Inhabiting Manufactured Landscape: An Architectural Approach to Minnesota's Post-Industrial Iron Range

by

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Contents

Abstract

Surface mining has created manufactured landscapes all over the world. While often viewed in a negative light as '*scars on the land,*' they are a tangible imprint of humanity's action on the landscape. Through the lens of photographers and artists whose depiction of these industrial manufactured landscapes are simultaneously menacing and celebratory, this thesis aims to showcase the facets of these evocative landscapes which continue to fascinate humankind.

The thesis rejects the standard method of mine reclamation on Minnesota's Iron Range, which is to flood the pit and create a lake. Instead, the manufactured landscape is inhabited by means of a connection between two communities. The insertion of architecture to support a range of programs helps to engage and better understand these sublime and often restricted places.

Acknowledgements

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Most importantly, I must acknowledge my parents, without whom none of this would have been possible. You have always been there unconditionally and supported me in every way possible. Thank you and I love you.

Chapter 1: Introduction

Manufactured Landscape: Observed

Surface mining plays a vital role in the landscapes of North America, be it the economical, political or physical landscape. For decades the mining industry has provided bountiful employment and been a driving force in the world economy. The results of this industry are spread around the globe, taking the shape of cavernous underground chambers and huge craters in the Earth's surface that are often compared to natural wonders such as the Grand Canyon.

However, as time moves forward, the adverse effects of mining have become more apparent, and these sites, grouped together with other manufactured industrial landscapes have come to symbolize the destructive impact humans inflict on the environment. Manufactured landscape is seen as *unnatural* and therefore out of place, a scar on a once pristine wilderness. Reclamation of these sites usually involves language and processes that attempt to 'return to the natural' and emphasis is placed on erasing physical signs of human intervention.

Many scholars, including John Brinckerhoff Jackson, one of the foremost influential writers on landscape interpretation (Pauli 2003, 10), argue that mankind is a part of nature, and therefore the results of our interaction with the land is 'natural' (Jackson1984, 7). By proposing to define landscape as a composition of human created spaces on the land, we can view these 'manufactured' landscapes through a different lens and appreciate their awe-inspiring characteristics, many of which are valued as positive attributes in the 'natural' landscape (Jackson 1984, 143).

For more than a century, painters and artists have realized a fascination of manufactured landscape exists and have portrayed these scenes in their works. This work often demonstrated the sublime features of these landscapes and served as a documentation of human's ability to shape the Earth's surface (Pauli 2003, 18). Edward Burtynsky's work is of particular note, as mine pits are an often photographed subject of his. His photographs serve more as emblems of our time then as a call for social action. He describes these pits as an organic architecture created by our pursuit of raw materials and is fascinated by how technology has inadvertently created sublime landscapes (Pauli 2003, 22).

Manufactured Landscape: Applied

This thesis applies this altered method of observing manufactured landscape and examines methods of inhabiting and utilizing it to connect two communities on northern Minnesota's Iron Range. Discovered in the mid 1800s, the area quickly boomed into the largest supplier of iron for the production of steel in the United States (Marsden n.d., 3). Mines were created along the iron vein and towns were constructed beside the mines to house workers. Production peaked in the 1960s, while today only a handful of operations remain.

Once mining operations have ceased, the standard method of reclamation used on the range is to flood the pit, forming a pit lake. These lakes are an attempt to return the site to nature, an erasure of human involvement in transforming the land. Unfortunately, they often remain inaccessible and elicit none of the phenomenological characteristics of mine pits.

An alternative method of post-industrial use is proposed for the Thunderbird mine pit, one which will preserve and enhance the characteristics of the mine pit, while creating a connection and community hub between the towns of Virginia and Eveleth.

By giving the public access to the pit, creating a network of trails that descend into the pit, and placing program within it, the public can experience the pit in ways never before possible.

The end result is an integrated system that better connects Virginia, Eveleth and the Thunderbird mine. The colossal crater is maintained, showcasing its vast size as a testament to human will and ingenuity while the pit form is utilized to create inhabited spaces which serve both communities.

Collage exploration of potential use of the Thunderbird mine pit

Chapter 2: Landscape Revisited

[Un]Natural Landscape

The term "*scars on the land*" is a common descriptor when discussing industrial or manufactured landscape. This is of course a negative term, meant to demonstrate that human actions have degraded the '*natural*' landscape. Scenes of oil refineries, barren forests, mines and industrial waste sites are synonymous with the global climate crisis, and indeed, they can have devastating effects on the Earth and its ecosystem. However, this may not be the only lens in which to view these landscapes through.

Manufactured landscapes are usually viewed as 'unnatural' because they were altered by human. I would like to argue that humankind is itself part of nature, to the same extend as wind and water. When water crashes against a stone outcrop, the rock is ever so slowly eroded away. This erosion is, and has always been, viewed as a natural process (Jackson 1984, 12). Some termites build massive mounds with diameters that reach up to 30 metres. A complex system of tunnels and conduits serves as the ventilation system for these underground nests (Pennisi 2015, 596). These mounds have an enormous effect on the land they occupy, yet their creation is considered the natural result of termites inhabiting the land. Can the same not be said for the inhabitation of humans on the land?

Defining Landscape

In *Discovering the Vernacular Landscape* John Brinckerhoff Jackson delves into the origins of the word landscape and suggests it was originally used to describe a composition of human made spaces on the land. In this context,

landscape is not a natural feature of the environment but rather a systematic space overlaid on the Earth's surface and functioning not according to natural laws, but rather to serve the needs of a community (Jackson 1984, 8).

Fields south of Pheonix, Arizona as seen from above (Google Maps, n.d.)

J.B. Jackson speaks of a new type of landscape that we are learning to see, those of large-scale organizations of human made spaces. He gives the example of the mosaics of irrigated land, especially those in the western states like Arizona or Utah that stand out in contrast to the pale dessert backdrops. By no means are these new landscapes, but rather landscapes that require a certain viewpoint to fully comprehend. While passing through at eye-level they are hard to interpret. The proliferation of air travel, and more recently, satellite imaging services such as Google Earth has given us a unique aerial perspective to fully understand the composition of the fields and to perceive them as units, with varying textures, colours and shapes. Jackson advises that we recall the definition of landscape as an organization of human created spaces, and the artist's eye interprets that into a landscape (Jackson 1984, 141).

Manufacturing Fascination

Regardless of one's personal beliefs regarding the impact of industrial activities on the land, we cannot deny that humans are fascinated by these industrial landscapes. The term 'manufactured' is often applied to them, signifying the fact that they were created by humans. The word 'manufactured' also carries connotations of production on a large scale, and it is perhaps this notion that creates such a sense of awe (Pauli 2003, 10). It speaks to the triumph of human ingenuity over nature. That we have discovered ways to cut through solid rock is only a small factor of this fascination.

The true amazement lies in the tenacity of workers, removing relatively small amounts of material year after year for decades, creating something that seems beyond the realm of human creation.

Altered Landscape in Art

Consequences of pipeline to the landscape, 1869; photograph by Carleton Watkins (Pauli 2003, 18)

This fascination with altered landscape is not a new phenomenon. Painters and photographers have explored the manufactured landscape for decades. As early as 1871, a series of photographs by Carleton Watkins of the North Bloomfield gravel mines in Nevada County, California drew crowds. This series of photographs displayed two seemingly competing narratives, as some pictures showed industry comfortably enveloped in nature, while others such as *Malakoff Diggins, North Bloomfield*, displayed the turmoil a pipeline created on the landscape (Pauli 2003, 18).

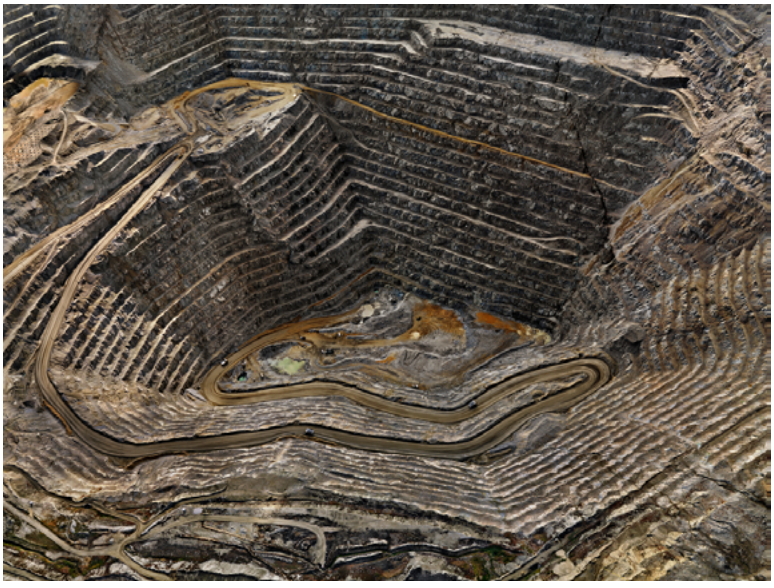
In 1909 George Bellows painted *Pennsylvania Station Excavation* which depicted the colossal hole that had been

George Bellows, *Pennsylvania Station Excavation*, 1909 (Pauli 2003, 18)

dug in the middle of Manhattan, the largest human made hole ever dug at the time (Pauli 2003, 18). Dubbed “a homegrown Grand Canyon”, the pit drew in visitors from neighbouring states who came to marvel at this engineering feat. The painting depicts a very industrial scene, with smokestacks, cranes, and rail carts and uses tiny human figures to demonstrate the immense scale of the excavation. While the scene is both threatening and triumphant, it showcases human’s ability to make marks on the land (Pauli 2003, 19).

A sincere interest in the industrial scene is demonstrated in many photographs and paintings from the 1920s and 30s. Works by William Gropper, Charles Burchfield, Edward Weston and Margaret Bourke- White all showcase modernist fascination with factories, assembly lines and mines (Pauli 2003, 18).

The large colour photographs of Edward Burtynsky have become strongly associated with manufactured landscape.



Edward Burtynsky, *Highland Valley #8*, 1998 (Pauli 2003, 69)

His portrayals of humanity's imprint on the environment take us to places where human activity has significantly reshaped the surface of the earth. Burtynsky consciously avoids defining his work in terms of moral or political implications. His interest is anthropological, and attempts to document human's ability to affect the landscape in our pursuit of progress than a diatribe against industry (Pauli 2003, 11).

Thesis Question

What if, by viewing manufactured landscape and the inhabitation of humans on this land as a natural process, architecture is used to inhabit and maintain the phenomenological experiences of a post-industrial Iron Range Mine?

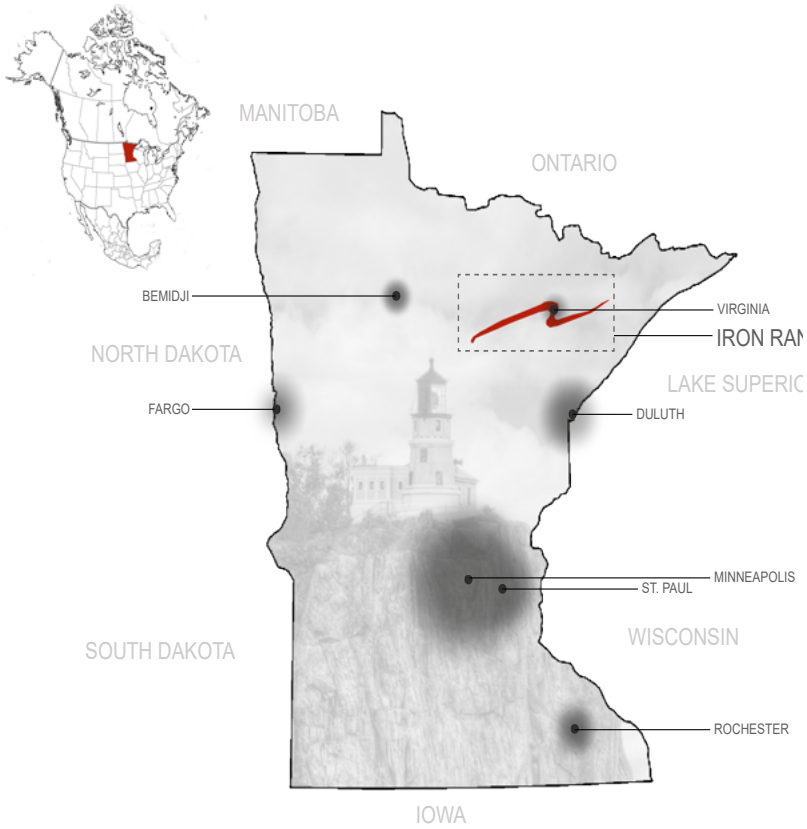
Chapter 3: Minnesota's Iron Range

Discovery of Iron Ore

The discovery of Iron Ore in Minnesota can be attributed to the discovery of gold in Lake Vermillion in the mid 1800's. While very little additional gold was ever discovered, large amounts of iron were noted (Havighurst 1958, 52). Initially ignored while in search of far more valuable gold, miners soon turned their focus to iron when gold was only found in small amounts, embedded in quartz (Havighurst 1958, 54). A systematic search for ore began in 1875 (Marsden n.d., 3). Early exploration led to the discovery of low-grade ores, but the technology to extract the iron from these minerals did not yet exist. On November 16, 1890 the first high grade ore was discovered near what is now the town of Mountain Iron. This set in motion a flurry of exploration and soon after high grade iron ore was discovered near the towns of Biwabik, Hibbing, Virginia, Eveleth, and McKinley (Marsden n.d., 3).

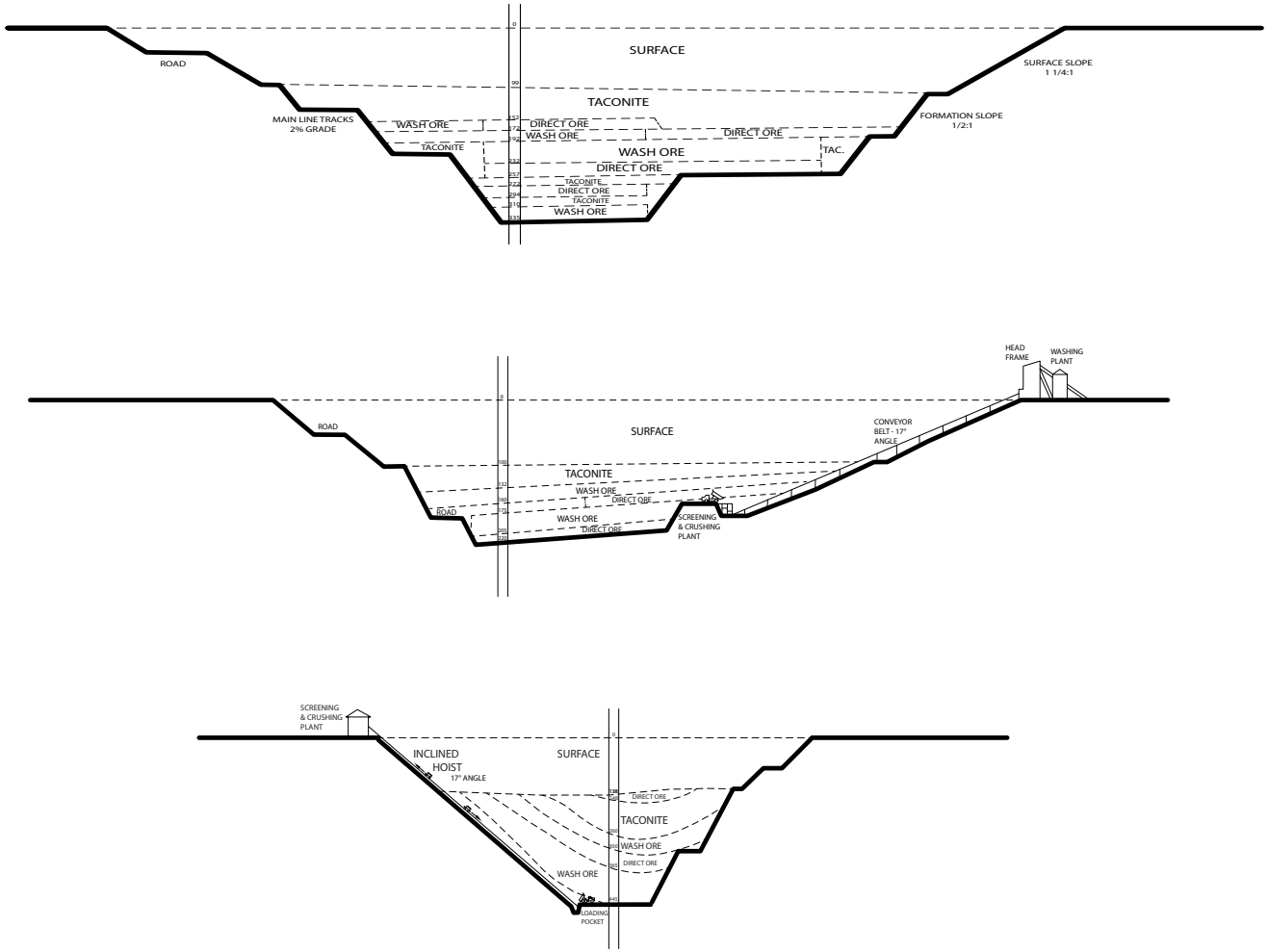
These discoveries led to a period of blistering development. By October 1892 the Duluth, Missabe & Northern Railroad was completed which connected the Mountain Iron pit to the port of Duluth, on Lake Superior (Havighurst 1958, 67). Between 1891 and 1900 the range produced over 43 million tones of iron ore. In the following decade, production increased to 208 million tons, and between 1940 and 1950, over 650 million tons were produced (Marsden n.d., 4).

One of the factors which allowed for this rapid development was the switch to open pit mining. While the original mines of the range used a method of underground mining, large scale open pit mines soon became the norm as mineral



Map of Minnesota showing the location of the Iron Range in relation to key cities and bodies of water (base map from Google Maps, n.d.)

Map showing shipping routes and final destinations for iron ore mined in Minnesota (base map from Google Maps, n.d.)



Cross section of three mine pits. The top image shows a pit which was excavated by rail. The middle image show a pit which was excavated by conveyor belt and the bottom image was excavated by inclined skip hoist. This demonstrates how advancing technology allowed for deeper pits which consumed less surface area.

extraction could be achieved at a much higher rate (Marsden n.d., 5).

The first open pit mines used steam powered locomotives on a rail haulage system. This system results in a very large mine pit as trains can only operate on a maximum 3% grade. Though widely used in the beginning, rain haulage is impractical once the pit reaches a depth of 200 feet. To reduce the length of excavation track and the size of the pit outside of ore boundaries, truck haulage was developed. Trucks are able to operate at slopes of up to 10% and one mammoth truck is capable of carrying 50 tons of material (Marsden n.d., 8).

Two additional methods of extraction have been used to allow for deeper pits that cover a dramatically reduced surface area. The conveyor belt was first used in 1932 and operated at a 30% slope, while the skip and hoist method could be used on even steeper slopes and created pits that were over 500 feet deep (Marsden n.d., 11).

Range Towns

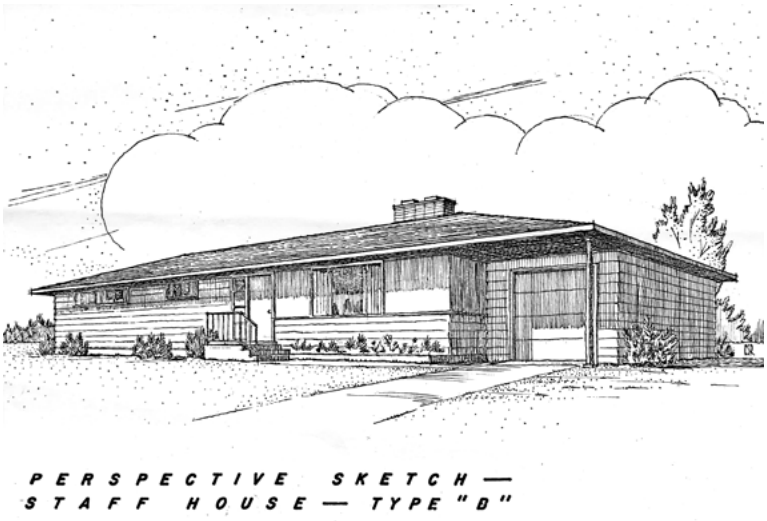
As production on the Iron Range rapidly increased, so did the need to house workers. Most of today's Range towns began as mining locations. Mining locations were temporary or semi-permanent urban places with the sole function of housing miners. The first ones were established by the miners themselves, with later ones being established by the mining companies (Hoagland 2010, 57). These locations were often larger and contained some amenities, such as a saloon or a brothel (Havighurst 1958, 79).

Small incorporated towns started to develop. Dr. Paul Landis noted that these towns were emblematic of the

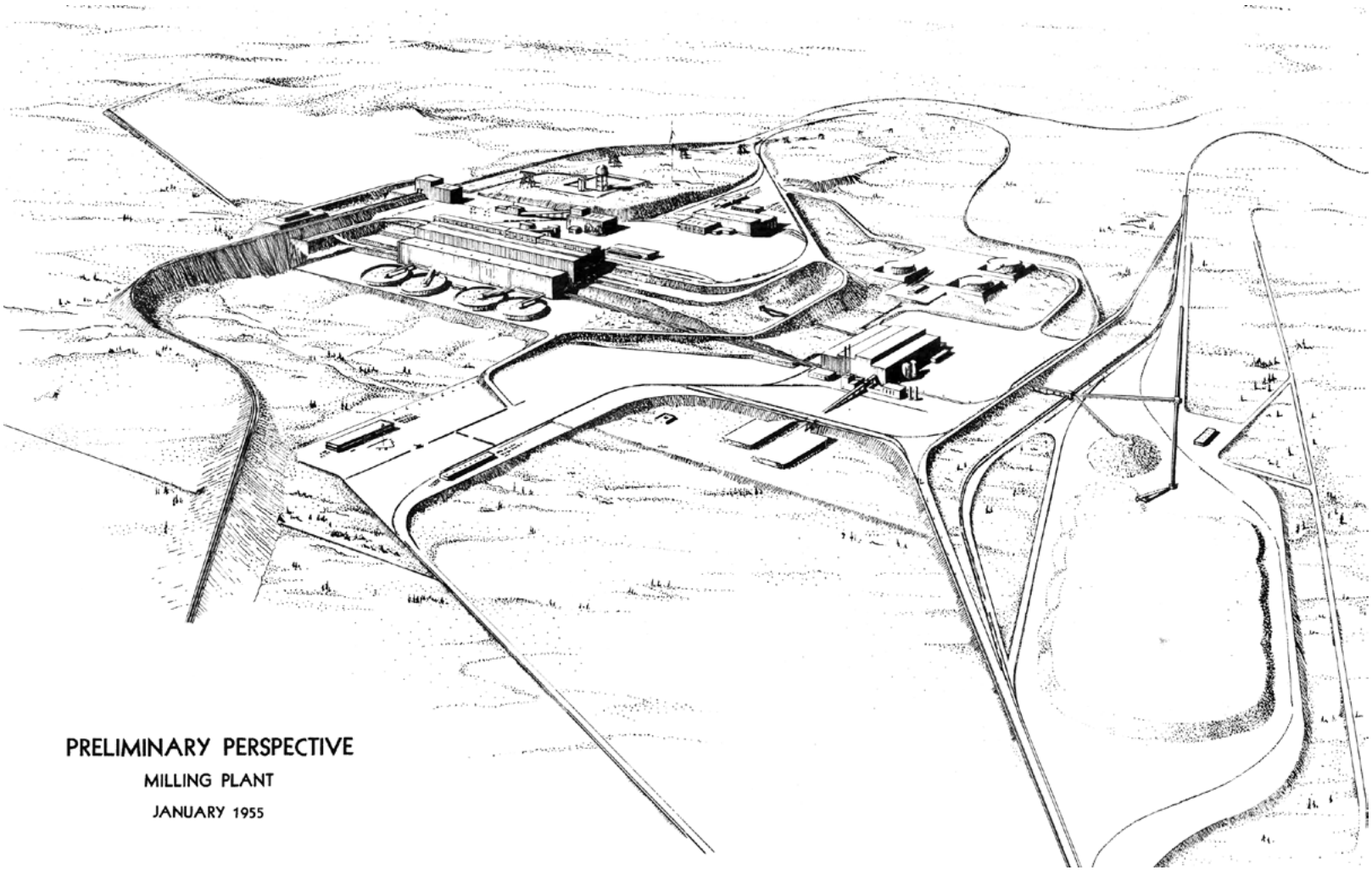
western frontier, with large male populations, few children and a high tolerance of prostitution, gambling, drinking and fighting. A main street was usually established, as well as some sort of central city government (MAGE 2014).

When a particular source of iron ore was established as long-term and profitable, these towns grew to small mining-oriented cities characterized by urban growth and a gradual decrease in the frontier qualities of the town. As the urban place matured, the male-to-female ratio shrunk, as couples and eventually families moved to area (MAGE 2014).

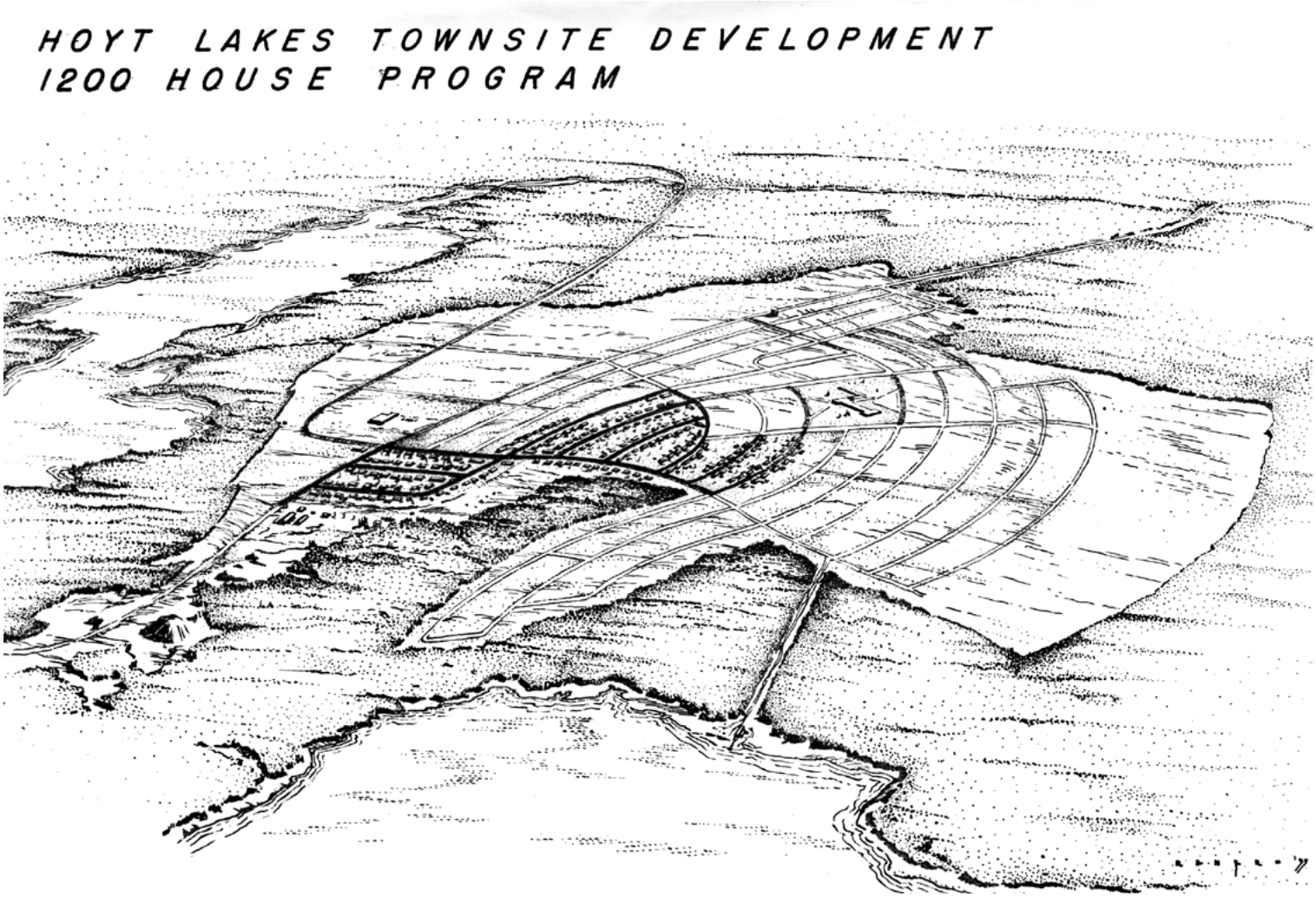
Some range towns developed in a more traditional way, located close to working mines, but not actually developed by the mining company. Other towns were purpose built by mining companies, like the city of Hoyt Lakes. Located on the eastern end of the Range, Hoyt Lakes was developed in the 1950s to house workers of the new Pickands Mather mine located north of the new town (Havighurst 1958, 179). A



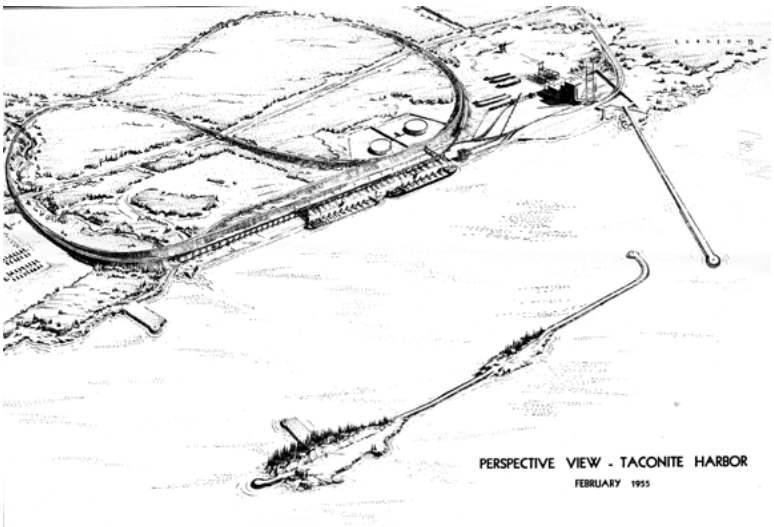
Perspective sketch of an example staff housing offered in Hoyt Lakes (Taconite Contracting Corp. 1955, 5)



Perspective view of the new milling plant constructed by Pickands Mather north of the new town of Hoyt Lakes (Taconite Contracting Corp. 1955, 3)



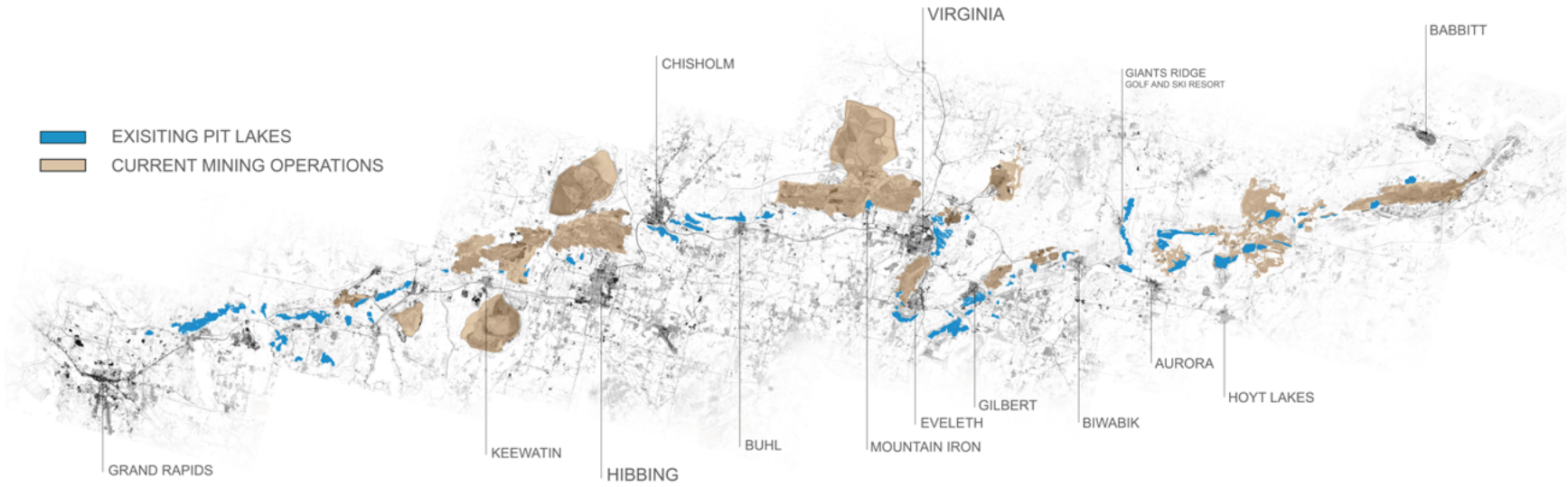
Perspective view of the town of Hoyt Lakes built by the Pickands Mather mining company to house workers of the new mine. The first residents moved into the town in 1955 and were referred to as “mudders” (Taconite Contracting Corp. 1955, 4)



Perspective view of the proposed Taconite Harbor on Lake Superior, terminus of the new railroad built (Taconite Contracting Corp. 1955, 6)

new railroad was built to connect the mine to a new harbour, called Taconite Harbor, on Lake Superior 73 miles away. The town was designed to have 1200 houses and a population of over 5000 people. Two and three bedroom homes were offered in 15 different variations of styles. Larger houses on prime corner lots were reserved for company management. Four churches, a post office, two schools and a mall were constructed to serve the town (Havighurst 1958, 181).

Today, the Range has three urban hubs: Grand Rapids in the west, Hibbing and Virginia in the east. Hibbing is the largest city with a population around 16 000. Grand Rapids and Virginia each have around 10 000 people (Phadke 2018, 165). Smaller towns with populations from 500 to 3000 are linearly located along the narrow vein of iron. Iron Range towns include, from west to east, Grand Rapids, Coleraine, Bovey, Taconite, Calumet, Keewatin, Hibbing, Chisholm, Buhl, Mountain Iron, Virginia, Eveleth, Gilbert, McKinley, Biwabik, Aurora, Hoyt Lakes and Babbitt (Baeten 2018, 247).



Map of Iron Range showing Range towns. Exisiting mining operations are shown in brown, while the blue represents former mining operations that have been flooded to form pit lakes. (base map from Google Maps, n.d.)

Decline of the Range

Natural ores and concentrates were produced until the mid 1950s, when the depletion of high grade iron ores necessitated new processes on the Range. Pelletizing is a process of upgrading the iron ore content through beneficiation, and quickly became the method of choice. By 1960, 85% of production on the Range was in concentrated pellets and a conscious effort was made to conserve the high grade direct shipping ores which could be quickly extracted and shipped without processing in the event of a national emergency (Marsden n.d., 18).

Today, only 6 mines remain operational on Minnesota's Iron Range, producing around 18 million tons annually (Phadke 2018, 169). The towns of the Range have soldiered on, by no means thriving, but certainly still relevant. Rapid population decreases in the 1980's and 90's have plateaued and populations have remained somewhat constant in the past decade (Baeten 2018, 252). While the towns were built so workers could live close to the mine they worked in, today many people in the peripheral Range towns commute to Virginia or Hibbing to work in sectors such as health care and manufacturing (Baeten 2018, 253). While no longer the primary source of employment, mining still plays a vital role on the Range and new proposals to mine nickel and copper have strong support.

Current Post-Industrial Use

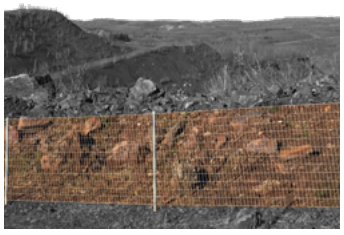
Mining operations on the Range use a typical method of handling mine pits no longer in use. Once mining operations have ended the pit is flooded to create a pit lake. Mining companies often tout these lakes as a tremendous benefit to the surrounding area. They claim that the pit lakes will

mimic the beauty of natural lakes and can be utilized for recreational activities such as canoeing, kayaking, scuba diving and fishing. Indeed, some pit lakes are stocked with trout, such as Miner's lake in Ely (Baeten 2018, 253). Unfortunately, pit lakes often do not resemble their natural counterparts. Access to these lakes is limited as overburden piles often remain around the perimeters. Many are located on sites that are still owned by the mining companies, and while mining may not be ongoing in that particular area, the entire property is fenced off and restricted to the public.

Edge condition of Rouchleau Pit Lake, Virginia, Minnesota

Another barrier to utilizing the water's surface comes from the steep walls which surround most pit lakes limiting access to canoers and kayakers. The process of open-pit mining usually results in a large roundish hole. When flooded to form a lake this does not create interesting edge conditions. Unlike a natural lake whose organic shape can hide and reveal inlets, rivers, and additional places to discover, a pit lake reveals itself all at once and does not allow for continued discovery. When one considers that the Boundary Water's Canoe Area is located only 35 miles north of the Range, it is hard to justify the use of pit lakes as a recreational haven. The boundary Water's Canoe Area is a 1-million-acre wilderness area within the Superior National

Edge condition of Hill Annex Mine, Calumet, Minnesota



Fence preventing access to Rouchleau Pit Lake site, Virginia, Minnesota

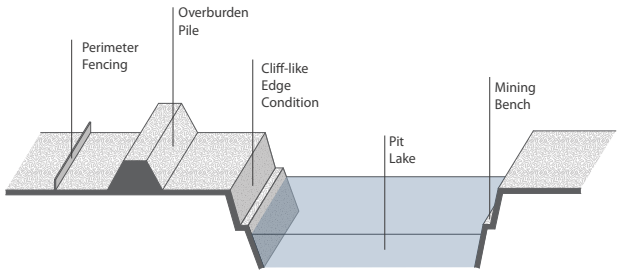


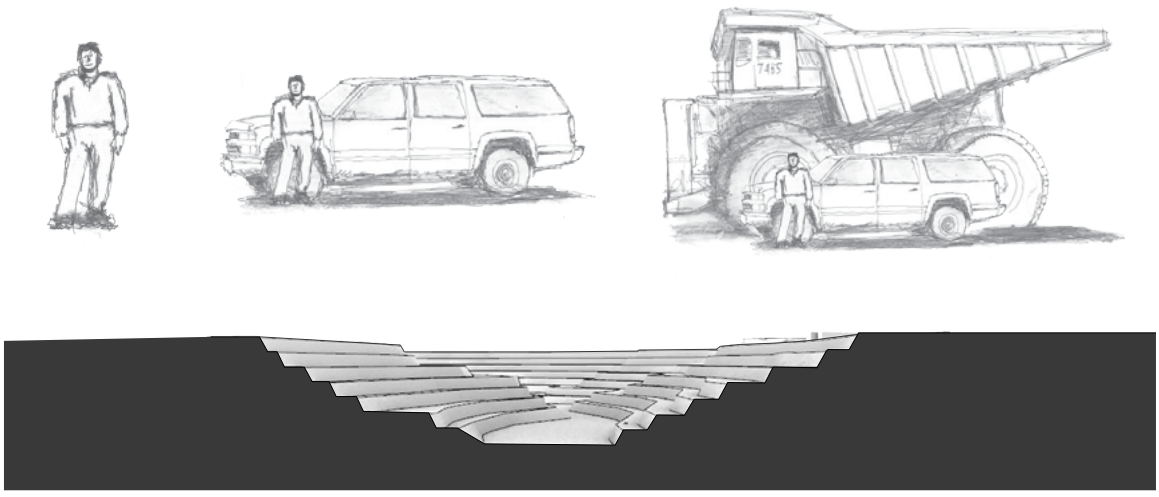
Diagram showing barriers to post-industrial pit lake access

Forest. It contains over 1100 interconnected lakes and hundreds of miles of rivers and is one of the most visited wildernesses in the U.S (Watson 2013, 601).

Manufactured Landscape Erased

When a mine pit is flooded, the architectural form created by the removal of millions of tons of minerals is erased. The mesmerizing pit form with its integrated excavation ramps, and stepped benches that took decades for humans to create are hidden from perception in one action. The truly phenomenal and sublime nature of the pit is turned into an unremarkable water surface, hiding the unique form stretching hundreds of feet into the earth.

Human fascination by the shear scale of the pit is also altered when it is filled with water. There is a sense of wonder and awe when one looks down into a mine pit and realizes that the tiny shape they see is actually a massive dump truck. A pit filled with water looses that great sense of depth as one can only perceive the lake as existing on one horizontal plane.



Scale study of the relation between human, SUV, Range dump truck and entire mine pit.

Chapter 4: The Thunderbird Mine

Between Two Towns

The selected site is the Thunderbird mine owned and operated by United Taconite. It is centrally located on the Iron Range between the towns of Virginia and Eveleth. In operation since 1976, the currently operating mine processed 5.2 million tons in 2017 (Phadke 2018, 168). Currently there are no plans to end mining in this location, and therefore this thesis looks at a theoretical point in time when mining has ceased at the Thunderbird mine pit.

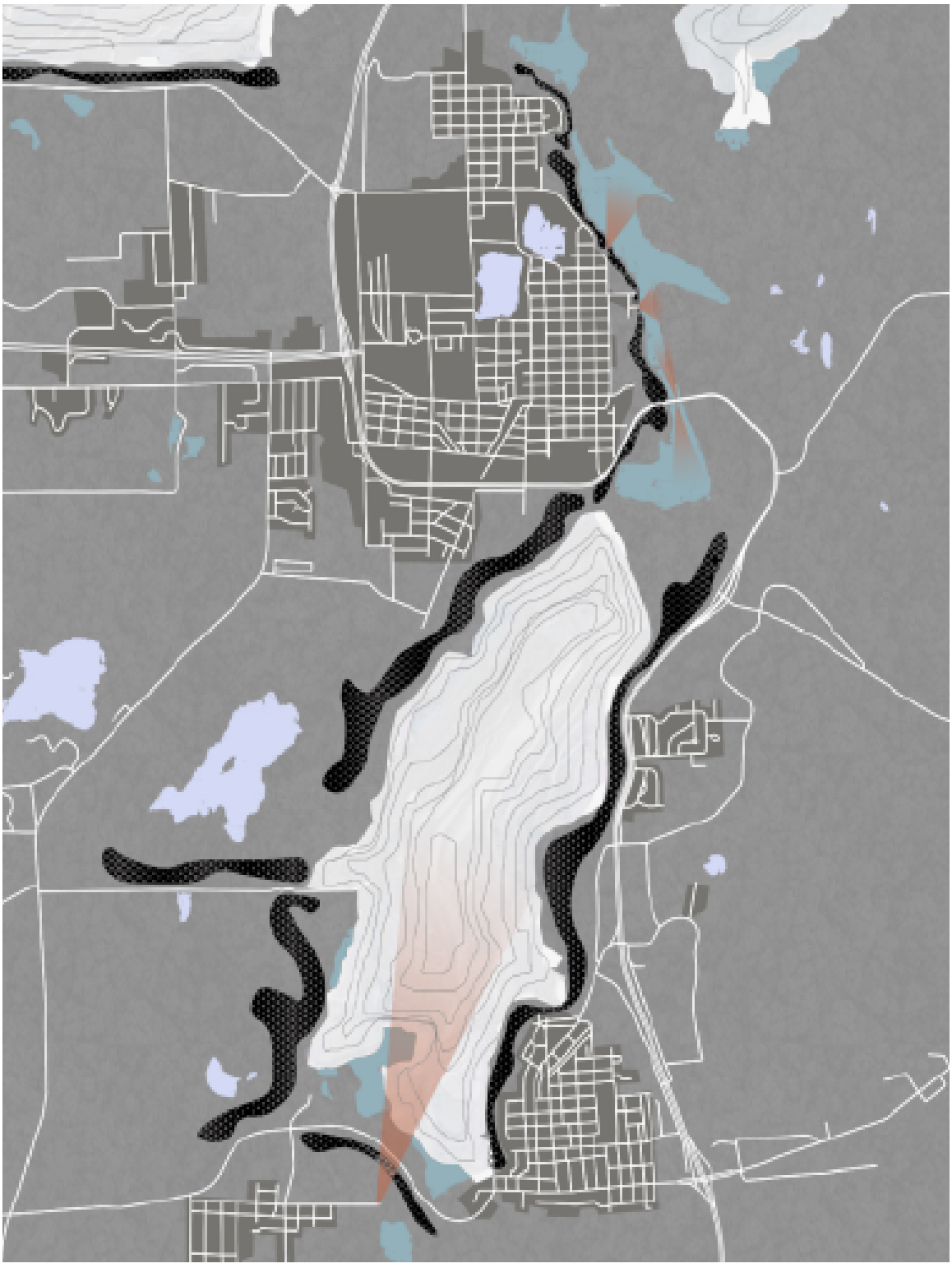
In addition to the mine pit, two adjacent urban areas must be considered. Directly to the north of the pit lies the city of Virginia, one of three hubs on the Range. Once a booming city, the population reached its maximum in 1960 with 14,000 people calling Virginia home. Constant decline since that time has resulted in a current population of 8,400. Today mining plays a much smaller role in the town, and the top employer is the hospital (MAGE 2014).

The town of Eveleth is south of the mine pit. The home of the U.S Hockey Hall of Fame, this small town of 3,500, had a population of over 7,000 in the 1930s (Phadke 2018, 167). Mining plays a crucial role in the history of Eveleth as the town was moved from its original location in 1900 when a mine needed access to the minerals under the town (Marsden n.d., 41).

[Dis]Connection to the Pit

While both urban areas are inextricably linked to the mining industry and to the pits that lie ominously close to their borders, there is a striking disconnect between the pit and the

Map of Virginia (top), Thunderbird mine pit (middle) and Eveleth (bottom) (base map from Google Maps, n.d.)



Map of Virginia (top), Thunderbird mine pit (middle) and Eveleth (bottom). The dark black forms indicate overburden piles while the red indicates view corridors (base map from Google Maps, n.d.).

towns. Part of the mining process involves the removal of the top soil that covers the layers of taconite. This overburden is piled high around the edge of the mine creating a barrier between the urban areas and the noisy operations at the mine. This creates a unique sense of isolation from the mines while in the towns. When one looks at the area from above via satellite images, the towns and the mines seem to be interwoven, each a part of one another. From above it seems like the pits would be a dominant visual feature from many points within the towns. However, this is not the case, demonstrated by the former Rouchleau mine pit, which lies directly to the east of Virginia. Converted to a pit lake after mining operations ceased, this lake is surprisingly inaccessible from the city which surrounds it. Only two small lookout points allow sightlines to the lake, and access to the lake surface is restricted. Similar conditions exist in Eveleth. While the Thunderbird site is positioned along the town's northern boundary, there is not a single point within the town where one can see into the pit. The Leonidas Overlook is about 3 miles to the west of town and offers a partial view of the Thunderbird mine pit.

The view from Highway 53, which connects the towns and runs parallel to the pit is also blocked by overburden piles. As part of a decade's old agreement, the Minnesota Department of Transport agreed to realign Highway 53 when the mine needed access to the minerals under the roadway. To allow for the re-alignment, a new bridge was built over the Rouchleau pit. A very brief glance of the pit can be attained as one crosses the new bridge, the tallest in the state. While it is designated as a tourist attraction, the pedestrian sidewalk that offers one of the only views of

the Rouchleau pit is only assessable by a trail that begins almost 5 miles away from the bridge.

This re-alignment also meant the closing of “Mineview in the Sky,” one of the limited number of overlooks and information kiosks on the Iron Range. When it was open, it gave stunning views of the Rouchleau pit, the Thunderbird pit, and U.S Steel’s Minntac site north of Virginia. Its closure is another example of the diminishing ability to experience these colossal human created chasms and to view an operating mine.

Chapter 5: Design Method

Objectives

As a way to examine the thesis question stated above, 5 objectives have been established for this project.

1. Creating a connection between the towns of Virginia and Eveleth

As highway 53 is the only existing travel route between the two towns, the project will provide alternative ways for vehicles, bikers and hikers to travel from one to another.

2. Inhabiting the Thunderbird Mine Pit

This project must create new programmatic spaces along the new connection. Not simply a way to get from town to town, but to encourage gathering and community activity in between.

3. Encouraging exploration

While mining lookouts currently exist on the Iron range, this will be the first opportunity to not simply view a pit from afar. Access to the depths of the pit must be created and the public encouraged to explore and experience this unique manufactured landscape.

4. Honouring the important role the mine pit has played in the lives of Iron Range residents

Iron Range towns exist because of the iron ore mines such as the Thunderbird. For the most part, its residents either worked in the mines, or for a business designed to support mining operations. This project must aim to keep those ingrained memories alive through both physical and

non-tangible means, once mining has ceased in Northern Minnesota.

5. Maintaining the unique phenomenological aspects of this manufactured landscape

The awe-inspiring nature of this human made crater is lost when the traditional method of post-industrial use is enacted, mainly, filing the pit with water. The project must maintain and display the massive void and unique stepped forms created during the mining process.

Design Tools

Control of Water Level

During mining operations, the pit is continuously pumped to prevent it from filling with ground water. Under normal post-industrial practises, the pumping would completely stop, and the entire pit would naturally fill with water. By determining where the new water level will be, a balance can be achieved which allows for a lake and the recreational activities associated with it, as well as a maintaining the form of the carved-out pit.

The water level was carefully chosen to rest at the edge of a vertical bench, allowing easy access to the water from one of the largest flat areas in the mine. By selecting this bench, as opposed to one higher or one lower, the lake is divided into two sections by the peninsula which juts into the lake at around the midway point. This division creates separation between the paddling course and the general recreational side of the lake, and creates more opportunities to explore and discover.

Use of Materials from Within the Pit

Materials for the project were selected to showcase the unique structural qualities of materials that originate from within the pit itself. Steel and concrete made with iron ore tailings are the primary materials used.

Steel

The production and use of steel was the lifeblood of this region. These mines came into existence as automobile manufacturing and the use of steel as a building material exploded in the United States. For generations, it has been a source of pride for residents of the Iron Range that most American steel originated from the borders of these humble towns. Using steel for this project pays homage to that history and ingrained memory.

The many suspended structures, long spans and elegant curved forms of this project require the strength and versatility of steel, which is especially strong in tension.

Concrete

While steel excels in tension, concrete shows excellent strength in compression. It is used extensively in this project as a heavy grounded element, often used to hold back the heavy earth. Because it is formed and poured on site, it can take on the curvaceous forms that define the built spaces of this project and direct flow through it.

A special type of concrete is used in this project. Taconite tailings, the leftover material after iron ore is separated from the taconite, is used at the aggregate. Every year, mining and processing of Minnesota taconite generates about 125 million tons of tailings. While tailings have been used in road construction in Minnesota since the 1960’s, their use

in construction aggregate purposes has only been studied since the early 2000s. These studies have shown that the compressive strength of concrete with iron ore tailings was 11.56% stronger than those with conventional aggregates. This concrete shows a low potential of corrosion and acid attack due to high pH values of their resulting solution. Since tailings are being produced as a by-product of another process, the cost of production is much lower than for traditional aggregates. It is also a far more environmentally friendly concrete, traditionally a huge producer of carbon dioxide.

Finally, while tailings are produced by separating the iron from the ground rock, trace amounts of iron remain and give the aggregate a red colour. This colour is maintained in the final concrete product and is used as a design element to showcase the unique makeup of this concrete.

Reuse of Industrial Infrastructure

At its core, this is an industrial reuse project. Previous industrial re-use and manufactured landscape projects were studied for applicable design tools, which were then applied to the Thunderbird site.

Gas Works Park

Designed by Richard Haag, Gas Works work was “one of the first post-industrial landscapes to be transformed into public space” (Way 2015, 147). The former gasification plant was closed in 1956. In 1975 the new park opened and while the rusted towers and pipelines of the former plant remained, they could only be observed from a distance, being blocked off for safety reasons. While the public does not have access to this historic infrastructure, the character

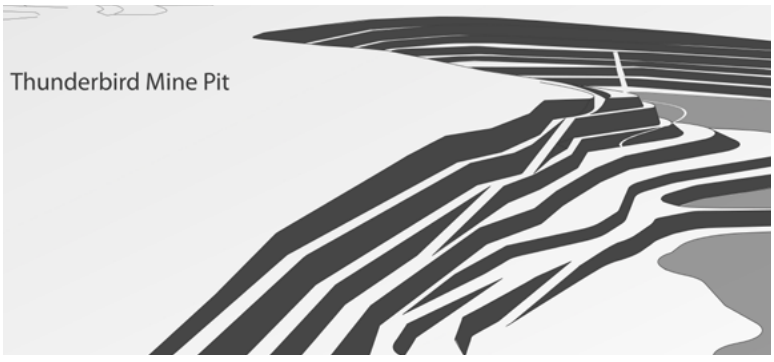
and history of the site has been maintained (Way 2015, 149).

Landschaftspark Duisburg-Nord

Located in Germany, the Landschaftspark Duisburg-Nord is a former steel-works plant which has been transformed into a public park which celebrates the site's "brutal beauty and productive heritage." Unlike the Gas Works Park, the public is permitted to explore and interact with the residual infrastructure, some of which has been repurposed to include a massive concert hall and Europe's largest indoor dive site. At night, a neon light show creates a "sci-fi dystopia' landscape that amazes and inspires visitors (Leppert 1998, 33).

A common design tool in all of these projects is the reuse of the industrial infrastructure. By keeping elements of the original industry, memory of its productive past is preserved and understood in later generations. While the built elements may not be used for their original intent, their form and esthetic are used to develop a design language.

Because processing plants were located off-site, and no buildings were built on the Thunderbird site, the mine may seem at first to have no left-over industrial infrastructure to



Stepped walls and excavation ramps are the residual industrial infrastructure which informs the project's design language.

utilize in this way. However, the residual infrastructure which informs the design language takes form in the shape of the pit itself. The results of industrial operations on this site are in fact the deep chasm, stepped walls, and excavation ramps. The ramps for example, during mining times were used for trucks to haul massive loads of rock from the depths of the pit to the world above. The slope of these ramps allows for them to be repurposed for use by everyday vehicles as part of the path network which traverses the mine.

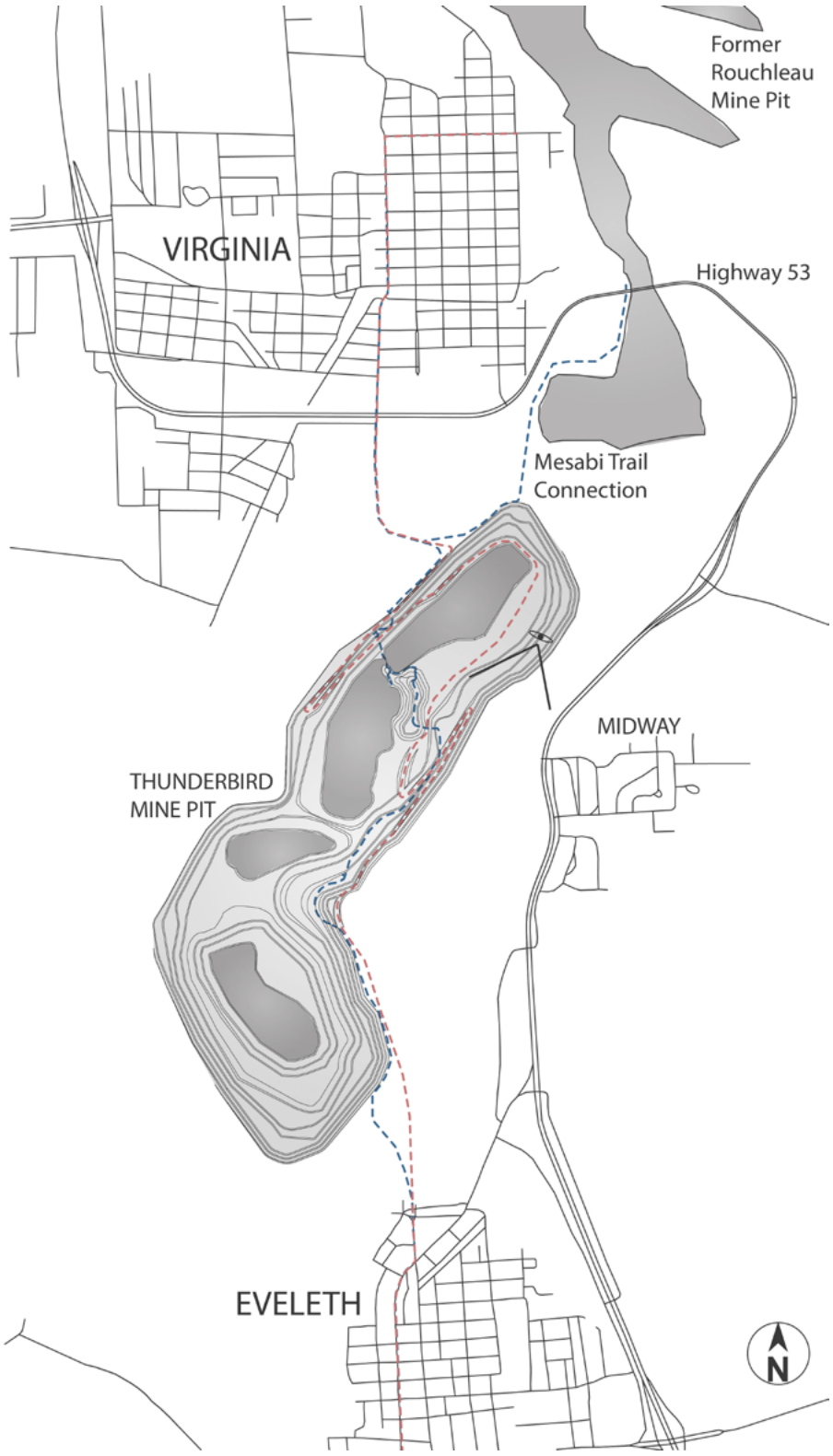
Chapter 6: Design

Connection

The backbone of this project is a connection between the towns of Virginia and Eveleth, created by inhabiting the manufactured landscape which separates the two. This connection not only joins the two towns, but reconnects each town to the mine, which in turn becomes a central gathering hub. While the specifics of various aspects of this connection are discussed later in this chapter, the following is a broad overview of the new connecting system.

The path begins in the heart of each town, its main street. For Virginia that is Chestnut street and South 5th Ave. Chestnut street in particular has the appearance of a frontier town main street. The commercial density of this street spills onto South 5th Ave, where the library and high school are located. Eventually the road transitions to a more residential road, but large trees and elegant light posts make it clear that this is a special thoroughfare. The road currently dead-ends just past Highway 53 and this is where this projects' scenic parkway begins. The connection is made by a vehicular road and a pedestrian path which share a similar directional trajectory but diverge and converge at various places along the route.

As the new path nears the mine, another path converges with it. This is the Mesabi Trail, an existing paved bicycle path which traverses 135 miles of Minnesota's Iron Range, making it one of the longest paved trails in the United States. By tying into this new project, the Mesabi trail will be extended and direct access will be available from Eveleth.



Map showing new pedestrian and vehicular routes connecting the towns of Eveleth and Virginia via the Thunderbird Mine Pit (base map from Google Maps, n.d.)

Once past the overburden piles, the road utilizes the excavation ramps formerly used by dump trucks removing loads of earth from within the pit. The slope of the ramps are shallow enough that everyday vehicles can use them with ease, and through a series of switchbacks, which provide constantly changing views of the mine, the trail reaches the bottom-most bench beside the new lake.

The road continues around the North East banks of the lake before passing beneath the bridge which provides access to the ‘Bump’. It then travels up excavation ramps on the South side of the pit and emerges over the rim beside the Eveleth tower, where it rejoins the pedestrian path. Together, pedestrians and vehicles continue towards the town of Eveleth, eventually joining the main street, Grant Avenue.

Traveling on this new connection will be a public shuttle bus. The bus will stop at several locations within each town and then utilize the new scenic boulevard through the pit to travel to the other town. The bus will stop at all new major points within the pit, allowing those without a vehicle access to these wonderful new programmatic spaces.

Overburden

When a mining operation begins, there is a layer of earth resting above the iron enriched rock. This layer must be removed to access the valuable iron below. The removed material is piled around the perimeter of the mine site. These overburden piles help reduce noise levels from the heavy industrial work occurring in the mine. They serve as a physical and visual barrier between the towns and the pit. To cross these piles and provide access to this pit site, several cuts are made. Curving concrete walls hold back

these piles while allowing pedestrians and traffic to pass through.

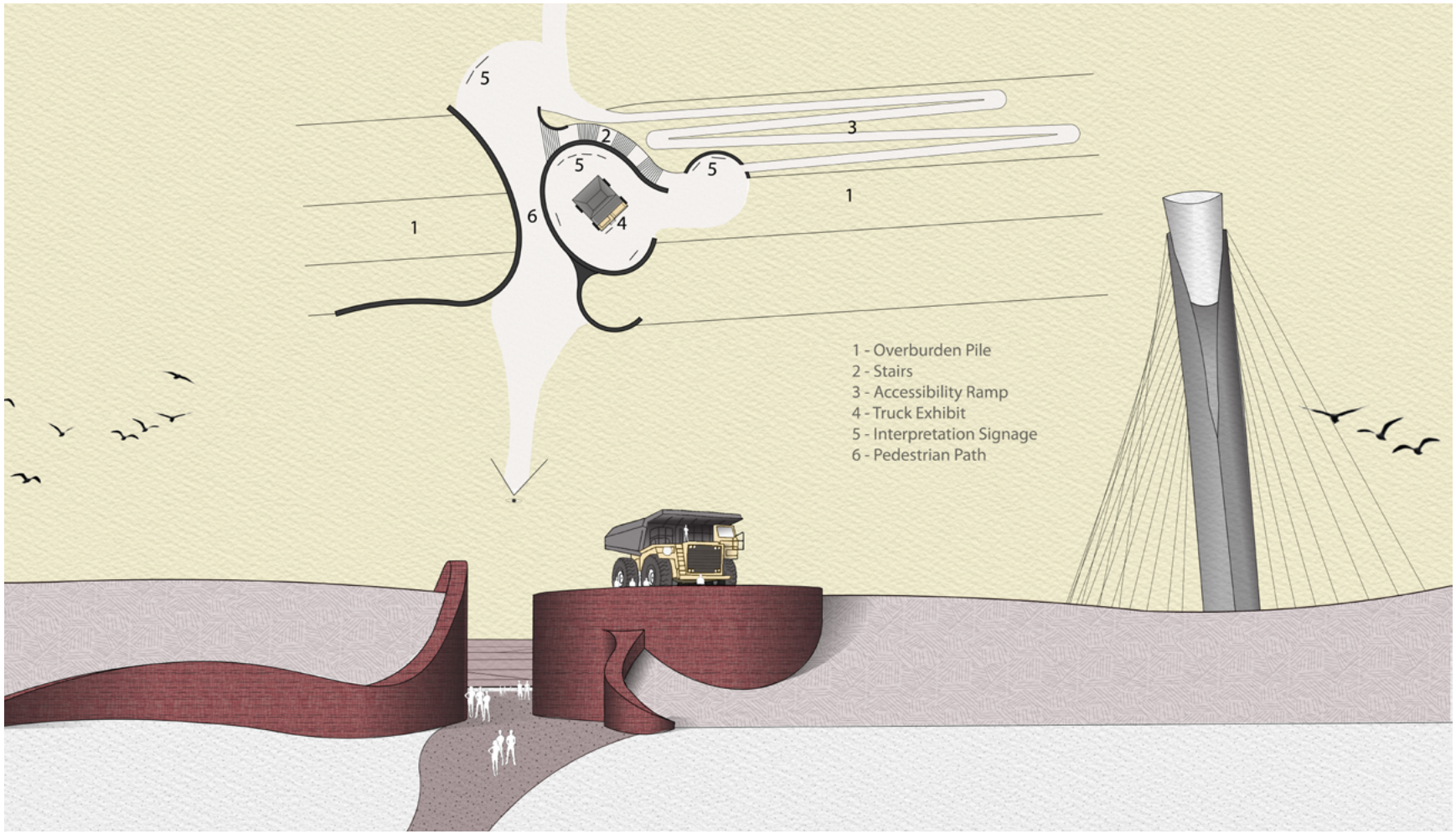
Welcome Centre

Located at an overburden cut, the welcome centre serves as an entrance to the Thunderbird mine site. As one approaches the cut, they can see the architectural language that defines the project. Concrete is used in compression to retain heavy rock and direct flow, and steel in tension, as witnessed by the tower high above. On the right of the cut, the concrete forms an oval platform on which sits a dump truck. This platform, at the top of the overburden pile is accessed via a staircase or an accessible ramp.

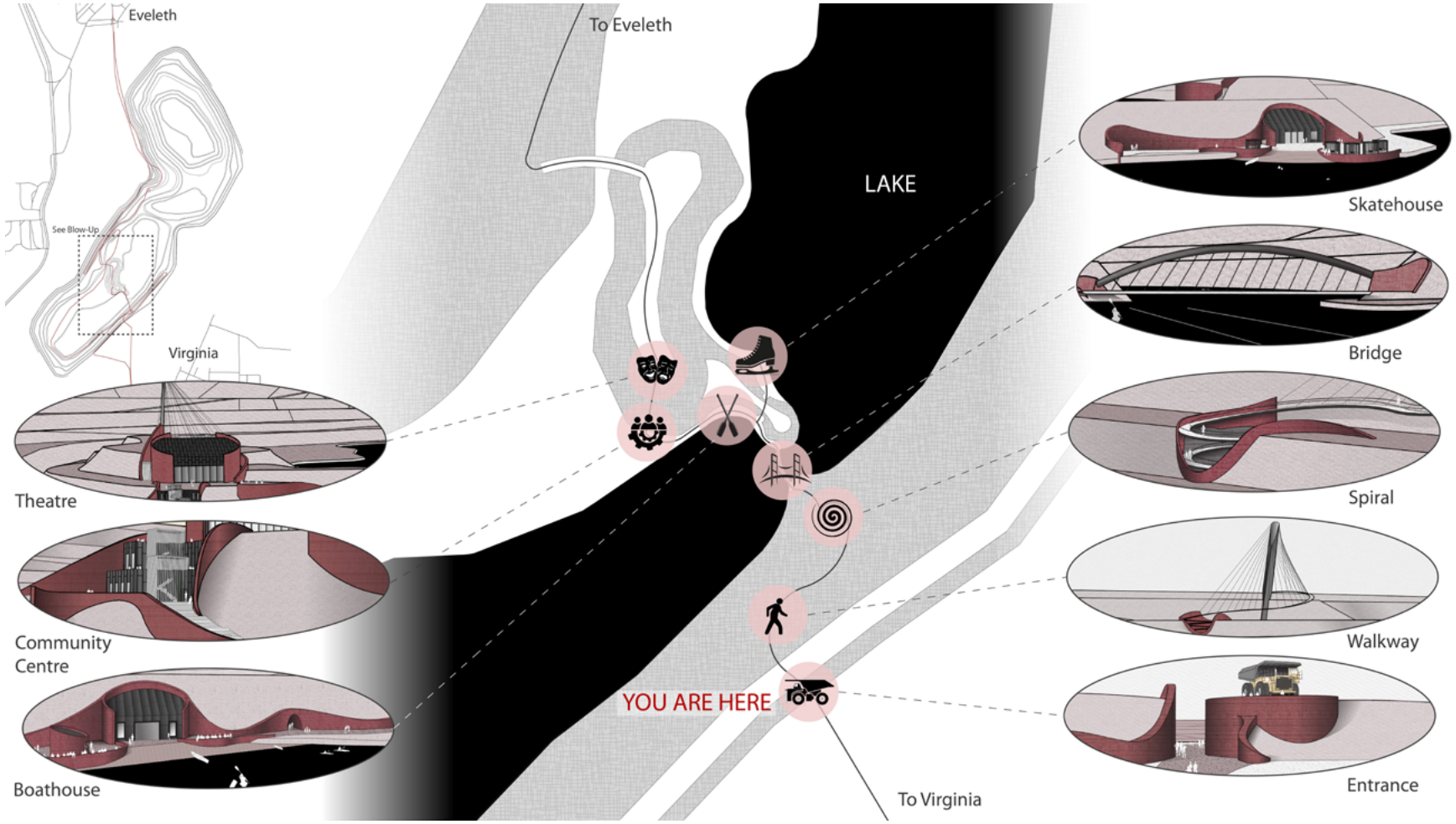
In 2018 when Highway 53 was reconfigured to make room for expanded mining operations, the “Mineview in the sky” display was also closed. This former information centre had interpretive signs, great views of the local mine pits, and a dump truck that visitors could explore. The welcome centre in this project will display that exhibit as well as make that dump truck accessible to the public once again. Being able to get up close to this truck is an important experience, as it is one of the only things to help establish scale. When “Mineview in the Sky” was open, visitors would watch operations in the pit below, and see the tiny yellow dots moving. Only when standing next to the truck and realizing how massive they actual are, can one truly comprehend the size of the pit below.

Towers

While the removal of the entire overburden pile to establish a visual connection between the pit and the towns is not a feasible task, this connection is achieved by use of the



Virginia entrance to the Thunderbird mine site. Concrete walls made from the iron-ore tailings retain the overburden piles allowing access to the site. The steel tower which supports the descending walkway can be seen above the overburden pile serving as a beacon to entice visitors from the town, and create a visual connection to the pit. A welcome kiosk sits on top of the overburden pile, where information signage and a dump truck formerly used within the mine is on display.



Example of way-finding signage displayed throughout the newly created system. This sign is located at the Virginia welcome centre adjacent to the dump truck display.

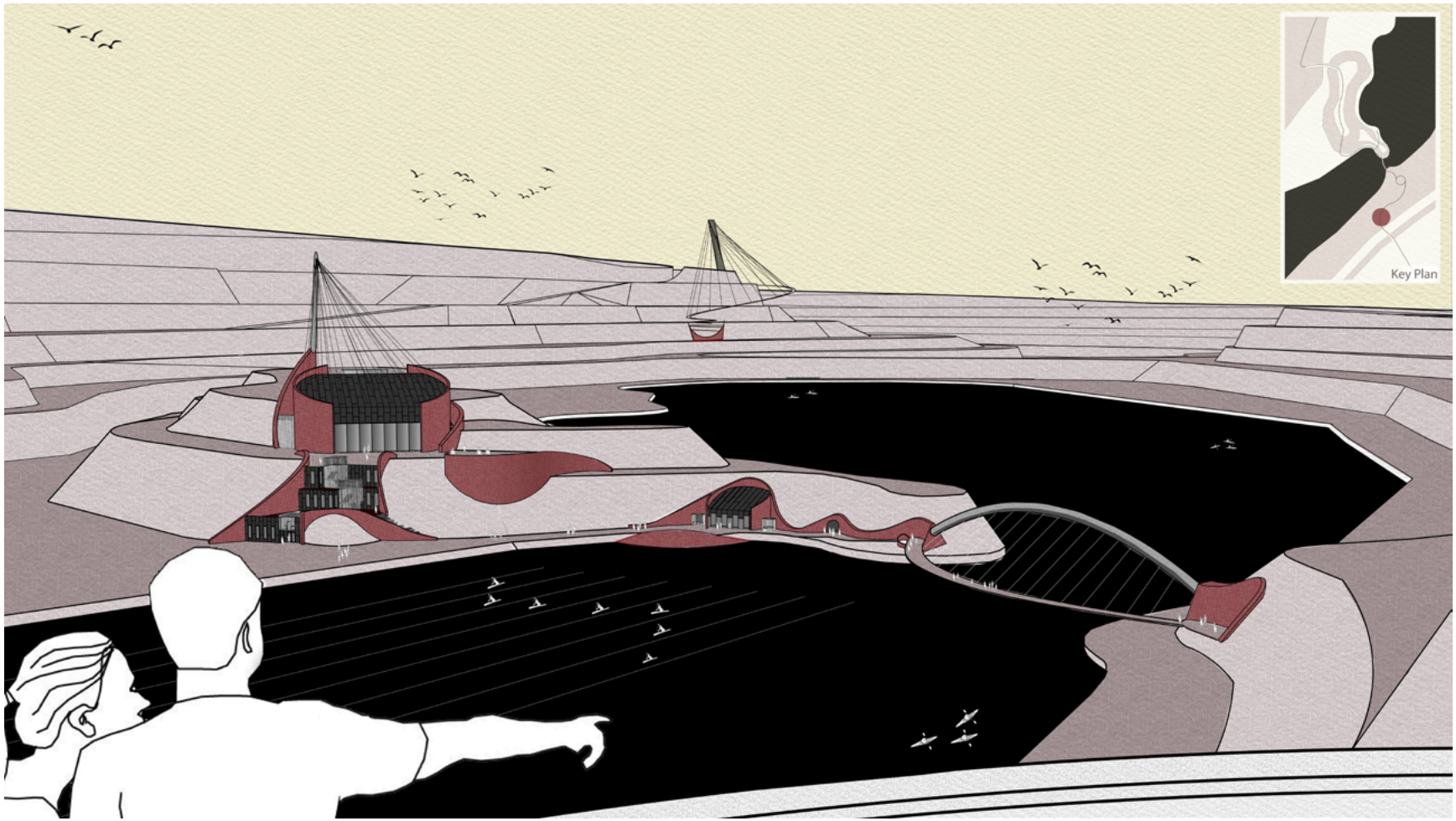
towers. Two towers, one on the Virginia side, and one on the Eveleth side, stand over 80m in height. These towers form the support for the suspended walkways which meander down the stepped wall faces of the pit, but also serve as a visual connection and wayfinding device. From the town, the pit is not visible, but the tower acts as a beacon, indicating that there is something exciting, and entices people to explore. The towers also indicate where the route through the pit begins and ends.

Elevated Descent

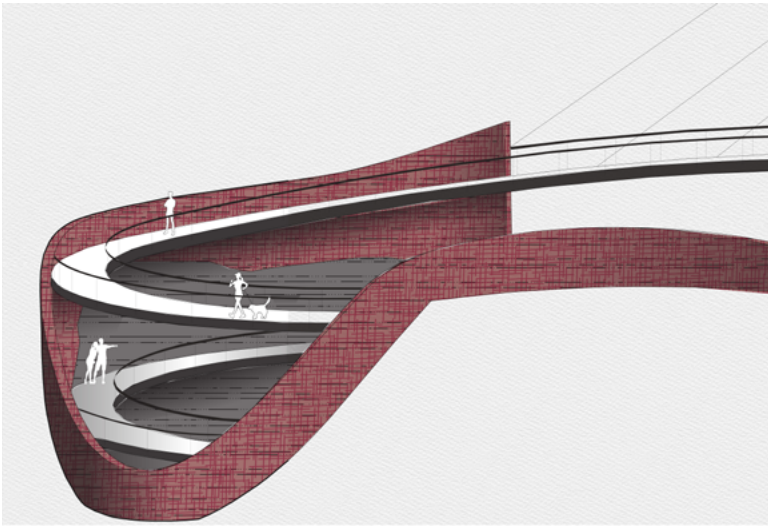
After passing the overburden pile, one continues towards the tower and the edge of the pit. As they draw nearer to the edge, they can start to see that the cables from the tower are supporting a curved walkway which gracefully descends along the stepped forms of the pit. The walkway is suspended far over the edge, giving the impression of flying over the pit. From this vantage point, the enormity of the pit is on full display. No longer simply a line on a map, the newly created path through the pit can be seen and understood with the patron’s own eyes.

Spiral

As the elevated walkway nears the ground it begins to curve around into a spiral which descends into the earth. This spiral has the unique attributes of being both above the ground and with-in it. The glass railing securing the walkway above is first replaced with the solid concrete wall which frames the spiral in the hillside. As one continues to descend, the spiral is released from its concrete bounding and again takes on a weightless form, suspended over the void below. It winds back into the earth and this time the visitor can come into contact with the bare rock. The marks made by the massive



View from the Virginia elevated descent. From this vantage point, the visitor can see the newly created infrastructure such as the lake, boathouse, community centre and theatre. The walkway is suspended above the stepped rock walls of the pit and gives the sensation of flying over the edge.

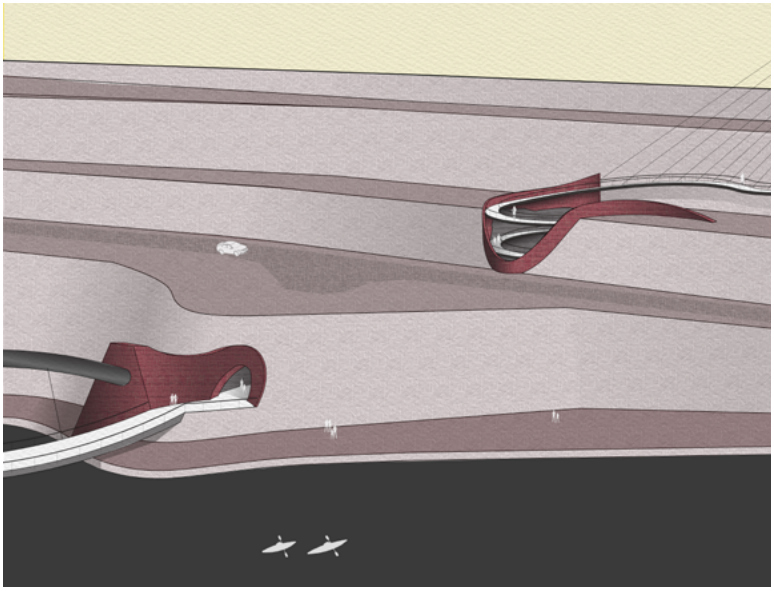


As the suspended walkway nears the ground it forms a spiral framed by concrete walls. As the spiral descends the concrete encasement changes to natural rock, allowing the visitor to experience the material up close.

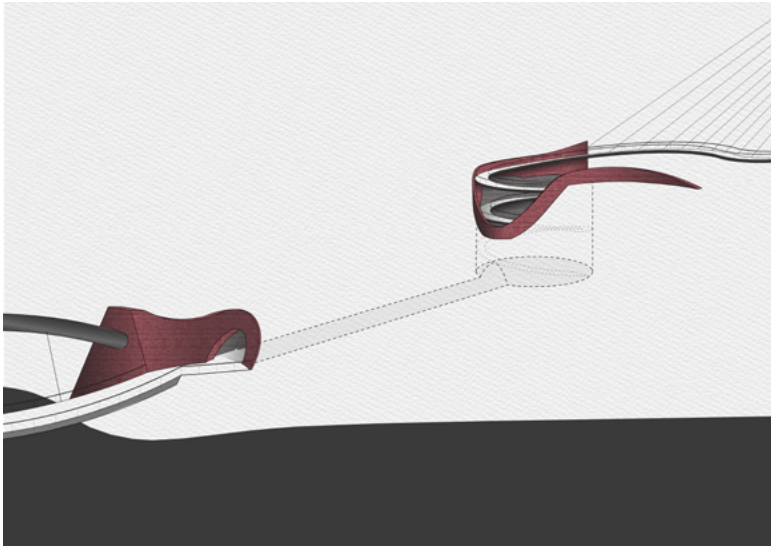
machinery are put on full display and the person can touch and examine the rock up close. Continuing down the spiral, it descends under the ground to a depth around 10m. At the bottom of the spiral, a horizontal tunnel emerges into the daylight. While traversing the tunnel the visitor can experience the immense weight of the rock above. The tunnel emerges on the banks of the newly formed lake.

Bridge

The 100m long cable stayed pedestrian bridge is supported by an elegant steel arch anchored on either side by concrete piers. The bridge's glass railings allow for an optimum view of the lake and paddling course. The bridge is wide enough to allow a two-way flow of pedestrians as well as stopped spectators who may pause to observe a paddling race. The bridge creates an interesting change of perspective as normally these types of bridges would dominate the skyline of a city. Here, in the depths of the colossal pit, the bridge seems almost miniature, and helps the visitor

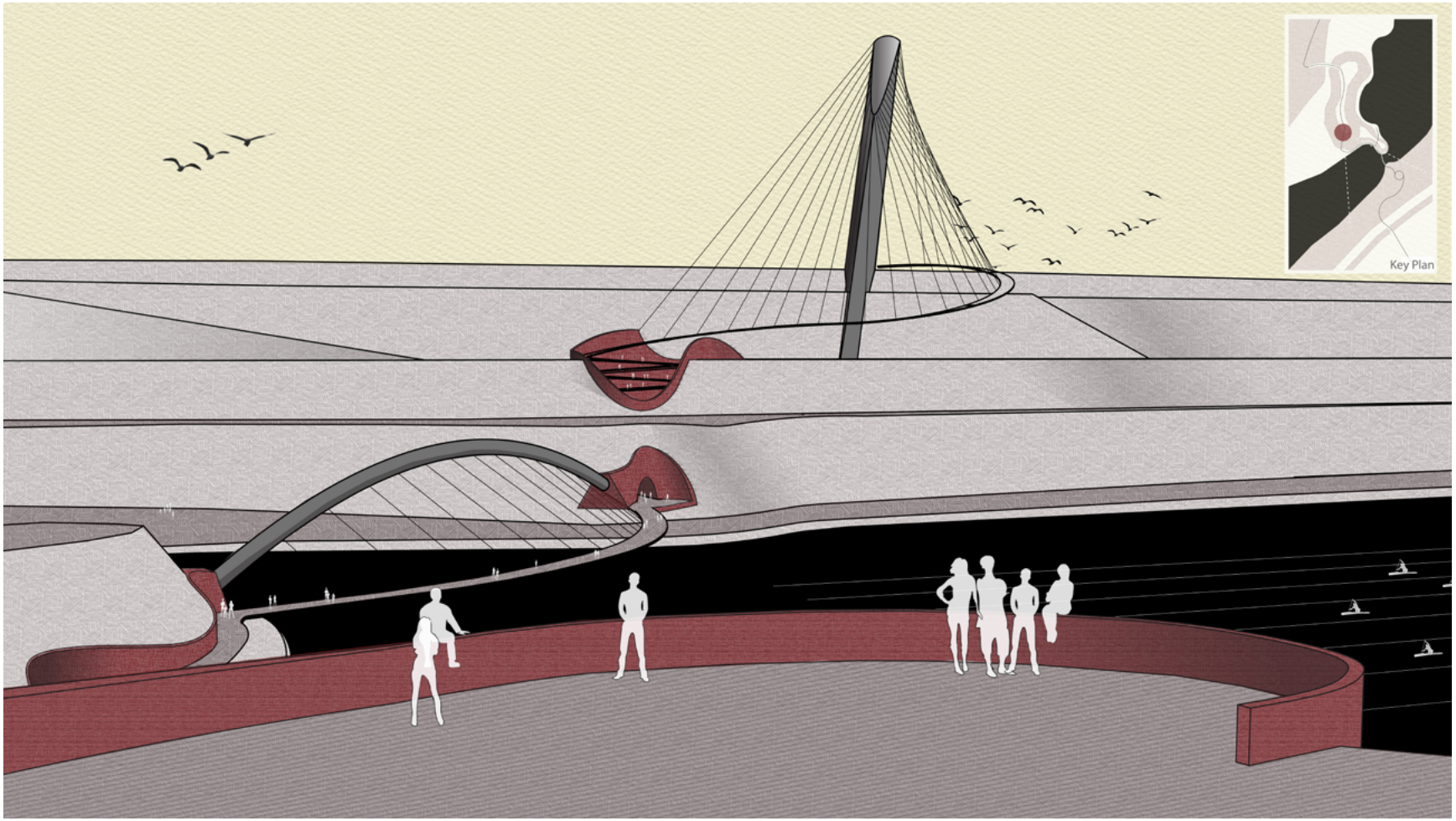


The spiral takes the visitor from above the rock walls to deep within them.



At the base of the spiral a horizontal tunnel leads to the bridge which crosses the new lake.

understand the vast scale of this manufactured crater. The bridge terminates on the peninsula and the concrete pier which supports the arch melds into a curving wall leading the pedestrian towards the boat and skate houses. Further down the path an entrance to another tunnel opens on the right. This 35m tunnel crosses the peninsula to the west side and emerges at the skatehouse.



View of elevated walkway, spiral, tunnel entrance, bridge and lake. The water level is controlled allowing easy access to the lake. An Olympic regulation canoe/ kayak paddling course is set up in the lake and is serviced by the new boathouse.

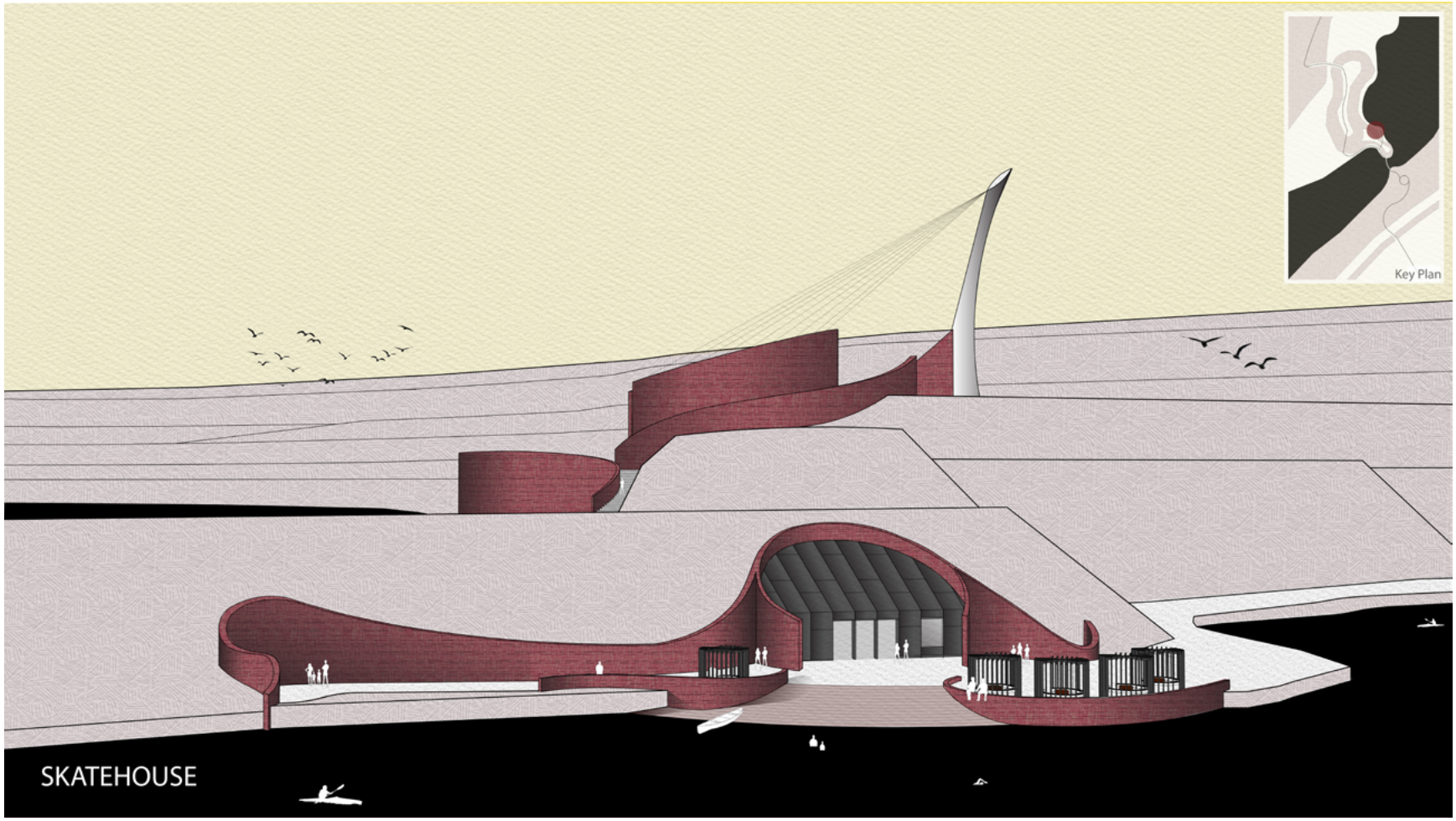
Skatehouse

The skatehouse is the name of the recreational area on the west side of the peninsula. It is accessed by either the pedestrian tunnel from the boathouse side of the peninsula, or a connection to the main road on the back side of the ‘Bump’. This area is less formal than the boathouse and is designed for year round recreational use.

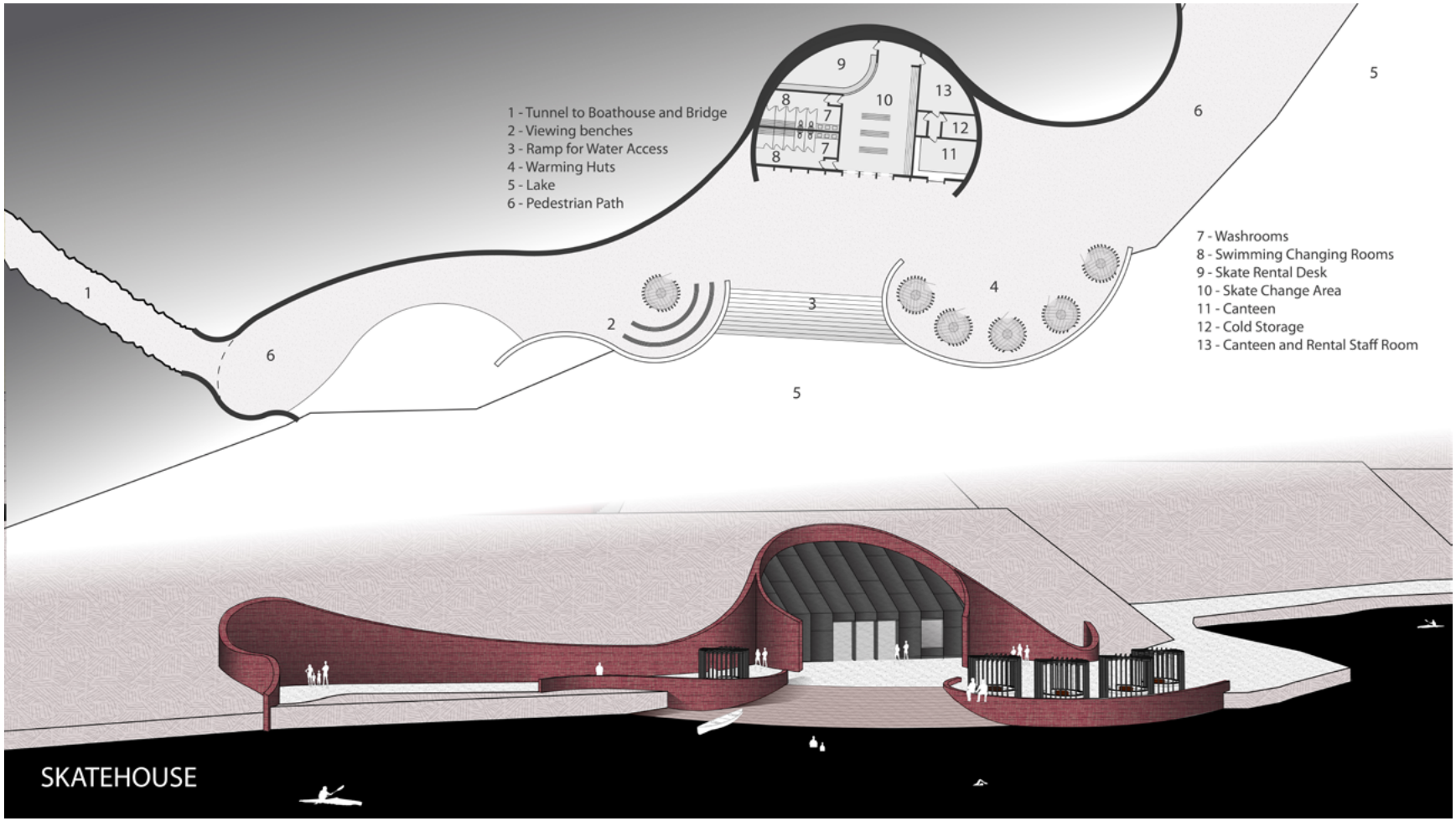
The tunnel emerges from an opening in the concrete wall which holds back the steep hillside. This flowing wall defines the path and leads the visitor towards the skatehouse. The wall curves further into the hillside and defines the shape of the skatehouse, seemingly embraced by the concrete wall extensions which wrap around the steel-clad structure. A central space with benches and storage lockers is accessed through framed openings. To the left are washrooms which also have several change stalls with showers for the use of swimmers. A canteen occupies the right side of the pavilion. This canteen sells refreshing beverages and small meals in the summer, and warming comfort snacks in the winter months.

Directly in front of the pavilion is a large shallow ramp which slopes down into the water. This serves as the primary access to the water for swimmers. After a refreshing dip, the swimmer can use the ramp to lay out on a towel and sunbathe.

Minnesota is known for very cold winters, and a favourite pastime of the locals is ice skating. When the lake freezes in the cold months, this area becomes the bustling hub of skaters who come from all over the Iron Range to enjoy miles of open ice. The framed openings of the skatehouse are closed in with doors and the large interior space is used



The skatehouse is located on the opposite side of the peninsula from the boathouse and is accessed by a tunnel which crosses this peninsula. The skatehouse supports swimming in the summer and skating in the cold months.

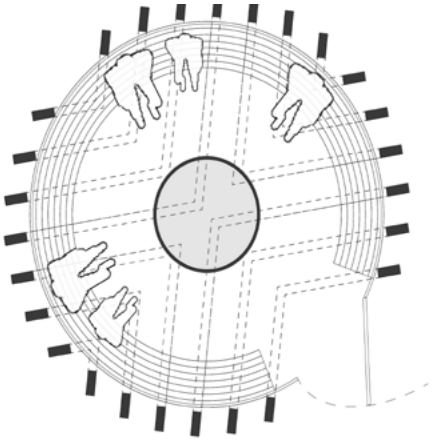


Nestled into the hillside the skatehouse houses washrooms, change rooms, skate rentals and a canteen. Located along the shores of the lake are five warming huts.

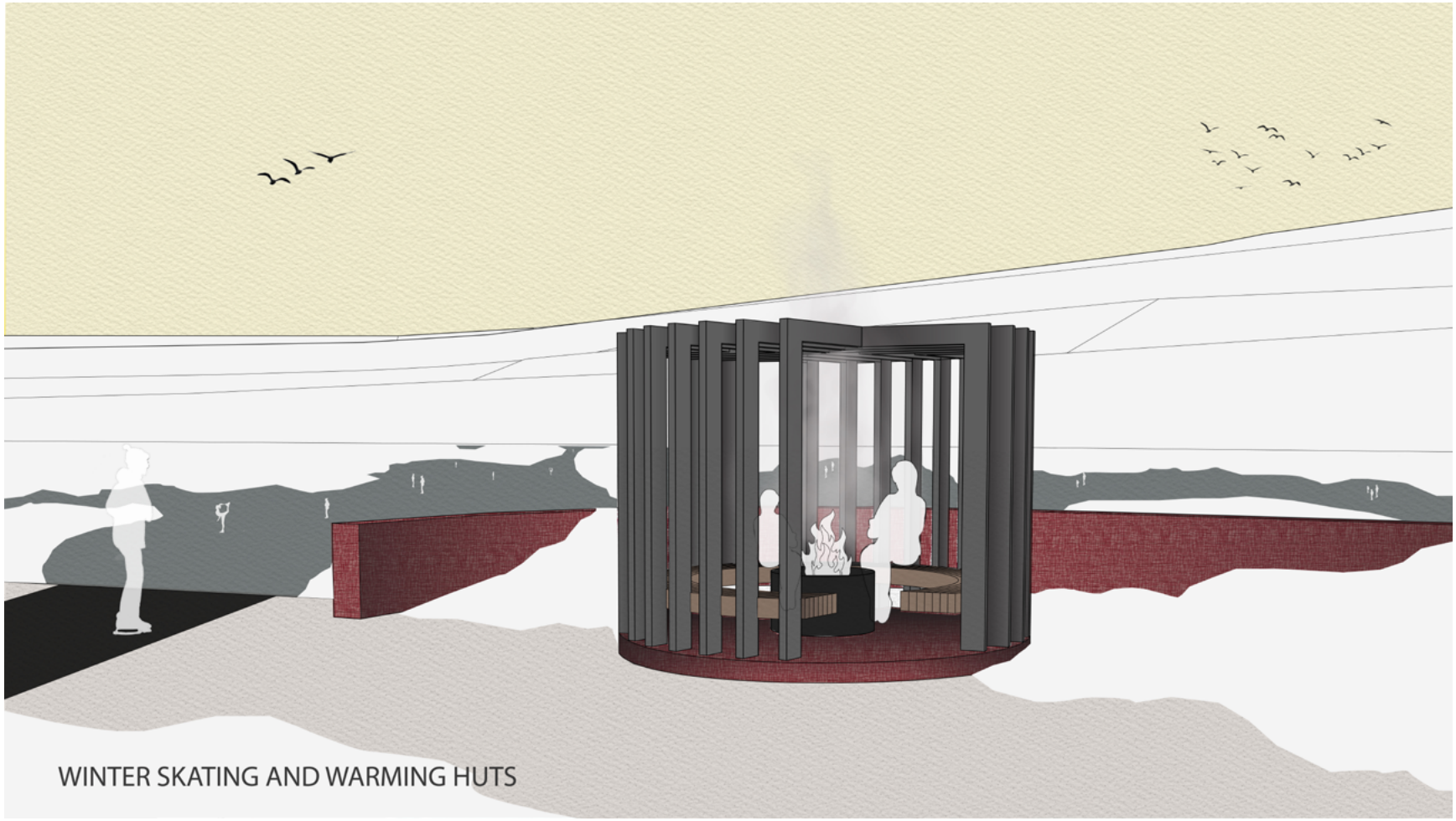
to put on skates, and store winter boots. The large room and open counter at the rear of the building is used to rent out skates. Rubber matts are placed on the ground and ramp between the building and the ice surface as to not dull the sharp skates. Informal hockey games break out and occasionally pond hockey tournaments are organized. As with the boathouse on the opposite side, spectators can watch the skaters from benches, along the paths, or from inside the warming huts.

There are 6 warming huts located along the concrete retained shores of the lake. These warming huts are framed by vertical steel slats, a design element which is repeated later to enclose the exterior stairs of the community centre and to frame the entrance of the theatre.

The huts are enclosed with clear acrylic which is curved to fit the inside face of the steel structure. This layer allows the huts to feel like an open-air structure with views of the surrounding lake while helping to keep heat from the fire inside the hut. Clear acrylic doors complete this protective layer. Smoke from the fire is released through the roof, which is framed when the vertical slats transition horizontally and form a unique pattern.



Warming Hut floor plan



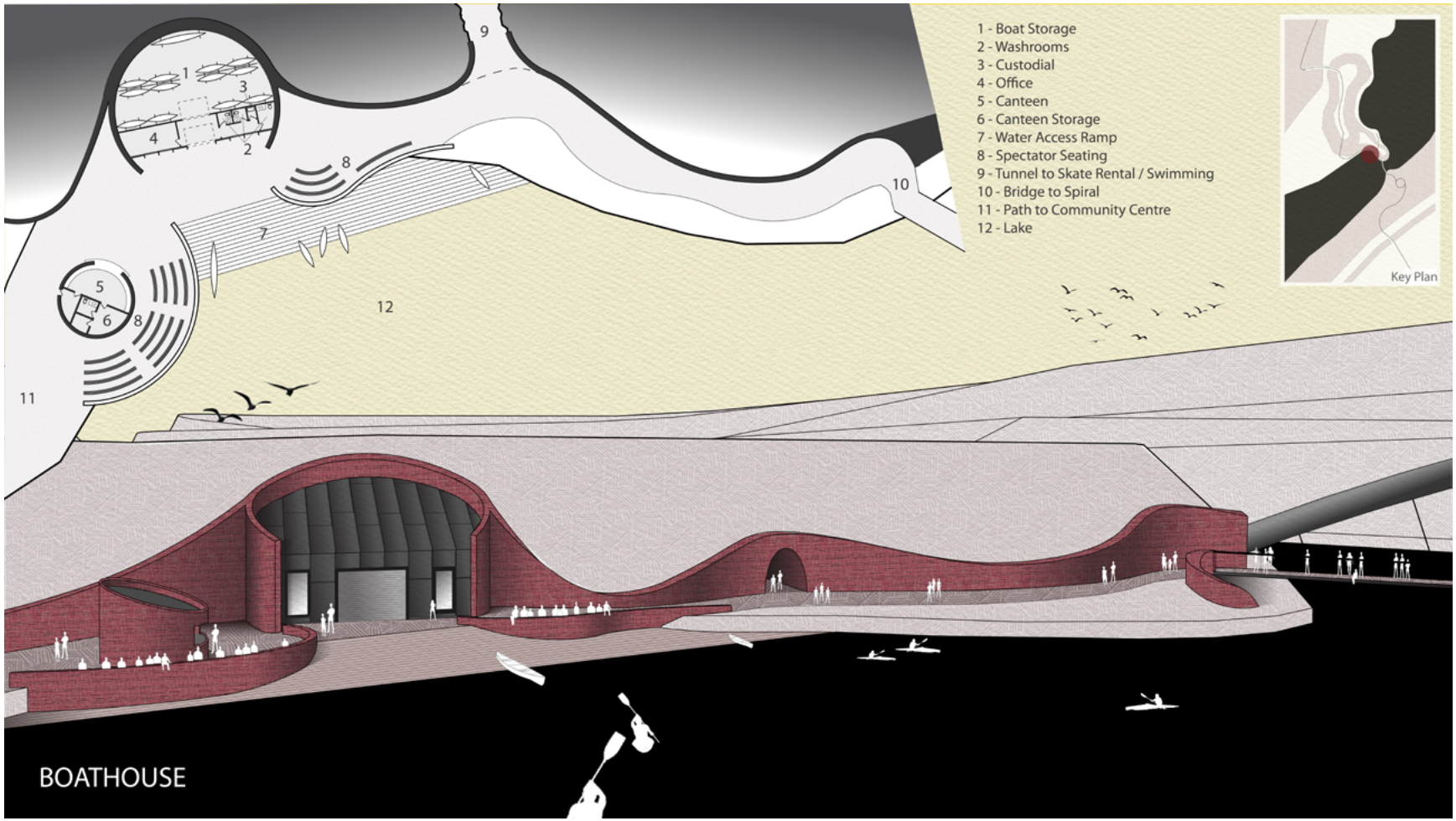
One of 5 warming huts located on the shore of the skating area. Framed by steel slats which echo the design language of the community centre and theatre, and enclosed by clear acrylic, these are an excellent place to warm up after a day of skating.

Boathouse

Located on the East side of the peninsula, the boathouse shares a common design language as the skatehouse on the West side. A solid concrete wall undulates and flows to form built space and direct flow through the area. The primary purpose of this area is to serve the canoe and kayak paddling course which is set up in the new lake. The Olympic regulation course is an 8 lane 1000m long course. Each lane is 9m wide, for a total course width of 72m. The length is divided into 1000m, 500m and 200m intervals which accommodate the three different lengths of official races.

To easily accommodate the boats, overhead doors are placed in-line with the entry/exit ramp to the water. The large boat storage room is behind a second overhead door which can be locked, securing the boats while still allowing the public access to washrooms and the office. A stand-alone canteen serves seasonally appropriate snacks and beverages. Concrete walls retain built-up spectator pads with benches allowing for plenty of seating, however good views of the lake and course can be seen from many places around this hub such as the path and bridge.

The boathouse is also where canoes and kayaks can be rented by the general public. After launching from the sloped ramp, boaters can watch the races on this side of the lake or paddle under the bridge to explore the skatehouse side. This offers a completely new perspective, as the outside world is blocked from view with only the pit walls towering above on all sides. Previously, the only way to view a mine pit was from distant lookout points high above the rim of the pit. Most of the public has never been able to experience the



The boathouse serves the paddling course set up in the lake canoe/kayak storage, an office, and washrooms. A canteen serves snacks to spectators who can watch races from seating areas on the banks of the lake, or from the bridge which crosses it.

sensation of being at the bottom of the pit looking up. This makes exploring this lake by boat a truly unique experience.

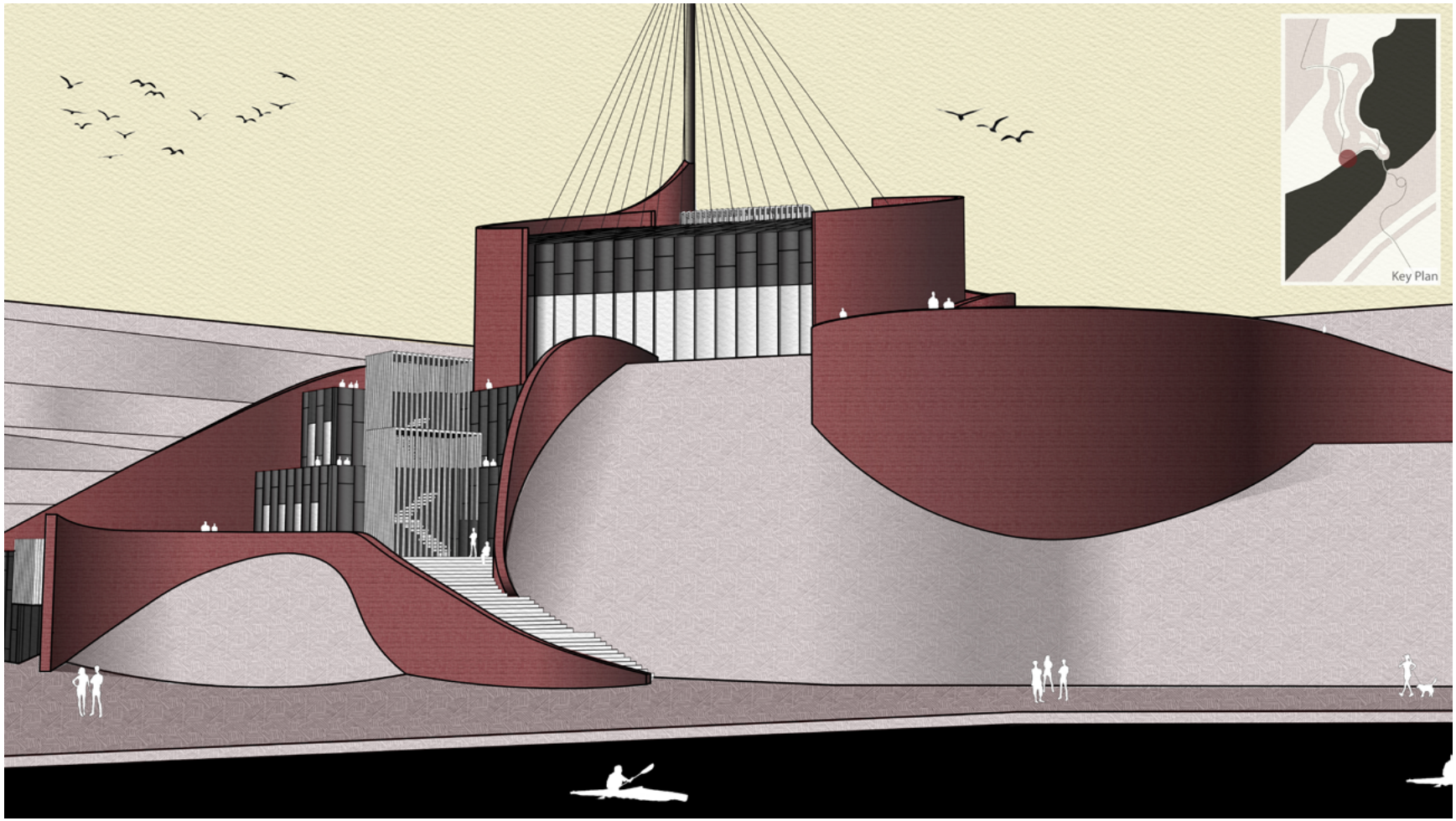
Anchor Building

Community Centre

The community centre occupies the bottom three floors (designated -2, -3, and -4 levels) of the anchor building. The building is built into the ‘bump’, an unexcavated hill which rises two bench heights beside the lake. The centre is buttressed on either side by curved concrete walls which hold back the heavy rock of the slope. Between these two bookend walls the centre takes form in terraced levels clad in black steel. Large punch windows break up the dark mass of the steel and allow for light to infiltrate the space behind, which is largely underground. Large open-to- below spaces and interior glazing aid in this penetration of light. The building itself acts as a continuation of the pedestrian path and allows visitors to choose an exterior or interior path. The exterior path uses a large sweeping staircase to traverse from the lakeshore level to the large exterior terrace which forms the roof of the -4 level. From there, switchback staircases enclosed in vertical slats take the visitor to two additional terraces. The vertical slats echo the structure of the warming huts below and again serve to breakup the dark steel mass.

-4 Level

The lowest level of the building serves as the formal entrance beside the lake. This level houses the first community room. These rooms are flexible spaces, designed in various sizes that can accommodate many types of group activities. Behind the community room, a large lobby rises multiple



Visitors are led by curving concrete forms from the boathouse to the community centre which also serves as a continuation of the pedestrian path. The exterior stairs are framed by vertical slats which echo the design language on the warming huts below.

stories allowing light from above to trickle down to the lounge seating. Inquires and room rentals can be completed at the information desk which has a large storage room utilizing the space under the exterior staircase. In the centre of the lobby is a wide, open staircase which leads to the -3 level, or for those with accessibility issues, an elevator is available.

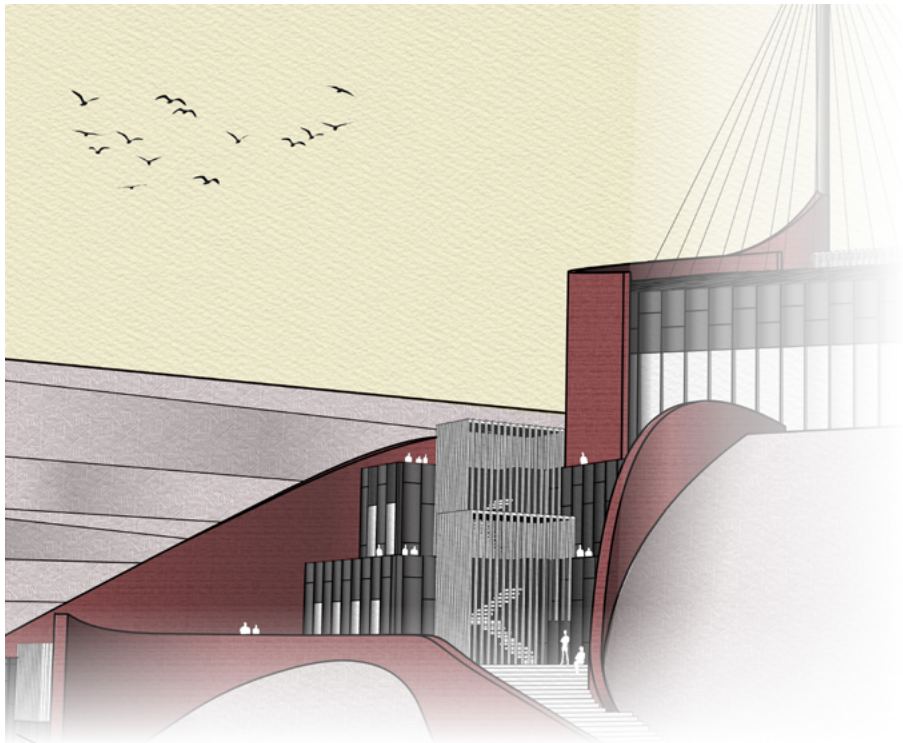
-3 Level

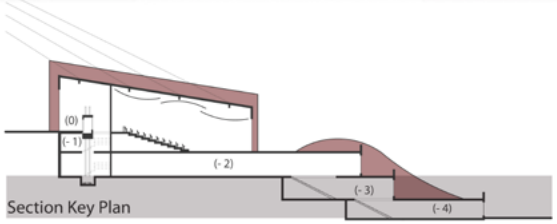
A large exterior terrace is the defining feature of this level. From this elevated spot, the lake and paddling course can easily be viewed. Inside, a smaller boardroom is lit by a large window to the multiple story open space. An open lounge with comfortable seating is a great spot to read a book or host an informal meeting.

-2 Level

The heart of the community centre, this level serves as a transition between the centre below and the theatre above. After climbing the interior stairs, one is greeted by an expansive space ahead, the art and sculpture gallery. To the left, a glass-walled boardroom allows light from the exterior to pass through into gallery beyond. Here, the works of local Iron Range artists and craftspeople is on display. The familiar red concrete wall curves around the space and directs the visitor to the front lounge where a staircase and glass elevator lead to the main lobby on the 0 level above.

This level also has public washrooms and several rooms which service the theatre above. A large rehearsal room which can double has a flexible community room or host smaller performances has direct access to a hallway and a back staircase leading directly to the stage. A green room





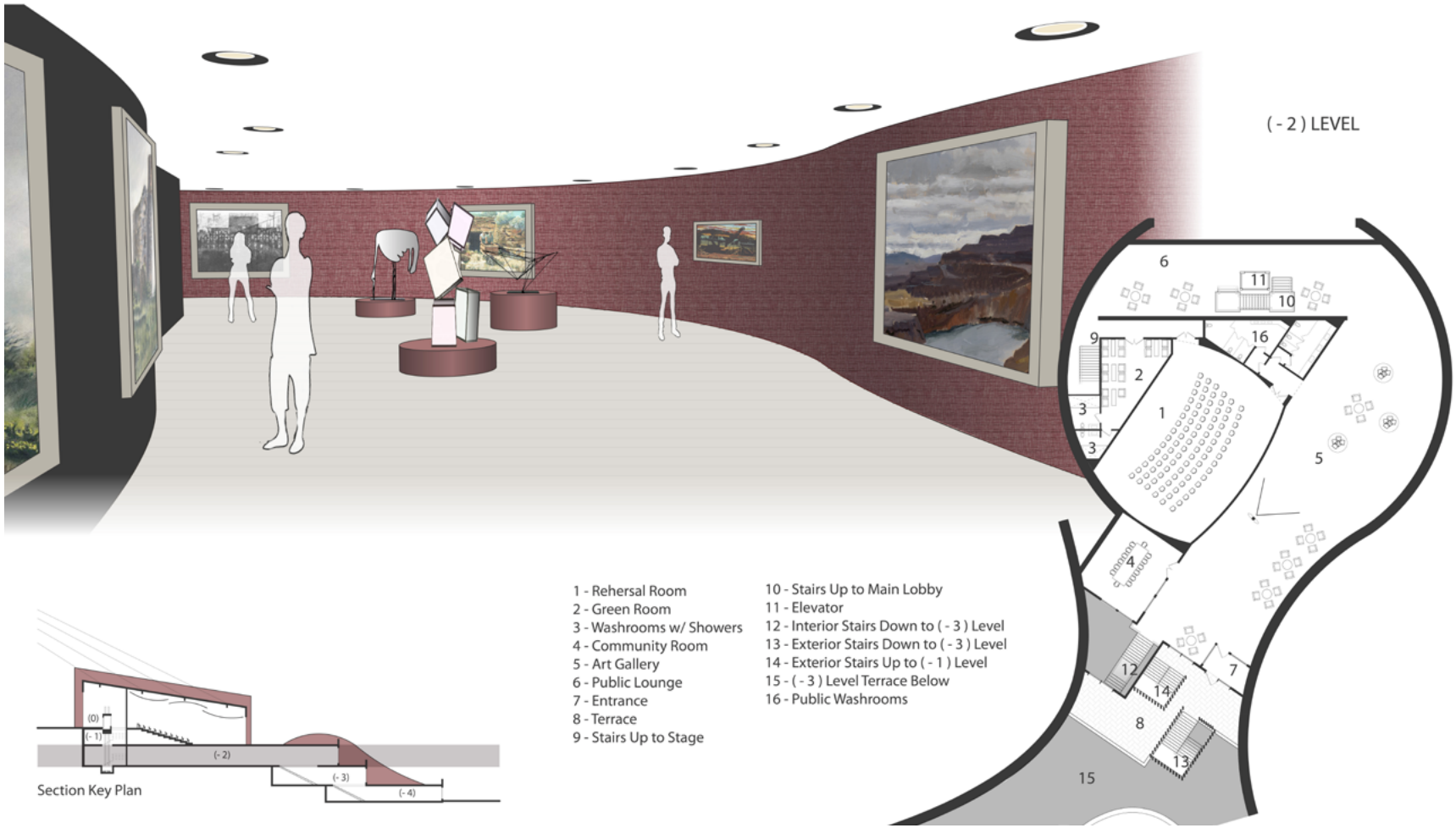
(- 3) LEVEL

1 - Exterior Terrace
2 - Exterior stairs Down to Boathouse Level
3 - Exterior Stairs Up to (- 2) Level
4 - Entrance
5 - Public Lounge
6 - Storgae
7 - Elevator
8 - Community Board Room
9 - Stairs Down to (- 4) Level
10 - Stairs Up to (- 2) Level

(- 4) LEVEL - LOWER GROUND ENTRANCE

1 - Entrance
2 - Community room
3 - Public Lounge
4 - Information Desk
5 - Coat Room
6 - Storage Room
7 - Elevaor
8 - External Stairs to (- 3) Level Terrace
9 - Internal Stairs to (- 3) Level

Buttressed on either side by solid concrete walls, the tiered lower levels of the community centre contain an information desk, community rooms which can be booked, public lounges and a continuation of the pedestrian path.



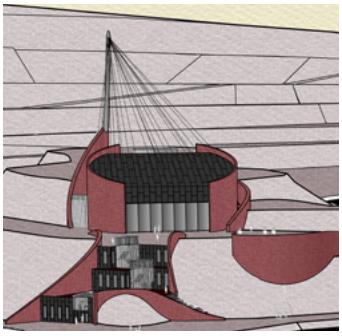
View of the art and sculpture gallery. While showcasing the work of Iron Range artists, this space also serves as a continuation of the pedestrian path. The rehearsal room, green room with showers, and community space are also located on this level.

with washrooms and showers is also connected to this hallway, giving easy access to the stage above.

-1 Level

This intermediate level occupies the space created by the rake of the theatre seating above. It houses the main public washrooms for the theatre as well as instrument and theatre storage.

Theatre (0 level)

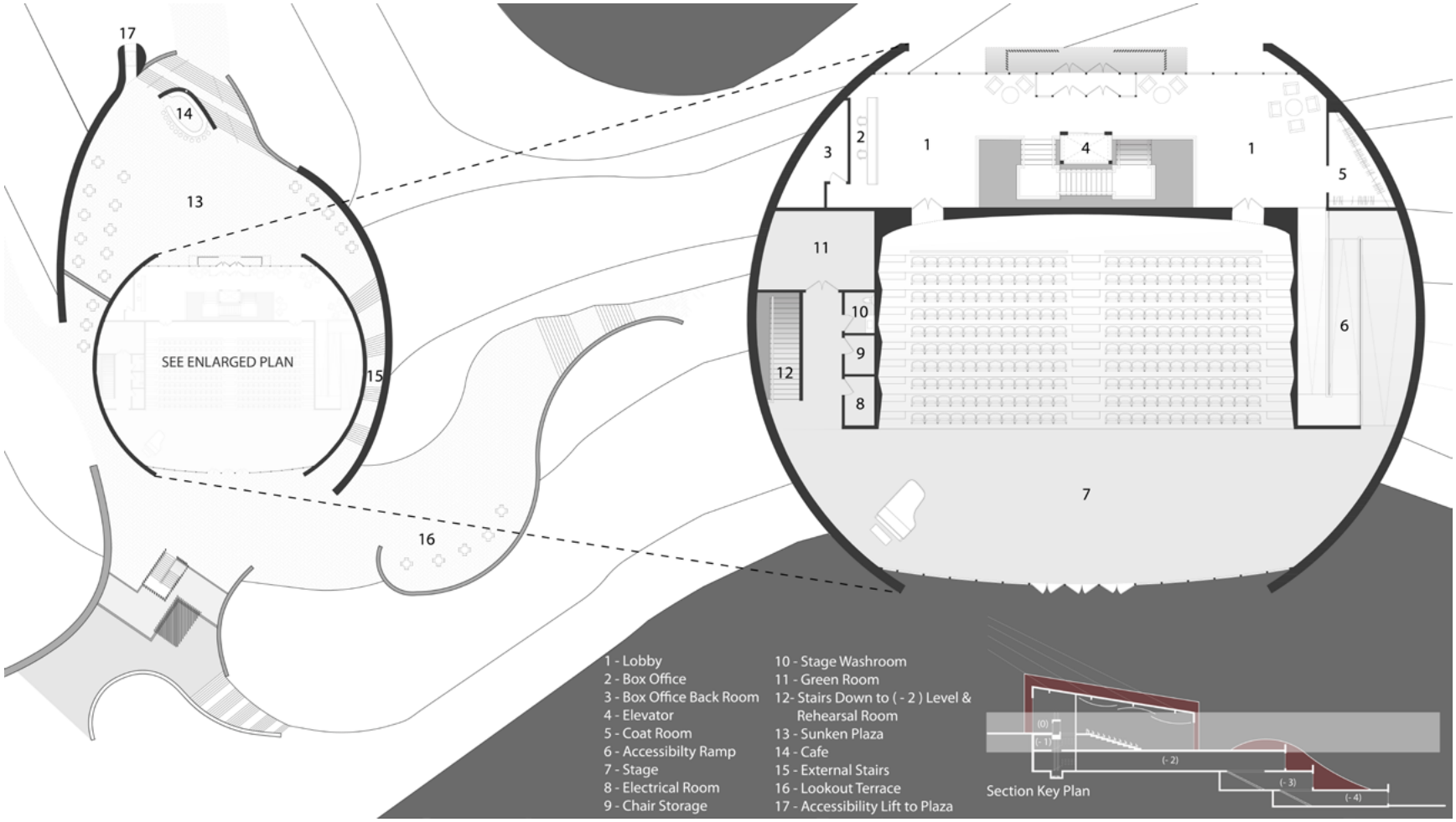


Exterior view of community centre and Iron Range Theatre

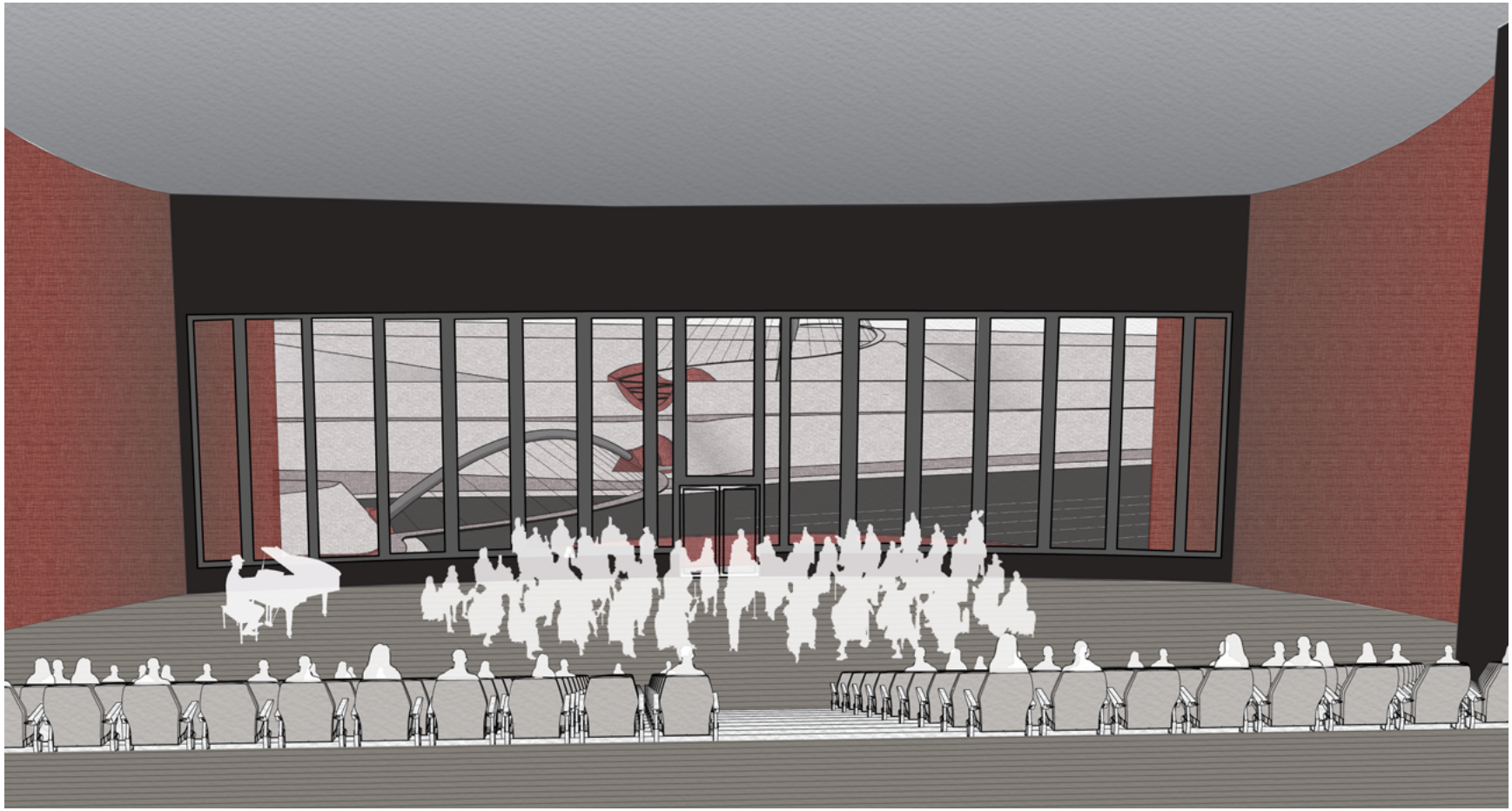
Resting on the very top of the anchor building is the theatre level. Visible from almost anywhere in the pit, this structure is the embodiment of the design philosophy used throughout this project. Thick, semi-circular concrete walls ground the building into the earth and give it its form. The exterior route takes the form of a curved staircase sandwiched between two curving walls and allows pedestrians to travel between the plaza and the lakeside viewpoint. The thin steel framed roof is suspended by cables to the large mast high above. This gives the roof the impression of weightlessness to those underneath, and demonstrates the strength of steel in tension.

Inside, visitors arrive in the lobby, either through the plaza entrance doors, or via stairs/elevator from the art gallery below. In the lobby, one experiences very high ceilings which appear to float unsupported. An information desk/box office and coat room occupy either side of the lobby. Two sets of double doors allow entrance into the performance space.

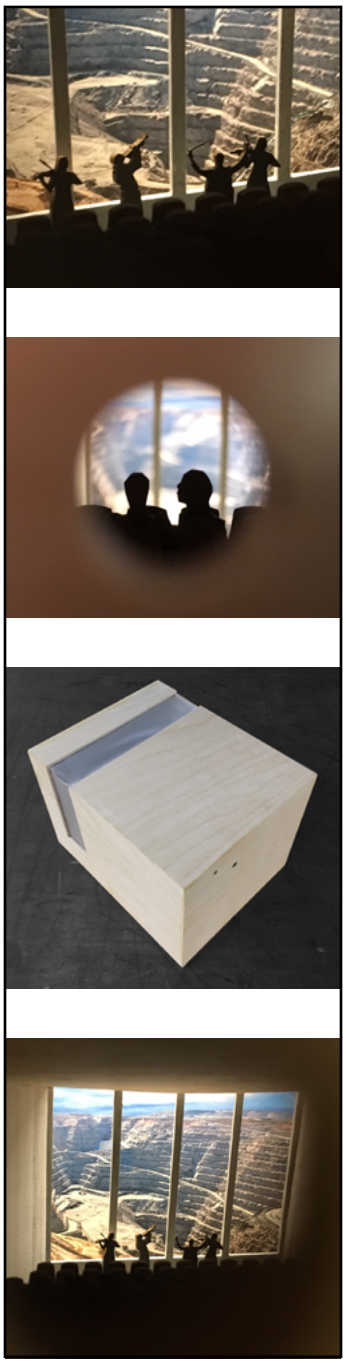
The theatre has seating for 300 people and is the new home of the Mesabi Symphony Orchestra as well as many other musical organizations across the Iron Range. The setup of the stage area allows this venue to be used for a variety



The new Iron Range Theatre will become the home of the Mesabi Symphony Orchestra. The 300 seat theatre can also host lectures, a variety of musical acts and small scale performances.



Interior view of the Iron Range Theatre with its dramatic wall of glass. The lake, bridge, new infrastructure and the pit itself serve as a spectacular backdrop to any performance.



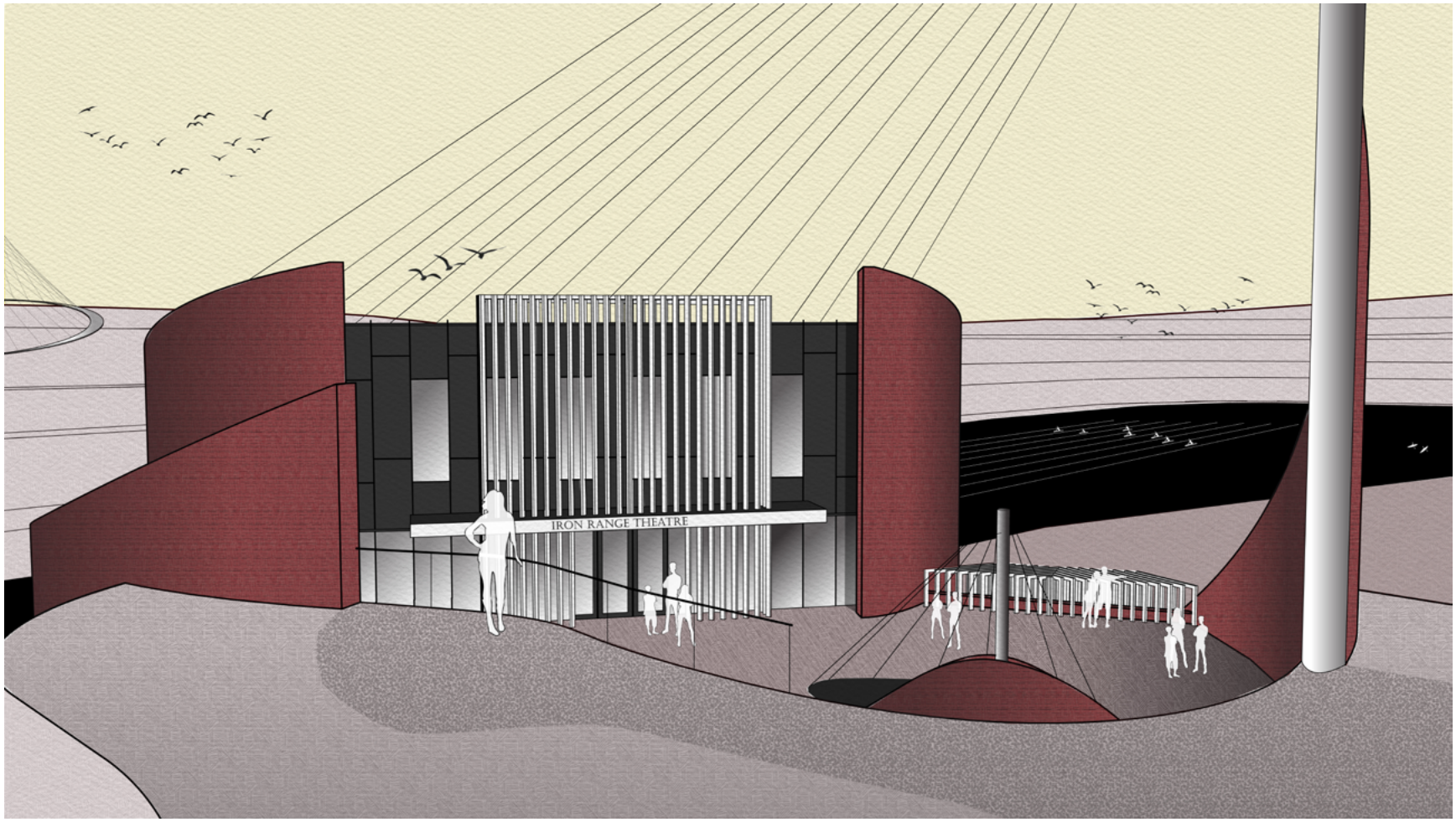
Diorama exploring experiential conditions of new theatre space

of performances, from dance recitals, to visiting lecturers. Instead of black curtains, the back of the stage is an enormous wall of glass, and the mine pit and lake form the stunning backdrop to every performance. The building has been strategically positioned so that the setting sun does not shine in the eyes of patrons.

To the right of the seating is a accessibility ramp which gives universal access from the lobby to the stage floor. Occupying the space to the left is a chair storage room, control room, a stage washroom, and a stage level green room. This green room also allows access to several storage rooms on the -1 level where musicians can store instruments, or any other equipment that is not always necessary. A back staircase which leads to the main green room and rehearsal room is also located in this area.

Plaza

While the theatre lobby can be accessed from the community centre below, the main entrance is located in a sunken plaza which sits atop the ‘bump’. This space is designed as a pre or post concert gathering spot. From the approaching path, the visitor descends a wide stair which divides and encircles the bar which serves pre-show cocktails or a casual coffee to those enjoying the space. Overhead, the cables which suspend the roof from the tall mast can be seen. The entrance to the lobby is framed with the vertical slat elements which repeat in several places throughout the project. An accessibility lift is located inside the base of the mast and allows universal access to the plaza and into the building. To the left, exterior stairs follow the curve of the building to the terrace below. The plaza is a destination in



This plaza serves as the main entrance to the Iron Range Theatre. With its own cafe/bar it is an excellent gathering space before or after a performance, but can also host its own performances.

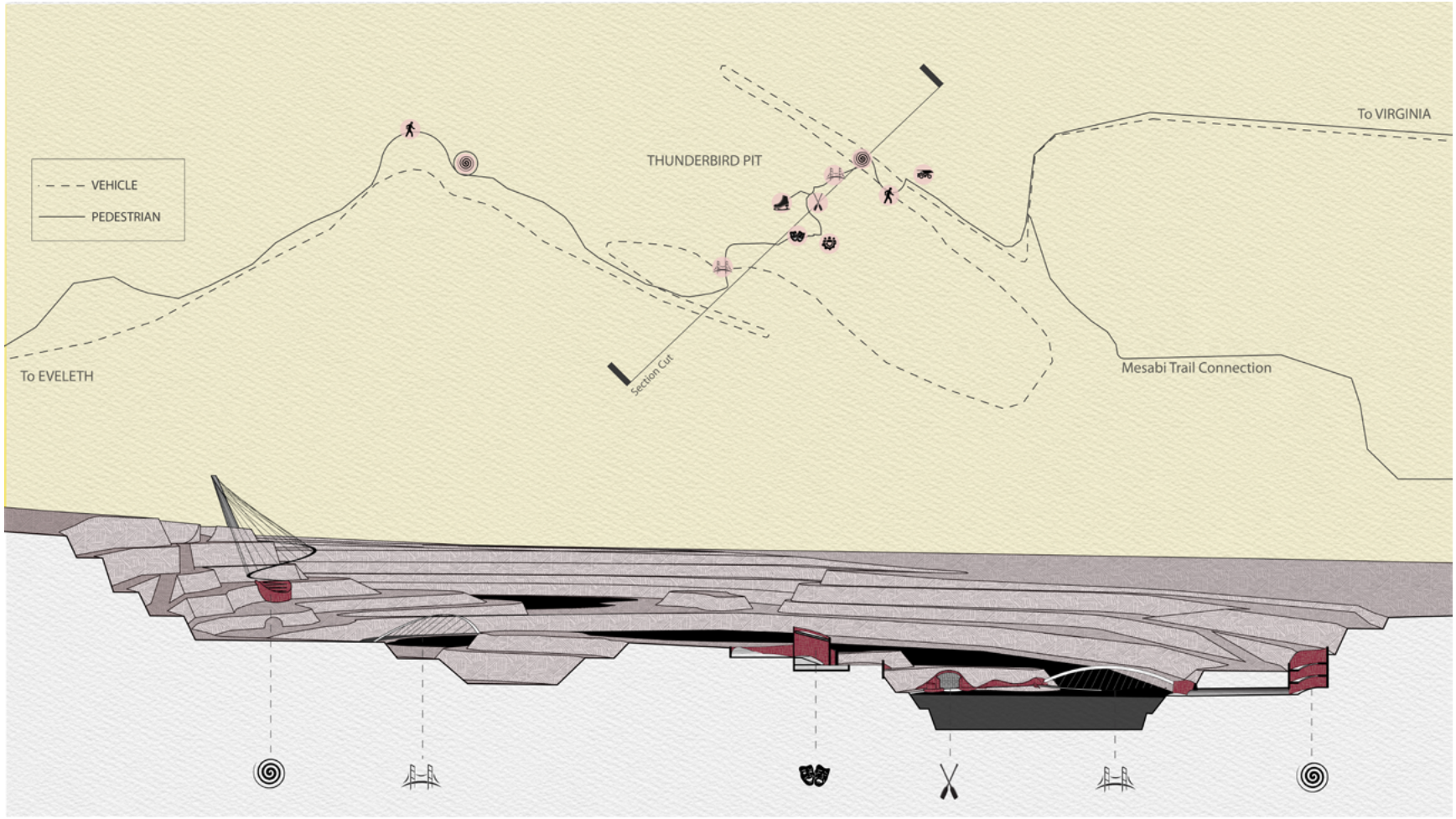
itself, and can host small performances such as buskers or small musical acts.

Completing the Connection

Continuing the journey through the pit, the pedestrian path travels away from the plaza along the top ridge of the ‘bump’. The journey to the Eveleth side of the pit is completed in reverse order of the descent. The path leaves the ‘bump’ via a bridge which crosses over the new vehicle road. On the Eveleth side of this bridge is a parking area for patrons of the theatre and community centre. The pedestrian path continues along the edge of a bench to where a tunnel takes them into the rock wall. As with the Virginia side, a spiral raises them two bench heights before emerging on a curved elevated walkway suspended from the Eveleth tower. Once over the rim, the path and road come together in a boulevard which connects vehicles and pedestrians to the main street of Eveleth, Grant Avenue.

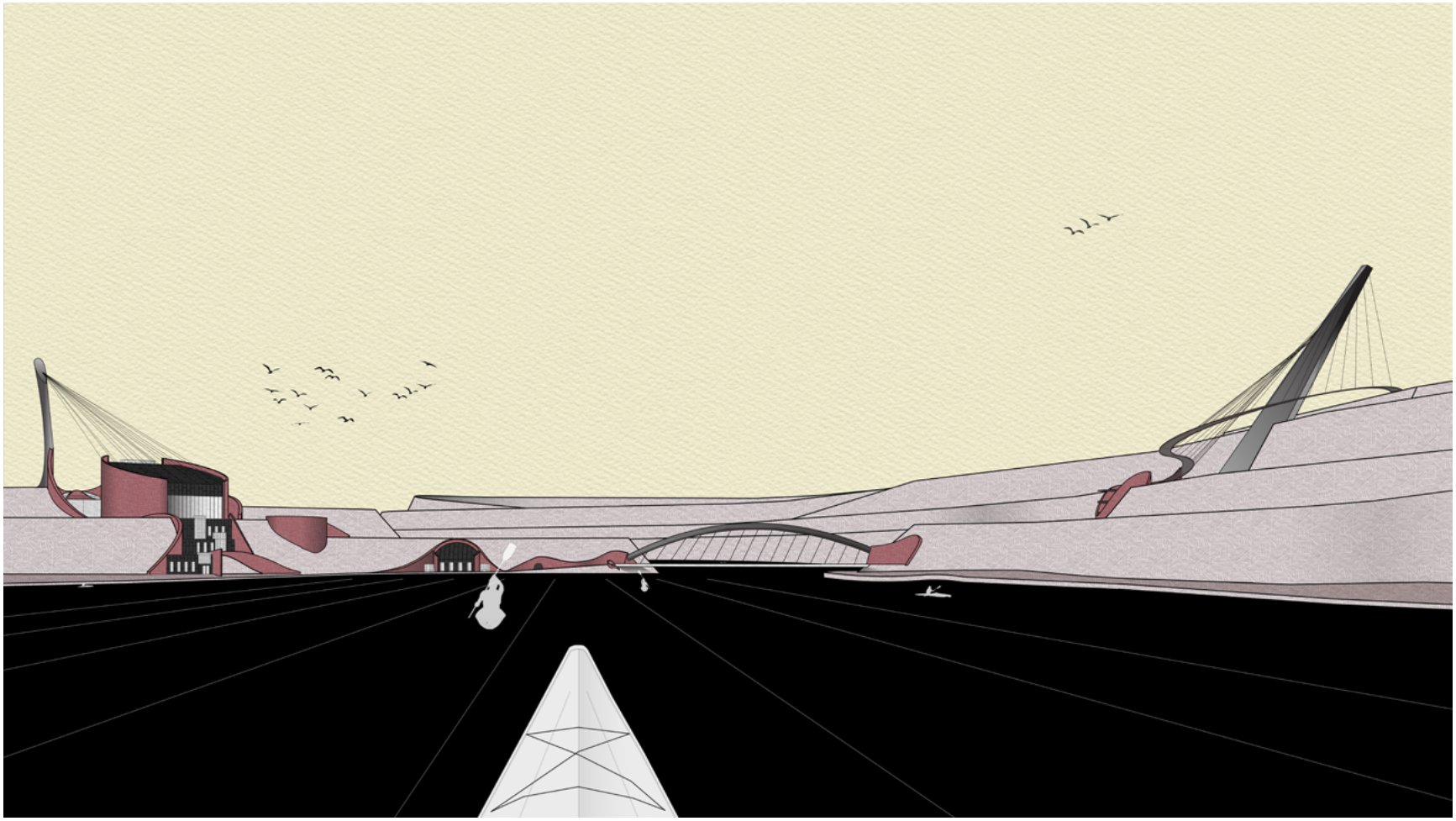
Completing the Vision

The connecting paths and new infrastructure laid out in this proposal by no means complete the vision for the Thunderbird Mine. By laying out a framework that can be ever expanded upon, the pit can be naturally inhabited with needed program as time passes. The new road and pedestrian trail provide access to every bench in the pit, opening up areas for future buildings, sports fields, or other recreational areas. Additional trails will develop in a more natural way as visitors explore new areas of the pit. While this proposal heavily programs one of the newly formed lakes within the pit, there are 2 other lakes which can be used for various activities as needed. Like the paddling lake, the



Section of the Thunderbird Mine Pit

water level on these is controlled, allowing for convenient access to the water helping to overcome the challenges of utilizing previous pit lakes.



View of Thunderbird Mine Pit from kayak in lake

Chapter 7: Conclusion

The proposal laid out in this thesis is a drastically different approach to current methods of post-industrial mine pit usage on Minnesota's Iron Range. This difference is rooted in the method of observing the manufactured landscape that mining activity has created. Traditionally, pits like the Thunderbird are viewed under the paradigm of "untouched land is natural and good whereas manufactured land is bad." It is this view which encourages the traditional approach of 'returning the site to nature,' in an attempt to erase human interaction with the land. Lakes are often viewed as untouched nature, conforming to the previously mentioned 'good' category. By allowing post-industrial pits to flood, creating lakes, it is often argued that human interaction with the land has been erased, and thus 'good'. However, due to various factors such as high edge conditions and cordoned off sites, these lakes often remain unused, and uninhabited.

The inhabitation of landscape is a natural process, part of the natural life cycle of land. Whether it be by termites, or humans, land evolves through cycles, from untouched to touched, formed to re-formed, in an ever evolving process. Land is inhabited for a particular use, then reformed to enable the inhabitation of a different use. If, as John Brinckerhoff Jackson believes, land is what you find and landscape is what you build, than landscape is an interpretation of the land, constantly being reworked in the natural process of inhabitation (Jackson 1984, 8). The landscape formed by the mining process, while indeed being a manufactured landscape, is still a natural one, not to be seen as a 'scar on the land', but as the result of the natural process of inhabitation.

By viewing this landscape as the result of a natural process, we can re-examine the post-industrial use of the land. This project does not attempt to cover up human's interaction with the land, but rather embraces and supplements the landscape which was manufactured by the mining process.

The inserted architecture not only provides built programmatic space, it provides access to all areas of this manufactured landscape. It is only by this new access that humans can inhabit the pit, reworking the land in the natural evolution of the landscape.

This access is realized in several different forms which create unique experiential conditions. From the curving walkways suspended from towers high above, to the descending spiral which allows visitors a true sense of the iron material, to the cable stayed arch bridge crossing the lake, these interventions rely on the manufactured landscape. Without the mining process, the landforms which embrace these structures would not exist. In a reciprocal relationship, the structures are then used to display the manufactured landscape, strategically placed to showcase the unique and beautiful facets of the reformed land.

While this is not intended to be a widespread solution to all of the range pits, the central location, geographic and social conditions at the Thunderbird site make this an ideal test location. The method of viewing manufactured landscape as a natural process, can have far reaching applications beyond the Thunderbird pit. By giving the site back to the public, it can be inhabited, explored and utilized to its full potential. The inserted architecture sets up a framework, no longer viewing the site as a 'scar on the land,' but as the result of a natural process, to be embraced and inhabited.

Appendix - Case Studies

Dalhalla Theatre

Located 7 km north of the municipality of Rättvik, Sweden, the Dalhalla theatre was created in an old limestone quarry. The pit, formerly named Draggängarna Quarry until operations ceased in 1990, is 200 feet deep and 1300 feet long. The theatre opened in 1995 and seats over 4000 people. The theatre is said to have amazing acoustical qualities that rival the best opera hall in Europe. This is due in part to the shape of the pit but all the makeup of the high stone walls surrounding it (Hajek and Svobodova 2017, 963).

This theatre is an example of experiencing the phenomenology of human made chasm. The amphitheatre is located low in the pit, leaving the high quarry walls on full display. At night, light illuminates the massive walls, showcasing the patterns of cuts made by humans to remove the stone. There is a progression from the rim down to the seating area which uses the ramps and benches of the former quarry. Few attempts have been made to make this feel like a 'natural' environment, and the industrial manufactured qualities of the site are put on full display.

Intercontinental Shanghai Wonderland Hotel

Within the Songjiang district of Shanghai, a hotel and park was built. Referred to as a 'groundscraper' this 18 story building extends 90 metres down, built against the walls of an abandoned quarry. The hotel's positioning along the cliff walls helps it to employ principles of earth sheltering, drawing on the mass of the surrounding rock to help regulate its internal temperature.

What makes this project of relevance to the Thunderbird mine proposal is the quarry's proximity to an urban centre. The pit is located within an established town, and design for the hotel and park was considerate of the larger urban scheme. Connecting roads, trails, and parkland open up the quarry site to not just guests of the hotel, but also to residents of the town, creating public space in a once restricted area.

Salina Turda Amusement Park

Located in one of the oldest salt mines in the world, operating for over 2000 years before being closed in 1932, the Salina Turda Amusement Park opened in the 1990's. Previously used as a cheese storage facility and a World War II bomb shelter, today it offers and underground amusement park, theatre, museum, an underground lake with rowboats, mini-golf course and a ferris wheel (Latimer 2014).

Like the ore mines of Minnesota, it is often difficult to understand a sense of scale in these subterranean caverns, and the massive ferris wheel looks small, easily fitting within one of the chambers. The heavy rock ceiling looms high overhead, seemingly floating unsupported. Visitors report a memorizing effect and a sensation that they have left reality, and entered the sublime.

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