Hollowed Ground

Danielle Marie Gustafson
Spring 2012, Design Theiss
Professor Stevie Famulari

HOLLOWED GROUND

A Design Thesis Submitted to the Department of Architecture and Landscape Architecture of North Dakota State University

By

Danielle Gustafson

In Partial Fulfillment of the Requirements for the Degree of Bachelors of Landscape Architecture

Primary Thesis Advisor

Thesis Committee Chair

May, 2012
Fargo, North Dakota

Permission Rights

NON-EXCLUSIVE DISTRIBUTION LICENSE

By signing and submitting this license I, Danielle Gustafson (the author(s) or copyright owner) grants to North Dakota State University (NDSU) the non-exclusive right to reproduce, translate (as defined below), and/or distribute my submission (including the abstract) worldwide in print and electronic format and in any medium, including but not limited to audio or video.

I agree that NDSU may, without changing the content, translate the submission to any medium or format for the purpose of preservation.

I also agree that NDSU may keep more than one copy of this submission for purposes of security, back-up and preservation.

I represent that the submission is your original work, and that I have the right to grant the rights contained in this license. I also represent that my submission does not, to the best of my knowledge, infringe upon anyone's copyright.

If the submission contains material for which I do not hold copyright, I represent that I have obtained the unrestricted permission of the copyright owner to grant NDSU the rights required by this license, and that such third-party owned material is clearly identified and acknowledged within the text or content of the submission.

IF THE SUBMISSION IS BASED UPON WORK THAT HAS BEEN SPONSORED OR SUPPORTED BY AN AGENCY OR ORGANIZATION OTHER THAN NDSU, I REPRESENT THAT I HAVE FULFILLED ANY RIGHT OF REVIEW OR OTHER OBLIGATIONS REQUIRED BY SUCH CONTRACT OR AGREEMENT.

NDSU will clearly identify Danielle Gustafson as the author(s) or owner(s) of the submission, and will not make any alteration, other than as allowed by this license, to your submission.

Name:____________________________ Date: 4/29/2012

Table of Contents

Abstract

This research explores how to enhance relationships between wetlands and toxic mining sites using phytoremediation. By creating a site that is interactive for visitors, it is intended to educate and enrich their experiences and knowledge of the phytoremediation role that wetlands can have on old mining sites.

Keywords:

- Wetlands
- Copper Mining
- Toxic Tailings
- Phytoremediation
- Educational / Recreational Design

Problem Statement

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

Statement Of Intent

Project Typology

Mine phytoremediation and education.

The Claim

This thesis aims to prove and exhibit the effects that wetlands have on toxic mining sites. The use of wetlands to remediate the past blunders of these mining sites provides a chance to educate people about what has been done to the land and how we can attempt to fix it.

The goal of the design is to result in a site that helps people interact with their environment while learning and experiencing new knowledge of a wetlands phytoremediation roles.

Theoretical Premise

Landscape architects, alongside engineers and biologists, collaborate to create a space that will continue to attract people to the site to learn and experience the role of phytoremediation.

Being a working paradigm, the site will draw in onlookers to gain knowledge of the phytoremediative role the wetlands are playing. Ultimately, the site could be used to promote phytoremediation and sustainablility.

The pre-existing mining area(s) will be transformed into wetlands to allow for remediation to take place throughout the entire site.

Project Justification

Resources are continually depleted everyday throughout the world, thus resulting in questions being raised as to what will we do when they are gone, either by overuse or by contamination. Well, we can undo some contamination by means of phytoremediation, resulting in improvement of our quality of life and giving back to the environment. (Road map to understanding innovative technology options for brownfields investigation and cleanup)

Proposal

Narrative

Our land is becoming increasingly more valuable as resources begin to deplete at higher rates than expected. To counteract this event, a community can seek innovative ways to both limit resource uptake and filter out areas of contaminated resources, that cannot be readily accessed, for reuse. Both of these actions contribute to the relatively recent push towards sustainability. Addressing areas of contamination, this project looks to remediation. Remediation is becoming our regular counter in cleaning up land and resources. Focusing on cleaning up old mining sites, we employ phytoremediation to filter out toxins and contaminants overlooked in the past as we move towards a more sustainable environment. One effective way of doing this is with the use of a wetland system.

A User/Client Description

People who use this site are those who inquire upon sustainablilty and cleaning up our resources, along with those who may simply stumble upon new knowledge due to the recreational nature of the design surrounding a wetland. The main intention of this proposal is geared towards phytoremediation of a mining site by use of wetland systems while informing the visitor of what is happening around them. Because the context of the site is a wetland setting, circulation and signage will play an imperative role in the visitor's experience and knowledge gained during their visit.

A User/Client Description

User #1

The Researcher

This group will use the site as a precedent and working archetype from which to base conclusions and future design.

User #2

The Recreationist

As the site will twofold as a recreational park, the visitor experiencing it as such will learn about innovative actions that the site is undergoing in order to remediate the area for the best possible sustainablility of the earth, thus promoting sustainable practices in different aspects of their own everyday lives.

User #3

The Lawmakers

As the site will be an archetype of a phytoremediation project, lawmakers may use it as a precedent by which to base new laws and restrictions of pollutants and clean up processes.

Major Project Elements

Scope

The elements addressed in this project are straightforward and step by step. Beginning with placement of the wetland system, analysis of the site must be conducted to see where the most optimal place in the area of the mine will be best suited for remediation. Circulation also must be addressed to see how it can be used to move people throughout the site and give them inspirational experiences. Plant materials must be chosen for specific toxins along with an efficient amount of waterflow to assist in the phytoremediation process. Collaboration of landscape architects, engineers, and biologists is a must when doing the analysis of this project before breaking ground.

The master plan will depict, at first glance, a well-designed wetland refuge, but upon inquiry will show the educational factor to phytoremediation and the steps being taken to ensure cleansing of the land.

Major Project Elements

Placement

The placement of the wetland system will determine its accessiblity to visitors alongside the quality of its remediation. The accessiblilty to the site will determine how and how well the word is spread from person to person about the remediative properties taking place there.

Circulation

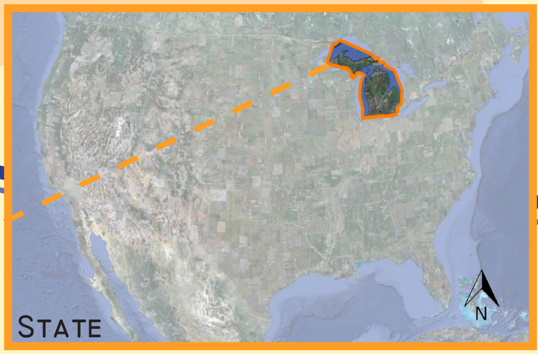
Movement throughout the site is critical. Visitors must feel intrigued and enlightened on the properties of the land. Experience of the site depends on circulation and making sure that the visitor has had optimal views to ensure comprehension of what is going on around them.

Phytoremediation

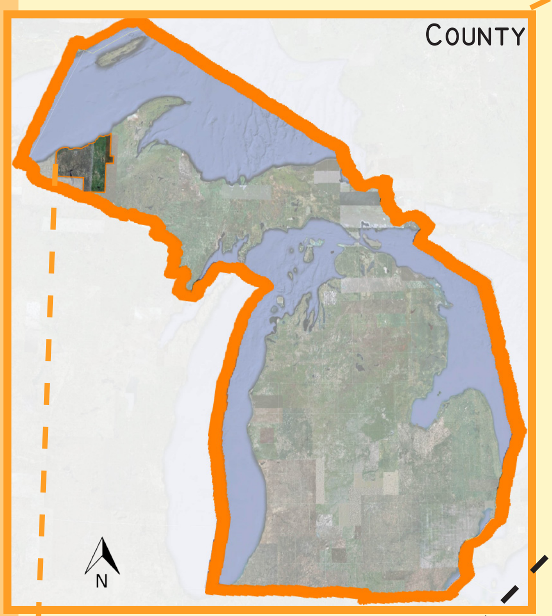
The use of a wetland system to remediate the site of its toxins must carefully be addressed. Different stages and plant material must be used in a way that guides and informs visitors that there is something special going on in the site.

Site Information

A site that has met my criteria is **White Pine Mine**, a copper mining site located in the Upper Penninsula of Michigan.



Site Criteria:

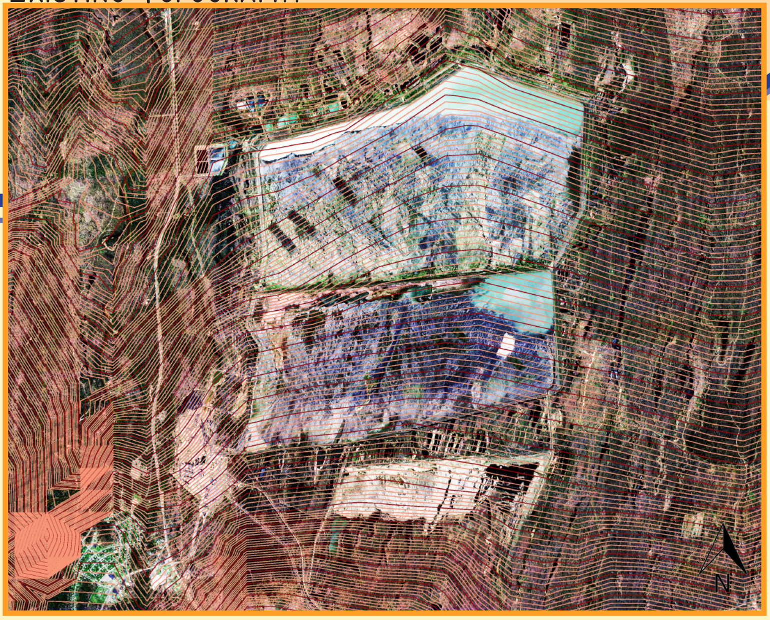


- Closed mining site.
- Above ground.
- Tailing ponds.
- Surrounding towns formed from mining activies.
- Optimal views of mine and surrounding area.
- EPA has requested addressing the toxins on site to be remediated.
- Ability to converse with those who are cleaning it.
- Toxin has a negative effect.
- Potential for clean-up.
- Site must be within a proximity that I will be able to visit at least twice during the school year.

Site Map

Site Information

EXISTING TOPOGRAPHY



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.

Project Emphasis

The majority of my focus will be on creating a remediative wetland site with various aspects of recreation. The spacial relevance between focal points and different kinds of recreation will be a key issue when dealing with the thousands of acres located on this site. In turn, the layout of the site and its amenities will be crucial to its success, and the success of the community.

The wetland system and surrounding activites will give visitors unique opportunities to view, enjoy, and be educated by the site and what will be going on there. Boardwalks will meander throughout the wetlands, providing optimal views and up-close experiences of the ecosystem being remediated. Trails will also connect with the boardwalks and lead visitors to other proposed activities, such as a possible paintball course, and into town for shopping and other historical sites.

After all, each individual's experience is what really matters and will keep people coming back and spreading the word to attract others.

Plan for Proceeding

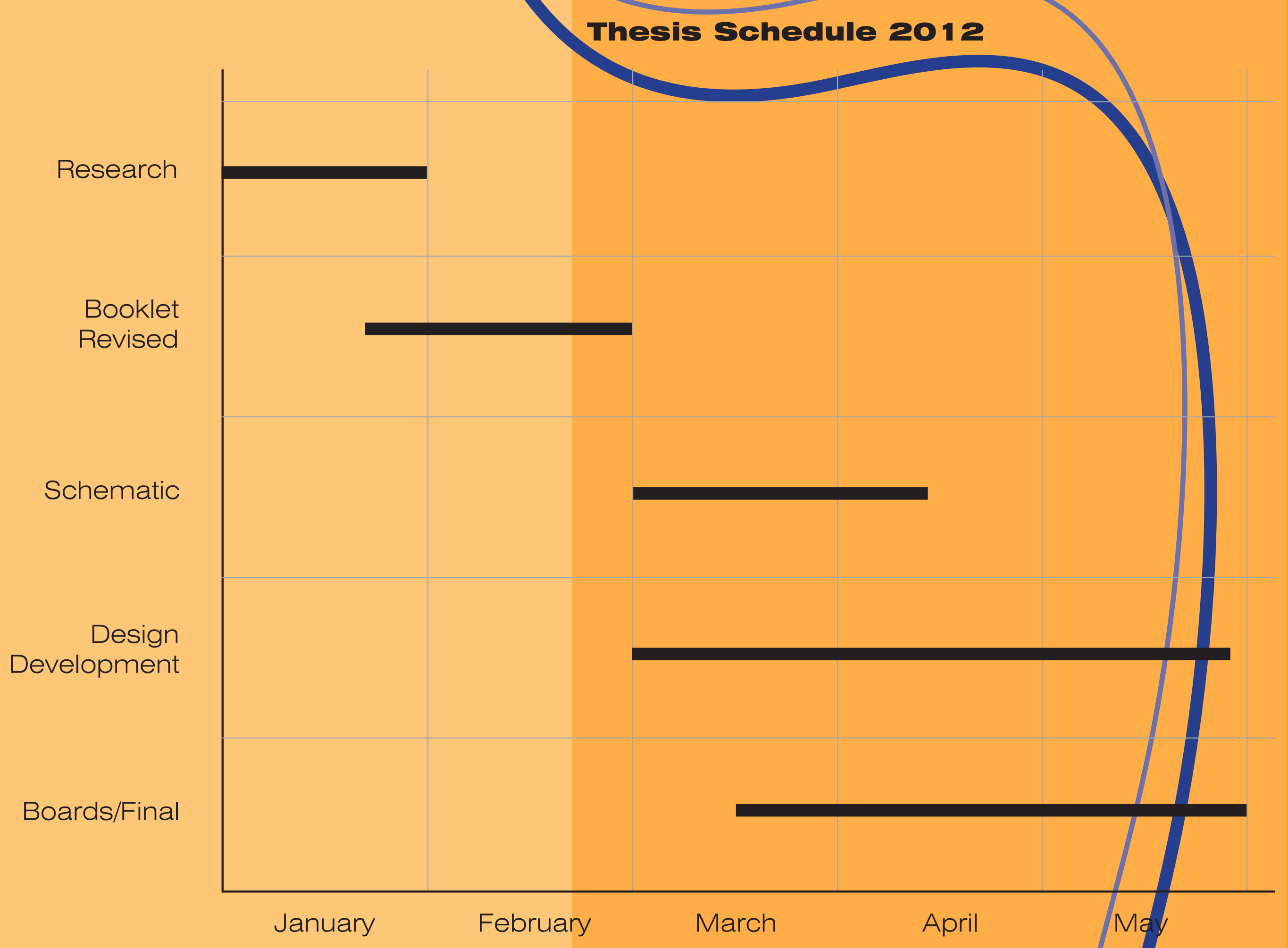
Definition of a Research Direction

Important aspects of the design that need to be addressed include finding out such things as desirable walking distances, types of materials that would best suit the site (ecologically and aesthetically), construction processes, what kind of maintenance will need to be done regularly, and types of remediative plants that will be used.

Design Methodology

Collaboration and involvement of the surrounding communities and mine owners will be necessary to insure a successfully supported design. I have been in contact with the Ontanogan County's Historical Society coordinator and locals that express interest in the combination of remediating the mine and creating attractive recreational activites. The Historical Society's coordinator is also putting me in contact with a project manager from Orvana Minerals that is planning on starting up a new copper mine to the west of White Pine, as in order to get the permitting for their mine they had to do extensive research on the White Pine Mine, information which I can be provided with.

Plan for Proceeding



Previous Experience

2nd Year

2007 Fall Semester — Kathleen Pepple
Tea House - Fargo, ND

2008 Spring Semester — Mark Lindquist
Wolseley Neighborhood - Winnipeg, Canada

3rd Year

2008 Fall Semester — Stevie Famulari
Ice Sculpture Project - Fargo, ND
Regent site design- Regent, North Dakota

2009 Spring Semester — Kathleen Pepple, Jay Kost
Roosevelt Neighborhood - Fargo, North Dakota

4th Year

2009 Fall Semester — Jay Kost
Duluth Master Plan - Duluth, Minnesota

2010 Spring Semester — Stevie Famulari
Phytoremediation implementation - Cuyuna Range, MN

5th Year

2011 Fall Semester — Catherine Wiley & Dominic Fischer
Sketch Project- Seattle, Washington

Program

Research Results & Goals

***Road map to understanding innovative technology options for brownfields investigation and cleanup.* (2005). *(Fourth ed.).* Washington , DC: U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Technology Innovation Office.**

This book explores the steps taken in order to understand, investigate, and clean up brownfields. It takes you through how to identify a brownfield, look at what it is going to be used for, see how contaminated the area is, and if and how it should be remediated before redevelopment.

This book also contains some very good resources pertaining to different aspects of remediating varying kinds of brownfields. It guides you in specific directions according to site, contaminant, use, safety, and plan for redevelopment.

Research Results & Goals

Relative to my design concept of remediating an old mining site with the use of wetlands, this book gives many examples and contributes new and innovative ideas for me to consider while observing different ways to remediate my site. My site, being an old copper mine, contains many contaminants and toxins that need addressing. I will use this book to give me a rough guideline of the steps that I need to take in remediating my site of toxins.

Research Results & Goals

Interstate Technology & Regulatory Council. 2006. *Planning and Promoting Ecological Reuse of Remediated Sites.* Washington, D.C.: Ecological Land Reuse Team, Interstate Technology & Regulatory Council.

This source outputs a variety of information on reusing a previously contaminated site, and in which order to persue doing so. It discusses the qualities of ecological land use, the good and bad of it, seeing what you can and can't do, planning, and costs.

There are many ways to approach designing a site for reuse and remediation. This book exhibits a great deal of natural ways a site can be remediated and designed for reuse through natural or green remediation strategies.

Research Results & Goals

Some of the book talks about how important the team doing the project is. For example, in a project based on wetlands you might need a highly multidisciplinary team including anyone from biologists, to remediation specialists, to engineers, to geologists. By using a multidisciplinary team, most information needed to go forth with a project is at your fingertips or within moments of knowing from those around you. This idea is an important time-saver and great example of working together to accomplish a common goal.

Stakeholders are also pointed out as being important in the design of a reused, remediated site. The stakeholders are those who will decide and drive the project in a certain direction. For example, community stakeholders have a huge influence on a project and deciding what should be done. It is suggested that they be involved from the very beginning and to give them a great amount of input on the project to make sure it will succeed, as they are the ones that will be using and experiencing it on a regular basis.

Research Results & Goals

This source relates to my thesis by exploring the ways and processes that the site can be reused and remediated. It also exhibits some great information on case studies that include some step-by-step considerations that need to be made when beginning a project. Some of these being cost and funding, site assessment approach, obstacles, etc. These considerations are all things that I will need to address in my thesis project remediating a copper mine site.

Research Results & Goals

***Introduction to Phytoremediation.* (2000). Washington, D.C: Office of Research and Development.**

Understanding phytoremediation is vital to my thesis project. This book summarizes the different types of phytoremediation and ways of going about them.

Plant selection is the core of phytoremediation, whether it be for remediating soil, water, or air, the selection of the plant determines what of and how much of a certain contaminant or toxin can be taken up. The book talks about the importance of root systems, canopies, types of uptake, and placement. A description is also given of advantages and disadvantages of each type of phytoremediation.

Research Results & Goals

The information given in this source compliments my thesis in that it restates the variety of ways that I can remediate the site that I had previously learned. The book goes into detail on each of the different types of phytoremediation and exhibits the extent of detail I should look into.

Phytoremediation is key to my thesis design. It is one of the sole attributes in how I intend to design and remediate my site.

Research Results & Goals

Jacob D.L. & Otte M.L. (2004). Long-term effects of submergence and wetland vegetation on metals in a 90-year old abandoned Pb-Zn mine tailings pond. *Environmental Pollution 130*: 337-345.

This article talks about different effects of remediation as it pertains to long-term and short-term studies as well as submerged versus exposed wetlands and toxins. Donna talks about her reasonings to do this long term research and how she uses information from others' studies to conduct testings and direction of her project.

The levels of the toxins in the site are related to the previous mining that had gone on there. However, by testing that site and comparing it to the levels in surrounding area lakes, she was able to determine what the normal levels are as opposed to what is affecting the land and is a result of the past mining activites.

Research Results & Goals

The research going into the planning of this wetland remediation project shows me how in-depth this design can be taken. It applies to my project corresponding with measuring levels, finding out what is directly traceable back to the mine, finding out what plants and organic material will best suit and affect the mobility of the onsite metals, and knowing that there are options for both submergeable and exposed remediation with wetlands.

Summary

Phytoremediation through wetland systems has been around since the 70s, but the way in which it can be done evolves every day. By acknowleding innovative ideas to involve visitors and provide them with intriguing experiences, recognition of this type of remediating process can spread and become a prototype for mine remediation sites everywhere.

Title of Project: Flambeau Mine Reclamation
Location: Lady Smith, Wisconsin
Date designed/planned: 1993-97 mine operational use, 1998-present reclamation and recreational use
Size: 181 acres
Cost: over $20 million
Landscape Architect: Applied Ecological Services Inc.
Client: Flambeau Mining Company and Local Governments
Managed by: Flambeau Mining Company

CONTEXT

Flambeau Mine is located about 1.5 miles south of Ladysmith, Wisconsin, on Highway 27. The Flambeau Mine began production in 1993 and shut down in 1997, during which time the mine produced tons of copper, silver, and gold and boosted the surrounding area's economy. This mine is one of historic importance to Wisconsin, as it was the first to be approved and break ground under the state's new mining laws and provisions (very strict). As a result, the mine was operated at an environmentally safe level and was reclaimed into a recreational destination upon closure.

ANALYSIS

The Reclaimed Flambeau Mine site now contains a series of outlooks and trails, ranging from mowed grass to gravel and pedestrian to equestrian, throughout a variety of grasslands, woodlands, and two wetlands. Informational stations are placed along the trails to provide visitors with their locations and brief historical importance of happenings of the past on the site. The grounds also provide seperate designated areas for parking, one for the nature (pedestrian) trail and one for the equestrian trail, as the trails are placed in specific areas on the site.

Some activities promoted on the site are hiking, biking, birdwatching, dog walking, snowshoeing, cross country skiing, fishing, picnicking along the Flambeau River, community and fitness events, school fieldtrips, and geocaching. The Reclaimed Flambeau Mine site is open year round to the public from sunrise to sunset and is free. The reclamation of the site has also brought back a large variety of bird species and butterflies to the area.

http://www.flambeaumine.com/visitsite/site_tour/map3.html

BACKGROUND AND HISTORY

The Flambeau Mine began the process of permitting in 1989 and was approved in 1991 by the state of Wisconsin's Department of Natural Resources, per the new mining regulations, to establish the mine. After the approval in 1991, the Flambeau Mining Company began the construction and preproduction process, taking another two years, until 1993. In 1993 the mine broke ground on its mining operations, lasting until 1997, during which time 181,000 tons of copper, 334,000 ounces of gold, and 3.3 million ounces of silver were extracted. The mine, being the open pit archetype, was backfilled in the fall of 1997, returning the land to its original contour topography. In 1998 the reclamation process began and implementation of prairie grasslands and other vegetation were re-introduced to the land along with wildlife. Recreational use by humans began to be promoted in the site as the vegetation began to take, and as a result trails, overlooks, signage, and activities were implemented to produce what is located on the site there today. The reclaimed mine site was submitted in 2001 for its Notice of Completion, upon meeting all of the standards, to the Wisconsin Department of Natural Resources. Required monitoring will continue to take place for another four years on the reclamation progress before the reclaimed mine site can receive its Certificate of Completion.

The Flambeau Mine has employed 150 people during the construction/preproduction phase, 60 people during production, and 80 people during its reclamation phase. In total the Flambeau Mining Company has paid more than $27.7 million in fees and taxes to state and local governments. This is outside of and in addition to local expenditures for services and goods along with employee salaries.

GENESIS OF PROJECT

The goal of the project was to reclaim the Flambeau Mine site to its original topography and ecology while enhancing it for recreational and educational use. The reclamation was part of the agreement in the permitting process to establish the mine in the first place to ensure as little of a long term impact on the environment as possible.

http://www.flambeaumine.com/history.html

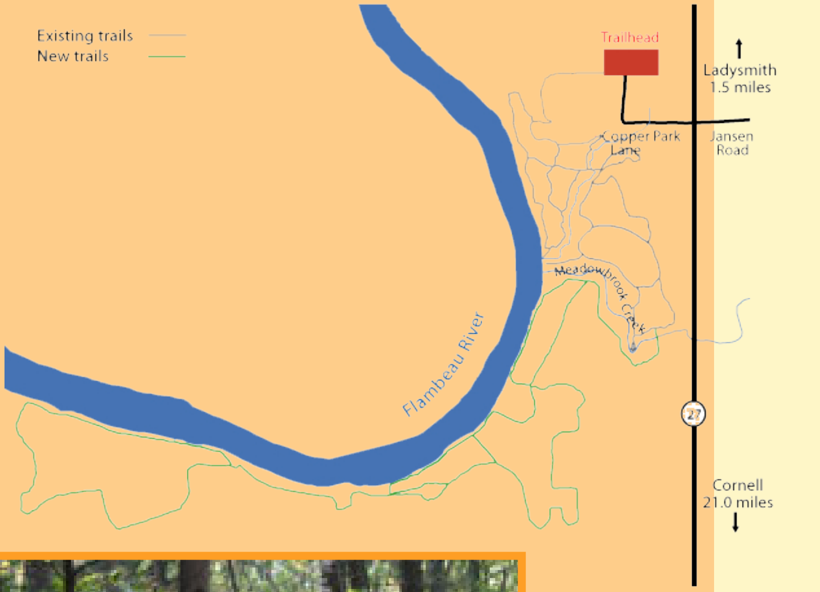
http://www.flambeaumine.com/links.html

DESIGN DEVELOPMENT PROCESS

The reclamation of the Flambeau Mine began with the initial permitting process gone through in order to establish the mine. However, the Flambeau Mining Company decided to apply, in the summer of 1998, for authorization from the Wisconsin Department of Natural Resources, amid input from local environmentalists, to improve upon their original reclamation plan. They were approved and began implementation on the following: "returning the site to its original approximate contours, planting clusters of trees to attract and support wildlife habitats, creating and restoring over 10 acres of wetland on site, creating over 120 acres of grassland habitat, and constructing four miles of trails for non-motorized activities" (http://www.flambeaumine.com/documents/factsheets/reclamation.pdf). They have since added another 10 miles of equestrian trails for the public. Hiking and bicycling is also encouraged along these trails.

PROJECT ELEMENTS

Some of the main project elements that were implemented on reclaimed site were hiking trails (mowed grass and gravel), equestrian trails, information stations, and scenic overlooks. There were also two wetlands placed on the land to assist in remediating the water on site and runoff before it drains into the Flambeau River to the southwest of the site.



http://www.flambeaumine.com/visitsite/naturetrails.html

http://www.flambeaumine.com/visitsite/equestrian.html

MAINTENANCE AND MANAGEMENT

The Reclaimed Flambeau Mine site is managed by the Flambeau Mining Company. There are also a few other parties that are involved in the use of the site, such as the Flambeau Riders Inc. (an equestrian group) and local governments including the town of Ladysmith, Wisconsin.

SIGNIFICANCE AND UNIQUENESS OF PROJECT

The Reclaimed Flambeau Mine site is historically important to the state of Wisconsin in that it was the first mine to be opened under its new, very stringent, mining laws. The mine was subject to very strict permitting and planning before any ground was allowed to be broken. This site is also unique to being a once open pit copper mine to now a close to fully reclaimed and completely revamped old mining site. The use of the reclaimed site to bring in visitors has helped to boost the surrounding area's economy. There have been about 450 jobs that have either been created or retained from the Flambeau Mine.

LIMITATIONS

The only limitations found on site are those of certain recreational activities. It is asked that people stay on the trails to protect the vegetation and wildlife, there is no hunting allowed on the property, and fishing is limited to the Flambeau River and not in either wetlands located on site.

http://www.flambeaumine.com/visitsite/site_tour/infostations/two.html

http://www.flambeaumine.com/visitsite/wildlife.html

COMPARISON TO OTHER PROJECTS

The Reclaimed Flambeau Mine is one of the more successfully reclaimed copper mines that I have found, in its ability to tie into the community and bring in visitors from all over.

BIBLIOGRAPHY OF PROJECT CITATIONS

Flambeau Reclaimed. Retrieved November 10, 2011, from http://www.flambeau-mine.com/

WEBSITE LINKS

http://www.flambeaumine.com/index.html

CONTACT FOR FURTHER INFORMATION

Dave Cline
Kennecott Minerals Company
224 North 2200 West
Salt Lake City, Utah 84116
Telephone: (801) 238-2489
Facsimile: (801) 238-2488
E-mail:clined@kennecott.com
Jana Murphy
Environmental Manager
Flambeau Mining Company
N4100 Highway 27
Ladysmith, Wisconsin 54848
Telephone: (715) 532-6690
Facsimile: (715) 532-6885
E-mail: info@flambeaumine.com

http://www.flambeaumine.com/index.html

http://www.flambeaumine.com/visitsite/visitsite.html

Case Studies

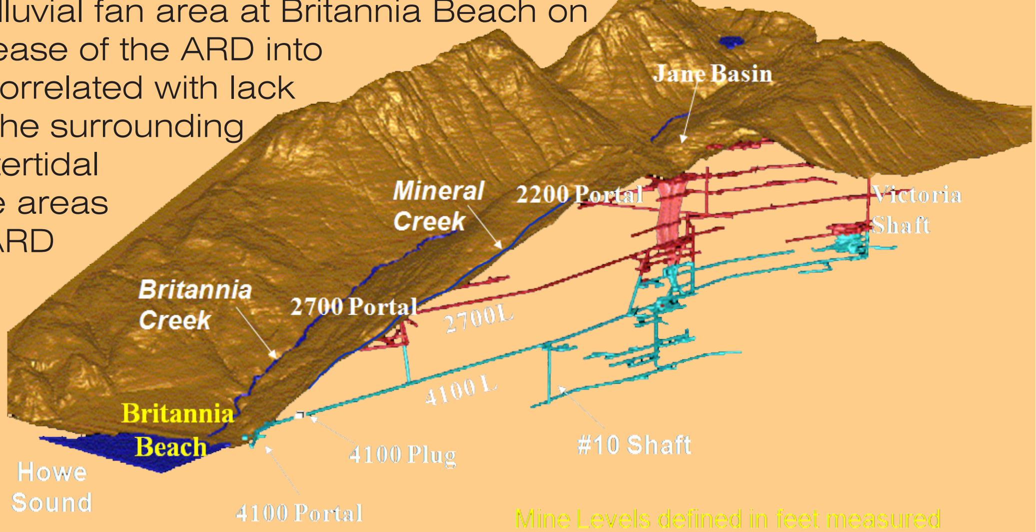
Title of Project: Britannia Mine Remediation Project
Location: Britannia Beach, 45km north of Vancouver, British Colombia
Date designed/planned: 1905-1974 operational, early 2003 remediational
Size: 36.5 sq. km. (9,000 acres)
Cost: over $30 million
Landscape Architect: Crown Land Restoration Branchhas
Client: Province of British Colombia
Managed by: Golder Associates

CONTEXT

The Britannia Mine is located 45 km north of Vancouver, British Colombia. The mine was in production for over 70 years. From 1905 to 1963 the mine was operated by the Britannia Mining and Smelting Company Ltd. and then changed ownership. From 1963 to 1974 it was operated by the Anaconda Mining Company. During its time of operation the Britannia Mine produced about 47 million tons of rock that were then mined for copper, zinc, lead, cadmium, silver, and gold. It has since released over 40 million tons of tailings around the site and into the Howe Sound (located adjacent to the mining site about 5 to 7 km from the inland mining site). Because of the topography of the land and the location of the mine, the contaminants are flowing through two different watersheds down to Britannia Beach and into Howe Sound, affecting the ecology and wildlife in the area.

ANALYSIS

The Britannia Mine Remediation Project is complicated in that the land was mined in several different methods: open pit mining, underground mining, and glory hole developments. This all led to there being a total of 80 km of underground development, covering a vertical distance of 1,700 m. With all of these workings open to the environment, rainwater runoff along with seasonal melting of snow creates a means of transportation for the acid rock drainage (ARD) from the mine to travel and be spread. The main deposit/polluted area of these tailings is now in the Britannia alluvial fan area at Britannia Beach on Howe Sound. The release of the ARD into the sound is directly correlated with lack of intertidal ecology. The surrounding areas have thriving intertidal communities as those areas don't have as much ARD and leftover tailings inhabiting the site.



From PPT: http://www.agf.gov.bc.ca/clad/britannia/consultation.html

BACKGROUND AND HISTORY

The Britannia Mine opened in 1905 and operated right up until 1974 when the resources and deposits became exhausted. During the 70+ years of operation the Britannia mine has produced large amounts of copper, zinc, lead, cadmium, silver, and gold.

GENESIS OF PROJECT

The goal of the project was to remediate the tailings and reduce the amount of acid rock drainage being transferred off of site. The remediation of the Britannia Mine will have to take place in a variety of ways in different places due to the combination of ways the area was mined. The first area to be addressed will be that of the fan area on Britannia Beach going into Howe Sound.

DESIGN DEVELOPMENT PROCESS

The Overall Mine Closure and Remediation Plan (ORP) was developed in 2003 by Golder Associates Company, contracted out by the Province of British Colombia. The ORP looks at all the different aspects of remediation that needs to be addressed with the Britannia Mine such as; remediation of the Fan Area and other areas onsite with similar issues, the water treatment plant and excess drainage, and removal of polluted soils and waste products from the water treatment plant. Some mineral ores found in the area also create acid rock drainage (ARD) when they come in contact with natural processes of the environment (oxygen and water). So far to reduce drainage, at the 2200 Level portal of the mine a concrete plug was installed to reroute the water drainage from going directly into Britannia Creek and instead sending it back into the mine workings down to the 4100 Level portal. There has also been installation of a groundwater management system that will get rid of metal polluted groundwater from the Britannia Fan Area before it reaches Howe Sound. Some more headway that has been made is a water treatment system at the 4100 Level portal to treat the ARD, installation of a deep-water outfall for the water treatment plant (at a level that won't affect wildlife or ecology), transfer of about 50,000 cubic meters of contaminated soils from the 4100 Level to the nearby open pits of the Jane Basin where the ARD is currently treated by the water treatment plant, and installation and improving of surface water diversions to mitigate water flow and clean it along the way before discharging into Howe Sound. Environmental improvements to the groundwater management system will continue to be made in the near future along with installation of waste dumps near the 2200 Level and continued reduction of the contaminated surface water drainage into the Fan Area.

SIGNIFICANCE AND UNIQUENESS OF PROJECT

The Britannia Mine Remediation Project shows the worst of the worst situations being carefully addressed and planned out step by step to insure the success of the remediation. It is unique in that the contaminated area covers multiple watersheds and has affected the Howe Sound coastline. These attributes are inspirational in that they depict a worst-case scenario pertaining to the White Pine Mine that I intend to remediate, as if left untouched it could contaminate downstream into Lake Superior.

BIBLIOGRAPHY OF PROJECT CITATIONS

Crown Land Administration Division - Britannia Mine - Province of British Columbia. (n.d.). BC Ministry of Agriculture, Food and Fisheries. Retrieved November 23, 2011, from http://www.agf.gov.bc.ca/clad/britannia/index.html

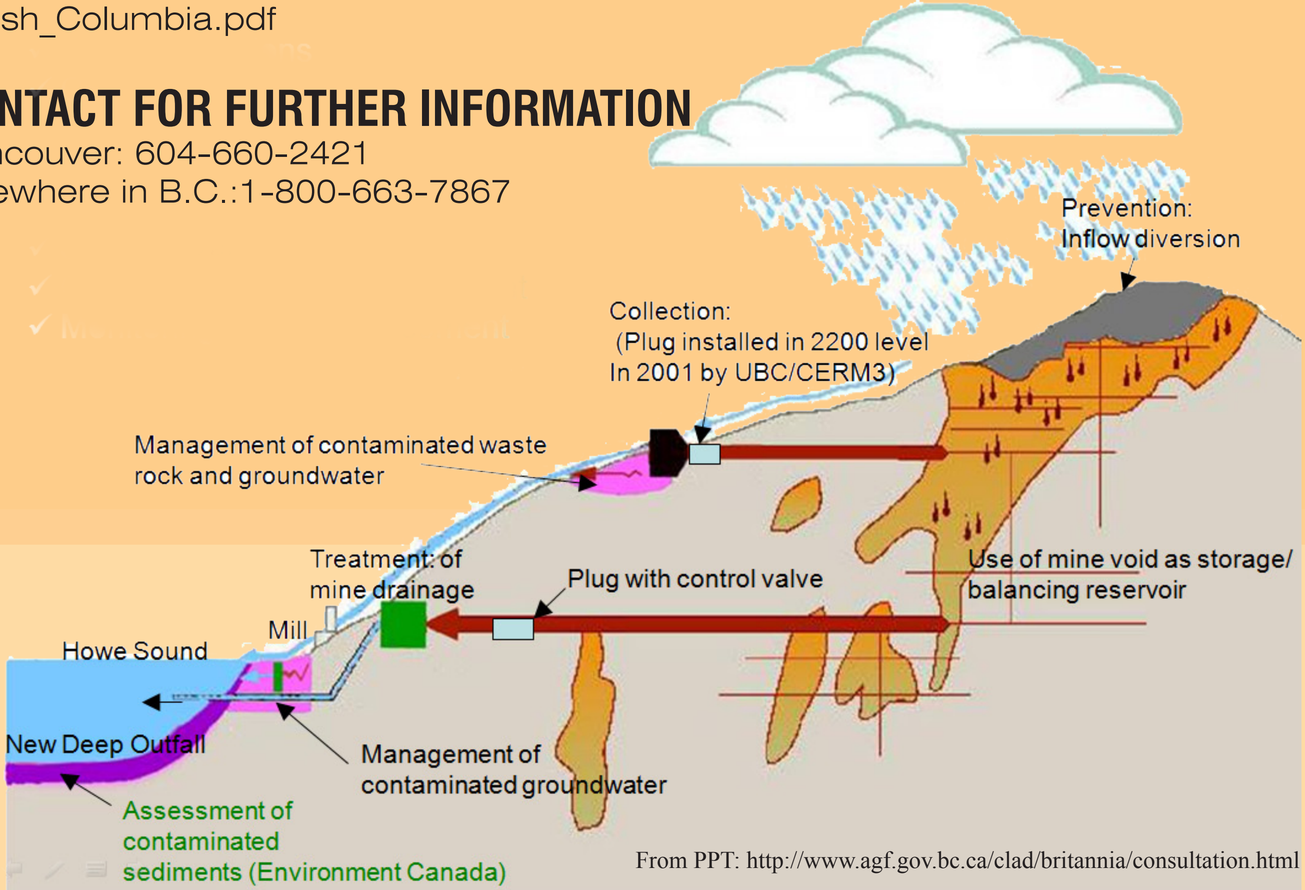
O'Hara, G. (2004, August 25). Britannia Mine remediation project. 16th Int'l Conference,. Lecture conducted from Society for Ecological Restoration, Victoria, British Colombia,Canada.

WEBSITE LINKS

http://www.agf.gov.bc.ca/clad/britannia/index.html
http://www.ser.org/serbc/pdf/Britannia_Mine_environmental_remediation_project,_British_Columbia.pdf

CONTACT FOR FURTHER INFORMATION

Vancouver: 604-660-2421
Elsewhere in B.C.:1-800-663-7867



From PPT: http://www.agf.gov.bc.ca/clad/britannia/consultation.html

Title of Project: Animas River Corridor Revitalization Project & Eureka Town Site
Location: Silverton & Eureka, CO
Date designed/planned: Original River Corridor plan in 1998 that has been built and expanded on in 2004 with a new enthusiastic community partnership.
Size: 2 mile stretch along the Anima River going through Siverton, CO. Eureka town site is located about 8 miles upstream from Silvertown.
Cost: Over $12,237,000.00 so far received in funding.
Landscape Architect: Mountain Studies Institute/DHM Design, Silverton/San Juan County Planner
Client: City of Silverton, CO & San Juan County, CO
Managed by: Silverton/San Juan County Planner

CONTEXT

The Animas River Corridor Revitalization Project occurs along a 2 mile stretch of the Animas River that runs through Silverton, CO. The project will address the issues with flooding, coinciding revitalization and recreational uses, include information on hydrology and the riparian ecology into design and education, whilst involving the community in designing a master plan. There is also a proposed corridor connection to the Eureka Town Site, located about 8 miles upstream from Silverton. The Eureka Town Site contains tailings from abandoned mines such as gold, silver, lead and zinc. These tailings now contaminate a mile long area of the Animas River Valley floor through Eureka. These tailings can be transferred with natural processes, such as flooding, carrying them downstream. Relocation of these tailings is being considered, but places for tailing storage in San Juan County are hard to come by.

ANALYSIS

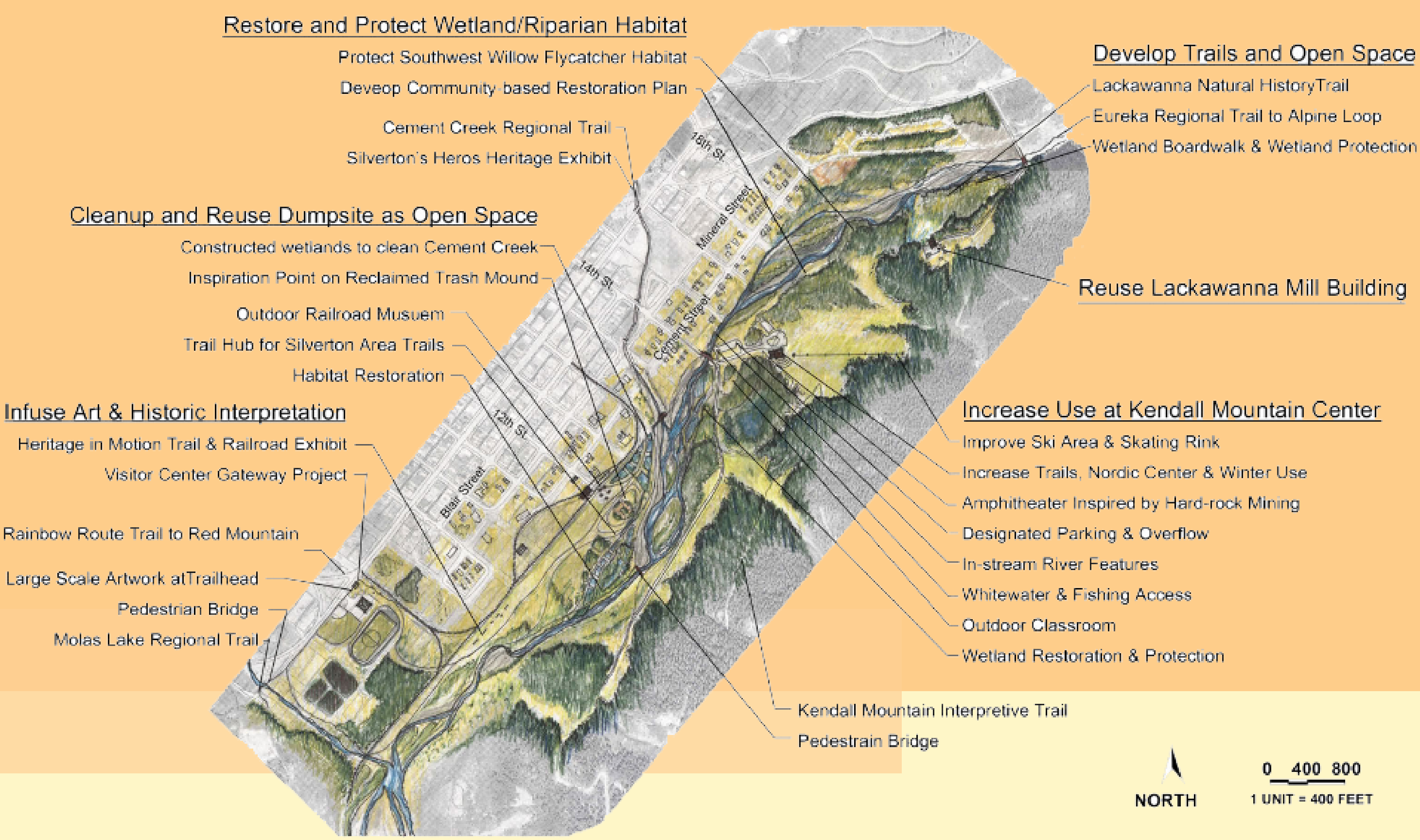
The project addresses different aspects of the land, from hydrology and riparian ecology to toxin remediation and human interaction with the land. The town of Silverton, Colorado, is allowing the project to be very open to the community and their opinions on design and implementations. With help from the community, there have been many great suggestions for recreational use throughout this corridor. Some pretty fascinating ones that make use of the land and its terrain well are; fish habitat improvements, new trails, whitewater park, wetland improvements with educational points on the riparian ecosystem, local artwork, and historic emphasis on the areas background on mining, mountain, and railroad heritage.

BACKGROUND AND HISTORY

Silverton and Eureka, Colorado, are towns located in San Juan County along the Animas River, well known as one of the most breathtaking rivers in Colorado. The towns of Silverton and Eureka were born of mining heritage and railroad destinations for those who came for both the mines and the mountains. Due to the history of mining, both towns contain large amounts of tailings along their riverbeds. In 1998, Silverton and San Juan County came up with a master plan for the Animas River Corridor and in 2004 started expanding on the elements to be implemented in it, such as trails and outdoor classrooms. The county of San Juan, Colorado, only has a population of 576 year-round and has a higher-than-national-average poverty level and below-national-average per capita income. Therefore, this Animas River Corridor Revitalization Project could be exactly what the towns need to bring people in and boost their economies.

GENESIS OF PROJECT

The Animas River Corridor Revitalization Project aims to, with collaboration of the community, create a plan that will address recreational uses, revitalization, art displays, mine clean up, and integrate information on hydrology and riparian ecology to develop the river corridor.



ANIMAS RIVER CORRIDOR- SILVERTON CONCEPT PLAN **Alternative 1**

Animas River Corridor Revitalization Project

http://www.mountainstudies.org/sites/default/files/images/education/AnimasCorridor/Silverton-Corridor-Concept-Plan-alt1.jpg

DESIGN DEVELOPMENT PROCESS

This river corridor project has been developed in stages (I-III). "(I) create a community vision for a Revitalization Plan, (II) conduct a Remediation and Restoration Activity Assessment, and (III) research Funding Opportunities to support the Revitalization Plan." (Mountain Studies Institute,2006)

The schedule is as follows as of 2008:

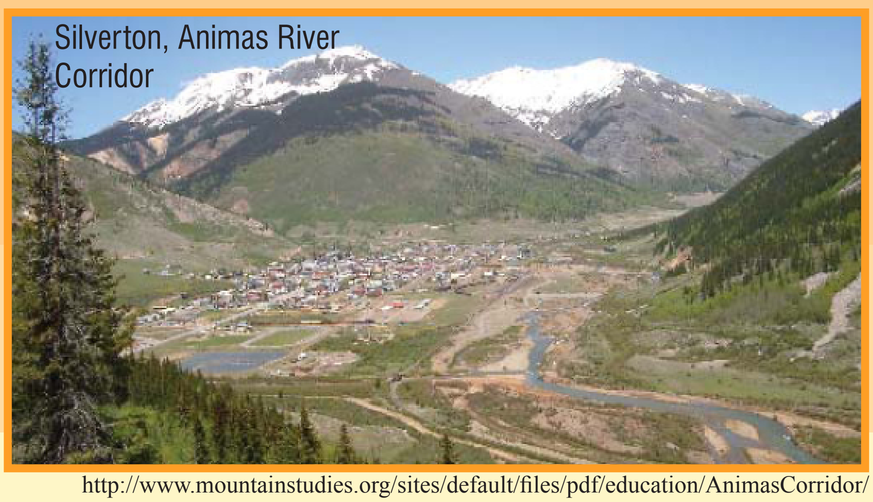
PHASE I
March 15th - Community Meeting & Project Introduction
April/May - Animas River Walk
April - Collections of Mountains, Water & Memories—Animas River Scrapbook
May - Humanities + Arts + Sciences Workshop
June - Animas River Celebration & River Clean Up
June - Community Meeting & Presentation

PHASE II
Draft Restoration and Redevelopment Assessment

PHASE III
June-July - Draft Funding Plan
July - Draft Revitalization Plan Released for Public Comment
August - Final Plan Meeting & Celebration
(1)

SIGNIFICANCE AND UNIQUENESS OF PROJECT

This revitalization project addresses unique aspects as pertaining to anticipated future uses. For example, the proposed use of a whitewater park, art displays, outdoor classrooms, and historical references all contribute to the probability of an economic rise post-implementation due to public interest. These activities are rarely found in small towns. It shows the area's pursuance of survival and pride in their heritage that they want carried on.


Silverton, Animas River Corridor

http://www.mountainstudies.org/sites/default/files/pdf/education/AnimasCorridor/Animas%20River%20Plan-Update-08-06.pdf

WEBSITE LINKS

http://www.epa.gov/aml/revital/msl/pdfs/animas.pdf

http://www.fs.fed.us/psw/cirmount/wkgrps/gloria/publications/pdf/GLORIA_Benchmark_Newsletter.pdf

http://www.mountainstudies.org/index.php?q=content/phase-1-community-visioning-process-conceptual-planning-initial-site-assessments

CONTACT FOR FURTHER INFORMATION

Willy Tookey San Juan County Administer
sanjuancounty@frontier.net 970-387-5766

Beverly Kaiser Silverton/San Juan County Planner
bksilverton@frontier.net 970-387-5522

Bill Simon Alpine Environmental Services Animas River Stakeholders Group
wsimon@frontier.net 970-385-4138

Marcie Demmy Bidwell & Ellen Stein Mountain Studies Institute/DHM Design
marcie@mountainstudies.org; 970-426-8863/970-259-1478 estein@mountainstudies.org 970-247-7044

HISTORICAL CONTEXT

HISTORICAL CONTEXT

Mining has been around for as long as the human race can record, from flint used to start fire to Uranium used for atomic bombs. However, mining didn't become a developing investment until it began to be used for all of our basic needs. In 1762 coal was first discovered in northeastern Pennsylvania. It was estimated that between the anthracite seams there was about 7 to 8 billion tons of recoverable coal. Anthracite coal's first use was recorded in 1768 and the first mine started in 1775 near Pittston, Pennsylvania, provoked by the industrial revolution. The preliminary use was to support the Colonial Iron Industry and then, in the 1800's, to support Andrew Carnegies steel mills, and now, to fuel electric power plants. Similar stories run across the board with other minerals such as Iron Ore, with its first recorded mine beginning in the early 1700's (approximately 1730), to copper, to silver, and so on. Business was booming and mining was fueling America, but unfortunately, so were the beginnings of major pollution. (FacWeb History of Coal Mining, n.d.)

Contaminated wastes from mining were being thrown into either dug ditches, natural valleys with earthen check damns, stacked into piles, or buried. This isn't a problem when it is done correctly, but at this time often it wasn't, and it lead to failure. Some of the worst case scenarios come from what fueled the economy, similar to mining, in times of war and peace in the 1970's, such as nuclear waste sites. The prevalent issue of nuclear waste was the longevity of the radioactive substance's half life, making it difficult to find safe storage that will stand the test of time. (Silverman, M.J., n.d.) As with radioactive waste, when exposed to the open environment, mining contaminants have major effects on the earth and ecosystem.

Photo: http://billhicksisdead.blogspot.com/2011/10/peak-coal-hits-appalachia.html

HISTORICAL CONTEXT

One of the major bi-products of mining is leftover materials from the separation process of the valuable mineral from the the invaluable portion, these leftovers are called tailings. These tailings, either in slurry form or left as particles, can infiltrate the natural processes of the land to contaminate our ecosystem. Their size and consistency often allow for them to either percolate into the groundwater system and/or be carried away, contaminating new areas by way of runoff, streams/rivers, or wind. The more these tailings get spread from the source, the harder it is to clean it up, and more importantly the further spread the effects will be felt. When interacting with natural processes, certain types of tailings can react differently, such as some left over ores can produce ARD (Acid Rock Drainage), also known as AMD (Acid Mine Drainage). (Silverman, M.J., n.d.) ARD can affect the ecology of the area preventing and harming the growth of plants by contaminating the water system and altering the Ph levels. ARD occurs more often when the mine interferes with an existing watershed, more common in underground mines and/or open pit mines established on hill or mountainsides. The reason being, the ore gets exposed more regularly to water, reacting with it, passing down throughout the watershed and ultimately contaminating more areas. Examining above ground operations of a mine, pollution is mainly contributed to the bi-products of the processing of the materials, including tailing disposal and plant emissions.

Acid Rock/Mine Drainage

Photo: http://cbf.typepad.com/.a/6a00d8341bfb5353ef0134863d7d4f970c-pi

HISTORICAL CONTEXT

One of the most efficient ways to separate the valuable material from the invaluable is through a process called smeltering. Smelting plants, or plants of similar means like beneficiary plants, tend to put out large emissions of smoke. Back before regulations, these emissions provided extensive spread of fine tailings through the air. These tailings proved to have major effects on the surrounding vegetation. In White Pine, Upper Peninsula Michigan, according to the copper mine workers and local population, the smoke emissions from the smeltering plant "killed every tree in its path, leaving behind a barren land." Other tailings from the site were placed in large shallow pits that stretched for thousands of acres. These areas, according to residents, became "desert-like," and nothing was able to grow there. The tailing particles were too fine to retain any water and killed everything they were dumped on. The water percolated quickly through the tailings, contaminating it on its way to the groundwater supply. These areas were so large and contained such an enormous amount of tailings (80 feet deep in some valley areas) that they created their own microclimate, reaching temperatures over 100 degrees Fahrenheit regularly in the summer. (Williams, T. 2004) Happenings such as these also have great effects on the wildlife habitat and in turn on human wellbeing.


White Pine Mine (current)


White Pine Mine Tailings

Photo 1: http://www.airphotona.com/image.asp?imageid=6950
Photo 2: http://ecorestoration.montana.edu/mineland/histories/metal/white_pine/default.htm

HISTORICAL CONTEXT

Depending on the tailing, the toxins associated with them can have many different effects. The toxins can be spread from vegetation and water supplies to the wildlife and human populations, in some extreme cases causing cancer and other diseases and defects.

At the first signs of negative effects on the ecosystem, the initial reaction was to find a way to contain the tailings more effectively. This mostly happened by just gathering and containing them in one specific area. The next big steps came when enforcement of the state water quality standards began to be made. The first steps taken by the government came in the formation of the EPA (Environmental Protection Agency). Their initial ideas/obstacles were to make violators abide by the water quality standards set forth by the government, stopping pollutants from being dumped into any water system.(Williams, D. C. 1993)

One of the first mining sites to be deemed a Superfund Site by the EPA was Tar Creek, located mostly in Ottawa County, Oklahoma. This site was a result of lead and zinc mining beginning in 1891 and ending in 1970. The room and post style of mining that was used began to slowly fill with water and dissolving sulfide minerals, generating giant pools of acid. This acid began to fill the mines and eventually started leaking out through abandon mine shafts, boreholes, and natural springs all dumping into Tar Creek. It has been a slow process, but so far the EPA has relocated lead-contaminated soil from over 1,700 residences and capped 83 toxic wells. However, there still remain 75 million tons of chat (tailing piles) and over 800 acres of acidic flotation ponds on site. (The results of mining at tar creek. n.d.)

Photo:http://www.umich.edu/~snre492/cases_03-04/TarCreek/TarCreek_case_study.htm

HISTORICAL CONTEXT

The Tar Creek Superfund Site is a precedent which no mining company should follow, but unfortunately it is not a unique incident. Because of incidents like these, stringent laws and new ways of storage have been forced upon any working or up-and-coming mine.

Storage is the foremost issue when it comes to mining pollution. Over the years there have been many different methods to storing these tailings, slowly becoming safer. Companies have progressed from simply dumping tailings into streams and rivers to finding ways to capture the pollutants and stop them from getting into the ecosystem. More recently, direction is being taken towards forms of phytoremediation. The most commonly known method so far in the industry is phytostabilization. This method involves implementing plants that immobilize the specified toxin in their root systems, keeping it relatively unavailable to wildlife and humans for uptake. These plants for phytostabilzation deal with contamination in the soil; however, there are many other ways to deal with contaminants in the environment that have not yet become mainstream. Such examples are phytovolatilization (taking up the toxin and using it throughout the plants system then releasing it into the air), phytoextraction (using plants to absorb toxins from air, water, or earth then have them removed), phytotransformation (the chemical modification of toxins from air, water, or earth into natural emissions from the plant), and rhizofiltration (the absorption of toxins into the root system of plants).

Photo:http://www.umich.edu/~snre492/cases_03-04/TarCreek/TarCreek_case_study.htm

HISTORICAL CONTEXT

All of these methods are now options when it comes to remediating toxins from abandoned mine-lands. Some innovations being made to the process of phytoremediation are the way the plants now can be grown. Some plants are now grown underground and genetically altered to thrive in certain conditions and absorb specific toxins. (Mendez, M. O., & Maier, R. M. 2007)

Solving the crisis of tailing storage is one of the major issues surrounding any institution looking to start a mine in this time. Most states now have their own stringent laws on mining and have extensive permitting processes that require reclamation and remediation of the site after the mining concludes. Phytoremediation is becoming the main counter in solving this storage crisis and will continue to develop new and more effective ways to rid the environment of contaminated waste from mining.

Photo:http://www.flambeaumine.com/photogallery/2010_calendar/photogallery.html

Goals

Thesis Goals

This thesis aspires to take a contaminated, avoided site and transform it into a desirable location for people to enjoy. By doing so and attracting people to the area, I intend for the town of White Pine, and surrounding communities, to have an economic boost and, by involving them in the design process, give them pride to embrace their history and overcomings.

Academic Goals

- To examine the aspects of large scale planning pertaining to proximities of amenities needed by visitors while maintaining a pristine environment.
- I will further my studies in remediation and combining post-remediated sites with recreational and educational uses.

Professional Goals

- Further progress for remediation and green initiatives to rural communities.
- Provide an environment for collaboration while creating designs and programs to embrace the community.
- Transform a past contaminated site into an outdoor recreational hot spot for a variety of people with different interests whilst providing information and educational amenities for awareness of the project.

Personal Goals

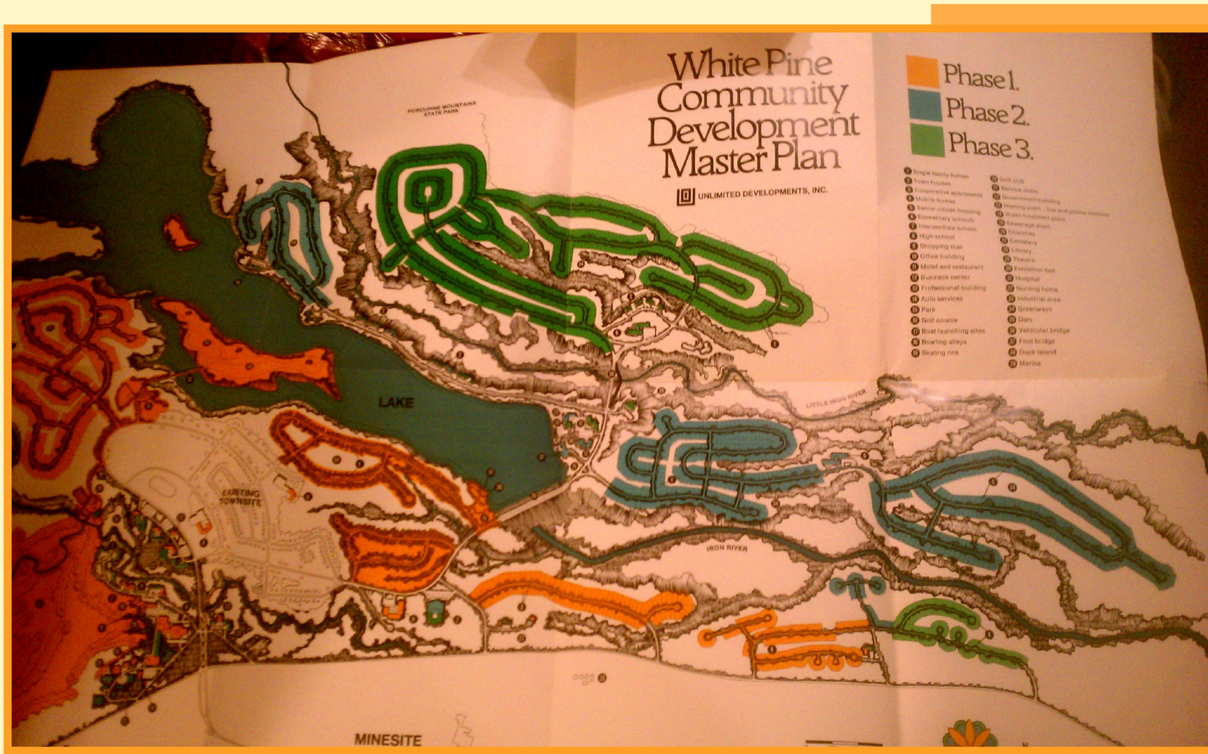
- Create an inviting space that people will want to visit annually, watching the site grow as they do.
- Regenerate the town of White Pine by using its history of being a mining town to its advantage as in Ely, Minnesota, with the Soudan Underground Mine.

Analysis

History & Community

The city of White Pine was established as a mining town following the opening of White Pine Mine in 1955. The town was booming at the time and as depicted in the below photograph, the community took on developing a master plan for the town as it grew. Each of the different colors associated on the plan represent different phases in which the plan was to be installed.

The town made it through phase one of the masterplan and everything was going according to plan until the mines minerals started to become exhausted.

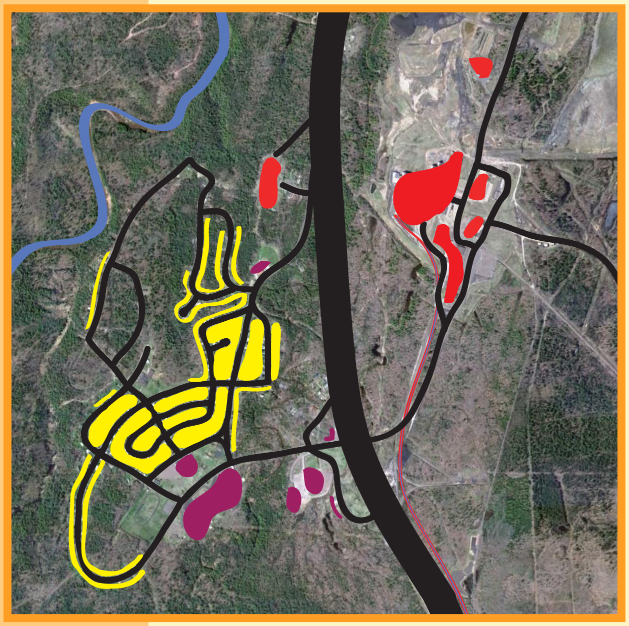


Photos: taken by myself

Vegetation and Conservation/Wildlife Areas

Analysis

Building Analysis & Uses



residential

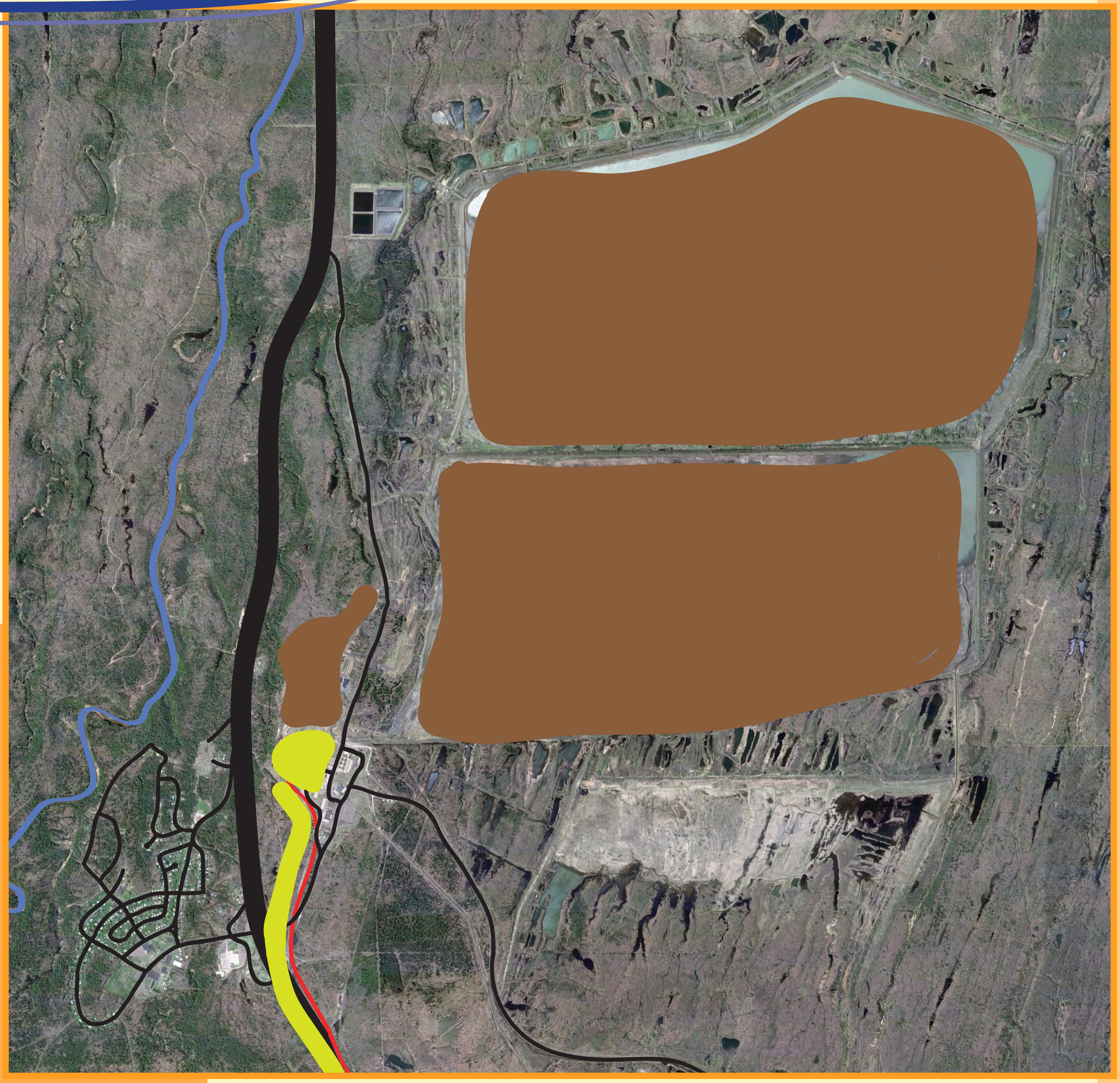
industrial

commercial

The buildings located on site, both residentail and industrial, have one main attribute in common. The buildings were constructed quickly, with cheap materials and prototypical designs. Residential homes have similar facades and overall shapes. The same goes for facades when it comes to industrial buildings; they all more or less look like large tin sheds with the exception of the old guard shack and similar older small buildings.

Analysis

Pollution Sources On Site



Air Pollution (Smelting Plant & Train)

Earth/Water Pollution (Tailing Piles & Ponds)

Analysis

Revitalizing a Community and Landscape

1

2

Landscape architecture applications have the ability to address many different issues pertaining to the ultimate clean-up mining sites.

Some issues I plan to tackle are:
- revitalization of community
- celebration of history
- phytoremediation of site

Through my research, I found that the Flambeau Mine site (1993-1997), near Ladysmith, Wisconsin, has taken such issues at hand and directed them into a successfully revegetated site that involves the community through activities, attracts visitors to support the community, exhibits its history as a mine, and works to clean the site of harmful toxins.

3

1 & 2 : http://dnr.wi.gov/org/aw/wm/mining/metallic/flambeau/
3: http://www.flambeaumine.com/reports/annrec2006/documents/attachment2/Pictures18-28.pdf

Analysis

History & Community

Photos: Courtesy Archives of Michigan

Photos: Courtesy Archives of Michigan

The town of White Pine was established in 1954 following the opening of the White Pine Mine the previous year. The mine was one of promise due to the concentration of copper sulfide discovered in the area, a new era to the mining business. The location of the mine was along the southwest edge of the copper band in the Upper Peninsula of Michigan. Contrary to previous copper mines in the area, the White Pine Mine aspired to become more than just a mine with a man camp. The owners of the mine, Copper Range, realized that in order to attract and retain workers they would need to create a self-sustaining community, for the simple reason that the targeted workers were surveyed to be family men.

Copper Range aspired the White Pine location to become an unrivaled mine by producing copper in vast amounts that had not been previously achieved. This was accomplished as a result of adopting mining techniques from a different kind of mining. Instead of the traditional lake copper mines, consisting of hanging walls and drifts, White Pine Mine was created using entries into the ground with a roof of earth overhead, also known as room and pillar mining.

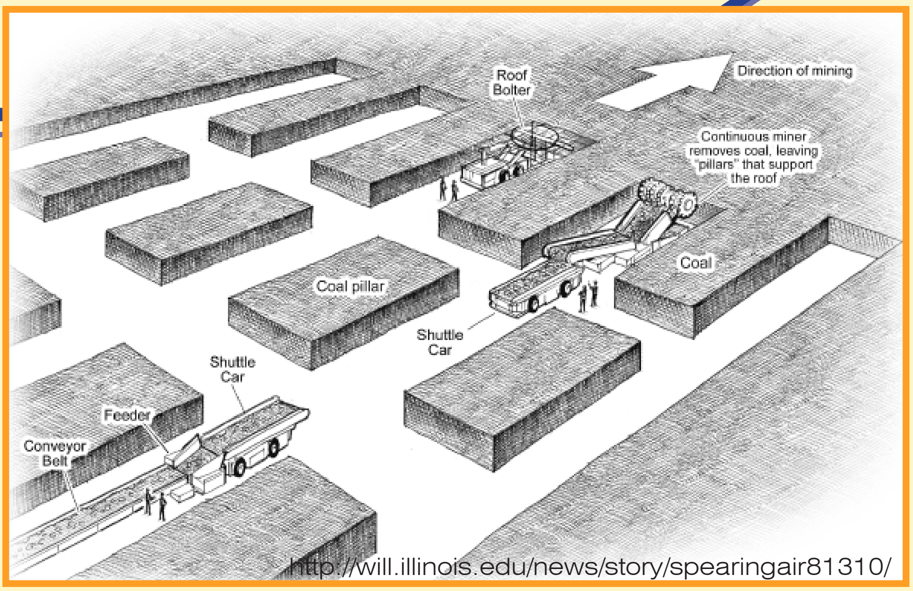
This application of mining called for new technologies propelling the mine well ahead of competition. The mine poured its first concentration of copper in January of 1955, almost three years after the initial construction of the mine began. Within its first year, White Pine Mine's copper production immensely surpassed all others in the area. In 1955, the mine boasted an unheard-of 68 million pounds of copper extracted, only continuing to increase its production to 77 million pounds per year by 1959. The White Pine Mine peaked in 1969 with an astounding 157 million pounds of copper produced.

Although the White Pine Mine grew to become one of the largest-producing copper mines of its time, it had a difficult time getting employees to establish their residency in the town itself.

Most workers chose to travel from adjacent towns. Distances ranged from 13 to 43 miles one way for some workers. White Pine Mine brought in workers from a total area of about 250 highway miles away.

Information: Lankton, L. D. (2010). 20-22. Hollowed ground: copper mining and community building on Lake Superior, 1840s-1990s (pp. 251-303). Detroit, Mich.: Wayne State University Press.

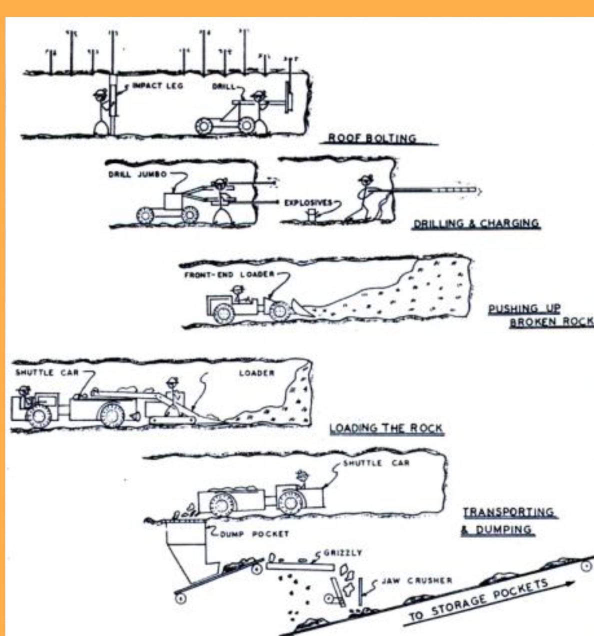
Analysis

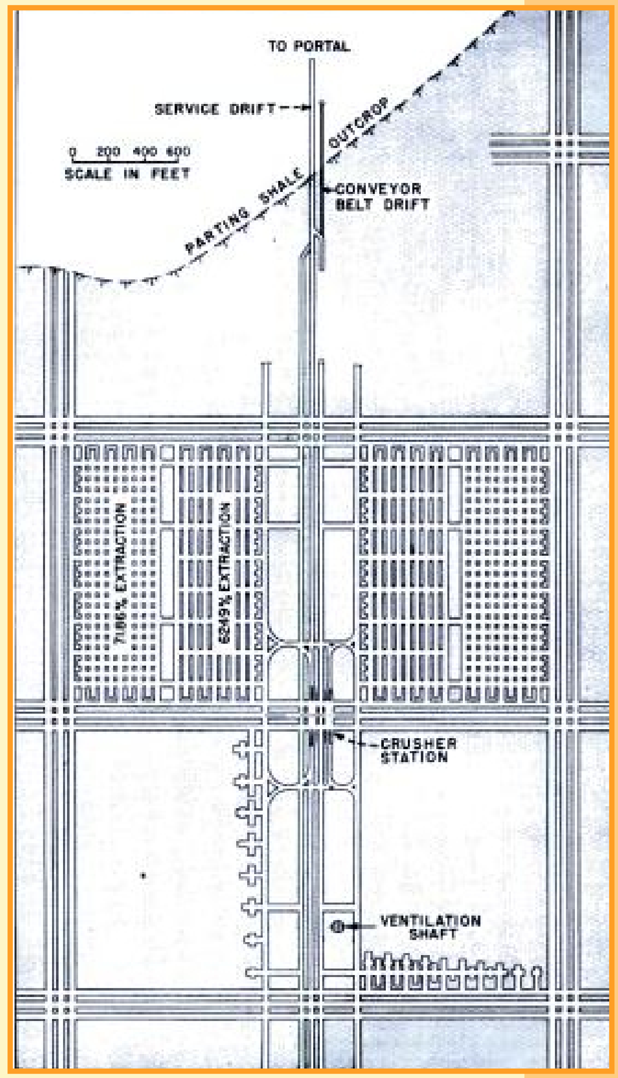


http://will.illinois.edu/news/story/spearingair81310/

Room and Pillar Mining

The large production of minerals at White Pine was due to the method of mining used at the mine. Room and pillar mining was originally used in coal mining and first adapted to copper mining at White Pine, where it proved to be more than successful. The underground method allowed for the mine to gain more efficient access to the bands of mineral deposits, resulting in the astounding amounts of minerals excavated.





Above & Left: http://books.google.com/books?id=1__lh6nfdSkC&pg=PA322&dq=Hallowed+Ground:+Copper+Mining+and+Community+Building+on+Lake+Superior&hl=en&sa=X&ei=X6wdT8KGKqns2AWAyfTfCw&ved=0CDAQ6AEwAA#v=onepage&q&f=false

Analysis

History & Community

In 1970, Copper Range enlisted the help of Unlimited Development to come up with a new plan to boost the town's population. This plan included a constructed lake, nursing home, townhomes, senior citizen housing, etc., all equipped with cable television. This plan was divided into three phases for installation and cost about $40 million. Unfortunately, the town never got past the first phase. It was decided that there were not enough people residing there to support the town.

The history of White Pine can best be described as a roller coaster ride, peaking with major copper production and hitting its low with population deficits and ultimately the closure of the mine.

Through all of the ups and downs, White Pine remains a town invested in its history with pride.

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.

SMELTING PLANT
(Under Construction)

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

Analysis

Toxins

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

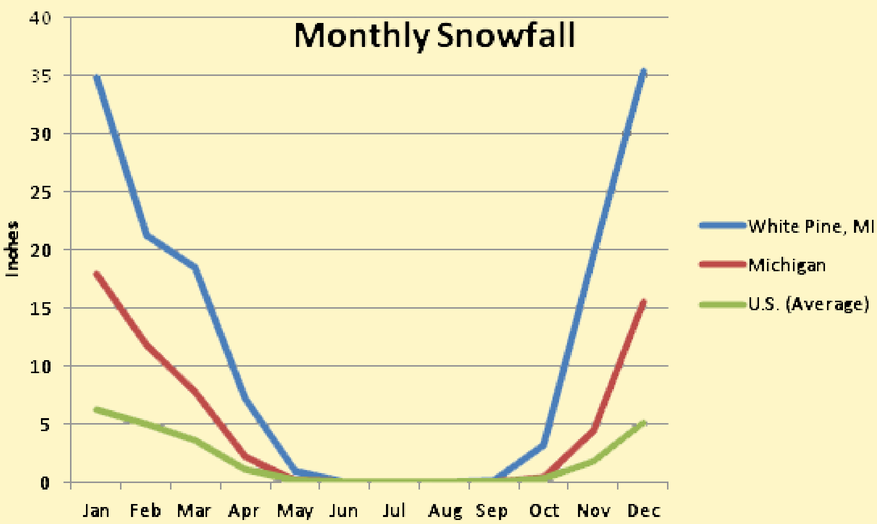
Humans

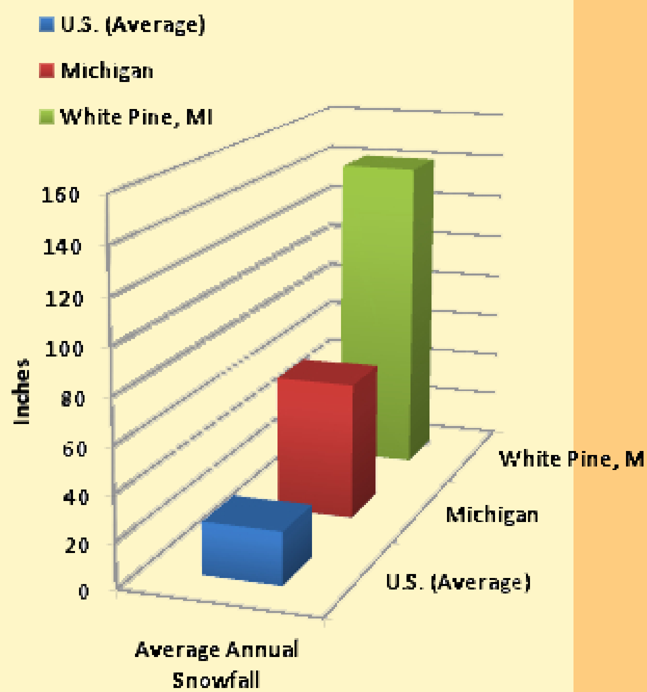
- Fatal to Brain and Kidneys
- Neurological Damage (especially to fetuses, infants, and children)
- Gastrointestinal Damage (if ingested)

Animals

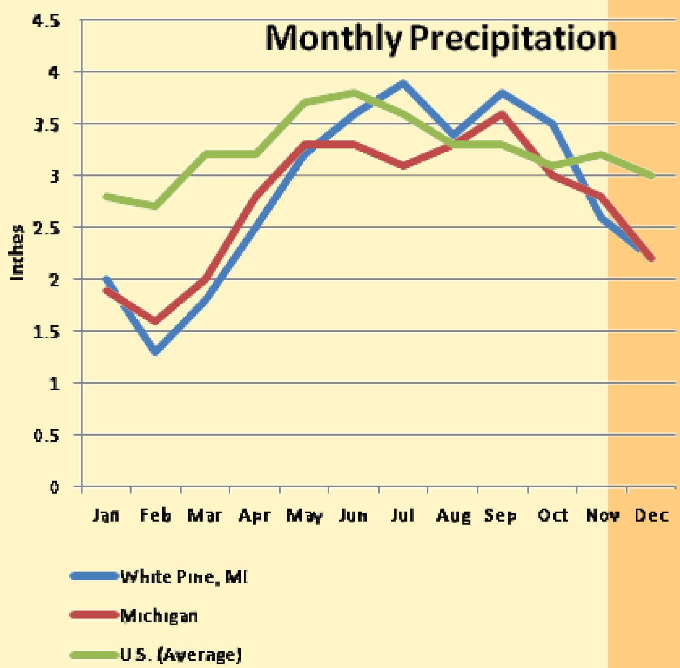
- Neurological (birds)
- Reduced production (hatching) of birds
- Deformities in developing animals

Analysis





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 above, 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.

Analysis

http://www.westernup.net/ski/?cat=11

http://www.thetimbersresort.com/

http://www.bowhunting.com/publisher/Hunting-News/2011/9/19/Michigan-Hunter-Attacked-by-Black-Bear-While-in-Stand

WILDLIFE

Another contributor to spreading toxins is the wildlife in the area. Toxins such as mercury tend to be in high concentrations in water, so in turn fish absorb it and pass it on to humans when eaten.

Other forms of wildlife in the area are black bears, deer, wolves, cougars, and various species of birds to name a few. All of the animals in the area contribute, just as humans do, to the transfer of toxins in their patterns and means of circulation.

The animals, similar to the previously mentioned fish example, will sometimes pass these toxins on to humans when eaten.

http://www.thetimbersresort.com/

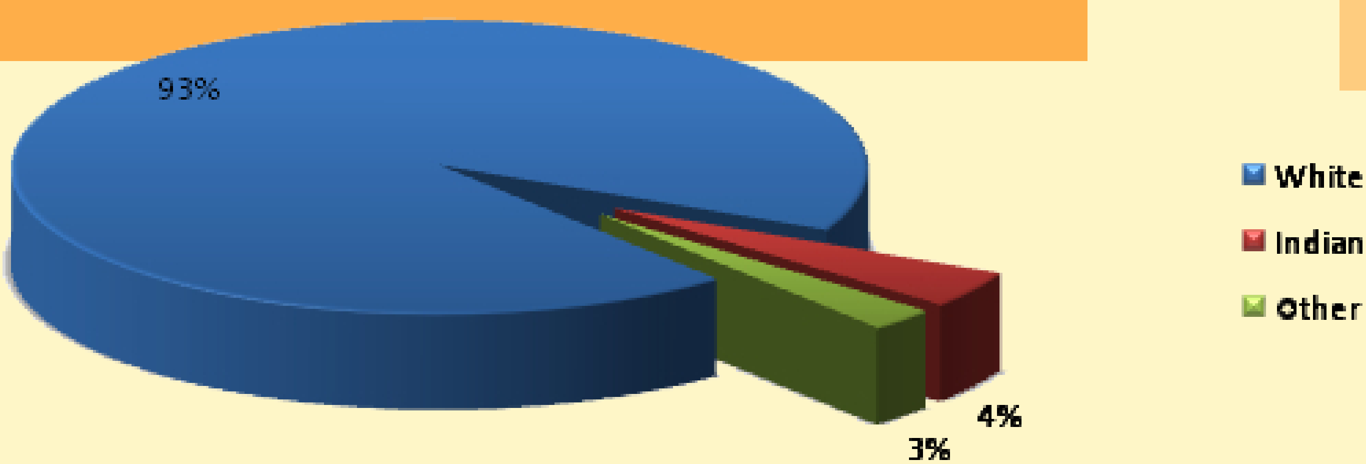
http://www.porcupinelodgemi.com/upgallery19.html

http://www.exploringthenorth.com/konteka/motel.html

Demographics

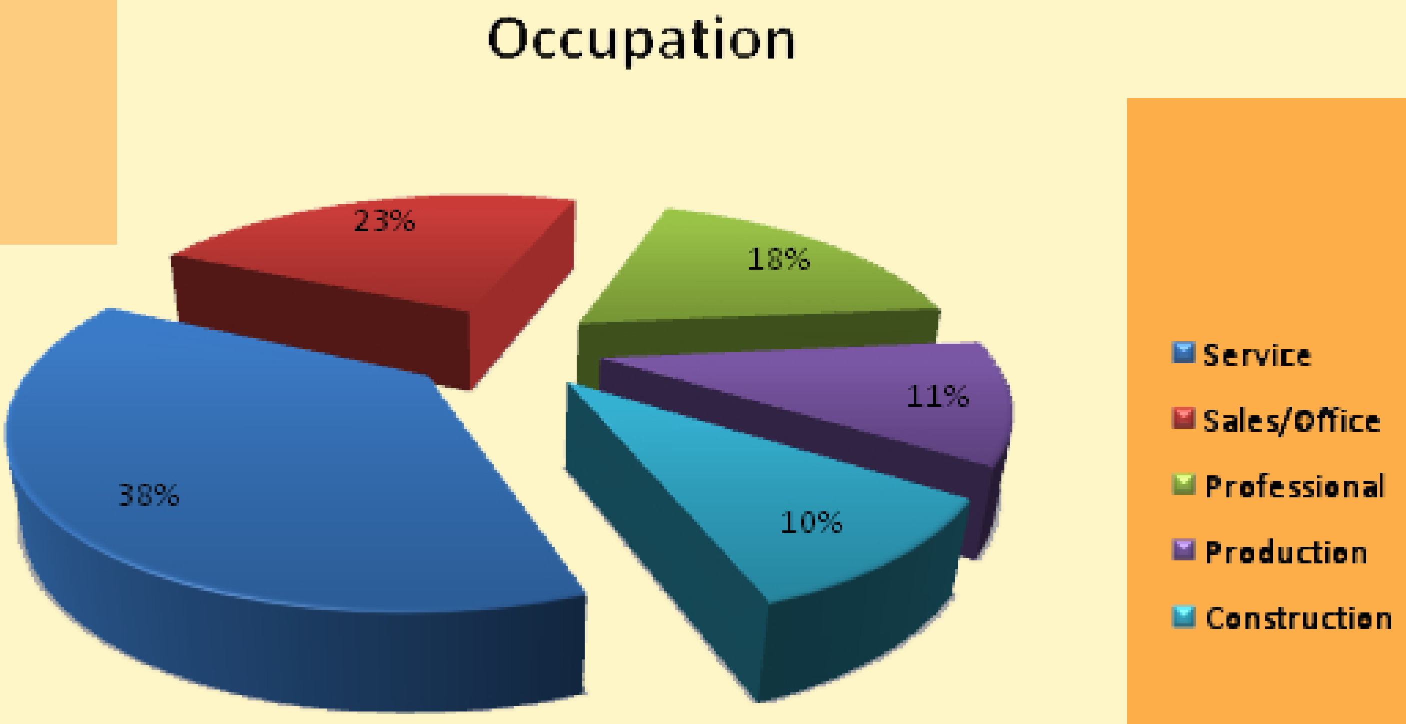
White Pine is a small town of 483 people, most of which make their living in the service industry. Commuting 20-30 miles to reach workplaces is a common occurrence among the community.

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.



Analysis

In order to revitalize the town, an attraction must be made, not only to a tourist's eyes, but also to families looking to start anew. The town must develop a core self sustaining career network. This network will provide a sense of community with each business supporting and contributing to one another. This sense of community is what will ultimately draw in families and younger people to start a new life in White Pine.



Local | Activities

http://www.fishweb.com/recreation/orv/reports.html

The community of White Pine largely strives on its tourism through all seasons. In summer, people come for the sites, hiking, fourwheeling, camping, etc. In the fall, people come for hunting, fall colors, hiking, camping, etc. As for the winter, the Upper Peninsula is known countrywide for its snow.

http://www.upmihikingtours.com/

The large amounts of snow that White Pine receives are a large factor in the economy of the Upper Peninsula, as people travel from many many miles away to snowmobile, snowshoe, cross country ski, and participate in other winter activities.

http://www.newberrychamber.net/

Activities that make people travel from miles around are what residents of White Pine enjoy in their everyday lives. Its what attracted them to stay in the town originally and kept them there with the home town values and mentality.

Where to go from here?

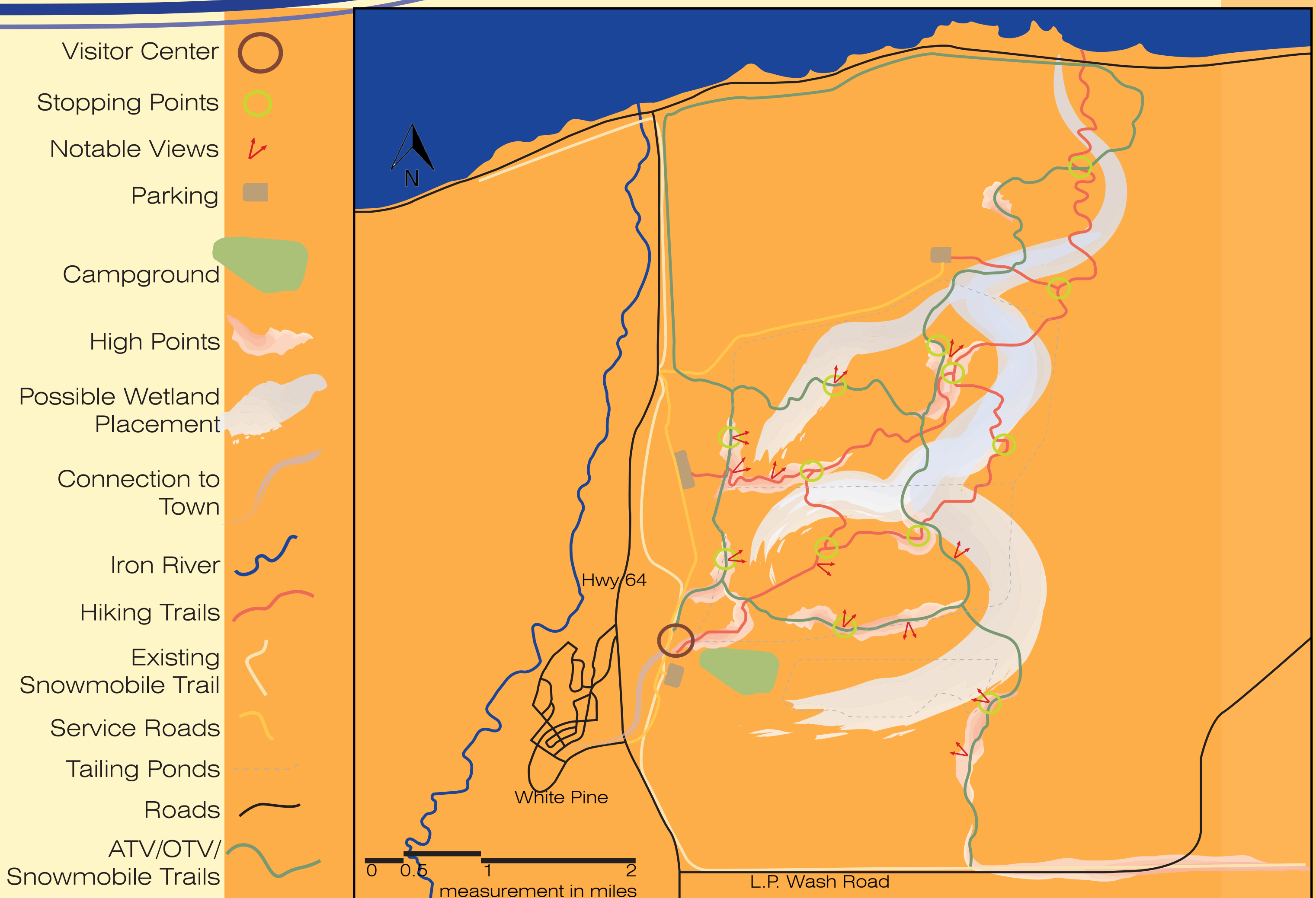
I want my design to clean out toxins left behind from the mining while bringing in and educating those who visit the site. I would like to revitalize the town of White Pine, by creating a harmonious environment and active community. I plan on doing so by establishing a trail system through the revamped tailing ponds that will participate in the education of the phytoremediative quality that wetlands can have on toxins.

These trails will connect with pre-existing trail systems from around the area. Along the trails it will be made visible to visitors the process of phytoremediation and the celebration of the town and mine's rich history. Involving citizens and tourists alike in events and activities throughout the site will also help to develop White Pine into an active community and destination instead of just a thoroughfare.

From a hollowed community ~

~ to a harmonious spirit!

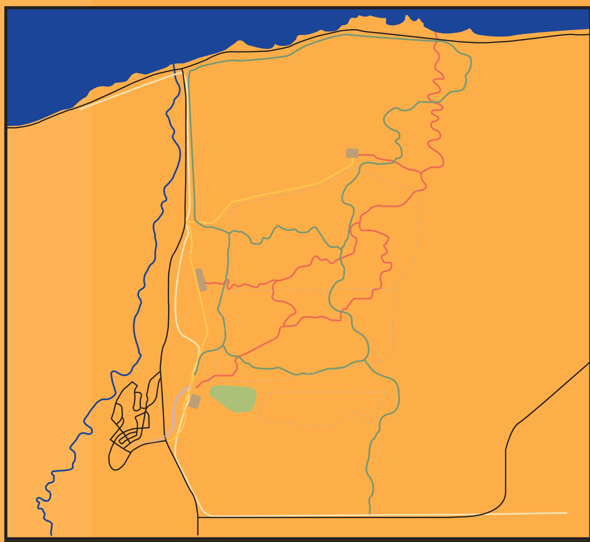
Design Concept



Conceptual Plan

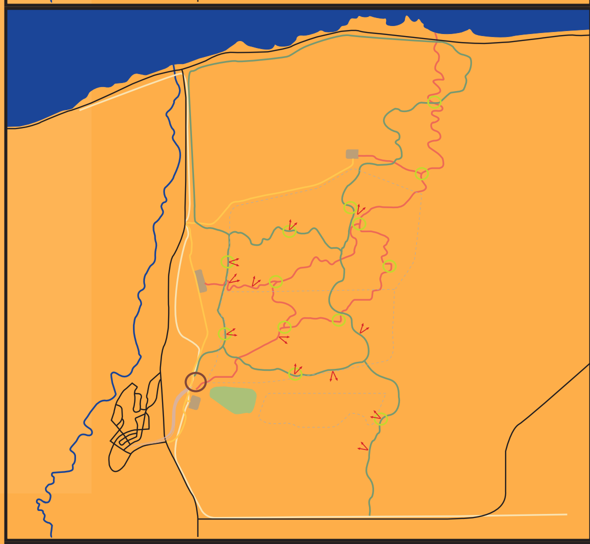
The design goal for my conceptual plan was to provide a careful **placement** for each element that was to implemented. From analyzing the topography and surrounding ecosystems, I came up with the following plans that include different trail systems, a vague outline for wetland placement, gathering areas/ stopping points, notable viewsheds, and connections throughout the site and town.

Design Concept



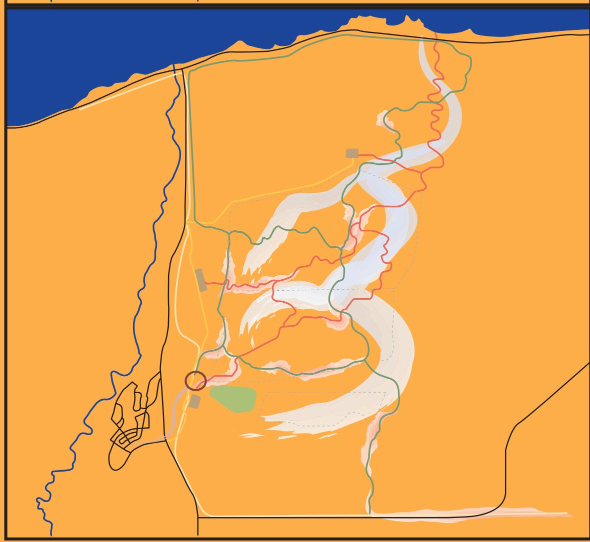
Trails

Depicted below are a combination of trail systems that will guide visitors throughout the site. The hiking trail will be the most **interpretive** of the trail systems. Beginning with the celebration of White Pine's mining history, then on to demonstrating the process of phytoremediation, and finally showing ecological change into the future. The motor vehicle trails will put the aesthetic views on display to riders from high points on the land.



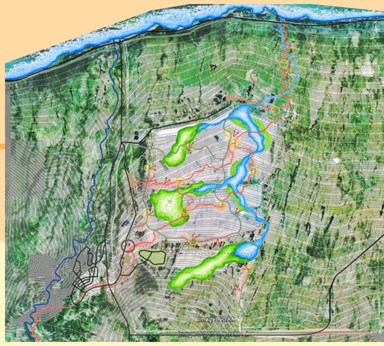
Interest Points

Shown below in green circles are interest points along the trails that I plan to establish stopping/ gathering areas for visitors. These places are chosen for their **views** (depicted by the red arrows), the topography of the trails, and by where the trails come to meeting points. The larger maroon circle shows where the visitor's center would be located. Currently there are some historical mining buildings located onsite I plan to incorporate.

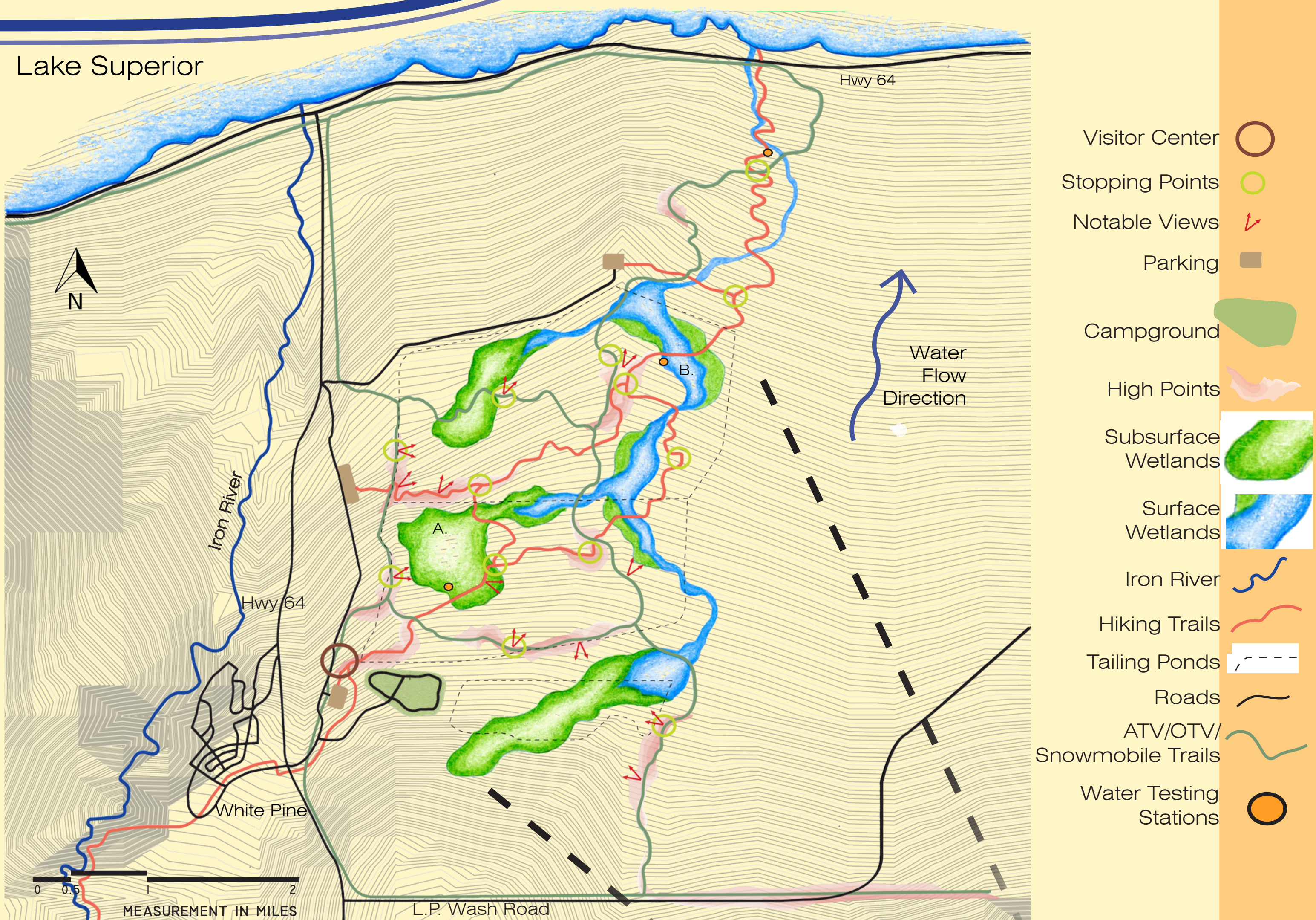


High Points/Low Points

This map shows the high points located along the trail systems in red/pink hues. This is the main **reasoning** behind the placement of the trail systems. By establishing these trails on the changing topography, visitors will experience varying aesthetics provided by the landscape. Shown in the blue hue are potential areas for the phytoremediative wetlands that will cleanse the site of toxins.



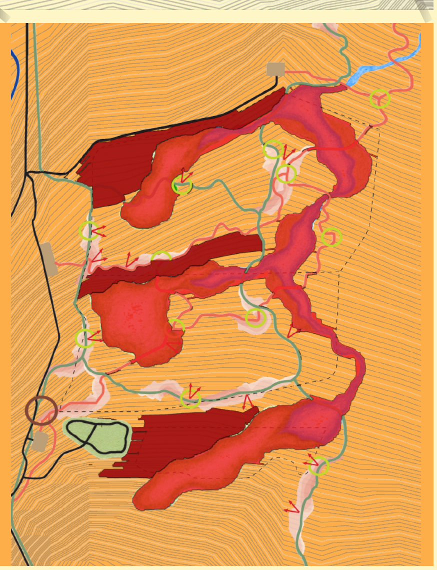
Schematic Masterplan



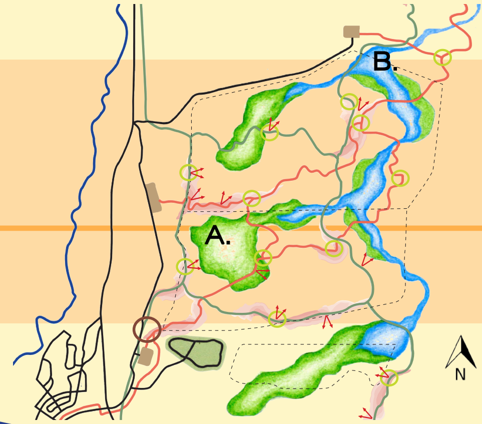
Cut/Fill Plan

CUT

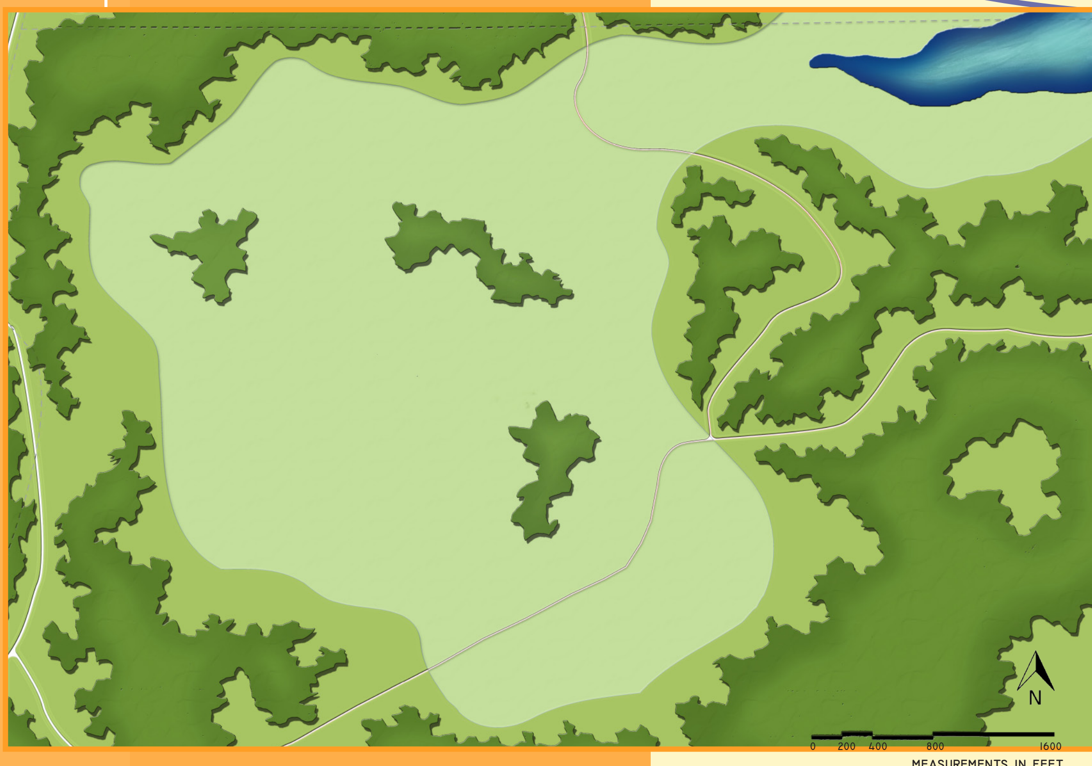
FILL



Wetland Systems



A | Subsurface Wetlands



This detailed masterplan shows how the hiking trails will be placed throughout the subsurface wetlands as to keep hidden from sight of other trail openings.

Subsurface Wetland

Regular Terrain

Wooded Areas of Vegatation

Surface Wetland Area

B | Surface Wetlands

Again, in this plan you can see how the views from the trails are kept pristine and out of sight of each other. Also shown in this plan are the vehicular trails and how they will be made minimally visibile to those on the hiking trails.

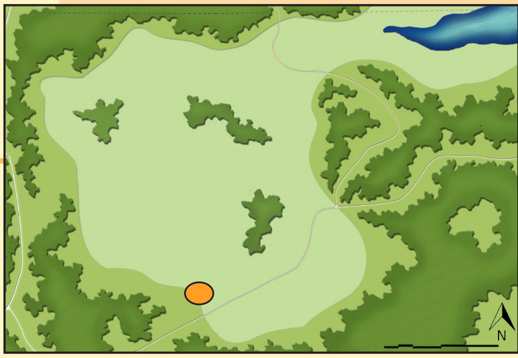
Emergent Planting Area

Regular Terrain

Wooded Areas of Vegatation

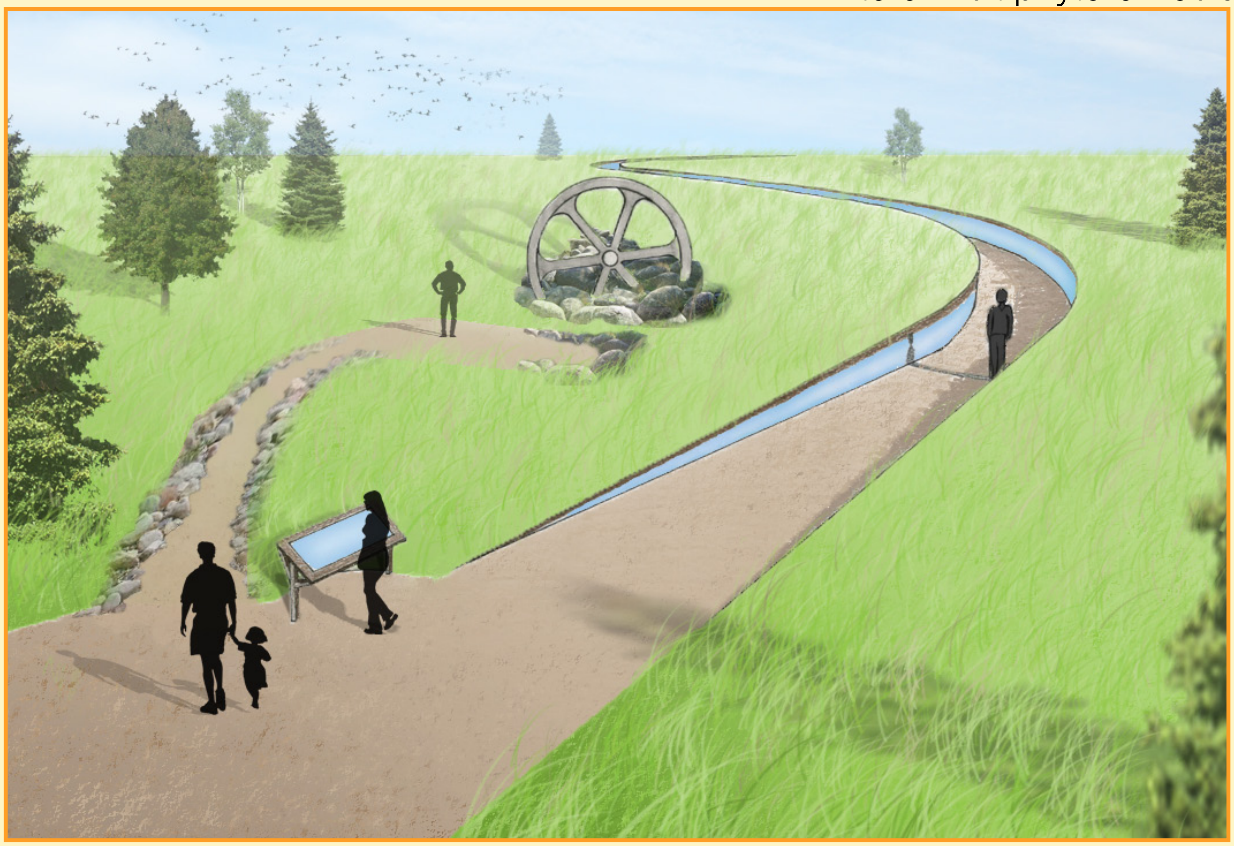
Surface Wetland Area

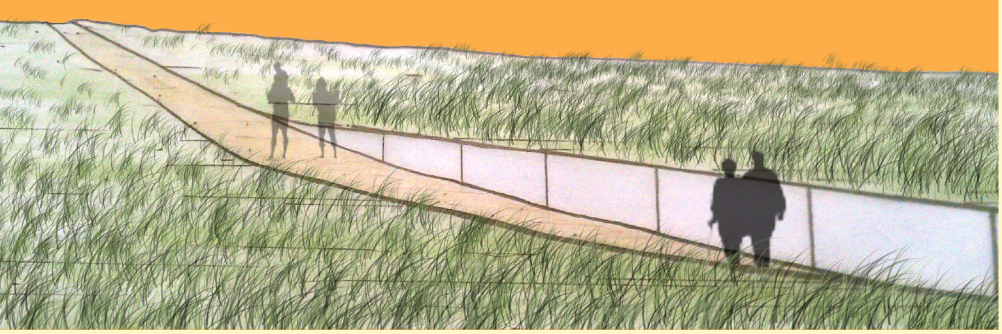
High Point in Topography

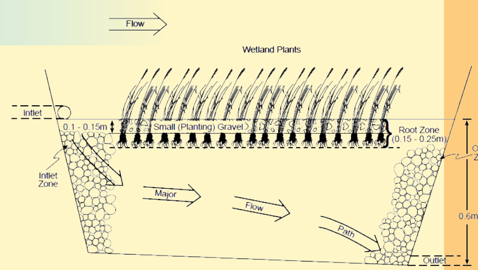


Subsurface Wetlands

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 educative qualities, the path with cut down into the ground and the inner workings of the system will be made visible to onlookers.







http://www.epa.gov/owow/wetlands/pdf/Design_Manual2000.pdf

Not to Scale & Dimensions Are "Typical"

Figure 5-2. Preferential Flow in a VSB

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.

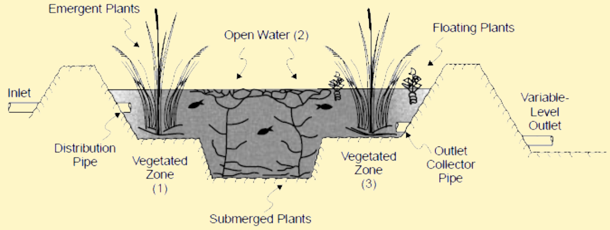


Figure 2-4. Profile of a three-zone FWS constructed wetland cell

http://www.epa.gov/owow/wetlands/pdf/Design_Manual2000.pdf

Limestone Features

As shown to the left, 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.

Phytoremediation

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 thoughout the site in all conditions. The aesthetics of each type of Bentgrass will contiribute to corresponding features of that part of the trail system by either hiding or exposing land with their height.

http://www.bing.com/images/search?q=spike+bentgrass+Agrostis+exarata+&view=detail&id=00D170A801DAD5CDC2173648E3052D5B07D7AE66&first=0&FORM=IDFRIR

Zucchini Varieties

Depicted 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.

http://www.missouribotanicalgarden.org/gardens-gardening/your-garden/plant-finder/plant-details/kc/a686/cucurbita-pepo.aspx

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.

http://en.wikipedia.org/wiki/File:Salix_alba_leaves.jpg

Other Phytoremediative Plants

Mercury

- Autumn Fern
  Dryopteris erythrosora
- Hybrid Poplar
  Poplulus 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 scrabra
- Common ragweed
  Ambrosia artemisiifolia L.
- Indigo Bush
  Amorpha fruticosa
- Sideoats Grama
  Bouteloua curtipendula
- Zucchini
  Cucurbita pepo

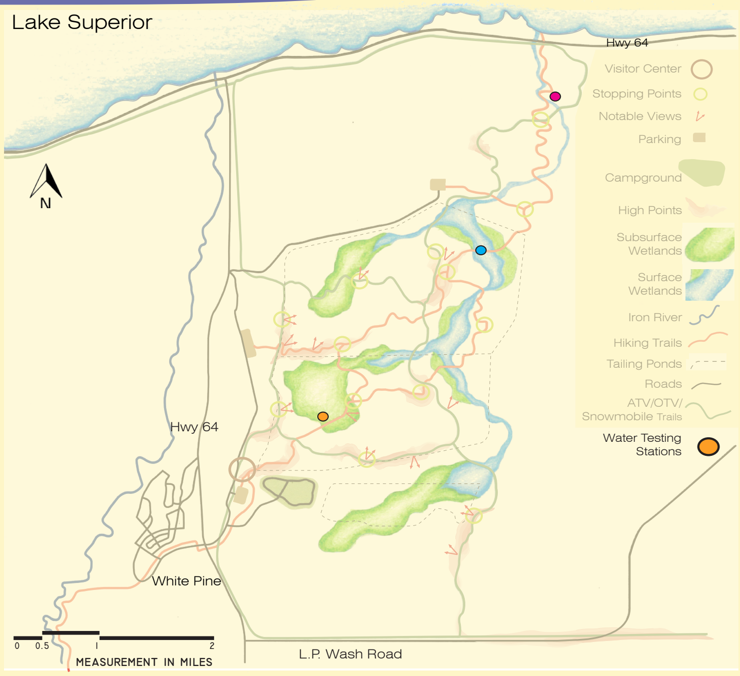
Lead cont.

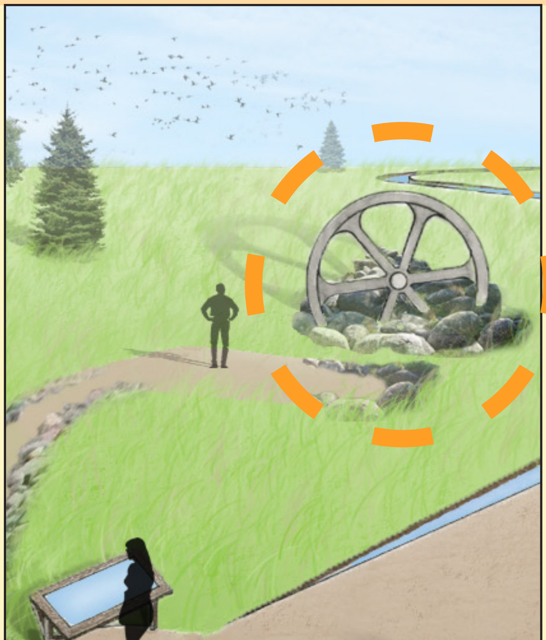
- Bermuda grass
  Cynodon dactylon
- Tufted Hairgrass
  Deschampsia caespitosa
- Inland Saltgrass
  Distichlis spicata
- Autumn Fern
  Dryopteris erythrosora
- Pondweed
  Elodea canadensis
- Tall Fescue
  Festuca arundinacea
- Honey Locust
  Gleditsia triacanthos
- Sunflower
  Helianthus annuus
- Hydrilla – 5a
  Hyrdilla 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
- Smartweed
  Polygonum lapathifolium
- Eastern Cottonwood
  Populus deltoides
- Quaking Aspen
  Populus tremuloides
- Virginia Glasswort
  Salicornia depressa
- Golden Weeping Willow
  Salix alba 'Tristis'
- Laurel-Leaved Willow
  Salix pentandra
- Prarie Cascade Willow – 5a
  Salix pentaphyllum 'Prairie Cascade'
- Common Bur-reed
  Sparganium eurycarpum
- White Clover
  Trifolium repens
- Eastern Gamagrass
  Tripsacum dactyloides
- Common Wheat
  Triticum aestivum
- Broad-Leaved Cattail
  Typha latifolia
- Cattail
  Typha latifolia L.

Arsenic

- Bentgrass
  - Agrostis capillaris L.
- Highland Bent Grass
  - Agrostis castellana
- Spike Bentgrass
  - Agrostis exarata
- Rough Bentgrass
  - Agrostis scrabra
- Colonial Bentgrass
  - Agrostis tenuis
- Big Bluestem
  - Andropogon geradii
- 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 effuses
- 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.

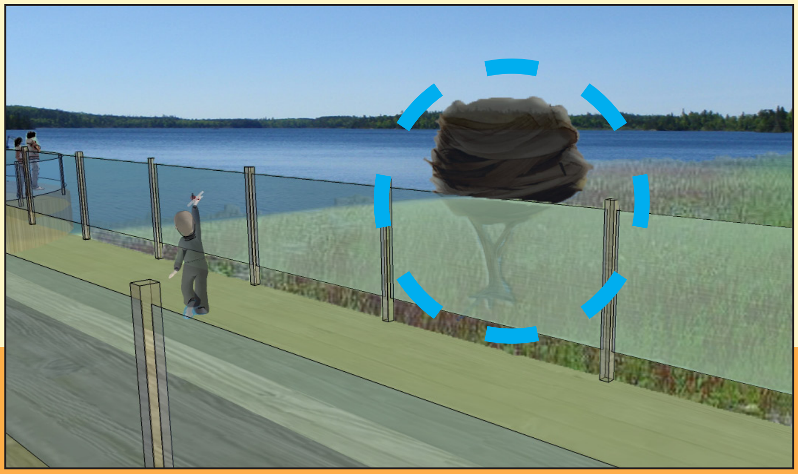
Water Testing Stations





Historical Significance

The wheel represents the old water wheel system used in the mines to pump water.



Phytoremediative Significance

The tree located in the marshes of the surface wetland portrays the cleaning aspect of the wetland systems.

Future Significance

A large sprout structure will represent the last water testing station. The sprout will take on the meaning of new beginnings and a revitalized future for both the local ecology and economy.

Water Testing Information

Material Connections

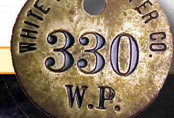
The Miner's Tag will be a reoccuring element repeated throughout the site within different structure and shapes of structures.

Interactive Kiosks

These interactive kiosks will accompany each water testing structure and relay the information collected by fun and educating means to visitors.

Stop #1

Visitors' Center | Beginning



Room and Pillar Exhibit

The building foundation (pictured to the left) 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 to the left middle) 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.

Progression to Trail Systems

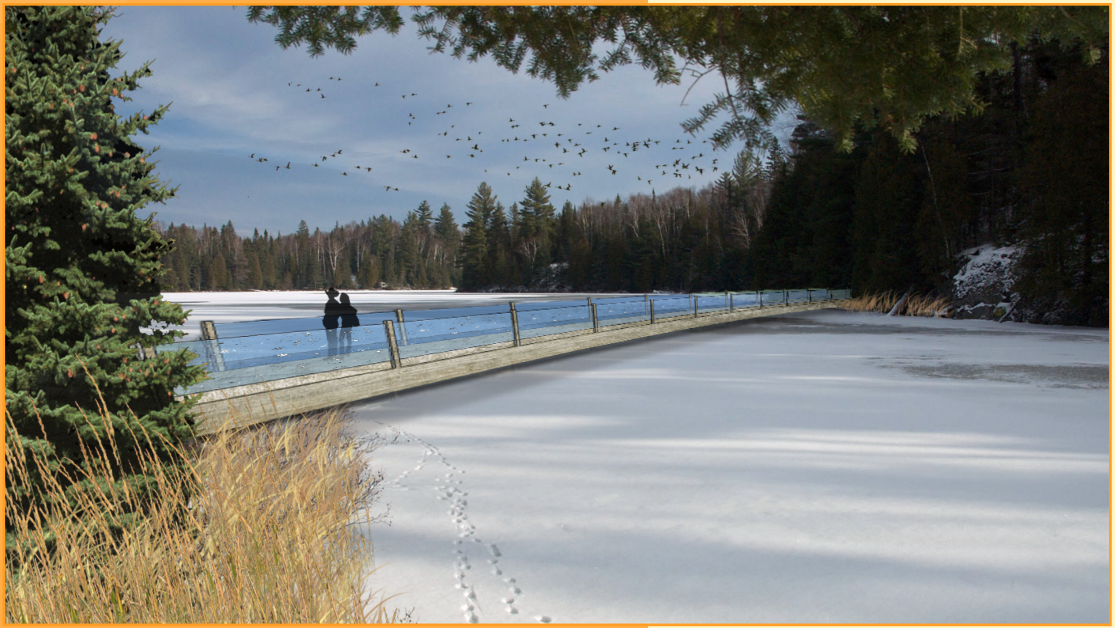
Boardwalk/Bridge over Surface Wetlands

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.

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.

Conclusion to Design

By including interactive and educational ammenities 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.

Trail Meeting Points >

APPENDIX

see attatched files...

References

Crown Land Administration Division - Britannia Mine - Province of British Columbia. (n.d.). BC Ministry of Agriculture, Food and Fisheries. Retrieved November 23, 2011, from http://www.agf.gov.bc.ca/clad/britannia/index.html

District 1 History. (n.d.). Mine Safety and Health Administration (MSHA) - Home Page. Retrieved December 4, 2011, from http://www.msha.gov/district/dist_01/history/history.htm

EPA. (2006). Animas River Corridor Revitalization Project. US EPA, 1(1), 2. Retrieved November 29, 2011, from http://www.epa.gov/aml/revital/msl/pdfs/animas.pdf

Flambeau Reclaimed. (n.d.). The Reclaimed Flambeau Mine site in Ladysmith, northern Wisconsin offers hiking and equestrian trails along the Flambeau River.. Retrieved November 10, 2011, from http://www.flambeaumine.com/

History of Coal Mining. (n.d.). FacWeb. Retrieved December 4, 2011, from http://facweb.stvincent.edu/EEC/MRIP/history_of_coal_mining.htm

Interstate Technology & Regulatory Council (ITRC). 2006. Planning and Promoting Ecological Reuse of Remediated Sites. Washington, D.C.: Ecological Land Reuse Team, Interstate Technology & Regulatory Council.

Jacob D.L. & Otte M.L. (2004). Long-term effects of submergence and wetland vegetation on metals in a 90-year old abandoned Pb-Zn mine tailings pond. Environmental Pollution 130: 337-345.

Mendez, M. O., & Maier, R. M. (2007, December 17). Phytostabilization of Mine Tailings in Arid and Semiarid Environments—An Emerging Remediation Technology. Environmental Health, 116, 278-283. Retrieved December 5, 2011, from http://ehp03.niehs.nih.gov/article/fetchArticle.action?articleURI=info:doi/10.1289/ ehp.10608#Phytostabilization%20as%20a%20remediation%20strategy

Mountain Studies Institute (2006, January 2). Animas River Corridor Revitalization Project. The Benchmark, p. 8. Retrieved November 30, 2011, from http://www.fs.fed.us/psw/cirmount/wkgrps/gloria/publications/pdf/GLORIA_Benchmark_Newsletter.pdf

Phase 1 - Community Visioning Process, Conceptual Planning, & Initial Site Assessments | www.mountainstudies.org. (n.d.). www.mountainstudies.org. Retrieved November 29, 2011, from http://www.mountainstudies.org/index.php?q=content/phase-1-community-visioning-process-conceptual-planning-initial-site-assessments

References

O'Hara, G. (Director) (2004, August 25). Britannia Mine Remediation Project. 16th Int'l Conference,.Lecture conducted from Society for Ecological Restoration, Victoria, British Colombia,Canada.

Rockaway Township NJ History, Geography and Demographics. (n.d.). Rockaway Township Free Public Library Home Page - Rockaway, NJ, New Jersey. Retrieved December 4, 2011, from http://www.rtlibrary.org/history.html

Silverman, M. J., History, D. o., & University, C. M. (n.d.). Radiocative Waste Management. Civil and Environmental Engineering - Carnegie Mellon University. Retrieved December 5, 2011, from http://www.ce.cmu.edu/GreenDesign/gd/education/edradiocase.html

The Results of Mining at Tar Creek. (n.d.). www.umich.edu. Retrieved December 5, 2011, from www.umich.edu/~snre492/cases_03-04/TarCreek/TarCreek_case_study.htm

United States Environmental Protection Agency. (2000). Introduction to Phytoremediation. Washington, D.C: Office of Research and Development.

United States, E. P. (2005). Road map to understanding innovative technology options for brownfields investigation and cleanup. (Fourth ed.). Washington , DC: U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Technology Innovation Office.

Williams, D. C. (1993, September 5). The Guardian: EPA's Formative Years, 1970-1973 | About EPA | US EPA. US Environmental Protection Agency. Retrieved December 4, 2011, from http://www.epa.gov/aboutepa/history/publications/print/formative.html

Williams, T. (2004, August 1). White Pine Mine. Ecosystem Restoration. Retrieved November 16, 2011, from http://ecorestoration.montana.edu/mineland/histories/metal/white_pine/default .htm#

"To new people, experiences, & opportunities... to NDSU."

Danielle Marie Gustafson
27058 Lonesome Road
Merrifield, MN 56465
218-330-1619
danielle.gustafson1989@gmail.com

Hometown: Merrifield, Minnesota

Personal Information