IRRRB Innovation Grant Program

Pit Lake Shoreland Zone & Upland Development Handbook V1.0

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1.0 Overview

This handbook, which is a work-in-progress, is intended to illustrate practical and replicable practices to use current mining activities to shape the future landscape of the Mesabi Iron Range. Specifically, the handbook addresses the shaping of future shoreland and associated upland areas that will evolve once mining ceases and mine pits fill to become lakes. While the handbook obviously can guide reclamation of shoreland and upland areas at inactive pits possessing already developed mine pit lakes, the focus is on making efficient and effective use of ongoing mining activities.

The handbook begins with a brief review of mineland reclamation law and strategic direction. That is followed by a review of pertinent reclamation and shaping projects. The final section presents the initial handbook.

The term “shoreland” as used in this document refers to both the upland and aquatic portions of the shoreline and can be considered synonymous with the term littoral. Within the aquatic portion of the shoreland the most important segment is that which extends downward to the limit of rooted vegetation.

2.0 Context for Reclamation

IRRRB Reclamation

Established in 1977 Iron Range Resources and Rehabilitation Board's Mineland Reclamation Program focuses on making today's mining lands the basis for future recreation and economic development. The legislation creating the program states its purpose is to "provide for the reclamation, restoration or reforestation of minelands not otherwise provided for by the state law for the purpose of reclaiming and enhancing those areas of northeastern Minnesota adversely affected by (the) mining (of) taconite and iron ore" (Minnesota Statutes 298.223 1977).

In general, the program is intended to change existing mining landscapes in ways that make them better suited to other uses. Projects seek to eliminate dangerous areas, establish vegetation and reforestation, repair and prevent erosion and dust problems, create recreational areas, or restore wildlife habitats.

The Laurentian Vision Partnership (LVP) annually reviews and ranks applications submitted by local communities, mineland reclamation committees, and the Inspector of Mines. Approved projects receive IRRRB funding. The range of projects includes:

- reshaping and revegetating mine pit walls and stockpiles
- eliminating safety issues around abandoned mine areas
- capping old underground mine openings
- establishing wildlife habitat
- building public boat accesses at mine pit lakes
- stocking fish in mine pit lakes
- constructing campgrounds, hiking trails and other recreation areas
- environmental education of local residents
- converting minelands into commercial and residential sites
- promoting tourism.

Governor's Committee on Minnesota's Mining Future

The Governor's Committee on Minnesota's Mining Future was formed in 2004 to advise the Governor on ways to strengthen and develop a sustainable mining and minerals industry in Minnesota. The Committee was a forum to review governmental policies that affect the mining and minerals industry. While the committee focused on ways to stabilize and enhance the growth of the mining and minerals industry, its output included components that impact redevelopment of the area in a post-mining future.

Among the committee's priority strategies for industry development was: "Environmental Quality: Formulate environmental policies and land management strategies that facilitate exploration, encourage investment and sustain production while maintaining good land and environmental stewardship."[1] One of the specific recommendations under that strategy was: "Sustainable development strategies should be developed and deployed to enhance land-use planning, manage

[1] *Governor's Committee on Minnesota's Mining Future Final Report*, September 2004.

conflict concerning land uses, incorporate future land forms, lakes and wetlands into current permitting and planning, and make lands available for leasing and exploration." [Emphasis added]

The committee's report commented on the LVP. Specifically, it noted that LVP's efforts "could mutually benefit mining and community interests by providing ways to continue economically viable mining in the long term while reclaiming lands left behind for alternative uses." In addition, the committee recommended the development of tools to enhance post-mining land use plans and explore the land use implications for all types of mining. The committee stated that "[f]uture lakes and wetlands, resulting from and remaining after mining, could be incorporated into current permitting and land use planning."

The Laurentian Vision Partnership

While the Mineland Reclamation Program addresses restoration of existing mines as well as shaping a desired future, the Laurentian Vision Partnership (LVP) was created to focus on "transforming pits and piles into living lakes and landscapes" as the basis for a dynamic and diverse Iron Range.

The LVP is "a coalition of local, regional and state mining, business, government, education, professional and community interests representing all parts of the Mesabi Iron Range that promotes sustainable mining and the reshaping of mining sites into productive future landscapes." LVP nurtures discussion and decision-making among the region's stakeholders encouraging the crafting of strategies and actions that transform goals into reality on the ground. The LVP is a collaborative of regional interests with staff provided by Iron Range Resources & Rehabilitation Board (IRRRB) and additional support from corporate sponsors.

The LVP's mission is to promote "the development of productive post mining landscapes" through cooperative actions by its members in:

- ***Preserving*** lands necessary to sustain current and future mining.
- ***Promoting*** landscape options for post mining uses.
- ***Identifying*** and discussing new development opportunities.
- ***Providing*** the tools to achieve these goals.

The Innovation Grant program is the mechanism used by LVP and IRRRB to fund demonstration projects in mineland reclamation with particular focus on shaping the land for a desired future landscape.

3.0 Review of Projects to Date

3.1 General

The IRRRB established the Innovation Grant program to foster appropriate redevelopment and repurposed uses of minelands. This program takes full advantage of a critical component of the State's mineland reclamation rules. Under those rules the Department of Natural Resources (DNR) can issue a variance to a mining company's permit to mine for the purpose conducting "acceptable research". Acceptable research is defined as: site related; reasonably designed for the purposes of demonstrating the goals of sloping and landform design can be achieved; no larger than necessary to adequately demonstrate the proposed measures; and compares to the intent of the standards the research is replacing.[2]

Between 2006 and 2010 the Innovation Grant program has funded projects focused on mineland reclamation. These include identifying and developing renewable wind generation across the Iron Range at various mining sites, growing switch grass on a tailings basin to provide an alternative source of biomass for the green energy industry, and documenting the extensive network of sub-surface mines across the Mesabi Iron Range.

In addition, since 2001, Innovation Grant funds have allowed the LVP to sponsor land-use design workshops (called charrettes) conducted by the mining company, property owners and neighboring communities, and staffed by teams of landscape architects and planners. Local communities and mining companies are currently implementing aspects of the land-use plans that resulted from charrettes that were conducted in the Virginia, Hibbing/Chisholm, and Biwabik areas.

3.2 Innovation Grant Projects

To date the Innovation Grant program has funded projects specifically intended to develop new approaches to mineland reclamation including the Hibbing Taconite (HibTac) / Cliffs Natural Resources project which was the first of the in-pit projects utilizing active mining.

Land Design for Taconite Mining Workshop

In 2009 over 35 mine engineers from regional iron ore mining companies attended a course that presented concepts and exercises about land shaping and tools for planning short and long term end uses at mines. The course was presented by landscape architects from the University of Minnesota. It was funded by an Iron Ore Cooperative Research Grant.

United Taconite Highway 53 Corridor Stockpile

This project was intended to innovatively shape and vegetate a surface overburden stockpile adjacent to the heavily traveled Highway 53 corridor. The project's goals were to: reshape the stockpile into a positive community and company resource; explore use of design devices to improve appearance; and explore on-site moisture retention techniques

[2] Department of Natural Resources, Taconite and Iron Ore Mineland Reclamation Rules, Chapter 6130, 6130.0100 Definitions, subpart 1.

KeeTac Dump #43

This project takes on the difficult task of shaping and vegetating a rock stockpile, which is significantly more challenging to contour and vegetate than an overburden stockpile. The project involves regrading and planting 450 feet of the west side of Dump #43, a rock stockpile located on the KeeTac mine facility. The project will explore how to shape and vegetate challenging rock medium in anticipation of the future development of such stockpiles within public views. As with other Innovation Grant funded reclamation projects, this effort will provide mine engineers with templates for land shaping and vegetation composition. The templates will include land development standards, models of regional natural landforms, lake edges, lake bed profiles and vegetation patterns, and design devices applied to achieve beauty and functionality.

Hibbing Taconite Stockpiles 4090 and 5012

This project involves reshaping and revegetating two stockpiles that lie in close proximity to Kleffman Road. The road poses a constraint in terms of ability to shape the piles and an opportunity in that they are in full, close view by the public. Key objectives of the project are to: soften engineered ridges and slope faces, break up horizontal slope faces and crests, and reconnect to remnant forested areas. Goals include planting for native species diversity and habitat, improving soil stability and water quality, creating opportunities for seed production, and improving public views from the roadway. The general concept is to create a more natural-looking and pleasing appearance and to provide an environment for native plant establishment. Stockpile 4090 offers the opportunity to reshape a site for enhanced visual interest of the passing public.

Hull Rust Mahoning Mine In-Pit Shoreland Development

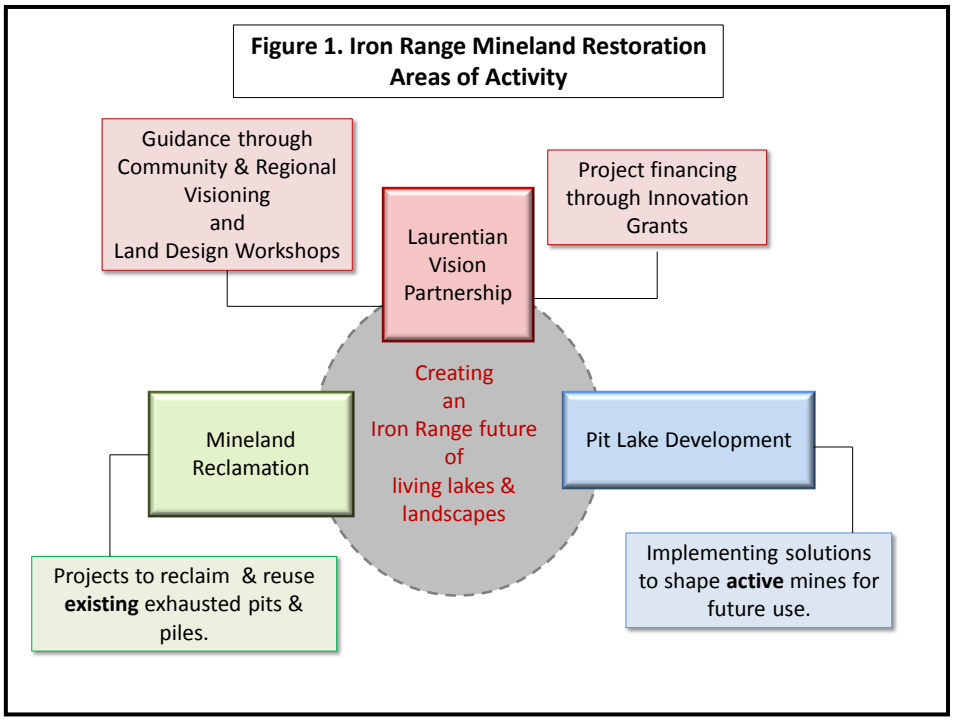
This project is the first to use ongoing mine activity to shape an in-pit site for future shoreland. Its stated purpose is to “design and build new mine pit lake shoreline, shallow pit lake areas suitable for aquatic life, fish spawning areas, islands and usable upland areas. “

4. 0 Pit Lake Shoreland Development Handbook

4.1 Purpose

This handbook is intended to illustrate practical and replicable practices to use current mining activities to shape the future landscape of the Mesabi Iron Range to help meet the mission of the LVP: "transforming pits and piles into living lakes and landscapes". Specifically, the handbook addresses the shaping of future littoral and associated upland areas that will evolve once mining ceases and mine pits fill with ground water to become lakes.

Figure 1 presents the basic components of mine area restoration. This handbook focuses on "pit lake development" although its techniques will have applicability for "mineland reclamation" as well.



4.2 Guiding Principles

The following are offered as guiding principles for future in-pit site restoration, redevelopment, and reclamation efforts.

1) **Create landforms and vegetation regimes that mimic those typical of the pre-mining / pre-settlement era.**
    - Apply Ecological Classification System, especially at the Native Plant Community level, to determine desired land form and vegetation communities.
2) **Maximize amount of functional littoral area.**
    - In the aquatic zone this is generally interpreted as water less than 30 feet deep (the active photic zone).
    - It includes a site-specific amount of upland immediately adjacent to the anticipated lake level.
3) **Create upland areas capable of supporting functional forests that can sustain productive management and harvesting.**
4) **Take fullest advantage of current mining activities to help shape the future landscape.**
    - Maximize future applicability of actions taken today.
    - Emphasize practical solutions.
    - Devise a site design that is within the capabilities of mining equipment typically used for reclamation.
    - Minimize if not eliminate the need for future handling and shaping of materials to achieve desired landscape.
    - Reduce current mine operating costs related to handling and disposal of materials.
    - Do not compromise ongoing mining operations.
5) **Provide locations for ongoing research into site development including material settling and compaction, success in vegetating site, colonization by plants and animals, and vegetation succession.**

4.3 Recommendations

A number of actions are recommended to follow through and fully implement this handbook.

1 / Create the Handbook as an on-line tool.

In keeping with discussion at recent LVP meetings about the strategic planning process, pursue development of the handbook as an on-line tool. Among the objectives of such an effort would be: make the information more readily accessible to practitioners and easier to update, integrate various data resources from a variety of endeavors (e.g., underground

mining maps, surface imagery, mine expansion, community development, pit lake elevation analysis, etc.), and provide location for information on project monitoring.

2 / Establish portfolio of all reclamation projects.

Create an on-line portfolio of all mineland reclamation projects. This would be a readily accessible reference library as well as provide a vehicle for ongoing monitoring.

3 / Encourage research and monitoring of project sites.

Key mineland reclamation projects should have accompanying long-term research to provide information vital to undertaking future projects. Research areas include understanding changing physical conditions (e.g., settling, soil compaction/shifting, evolving drainage and moisture regimes), success in vegetation plans, and plant and animal colonization and succession.

4 /New areas for practical research.

Undertake projects exploring innovation in one or more of these areas for practical applied research:

- Shoreland shaping.
- Wetland creation.
- Upland and aquatic habitat development.
- Vegetation.
- Land slope.
- Understanding soil settlement and structural qualities of overburden and rock piles.
- Creating landscapes to serve transitional uses such as biomass growing sites.
- Understanding vegetation succession on inactive minelands and on intentionally shaped restored mine areas.
- Use of existing mining operations to achieve future landscape goals and reduce mining costs.

Appendix

This appendix contains summaries of the type of reclamation related projects that would be contained in an online portfolio.

A. Peter Mitchell Pit Standards

The following guidelines for creating aquatic habitat in a mine pit lake were prepared by the Minnesota DNR in conjunction with Northshore Mining Company for enhancing aquatic habitat through in-pit disposal of overburden and waste rock at the Peter Mitchell Pit. This plan represents the DNR's current level of thinking regarding the creation of aquatic habitat within current or future mine pit lakes. This information is presented here to indicate how reclamation guidelines are evolving and how they can inform other projects; in this case these standards were used in the (Hull Rust Mahoning) Mine In-pit Shoreland Development Project.

This document describes a component of the mitigation strategy for the loss of the headwater watershed and upper portion of the Partridge River which has been taken by the removal of taconite in Northshore Mining Company's Peter Mitchell Pit (PMP) (a.k.a. Northshore-1 Pit). Due to the un-restorative characteristics of this project, the permit condition (under the current Permit to Mine) has been applied that requires Northshore to mitigate the loss of watershed area impacts under MN Rules 6130.2200 and 6130.4300, subpart 7, item C.

Northshore Mining Company, through their consultant, Barr Engineering, proposed five possible components of a mitigation plan (Barr letter to John Adams, May 21, 2009): 1) Creation of littoral zones within the PMP, 2) Creation of wetlands within the PMP, 3) Evaluation of effects of flow increases on the Dunka River, 4) Evaluation of effects of flow decreases on the Partridge River, and 5) Public access and use of the PMP lake after mining.

As a component of a plan to mitigate the loss of stream channel and watershed, it is proposed that surface overburden and waste rock materials be disposed in the PMP in such a fashion that aquatic habitat will be enhanced when natural water inflow into the pit reaches its ultimate stable water level following pit closure at a future unknown date. Taconite ore production in the PMP is expected to continue until around year 2078. The following assumptions and conditions were used to arrive at the design guidelines:

1. The ultimate water level in the pit will be approximately 1500 feet above sea level (NAVD1929 datum) according to information submitted to MDNR (*Long-Range Hydrology Study: Northshore Mining Company Final Report, November 2008, Barr Engineering Company*).
2. The productive littoral zone for lakes extends to a depth of 15 feet below water surface. However, in mine pit lakes the functional littoral area could extend to a water depth of up to approximately 30 feet below water surface, but will decrease with time as the lake matures.
3. The productive shallow marsh wetland zone will extend to a water depth of no greater than 6 feet.
4. The desirable elevation range of the top of the stockpiles will be between 1515 and 1470 above mean sea level or between 30 feet below and 15 feet above the ultimate pit water level.

5. The desirable slope range of the stockpiles for creation of littoral zone will be between 3 percent and 7 percent.
6. The desirable slope range of stockpiles for creation of shallow marsh wetlands is between 0 percent and 2 percent.
7. The minimum littoral zone in a productive lake is approximately 20 percent of the lake surface area based on the MDNR littoral zone standard comprising of the area of the lake 15 feet deep or less. A sampling of littoral zone area of large lakes in St. Louis and Lake counties in northeastern Minnesota have been found to average 32 percent of the lake surface area (with a range of 20 to 51 percent). The final PMP area will encompass approximately 5350 acres. Estimated future water surface will be approximately 3200 acres. Therefore, target acreage of littoral zone and adjacent/connected wetland areas within the PMP should encompass a minimum of 640 acres (20 percent) (habitat inventory) and maximized to the extent practicable. This acreage is to be based on the MDNR littoral zone standard as stated above. Productive littoral zone is expected to reach a depth of up to 30 feet, but is also expected to decrease with time as the lake matures.
8. Shoreline irregularity, complete with bays and inlets, is highly recommended to enhance aquatic habitat and general aesthetics.
9. The creation of islands is encouraged and will be included in the habitat inventory. Some small islands (less than 2 acres in size) containing bare coarse rock is encouraged for nesting opportunities for ground nesting birds.
10. In-pit stockpiling within the above stated ranges of elevations and slopes is generally feasible along much of the future north shore of the PMP based on material availability and fee ownership distribution. Upon closure, the entire PMP will contain approximately 130,000 feet (25 miles) of shoreline. This would constitute approximately 53,000 feet (10 miles) of potential enhanced shoreline along the north shore of the PMP. The in-pit area north of the north shore (above elevation 1515 mean sea level) will be upland and, therefore, will not be considered as areas where creation of littoral zone and/or wetlands is feasible. Upland areas, containing various stages of plant succession, will assist in providing a constant source of nutrients for the PMP lake. The south shore of the PMP (those areas along the headwall of the pit) may not be suitable for creation of littoral zone due to the depth of the pit and potential future access to minerals. However, in these areas of potential excessive depth in the pit, the company will be encouraged, where possible and after consultation with MDNR, to fill with excess pit material to achieve a less deep area. This activity should not encumber future mining potential and may be considered a form of mitigation.
11. The south final pitwall slopes consisting of glacial overburden shall be designed and constructed consistent with MN Rules 6130.2900 and 6130.3600. These may include certain pitwall areas that would normally be exempt due to pre-MN Rules 6130 establishment or non-Northshore impact. Due to the potential of future PMP lake recreation, pitwalls should be safe, stable and aesthetically pleasing. Laying pitwalls back (beyond what will be required by MN Rule) may be a form of mitigation.

12. Flooded timber and existing organic debris has been found to have great potential at jump-starting abandoned mine pit biological productivity and enhance subaqueous habitat. Herbaceous vegetation and tree growth will be encouraged for stockpile areas that will eventually be below water surface (1500 – 1470 mean sea level), in addition to those in future upland areas. This condition (for vegetating stockpiles/slopes that will eventually be below final pit water surface) is above and beyond what is required per MN Rules 6130.3600, subpart 1, item K.
13. Since the aquatic enhancements proposed for the PMP lake is intended to increase biological productivity and public value, it is likely that this enhanced resource will attract public use in the future. Therefore, adequate public access to the PMP lake should be part of the development plans and design. These access points should be in accordance with local preferences and consistent with the public access standards of the time.
14. The final reclamation plan could consist of modifications to include areas for spawning habitat specific for target species as well as introduction of native aquatic plant species based on the lake management plan goals.

B. Land Design for Taconite Mining: A Land Shaping Workshop

In 2009 over 35 mine engineers from local iron ore mining companies (e.g. Minntac, Keetac, Hibbtac, United, Arcelor Mittal, Northshore) attended a workshop entitled Land Design Opportunities in Taconite Mining. The course presented concepts and exercises about land shaping and tools for planning short and long term end uses. Participant evaluations indicated that the course was extremely successful in demonstrating how creative land shaping, planting and planning for future land use scenarios can meet current applicable permits and laws, enhance the appearance of the landscape and improve company image

The workshop was sponsored by the Iron Ore Cooperative Research Program, Iron Range Resources & Rehabilitation Board, and Hibbing Community College. Instructors were: Tony Bauer, FASLA; Christine Carlson, Senior Fellow/Adjunct Faculty, University of Minnesota; and John Koepke, Associate Professor, University of Minnesota.

Course Objectives:

- Demonstrate relationships between mining, deposit features and land design.
- Practice the concept of sequential mining and land design.
- Explore how current mining practices and reclamation standards can integrate land design practices.

General Course Structure:

- Day 1: Topics & Tools
    - Context & theory
    - Approaches
    - Case Studies & examples
- Day 2: Time
    - Site applications & practice
    - Discussion

Course Outcomes:

- WHAT: Maximize land shaping/development opportunities during the mining operation.
- WHERE: Employ suitability and character analyses in end use planning.
- HOW: Use natural landscape character and design devices as frameworks for land shaping.

C. Project Example 1 / UTac Highway 53 Corridor Stockpile

This project redesigned a stockpile within the Highway 53 corridor near Virginia. Its objectives were to: reshape the stockpile into a positive community and company resource; explore use of design devices to improve appearance; and explore on site moisture retention techniques.

Because of its location within a heavily traveled corridor, the project stressed visual elements:

- *Landform silhouette*-most visible most of the time -against sky and manufactured backdrops
- *Horizontal surface pattern*-benches
- *Flatness of planes* -frontal and longitudinal surfaces
- High contrast with natural and cultural landscape

The project then examined a number of regional landscapes as the basis for a design template that drew upon the following concepts:

Nature the Designer

- Measure of physical features based on quantified dimensions
- Prototypical landscape features and patterns to mimic local character
- Location
- Spatial arrangement
- General form
- Profile, surface geometry and measurement
- Applicable to mine perimeter

The following figure is one of several that were prepared to present possible land shaping and vegetation schemes for the site. It is offered here to illustrate the concepts of the project site.

Source: University of Minnesota

D. Project Example 2 / Hull Rust Mahoning Mine In-Pit Shoreland Development

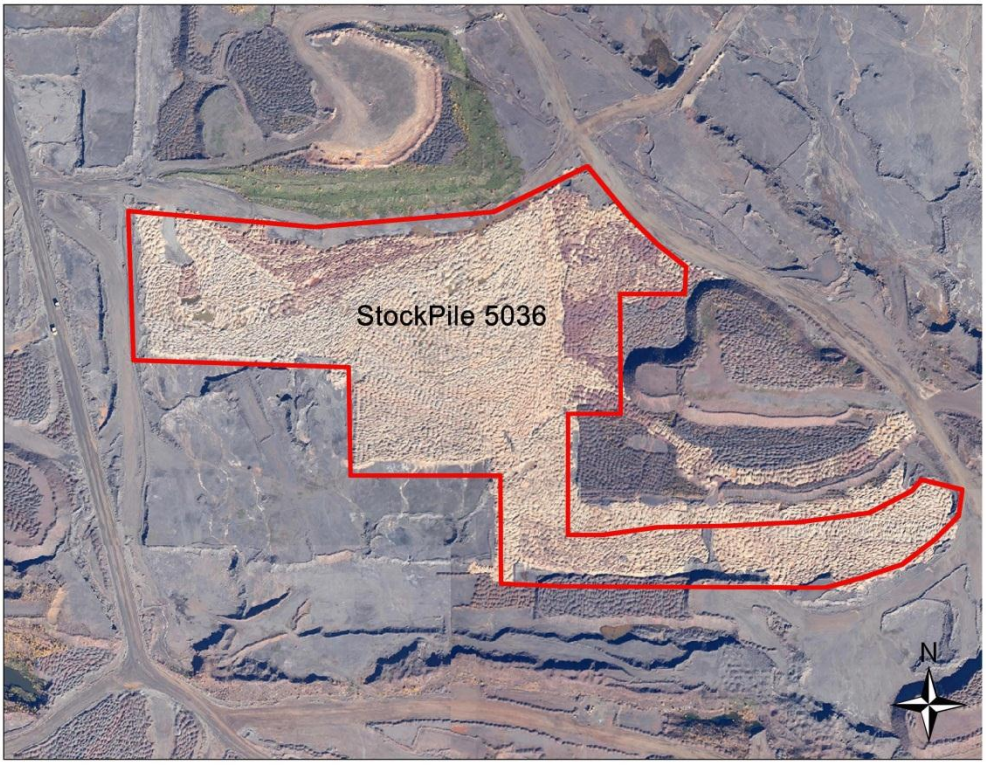
The Pit Lake Littoral Zone and Associated Upland Development Project was a first-of-its-kind undertaking intended to develop practical and replicable practices to use current mining activities to shape the future aquatic and upland landscape of the Mesabi Iron Range. The project took advantage of ongoing mining activity, in this case the relocating of stockpiled mine overburden at Hibbing Taconite (HibTac), to shape future aquatic, shoreline, and upland areas.

As the project unfolded **it became an experiment to recreate, within limits, the historical terrain and vegetation of the Laurentian Divide.**

The project's base objective was to develop practical and replicable practices to use current mining activities to shape the future aquatic and upland landscape of mined areas of the Mesabi Iron Range. As the project progressed a set of more detailed objectives emerged that can serve as guidelines for future similar reclamation efforts.

1) Create landforms and vegetation regimes that mimic those typical of the pre-mining / pre-settlement era.
2) Maximize amount of functional littoral area.
3) Create upland areas capable of supporting functional forests that can sustain productive management and harvesting.
4) Take fullest advantage of current mining activities to help shape the future landscape.
5) Provide locations for ongoing research into site development including material settling and compaction, success in vegetating the site, colonization by plants and animals, and vegetation succession.

The first of the following figures shows the project site after the overburden material had been hoosier-dumped (a colloquial Iron Range term for truck dumping of material) onto it. The second figure presents the final grading plan for the redeveloped site.



Pit Lake Littoral Zone and Associated Uplands - Stock Pile 5036
Innovation Grant - Hibbing Taconite Hibbing, MN
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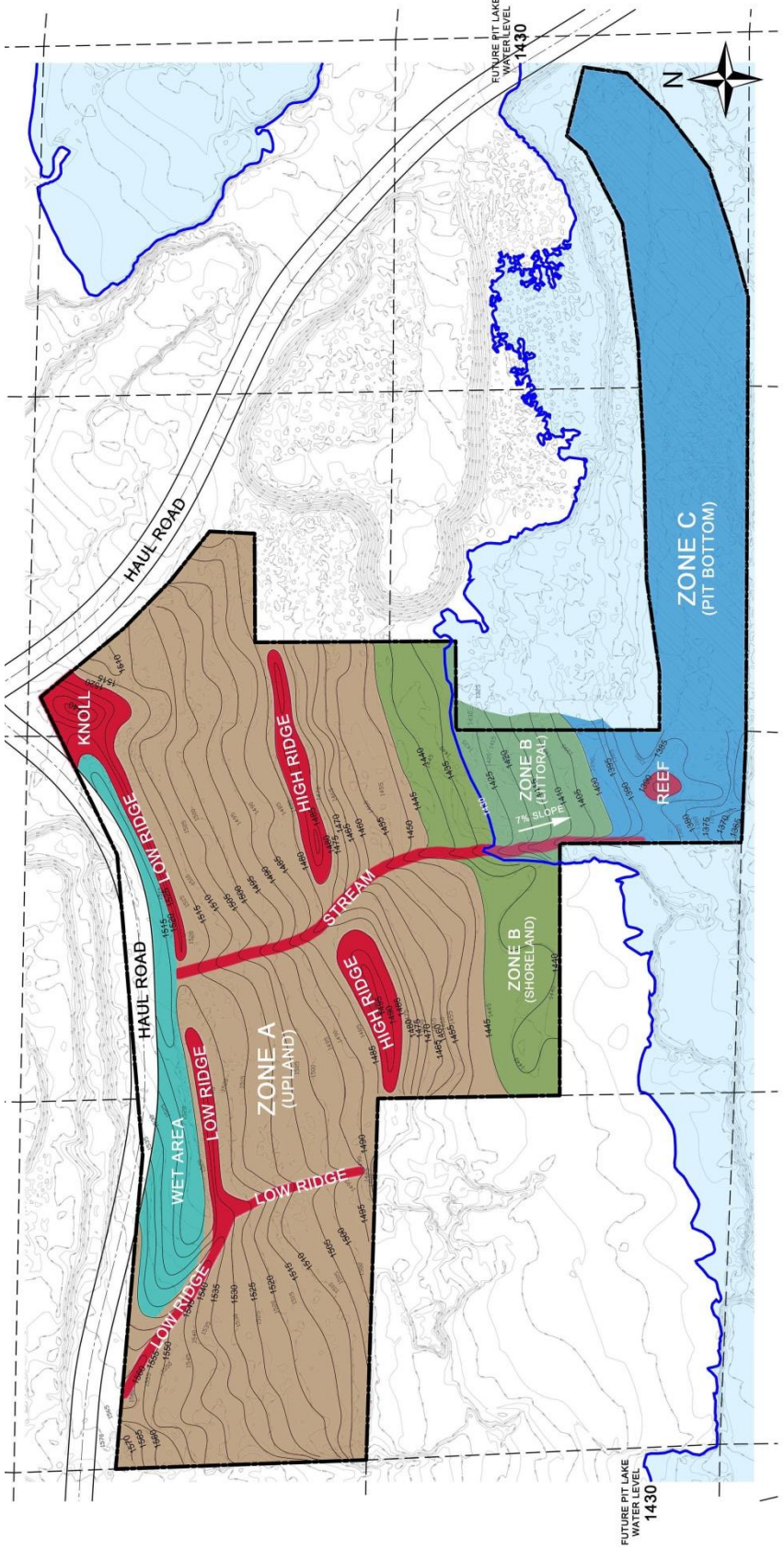

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Stock Pile 5036 - Topographic Features

Innovation Grant - Hibbing Taconite Hibbing, MN