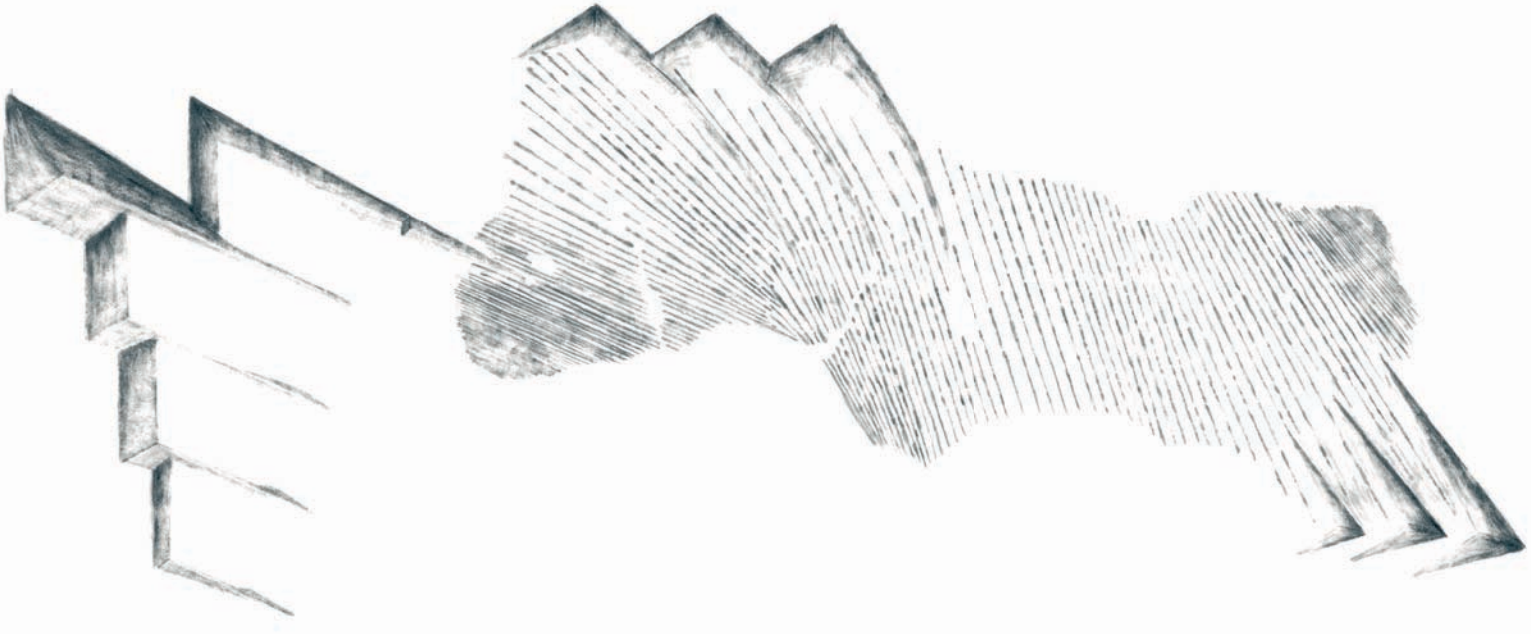
Re-formed Rock:

Designing waste rock piles for the post production landscape



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Re-formed Rock:
Designing waste rock piles for the post production landscape

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A practicum submitted to
the Faculty of Graduate Studies of the University of Manitoba
in partial fulfillment of the requirements of the degree of

Master of Landscape Architecture

Department of Landscape Architecture
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Abstract

The natural landscape of western North America is being destroyed in the search for mineral resources. There is an opportunity for Landscape Architecture to play a role in the remediation of these sites, in which alternate reclamation plans can be proposed.

This project is an exploration of industrial design in the early stages of a mine proposal. By analyzing the site as it sits prior to production, careful consideration of existing landscape elements can aid in better placement of waste material. Communication between the mining industry and affected communities allows for contributions to the final site design and the potential for an alternative end land use. Throughout this project I have explored layering the numerous industrial, social and environmental factors involved, and creating a design where these layers are represented in partnership with each other.

Acknowledgments

I would like to first thank my advisory committee. To Ted McLachlan for the endless amount of time you spent meeting with me, keeping me on track and encouraging me to explore. To Dietmar Straub and Maggie Bonnetta, your input and enthusiasm in round table meetings was invaluable, it was a pleasure to work with you.

To my family for their endless support and willingness to help gather information. To Leah and Lia for being there the entire step of the way and for the much needed encouragement and breaks. To all of my friends and colleagues in studio, I would not have made it without you.

Thank you.

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Preface

The Post Industrial sites that I have seen throughout my design education have always interested me, but for the majority of the projects Landscape Architects have been hired after the industry had ceased production and the sites need a new function or a celebration of the past. I wondered if there was a role that Landscape Architects could play in the mining Industry where they were not strictly coming in to clean up the mess.

Hearing of a new proposal on the edge of my home town, gave me the opportunity to explore this role and allowed me to envision a potential post-production outcome for this mine site. I strove to take advantage of the close communities and create a space that they could eventually use. I was interested in creating a relationship between the mining industry, the community and the environment that would be layered upon the site.

Guided by the mining processes, my aim was to sculpt the landscape for a post-industrial use.

I started this practicum with a love for the broken down, the decayed, the scarred, and found a beauty in the devastation. I found it amazing that a site ripped to its bones could support vegetation once again, and the natural processes of re-vegetating, with no encouragement or support, no human involvement, added another layer to the beauty of the destruction. I loved the romance of the forgotten but where I am from, industry is in full swing, the discarded is being reclaimed, re-explored, and resuming production.

I visited Highland Valley Copper Mine in the summer of 2011 and was fascinated by the industries affect on the land. I did not see it as a horrible destruction of the forest but an awe inspiring landscape that showed me what was below the surface, below the trees and grasslands and rocky outcrops. It was there that I saw the bones of the earth. The size of the pits is unimaginable. Their carefully calculated and regimented benches, from a distance, create a finely rippling texture but up close, they are taller than your house. I saw such beauty in what was left behind, but what comes out of the pit, the material that is not used, is piled around the site and encouraged to disappear. Engineers, geologists and environmentalists are involved with the mine before it can even begin production to determine what to do with the waste rock, how to minimize their affect on the land and encourage “nature” to take over again. Tours were being held at Highland Valley to demonstrate their reclamation work on the waste rock piles, but I found that I was uninspired by what they believed was making it look better.

The following fall an opportunity presented itself to me. Copper mines have been in production around Kamloops for decades, but with copper prices rising a new mine was being proposed that would open up two small existing pits for further development. Not having yet begun extraction, the waste rock, in my eyes, was not yet waste, it was a material that had to be moved and required a deposition location. Here was an opportunity to create a landscape inspired by the industrial process. I had found a place to insert myself, as Landscape Architect, in planning the industrial for the post-industrial.

Chapter 1
The Ajax Mine Proposal

I used the Ajax Mine Proposal as the background to my research. Using the Ajax proposed site as the site for my design, I wanted to understand the mining processes that they intended to use and the reasoning for each decision in the plan of the mine.

Situated on the southwest edge of the city of Kamloops, the Ajax Mine proposal will sit partially within the city boundaries.

As an alternate proposal, I intend to sculpt the site using the distribution of the waste material. The spreading of the waste material would occur throughout the mining process and move across the site, creating a place of discovery and promoting progressional reclamation and reuse.

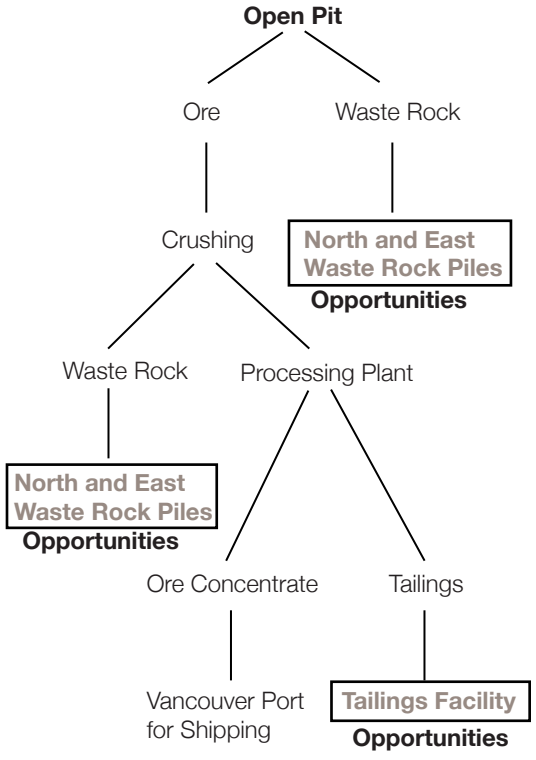
Figure 1: City of Kamloops: Seen from Coal Hill between Ajax Mine and the City

1.1 Background

Open pit mineral mining has been an immensely large industry in the interior of British Columbia for many decades. With many mines currently in operation and a number more proposed, the landscape of the region is being altered in a very drastic way. These mines are a major contributor to the local economy, but currently in Kamloops, BC news about the opening of a new open pit mine on the edge of the city has created extensive debate and an outcry from the citizens.

With many questions regarding their health and their environments safety, Kamloops citizens have questioned the mine on many aspects of the Ajax proposal. As the mine is still working on their application, they have taken these concerns into consideration, making their proposal stronger. This will alter their industrial process as they take measures to ensure minimal intrusion and therefore greatly increase their chance for approval.

Figure 2: The Existing Ajax East Pit



In the fall of 2011, KGHM Mining Inc., a Polish gold and copper company, proposed to further develop the Ajax Project near Kamloops British Columbia, and expand the historic copper and gold open pits. Situated southwest of the city, the current Ajax pits sit approximately 1 km from the city boundary and have sat quiet since 1997.

In 2005 exploration in the area led to the discovery of a large low-grade copper-gold deposit. Upon commencing production, with the expected start date in 2015, the mine is planned to operate for 23 years (KGHM Ajax Mining Inc., n.d). Approximately 60,000 tonnes of ore will be processed at the mill per day with the total material predicted to move from the pit being 1,702 Million tonnes (Mt) during the life of the mine.

After processing, the ore concentrate will be trucked to Vancouver where it will then be shipped to further destinations all over the world. The waste rock will be moved out of the pits by truck then crushed and conveyed to one of the two waste rock facilities (Figure 3).

With the mine site boundaries crossing the legal borders of the city, many of the industrial facilities will sit entirely or partially within the city of Kamloops. The North Waste Rock Management Facility, ore and soil stockpiles, Processing Facility and truck stop will lie within the boundary while the process water intake and line, Tailings Storage Facility, Thickened Tailings Plant and emergency pond will be situated partially within these limits (Knight Piésold Ltd., 2012).

Figure 3: Material Movment in the Mining Process

Excavation will resume in the two small existing pits and expand to form one large pit that consumes 263 ha of the current industrial site and surrounding ranch land. The pit will reach a depth of 450 m and will remain just outside of the legal city boundary. Due to its location it will require the removal of a few small hills, and the diversion of a portion of Peterson Creek.

Once the ore is extracted from the rock, the excess waste material will be distributed to one of three facilities. Rock from the pit that contains little to no copper or gold, will be conveyed to either the North or East Waste Rock Facilities. After processing, which removes the minerals through flotation and chemical processes, the waste material will be pumped as a slurry mixture to the Thickened Tailings Plant where a chemical binder will be added before depositing it in the Tailings Storage Facility (KGHM Ajax Mining Inc., n.d).

The North waste rock facility will contain 728 Mt (the equivalent of filling 1, 250 km of the Red River) of waste and will have an elevation of 1,084 meters above sea level once deposition is complete. The East waste rock facility will top out at an elevation of 1060 m and will contain 420 Mt of rock material (the equivalent of filling 720 km of the Red River). These piles will be re-contoured following the mine closure, capped with stocked overburden and topsoil, mulched and finally seeded to create potential grazing plateaus.

The tailings pile will be located to the west of the Pit and Waste Rock Facilities, between the Coquihalla Highway and Lac Le Jeune Road. This

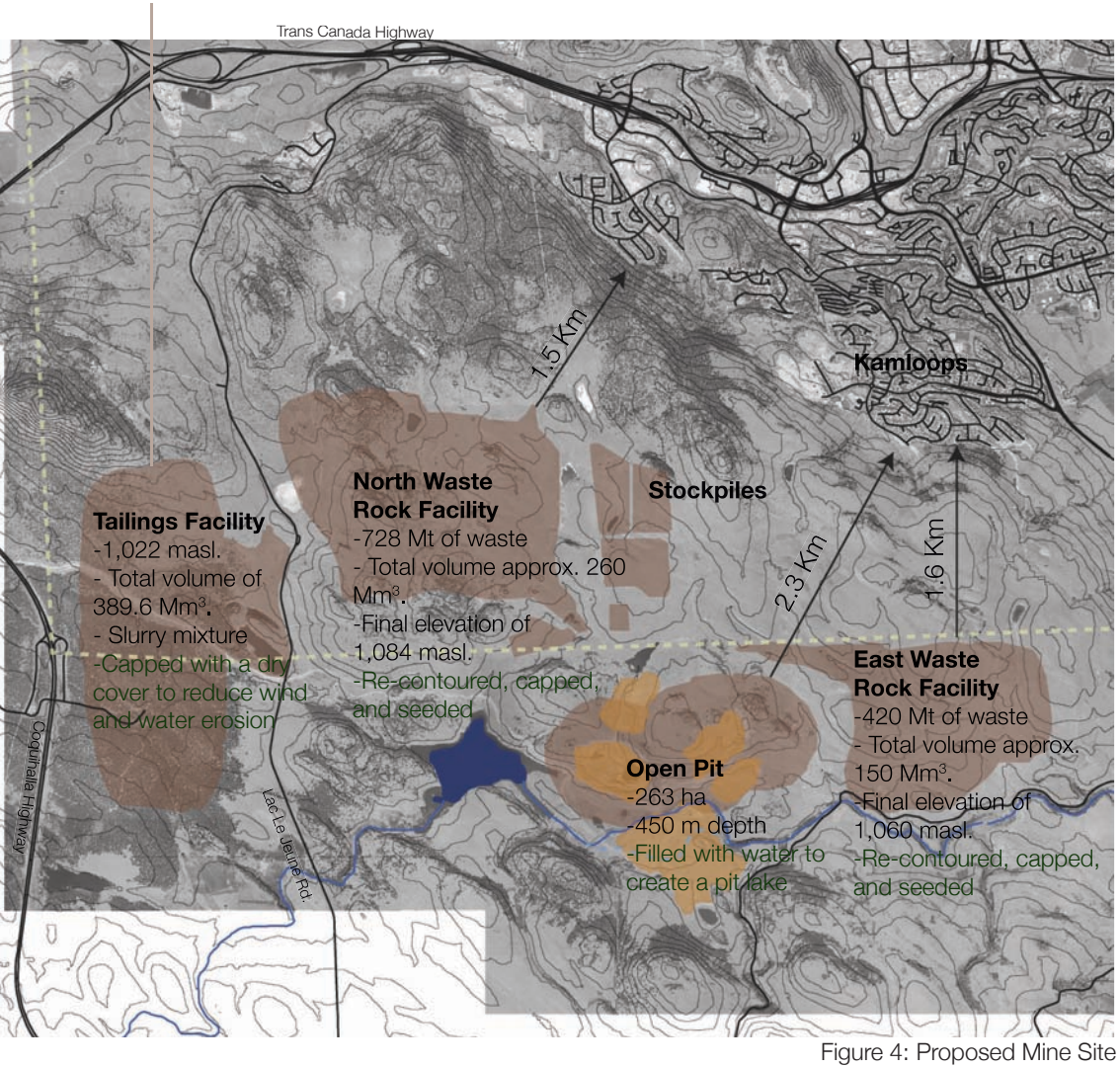


Figure 4: Proposed Mine Site

pile of slurry will reach a maximum of 1,022 meters above sea level and will have water collection ditches to divert any seepage to the Tailings Storage Facility pond where it will be contained and treated. Upon closure the tailings will be capped with a dry cover that will reduce wind and water erosion. The Tailings Storage Facility ponds will be reverted to wetlands once discharge requirements are met.

Following the end of the extraction processes, an expected 23 years, the surrounding site drainage will be altered to redirect runoff towards the pit. The pit will be filled to create a lake that will eventually become part of the Peterson Creek watershed (Knight Piésold Ltd., 2012).

Pre Mine

1. Are you aware of the Ajax Mine Proposal?
2. What is it about the Ajax Mine that Interests you? What do you see as the positive affects of the mine?
3. What is it about the Mine proposal that concerns you? What do you see as the negative affects of the mine?
4. (Dependant on previous answers) Do you have concerns in regards to environmental issues?

Mine Operation

5. As Kamloops is already a mining town, do you consider the lifestyle and the citizens who live here to change with the implementation of the Ajax Mine?
6. Would you be interested in being able to see and experience the processes of mining and learn about mining history?
7. As part of the mine is to be within city boundaries, should it change the way the mine operates?
8. Do you see the Ajax Mine affecting the city differently than the New Afton Mine, 9 Km away?

Post Mine

9. What would you like to see as an end result to the site?
10. If the revitalization plans were made public would it alleviate some of your concerns?
11. If there was an alternative end result for the mine, would you be more inclined to support it?
12. The BC Mines Act states that the land surface shall be reclaimed to an end land use approved by the chief inspector, that considers previous and potential uses. Based on previous uses what do you believe the most important land use would be? Putting it back to a natural state, ranchland, or preserving the mining history?
13. Landscahftspark Duisburg Nord is a park in Duisburg Germany that is a celebration of the industrial past of the city and RuhrDistrict. The industrial structures were preserved and kept as monuments while plantings and a circulation system were implemented making the site accessible while revitalizing and accentuating the production processes. What do you think of this park?
14. With Kamloops and the Thompson Nicola Regional District (TNRD) having a rich past in gold and copper mining are the history and memories of this past important to preserve and celebrate?
15. After doing this interview is there anything else you would like to add? Are there any questions that I have missed?

Figure 5: Interview Questions

1.3 Public Opposition

Due to the proximity of the proposed mine, the citizens of Kamloops are concerned about how the industry will affect themselves and their city. Because of this concern, the Kamloops Area Preservation Association (KAPA) has started a movement to “Stop the Ajax Mine.” This opposition group has distributed information regarding the mine proposal and is posing questions regarding health and environmental affects, which they hope KGHM will address before the mine begins production (Kamloops Area Preservation Association, 2012).

After hearing many of the KAPA’s comparisons and concerns I was interested in talking to people in Kamloops to find out first hand their thoughts on the imminent industry. Being a popular topic of debate at the moment, gathering information about people’s enthusiasm or concerns regarding the Ajax Mine was a simple process. On a return visit home I was able to interview a number of Kamloops citizens, a few also being mine workers at other mines in the area. I discovered many views both positive and negative regarding health, environmental, and social affects of the implementation of the mine (Figures 6 +7, more information in Chapter 4, Community Analysis).

I broke the questions into three groups: people’s feelings about the mine proposal, what they knew about open pit mining, and assuming the proposal will be accepted, what they felt was appropriate for the site following production (Figure 5). My questions were targeted at gaining information regarding the community opinions about the mine and what the perceived affects were. This information gave me multiple directions in which my practicum could take.

Figure 6: Benefits of the Mine to Involved Parties

Many people believe that the industry will benefit the economy of the city of Kamloops but believe that there are still many issues that need to be addressed. Whether in support or opposition of the mine, the location of the site and its proximity to the city is the underlying cause for the majority of concerns. It is here that I see an opportunity for the site. Following the closure of first pieces and eventually the entire mine, the closeness provides a chance for the city to utilize these new land features.

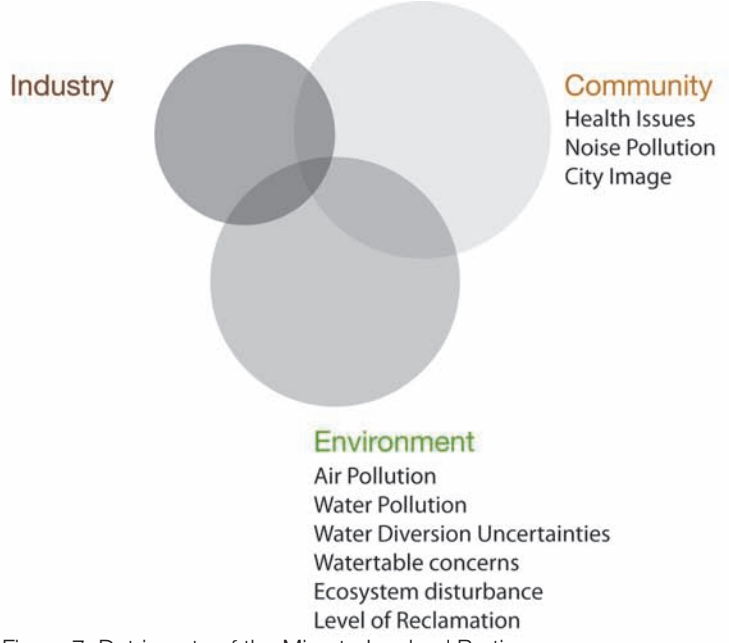


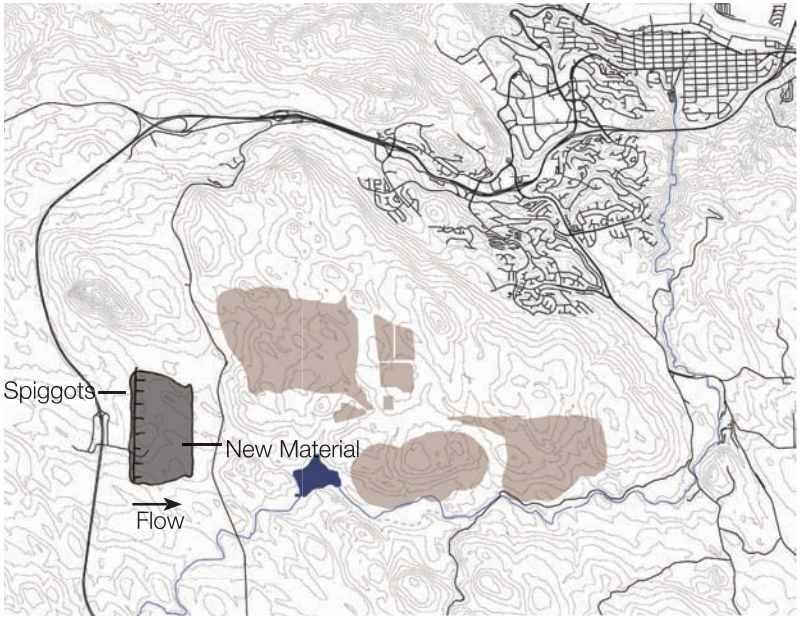
Figure 7: Detriments of the Mine to Involved Parties

1.4 Site Layout and Material Distribution

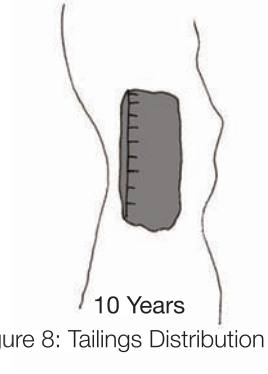
Tailings

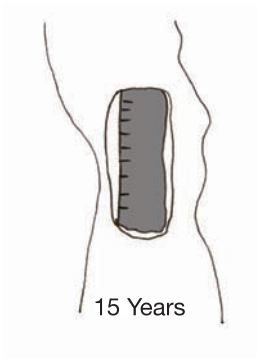
Situated between the Coquihalla Highway and Lac Le Jeune Rd., 3.5 km west of the open pit, the site of the Tailings Storage Facility (TSF) was chosen due to the ease of water management, and access and proximity to the mill (Abacus Mining and Exploration Corp, 2012). It is to sit in a shallow depression with Sugarloaf Hill at the northernmost point and the Coquihalla Highway climbing up on the west. The TSF sits lower than the rest of the mine site and the underlying topography slopes gently towards a low spot on the western side of the pile.

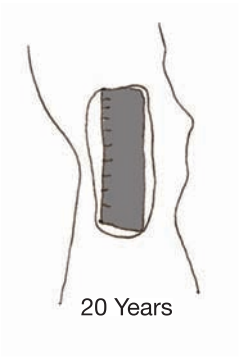
At the northwest corner of the Tailings Storage Facility a Thickened Tailings Plant will receive the tailings from the processing plant and pass it through thickeners to remove most of the water. The water will then be sent back to the mill and the thickened tailings pumped to the west side of the Tailings Facility where it is to be discharged through spigots to create a gentle east sloping mound (Figure 8). Waste rock from the pit will be used to initially build up the west side and establish a slope for the tailings to flow over. This will also be done periodically throughout production to stabilize the pile and keep the west edge higher for a continuously east sloping formation (Abacus Mining and Exploration Corp, 2012).

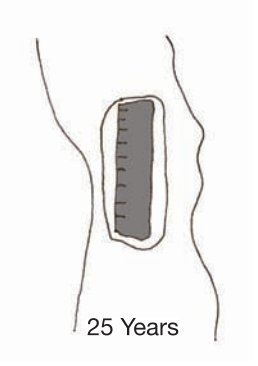


5 Years









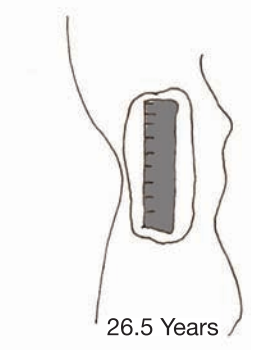


Figure 8: Tailings Distribution

Waste Rock

The location of the Waste Rock Facilities was chosen based on the water flow in the area. Originally looking to place the storage facilities to the south KGHM Ajax Mining Inc. found that the surficial water flow to Peterson Creek and Jacko Lake came from this direction, therefore the facilities were proposed in their current locations to the north and east of the pit (N. Thompson, personal communication, March 23, 2013). In these locations, the waste rock will be spread to fill numerous depressions amongst the rolling hills and create flattened plateaus.

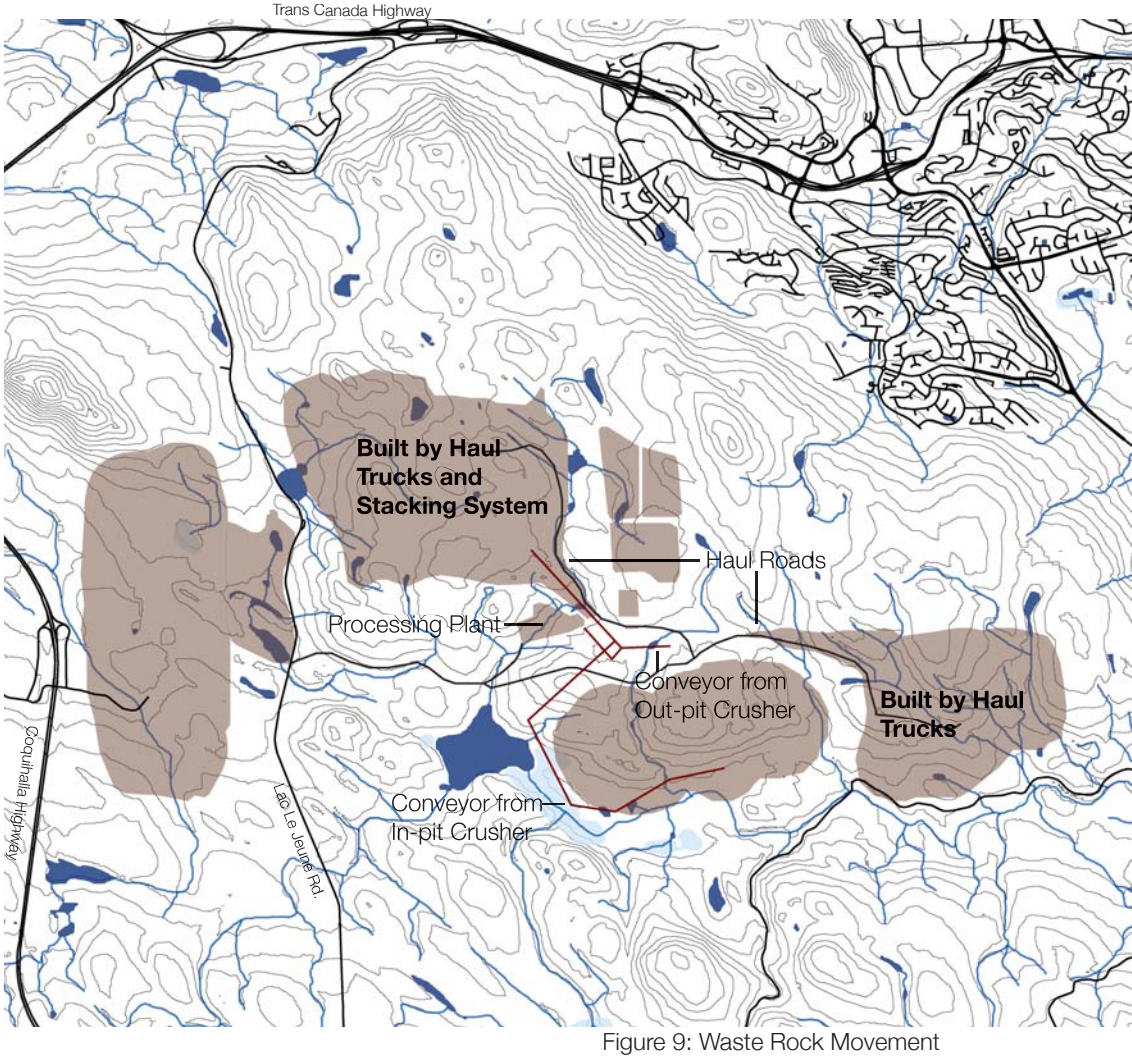
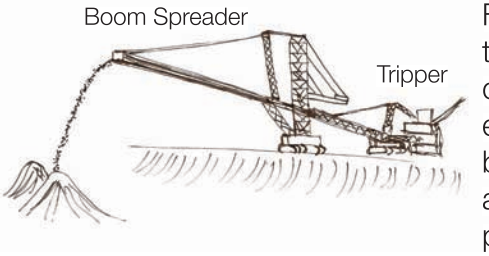
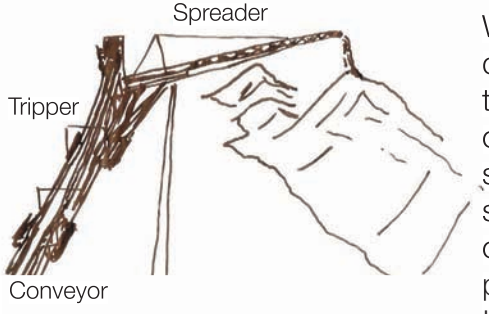


Figure 9: Waste Rock Movement



From the open pit, the North Waste Rock Facility (NWF) will be situated to the northwest while the East Waste Rock Facility (EWF) will be directly east. Beginning directly north of the processing plant, on the eastern side of the proposed pile, a section of the north dump will be built by haul trucks to its final elevation of 1,084 m. Once at this height a conveyor system will be utilized to carry the rock from the pit, to this point, and will be distributed by a stacking system. The conveyor system from the pit to the top of the pile is expected to be 35 m wide with the capability to move material one third of its size (Abacus Mining and Exploration Corp, 2012).



Waste rock distribution schemes can vary with combinations of different machinery. For this practicum, I have attempted to understand the capabilities of these machines and how they can be used in combination. The Ajax proposal currently states that “the stacking system will consist of shiftable conveyors, traveling tripper, and spreader……stacking will be developed using downcast mode, carried out by radial advance stacking by shifting the conveyor around a pivot point (Knight Piésold Ltd, 2012).” Not knowing the specific machines that will be used I have come to understand two possible techniques for waste distribution that could fit this description (Figure 11).

Figure 10: Waste Rock Distribution Machinery

For both techniques, the waste rock is brought to the final height of the North Waste Rock Facility by an overland conveyor system. Once at the top of the pile, the material is dumped onto another conveyor system. This second conveyor belt runs along the eastern edge of the pile, which has been formed by the haul trucks (Abacus Mining and Exploration Corp, 2012). The spreader then runs along this conveyor dumping the waste material off of the edge. Once the spreader reaches the end, the conveyor can move onto the material that was dumped and continue back down the track.

At this point, the movement and machines can vary. This second conveyor can rotate radially from the point where the first conveyor dumps its material (FLSmidth, 2012). As an alternative an additional conveyor can run perpendicular and Conveyor two can move laterally with the third conveyor transferring the material (Tenova Mining & Minerals, 2013).

Instead of having the material spread in a line, a Mobile Bridge Boom Stacker, on crawlers, can be added, in each technique, to increase the distance between the conveyor and the edge of the pile (Figure 10) (FLSmidth, 2012).

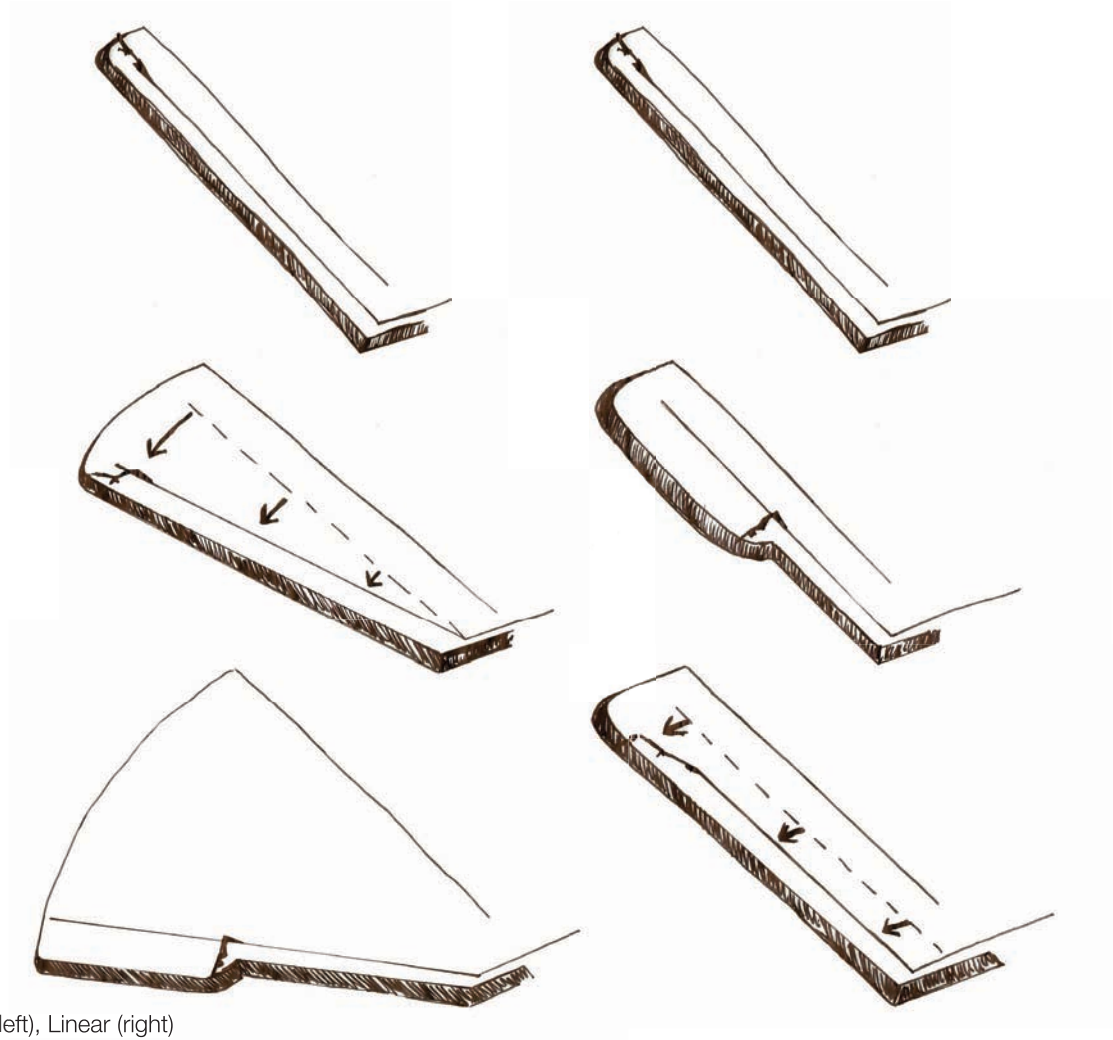


Figure 11: Conveyor Movement Radial (left), Linear (right)

1.5 Design Intentions

The Ajax Mine proposal, techniques of open pit mining waste distribution, and community proximity to the site guided my design process. With the proposed facilities being in such close proximity to neighbourhoods, the affect on the community requires more consideration than strictly leaving after production and covering up the mess. While not yet in operation and with the landscape still free of waste material, there is an opportunity for Landscape Architecture to play a role in the shaping of the industrial landscape.

With design involvement, the site has the potential to benefit the community and aid in the expansion of reclamation processes. The industry is currently seen as a destroyer of the environment, but metals are needed and mining is going to be around for a long time. Progressional reclamation has the potential to work along side production, allowing for areas of the site to regenerate at an earlier stage therefore turning over more quickly for the communities use.

An understanding of the techniques and machines that are used in the mining industry to distribute the waste material aided in rethinking how they would move across the site. The purpose of this was to utilize the landforms that they create in a more radical way, generating a diverse landscape in which opportunities for ownership will be present.

Throughout the design process, the following design intentions were considered.

- Reduce Mining destruction
- Develop an alternative land use
- Encourage ecological regeneration and biodiversity
- Allow for progressional reclamation as the mine operates
- Encourage awareness of Kamloops' industrial economy and history
- Alter perceptions of mining
- Encourage site awareness
- Create a draw or an interest
- Encourage Exploration
- Celebrate and explore the temporality of the site

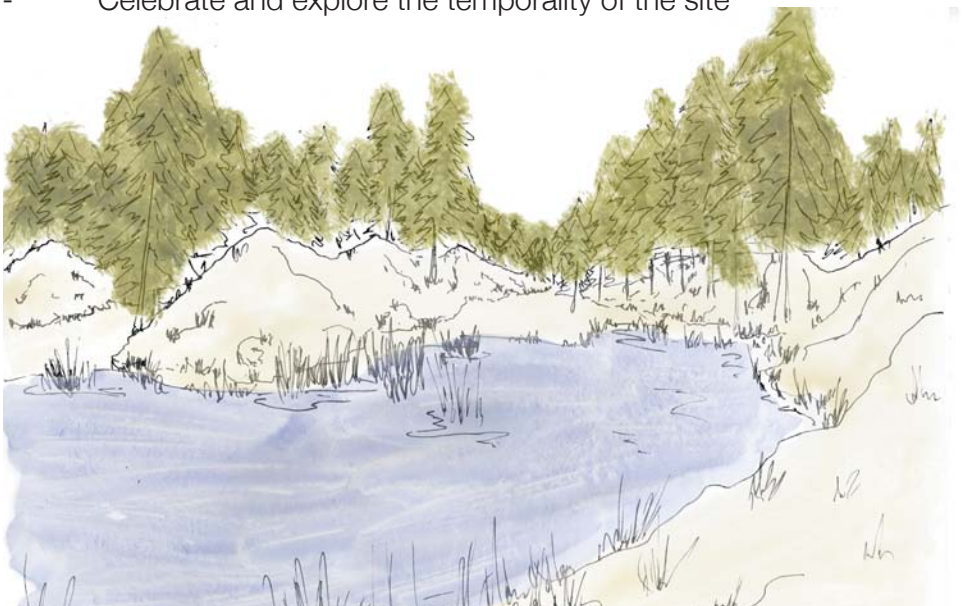


Figure 12: Design Proposal Pocket Lake (chapter 5)

Chapter 2
Regional Patterns: Thompson Nicola Regional District

Mining has been present in the Kamloops area for more than 150 years. From the first flakes of Gold found in Tranquille Creek, the minerals in the region have been a major contributor to the formation of Kamloops and the drastic changes to the landscape.

Discovering how the land was formed, inhabited and altered in the search for minerals, has contributed to my understanding of the interior of British Columbia and the mining industry. This history has been forgotten in many community members' discussions of the Ajax Mine Proposal.

The involvement of Landscape Architecture has the potential to bring this history back to view while simultaneously contributing to the healthy active image that Kamloops is currently representing.

Figure 13: Kamloops Landforms

Situated in the Interior Plataea of British Columbia, the rolling topography, mineral deposits and silty soils of the Kamloops region have a rich history that tells about the formation of the landscape.

200 million years ago the soils and rocks of Kamloops sat at the bottom of the ancient Pacific Ocean. Island volcanoes were formed and the continuous intrusion of magma, or melted rock, below the surface formed the copper ore bodies that have made mining in the region so popular today (Tourism Kamloops, 2012).

With the movement of North America, the edge of the forming continent collided with the volcanic islands fusing them together and extending the coastline westwards.

Following the extinction of the dinosaurs, volcanoes in the area erupted covering the landscape in ash and lava and forming the plateaus of the interior. Ancient Rivers cut through this volcanic material forming the valleys of the Thompson River watershed that we know today. It was these rivers that, as they flowed west, created the brow of the hill that separates the Ajax Mine site from the community of Aberdeen and the city below.

Two million years ago, BC was covered with Ice sheets. As this ice receded the land was further carved creating the landscape that we can see today. Ice movement was predominantly to the southeast, rounding out mountains and plateaus and depositing glacial till. Drumlins, mounded glacial till, are common in the area and trend towards the southeast, following the direction of the receding ice sheets (Kerr et al., 1993). These rolling deposits can be seen flowing across the plateau surrounding the Ajax site.

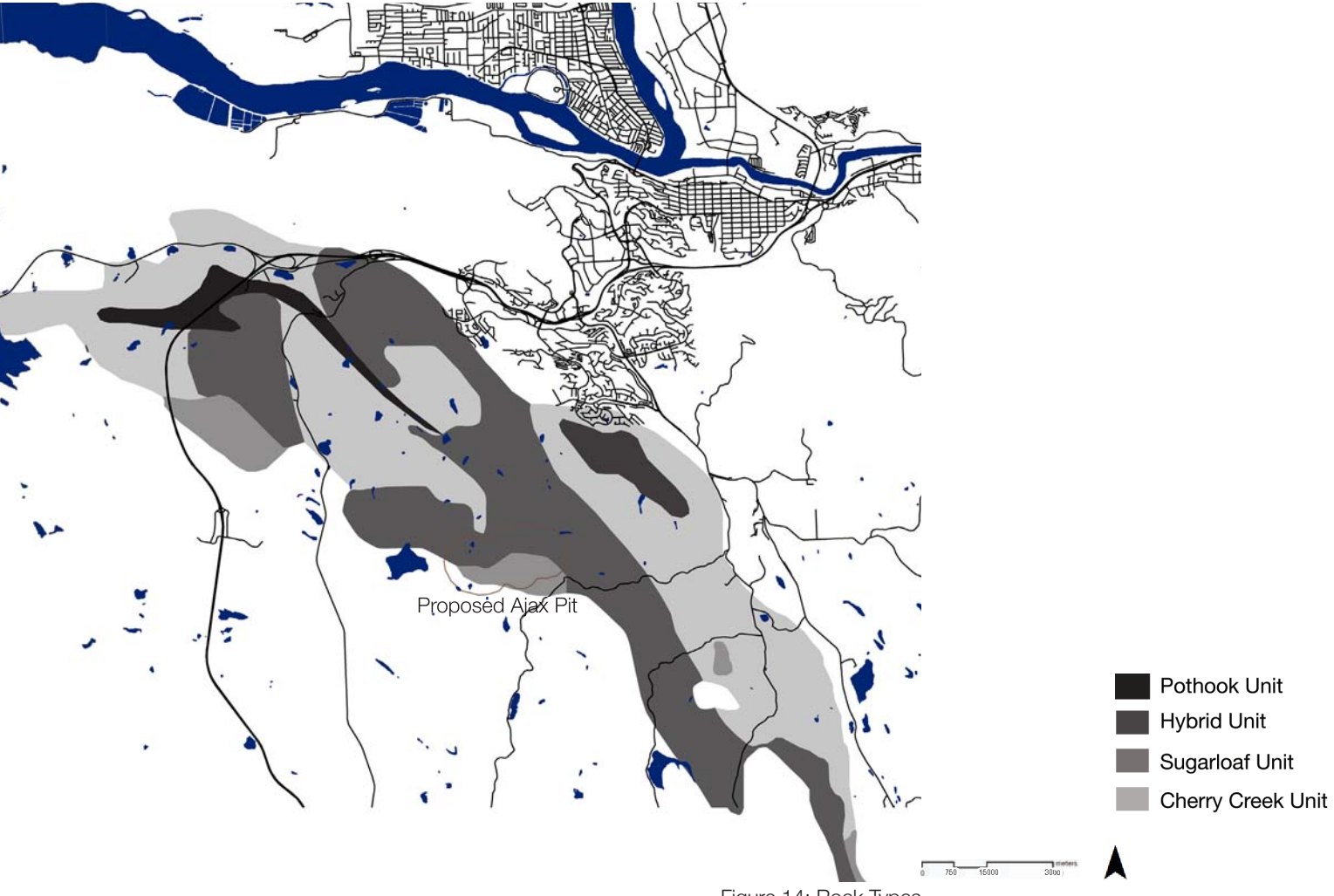


Figure 14: Rock Types

2.2 Mineral Deposit

The layering of oceanic sediment, intrusive magma, volcanic ash, lava and river sediment has created a complex system of rock formations in the Kamloops region.

Running in a northwestern direction underneath the southern hills of Kamloops, and through the Ajax site, is the Upper Triassic Iron Mask Batholith. This rock formation was created as magma, which was pushing towards the surface, intruded a pre-existing rock formation, the Upper Triassic Nicola Group (Falls & Friesen, 2009).

Magma intrusions occurred on numerous occasions creating multiple phases of rock units within the Iron Mask Batholith. Although all igneous rocks, each unit has different rock characteristics (more information in Chapter 4.2, Ajax Mine Site Analysis). The Pothook unit is the oldest rock unit in the batholith. Following this are the Hybrid unit, Cherry Creek unit and the Sugarloaf unit. The Ajax pit does not touch the Pothook unit.

Mineralization within the Iron Mask Batholith can be found within the Cherry Creek and Sugarloaf phases and is located along major fault zones trending easterly or southeasterly through the area (Falls & Friesen, 2009). At the location of the proposed Ajax pit, the Sugarloaf unit is highly fractured. At the northern end of the existing East pit, where the Sugarloaf unit contacts the Hybrid unit, a major fault is present (Falls & Friesen, 2009).

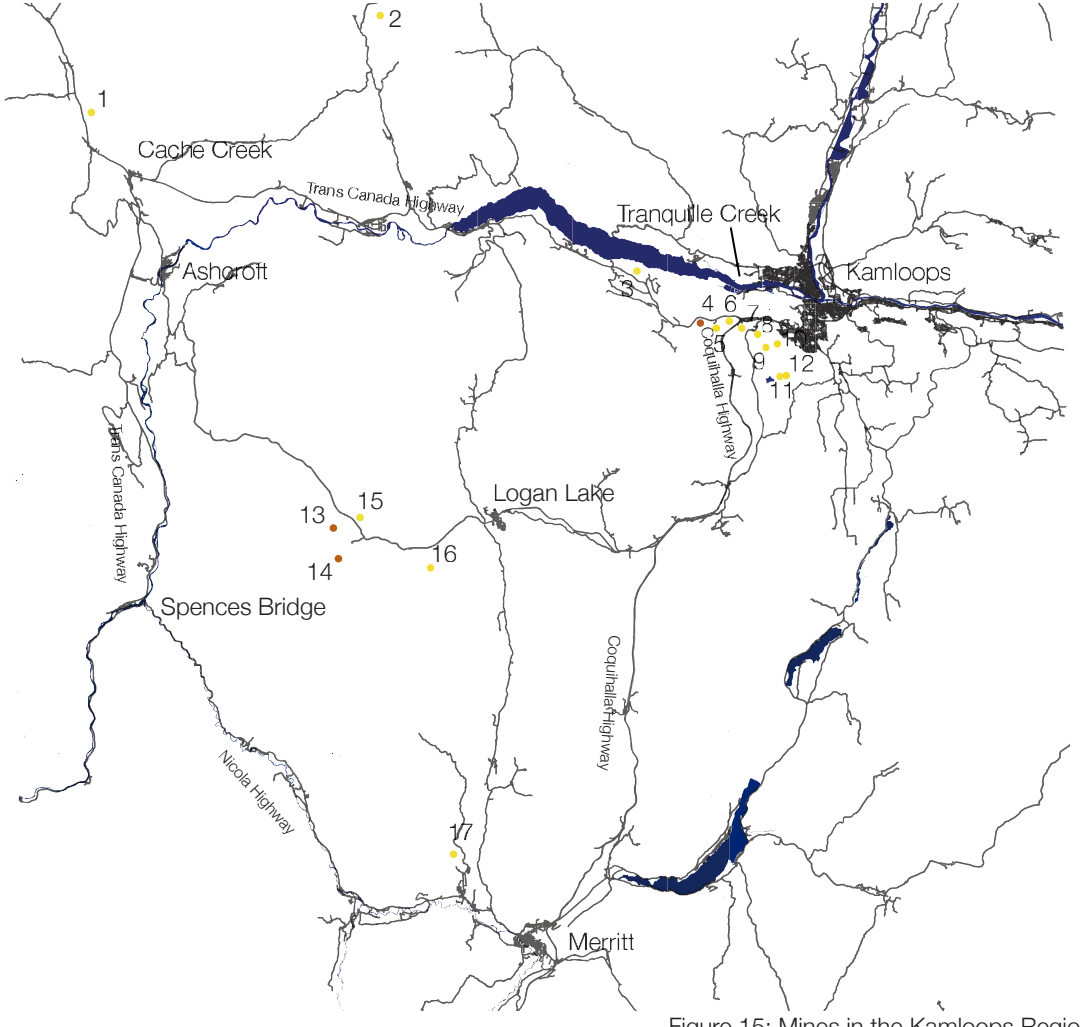
2.3 Kamloops Mining History

In the 1850's gold was discovered in the Kamloops area. In the early days of the Cariboo gold rush, prospectors traveled from Victoria up the Fraser and Thompson Rivers after obtaining a mining license. Miners from the Okanagan also passed through the Kamloops area on their way to the Cariboo goldfields. Discovering that Tranquille Creek in Kamloops had gold, many prospectors delayed their journeys north (Favrholdt, 2008). While many panned Tranquille (refer to Figure 15), the knowledge of minerals in Kamloops led others to search elsewhere around the area.

With the gold in Tranquille Creek diminishing, mining in the Kamloops region turned from panning to more permanent methods. Those still wishing to keep Tranquille alive turned to hydraulic techniques and the establishment of companies (Favrholdt, 2008). Shaft mining became popular on the surrounding hillsides and at the turn of the century, the south shore of the Thompson River had become vibrant with mining claims and exploration (British Columbia, 1897).

The road through the Thompson River Valley also saw benefits from the influx of miners. While Kamloops became a major destination along their route north, smaller mining towns and mining claims were established along the way. Many of these claims have resulted in further development throughout the 1900s and the establishment of major mining companies still operating today.

This history has played a vital part in the settlement of Kamloops. Having brought some of the first settlers to the region, mining continues to bring employees to the Kamloops area and provides thousands of jobs for the community. Many of the historical mine sites have been eliminated due to dilapidation and subsequent exploration but these sites still remain destinations for Kamloops explorers.



Active Mines

4. New Afton Mine
13. Highland Valley Mine
14. Lornex Mine (Highland Valley)

Former Mines

1. Maggie Mine
2. Vidette Lake Mine
3. Glen Iron Mine
5. Cliff Deposit
6. Crescent Deposit
7. Iron Cap Deposit
8. Iron Mask Mine
9. Galaxy Deposit
10. Python Deposit
11. Ajax West Pit
12. Ajax East Pit
15. Highmont Mine (Highland Valley)
16. Bethlehem Mine (Highland Valley)
17. Craigmont Mine

Figure 15: Mines in the Kamloops Region

2.4 Ajax Site History

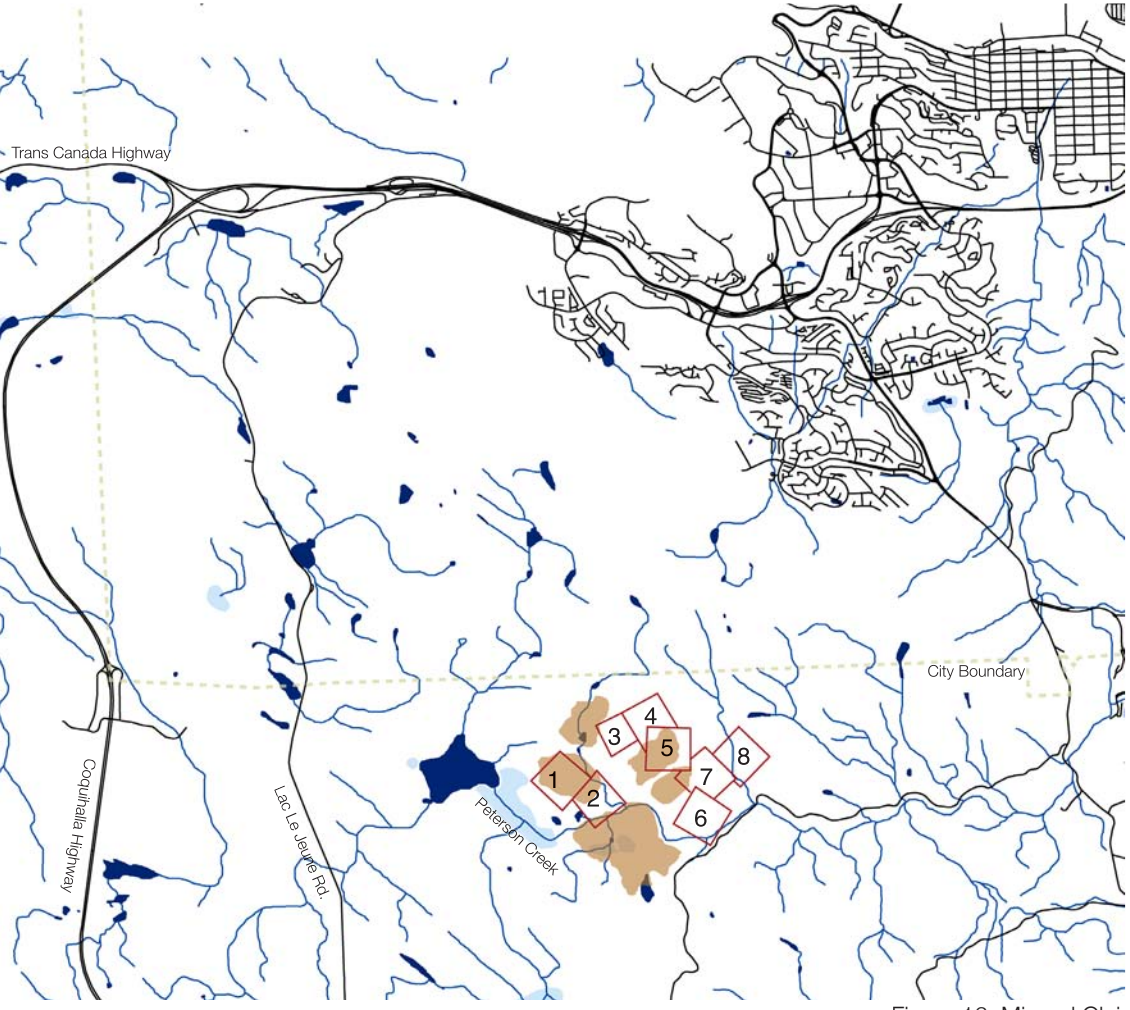
In the 1880's exploration in the Iron Mask Batholith resulted in the establishment of the Iron Mask copper-gold underground mine in 1896, approximately 1 km north of the proposed Ajax North Waste Rock Facility. Achieving the steadiest production in the area at the time, Iron Mask produced about 100 tons by 1900 when the property closed. It opened again later under new management and continued to change hands throughout its production life (Porteous, 2012).

In 1900 trenching began on the Ajax Claims, surrounding the existing Ajax west pit (1). Shafts were part of the original workings on the Wheal Tamar (5), Monte Carlo (7) and Ajax Claims (1). In 1929, the Consolidated Mining and Smelting Company of Canada Limited sampled the Ajax claim (1) and found sparse mineralization. Between 1954 and 1980, CM&S, later becoming Cominco Limited, did additional exploration work with newer technologies (Falls & Friesen, 2009).

In the 1970's exploration and claims increased in the Iron Mask Batholith following the discovery of the Afton deposit to the west of the city of Kamloops. In 1973 Afton Mines Ltd. began further exploring the Ajax (1) and Wheal Tamar (5) claims and in 1980 discovered a reserve of copper, gold and silver. Further exploration results indicated a large low-grade deposit with open pit potential. In 1986, Cominco Ltd., E&B Explorations Ltd., and Afton Operating reached an agreement for Afton Operating to place the property into production. This began in June 1989 following further drilling and evaluation projects and feasibility studies (Falls & Friesen, 2009).

Due to low metal prices between 1991 and 1994, production in the Ajax East and West pits was suspended. The pits officially closed again in 1997.

Beginning in 2005, after acquiring 8 crown grants covering most of the Ajax East pit, Ajax West pit and the Monte Carlo area (Figure 16), Abacus Mining and Exploration Corporation completed numerous drill holes around and under the existing pits. From this, resources of low-grade copper and gold were found below the pits (Falls & Friesen, 2009). This discovery led to the Ajax Proposal and the desire to resume extraction from the site.



Mineral Claims in the Ajax Project

1. Ajax
2. Neptune
3. Copper Star Fracture
4. Forlorn
5. Wheal Tamar
6. Grass Roots
7. Monte Carlo
8. Sultan

Figure 16: Mineral Claims

2.5 Mine Reclamation

Both the Federal and Provincial governments require that an environmental assessment be completed prior to any construction or production of the mine site. This assessment includes any potential environmental, social, health, heritage, and economic affects and the measures that need to be taken to prevent any harmful outcomes.

A closure plan and a revitalization plan are developed based on this information and address the issues of land use after production. The plans are required before any mining can begin on a site (British Columbia Ministry of Energy, Mines and Petroleum Resources, 2008).

The BC Mines Act, the Health, Safety and Reclamation Code states that:

- The land surface shall be reclaimed to an end land use approved by the chief inspector, that considers previous and potential uses. (Section 10.7.4)
- Land, watercourses and access roads shall be left in a manner that ensures long- term stability. (Section 10.7.6)
- On all lands to be re-vegetated, land shall be re-vegetated to a self-sustaining state using appropriate plant species. (Section 10.7.7)
- Where practicable, land and watercourses shall be reclaimed in a manner that is consistent with the adjacent landforms. (Section 10.7.9)
- Dumps shall be reclaimed to ensure 1) long-term stability, and 2) long-term erosion control. (Section 10.7.11)
- Watercourses shall be reclaimed to a condition that ensures 1) drainage is restored either to original watercourses or to new watercourses which will sustain themselves without maintenance, and 2) the level of productive capacity shall not be less than existing prior to mining, unless the owner, agent or manager can provide evidence which demonstrates the satisfaction of the chief inspector, the impracticality of doing so. (Section 10.7.12)

Sections are also included that declare the removal of structures, monitoring of water quality and security of openings but in the case of this practicum the previously stated sections are of importance.

Figure 17: Waste Rock Pile from Existing Pits

In the Interior of British Columbia, ranching is a considerable land use option for reclaimed mine sites. As ranching is also a large industry in the grasslands of the interior, waste facilities are commonly converted into grazing plateaus (Figure 17). Cattle can help in reclamation processes as they fertilize the soil and are capable of compacting slopes that are difficult for machinery (Gizikoff, 2003).

For this land use, mines flatten the tops of their waste facilities and gently slope the sides. They are re-vegetated with grasses, and though intended to be consistent with the surrounding landforms, they stand out in stark contrast as large, manmade mounds sitting on the landscape.

During the summer months, ranchers drive their herds to graze in the grasslands around Kamloops. Numerous ranches hold crown grazing tenures on land that is used jointly by recreational corporations (Sun Peaks Resort, 2013). Cattle can be seen wandering through the mountains at Sun Peaks Resort. It is apparent that ranching is present on the grasslands of the Ajax site but the fences also extend up onto and around Coal Hill, Ironmask Hill and Sugarloaf Hill.

If the cattle are able to graze on the steeper slopes of the Kamloops hills and crisscross highly used recreational trails what is the purpose of flattening the waste facilities and creating grassy platforms. Design involvement can alter the formation of the waste facilities, utilizing the sites for cattle grazing as well as other potential uses.

2.6 Findings

With a better understanding of minerals and mining in the Kamloops region, I was able to begin questioning the decisions of the Ajax Mine, and the current reclamation techniques used in British Columbia. From my examination of the area, the involvement of Landscape Architecture would benefit the revitalization process. The mining industry today is focused on hiding their presence on a site once production is finished, but it is because of the minerals and this industry that Kamloops, and the landscape around it, has developed to it's current state. Landscape Architecture can aid in combining these significant elements and develop a site plan that displays the past while still reclaiming the land that was destroyed.

Chapter 3
The Role of Landscape Architecture

The environmental movement of the 1960's changed the perceptions of the consumerist western nations in response to the extraction of the earth's resources. This environmental awareness influenced a change in reclamation regulations in the mining industry. As values of society changed, Landscape Architects and Land Artists began to play an active role in the reclaiming of old industrial sites (Krinke, 2001).

The perceptions of mining and the harmful effects on the environment have led North American's to see mining as a horrific industry. Many people forget that it is the lifestyles of the western nations that are driving the exploration for more minerals, and extraction of these resources will continue to boom as long as we are living this way.

Landscape Architects and artists are able to see the beauty and the potential that these sites hold, and through design are attempting to reduce the negative affects that they have on the land. Cleaning up contaminants and encouraging reuse of the site and structures is encouraging society to see heavy industries differently and attempting to provide a solution for their continued production.

Looking at the current, and past, involvement of Landscape Architects and Land Artists in postindustrial projects, helped me in understanding some of the issues that come with these sites. In regards to the Ajax Mine site, comprehending the process of material movement was difficult but projects by Kathryn Gustafson and Strijdom van der Merwe showed me possible formations and the capabilities of sculpting with large amounts of waste material. This research also brought perspective to the views and reactions that society has in regards to heavy industries and their affects on the environment.

3.1 Landscape Architecture and Post Industrial Design

Inner-city industrial sites, and those that are in close proximity to communities, are actively being recovered. Brownfield Redevelopment programs make remediating contaminated sites within cities a viable option for increasing property valuable and bringing a new function to the site (Berger, 2006).

Landscape Architects are often called in to address historical sites or those that have played an important role in the community and wish to be preserved. These sites have become celebrations of the past and important projects in the development of postindustrial design (Krinke, 2001).

Although these projects are important in regards to remediation and their presence in cities, the work is generally being done at the end of the industrial process. Landscape Architects are called in after the site has been damaged to develop a solution to clean up the mess.

The mining industry is one that has been present in North America for centuries and with the vast mineral deposits that the continent possesses and the high demand for metals, it will continue to be a productive industry (Berger, 2002). These sites are often much larger than the industrial sites around cities and create enormous destruction to the environment. Exploration and the development of new mines provide the opportunity for Landscape Architects to be involved in the early stages of the mine plans and the development of closure plans that address alternative functional end land uses.

3.2 Land Art

As societies values began to change regarding environmental degradation, a small group of Modernist artists left the gallery to go out into the landscape. These earthwork artists worked with the materials available to them on site- rocks, soil, water, topography, light and sky- while challenging the notions of art and drawing attention to the environment (Rogers, 2001).

Robert Smithson was one of these artists. He believed that the human intervention on the land was a part of nature and sought out industrial sites as places for his sculptures. He felt that art could address environmental remediation and could merge together ecology and industry. His works strove to draw attention to the site and the active human and environmental processes that affect it (Figure X). Intended to erode and change with the surrounding landscape, Smithson's works frequently took advantage of the overlapping layers of the site, expressing the industry and the beauty of the place (Krinke, 2001).

The massive amount of earth movement involved in open pit mining, and specifically the Ajax Mine, provides an opportunity to reshape the land. As the processes of mining are moving the material, their deposition provides an opportunity that the land artists of the Modern Movement never had, the availability and flexibility of a massive amount of earth. The form in which the mine waste is deposited has the opportunity to express the site and the environmental degradation of the mining process.

3.3 Strollology · Promenadologie · Spaziergangswissenschaft

The science of walking. To perceive the world through the act of walking or strolling.

The idea to walk, to take in the landscape and to explore, are concepts that excite me. In regards to the natural environment around Kamloops and my deep desire to walk around old industrial sites, the theories of Lucius Burckhardt helped me take my passion and bring it to my design process. In the 1980's Burckhardt, a Swiss theorists and professor, began taking his students on walks through the German countryside. His theory was that with the influence of the automobile, our perception of the world had become limited to destinations. With high-speed transportation, awareness of the journey between had become limited (Schmitz, 2006).

By walking, Burckhardt felt that one would have a more comprehensive and appreciative examination of the landscape. Slower movement allowed for lingering views and the opportunity to see smaller details (Fezer & Schmitz, 2012).

Burckhardt's theories on "Why Landscape is Beautiful" were also important to my understanding of the community's reactions in regards to the Ajax Mine proposal. He believed that "landscape" was a different concept for each person. When viewing a landscape, each person focuses on something different and how these are pieced together, along with our preconceived notions of landscape, create the image in front of you. Memories, experiences and images from each persons past play a role in their perception of a place (Fezer & Schmitz, 2012).

I have only known the Ajax site how it sits now, with the rolling grasslands and abandoned mine pits, and have been learning what it will become. The loss of many of the places on the site is upsetting, but my personal connections to it are limited. When I look at the site right now, I do not see what it used to be, as many people in Kamloops do.

This theory also made me question many people's desired reclamation outcomes. To many, the site is currently in a natural state. The view of the ranch land is charming and pastoral, but people in Kamloops have forgotten that it is not what the site was. It is a layer of the sites history. These questions of the natural site guided me in my design process. The many layers of the sites past and the new layer of industry portray the landscapes history, how viewers choose to see this is up to them and their desire to learn more.

3.4 Precedents
AM/PM Shadow Lines- Strijdom van der Merwe

In 2010 Strijdom van der Merwe was commissioned by the Living Edge of Africa Project (LEAP) to create a land sculpture at the De Beers Consolidated Mine, a diamond mine on the Namaqualand coast in South Africa. After suspending operations due to the inefficiency of recovering the remaining diamonds, much of the site is barren and restoration processes are anticipated to be too expensive and futile (Ferreira, 2010).

LEAP and Conservation International have joined together to develop a plan for the site that will help to reclaim the property and restore the economy of the impoverished region. The waste dumps and quarries that have been recognized as unable to support vegetation have been established as Land Art sites. Strijdom van der Merwe's Am/Pm Shadow Lines sculpture is the first piece in what will hopefully become a Land Art Park (Ferreira, 2010).

Using the materials found on the site, van der Merwe created a 100 m diameter circle that is composed of 2 m high ridges running NS and EW. Throughout the day, and changing with the seasons, the shadow lines of the ridges move and change, taking the 700 t sculpture and giving it a delicate, fragile appearance (Ferreira, 2010). The sculpture draws attention to both the mining process and the devastation that it has created on the landscape. Using the waste material, he has created something beautiful and instead of trying to hide the destruction, he has celebrated it and appreciated the rawness of the site.

Figure 18: Am/PM Shadow Lines. Earthworks by Strijdom van der Merwe

Known for creating flowing and rippling landscapes with the movement of massive amounts of material, Kathryn Gustafson sculpts the land to reveal the character of her sites. In 1984, she designed the Morbras Meeting Point, her first major solo project, in the Roissy- en-Brie community on the eastern side of Paris. With the creation of a retention pond by the Municipality, and the desire to avoid removing the soil from the site, Gustafson created a sculpted terrain around the new body of water (Amidon, 2005).

Approached as an interpretation of the site forces, landforms were created that designated areas for specific programs. The Strong, on the north side of the pond, is an interpretation of the most significant force acting on the site and creates a severe, sloping ridge. The Fluid, spills away from the ridge creating a shallower slope into the water. The Maternal force, most evident at the southwest corner encompasses the pond and allows for movement across the plateaus. On the Northwest, behind the Fluid, the Insidious force pushes at the Strong and encouraging it to arc around the pond. The east side of the site holds the Parasitic landforms which pull from the Maternal force and create small valleys along the pre-existing river (Amidon, 2005).

Within these formations, areas for recreation, and picnicking were created, as well as an amphitheater, camping terraces and wetlands to filter runoff and provide clean water for swimming (Amidon, 2005).

Figure 19: Morbras Meeting Point. Designed by Kathryn Gustafson

Chapter 4
Analysis

The topic of the Ajax proposal is popular with citizens of Kamloops and before beginning research I had already heard a number of people's opinions on it. A Community analysis (Section 1.2) was conducted to learn the specific concerns of the community in regards to this new mine. Introduced in Chapter 1, interviews were held with members of the community. In this analysis, answers from the interviews are further explored.

An analysis of the Ajax site and the proposed waste facilities (Section 1.2) was done with the intention of discovering the proposal's affect on the landscape and the community.

Intending to design a postindustrial site before the industry had begun, an analysis of the current site conditions was required. With 1,702 Mt of waste material placed on top of the landscape, most of the current conditions would be completely eliminated. The existing site analysis (Section 1.3) explored the conditions of this site and focused on discerning the characteristics that have drawn people to it.

4.1 Community Analysis
Interviews

Strong opinions have emerged from the citizens of Kamloops in regards to the Ajax Mine proposal. An opposition group has come forward that is circulating information about the detriments of the mine. Since KGHM International is still completing their assessments and their application, answers to many of the citizens' questions are still unknown.

Kamloops is a resource based city and dependant on the numerous industries that have played a role in it's establishment. With the implementation of the Ajax Mine, numerous jobs will be provided at the mine, in the mining industry and within the city in the service industries.

After conducting Interviews with members of the Kamloops community a number of concerns became apparent.

Environmental Issues
- Potential toxins leaching into nearby Peterson Creek and Jacko Lake.
- Ecosystem destruction
- The destruction of Inks lake and it's conversion to a Tailings Pond.
- Potential Chemical leaching from the Tailings Pile.

Health Issues
- Blasting vibrations, dust and noise affecting the ground stability and nearby communities.
- Dust, noise and diesel from the numerous vehicles constantly running on the site
- Air borne pollutants affecting the sunlight and air quality in a city that already has problems with air pollution

Landscape
- The site will be physically changed forever
- A massive hole will be left where previously there were rolling hills and creeks.
- The size and appearance of the Waste Rock Facilities and the Tailings Facility.

Figure 20: Area Comparison

During the interview process, I showed images of redesigned postindustrial projects in which the site was designed as a celebration of the industrial past. When asked if the processes of mining were important to Kamloopsians, many of them responded by saying that our history was important to maintain but that they would not want this site to be celebrated. Feeling that they were already aware of the processes of mining and not interested in learning more about it, a number of people compared their knowledge of Highland Valley Copper Mine to the Ajax Proposal.

As Highland Valley is one of the largest copper mines in the world, the processes are different than they would be at Ajax (Figure 19). The size of the pits, the proximity to the city and the quality of the mineral are all different. Opposition groups are misinforming people to look at Highland Valley as a reference to what will happen in Kamloops.

Interview Interpretation

After discovering the positive and negative affects that the mine was believed to have, I encouraged people to think about the revitalization plans for the site. Assuming that the Ajax Mine would proceed with production, I received a number of different answers for a potential end use, with some people putting a great amount of thought into their answers and attempting to think creatively.

- Returned to a “natural” state, or back to ranchland
- A park or open space
- Recreational facilities for camping, hiking, biking
- A multi functional site
- A new industry, something that continues to benefit the economy
- Gardens
- A fishing lake
- Fish farms
- Agriculture
- An industrial training facility
- A training or research site in partnership with Thompson Rivers University

After seeing examples of revitalized industrial sites a number of Kamloops citizens were able to recognize the sites potential for a new use. Realizing that it could never be put back exactly to the way it was prior to production enabled some people to see the site as an opportunity and the need for more design involvement to explore proposals for future use.

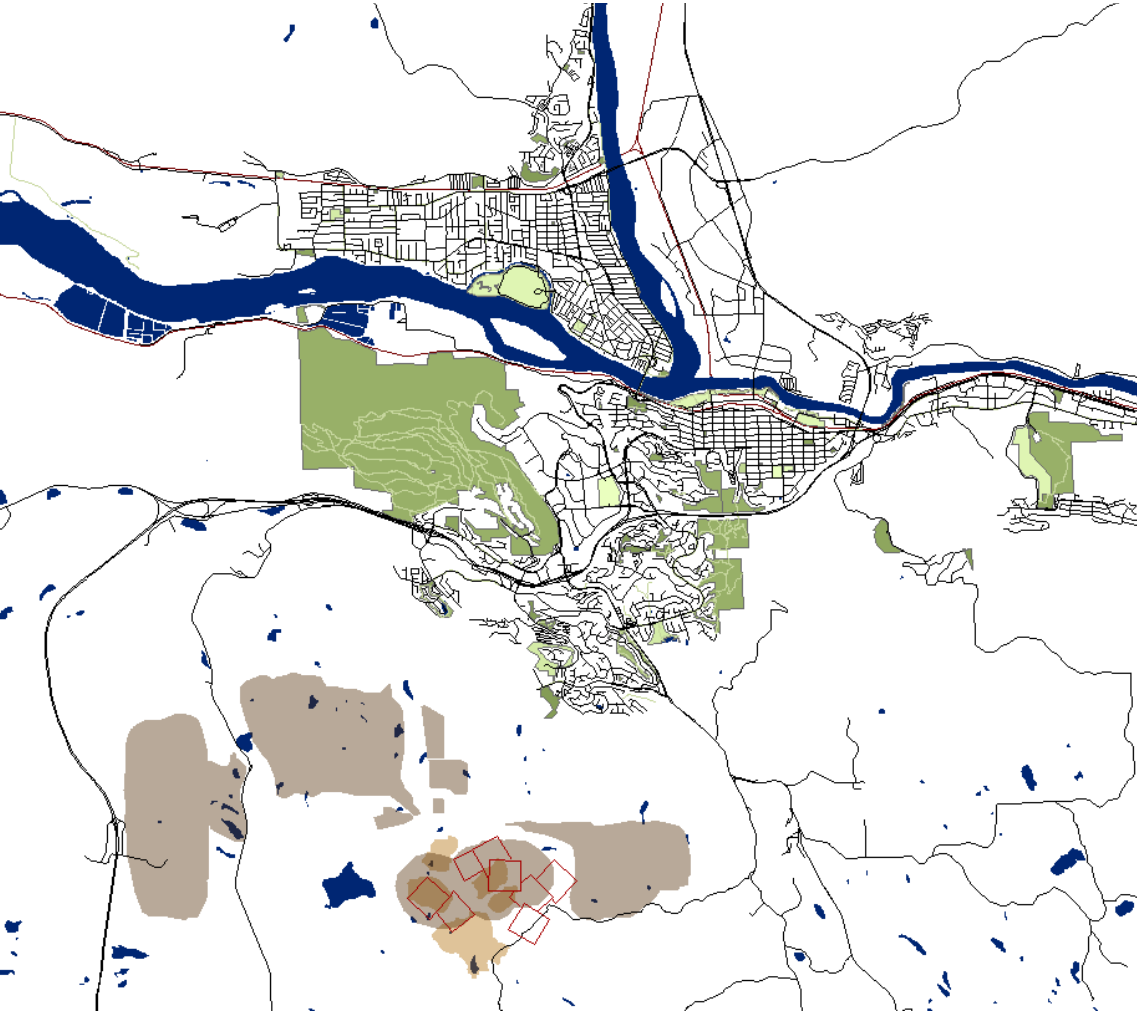


Figure 21: Parks and Recreation Spaces

Kamloops, Canada's Tournament Capital, prides itself on its healthy, active community and the opportunities for tourism and recreation in the area. Many people believe that with the implementation of the Ajax Mine and the air quality issues that may present themselves, health issues will emerge and Kamloops will no longer be a healthy, active community. How can we call ourselves the tournament capital if being outside is posing health issues? Kamloops has always been a resource dependant city and with the Domtar Pulp Mill, Lafarge Concrete, and transport industry, has managed to find a balance between tourism, active living and the heavy industries that have been here for years. With the execution of this new mine, opportunities to keep this balance will need to be created.

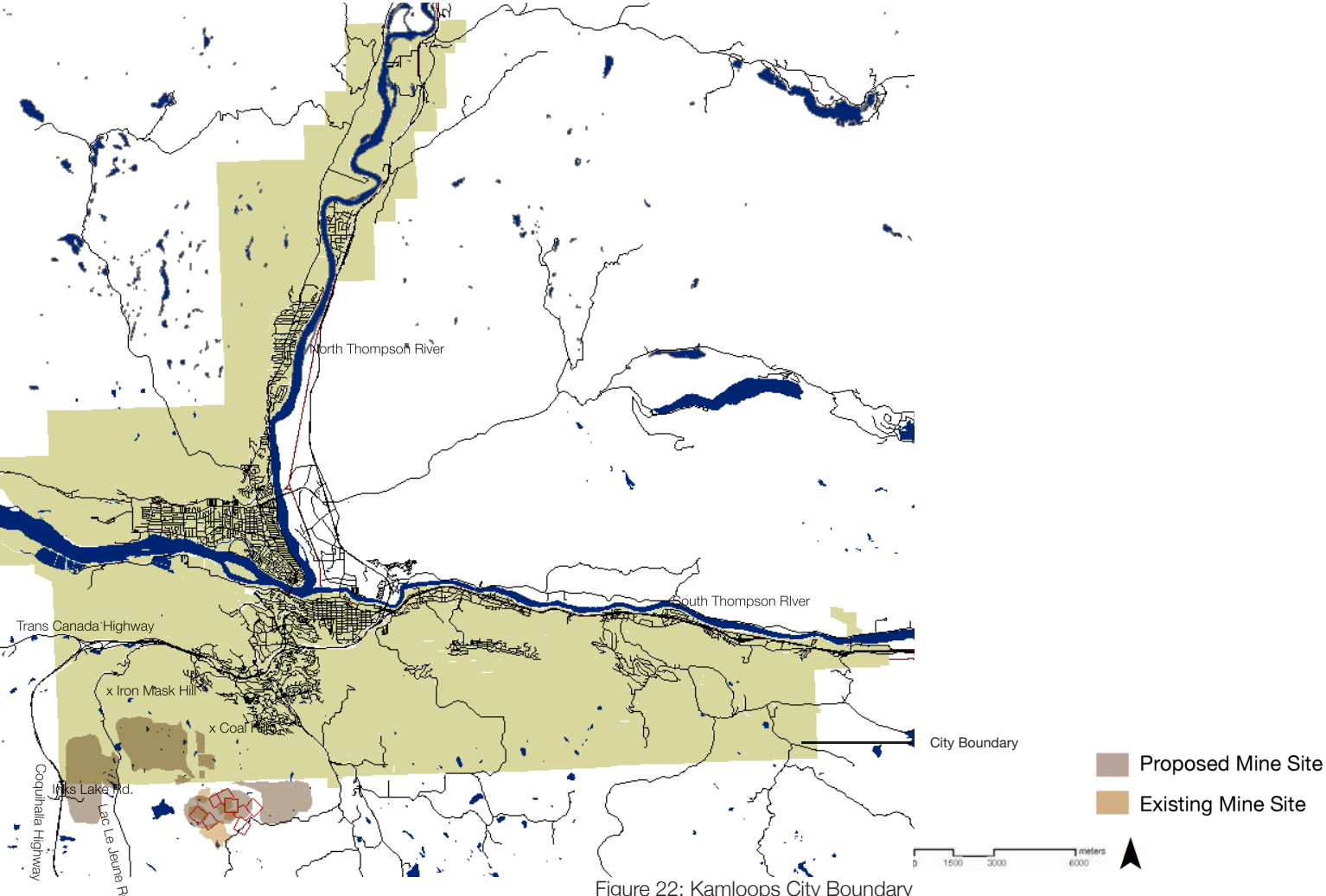


Figure 22: Kamloops City Boundary

4.2 Ajax Mine Site Analysis

Kamloops is situated in the Thompson Valley at the centre of the Thompson Nicola Regional District. 258 km west of the Pacific Ocean and a four hour drive from Vancouver, the city sits at the convergence of the North and South Thompson Rivers. The city centre is on the south shore of this junction, city development extends up both rivers and into the steep southern hills. On the south slopes of these hills, is ranchland where the proposed expansion of the Ajax Mine will sit. 2.3 Km from the closest neighbourhood, the open pit will sit just outside of the cities legal boundary (Figure 21).

The open pit, and the proposed material storage facilities will lie to the east of the Coquihalla Highway as it comes into Kamloops and connects with the Trans Canada Highway. Road access to the site can occur from the Inks Lake Rd. (Afton Mine haul road) from the Coquihalla Highway or where it crosses the Lac Le Jeune Rd. 9 Km south of Highway 1 (Abacus Mining and Exploration Corp, 2012).

I began by looking at the proposal as a study of the masses. Sitting amongst rolling foothills the waste piles will stand above their surroundings. Apart from being on the site, there are four main areas in the region where the Ajax proposed piles will be visible from. Three major highways meet in Kamloops and along these routes, the piles will be seen above the hills. On site, the materials used to create the piles would be visible. The characteristics of these materials could potentially alter the spaces that are created. The size, colour and texture could change the aesthetic in the spaces created.

Rock Material

The Ajax site is situated within the northwest trending Upper Triassic Iron Mask Batholith, a rock formation created by magma intrusion into the Upper Triassic Nicola Group volcanic Rocks. In the process of extracting the mineral deposits found within these rocks, great amounts of excess material will be removed from the earth. This rock, not containing ore, will be piled on the site and is to be the material that I use to sculpt the landscape.

On the site of the Ajax proposal three main rock units are present, the Iron Mask Hybrid, the Sugarloaf Diorite, and the Nicola Volcanics.

Gabbro: Example of Iron Mask Hybrid

Diorite: Example of Iron Mask Hybrid and Sugarloaf Diorite

Mafic Volcanic: Example of Nicola Group Volcanics

Figure 23: Rock Textures

Iron Mask Hybrid

- Igneous rock formed as a combination of the intrusive magma and existing Nicola Volcanics
- Hard rock
- Dioritic to Gabbrioic
- Texturally diverse
- Generally coarse grained
- Local albitic (white mineral) alteration

Sugarloaf Diorite

- Igneous rock formed from the intrusion of magma
- Hard rock
- Diorite (salt and pepper appearance)
- Fine to coarse grained
- Light to medium gray
- Phorphyritit diorite containing euhedral hornblend phenocrysts (well formed dark crystals)
- May show a variable weak to strong albite alteration (a white mineral) and can obliterate all original texture

Nicola Volcanics

- Preceded the intrusion of magma
- Made up of fine grained and large crystal volcanic rocks
- Dark in colour
- Dark green, fine grained Mafic volcanics
- Contains picrite which is dark green in colour and fine grained, generally unmineralized

(Abacus Mining and Exploration Corp., 2012).

Scale References

To get a better understanding about the size and amount of material each facility will contain I compared the piles to well know features in Winnipeg.

The area of the facilities was compared to the 1.6 km2 formal English style portion of Assiniboine Park. This is a large park in Winnipeg and houses numerous sports fields and the Winnipeg zoo. The East Waste Rock Facility will be just over one and a half times the size with the North Waste Rock and Tailings Facilities approximately two and a half times.

At its highest point, each pile was compared to Springhill Winter Park. With a skiable vertical of 39.624 m (130 feet) this hill rises up above the prairie landscape, the ski runs then dip down into the Red River floodway (Spring Hill Winter Sports Park Co. LTD, n.d). Each of the waste rock piles will be more than three times taller than this hill.

The amount of material that will be placed on the land surrounding the open pit is unimaginable to me. Finding a volume on the human scale that was large enough to compare to was difficult. The amount of waste material even exceeded filling the entire length of the Red River. The East Waste Facility, being the smallest, fills from the mouth of the river at Lake Winnipeg to Fargo, North Dakota. Filling the river once each with the North Waste and Tailings there is still excess material to fill the basin again, from Winnipeg Lake to Dryden, in the case of the North Waste Rock, and Winnipeg Lake to Grand Forks for the Tailings.

Red River

Assiniboine Park

Springhill WInter Park

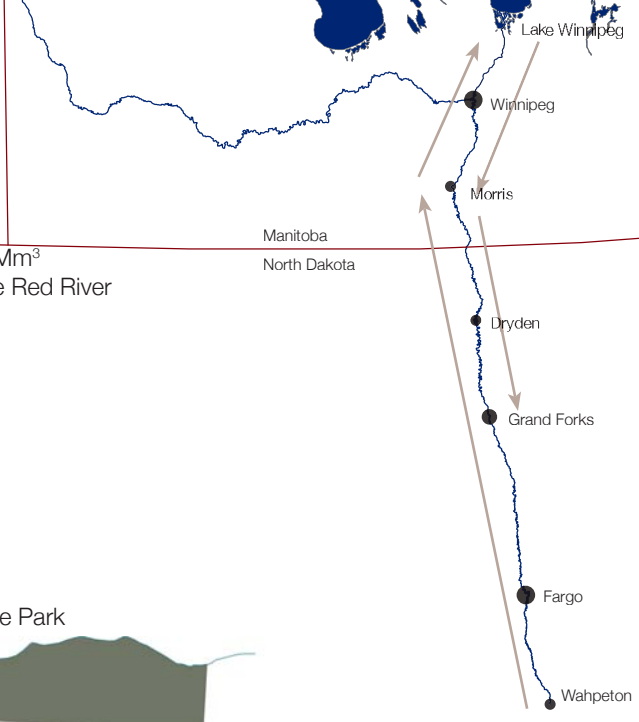
Figure 24: Comparison Landforms

Tailings Storage Facility
372.1 Mt

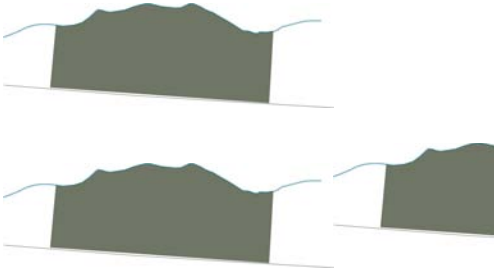
scale 1:75000

=

Volume: 389.6 Mm^3
1, 370 km of the Red River



Area: 3.91 km^2
2.4 x Assiniboine Park

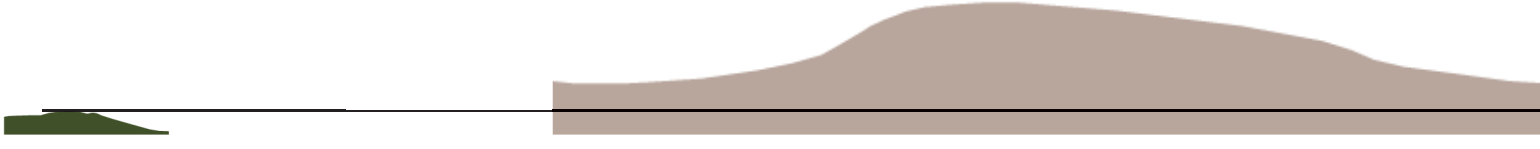


scale 1:75000

Height: Approx 212m at the highest point
(from the lowest contour)

5.4 x Springhill

Final Elevation: 1022 masl



Scale 1:12500

North Waste Rock Facility
728 Mt

scale 1:75000

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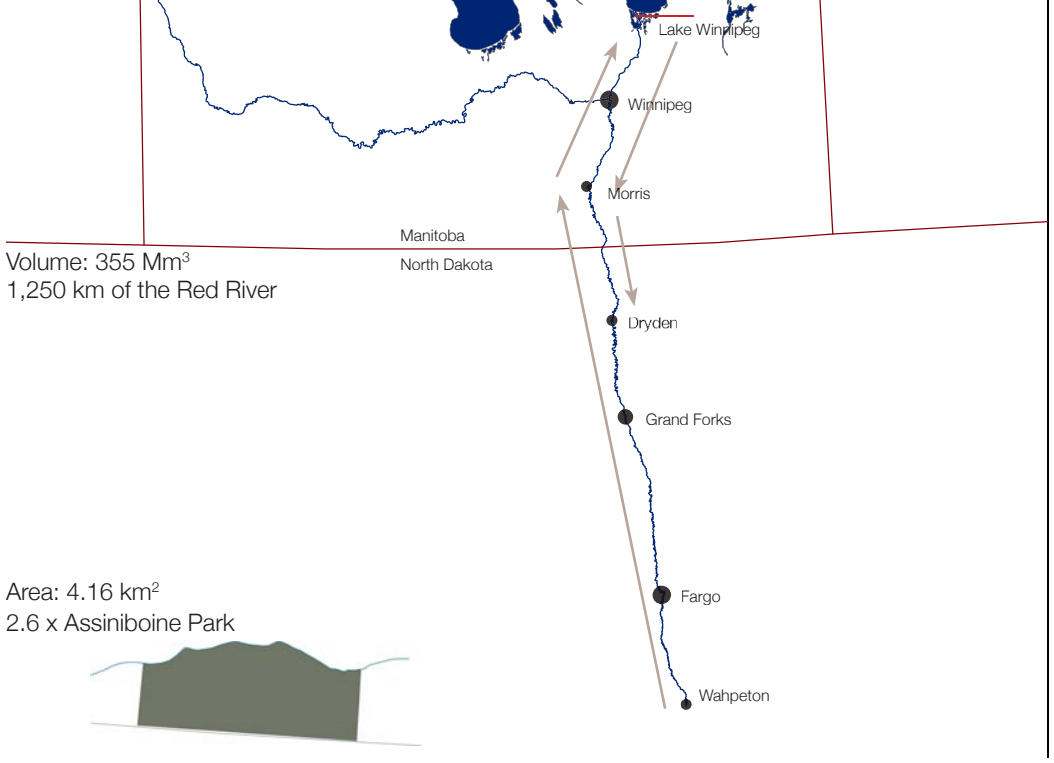
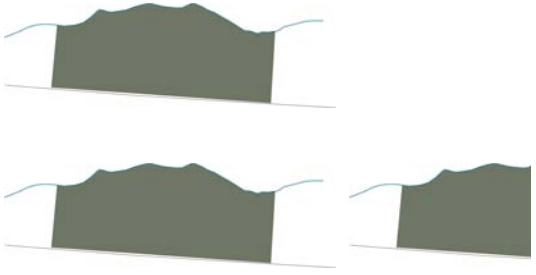
Volume: 355 Mm^3
1,250 km of the Red River



Area: 4.16 km^2
2.6 x Assiniboine Park



scale 1:75000

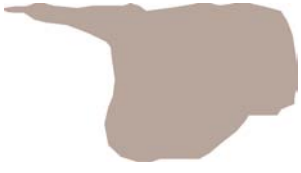
Height: Approx 144m at the highest point
(from the lowest contour)

3.6 x Springhill

Final Elevation: 1084 masl

Scale 1:12500

East Waste Rock Facility
420 Mt



scale 1:75000

=

Volume: 205 Mm^3
720 km of the Red River

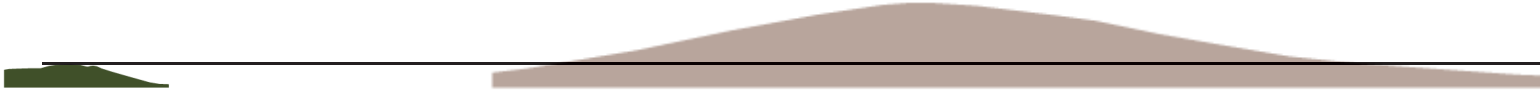
Area: 2.65 km^2
1.7 x Assiniboine Park

scale 1:75000

Height: Approx 140m at the highest point
(from the lowest contour)

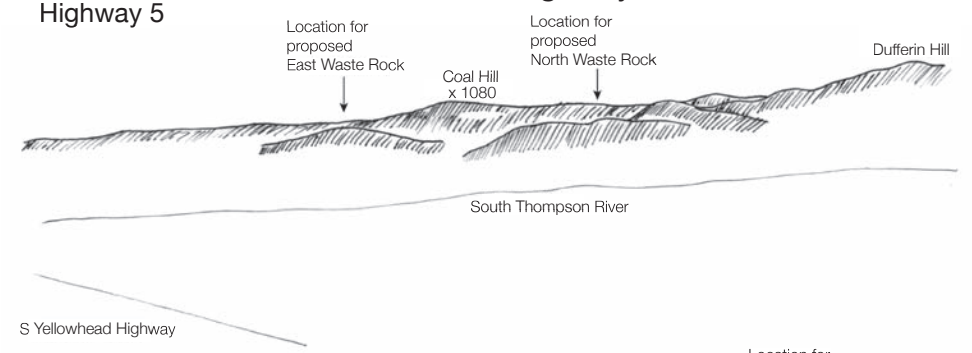
3.5 x Springhill

Final Elevation: 1060 masl

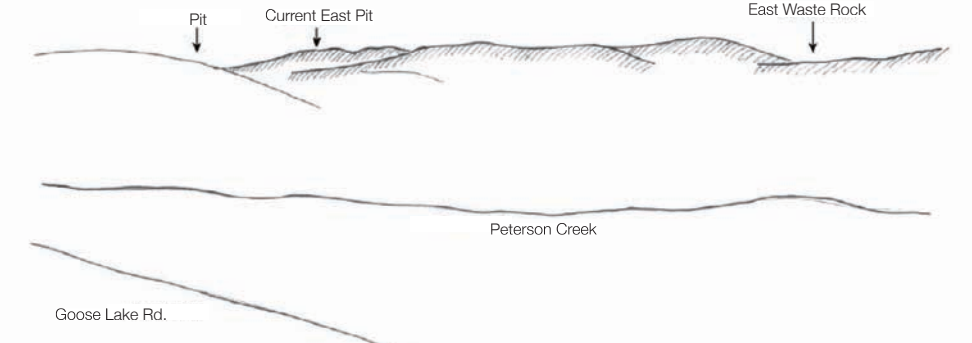


Scale 1:12500

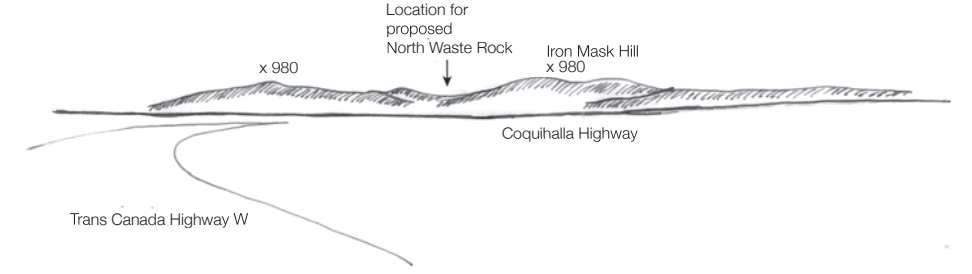
1 View From Southern Yellowhead Highway
Highway 5

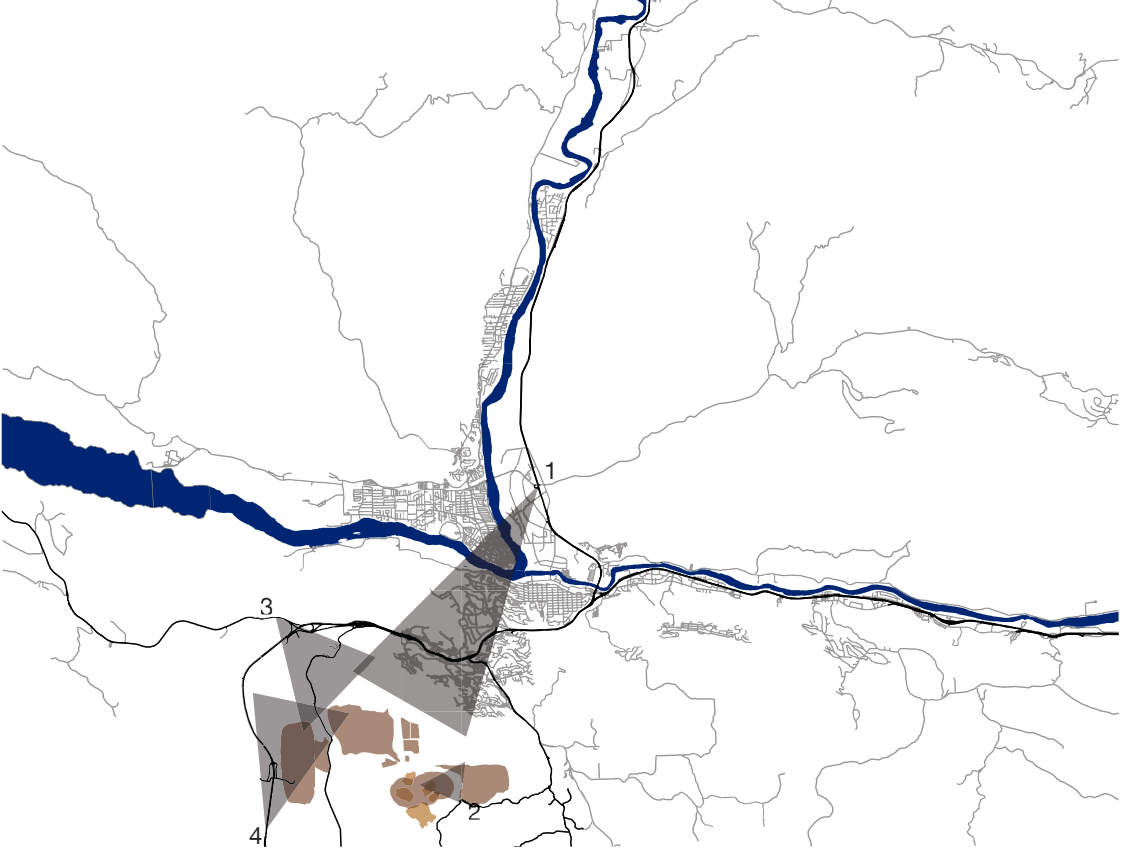


2 View From Goose Lake Rd.

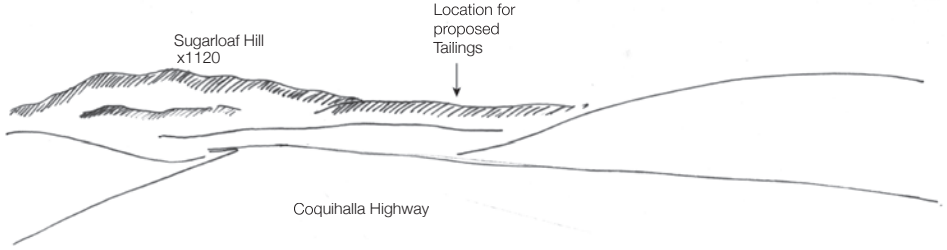


3 View From Trans Canada Highway
Highway 1





4 View From Coquihalla Highway
Highway 5



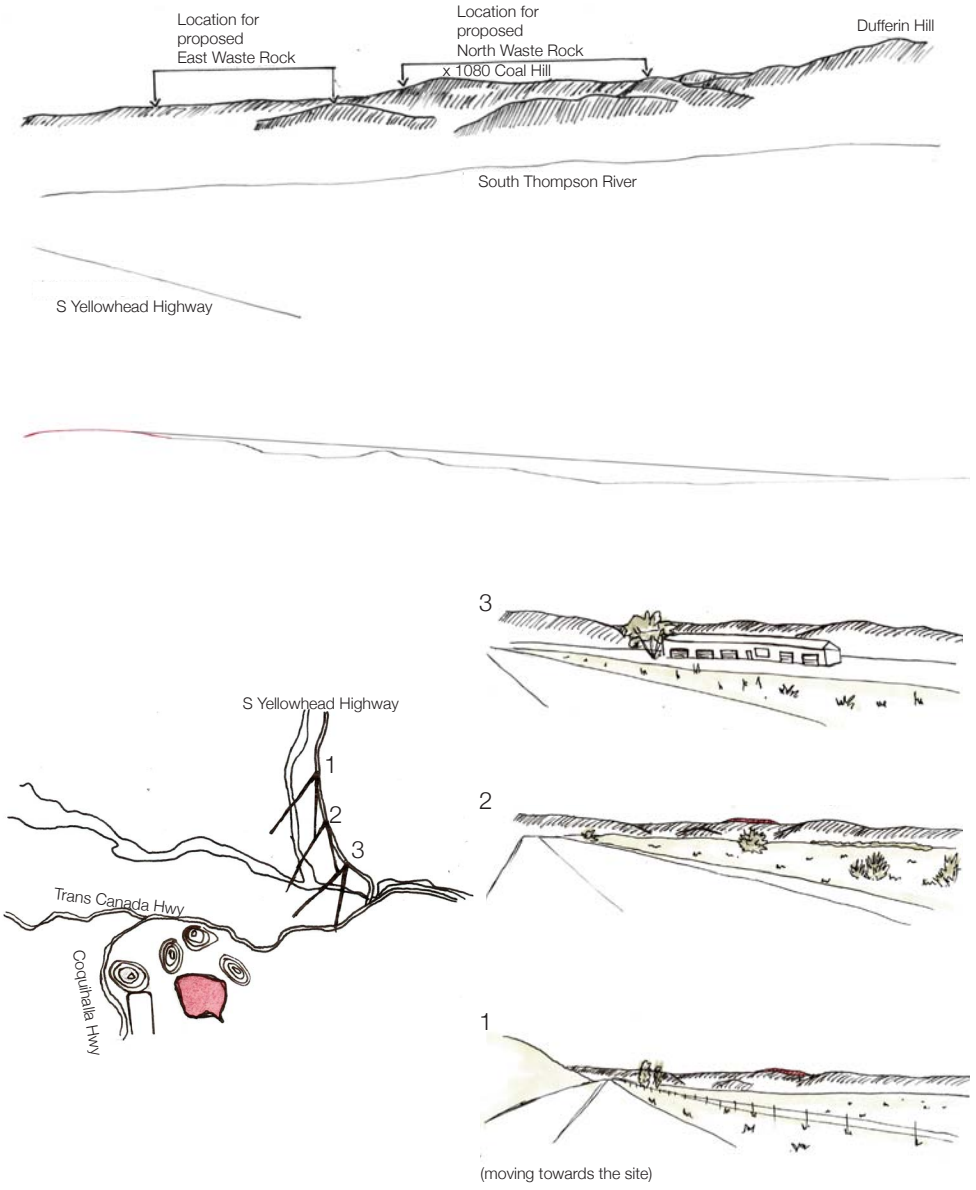
Viewsheds

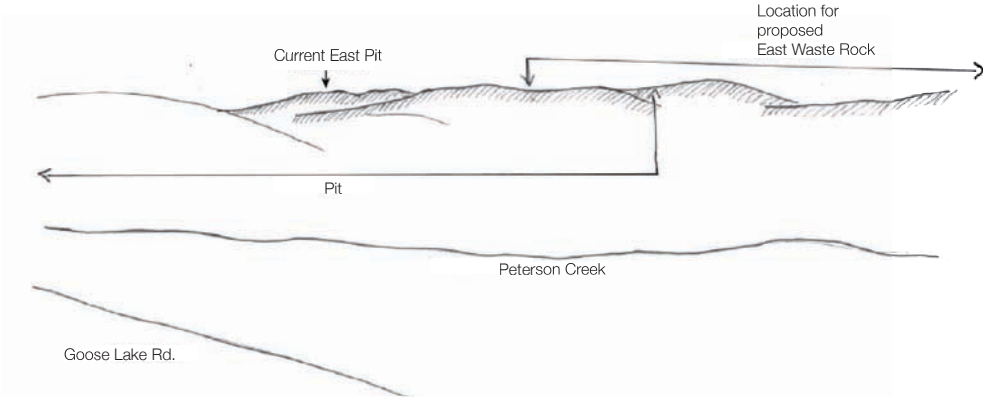
Kamloops sits within the Thompson River Valley and has expanded up the southern slopes, From the city, the piles of the Waste Rock Facilities and the Tailings Facility will rarely be seen above the hills. From the three major highways, to the north and west, the piles will be visible as one leaves or arrives into Kamloops.

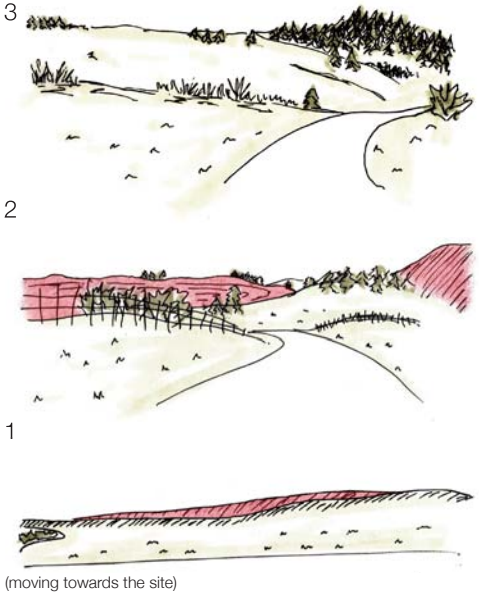
Visual studies were done, on the following pages, to determine points along each of these highways where the piles would be visible. These studies were done to distinguish connections between the site and the region and determine affected views. The results were used in the design process to visually alter the edges of the site and create elements that entice people to explore it.

1 Southern Yellowhead Highway

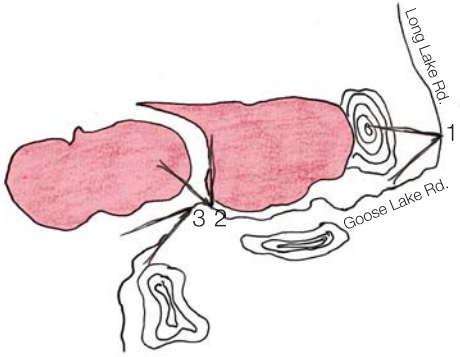
From the Southern Yellowhead Highway looking south, the proposed North Waste Rock Facility will be slightly visible overtop of Coal Hill. Beginning approximately 9 Km from its juncture at the Trans Canada Highway, the pile will be visible and will remain in sight for approximately 4 Km's. During the mines production life, because of the material and lack of vegetation, this pile may contrast with the surrounding hills, but after typical re-vegetation would blend in from this viewing point.







(moving towards the site)



2 Goose Lake Road

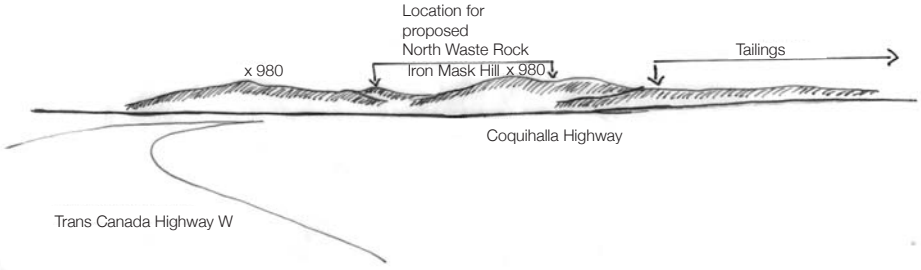
Goose Lake Road is a small dirt road that runs from Long Lake Rd and the Princeton Kamloops Highway west along the south side of the proposed East Waste Rock Facility and Open Pit. It then turns south to Goose Lake and various ranches. From Long Lake Rd. the rolling hills block any views of the mine but at the Goose Lake Rd. turnoff (1) the East Waste Rock pile becomes visible and remains on the north side of the road until the pit comes into view (2) and the road turns south (3). Goose Lake road is used predominantly by ranchers and outdoorsman accessing the forests and lakes around the area. The East Waste Rock facility will sit directly beside this road defacing their relaxing escape from the city.

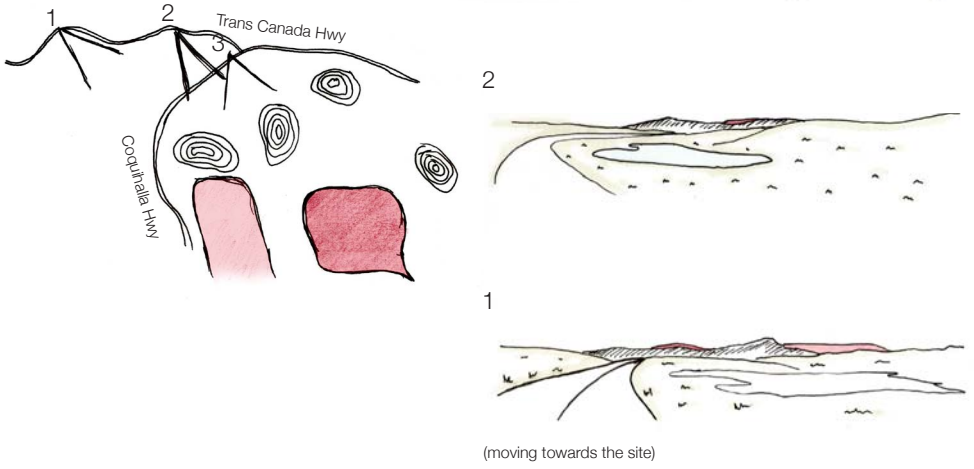
The proposed pile will appear as a wall, but at this point there is an opportunity to create topography that encourages the outdoorsmen to stop and enter the site to explore.

3 Trans Canada Highway

On the western side of the City of Kamloops, the Trans Canada Highway turns off south to follow the edge of Kamloops Lake towards the Fraser Canyon. 4.5 Km from the turnoff the Tailings Facility and the North Waste Rock Facility become visible (1). Driving east towards the city of Kamloops, the road dips down again and the surrounding topography blocks the piles from view (2). 2 Km from the turnoff, the North Waste Rock Facility briefly peeks above the hills once again before disappearing for good from the distant view (3).

As with the view from the Southern Yellowhead Highway, the waste facilities will stand out, during production, in contrast to the surrounding hills. With reclamation and revegetation they will blend in making the sight less noticeable from this direction.





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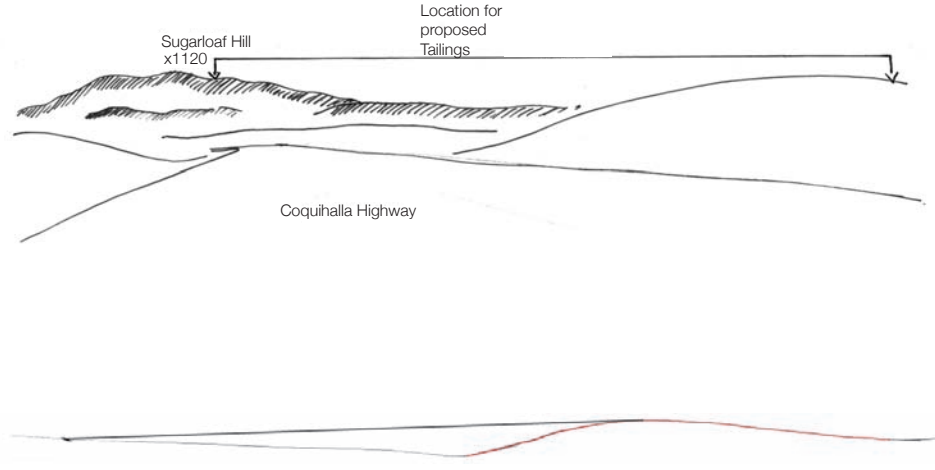
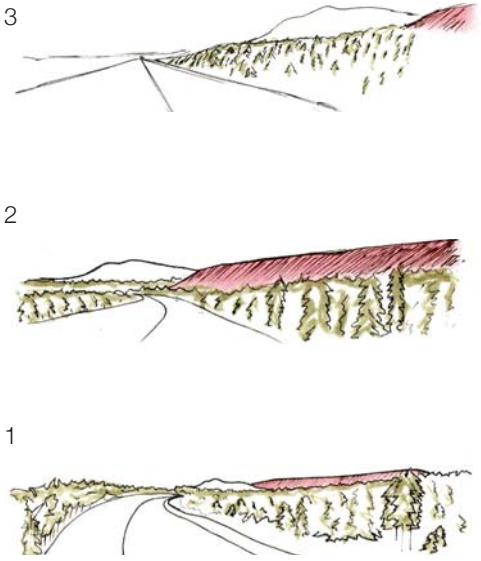
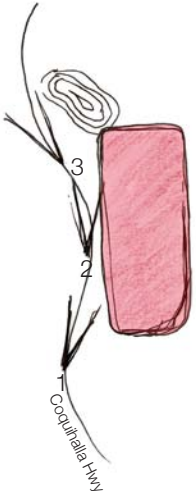






(moving towards the site)

4 Coquihalla Highway

On it's way into Kamloops, the Coquihalla Highway is on a constant down sloping hill. At the top of the hill, 9 Km from the Trans Canada Highway turnoff, Sugarloaf Hill and the adjacent Tailings Facility become visible (1). As the existing land beside Sugarloaf Hill is at a low elevation, the Tailings Facility will make a very large impact and fill in the gently sloping forest (1+2). The Tailings Facility will be visible as one drives along its entire length until passing Sugarloaf Hill and entering the city of Kamloops (2+3). This is the main route to and from Vancouver and the Tailings Facility will be seen as a wall of rubble and a distasteful introduction to the city.

Starkly visible to those on the Coquihalla Highway there is an opportunity here to draw attention to the site. With variation in the surface and carefully selected vegetation, this face could spark interest and draw visitors into the site.

The site of the proposed Ajax Mine is currently a popular place for the residents of Kamloops to play and discover. With hills along the northern edge and grasslands rolling south, the site provides diversity for numerous recreational activities. Covering the site with waste material will wipe out the current textures found throughout the site.

Intending to recreate similar opportunities, I strove to discover the features that made the site special. As a part of a complicated and diverse system, any disturbance to the local patterns may alter those down the line. Minimizing the affects of mining on the landscape led me to careful decision making when placing the waste material. An understanding of the site and regional patterns was important when reworking onsite systems.

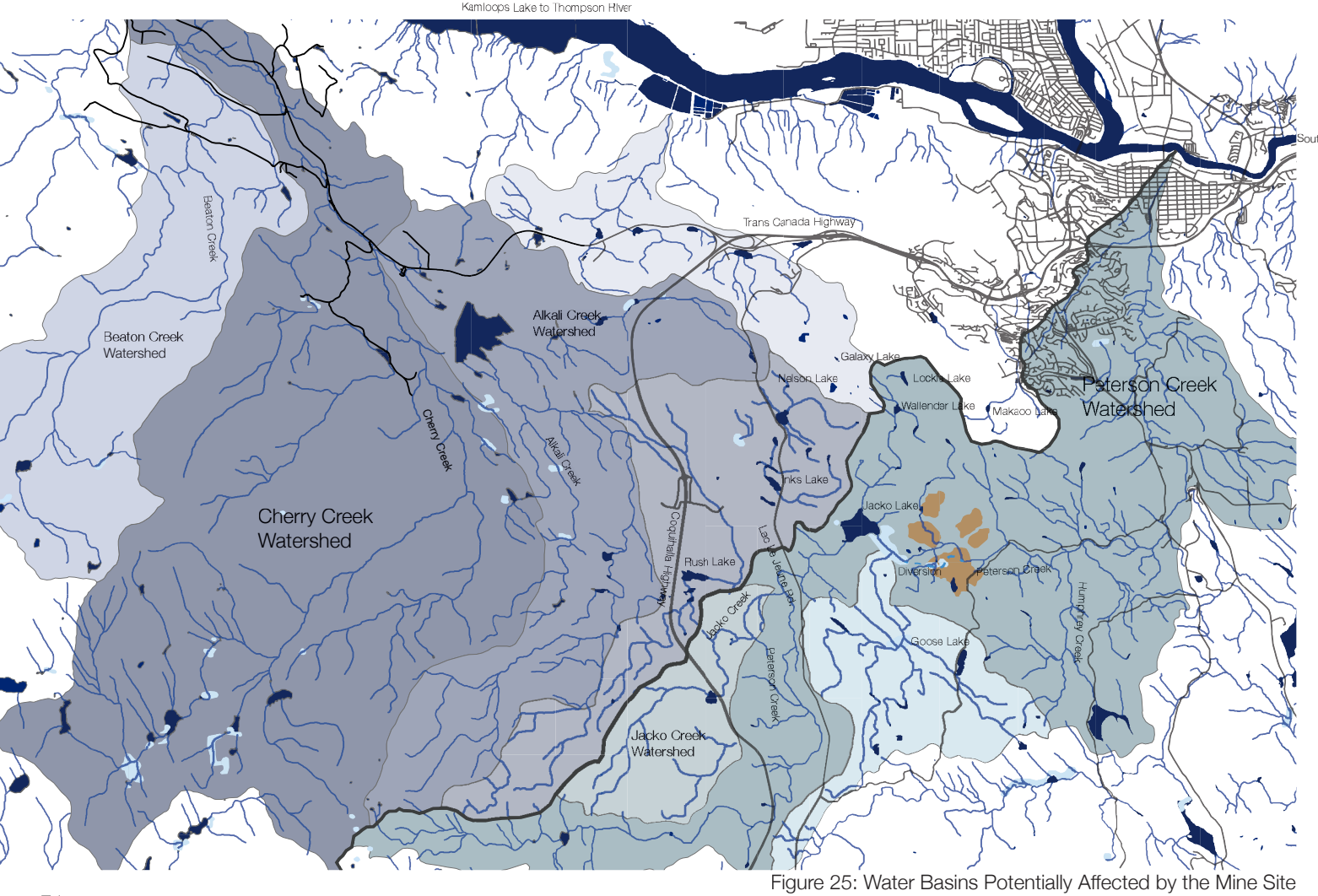


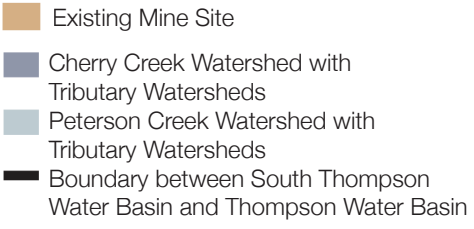
Figure 25: Water Basins Potentially Affected by the Mine Site

Numerous small creeks run through the mine site feeding into Peterson Creek or Cherry Creek to the west. The boundary of the Peterson Creek Watershed and the Cherry Creek Watershed runs through the site, northwest of Jacko Lake. This division is also the boundary between the South Thompson Water Basin and the Thompson River Water Basin. The smaller tributary creeks within the Cherry Creek and Peterson Creek watersheds also have their own watersheds (Figure 24).

As these smaller water basins are potentially altered or contaminated from the mining process, whether with excess sediment or leached chemicals, damage to both Peterson Creek and Cherry Creek can occur. This could result in polluting the South Thompson and Thompson Rivers.

Flowing from Jacko Lake, at the centre of the mine site, west towards Kamloops and the South Thompson River, Peterson Creek will be diverted slightly south along the edge of the pit (Abacus Mining and Exploration Corp, 2012). Inks Lake by the Lac Le Jeune Road will be converted into the Tailings Pond. Although KGHM has announced that there are no fish in the lake due to high acidity, this lake will be changed and contaminated. There is currently no outflow creek from Inks Lake but with the altered topography this could potentially change.

While developing my proposal for the site, re-establishing a water system that would minimally alter the exiting watersheds was important. The water pattern for the site was determined by analyzing where the water currently flowed and attempting to create a similar pattern.



Climate

Situated behind the Coastal Mountain Range, the climate in the Kamloops area is designated as semi-arid bordering on desert. Sitting in this rain shadow, Kamloops receives little precipitation year round. Average annual rainfall, 174.8 mm, falls in the form of short duration rain showers and thunderstorms in the spring and summer months. Snowfall in the winter is light, averaging 91.5 cm annually (Province of British Columbia, 2013).

Kamloops summers are a draw for vacationers and an amenity for the locals with abundant sunshine, temperatures reaching high into the 30s (˚ C) and clear lakes and rivers in and around the city. In the valley, the average winter temperature is fairly mild between -5˚ C and -15˚ C with short periods dropping down to -30˚ C around January (Tourism Kamloops, 2012). Temperatures in the nearby mountains are lower and snowfall is greater. Winter days around the city are often cloudy and the higher elevation neighbourhoods often start their mornings in the fog.

Winds in the valley are usually from the east but in the summer months often have a predominant westerly component and have stronger gusts (Province of British Columbia, 2013). Because the Ajax site sits in the southern sloping hills above the river valley, the winds at this elevation come mostly from the west.

The climatic conditions of the site determine different ground coverings for the waste material dependant on the distribution pattern. Water collection greatly increase the number of plant species that are capable of growing on the site and snow cover and the way that it falls on the piles can create a new texture on the site.

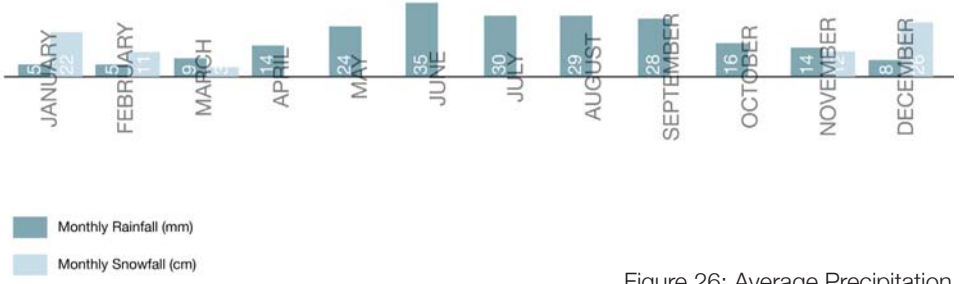


Figure 26: Average Precipitation

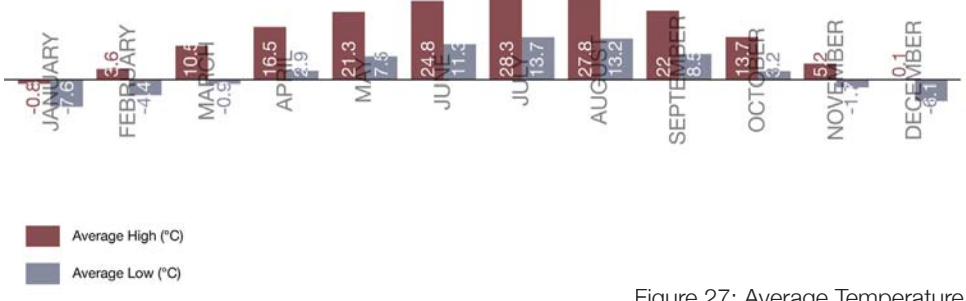


Figure 27: Average Temperature

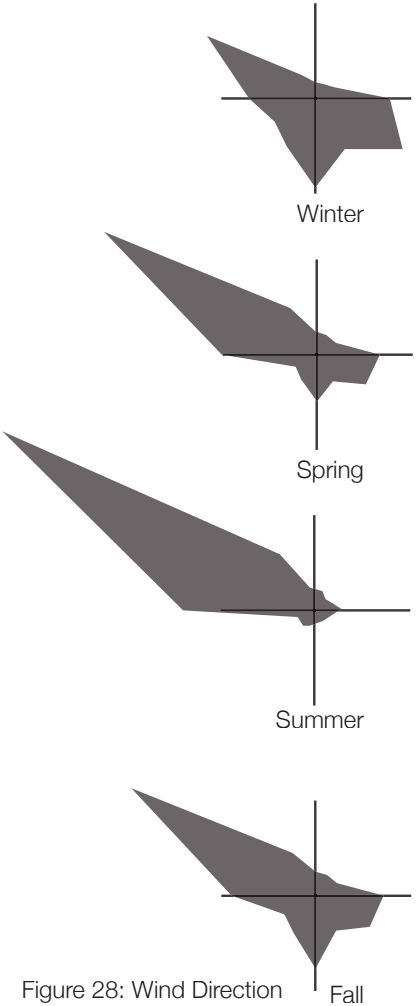
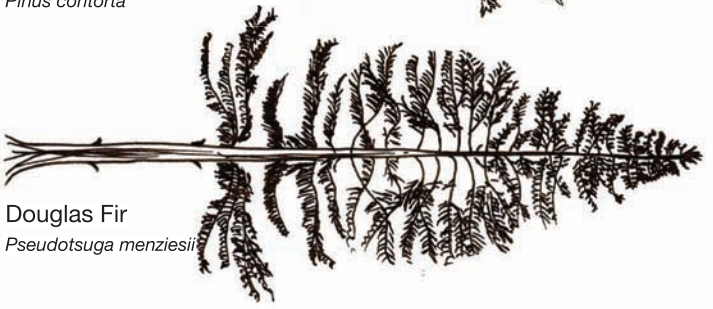


Figure 28: Wind Direction
Read as blowing from the centre out

Ponderosa Pine
Pinus ponderosa

Lodgepole Pine
Pinus contorta



Douglas Fir
Pseudotsuga menziesii

Bluebunch Wheatgrass
Pseudoroegneria spicata

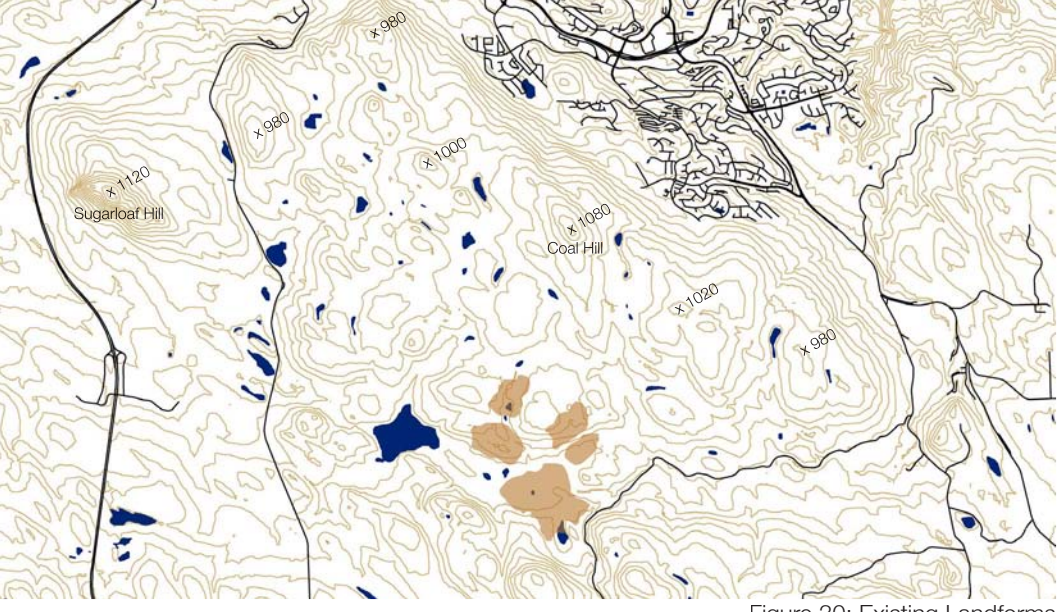
Junegrass
Koeleria macrantha

Rough Fescue
Festuca campestris

Figure 29: Existing Site Vegetation

Falling into the Interior Douglas Fir Biogeoclimatic Zone, the predominately south facing Ajax site has an ecosystem dominated by grasslands. Open ponderosa pine forests with Douglas fir stands colonize the higher hills and northern slopes. Dominant bunchgrass species found here consist of bluebunch wheatgrass, junegrass, and fescues. Sagebrush and prickly pear cactus are also found scattered throughout the grasslands. At the higher elevations, open clusters of Lodgepole Pines, Douglas Fir and Ponderosa Pine are found with grassy understories (British Columbia Ministry of Forests, n.d.).

The dry climate of the Kamloops region limits the plant species that are capable of growing here. Knowledge of the species that are capable of growing and currently thrive on the site is important for successful ecological establishment.



Existing Mine Site

0 500 1000 2000 meters

Figure 30: Existing Landforms

Sufarloaf Hill

The Ajax Mine site sits within the rolling hills to the south of the City of Kamloops. The highest peaks are to the north of the mine and form a ridge between the nearest neighbourhoods and the ranches that currently reside on site. From these peaks, the land gently rolls down and south towards Peterson Creek and Jacko Lake. Smaller lakes and ponds are hidden in the depressions created by the rolling topography. At 1120 meters above sea level, Sugarloaf Hill is the tallest hill in the surrounding area and is situated at the northern point of the proposed tailings facility.

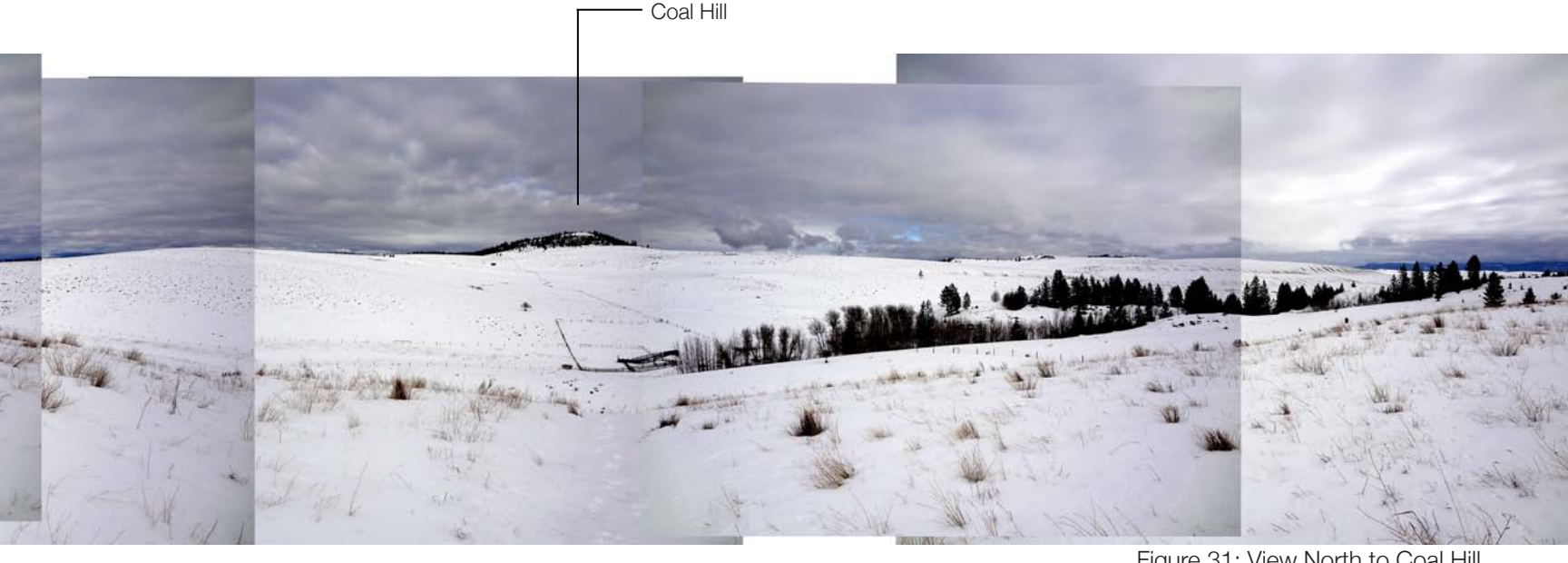
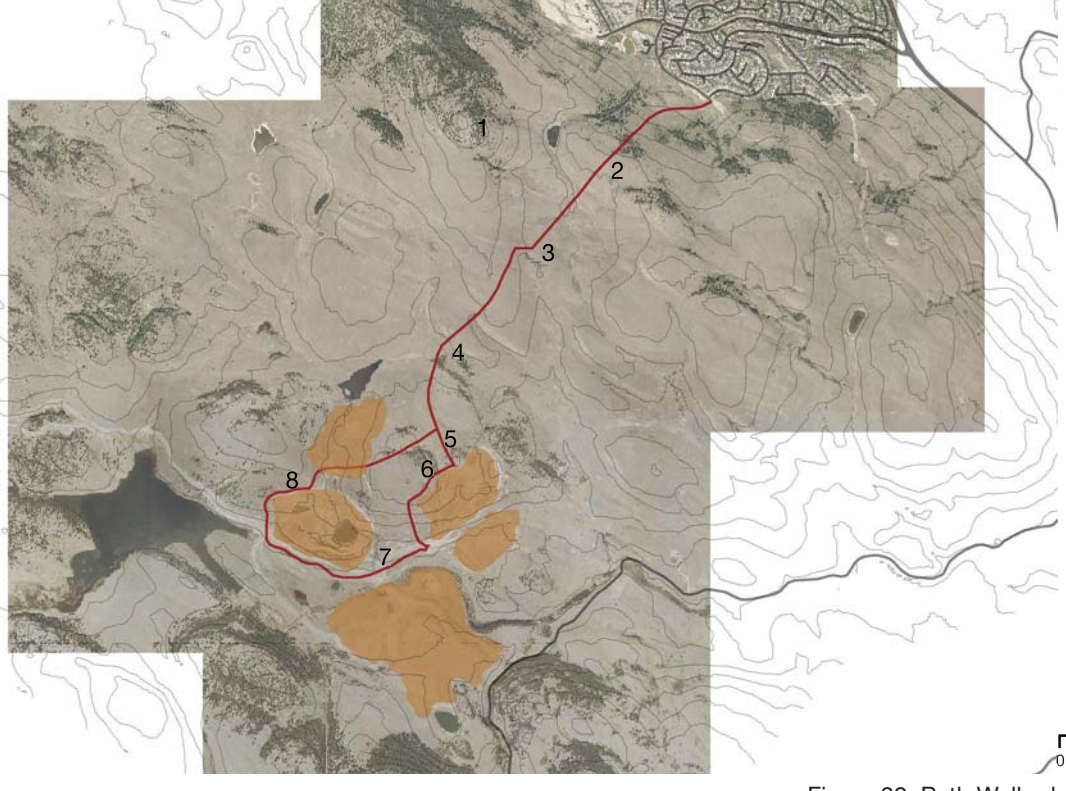


Figure 31: View North to Coal Hill



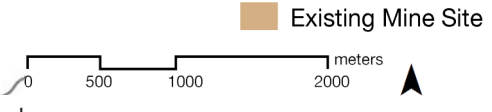
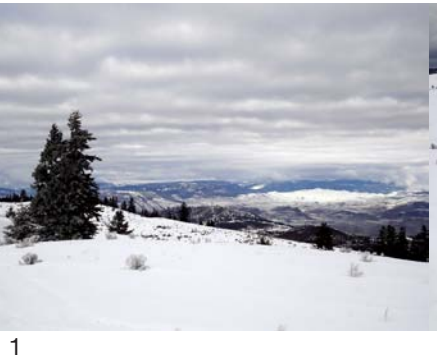


Figure 32: Path Walked



1

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As the existing and proposed mine elements are within such close proximity of Kamloops neighbourhoods, I decided to walk from the city, the highest point on Pacific Way, to the current pits. This was to experience the proximity of the site and to gain an understanding of the topography that will be affected by the proposed facilities.

Numerous cars were parked at the end of Pacific Way where I started out my hike. There were well-tracked pathways that led up the mountain. Following these pathways, I hopped a couple ranchland fences and came to the top of the ridge. As the pathways turned to follow the ridge, I stepped off into the snow hoping to find some other tracks to follow (1). On the south side of the hill, snowmobilers had been playing around on the rolling topography. Since the snow here was more compact, I began following these tracks which conveniently went all the way to the pits (2+3). Crossing a frozen and snow covered creek I came up a hill on the other side of the depression and here you could see a few small hills rolling away towards a line of trees ahead. These trees lined the backside of the current open pits. Continuing to follow the snowmobile tracks, I walked along the top of a down sloping plateau and into another depression where I found small clumps of trees and a ranching corral (4). Hopping the fence, and hiking up and across the hill on the south side, I was at the mine site (5, 6. 7,8). Aside from the snow, the hike was fairly easy and only took about an hour and a half. Between Aberdeen hill and the pits, the land rolls gently, making it easy to cross.

5


6


7


8

Site Access

The main access to the site is from the Old Haul Rd. via Lac Le Jeune Rd. The Old Haul Rd. will be utilized when the mine begins production and further road development will occur on site. Currently a gravel road, it runs from the Afton Mine by the Trans Canada Highway, under the Coquihalla and through the site to Goose Lake Rd.

Numerous informal trails run through the site where vehicles have worn tracks through the grasslands (Figure 32). These have been created by the ranchers whose land they cut across and by fisherman accessing the many small lakes. They are also utilized by hikers and mountain bikers and connect with the designated hiking trails above the community of Aberdeen. Smaller seasonal trails wind their way over Coal Hill and Iron Mask Hill, intersecting with the marked and more worn trails. More designated Hiking, Biking, and X-country skiing trails can be found on the west side of the Coquihalla Highway as well as farther south along Lac Le Jeune Rd.

Designated snowmobiling routes can also be found south of the mine site. No designated trails or access points are around the mine but on a site visit, numerous tracks were found. Access to the site would be fairly straightforward on a snowmobile as the forested areas have little to no underbrush and the rest of the site is open grasslands, the ranching fences are the most prominent barrier and restrict snowmobilers from traveling too far.

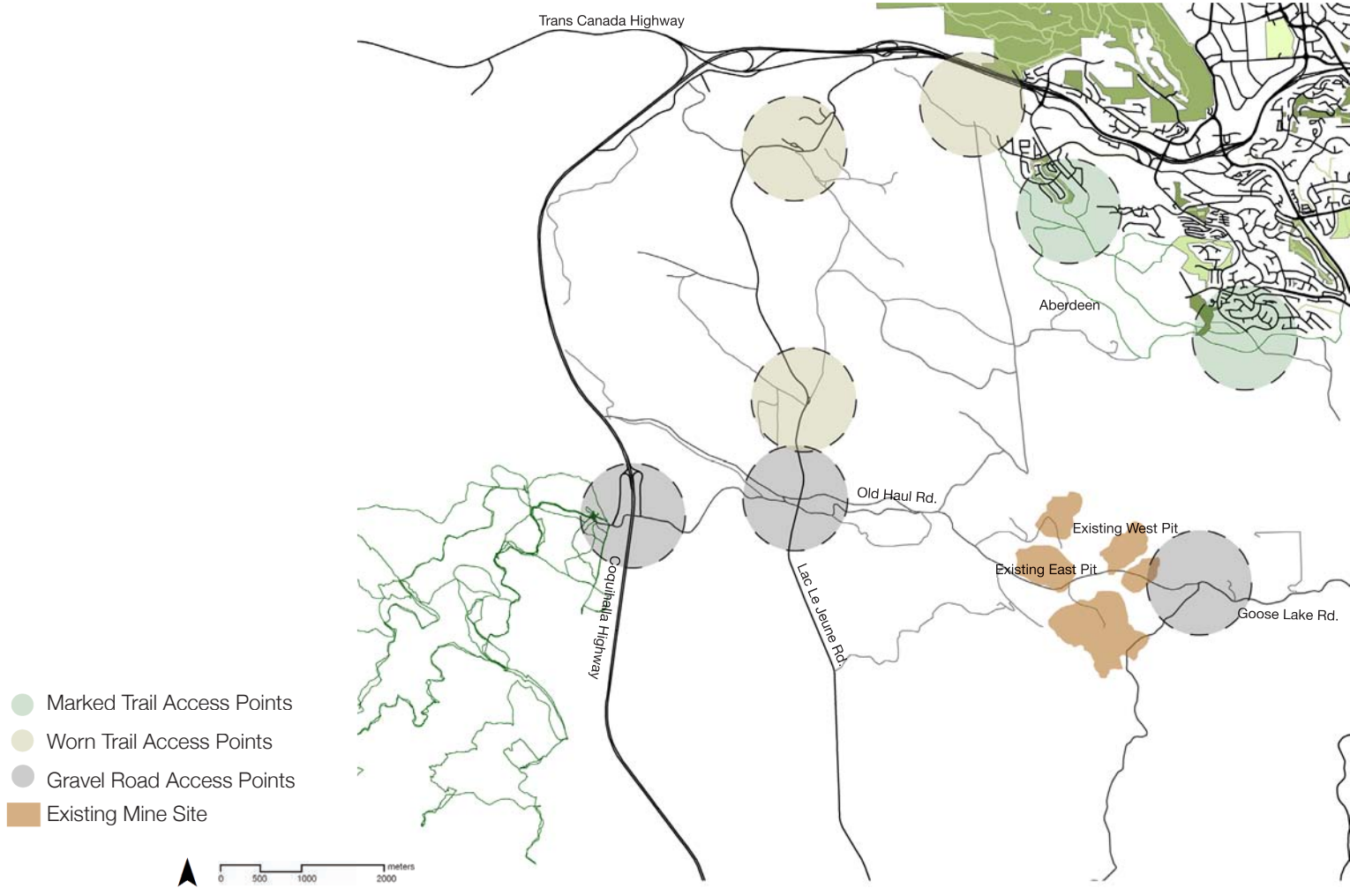
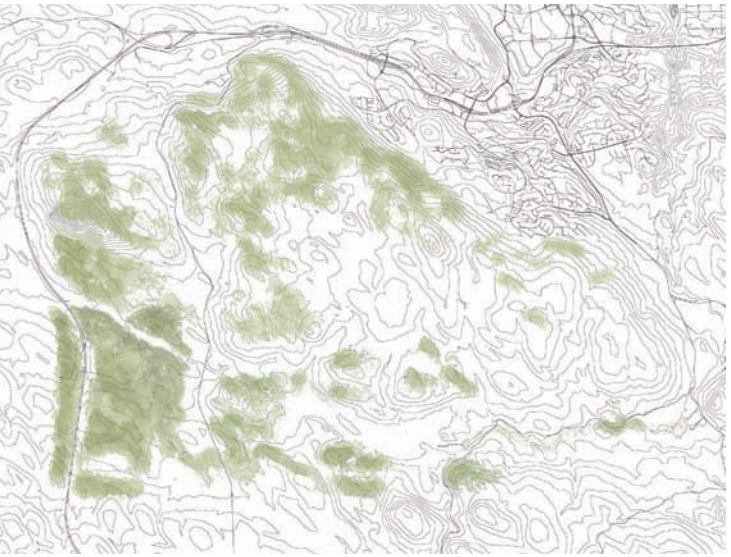
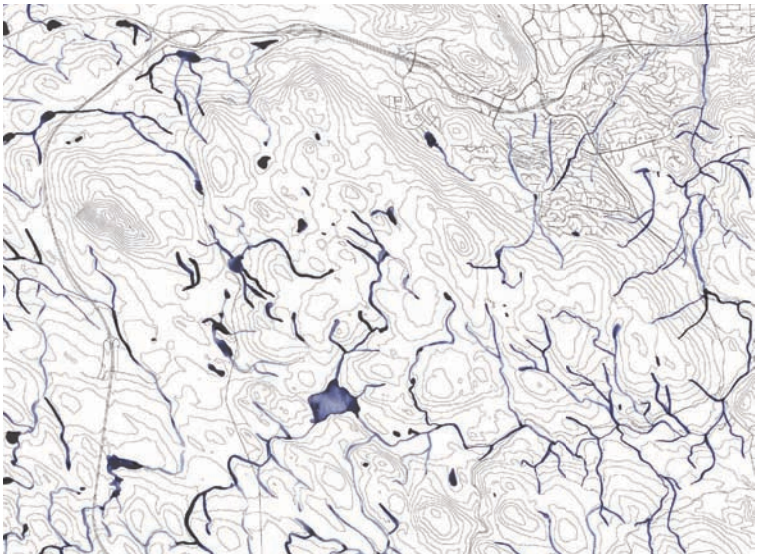
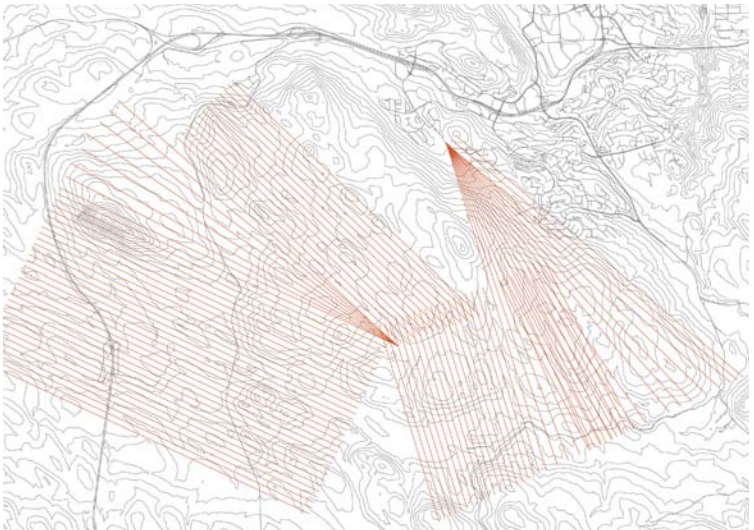


Figure 33: Trails and Access Points







Apart from the fenced off old industrial site, the site is currently used by local explorers, ranchers and naturalists. With pine forests and small hidden lakes, it is easy to forget that you are still within the city boundaries. The minor, intricately woven watersheds create small pocket lakes desired for fishing, their solitude and peacefulness a blessing in such close proximity to the city.

By studying the topography and visiting the site, both in the summer and winter, I discovered that the gently rolling topography, that the waste piles will be covering, feels larger and more impressive when your amongst it. The slight variations in this landscape and the small pockets that have been created provide an unlimited number of spaces to find adventure or to call your own.

The patterns and textures on the site are all part of a bigger system. Current mine reclamation aims to blend disturbed sites into the surroundings but instead isolates and alienates the site within the regional system. Through my design process I attempted to layer all of the systems that act on the site, industrial, environmental, and social, and create a landscape where the viewer is able to choose the path that they want to follow and the layer that they want to discover.

Figure 34: Inspirational Regional Patterns. Vegetation (top left), Hydrology (top right), Erossion and Landforms (bottom)

Figure 35: Existing Site

Chapter 5
Design Proposal

5.1 Intentions

The analysis of the existing site reveals numerous opportunities that would be eliminated with the landforms of the Ajax Proposal. With the massive amounts of material being placed on the site, most of the conditions that currently exist will be gone. There is an opportunity for the recreation of similar spaces and the implementation of an added benefit.

The site layout was developed with the intention of flexibility and having the potential to be altered based on changes in production. The movement and capabilities of the mining machinery determined the distribution of the material across the site. The design goals focus on the three main bodies affected by the mining process.

1. Industry- By using machinery already in the mining industry, waste material will be distributed by altering current waste rock facility techniques. This modified distribution method will reduce reclamation time at the end of production and give the mining industry a new image in regards to environmental and community sensitivity.

2. Environment- The waste rock distribution methods used for the site plan allow for reclamation processes to begin earlier in production. Machinery will be moved away from remediation areas reducing possible disturbances and allowing for stronger vegetation establishment. Microclimates and pockets will be created allowing for protection and a variety of ecological processes, these variations will result in a more diverse ecosystem and landscape.

3. Community- Earlier reclamation allows for the community to access remediated areas before the end of the mine's production. The pockets created in the landscape can potentially be areas of interest and destinations close to the city. Distribution techniques allude to the natural forces on the site and the layers of industry and erosion, calling attention to the sites history. The site design, with the layers of the site and the knowledge and enjoyment that can be found, aims to alleviate the communities concerns and change the negative perception of the mining industry.

Figure 36: Kamloops Lake Landforms

5.2 Inspiration and Interpretation

Inspired by the site itself, and the landforms around Kamloops, I reflected on their similarities to the forms created by mining machinery. Shaped by the deposits from volcanoes, and eroded by ancient rivers and glaciers, the land folds and ripples in directional patterns.

Being amongst the landforms and being used to them, we are blind to the patterns that they create. I have lived in Kamloops all of my life and I had never noticed how the topography flowed. Removing myself and my personal knowledge and connections to the area, I was able to look at the site from the outside where I began to see these arrangements and the intriguing and slightly unnatural qualities about them.

"..... seeing what has always been there but you were blind to it before."

-Andy Goldsworthy
(von Donop et al., 2001)

It was with these realizations that I began to sculpt the mine site. The mining processes and machinery were no longer as limiting, as the artificial forms that are possible to create resemble those that can be found in nature.

Through strategic distribution I created linear forms that mimic the surrounding topography and draws attention to the mining processes.

When depositing rubble, the machines used by the mining industry create rows of piles as they move along tracks. Where the piles overlap, creases and pockets are created. To the mining industry this is strictly part of the process and the most efficient way to distribute material. Once spread, the chains of mounds are flattened and capped creating a level surface, and destroying the intricacy and opportunities of this folded landscape.

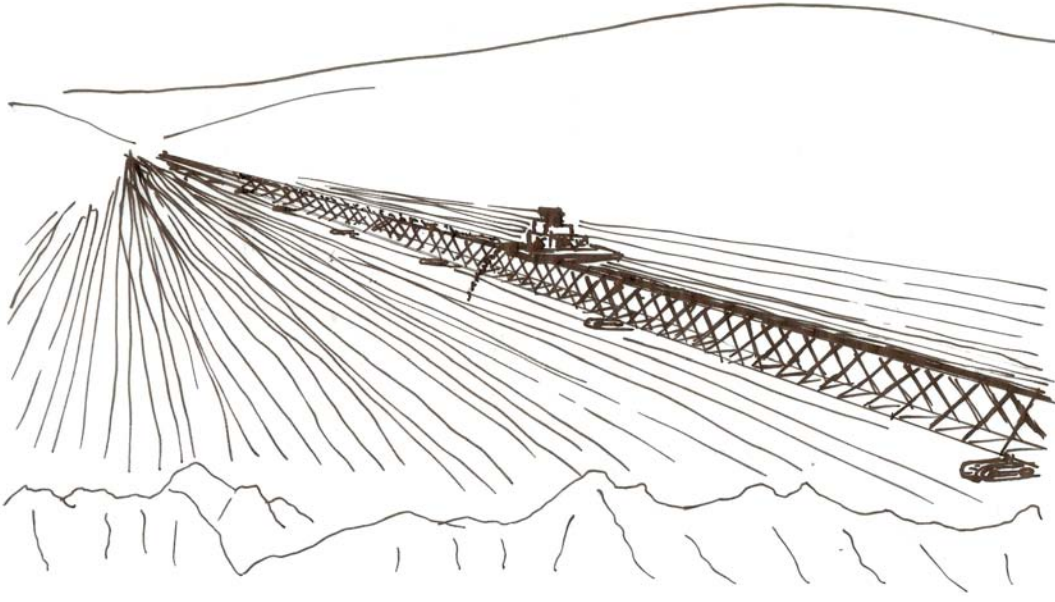


Figure 37: Forms Created by a Conveyor System and Spreader

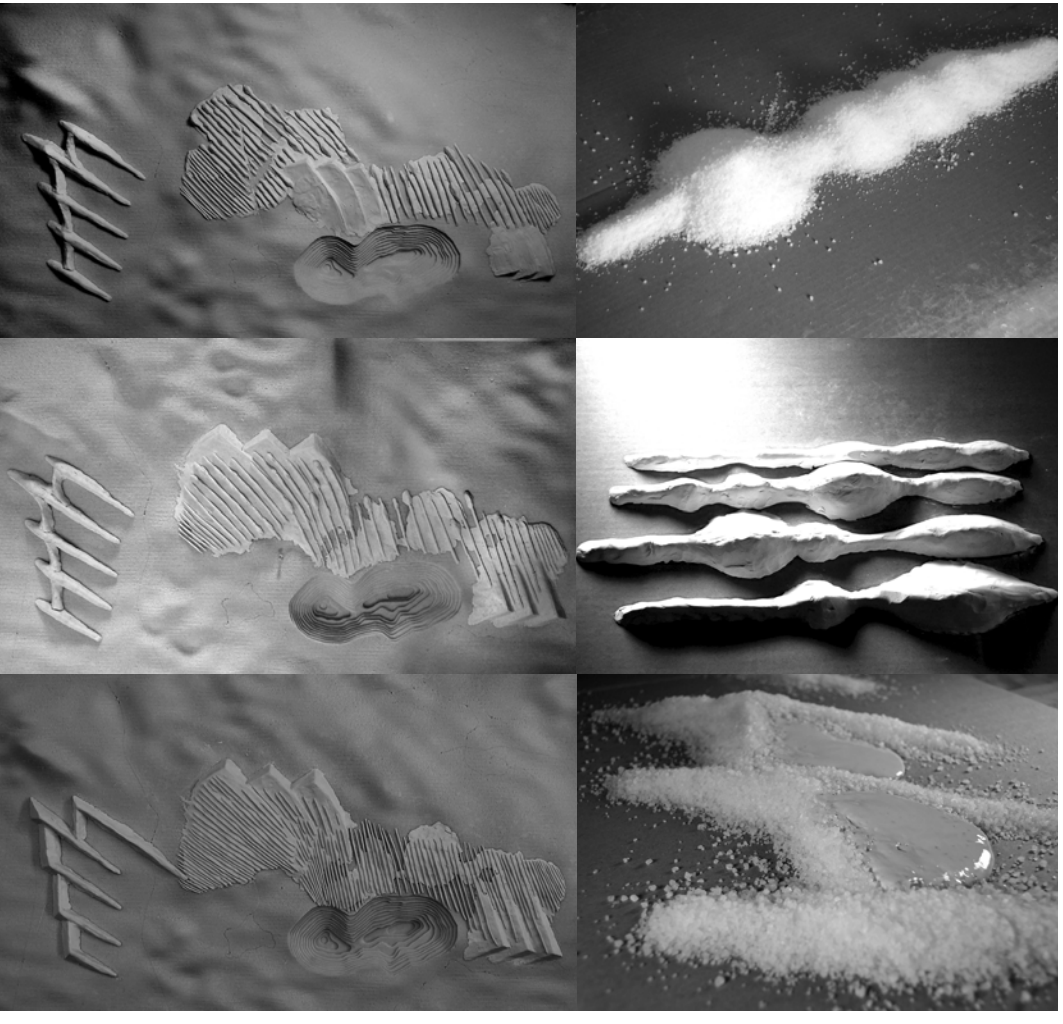


Figure 38: Exploring Forms Through Modeling

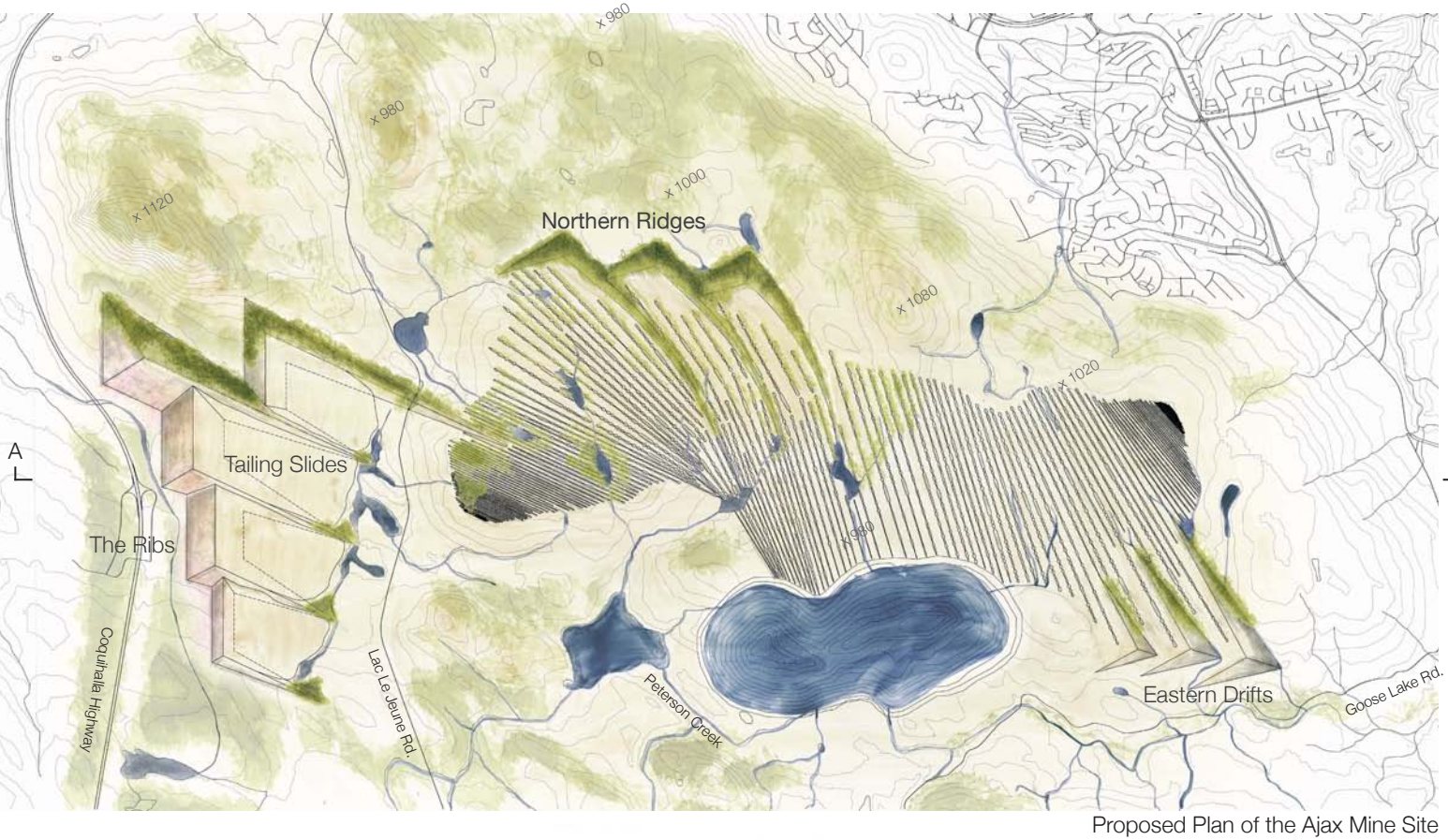
5.3 Exploration of Forms

Through an exploration of forms, using a site model and recreating waste distribution, the newly proposed “waste piles” became a system of landforms that are connected throughout the site.

To see the patterns that play on the site, and begin exploring their possibilities I had to first remove the large shapes of the Ajax Waste Rock Facilities. At this point I became aware of the amount of land that would be covered and the many places, that people had grown to call their own, that would be destroyed. Each small lake that has formed in the folded landscape is someone’s special fishing spot and a trail that comes down Iron mask Hill and crosses the grassland might be a favorite bike route. I realized how important these places are to the citizens of Kamloops and how the mining process would easily flatten it.

The forms that I was initially drawn to were the rows of connecting piles. This formation and the opportunities for diversity were exciting to me. As I explored the forms with my model, I began to grasp and appreciate some of the choices that the mine had made in the placement of their piles. North of the pit, the land flattens out slightly to create a plateau. This is where the North Waste Rock pile was to go and it seemed like a logical place in order to flatten the land for the machinery to move across and restrict filling in the more major pockets in the landscape.

As I moved the forms around I tried to relate their heights to those in each area of the site so that they didn’t stand out as much against the surrounding landscape and would follow the same patterns, rolling down towards Peterson Creek south of the pit.



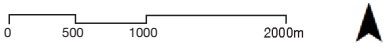
Proposed Plan of the Ajax Mine Site

Section A Mine Site

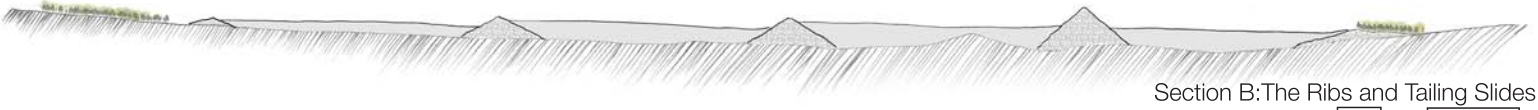
Keeping the tailings contained on the west side of the site, I choose to spread the waste rock across the landscape. Containment of the tailings was important to reduce contamination and isolate possible water discharge.

Three major forms were created to consume large amounts of the waste material, the Ribs, the Northern Ridges, and the Eastern Drifts. But unlike the Ajax proposal, the forms vary in height, stepping down through the landscape mimicking the natural topography and providing diversity. Streaming across the site, rock chains draw together the patterns of the region and the site as a whole.

Sculpted and artificial, the forms stand out as an obvious implementation by humans, but by drawing their shapes from the natural landforms they work in partnership with the land without blending in and pretending to be natural.



2 Detail Plan: Tailing Slides



Section B:The Ribs and Tailing Slides

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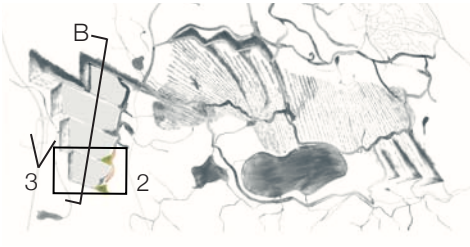
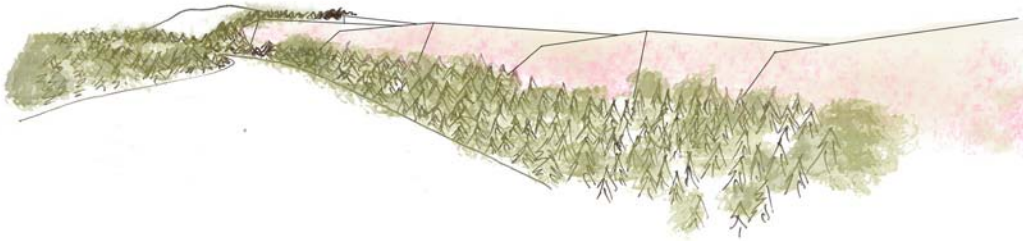


On the west side of the site, between the Coquihalla Highway and Lac Le Jeune Rd., The Ribs were created from waste rock to direct and contain the tailings slurry, which would otherwise flow to create a large blob. With Sugarloaf Hill to the north, being the largest landform in the area, each rib steps down until fading out into the landscape. From the Coquihalla Highway, the main thoroughfare from Vancouver, the faces protrude forward, creating different angles as the road curves, breaking up the mass.

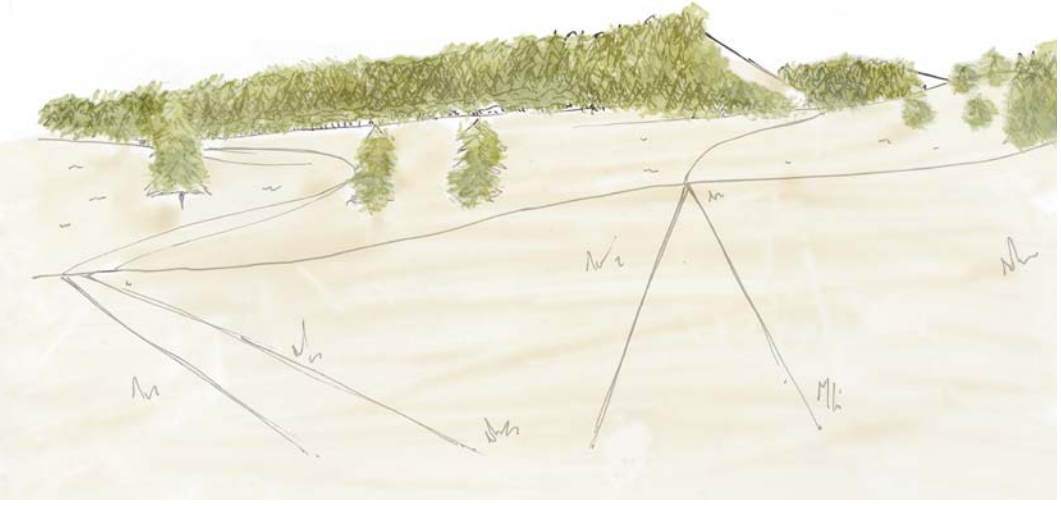
In between The Ribs, the tailings slurry would flow to fill the chambers and create the Tailing Slides.

Being the most viewed element of the site, the western faces of the Ribs are a constant reminder of the mining process. These faces, though aggressively visible, screen the rest of the site. Facing the valley they are open to the winds that blow through the fire prone area and are therefore available to catch the fireweed spores, making them semi permanently spattered in a vibrant pink. These eye-catching hills in all of their colour and rigidity, stimulate the desire to discover more.

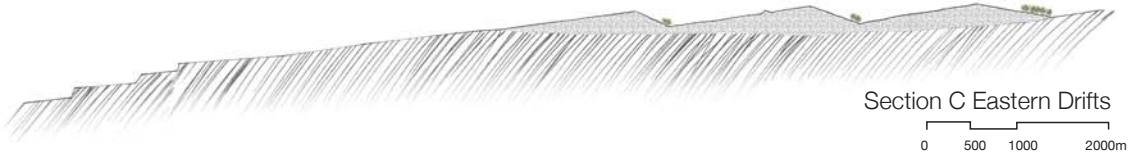
Ajax Proposal



3 The Ribs: View from Coquihalla Highway



4 Northern Ridges: View from Base of Coal Hill



Section C Eastern Drifts

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Section D Northern Ridges

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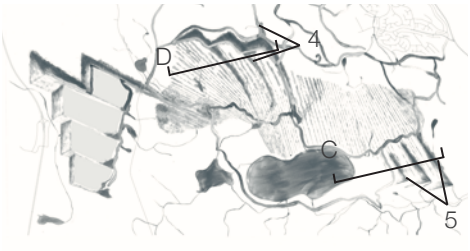
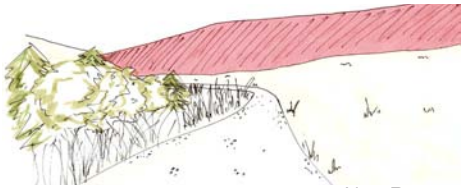


Crossing Lac Le Jeune Rd, to the grasslands of the existing mine site, two major waste rock elements were created that follow the rolling of the landscape, the Northern Ridges and the Eastern Drifts. These two formations allowed large amounts of waste material to be deposited and standing on top provides the opportunity to look down upon the site and across the landscape.

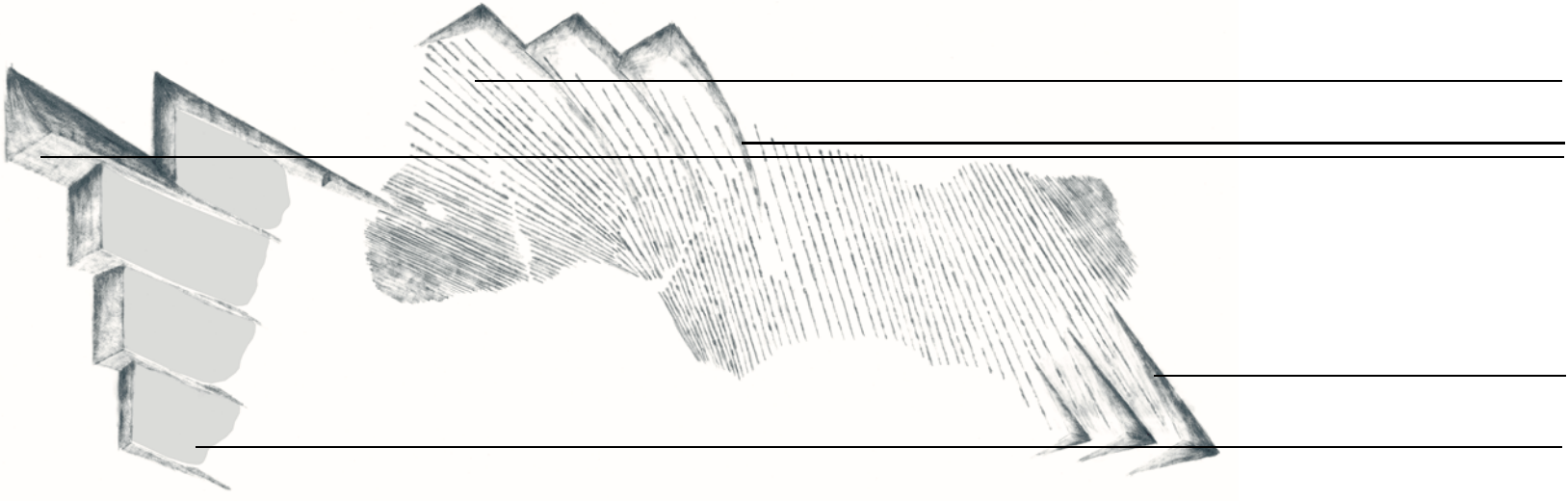
From these vantage points, the chains of waste rock can be seen rolling across the site. Dependant on location and surrounding vegetation, different conditions are created intriguing viewers and encouraging them to move into the site, discovering spaces to call their own.

The Northern Ridges and Eastern Drifts, while rigid and engineered, mimic the dominant land features of Coal Hill and Iron Mask Hill. Similar to the altered view from the Coquihalla Highway, the view of the Eastern drift is no longer as overbearing from Goose Lake Road.



Ajax Proposal

5 Eastern Drifts: View from Goose Lake Rd.



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Waste Material

Movable Conveyor System: Waste Rock

Haul Trucks: Waste Rock

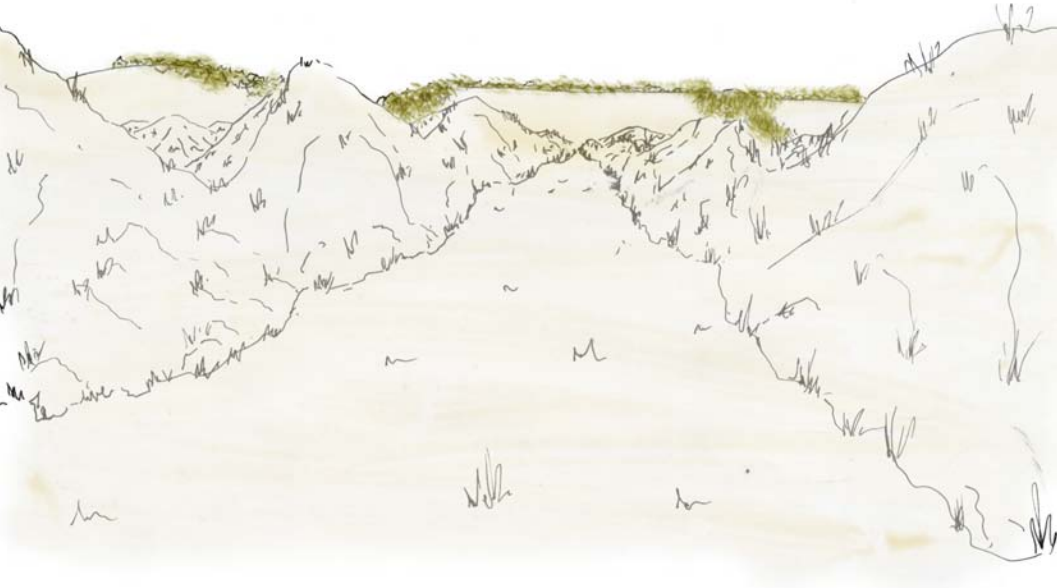
Spigots: Tailings

Figure 39: Material Distribution Methods

During production, similar distribution techniques to the Ajax proposal will be used. The mine tailings will be passed through thickeners to remove most of the water with the excess water being sent back to the mill for reuse. The now thickened tailings can be pumped along the western ridges of The Ribs where it will be discharged through valves to flow eastwards, creating the gentle slopes of the Tailing Slides within the waste rock chambers.

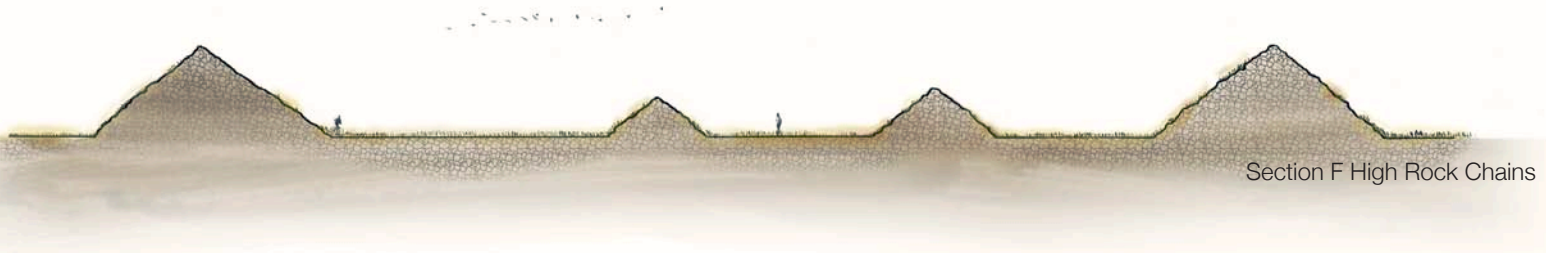
Similar to the initial stages of the North and East waste rock facilities in the Ajax Proposal, the three dominant landscape forms, the ribs, northern ridges and eastern drifts, will be created by haul trucks. Beginning with the farthest forms, trucks are able to start the piles from the direction of the open pit. The material can then be pushed to create a sloping surface in which the trucks can then drive up to dump the material over the edge, continuously making the hills longer. Once the first landforms are created a movable conveyor system with a traveling stacker can distribute the waste rock in rows.

As the stacker travels down the conveyor bridge it can vary the timing of its movement, creating taller and wider mounds the slower it moves. The conveyor system is then capable of moving laterally to begin a new row.

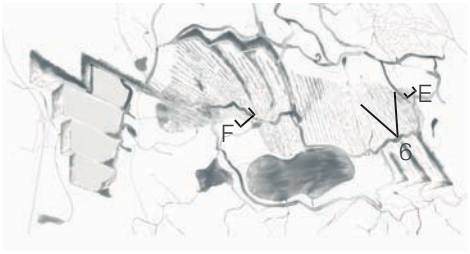


6 Rock Chains Grasslands: View Towards Ridge Separating the City

Section E Low Rock Chains



Section F High Rock Chains



Following the curve of the ancient erosive patterns the chains of waste rock pull from the Northern Ridges and Eastern Drifts, mimicking the rolling of the natural landscape. With the largest piles towards the peaks at 10 m tall, the rows pull away to smaller 1 m rippling mounds.

With wider and taller hills towards the centre of the site, the height of each row slowly reduces until fading out at the edges.

Distributed across the site, the experience within the chains varies significantly. Views are altered dependent on the height of the mound. Where they are lower, you are able to see across the rippling forms and into the surrounding landscape. Here interaction with others may be more frequent. In between the higher mounds it is much more isolating. The pockets within the higher chains provide more opportunities for possession of a space, similar to the lakes that currently exist on site.

Regional Landform Pattern

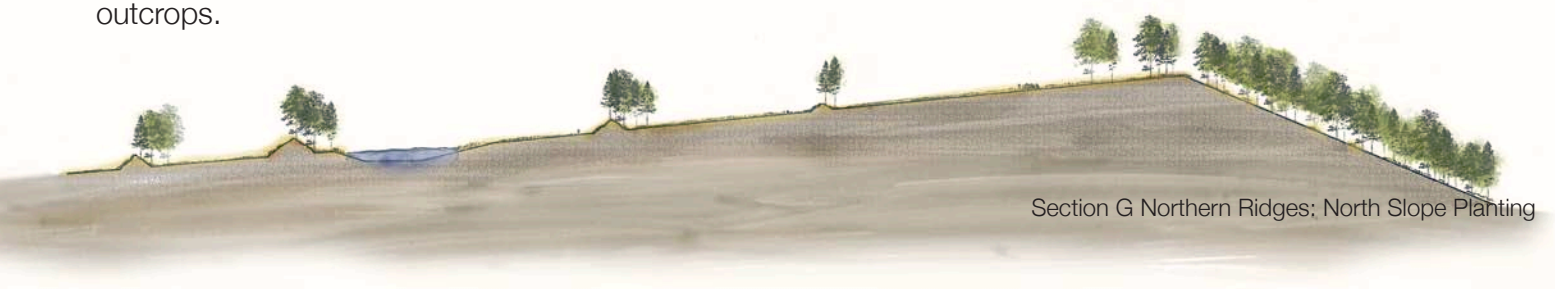
Ecological Establishment

By looking at the regional patterns, scenarios have been created for natural forces to occur, encouraging the reestablishment of natural drainage and vegetation patterns. Pockets are created in which water, debris and seeds can be collected, promoting ecological establishment and the opportunity for biodiversity.

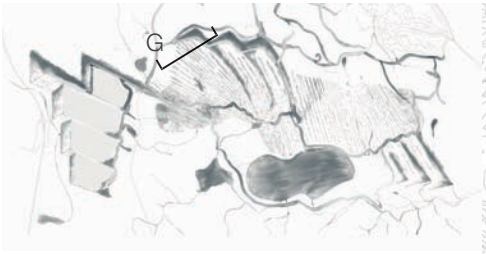
As with the material distribution, industrial reclamation techniques and machinery will be used to re-vegetate the site. Machinery such as soil slingers, hydro mulchers and hydro seeders will be used to cover the waste materials. Bottomlands and southern slopes will be spread with organic mulch and a diverse forage seed mixture to help re-establish grasslands.

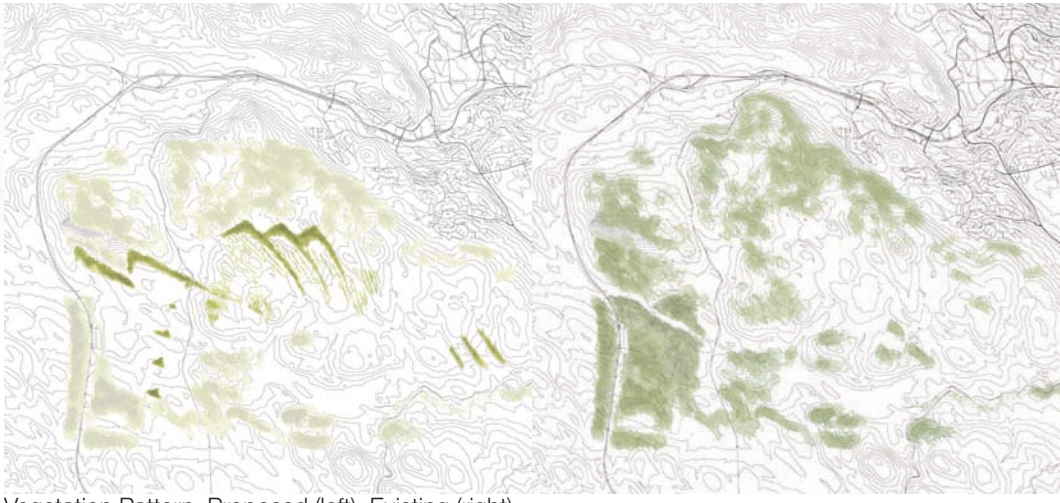
A forest blend consisting of ponderosa pine, lodgepole pine and Douglas fir will be spread on the northern slopes where, as with the surrounding forests, they will have a better chance of establishment and survival.

With the diversity of the waste rock particle sizes, growing material and seeds will settle into pockets creating small microclimates for vegetation establishment, and nutrient gradients will promote growth towards the base of the mounds. These processes may leave the tops and coarser areas bare, exposing the mining process and creating a texture of rocky outcrops.

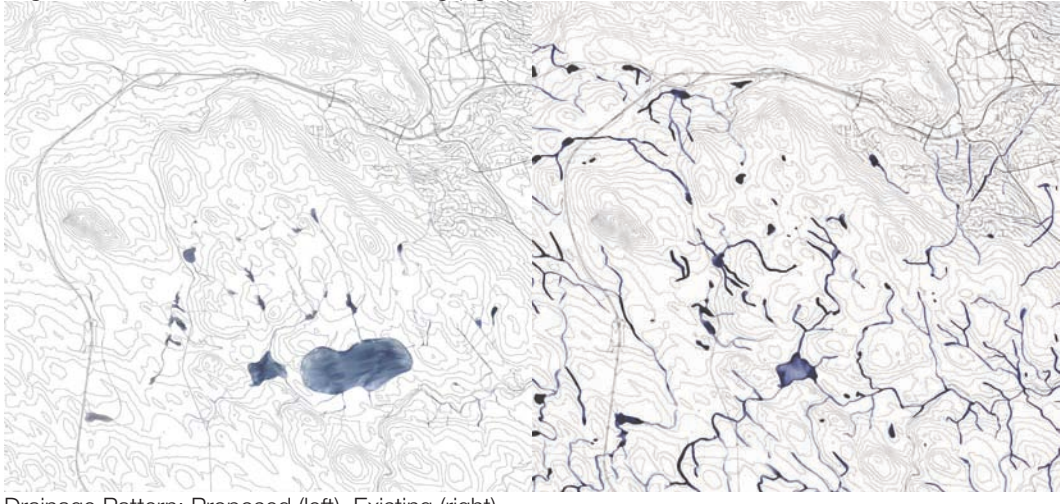


Section G Northern Ridges: North Slope Planting

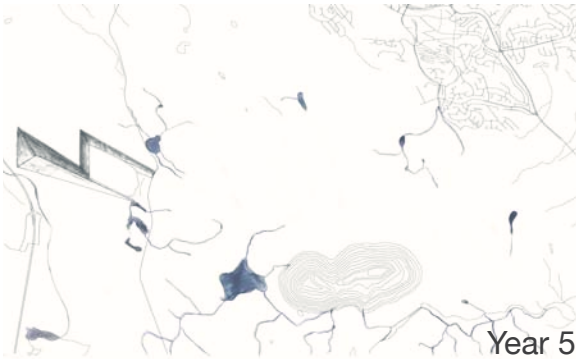


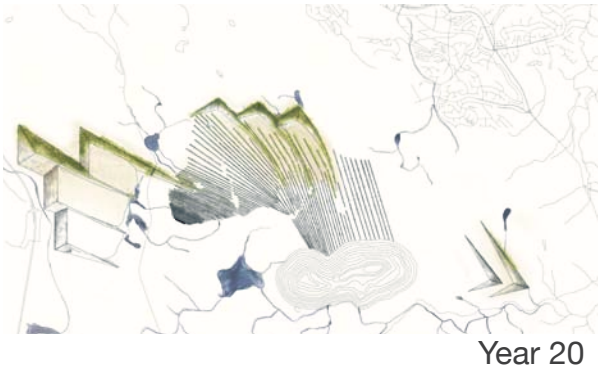


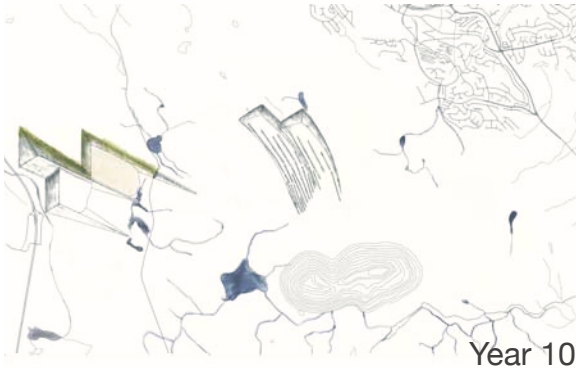
Vegetation Pattern: Proposed (left), Existing (right)

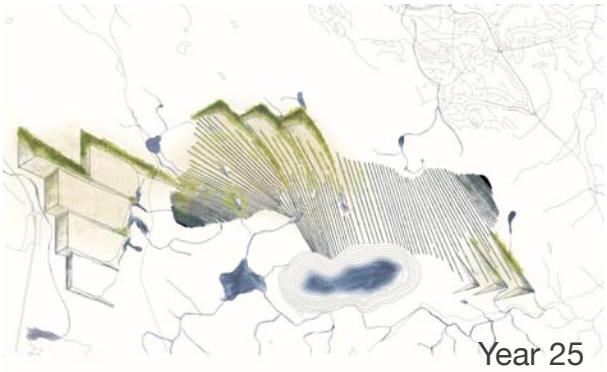


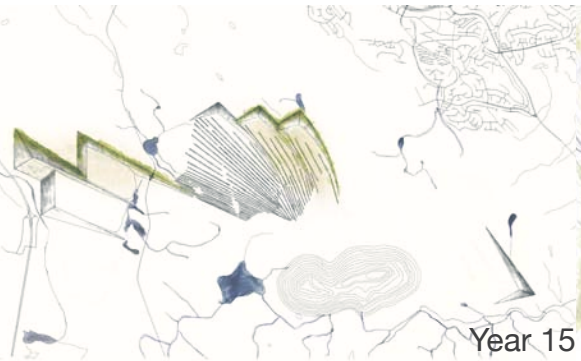
Drainage Pattern: Proposed (left), Existing (right)

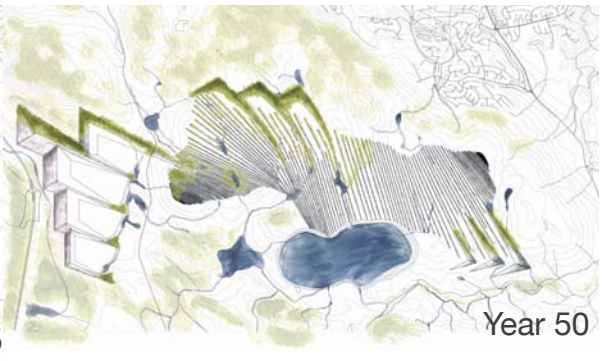










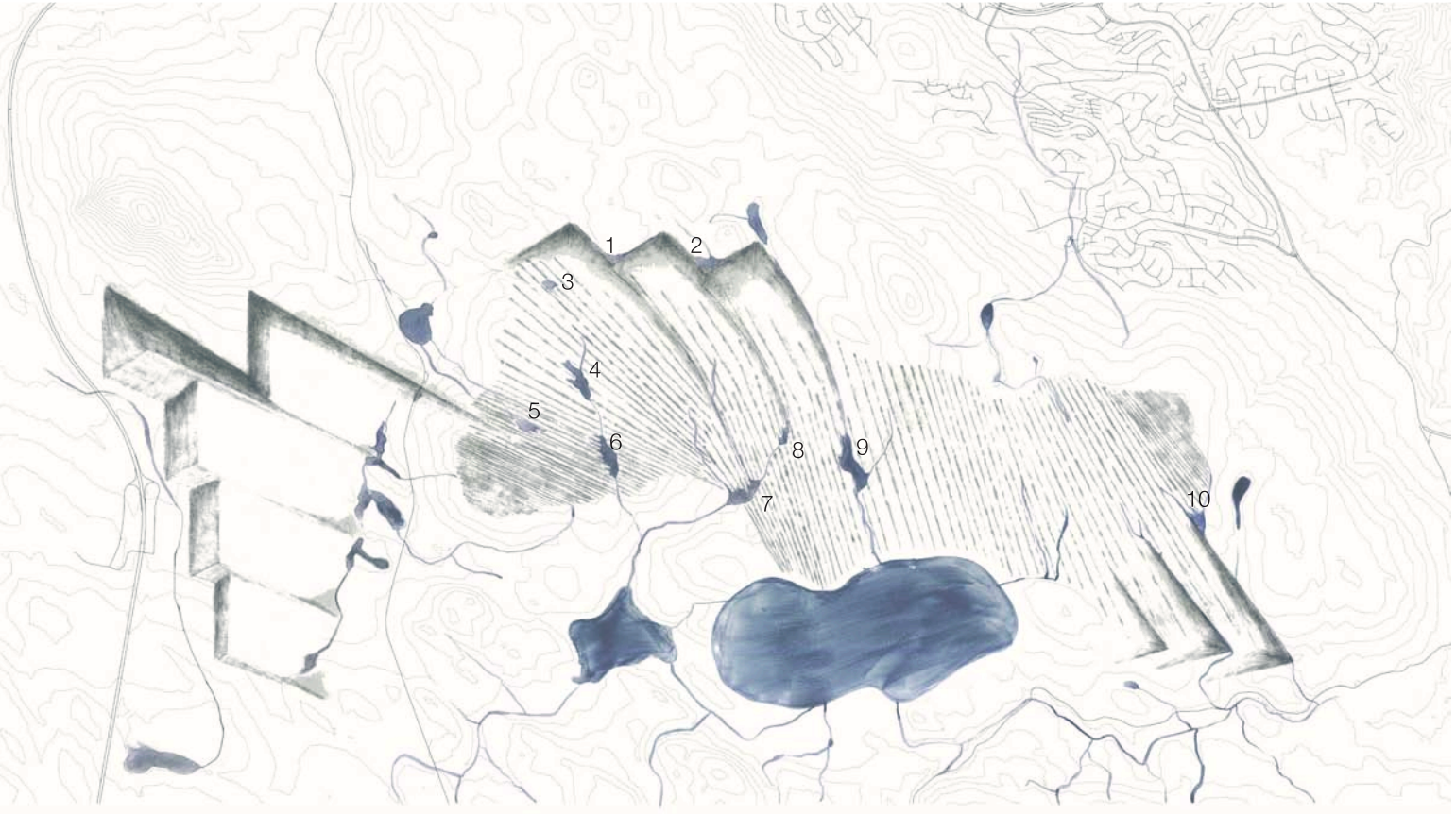


Stages of Reclamation

With numerous landscape components, the mining process can move across the site allowing for progressional reclamation.

The chambers of the ribs allow for reclamation of previously poured tailings, while distribution continues to move south. Additional chambers can be added according to need, keeping the plan flexible to changes in production.

Beginning just north of the pit the movable conveyor systems can continually step backwards towards the east and west edges of the site. This leaves earlier piles available for reclamation and areas closer to the city available for use to the public.



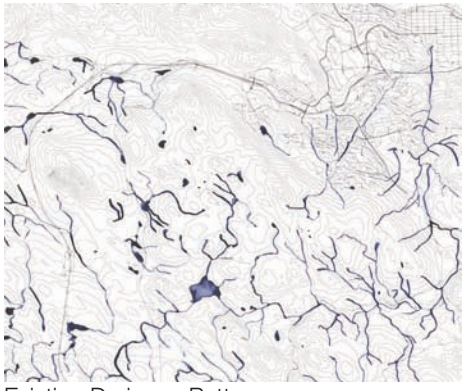
0 500 1000 2000m

Pocket Lakes

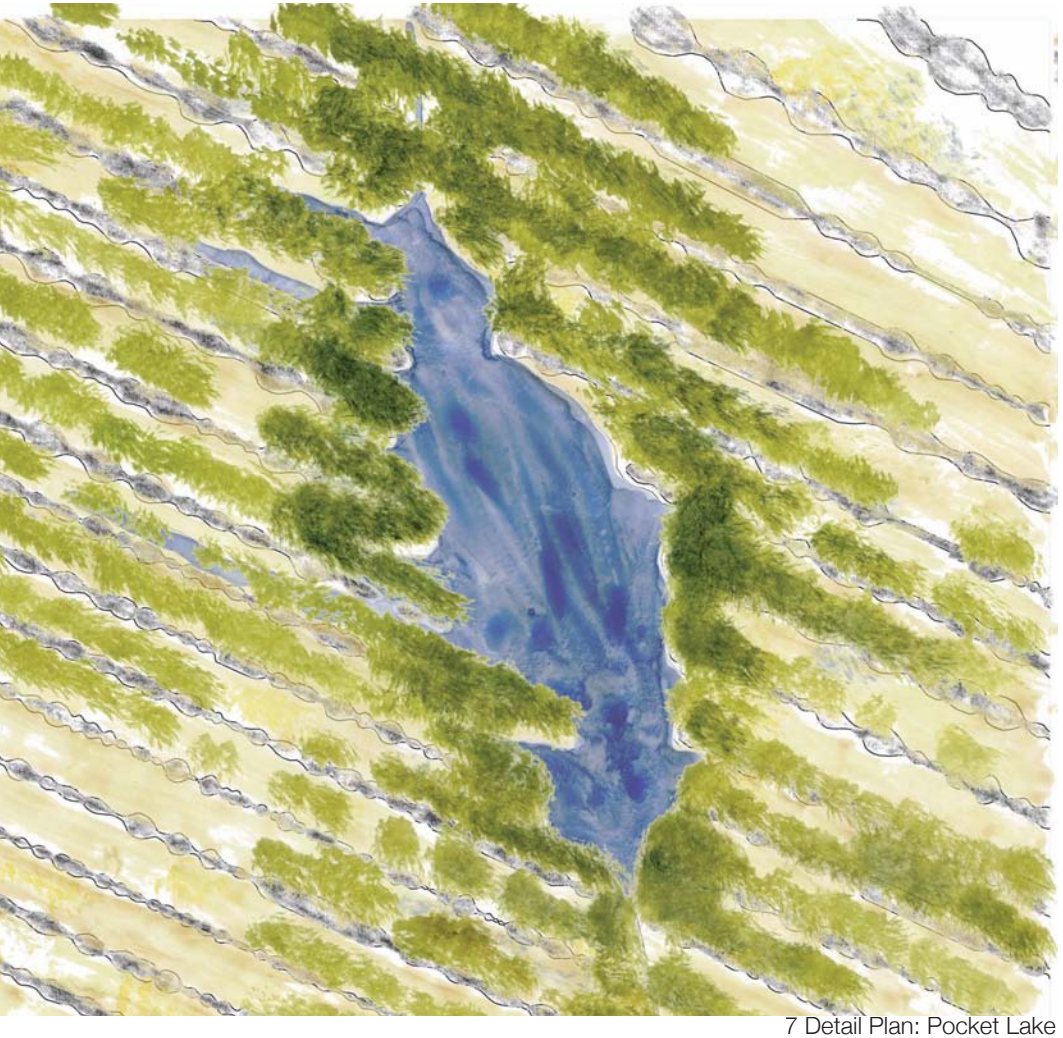
As the mining process would cover up the landscape and eliminate the trails and personal places that had been established on the site, I strove to recreate a landscape that would encourage true discovery. Opportunities were created for destinations.

Introducing the framework for water to gather, minor watersheds are established recreating pocket lakes, similar to those that were eliminated. With the water gathering along the chains, inlets are created providing isolation and the chance for a fisherman to feel like he has found a place of his own.

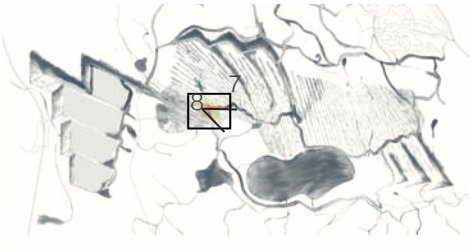
Ten small pocket lakes have been proposed in the site plan. These were determined based on low points created between the proposed waste rock forms. The majority of the pocket lakes are around the Northern Ridges and the chains that roll south from this feature. This was based off of the existing drainage patterns, with most of the small lakes around this area and the creeks running towards Jacko Lake and Peterson Creek. On the existing site and the proposed site plan a few small tributaries run west to enter into the Cherry Creek watershed. These proposed pocket lakes are an example of how water might collect, while the actual implementation may vary.



Existing Drainage Pattern



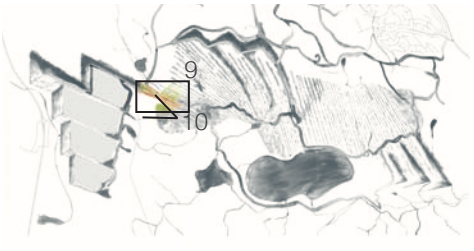
7 Detail Plan: Pocket Lake



An example of one of these pocket lakes is shows to the left. One of the larger proposed lakes, this catchment area is to the south west of the Northern Ridges and flows to Jacko Lake. Water collection extends northwest up between the chains forcing them to extend into the body of water. The creation of these small inlets provides many private spaces for people to enjoy. The character of each lake varies creating the opportunity to discover something new at each one.

8 Rock Chains Jutting into the Lake

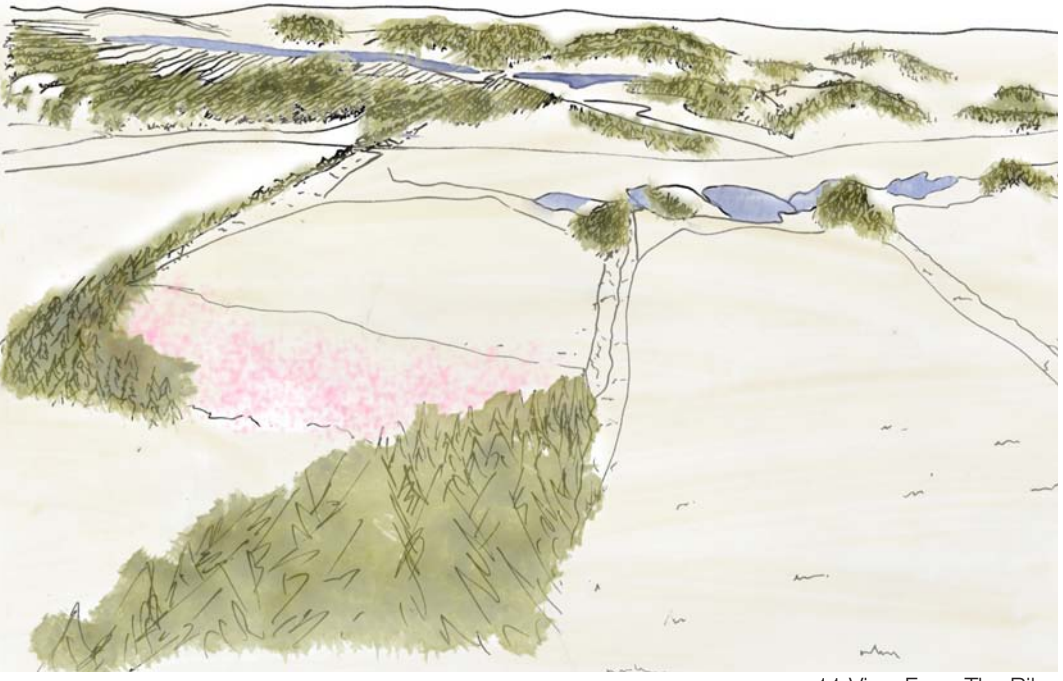
9 Detail Plan: Connecting Rib



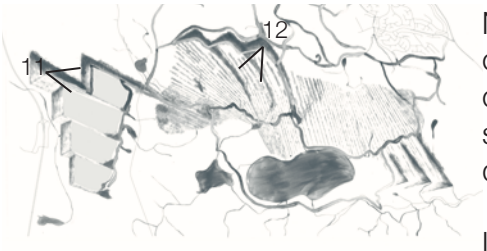
From The Ribs, a ridge extends over Lac Le Jeune Rd. forming another destination within the site and connecting the main body of waste material to the Tailing Slides. This ridge is accessed at the southwest end of the chains through a forested condition. Trees have been encouraged to take over these low lying mounds, coming up the side of the existing slope, and creating a wooded threshold to the ridge.

The ridge itself is a destination as you can stand above the road and look down the valley between Sugarloaf Hill and Iron Mask Hill. With the northern edge of the ridge forested, stepping out onto the bridge above the road opens up a new and beautiful view.

10 Forested Rock Chains



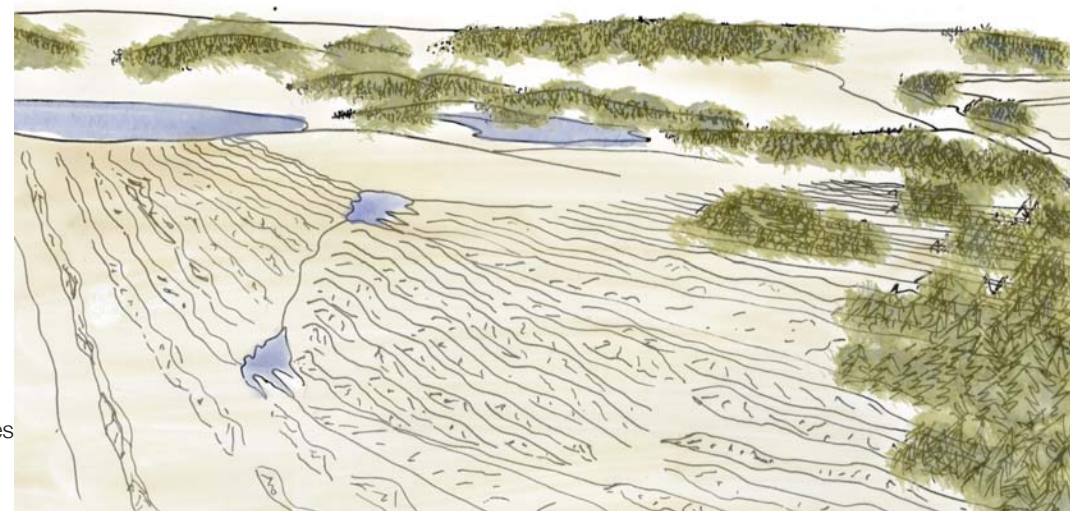
11 View From The Ribs



No set pathway system was established, but two ridge walks that connect to existing access points bring people to the highest points of the Ribs and to that of the Northern Ridges. At this time they are strictly sculpted rock ridges, but they bring you up above the landscape, displaying the history of the site and encouraging further exploration.

Looking south on the ridge crossing Lac Le Jeune Road, a view of the Tailing Slides is presented as it steps down into the landscape. The continuation of the ridge walk to The Ribs and the catchment wetlands at the base of each slide can been seen from this point encouraging visitors to make the decision to hike up to the point or down, discovering the various characteristics of the site.

Existing hiking trails connect behind Coal Hill and bring visitors up the Northern Ridges walk where they are able to see the entire mine site spreading out in front of them.



12 View From Northern Ridges

Chapter 6
Conclusion

In the continual search and extraction of the earth's mineral resources, the mining industry will destroy much of the natural western landscape. Alan Berger predicts that by 2230 most of the resources in the western United States will have been exhausted and the "resultant landscape will be designed as a new, reclaimed ecosystem (Berger, 2006, p. 13)."

The future of our countries landscape depends on the reclamation laws and the vision of mining companies. Focused on the business of mineral extraction, mining companies most often opt for an attempted recreation of the natural landscape. Landscape Architecture has the potential to benefit this process by proposing alternate end uses in which multiple systems may benefit.

With the intent of extracting all available sources, the mining industry will continue to move closer to communities. The concerns brought forward by the citizens of Kamloops would be comparable to those from other communities in the same situation. Landscape Architects often act as agents between companies and community members. In the mining industry there is an opportunity, and even a need, for Landscape Architects to take the concerns of the community and consider all other forces on the site when creating the site design.

My proposal of the Ajax Mine attempts to alleviate a number of the concerns from the community and layer upon the site the many environmental, social and industrial forces that act upon it. By mimicking natural systems the reintegration of the site into the surrounding landscape is made more feasible. Movement of the industry across

the site allows for these processes to begin at an earlier stage and the potential for the community to access them. This process also benefits the mine as their reclamation time following production is greatly reduced.

The plan sets the ecological processes in place but monitoring would be required to ensure establishment. This also provides the potential for reclamation research.

For the community of Kamloops the appearance of the destruction would be reduced and involvement with the industrial process would build a relationship between the two parties. The site design brings to light the history of our place and creates a place of interest and exploration.

Ideally our natural landscape would not be destroyed by heavy industry but these resources are required to maintain our standard of living. We have the opportunity to reduce the impact of the mining industry on the landscape and on communities but it requires more involvement and consideration of all of those affected.

Figure 40: Existing Ajax West Pit

List Of Figures

Photographs and drawings produced by author unless otherwise noted.
All copyrights have been obtained, where required.

Figure 23: Drawn by author. Information from Manitoba Land Initiative, 2011.

Figure 24: Drawn by author. Information from Government of Canada, 2013; GeoBase 2013.

Figure 26, 27: Drawn by author. Information from The Weather Network, 2013.

Figure 28: Drawn by author. Information from Environment Canada, 2008.

Figure 30: Drawn by author. Information from Government of Canada, 2013.

Figure 32: Drawn by author. Information from City of Kamloops, n.d.; Government of Canada, 2013.

Figure 33: Drawn by author. Information from Government of Canada, 2013; Roosters Offroad, 2013.

Figure 34: Drawn by author. Base Information from Government of Canada, 2013.

Figure 36: Photo taken by Steffen Sauder.

References

Abacus Mining and Exploration Corp. (2012, January 6). Ajax Copper/ Gold Project- Kamloops, British Columbia Feasibility Study Technical Report. Retrieved January 3, 2013 from http://www.ajaxmine.ca/documents.html.

Amidon, J. (2005). Moving horizons : The Landscape Architecture of Kathryn Gustafson and Partners. Basel Boston: Birkhäuser-Publishers for Architecture.

British Columbia Ministry of Forests. (n.d). The Ecology of the Interior Douglas Fir Zone. Retrieved March 5, 2013 from http://www.for.gov.bc.ca/hre/becweb/resources/classificationreports/provincial/index.html

Berger, A. (2006). *Drosscape : wasting land in urban America*. New York: Princeton Architectural Press.

Berger, A. (2002). Reclaiming the American West. New York: Princeton Architectural Press.

British Columbia. (1897). Kamloops Mining Camp. Kamloops, BC: Ballie and Bennet Publishers.

British Columbia Ministry of Energy, Mines and Petroleum Resources. (2008). Health, Safety and Reclamation Code for Mines in British Columbia. Victoria, BC: Government of British Columbia.

British Columbia Ministry of Energy, Mines and Petroleum Resources. (n.d.) Mineral Titles. Retrieved February 20, 2013 from http://webmap.em.gov.bc.ca/mapplace.maps/minpot/mtitles.mwf

City of Kamloops. (2012). History of Kamloops. Retrieved January 16, 2013 from http://www.kamloops.ca/museum/historyofkamloops.shtml

City of Kamloops. (n.d.) Geographic Information Services. Retrieved February 10, 2013 from http://www.kamloops.ca/it/gis.shtml

Environment Canada. (2008, July 29). Canadian Wind Energy Atlas. Retrieved February 4, 2013 from http://www.windatlas.ca/en/nav.php?field=EU&height=50&season=ANU&lakes=1&roads=1&cities=1&lat=50.608681&lon=120.399342&postal=&no=51

Falls, R & Friesen, R. (2009, March 16). Assessment Report on the Abacus-New Gold Joint Venture Diamond Drilling Program on the Ajax Property. Retrieved December 23, 2012 from http://aris.empr.gov.bc.ca/ArisReports/30668A.PDF

Favrholdt, Ken. (2008). Gold at Tranquille. Retrieved June 10, 2013 from http://salmonid.sd73.bc.ca/pinepark.html

Ferreira, Anton. (2010, April 25). Diamond in the Dust for Local Art. Sunday Times. Retrieved June 11, 2013 from http://www.timeslive.co.za/sundaytimes/article418944.ece/Diamond-in-the-dust-for-local-art

Fezer, J. & Schmitz, M. (2012). Lucius Burckhardt writings. Rethinking man-made environments politics, landscape & design. Vienna New York: SpringerWienNewYork.

FLSmidth. (2012). Tailings / Waste Stacking Systems. Retrieved May 24, 2013 from http://www.flsmidth.com/en-US/Products/Product+Index/All+Products/ConveyingMobileConveyorSystems/TailingsWasteStacking

GeoBase. (2013). National Hydro Network. Retrieved March 27, 2013 from http://www.geobase.ca/geobase/en/data/nhn/index.html.

Gizikoff, Katherine (2003). Re-Establishing Livestock Use on Mined Landscapes in the Southern Interior of BC. Retrieved March 22, 2013 from https://circle.ubc.ca/handle/2429/9008

Government of Canada. (2013, February 6). CanVec- 09I01, 09I02, 09I03, 09I06, 09I07, 09I08, 092I09, 09I10, 09I11, 09I14, 09I15, 09I16. Retrieved February 10, 2013 from http://geogratis.gc.ca/api/en/nrcan-rncan/ess-sst/29fe03d1-79bb-4783-8f11-f81562085bcf.html

Hatch Consulting Engineering. (2007, April). New Afton Project: NI 43-101 Independet Technical Report. Retrieved February 27, 2013 from http://google.brand.edgar-online.com/EFX_dll/EDGARpro.dll?FetchFilingHtmlSection1?SectionID=5155001-4574-513939&SessionID=RGPlHCg1k6zsWG7

Kamloops Area Preservation Association. (2011). KGHM Ajax Inc., A Mine too Close. Retrieved December 20, 2012 from http://www.stopajaxmine.ca/home

Kerr, D.E. et al. (1993). Preliminary Results of Glacial Dispersion Studies on the Galaxy Property, Kamloops, B.C.

KGHM Ajax Mining Inc. (n.d) Ajax Copper-Gold Project Fact Booklet. Retrieved January 10, 2013 from http://www.ajaxmine.ca/documents.html

Krinke, Rebecca. (2001). Design Practice and Manufactured Sites. In N. Kirkwood (ed.), Manufactured sites: rethinking the post industrial landscape (pp. 124- 148). London, New York: Spon Press.

Knight Piésold Ltd. (2012). KGHM Ajax Mining Inc. Ajax Project: Draft Application Information Requirements/ Environmental Impact Statement Guidelines, Application for and Environmental Assessment/ Environmental Impact Statement for Comprehensive Study.

Manitoba Land Initiative. (2011). Manitoba Land Initiative digital maps. Retrieved June 20, 2013 from http://mli2.gov.mb.ca/

Merwe, Strijdom van der. (2010). Am/Pm shadow Lines/Earthworks [Image]. Retrieved June 4, 2013 from http://www.strijdom.co.za/

Porteous, S. (2012, May 11). Big Gold Rush, Discovery of Copper ore set stage for Interior's mining Industry. Kamloops Daily News. pp. D4.

Province of British Columbia. (2013). Wildfire Management Branch. Retrieved February 12, 2013 from http://bcwildfire.ca/Aboutus/Organization/Kamloops/Climate/#Climate

Ralph, J & Chau, I. (2012, December 13). Kamloops Mining Division, British Columbia, Canada. Retrieved June 10, 2013 from http://www.mindat.org/loc-476.html.

Rogers, E. (2001). Landscape design : a cultural and architectural history. New York: Harry N. Abrams.

Roosters Offroad. (2013) Kamloops Trail Maps. Retrieved April 1, 2013 from http://roostersoffroad.com/kamloops-trail-maps.

Sauder, Steffen. (2008, Aug 14). Kamloops Lake [Image]. Retrieved May 17, 2013 from http://www.flickr.com/photos/feffef/3041529817/

Schmitz, Martin. (2006).The Strollology of Lucius Burckhardt. Topos, 56, 79- 83.

Spring Hill Winter Sports Park Co. LTD. (n.d.). Spring Hill Winter Sports Park: About Us. Retrieved June 10, 2013 from http://www.springhillwinterpark.com/About_Us.html

Sun Peaks Resort. (2013). Cattle Grazing Goes Full Circle. Retrieved June 7, 2013 from http://www.sunpeaksresort.com/media-centre/story-ideas/environment

Tenova Mining & Minerals. (2013). Conveyor Technology: Penasquito Waste Rock Stacking System and Overland Conveyors. Retrieved June 10, 2013 from http://www.yumpu.com/en/document/view/11680921/penasquito-waste-rock-stacking-system-overland-conveyors

Tourism Kamloops. (2012). Kamloops: Playtime Redefined. Retrieved February 12, 2013 from http://www.tourismkamloops.com

Turner, R.J.W et al. (2008). GeoTour Guide for Kamloops, British Columbia, Geological Survey of Canada. Retrieved June 5, 2013 from http://www.kamloops.ca

The Weather Network. (2013). Retrieved February 28, 2013 from http://www.theweathernetwork.com/forecasts/statistics/cl1163780/cabc0146.

Von Donop, A., Hills, L., Davis, T. (Producers), & Riedelsheimer, T. (Director). (2001). Rivers and Tides: Andy Goldsworthy Working with Time(Motion Picture). Germany: Mediopolis Film- und Fernsehproduktion.