Grizzly Creek Hydraulic Mine Biochar Pilot Project

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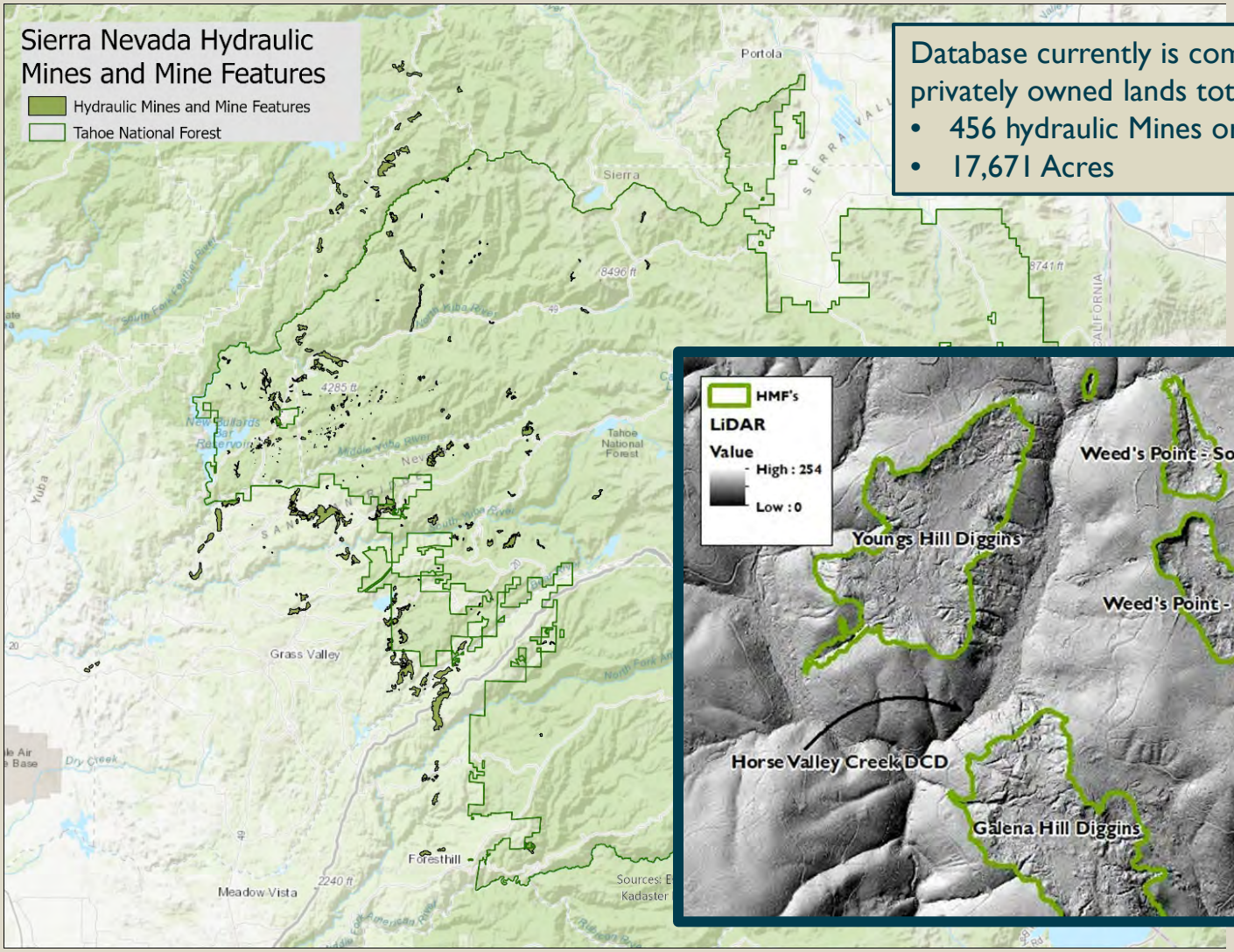
Hydraulic Mine Database

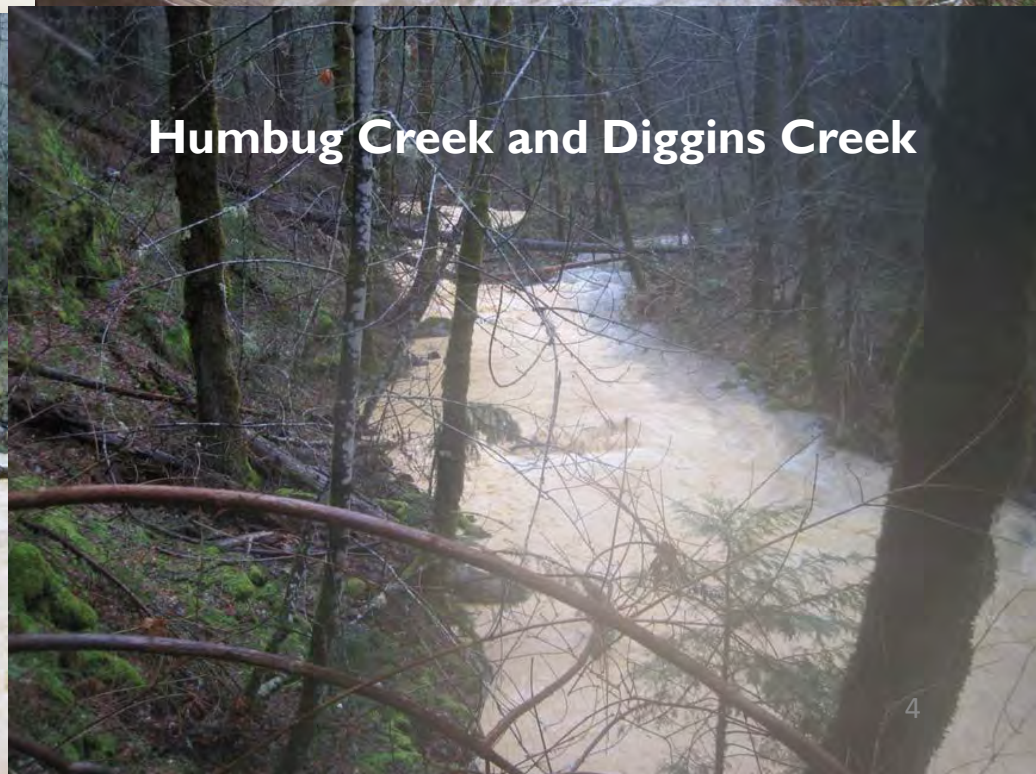


Database currently is comprised of publicly and privately owned lands totaling:

- 456 hydraulic Mines or Mine Features
- 17,671 Acres

Hydraulic Mine Site Characteristics

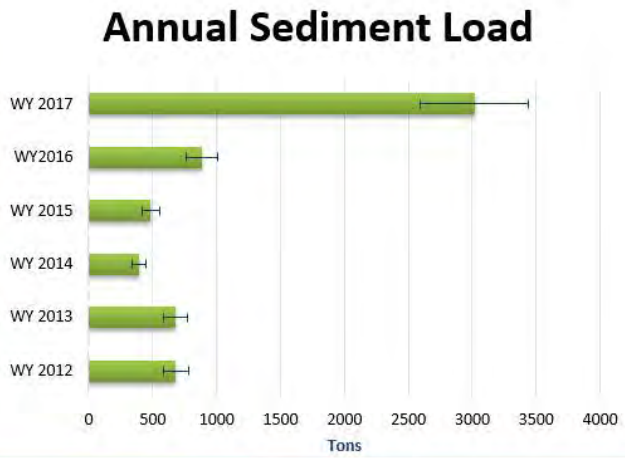
- Active Erosional Areas
- Drain Tunnels
- Ditches
- Ponds
- Gullies / Headcuts
- Multiple Outflow Points

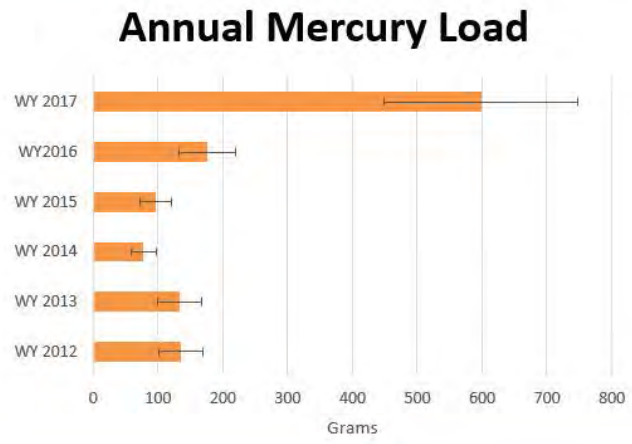


Photos taken by Dr. C. Monohan 3/14/2012

Humbug Creek Watershed Assessment

Malakoff Diggins Humbug Creek





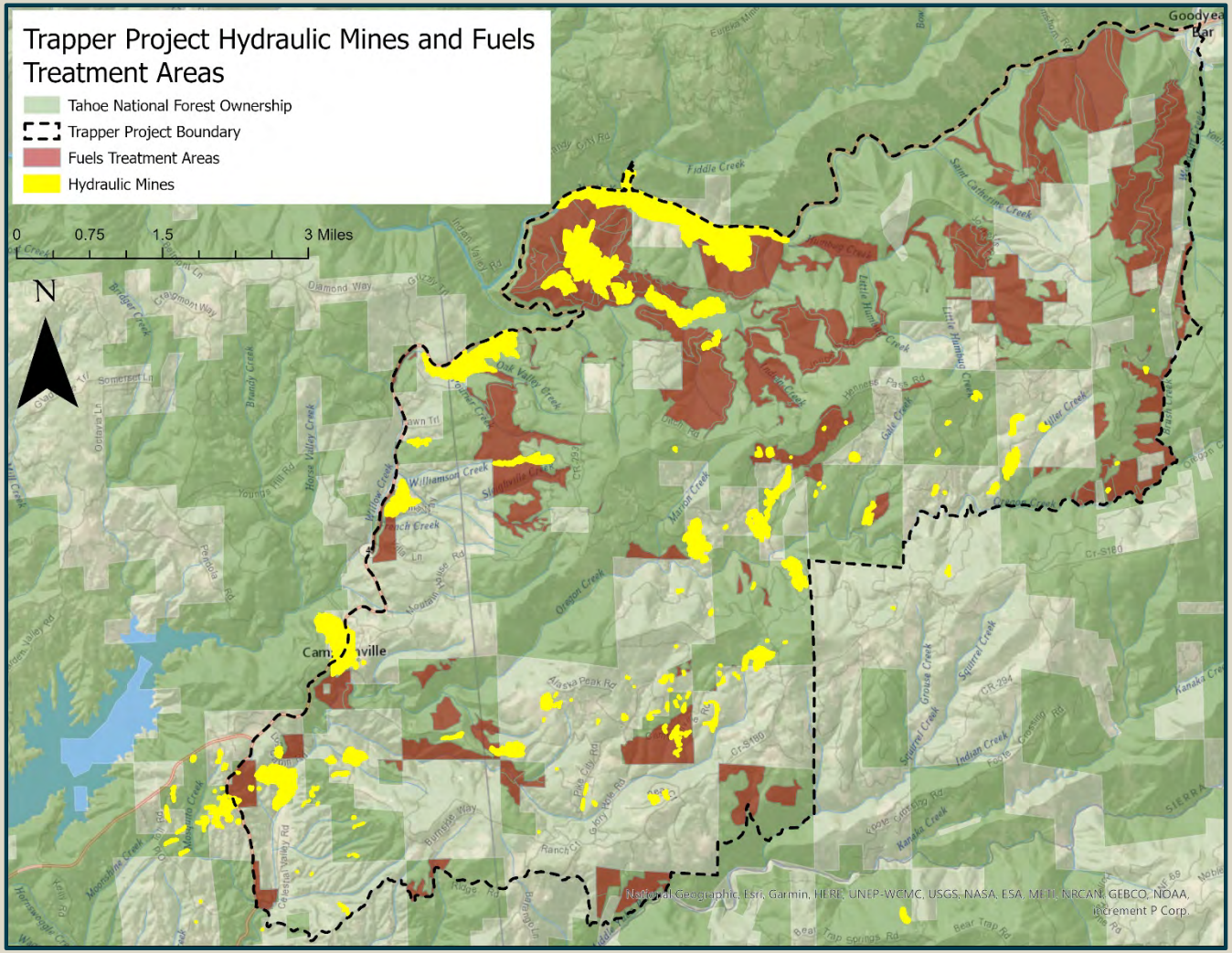
Trapper Forest Health Project

Approximately 31,000 acre planning area, with 19,300 acres of National Forest System

63 Hydraulic Mines
1,199 acres

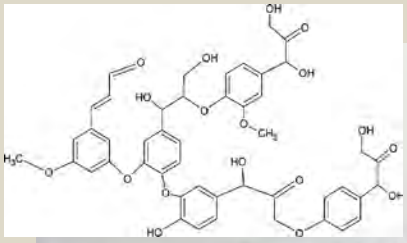
TN Forest Service project to enhance watershed health by improving;

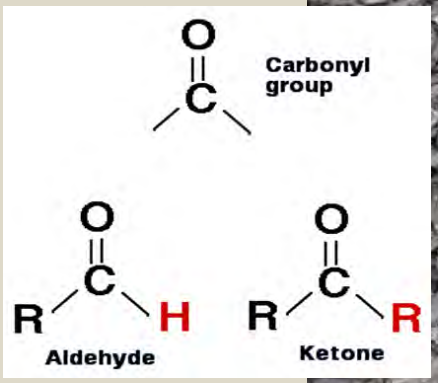
- Forest health and resilience to changing climatic conditions
- Reduce surface and ladder fuels
- Protect and/or improve wildlife habitat
- Maintain and improve watershed and soils conditions



What is Biochar?

- Different feedstocks-Woody Biomass
- Biochar pyrolysis temperature and organic material determine the binding sites present
- low pyrolysis temperature (300-400C) combined with organic material high in lignin creates more effective biochar compared to other temperatures and feedstocks





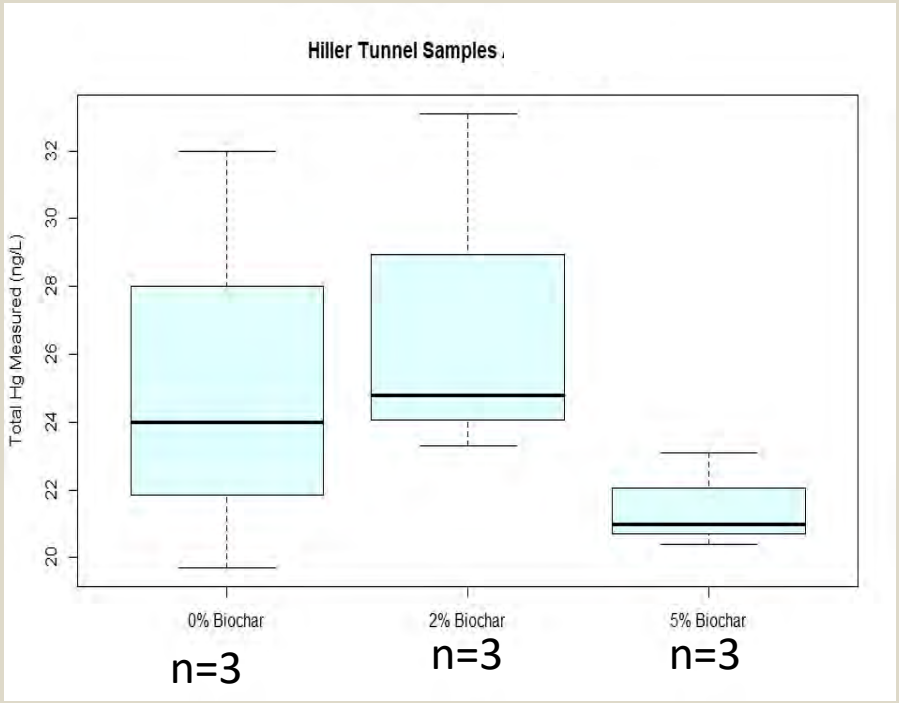
Biochar and Hydraulic Mine Remediation

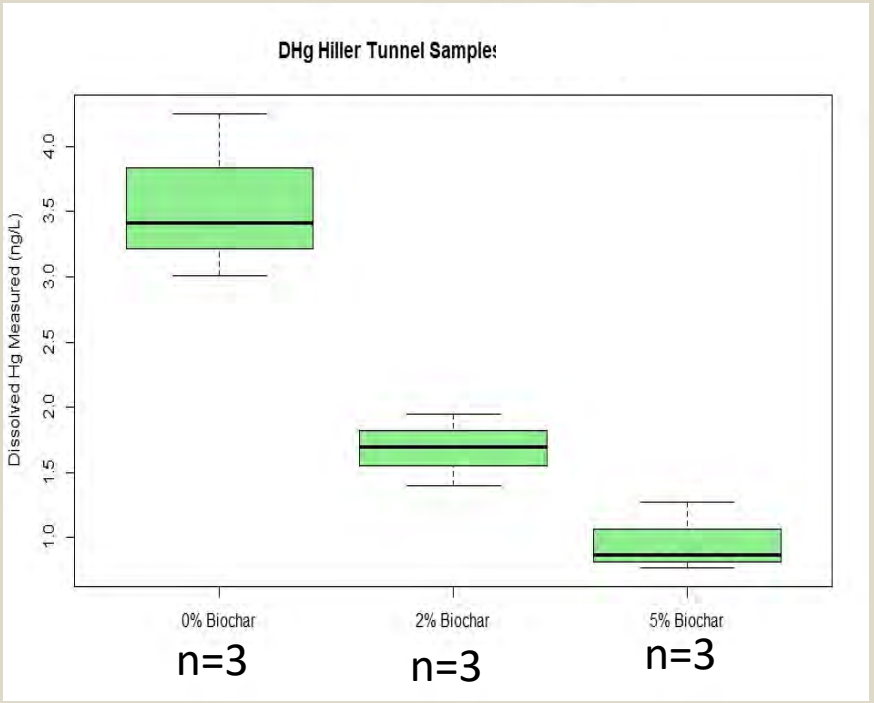
- Lab Tests: three experiments
  - biochar manufactured using Ponderosa Pine at 400C, by Phoenix Energy in Merced
- Storm water Sampling-background
- Field Tests: Planned 2022

BioChar Lab Tests
Experiment 1) Storm Water Columns

- Water Collected from Malakoff Diggins
- Passed through decomposed granite, with 0, 2, 5% BioChar
- Collected Turbidity, THg and f-Hg

BioChar Lab Tests
Experiment 1) Storm Water Columns



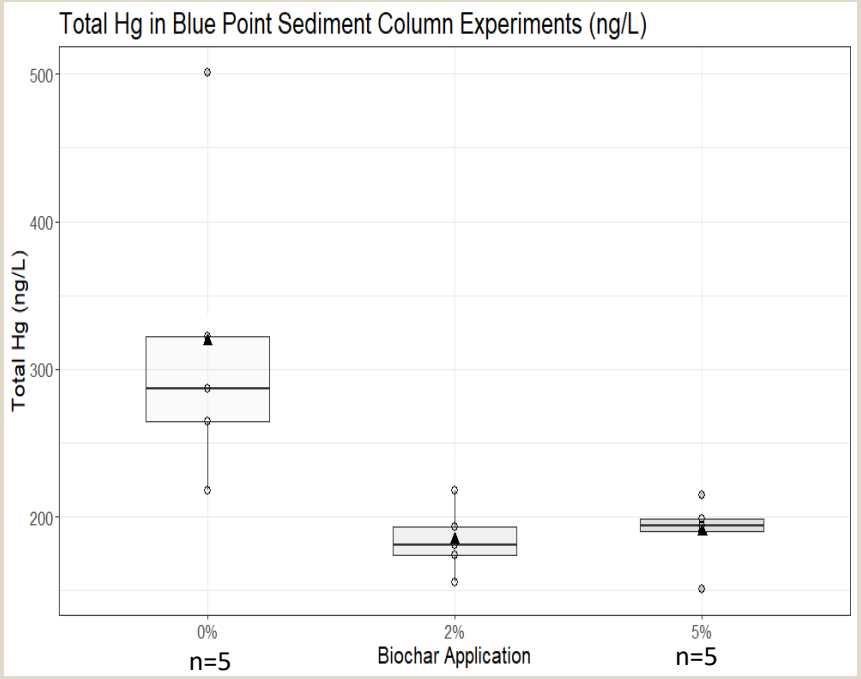


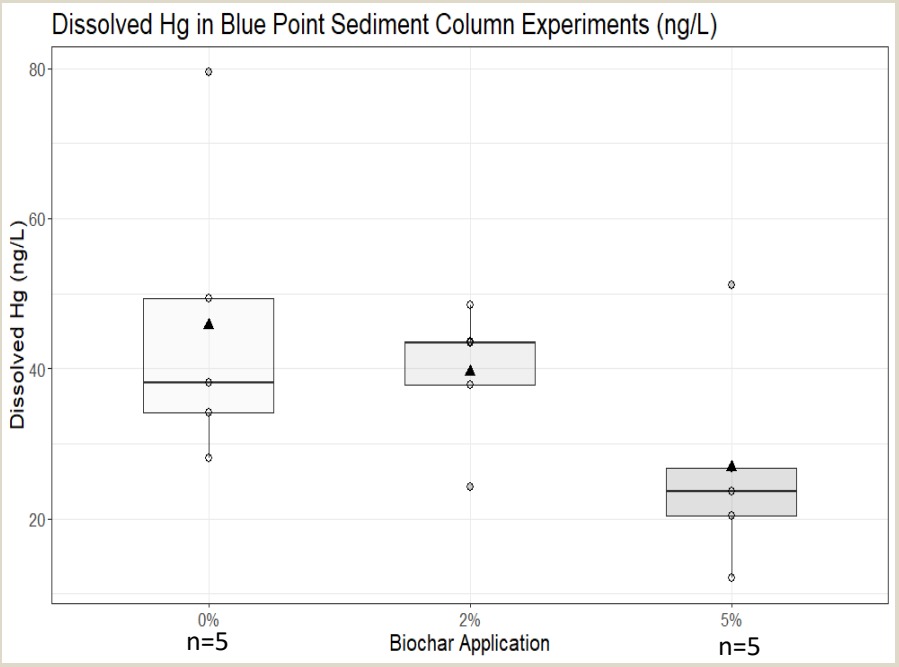
Brandt M., D. Page-Dumroese, J. Webster and C. Monohan. Biochar as a Soil Amendment: Reduction of Mercury Transport from Hydraulic Mine Debris. Energies. 2021, 14. (in review)

BioChar Lab Tests
Experiment 2) Sediment Sample Columns

- Hydraulic Mine Debris collected from Blue Point Mine
- DI water passed through debris with 0, 2, 5% BioChar
- Collected Turbidity, THg and f-Hg

BioChar Lab Tests
Experiment 2) Sediment Sample Columns





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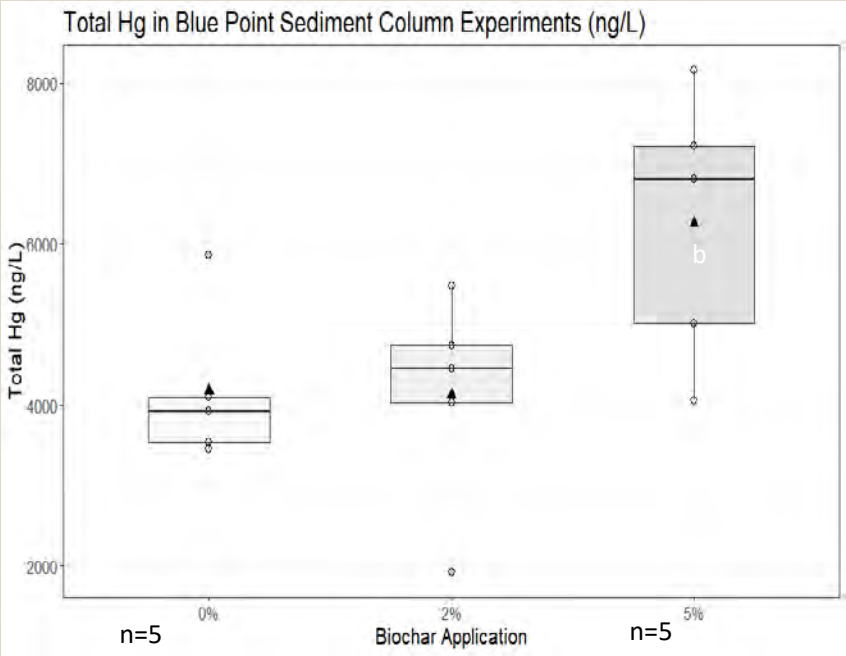
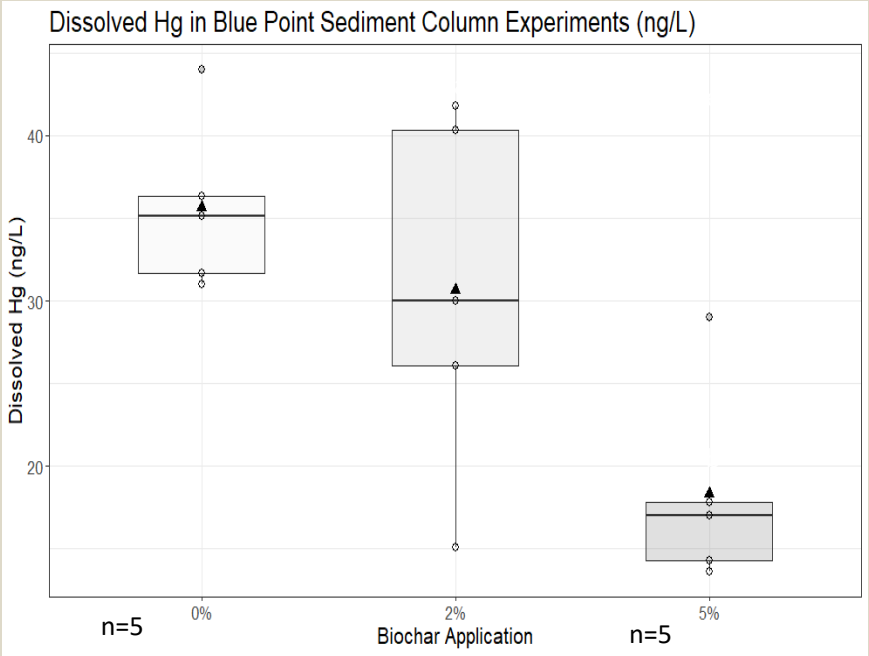
BioChar Lab Tests
Experiment 3) Sediment Sample Trays

- Hydraulic Mine Debris collected from Blue Point Mine
- DI water passed through debris with 0, 2, 5% BioChar
- Samples were sieved and 50% fines and 50% greater than fines
- Collected Turbidity, THg and f-Hg

BioChar Lab Tests
Experiment 3) Sediment Sample Trays





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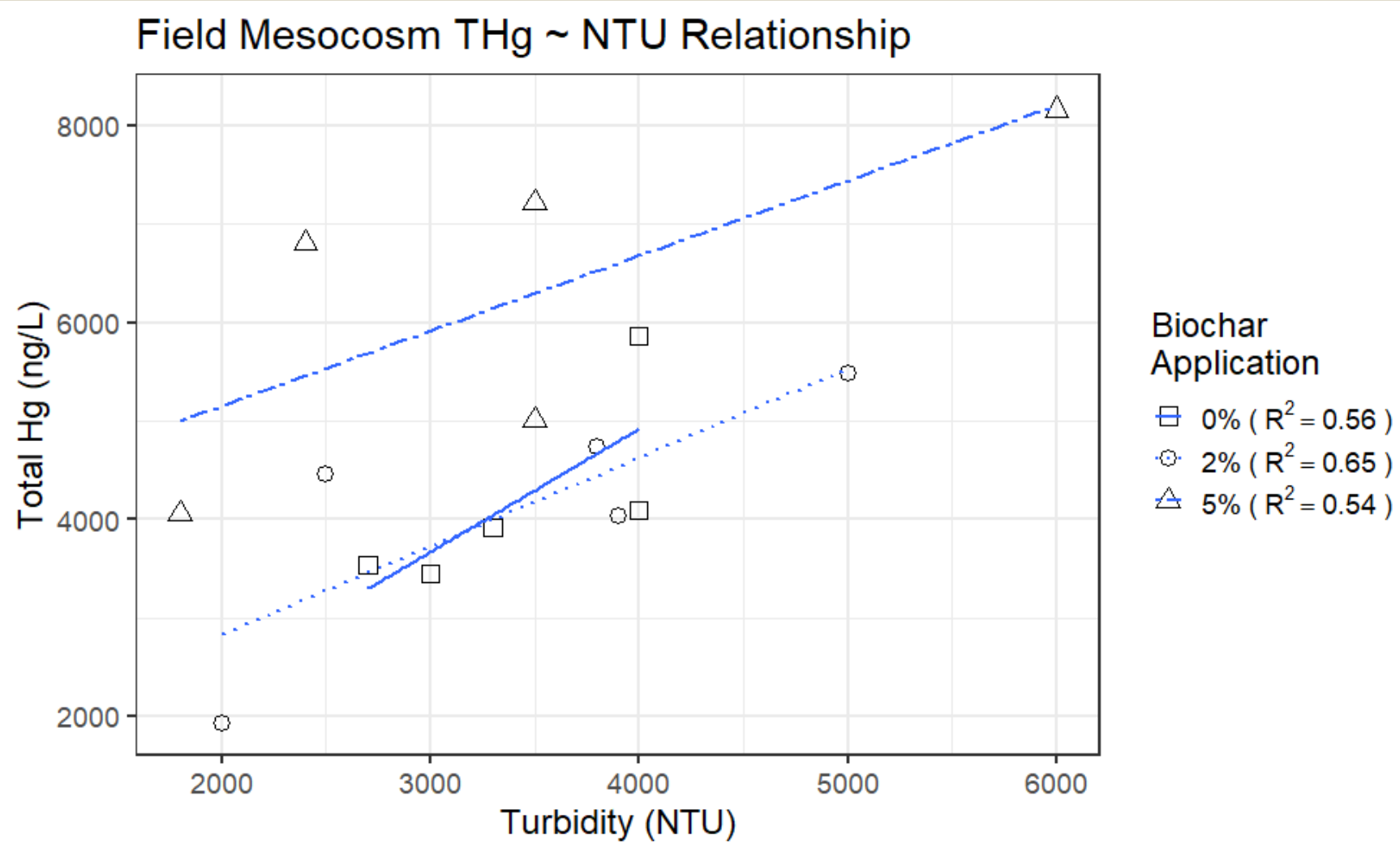
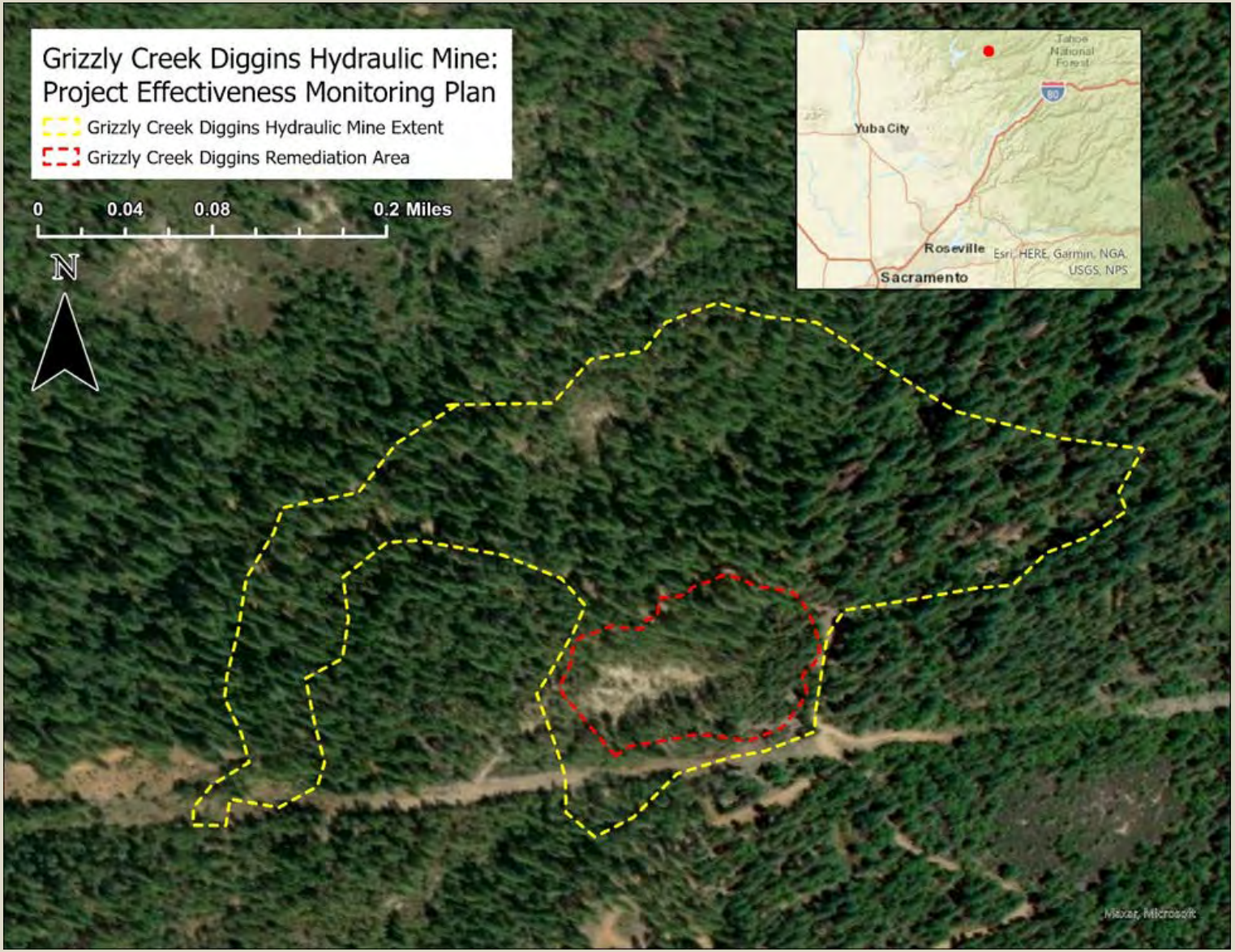
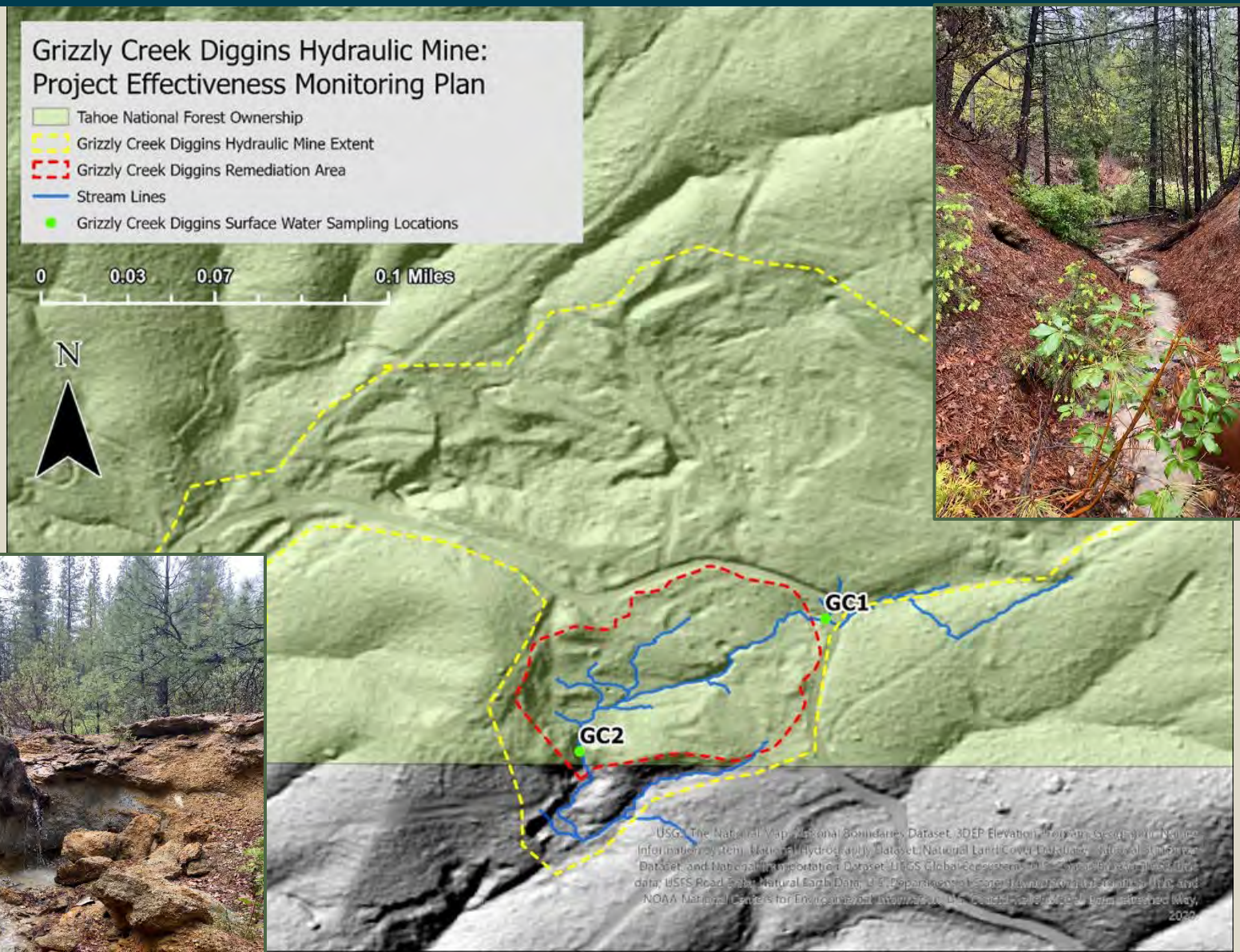


Grizzly Creek Diggins Pilot Project



Grizzly Creek Diggins Storm Water Sampling



Grizzly Creek Diggins
Storm Water Sampling Results

Site ID	Date	Time	THg (ng/L)	f-THg (ng/L)	p-THg (ng/L)	TSS (mg/L)	Q (cfs)	THg Load (ng/sec)	TSS Load (mg/sec)
GC1	3/22/2018	12:25	4.67	4.01	0.66	3	1.83	242	155
GC1	1/9/2019	12:45	6.55	4.88	1.67	2.4	1.68	312	114
GC1	1/17/2019	10:10	5.41	4.27	1.14	1.9	1.91	293	103
GC1	5/19/2020	14:00	10.7	4.5	6.2	n/a	0.08	24	n/a
Average GC1			**6.83**	**4.42**	**2.42**	**2.43**	**1.38**	**217.61**	**124.13**
GC2	3/22/2018	12:52	17.7	5.56	12.14	63.2	2.17	1,088	3,883
GC2	1/9/2019	12:30	13.4	4.36	9.04	40.9	1.82	691	2,108
GC2	1/17/2019	10:50	12.3	4.45	7.85	23.1	2.13	742	1,393
GC2	5/19/2020	14:15	73.9	5.38	68.52	n/a	0.13	272	n/a
Average GC2			**29.33**	**4.94**	**24.39**	**42.40**	**1.56**	**698.03**	**2461.53**

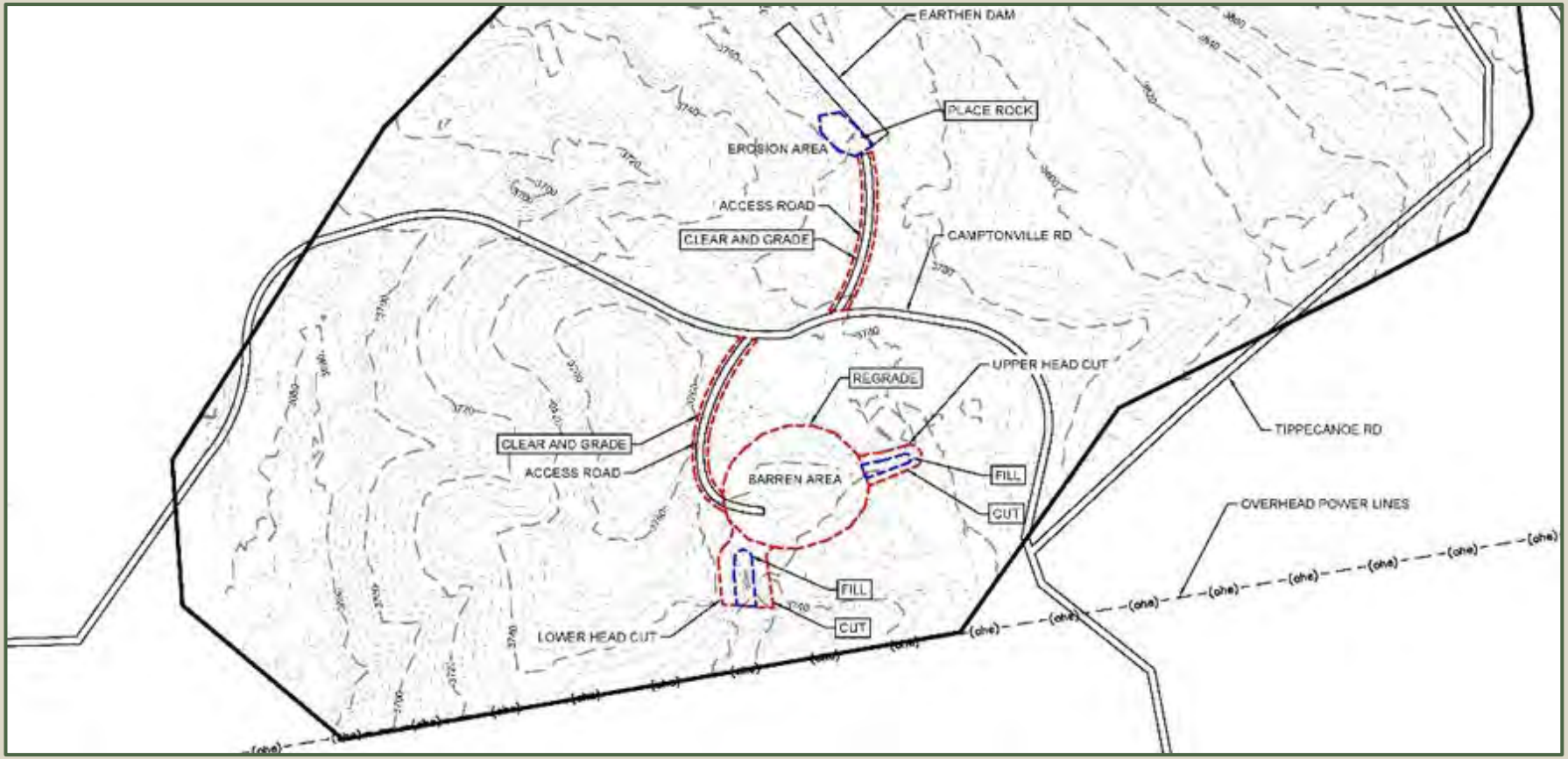
The CERCLA pre-screening criteria indicates that a discharge from the site for mercury would need to be ≥1 lbs/24hrs to trigger a CERCLA investigation. The contributing loads we calculated are 10,000 times below the trigger for CERCLA for mercury.

Grizzly Creek Diggins Remediation Design

-50 acres of fuels reduction
-Land re contouring to reduce erosion rates
-Stabilize two headcuts
-Stabilize a debris control dam
-Biochar and chips as soil amendments

Grizzly Creek Diggins
Biochar Test Plots

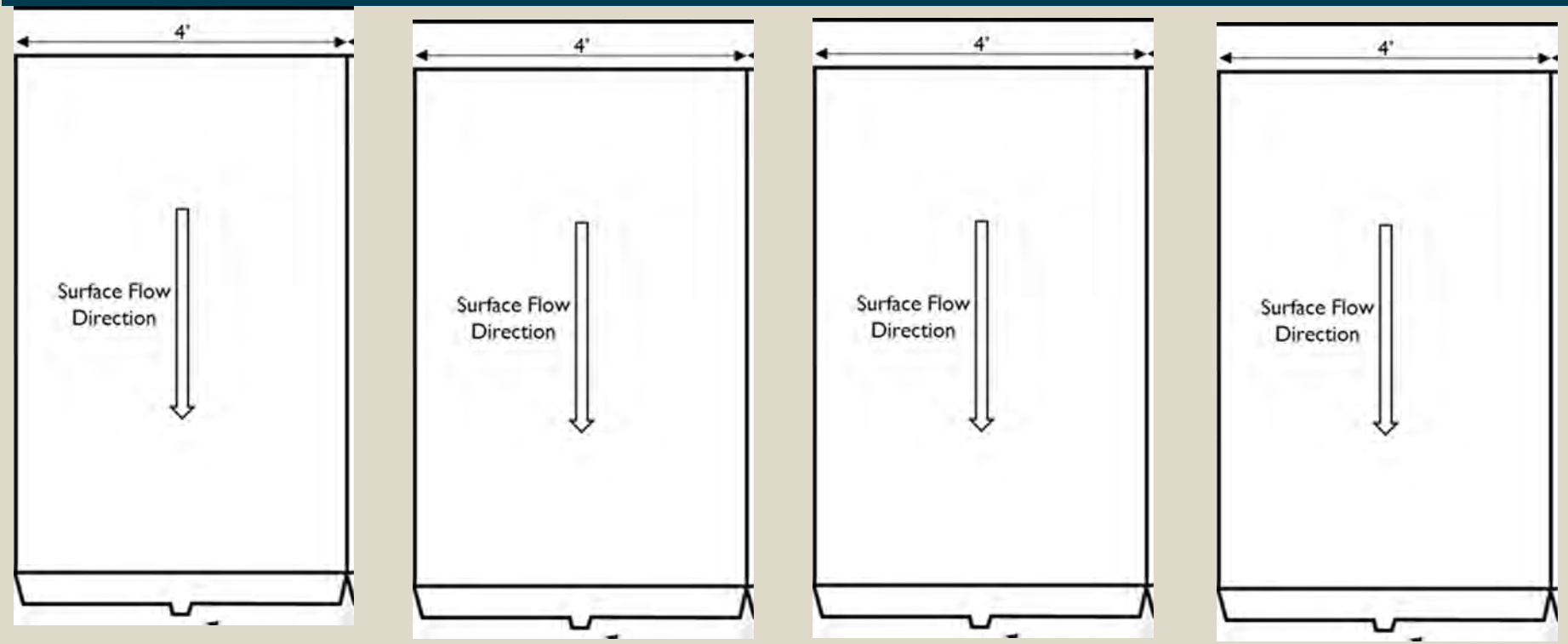
4'x10' test plots will be constructed within the "Barren Area" of the Grizzly Creek Diggins Hydraulic Mine pit.

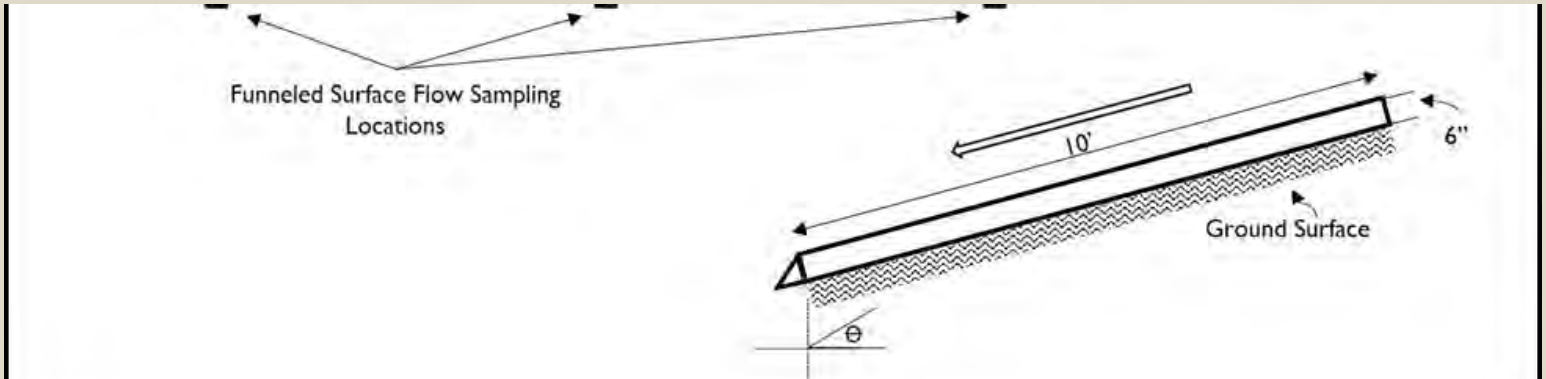


Biochar Properties Restoration Fuels

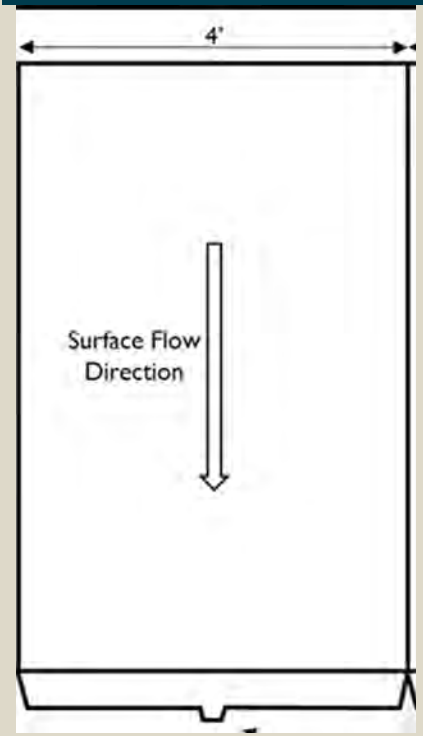
- Biochar source testing and documentation is necessary for any soil amendment to document the material is "clean" and that there aren't any contaminants which may affect the sampling and testing.
- FPL will conduct this Biochar testing.
  - Samples were sent to FPL over the summer and they are analyzing it for a range of characteristics.

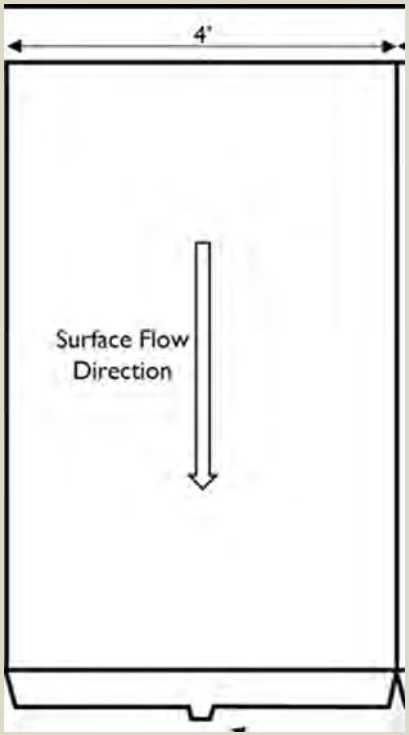
Grizzly Creek Diggins Biochar Test Plots

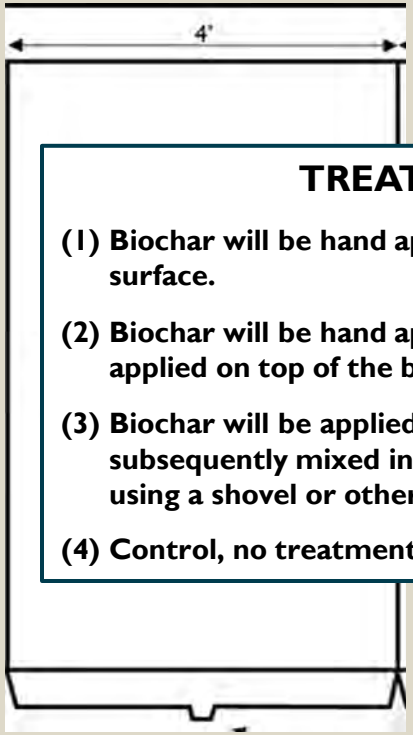


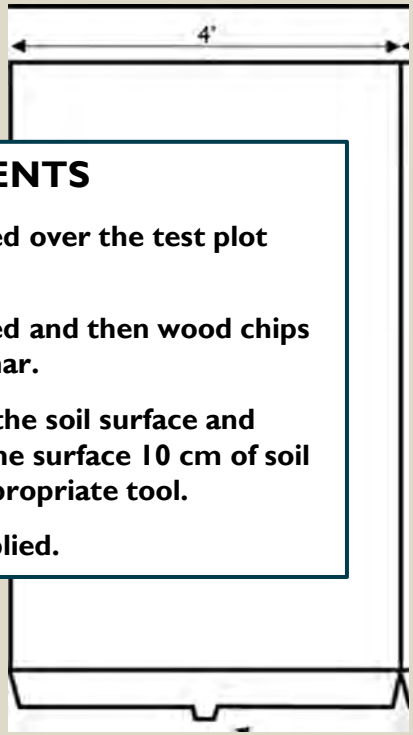


Grizzly Creek Diggins Biochar Test Plots









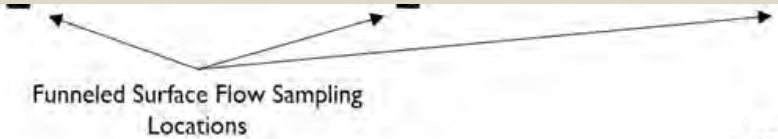
TREATMENTS

(1) Biochar will be hand applied over the test plot surface.

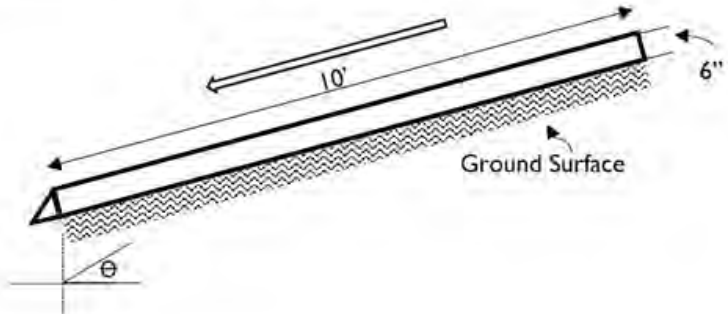
(2) Biochar will be hand applied and then wood chips applied on top of the biochar.

(3) Biochar will be applied to the soil surface and subsequently mixed into the surface 10 cm of soil using a shovel or other appropriate tool.

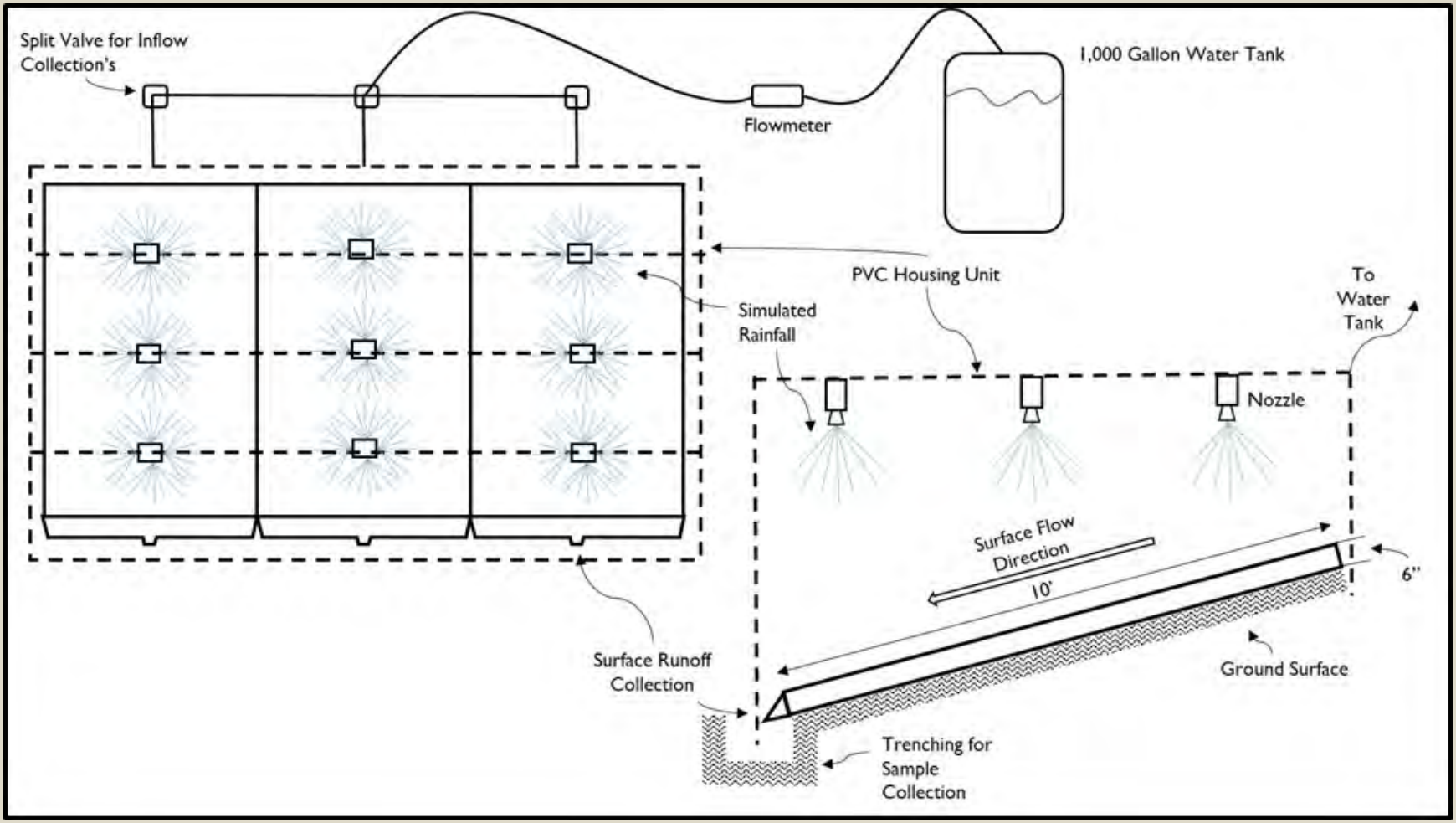
(4) Control, no treatment applied.



Total Mercury (THg)
Filtered-Total Mercury (f-THg)
Total Suspended Solids (TSS)
Turbidity (NTU)



Grizzly Creek Diggins
Biochar Test Plots, Simulated Rainfall



Grizzly Creek Diggins
Biochar Test Plots, Runoff Sampling
2022 and 2023

- T_0-In; Sample collection at time of runoff from the inlet port to the housing unit to monitor the incoming water quality to the simulated rainfall unit.
- T_{1-}Out; Sample collection at time of runoff from the outflow of the test plot
- T_{30}-Out; Sample collection at 30 minutes following runoff
- T_{60-}Out; Sample collection at 60 minutes following runoff

Conduct Tests in 2022 and in 2023

Grizzly Creek Diggins
Soil and Revegetation Sampling

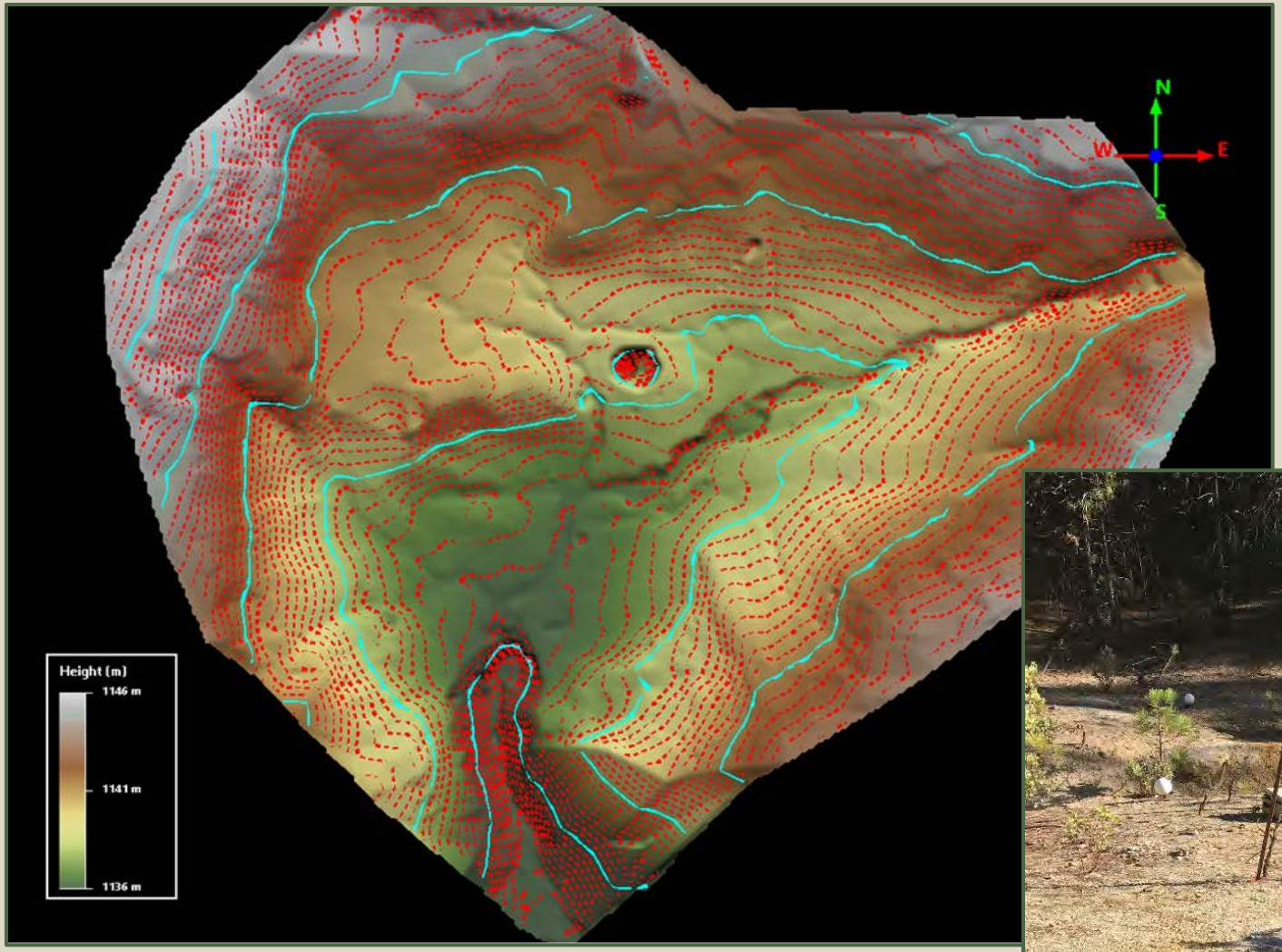
- Revegetate with a seed mix of native grasses and forbs from the local area
- At 1, 3, 6, and 12 months after seedling ground cover measurements using the Cover Management Assistant will be taken (Steinfeld et al. 2011)
  - The Cover Management Assistant will also be used to determine bare soil, biochar, and wood chip cover, and small-scale erosion.

- After 12 months:
  - a 20 cm^2 plot will be excavated to extract whole root systems for an estimate of belowground biomass.
  - 2 soil cores (2.5x10 cm corer) will be extracted from each treatment plot to determine soil C and N using a LECO CN analyzer (LECO Corp., St. Joseph, MI).
  - soil pH will be determined on a 2:1 (water:soil) slurry.
  - Soil OM content will be determined by loss-on-ignition at 350°C after 8 h.
  - Soil peds will be collected to conduct a slake test to determine the stability of soil aggregates in water.
  - An undisturbed core from each replicate will be collected to determine soil water holding capacity and pore size distribution using the WP4C water potential equipment (Meter Group, Pullman, WA).

- In one replicate of each soil treatment, soil temperature (Onset Computer Corp., Bourne, MA) and moisture (ECH_2O probes; Meter Group, Pullman, WA) probes will be installed at a depth of 10 cm for abiotic measures every 4 hr.

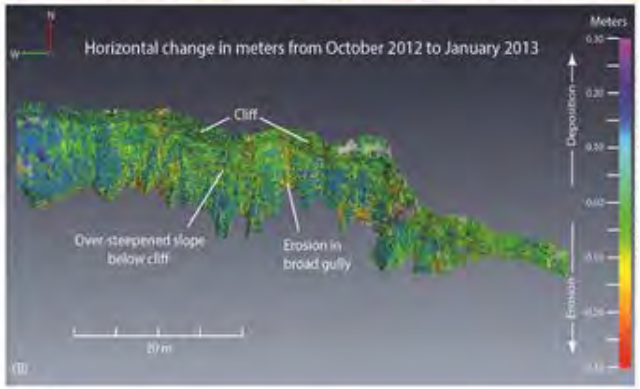
- To measure CO_2 flux from the soil surface, open PVC collars will be permanently installed in each study plot. Soil CO_2 measurements using the LiCor 8100A automated soil gas flux system (LiCore Biosciences, Lincoln, NE) will conducted each time soil cover is assessed. n

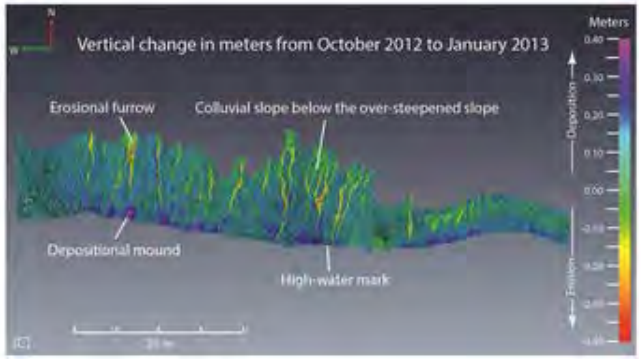
Grizzly Creek Diggins Terrestrial-LiDAR (T-LiDAR)

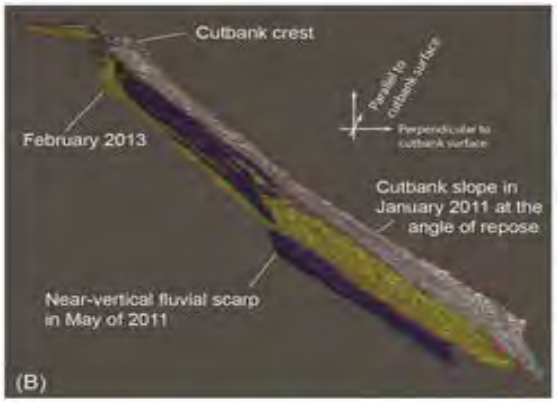


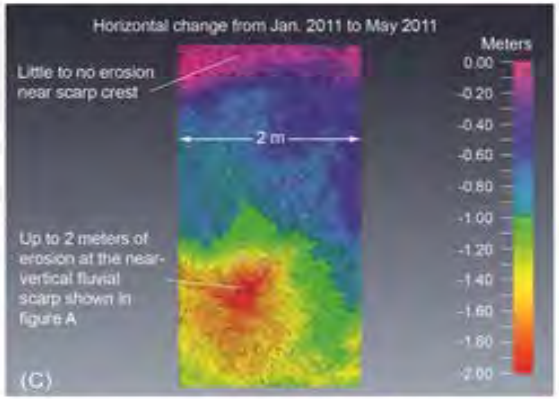
T-LiDAR: Erosion Rates before and after remediation

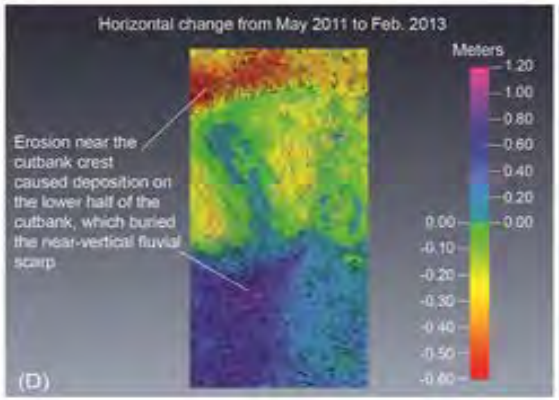
USGS Terrestrial LiDAR at other Sites

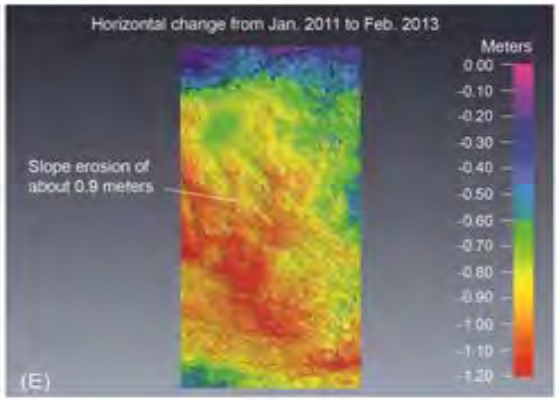












Next Steps?

-Grant Extension for US Endowment Funding

-Sampling and Analysis Plan / Work Plan Update

-Summer 2022 test plot construction and testing

-Apply for Implementation funding from SNC




Contact Us!

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