacred sites
- Visual effects of 'bathtub' ring
- Light pollution

Source: https://www.reviewjournal.com/wp-content/uploads/2021/07/15376249_web1_HOOVER-DAM-PRESSER-JUL16-21-CXS-004.jpg

- **Photo-simulations should include images representative of all conditions and from all viewpoints**
- **Site and design to minimize visual impacts – underground structures, vegetation, color choices**

Figure 12. KOP 16: NNR HiLine Route Northeast of the Lower Reservoir – Existing View Southwest

Figure 13. KOP 16: NNR HiLine Route Northeast of the Lower Reservoir – Photo-simulation View Southwest – Full Water Level

Figure 14. KOP 16: NNR HiLine Route Northeast of the Lower Reservoir – Photo-simulation View Southwest – Low Water Level

Source: https://www.whitepinepumpedstorage.com/project-photo-simulations

Recreation, Public, and Traditional Cultural Access

- Removal of access or changes in access locations or quality – temporary and permanent
- Impacts on land-based recreation (hiking, camping) including night lighting and noise effects
- Impacts on water-based recreation (open-loop) due to fluctuating water levels
- Spatial and temporal access for traditional cultural activities and for other (non-Tribal) subsistence activities

Source: https://clui.org/projects/offstream/pumped-storage-california

- **Understand how Tribes, the local community, visitors use the lands**
- **Avoid sensitive areas and receptors**
- **Create new amenities and access opportunities that are desired by affected parties**

General Siting Guidelines

- Engage early and often with Tribes, local communities, and governments
- Avoid sensitive and sacred areas
- Utilize previously developed sites if possible
- Site and design to minimize footprint and accommodate pre-existing uses
- Enhance existing conditions if possible
- Conduct risk assessments and develop avoidance/minimization plans for specific impacts

Thank You!

Questions?

mfischer@lowimpacthydro.org

www.lowimpacthydro.org

@lowimpacthydro

LOW IMPACT HYDROPOWER INSTITUTE

Discussion of Air Quality, Noise, Viewshed, and Access *Breakout Sessions*

Breakout Sessions

- 25-minute facilitated discussions, each covering:
  - Air Quality
  - Noise
  - Viewshed
  - Access: Traditional cultural access, recreation, and public access
- Participants will be randomly assigned to breakout groups

- Discussion questions:
  - *What potential PSH impacts related to air quality, noise, viewshed, and access concern you most?*
  - *What should PSH projects do to improve outcomes with respect to these topics?*

Back to Mural!

- When shared by the facilitator, click on the Mural link in Zoom chat or copy and paste it into an internet browser
- Keep Zoom and Mural open simultaneously
- Add your name (or remain anonymous) & click “Enter as a visitor”

Breakout Sessions

Returning around 12:15 PM

Quick Highlights from Breakout Sessions

Next Steps and Wrap up

Karen Janowitz, WSU Energy Program

Next Statewide Online Public Meeting

Meetings are 9:30 AM to 12:30 PM Pacific Time, subject to change

- December 4
  - Permitting and licensing
  - Other pumped storage and mechanical/gravity-based technologies

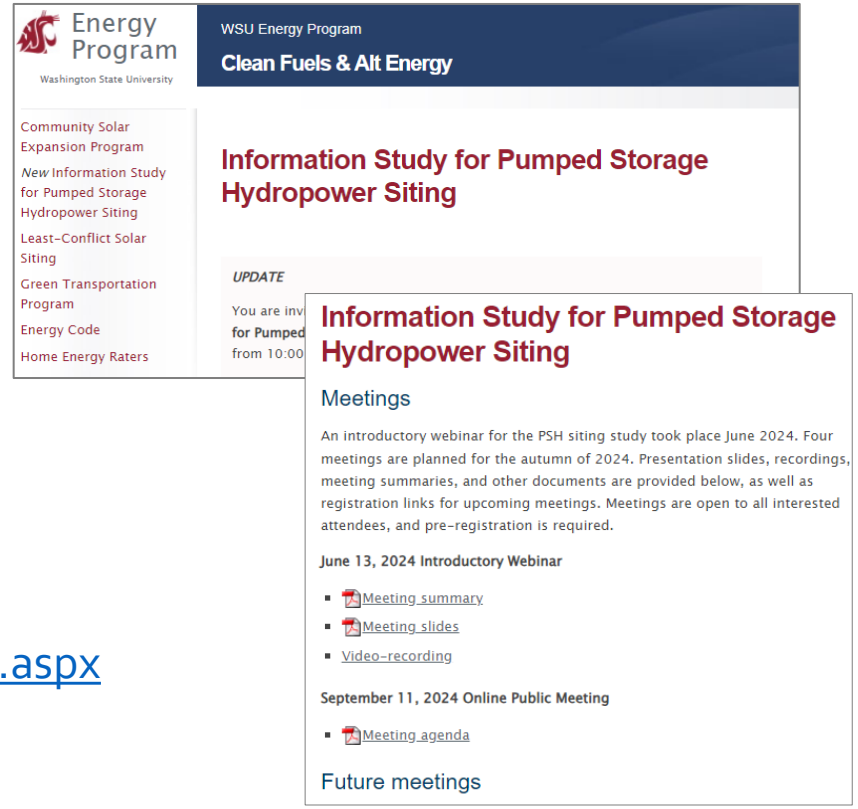
WSU PSH Website and Email List

WSU Energy Program PSH Siting Study Webpages:
https://www.energy.wsu.edu/CleanFuelsAltEnergy/PSHSiting.aspx

PSH Siting Study Meeting Webpage:

- Meeting summary
- Meeting video-recording
- Meeting slides

https://www.energy.wsu.edu/CleanFuelsAltEnergy/PSHSiting/Meetings.aspx



Sign up for the email distribution list:
https://www.energy.wsu.edu/CleanFuelsAltEnergy/PSHSiting/PHSSitingEmailRegistration.aspx

Karen Janowitz
janowitzk@energy.wsu.edu

Thank You!

Karen Janowitz and the PSH study team