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Evaluating Vulnerability of Closed Uranium Mill Tailing Sites to Event-Triggered Surface Erosion

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Track 1.5

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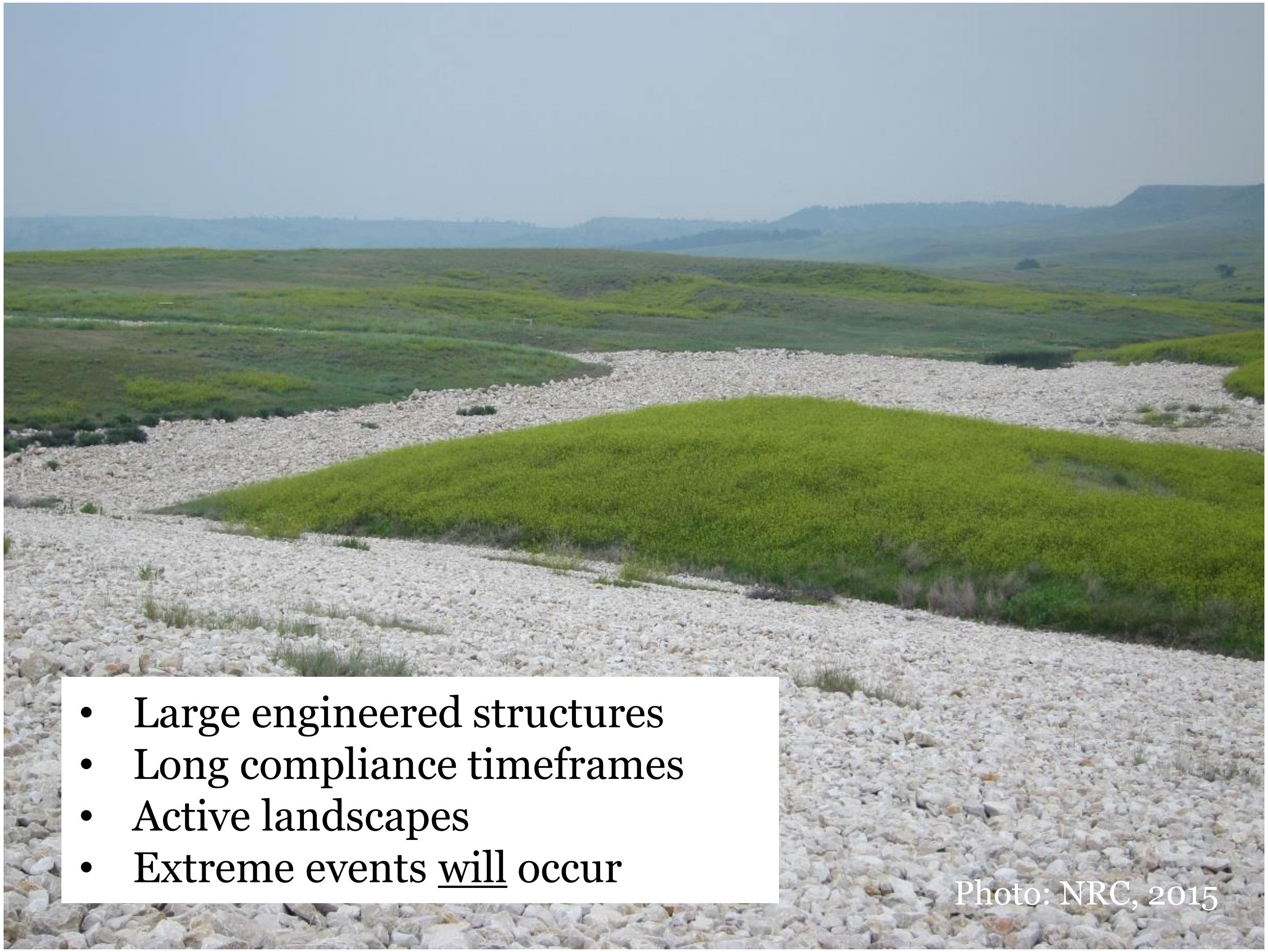
Challenges of Closed Uranium Mill Tailing Sites



- Large engineered structures
- Long compliance timeframes
- Active landscapes
- Extreme events <u>will</u> occur

Terrain Altering Events


Photo: L. Tonneson

Short Term:
- Mitigation actions
- Event monitoring
- Communication


Photo: Las Vegas Wash Coordination Committee photo

Long-Term:
- Erosion concerns
- Changes in design basis
- Change in monitoring metrics
- Large-scale mitigation actions

Vulnerability Assessment Approach

- Evaluation-parameter rating scheme
- Based on similar process used for geologic hazard mapping (e.g., landslide risk)
  - Use intrinsic trigger parameters responsible for hazard

- Rate site characteristics (e.g., geomorphic, hydrologic, biologic) relevant to processes of concern
- Example here focuses on surface erosion susceptibility
- Factors include:
  - Landform erosion potential
  - Saturated soil hydraulic conductivity
  - Percent slope
  - Watershed ruggedness

Erosion Susceptibility Factors

Landform Erosion Potential

- Identify landforms present in disposal site watershed (geomorphic map)
- Link landform to dominant surface process (weathering, mass wasting, surface water, groundwater, wind)
- Assign erosion potential based on processes
- Range from
  - 0 – Negligible for undisturbed hillslopes
  - 5 – Very High for debris slide slopes, gullies

Saturated Hydraulic Conductivity

- Account for differing ability of soils to infiltrate rainfall
- K_{sat} as a proxy for runoff potential
- Based on soil texture mapped by NRCS
- Range from
  - 0 – Very Rapid for coarse sandy soils
  - 5 – Very Slow for clay-rich soil and bedrock outcrops

Erosion Susceptibility Factors

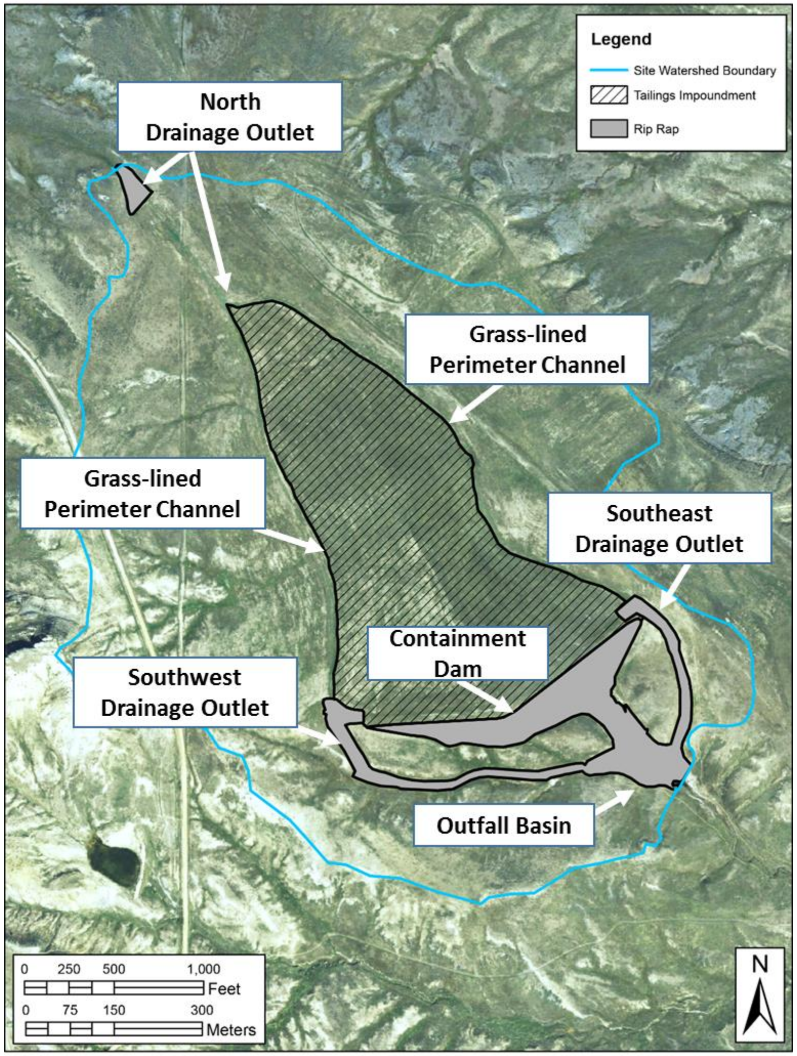
Percent Slope

- Slope controls degree of erosion from surface runoff and propensity of mass-wasting on hillslopes
- Adapted slope steepness categories of Kelsey (1977)
- Calculated in a GIS using USGS 10-meter DEM
- Range from
  - 0 – Negligible for 0-5% slopes (0 to 2.9°)
  - 5 – Steep to Precipitous for slopes greater than 60% (31°)

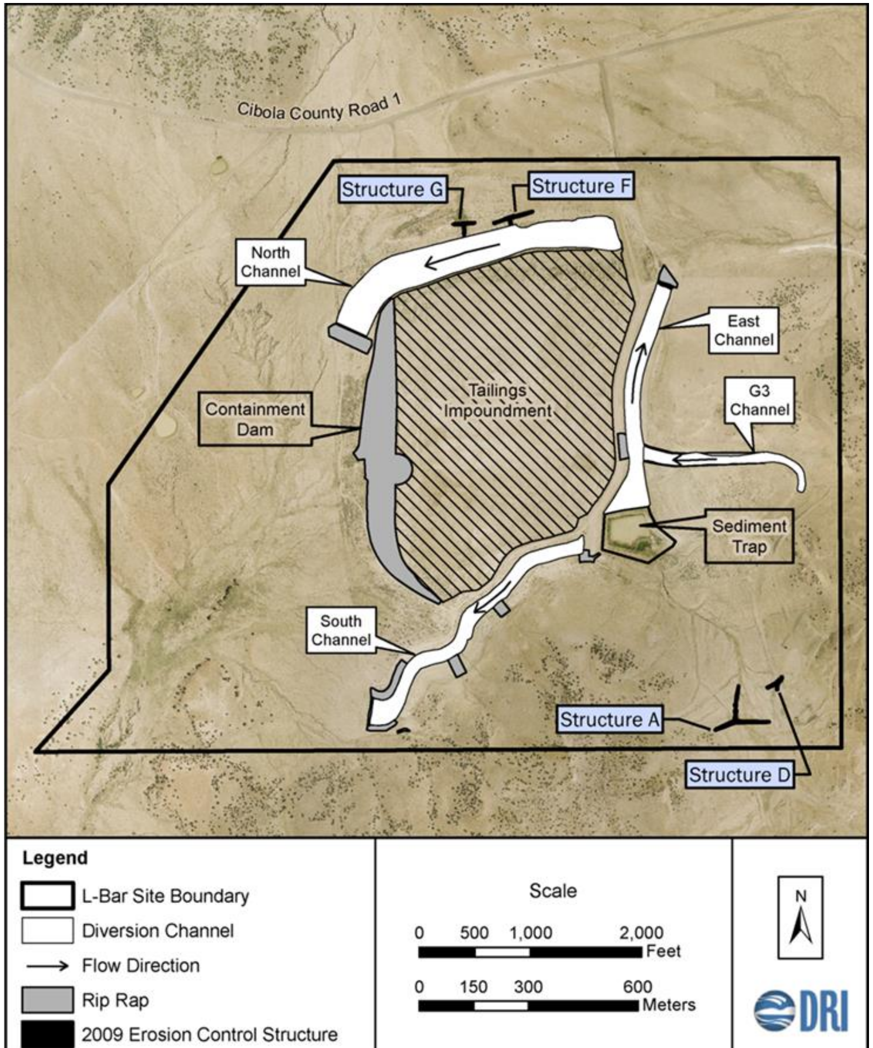
Watershed Ruggedness

- Similar in concept to slope, but on a watershed scale
- Indicator of relative dynamism of the basin and hazards related to water movement and sediment mobilization
- Based on Melton Ruggedness Number (1965) dividing watershed relief by area
- Range from
  - 0 – Very low relative relief
  - 5 – Extreme relative relief

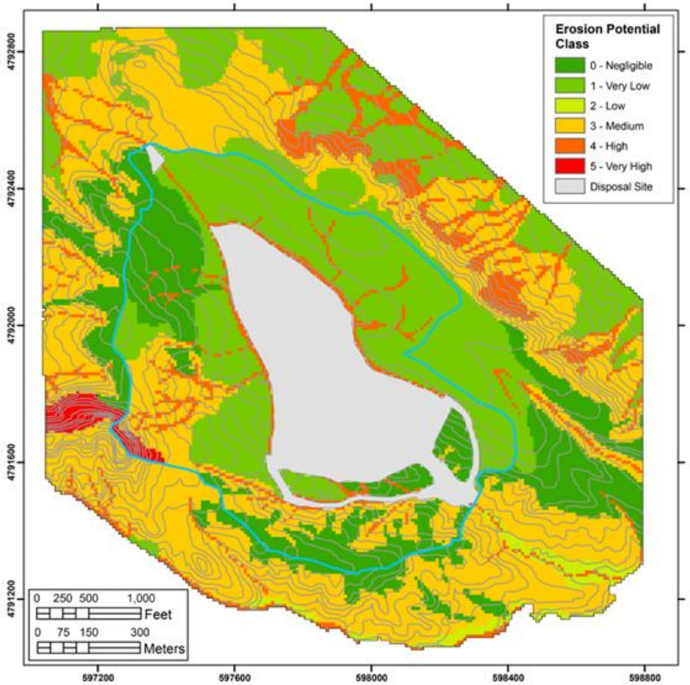
Edgemont Disposal Site

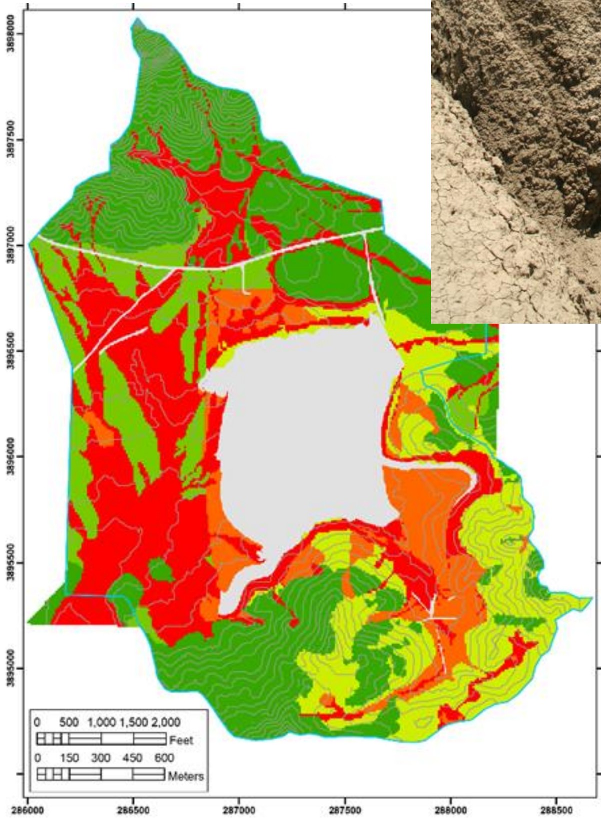


L-Bar Disposal Site



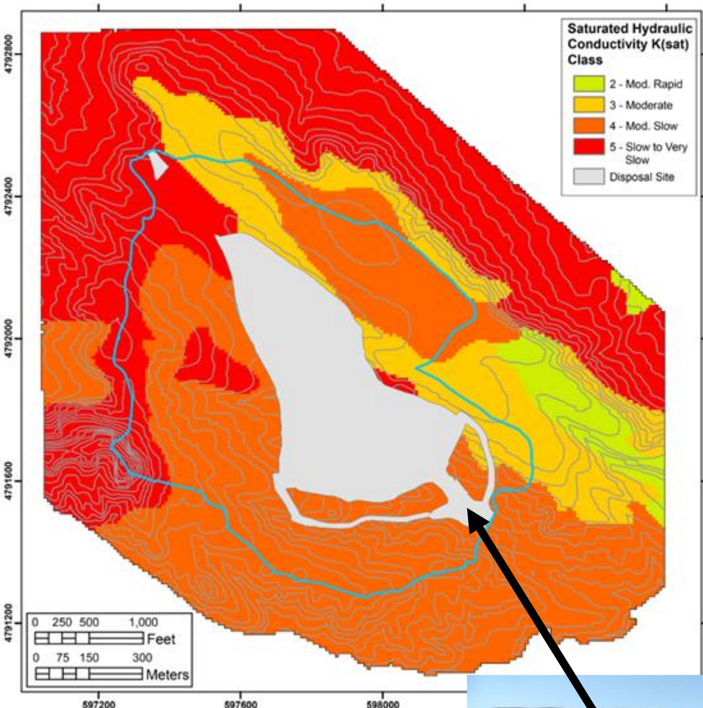
Factor: Erosion Potential





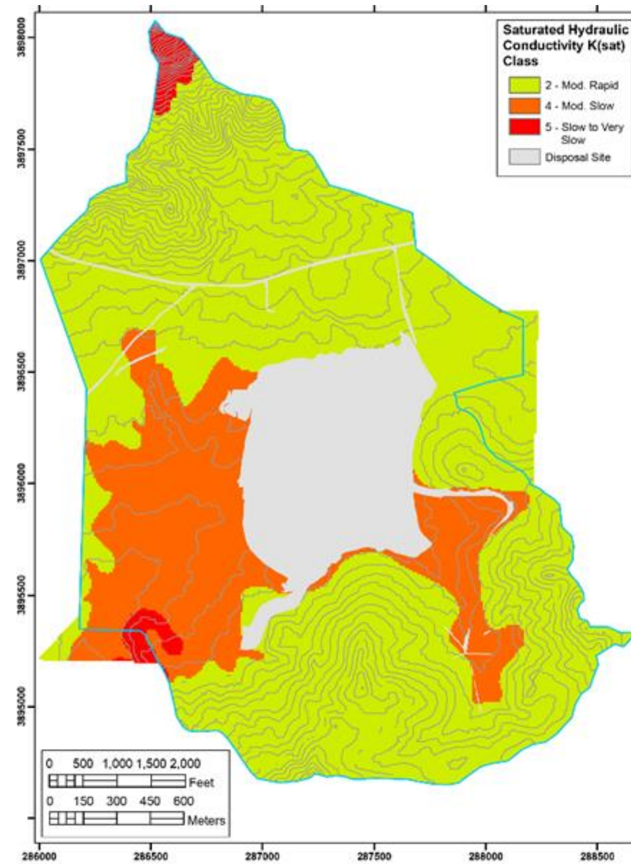
L-Bar

Factor: K_{sat}

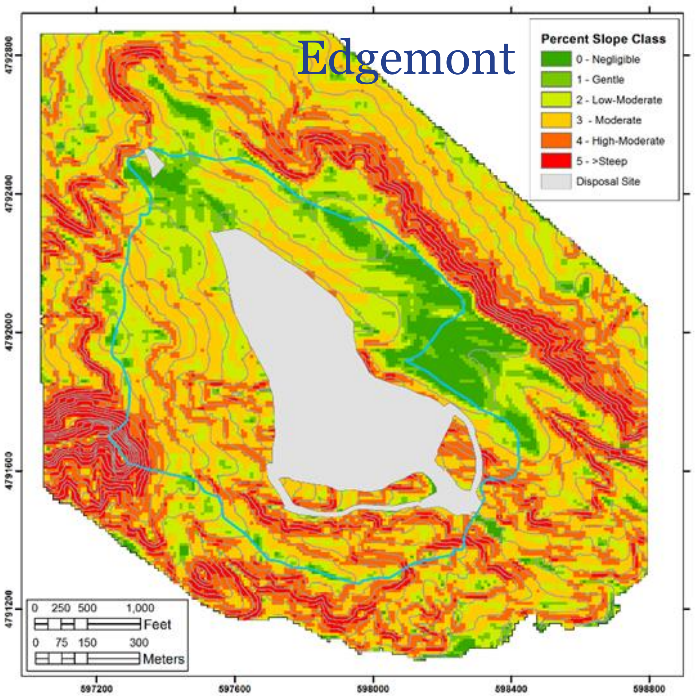


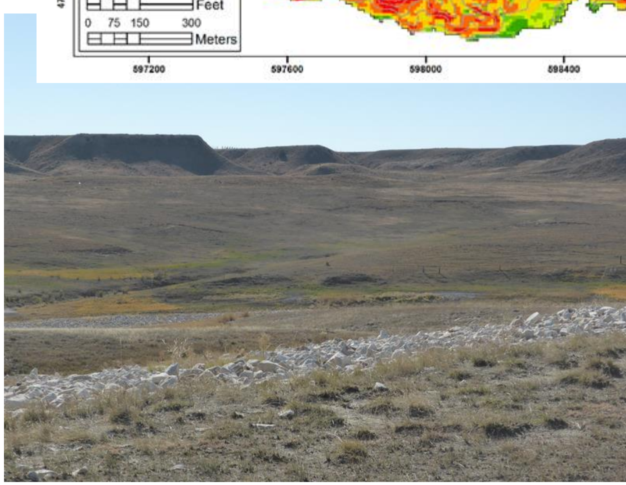
Edgemont

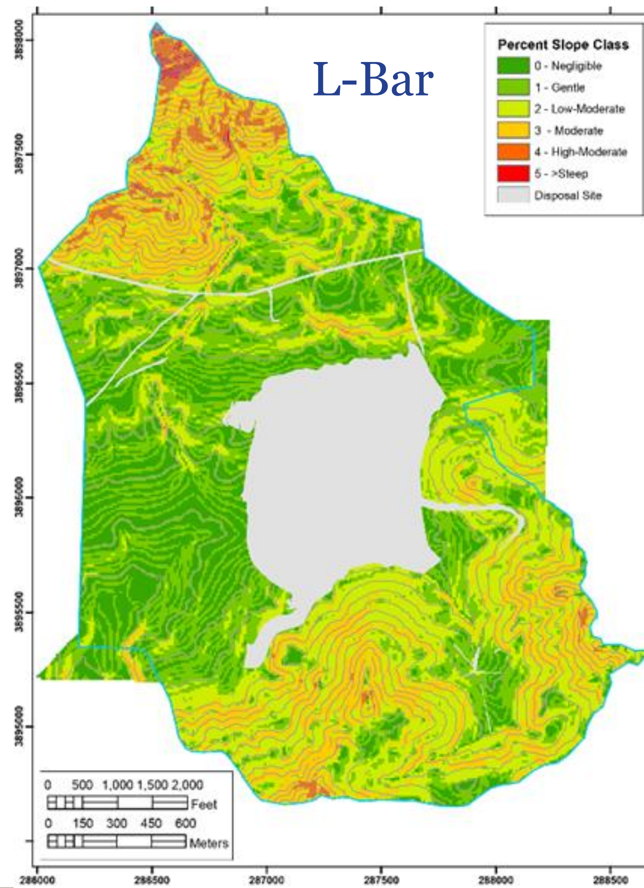
L-Bar

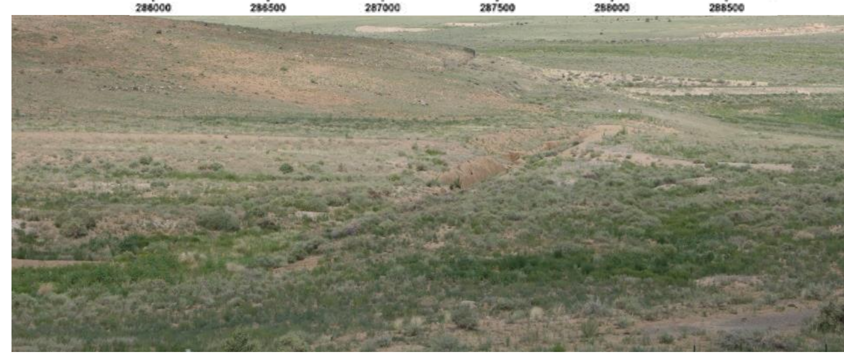


Factor: Percent Slope

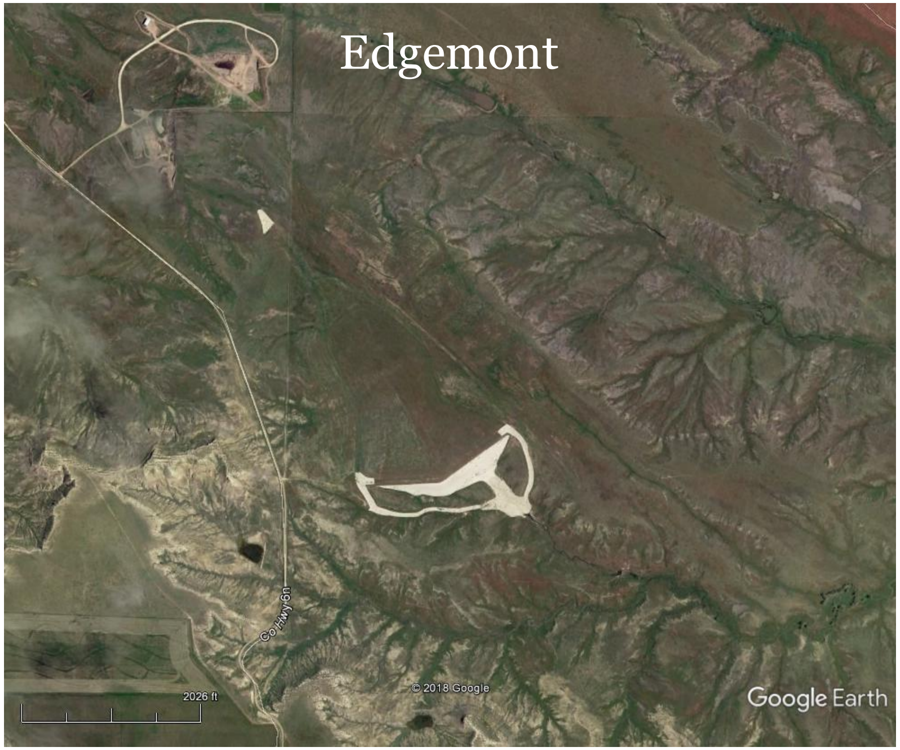








Factor: Watershed Ruggedness

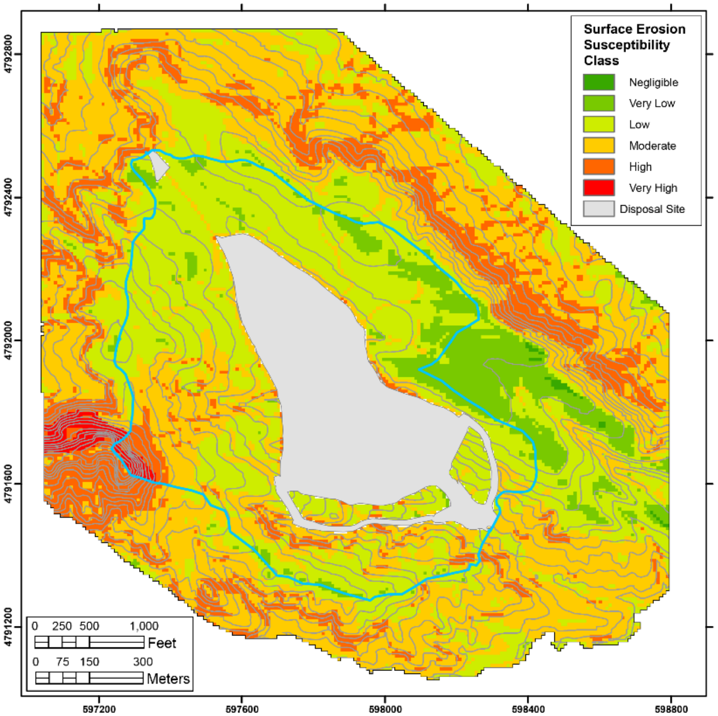


Melton Ruggedness Number 0.07
Very Low class (factor rating = 0)

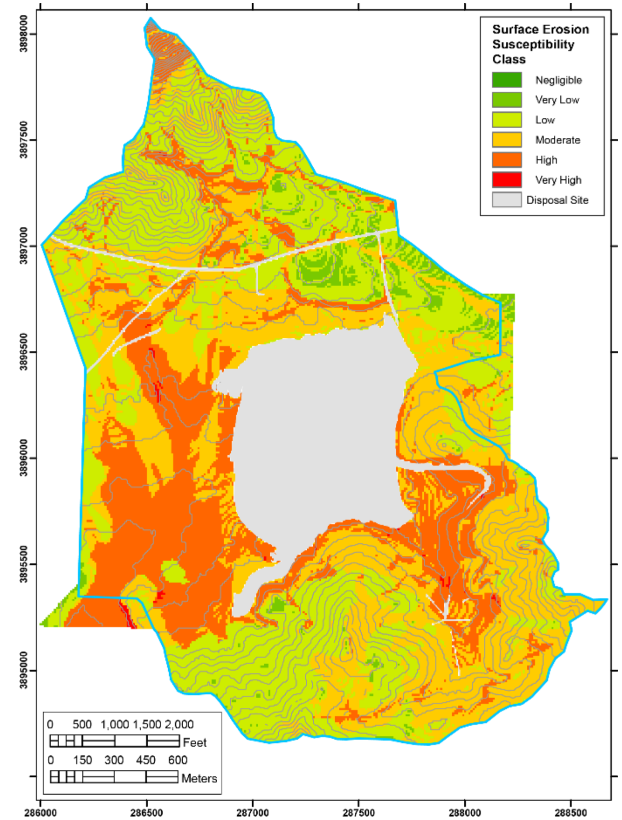
Melton Ruggedness Number 0.15
Low class (factor rating = 1)

Surface Erosion Susceptibility (SES)

Edgemont



L-Bar

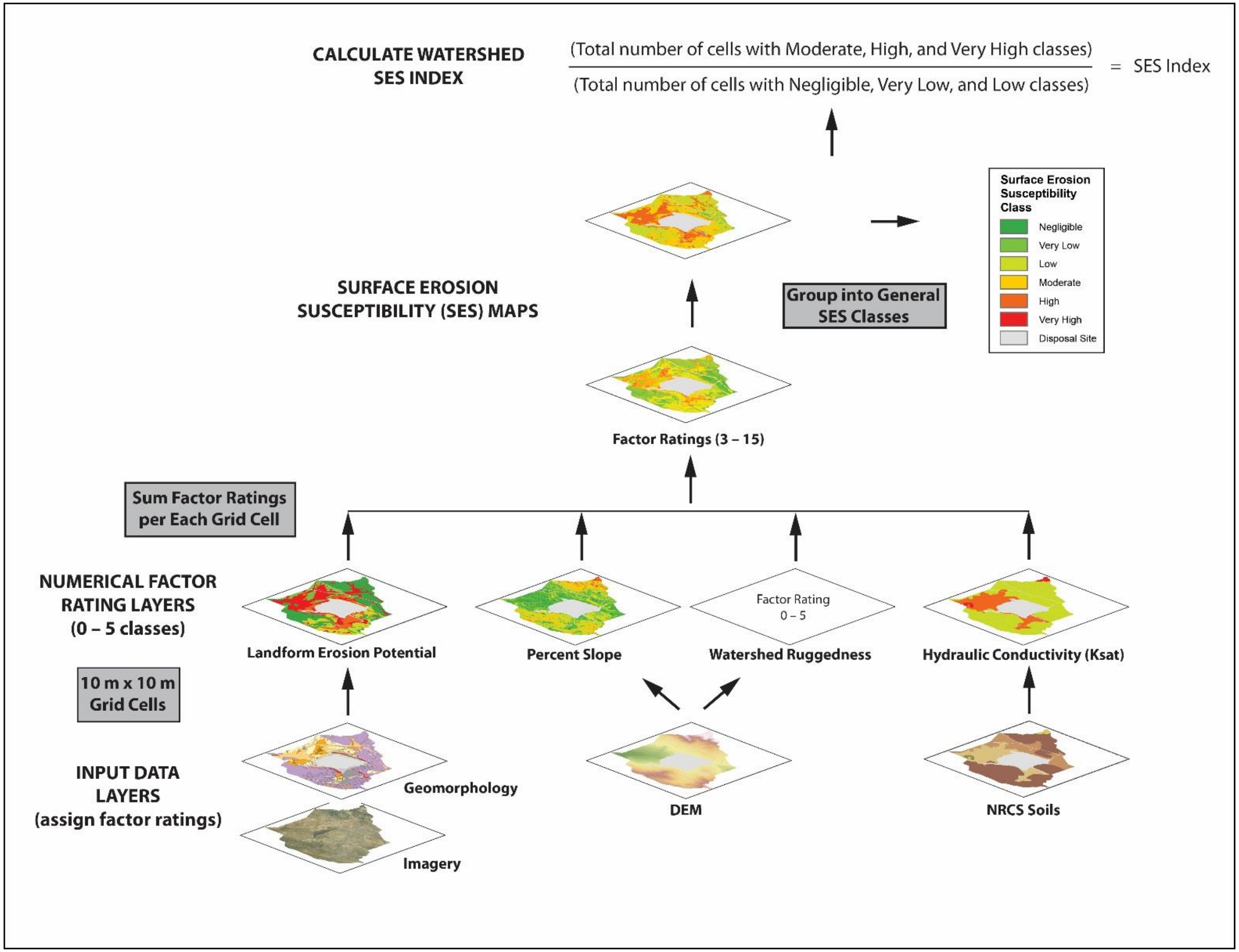


$$\text{SES Index} = \frac{(\text{Total number of cells with M, H, VH classes})}{(\text{Total number of cells with N, VL, L classes})}$$

SES Index = 0.46

SES Index = 1.67

Vulnerability Assessment Flowchart



Monitoring Implications

Focus on-ground monitoring on vulnerable site areas

Photo: NRC, 2015

Remote monitoring opportunities

Photo: LM Program Update Q3 2016

- Context for terrain monitoring through time
- Develop site-specific inspection plans focused on high risk factors
- Preparedness for event based monitoring after fire and flood

Conclusions

- Landform-based approach to identifying vulnerable site areas
  - Easily repeatable and transferable process
  - Based on GIS platform and available datasets
  - Use to develop response plans for terrain altering events & guide long-term monitoring

- Framework for Intra- and Inter-site comparisons
  - Focus resources to address higher risk factors at each site
  - Focus resources to address overall higher risk sites

- Approach can be tailored by using or adding other data layers
  - Climate factors affecting erosion such as freeze/thaw
  - Dissection index (topographic crenulation)
  - Drainage network density including overland vs. channelized flows
  - Seismic hazards
  - Subsidence history
  - Vegetation cover
  - Precipitation intensity