

# HOLLOWED GROUND

How can designing with phytoremediation be used to understand the role wetlands play in cleansing our past endeavors?

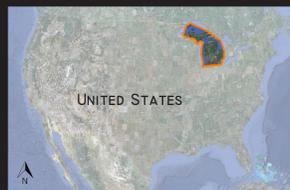


79  
White Pine Mine  
Cu  
Copper  
63,546

## Contextual Information

### Site Narrative

White Pine Mine is an ideal site that meets all of the criteria proposed for a successful mine waste remediation project. The large tailing ponds provide plenty of space for exploring unique ways of remediating the site whilst providing recreational and educational opportunities to the public. Also, the location of the site, as it pertains to Lake Superior, provides a challenge in that the amount of space (distance) is of limited quantity for the remediation of the groundwater.



### Demographics

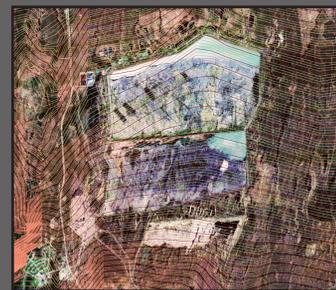
White Pine is a small town of 483 people, most of which make their living in the service industry. Commuting 20-30 miles to reach workplaces is a common occurrence among the community.

The community is aging and consequently slowly dying. The median age is about 55. Due to minimal amounts of careers possible in the town, most adolescents move away to make a living and start a life. Also due to the aging community, the economic wellbeing of the town has suffered. For example, the hospital/clinic has been closed along with the high school and grade school. The fire department is solely ran by volunteers, which is also an aging group.



### Existing Topography

The image to the right depicts the topography located on site. Water drains from the southern most portion of the site towards Lake Superior, located two and half miles north of the northern most tip of the tailing ponds. The close proximity of Lake Superior to the tailing ponds is one of the major contributing factors in my decision to assist in the purifying of the area's water.



To the Right:  
1. <http://www.westernup.net/ask/?cat=11>  
2. <http://www.bowhunting.com/publisher/Hunting-News/2011/6/19/Michigan-Hunter-Attacked-by-Black-Bear-While-in-Stand>  
3. & 4. <http://www.thetimbersort.com/>  
5. <http://www.upmihikingtours.com/>  
6. <http://www.fishweb.com/recreation/reports.html>  
7. <http://www.newberrychamber.net/>



Photo: Courtesy Archives of Michigan

### Brief History

The White Pine Mine pioneered one of the most successful copper mining operations in the Upper Peninsula of Michigan beginning in 1953 and closing in 1995. The mine produced around a total of 3.3 billion pounds of copper, 46,000 tons of cathode copper, and one million ounces of silver in it's lifespan of 40 plus years.

(<http://www.epa.gov/osw/nonhaz/industrial/special/mining/techdocs/copper/copper4.pdf>)

Due to the refining process of smelting located onsite toxins such as sulfur, lead, arsenic, and mercury were all released into the atmosphere and contaminated the surrounding ecosystems.

### Smelting

The process of refinement used at the White Pine Mine involved with use of "underground mining, underground primary crushing, above-ground secondary and tertiary crushing, grinding in rod and ball mills, flotation, filtering, drying, smelting, and electrolytic refining." (Site Visit Report: Copper Range Company, White Pine Mine, by EPA) The smelting plant, erected on site in 1953 with a 504 foot tall smelter stack, processed the ore but unfortunately released many toxins into the air which eventually settled to the ground and into the environment. After much damage was done to the surrounding area, the mine installed a smelter dust precipitator in 1958.



### SULFUR DIOXIDE

Humans

- Pulmonary Impairment
- Pre-term Births
- Respiratory Problems (asthma, lining of lungs, chronic bronchitis)

Animals

- Similar to human effects
- Carcinogen
- Fetotoxicity

### LEAD LCD - Lead Contaminated Dust

Humans

- Memory Loss
- Nerve/Brain Disorders
- Digestive Problems
- Reproductive Disorders/ Problems during pregnancy

Animals (ex. farm animals)

- Loss of Appetite
- Disease changes in skin and hair
- Reduced productivity

### ARSENIC

Humans

- Heart Disruptions
- Brain Damage
- Lung and other Cancers
- Infertility and Miscarriages
- Immune System Problems
- Stomach Irritation
- Irritation, Warts, and Numbness

Animals (birds)

- Death as result of consuming contaminated fish

### MERCURY

Humans

- Fatal to Brain and Kidneys
- Neurological Damage (especially to fetuses, infants, and children)
- Gastrointestinal Damage (if ingested)

Animals

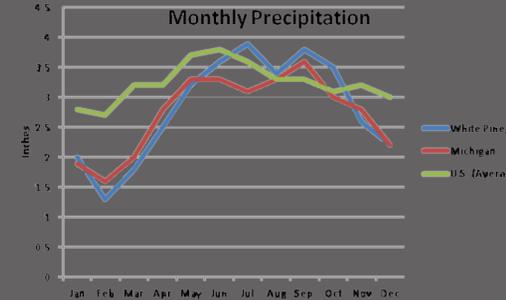
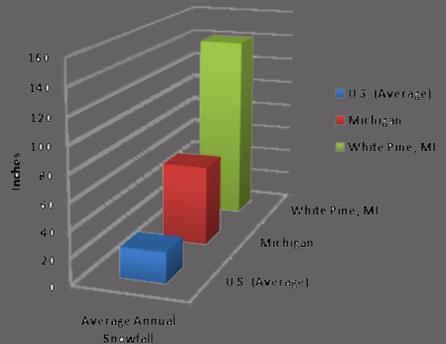
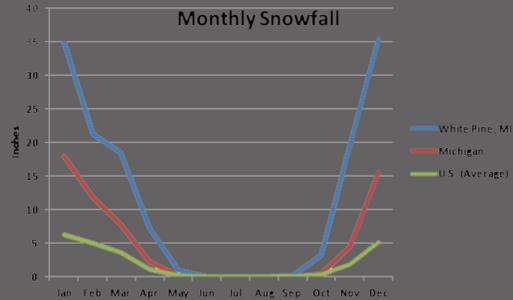
- Neurological (birds)
- Reduced production (hatching) of birds
- Deformities in developing animals



### Transfer of Toxins

The toxins from the smelting process, as previously mentioned, settle to the ground from the air and infiltrate in to the environment. These toxins then continue to be transferred around the ecosystem with assistance from the natural processes that occur in the Upper Peninsula of Michigan.

A major factor in the transfer of the toxins is the enormous amount of snowfall White Pine gets every winter and the coinciding snowmelt. As the charts depict to the right, White Pine receives up to 141 inches of snow during the winters. This phenomenon is due to the lake effect coming off of Lake Superior. As the snow melts, the toxins are pulled down into the soil, groundwater, and carried away in the water drainage. Thus spreading effects of the toxins, ultimately towards Lake Superior.



### Phytoremediative Plants

#### Bentgrass Varieties

Varieties of this plant that are suitable for this hardiness zone (listed to the far right) help to clean certain toxins out of the ground. For the proposed site, it will assist in cleaning up both lead and arsenic. The variety of grasses growth ranges from 4" - 24" tall. Bentgrass varieties will be located throughout the site in all conditions. The aesthetics of each type of Bentgrass will contribute to corresponding features of that part of the trail system by either hiding or exposing land with their height.



#### Zucchini Varieties

Shown below is a plant by the scientific name: Cucurbita pepo. This plant is also known as a "field pumpkin" and comes in many varieties. You can find it as a typical looking Zucchini on up to these type of pumpkins. This plant will assist in taking up both lead and arsenic contaminated soils. The aesthetics and seasonal significance of these plants can be used not only as a visual interest and enhancement on the landscape, but can also be incorporated into seasonal celebrations.



#### Willow Varieties

There are a couple different Willow trees that will grow in the hardiness zone for this site. These Willows are well known for being water loving and remediating kinds of plants. The trees will not only help in taking up such toxins as mercury, but will also provide shaded areas along the trail systems and give definition to paths by their placements.



#### Mercury

- Autumn Fern  
Dryopteris erythrosora
- Hybrid Poplar  
Populus trichocarpa x P. deltoides
- Eastern Cottonwood  
Populus deltoides
- White Willow  
Salix alba
- Niobe Weeping Willow  
Salix alba 'Niobe'
- Golden Weeping Willow  
Salix alba 'Tristis'

#### Lead

- Bentgrass  
Agrostis capillaris L.
- Highland Bent Grass  
Agrostis castellana
- Spike Bentgrass  
Agrostis exarata
- Rough Bentgrass  
Agrostis scabra
- Common ragweed  
Ambrosia artemisiifolia L.
- Indigo Bush  
Amorpha fruticosa
- Sideoats Grama  
Bouteloua curtipendula
- Zucchini  
Cucurbita pepo

#### Lead cont.

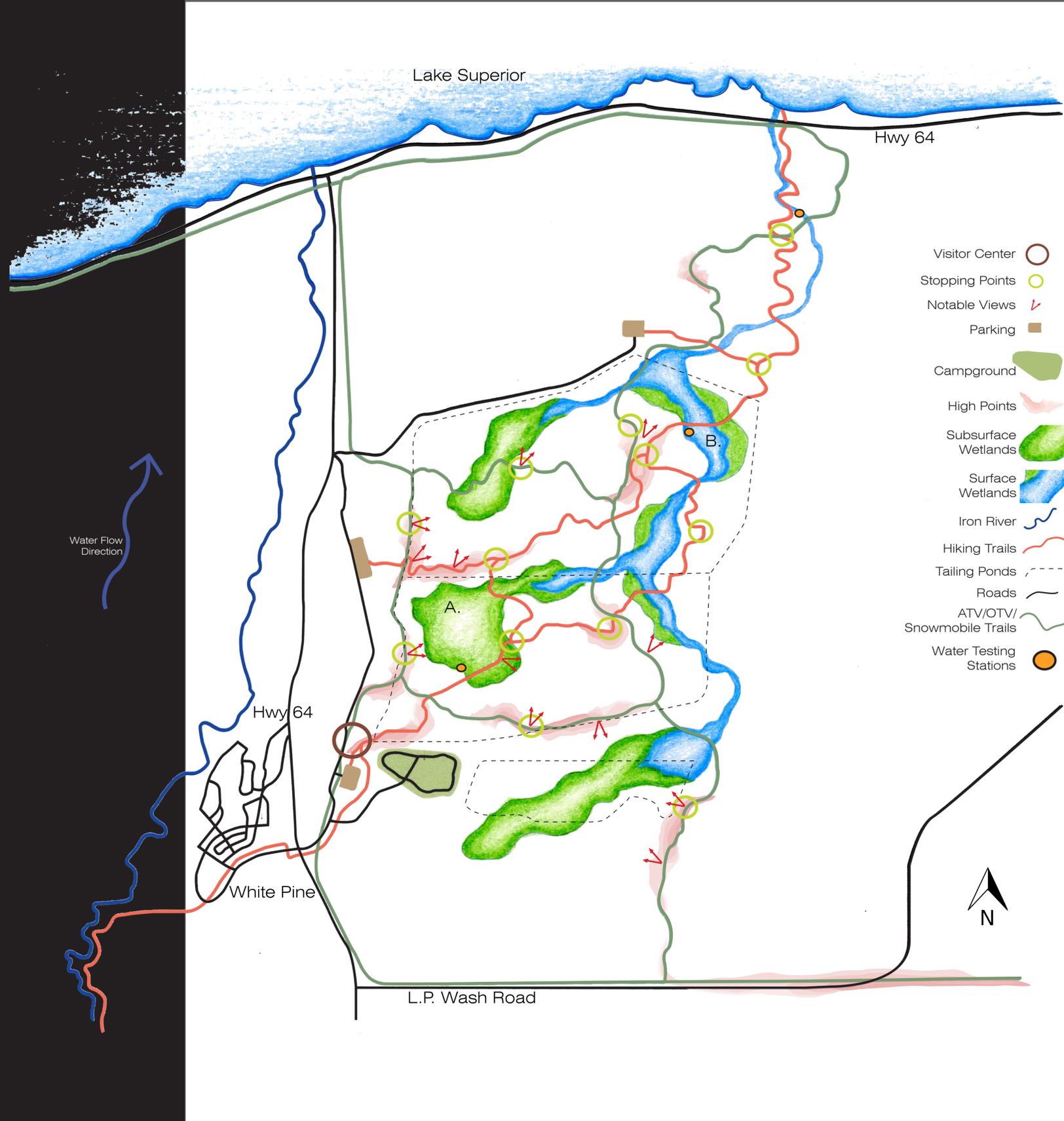
- Bermuda grass  
Cynodon dactylon
- Tufted Hairgrass  
Deschampsia caespitosa
- Inland Saltgrass  
Distichlis spicata
- Autumn Fern  
Dryopteris erythrosora
- Pondweed  
Elodea canadensis
- Tall Fescue  
Festuca arundinacea
- Honey Locust  
Gleditsia triacanthos
- Sunflower  
Helianthus annuus
- Hydrilla - 5a  
Hydrilla verticillata
- Lesser Duckweed  
Lemna minor
- American Shoreweed  
Littorella uniflora
- Ryegrass  
Lolium multiflorum
- Perennial Ryegrass  
Lolium perenne
- Western Wheatgrass  
Pascopyrum smithii
- Common Reed Grass  
Phragmites australis
- Garden Pea  
Pisum sativum

#### Arsenic

- Bentgrass  
Agrostis capillaris L.
- Highland Bent Grass  
Agrostis castellana
- Spike Bentgrass  
Agrostis exarata
- Rough Bentgrass  
Agrostis scabra
- Colonial Bentgrass  
Agrostis tenuis
- Big Bluestem  
Andropogon gerardii
- Sideoats Grama - deer resistant  
Bouteloua curtipendula
- Zucchini - pumpkin like (fall interest?)  
Cucurbita pepo
- Bermuda grass - turfgrass  
Cynodon dactylon
- Sunflower  
Helianthus annuus
- Bearded Iris  
Iris germanica
- Soft Rush  
Juncus effusus
- Ryegrass - good for erosion control  
Lolium multiflorum
- Eastern Cottonwood  
Populus deltoides

- Golden Weeping Willow  
Salix alba 'Tristis'
- Laurel-Leaved Willow - messy, invasive  
Salix pentandra
- Johnson Grass, Aleppo Grass  
Sorghum halepense (L.)
- Eastern Gamagrass  
Tripsacum dactyloides
- Cattail  
Typha latifolia L.

# Masterplans



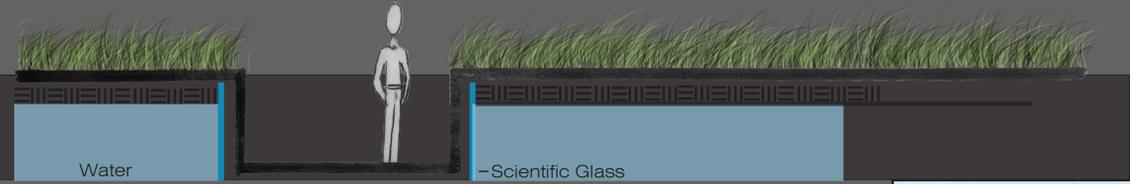
- Visitor Center
- Stopping Points
- Notable Views
- Parking
- Campground
- High Points
- Subsurface Wetlands
- Surface Wetlands
- Iron River
- Hiking Trails
- Tailing Ponds
- Roads
- ATV/OTV/Snowmobile Trails
- Water Testing Stations

A. Subsurface Wetland Detail Masterplan



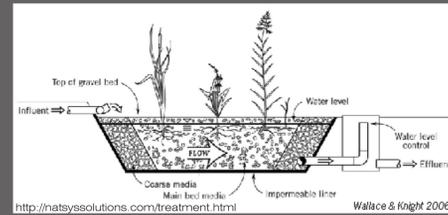
B. Surface Wetland Detail Masterplan



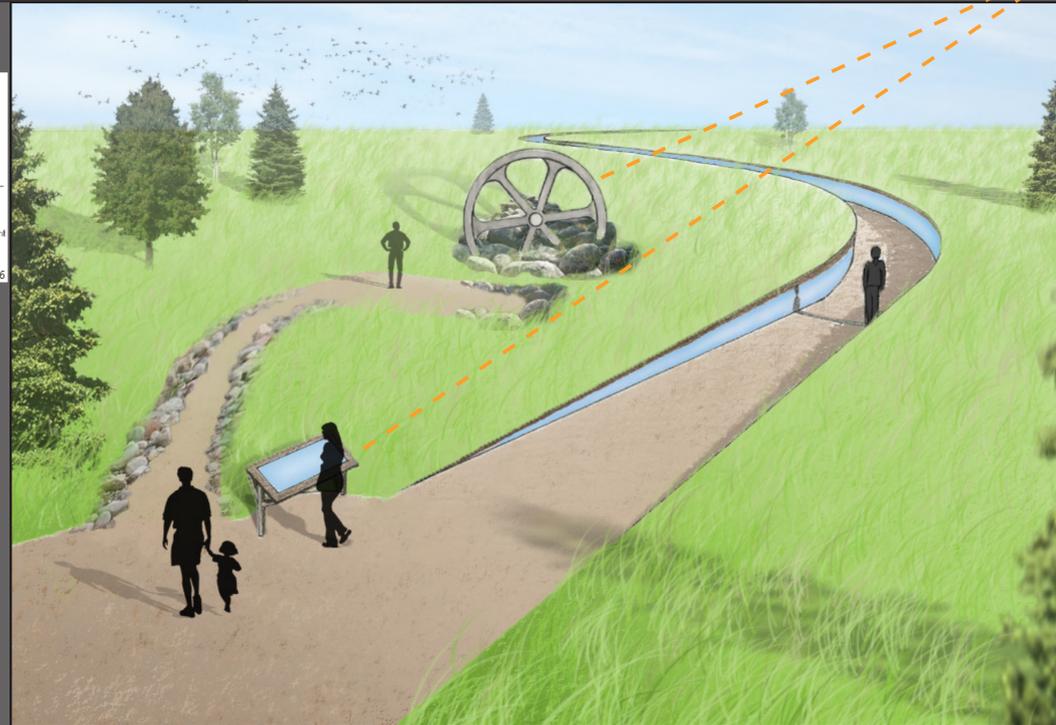


### Subsurface Wetlands

Constructed subsurface wetlands will be the first type of wetland systems encountered when exploring this site from the hiking trails. These wetlands aren't visible to the naked eye and work underground to clean out toxins. In order to exhibit phytoremediation educational qualities, the path will cut down into the ground and the inner workings of the system will be made visible to onlookers.



Pictured above is how a typical subsurface wetland works. As you can see to the right, the subsurface system will be revamped to become an aesthetic and educational amenity to the phytoremediation of the water and tailings located onsite. The trail system cuts down into the ground, exposing the processes of the wetland and providing interest to visitors. (also shown by the section cut at the top of this page).

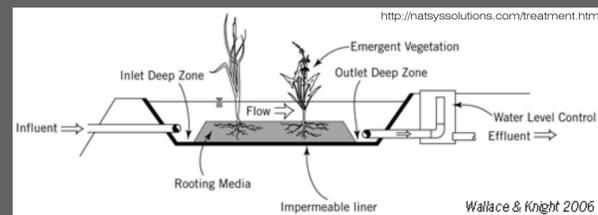


### Water Testing Station #1

Testing stations such as this one will be located at three points along the hiking trail system. These stations will include a structure of some sort, depicting elements of the area's past to elements used in the remediation of the land, accompanied by an interactive board that will provide visitors with the information collected and its relevance to the local and surrounding ecological systems.

### Surface Wetlands

Towards the second half of the hiking trails, wetlands will become more visible to visitors and display the clarity of the water as the wetlands come to their final stages in remediating.

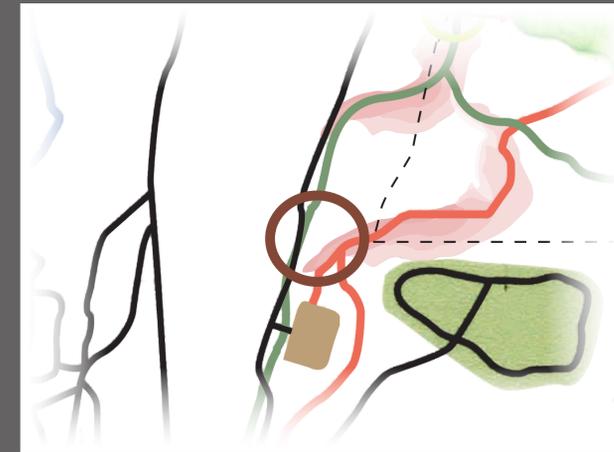


### Limestone Features

As shown to the right, Limestone sculptures will be placed throughout the surface wetlands to exhibit both the area's history (by the shapes) and the process of cleaning the water (by their deterioration over time). Similar to Buster Simpson's "Hudson River Purge" piece, where he immersed large antacid shaped limestone sculptures into the Hudson River, these pieces will address the pH level correction of the area's water.



## Detail Perspectives



### Room and Pillar Exhibit

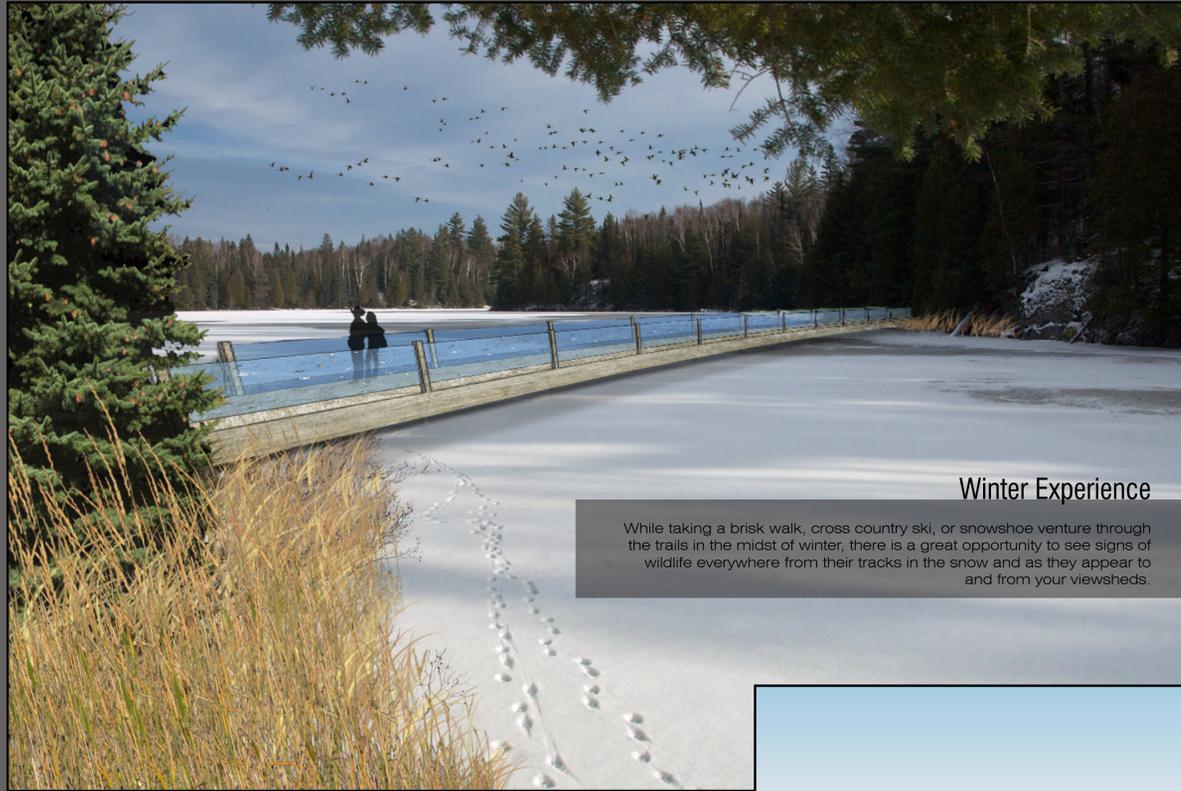
The above pictured building foundation will be refurbished into the site's main visitor's center. Within this proposed building there will be a fully immersive exhibit, focusing on the underground Room and Pillar style of mining. The White Pine Mine was the first mine to adapt the room and pillar excavating style to copper, making it one of the most successful copper mines in the Upper Peninsula of Michigan.

The exhibit will take visitors through spaces that fully encompass them in what it was like for a miner everyday on the job. Additionally upon entry of the exhibit, the visitor will receive a miner's tag (pictured in the upper right corner) that will personalize their experience with the different tasks that each miner specialized in.

The projected images and movies (sound included) on the walls and ceilings of the space will assist in its ambiance as visitors move through the experience. A select few projected screens will be interactive, by projecting a person's image onto it and letting them attempt to perform a miner's specific duty.

Upon completion of the exhibit, visitors can move forward to the educational trail systems with the souvenir of their miner's tags.





### Winter Experience

While taking a brisk walk, cross country ski, or snowshoe venture through the trails in the midst of winter, there is a great opportunity to see signs of wildlife everywhere from their tracks in the snow and as they appear to and from your viewsheds.

*By including interactive and educational amenities throughout an aesthetically designed wetland system, we can attempt to inform people that we do have the ability to remediate what we as humans have destroyed throughout our land. By careful pre-planning and furthering education of remediation and phytoremediation, our impacts on our planet will become substantially less.*



### Boardwalk/Bridge over Surface Wetlands

Bridges and boardwalks will be located over all crossing areas of the Surface Wetland systems. They will provide desirable views and give distinct opportunities to those who visit the site. This is made possible by careful placement of the stopping points in making sure that other crossings are out of viewshed for that point.



### Boardwalk Stopping Points

Mimicing the shape of the miner's tag, stopping points along the boardwalk will give visitors a chance to step down off of the main path onto a platform closer to the water. These areas will also providing a place for reflection and rest.