Coversoil Attributes And Influence On Vegetation Cover For Reclaimed Areas Of The Continental Mine Butte, USA

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Thank you to Montana Resources For Supporting This Study

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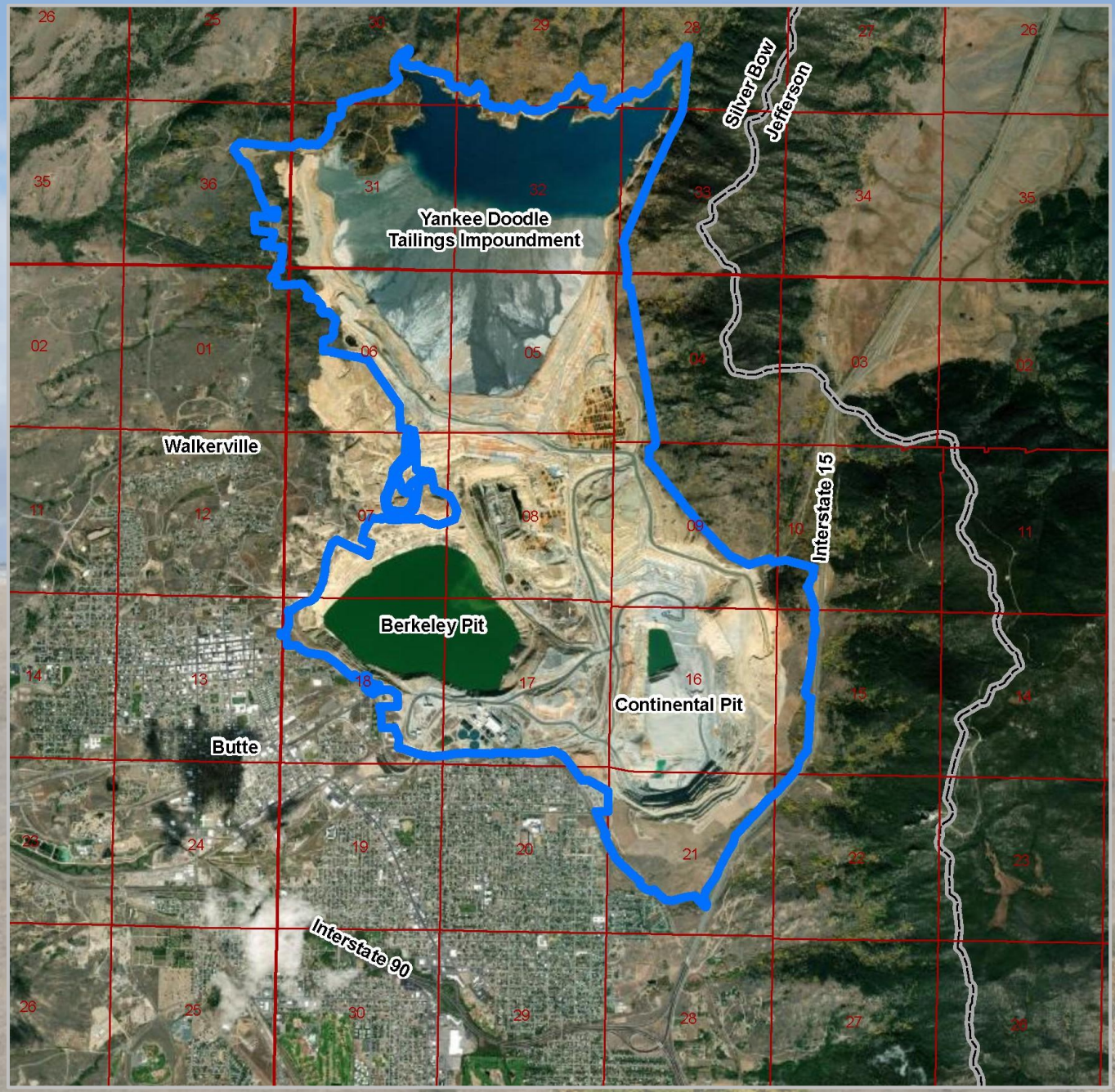
PROJECT LOCATION



BACKGROUND

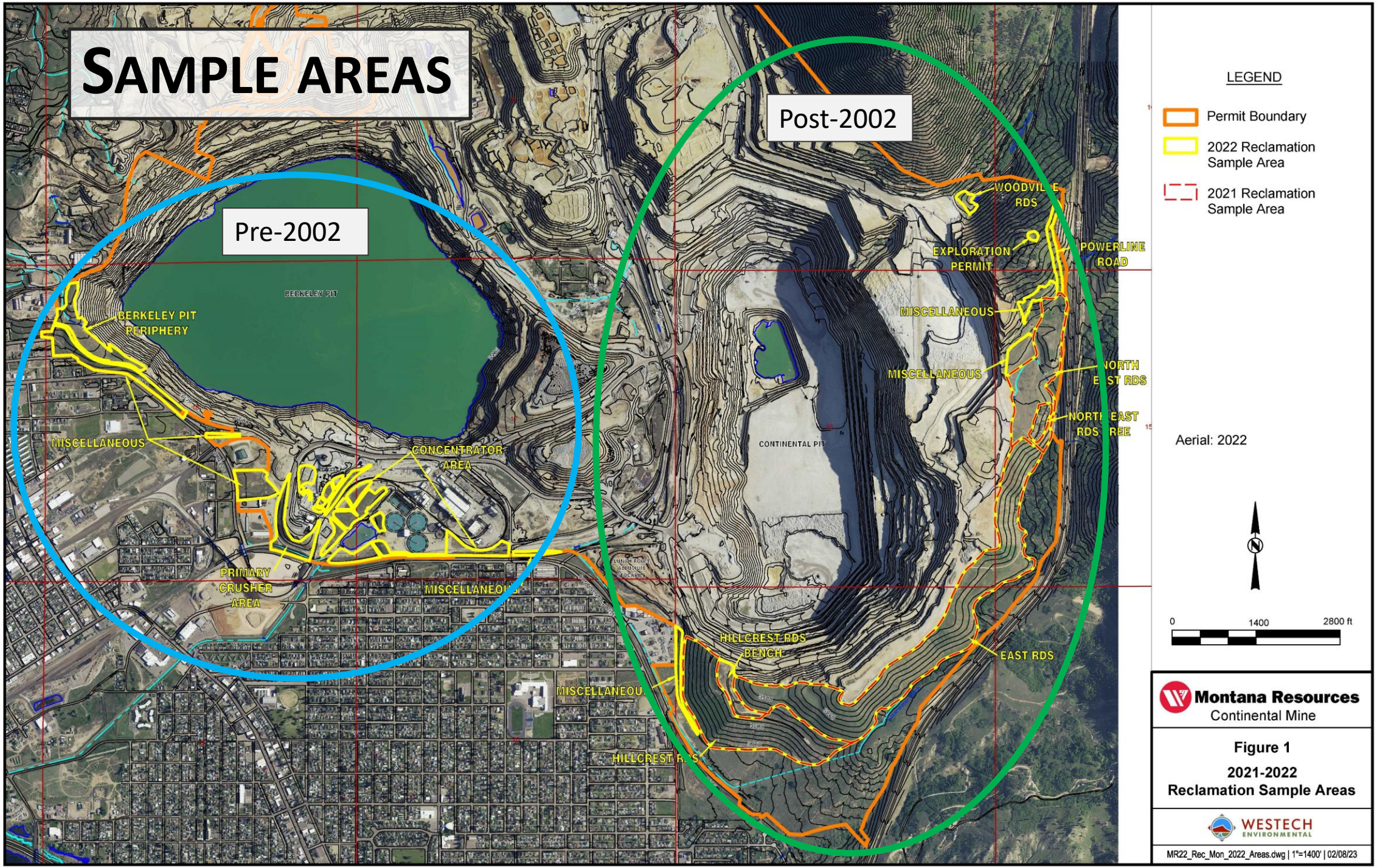
- This study evolved from reclamation monitoring data relative to utility and stability.
- Three main points:
  - Describe the coversoil recipe used for typical reclamation, and coversoil in non-standard reclamation.
  - Assess if the recipe provides adequate vegetation cover compared to adjacent areas.
  - Evaluate variability in coversoil attributes and how that may affect vegetation.

BACKGROUND

- Underground and placer mining near Butte began in late 19th century
- Surface mining in Berkeley Pit/Continental Mine began 1955
- Concurrent reclamation 1990 - 2019, majority completed since 2017
- Reclamation since 2002 based on coversoil recipe of:
  - 6 inches of topsoil above suitable alluvium
  - 1.5 % average organic matter
  - < 40% coarse fragment (> 2mm)
  - pH ≥ 6.5
  - Total metal index < 1700 mg/kg (As + Cu + Zn)
  - Coversoil Depth
    - 28 inches on slopes < 5%
    - 20 inches on slopes ≥ 5% and ≤ 37%
    - 30 inches on slopes > 37%

QUESTION

How do different coversoil attributes
(e.g., depth, pH, % OM, metals)
affect perennial grass establishment and growth?


SAMPLE AREAS
Pre-2002
Post-2002
BERKELEY PIT
BERKELEY PIT PERIPHERY
MISCELLANEOUS
CONCENTRATOR AREA
PRIMARY CRUSHER AREA
MISCELLANEOUS
MISCELLANEOUS
HILLCREST RDS
CONTINENTAL PIT
WOODVILLE RDS
EXPLORATION PERMIT
POWERLINE ROAD
MISCELLANEOUS
MISCELLANEOUS
NORTH EAST RDS
NORTH EAST RDS
HILLCREST RDS BENCH
EAST RDS
LEGEND
Permit Boundary
2022 Reclamation Sample Area
2021 Reclamation Sample Area
Aerial: 2022
N
0
1400
2800 ft
Montana Resources
Continental Mine
Figure 1
2021-2022
Reclamation Sample Areas
WESTECH ENVIRONMENTAL
MR22_Rec_Mon_2022_Areas.dwg | 1"=1400' | 02/08/23

Sampling: Soils and Vegetation

- Sampling in 2021 and 2022.
  - 2021 focus area = Rock Disposal Sites (RDS): n = 105 randomly located plots
    - Primarily reclaimed 2002 - 2019
  - 2022 focus area = Berkeley Pit periphery and mine facilities: n = 50 randomly located plots
    - Primarily reclaimed pre-2002
    - Resampled 3-year old revegetation on the East RDS

- Vegetation Sampling
  - 0.01 acre plot
  - Species composition
  - Species canopy cover

- Laboratory analysis of:
  - Texture
  - Metals
  - Organic Matter %
  - pH

Sampling: Non-standard Reclamation

- Non-standard reclamation areas:
  - Lodgepole pine stand (Tree Stand)
    - older site on rocky substrate
  - Hillcrest Bench
    - seeded, no coversoil – straight alluvium
  - Hot Spots - small, isolated areas with
    - typically low pH,
    - high metal concentrations, and
    - low vegetation
  - Non-standard reclamation data used as comparison to standard reclamation and evaluation of anomalous conditions


Pre-2002 Reclamation

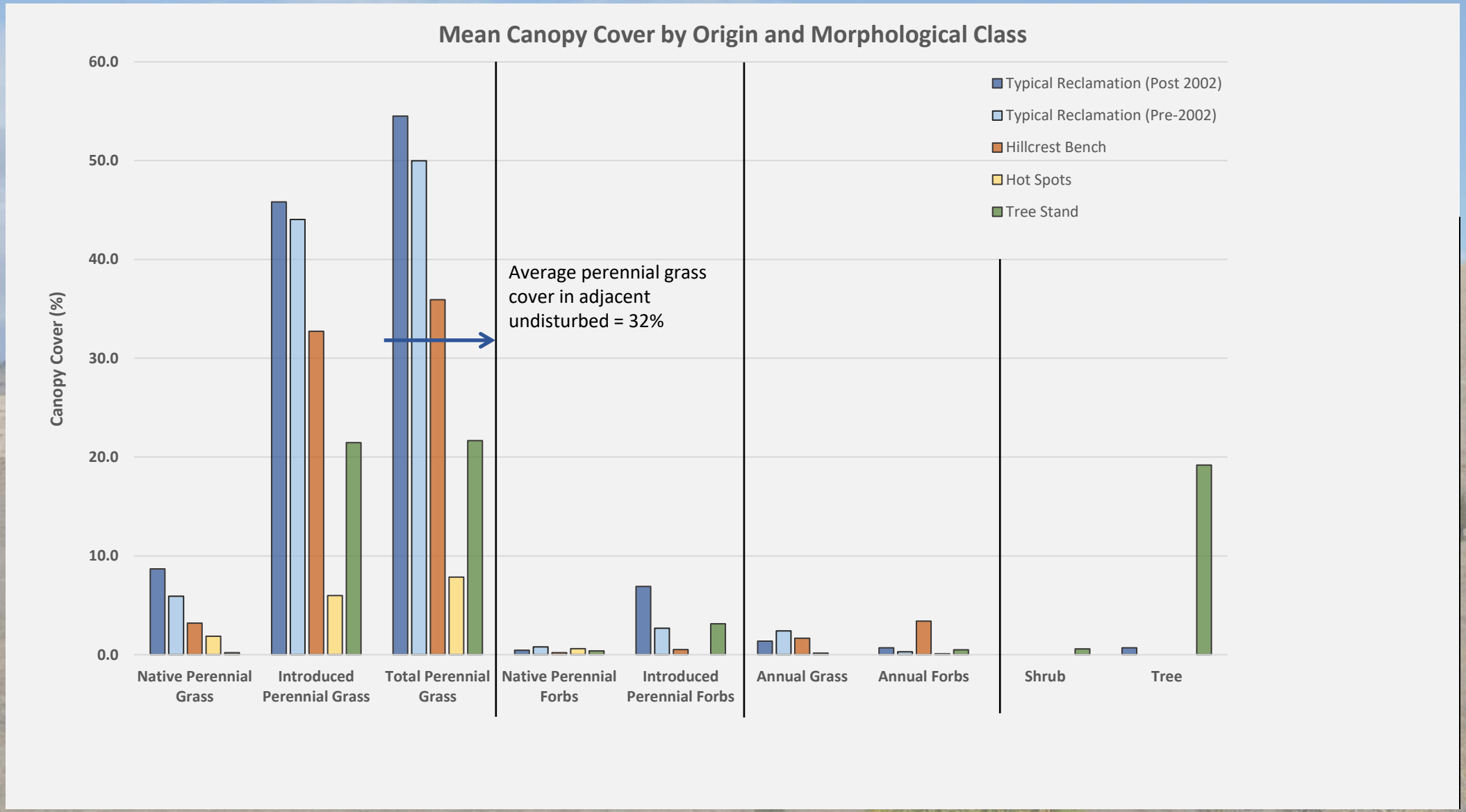

Post 2002 Reclamation


Hot Spot

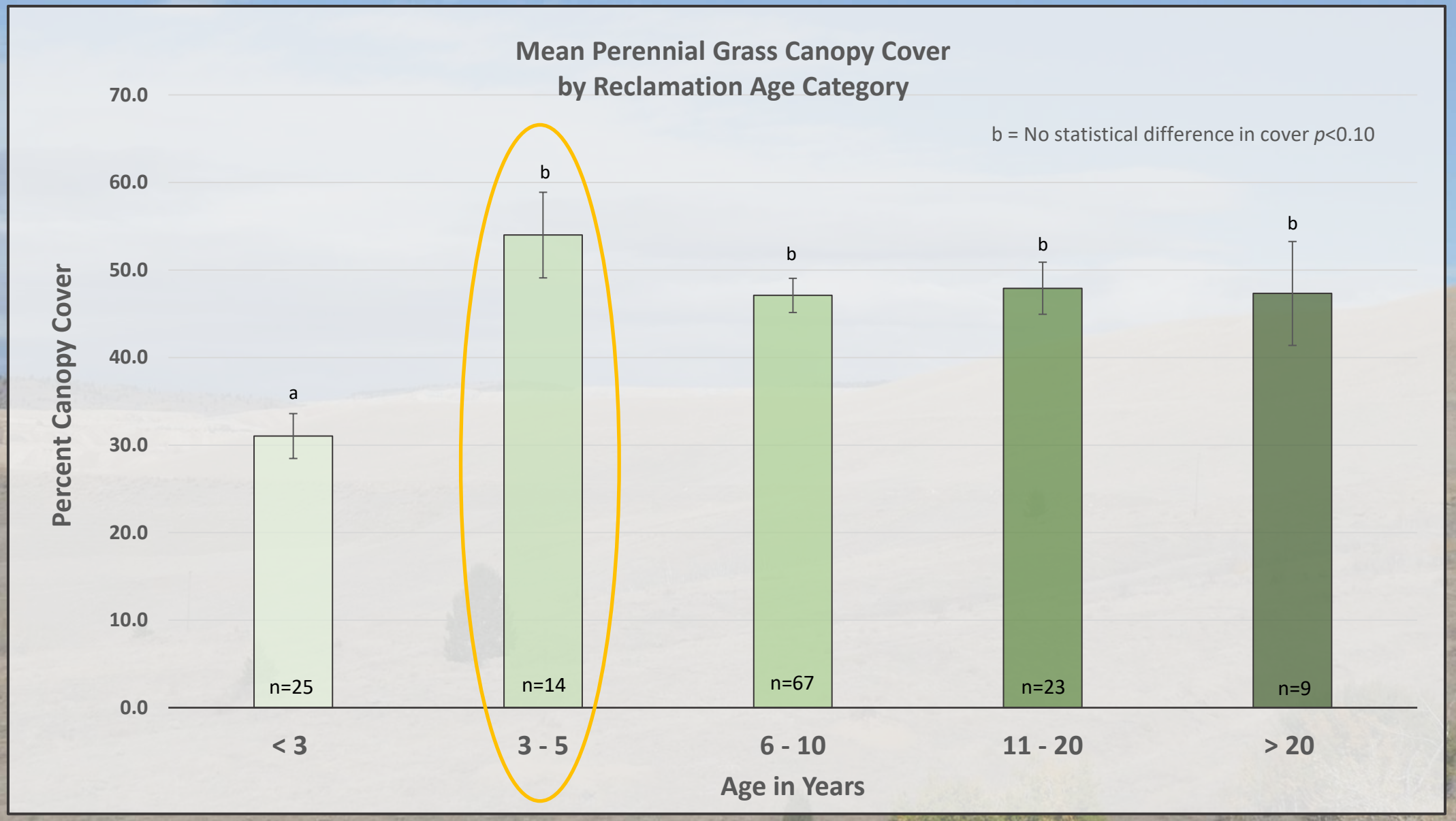

Hillcrest Bench


07 20 2021
Tree Stand

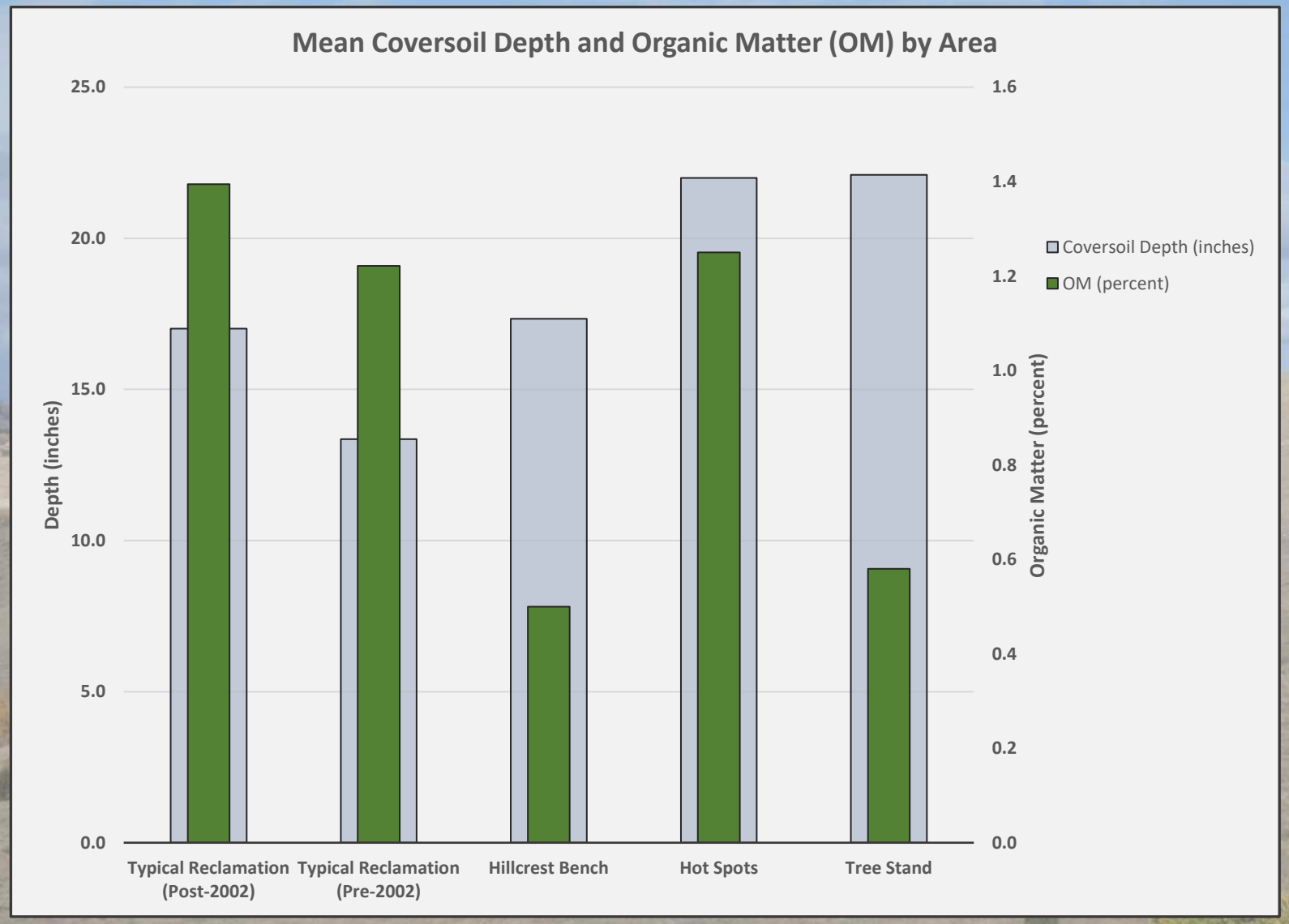
RESULTS: VEGETATION COMPOSITION



Results: Vegetation Age



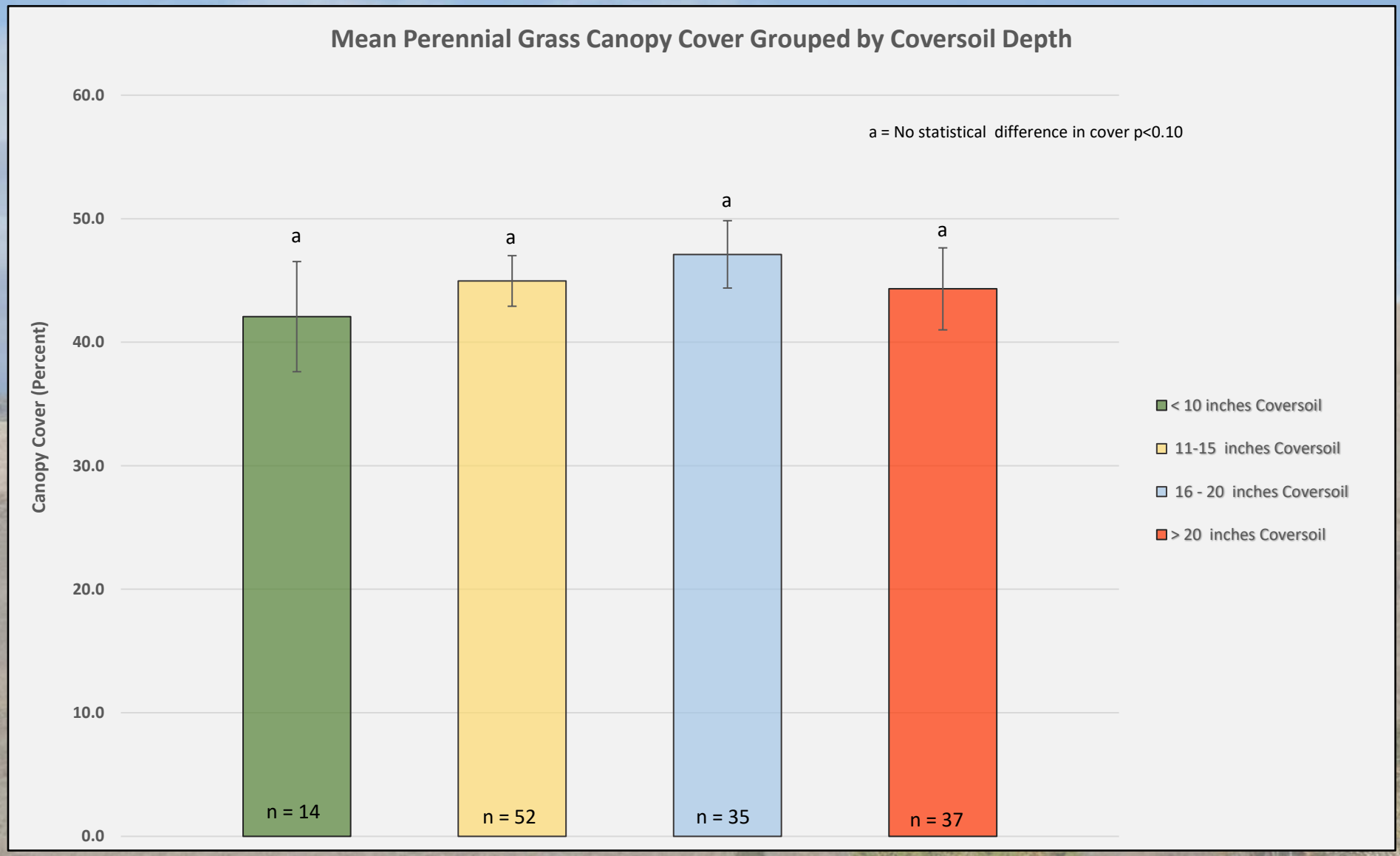
Results: Coversoil Depth and Organic Matter



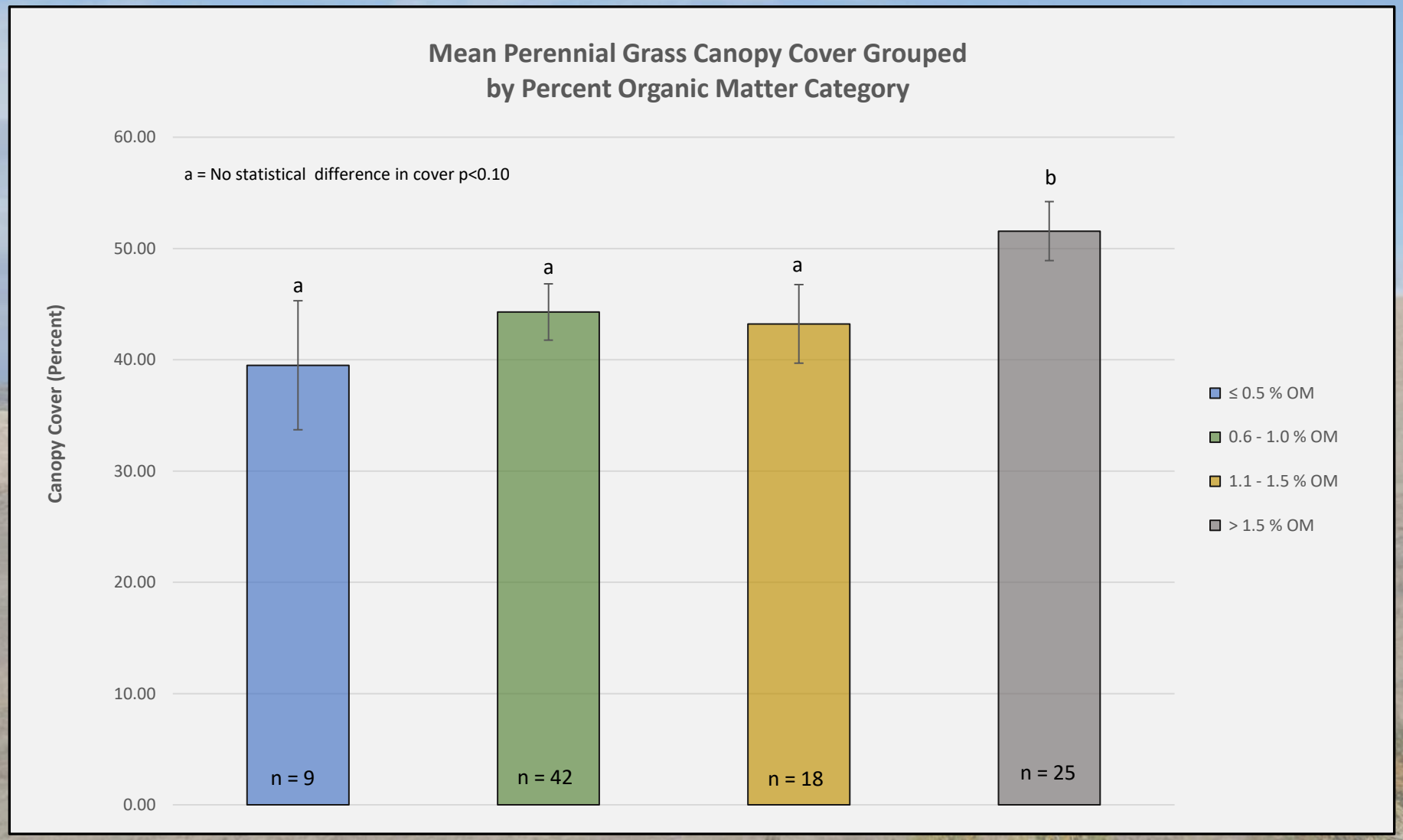
Average coversoil depths between 12 and 22 inches

Average OM >1% except on Hillcrest Bench and in Tree Stand

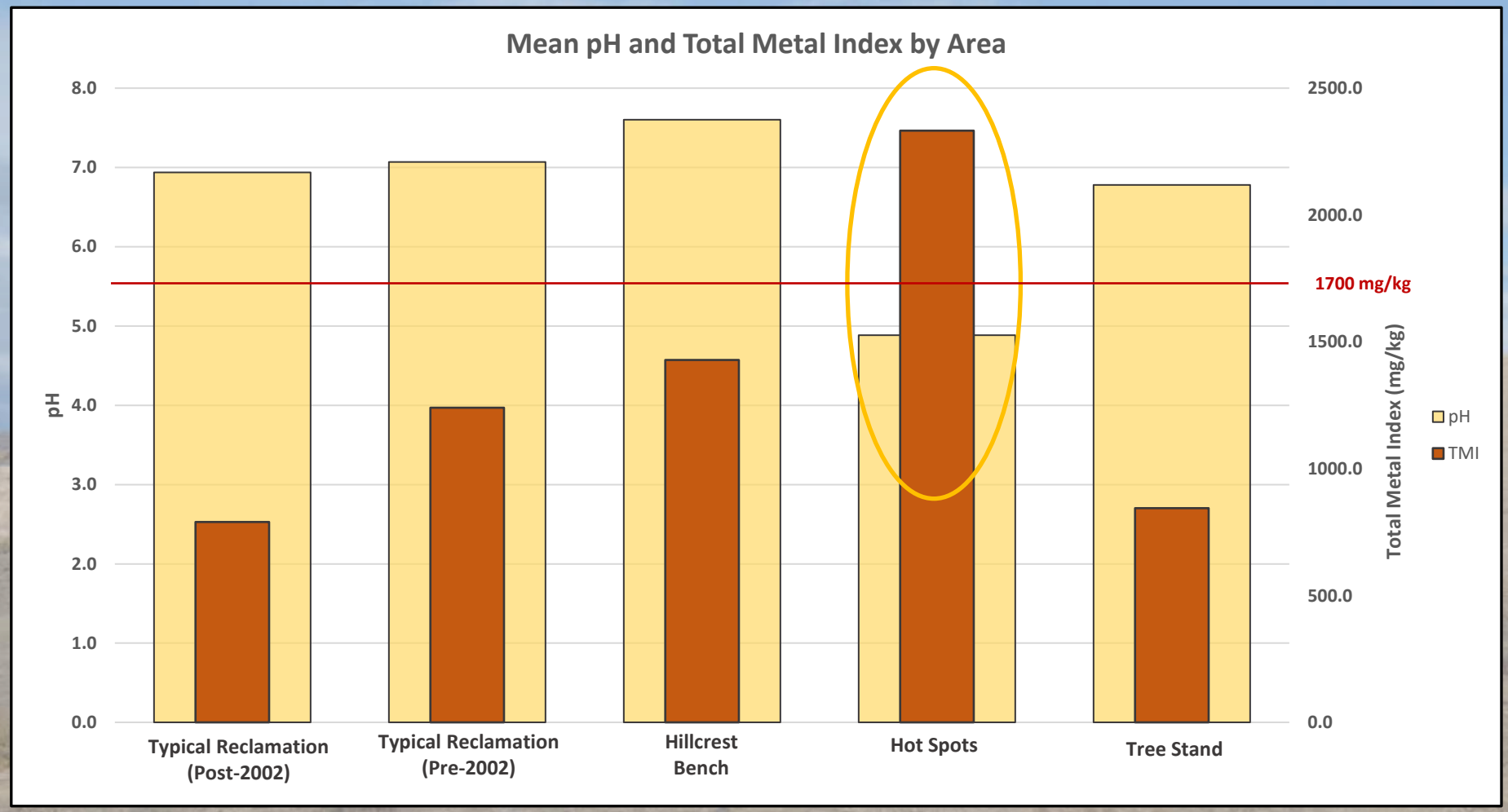
Results: Coversoil Depth and Perennial Grass Cover



Results: Organic Matter and Perennial Grass Cover



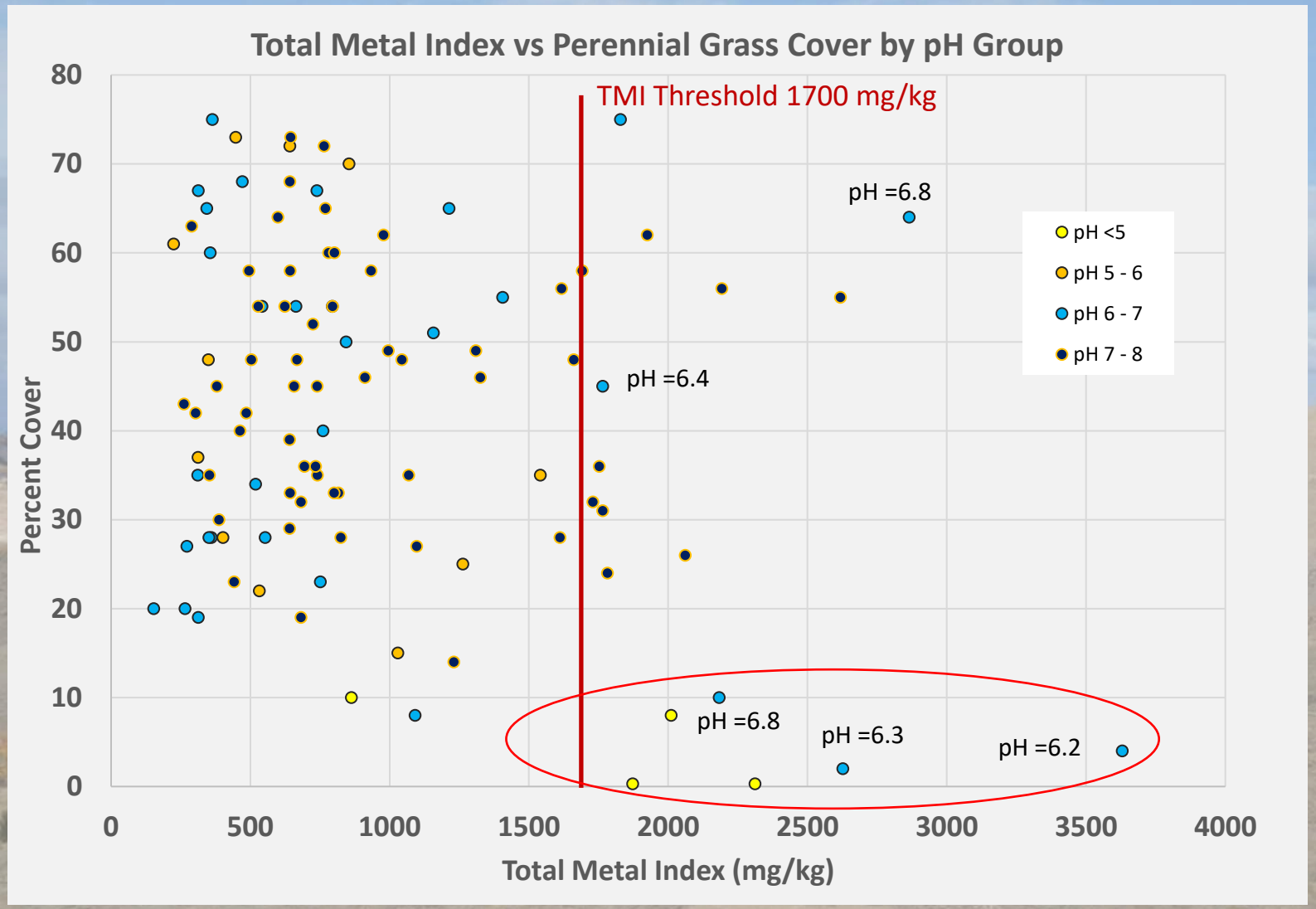
Results: Soil Composition By Area – pH and TMI



TMI Threshold for phytotoxicity at Anaconda Smelter and MR Reclamation Plan is 1700 mg/kg

TMI = Total Metals Index (sum of arsenic, copper, zinc concentrations)

Results: TMI and Grass Cover by pH Group



Not all sites with TMI > 1700 mg/kg have low canopy cover

pH may have inconsistent effect on TMI phytotoxicity

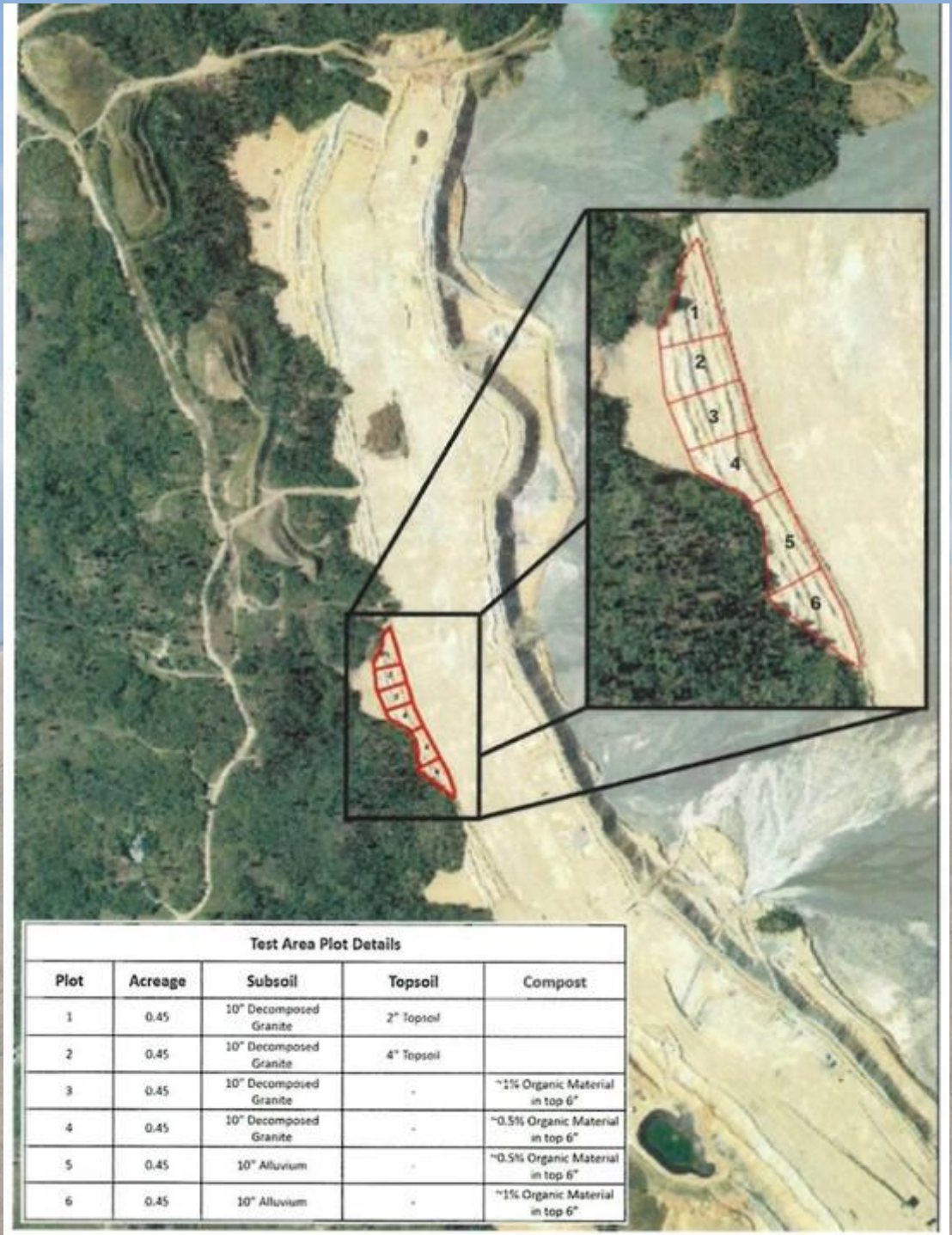
SUMMARY

- Average perennial grass cover was statistically similar regardless of coversoil depth or organic matter content up to 1.5 percent
  - Coversoil depths ranged from 2.5 to 36 inches
  - Organic matter content ranged from 0.15 to 5.1 percent
- All revegetated areas except the Tree Stand support comparable perennial grass cover to undisturbed areas
- Perennial grasses tolerant of:
  - wide-range of coversoil depths,
  - organic matter percentage, and
  - metal concentrations

Future Work

- Although coversoil depth and % OM may not influence perennial grass growth individually, there is a potential interaction between these variables.
- Designed study on West Embankment to identify thresholds of coversoil depth, straight alluvium, and amendments that can achieve comparable perennial grass growth.
  - Graded and soiled in 2023, seeded 2024.
  - Monitoring will begin in 2025.

Reclamation Trials – 2.7 acres



Test Area Plot Details

Plot	Acreage	Subsoil	Topsoil	Compost
1	0.45	10" Decomposed Granite	2" Topsoil	
2	0.45	10" Decomposed Granite	4" Topsoil	
3	0.45	10" Decomposed Granite	-	~1% Organic Material in top 6"
4	0.45	10" Decomposed Granite	-	~0.5% Organic Material in top 6"
5	0.45	10" Alluvium	-	~0.5% Organic Material in top 6"
6	0.45	10" Alluvium	-	~1% Organic Material in top 6"


Questions?