An Architecture of Reclamation in the City of Sudbury:
Where Land and Water Meet

by

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A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Architecture (M.Arch)

The Faculty of Graduate Studies
Laurentian University
Sudbury, Ontario, Canada

THESIS DEFENCE COMMITTEE/COMITÉ DE SOUTENANCE DE THÈSE
Laurentian University/Université Laurentienne
Office of Graduate Studies/Bureau des études supérieures

Title of Thesis Titre de la thèse	An Architecture of Reclamation: Where Land and Water Meet		
Name of Candidate Nom du candidat	Beaudry, Veronique		
Degree Diplôme	Master of Architecture (M.Arch)		
Department/Program Département/Programme	Architecture	Date of Defence Date de la soutenance	April 10, 2022

APPROVED/APPROUVÉ

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Abstract

The City of Greater Sudbury is home to a unique terrain that has been shaped by many events throughout time. The culture of the place is deeply rooted in industry as well as distinctive landscape feature such as barren rock outcroppings and bounty of lakes. After a century of invasive mining activity, the landscape is being reclaimed and the city of rocks is shifting to a city of lakes. Thanks to re-greening efforts many of Sudbury's 330 lakes have been brought back from their acidic state. However, urban development has created new challenges for lakes found within the city's core.

This thesis explores the potential for an architecture of reclamation that doesn't impose itself on the land but aids in the rehabilitation and ecological functions of the specific site. The project is a piece within a complex ecosystem that provides stormwater management benefits, educational amenities and ecological regeneration. Within the riparian zone of Ramsey Lake, this proposal acts as a mediary for clean water environments, where land and water meet.

Keywords

Reclamation / City of Greater Sudbury / Ramsey Lake / Watershed / Wetland / Riparian Zone / Natural Swimming Pool / Education Center / Sudbury History / Industrial Impact / Material Movement / Re-Greening / Gabion Wall / Active Transportation

Acknowledgments

To Sudbury,
I have bathed in your waters, climbed your rocks and watched you grow as much as you did I...
Thank you for shaping me.

To my mother,
The first place I swam and my continuous rock...
Thank you for supporting me.

To Terrance,
Who reminded me to hurry slowly...
Thank you for guiding me.

To Crumplin,
I hope to find you Knowhere...
Thank you for graciously sharing your time and knowledge.

To my friends,
This experience would not have been the same without you...
Thank you for the moments of laughter and everything in between.

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Prologue

Thesis Statement

Primary succession occurs in barren habitats, such as rock, where no soil is present. "Pioneering organisms colonize and modify the environment until new niches occur."[1] It is a slow and gradual process that is currently taking place in the City of Greater Sudbury. Only 50 years ago, the landscape in and around Sudbury hosted 84,000 hectares of semi-barren and barren lands, a result of over a century of exploitative industrial activity. Thanks to community efforts and industry support, the 'moonscape' has now been populated with over 11 million trees.[2] However, the story of reclamation is far from over. As the soil thickens on sulfur-stained rocks around the city's perimeter, development within the city continues to disrupt the ground by changing its form and introducing new aggregates. When preparing a site for development, the surface is leveled, either by blasting the outcropping rock or adding aggregates to stabilize marsh areas. This development method is inconsiderate to Sudbury's unique landscape and often leads to many expensive issues regarding water management infrastructure.

Through the re-greening process, we have learned that the health of the land greatly impacts the health of surrounding lakes. Using materials that echo Sudbury's ethos, the thesis project will propose an educational building that celebrates the relationship between land and water.

The shape of the surface on which we walk, build, drive, and play did not begin with the Anthropocene epoch. Shatter cones can be found all around Sudbury, giving evidence of a meteorite impact during the Paleoproterozoic era[3] that deposited nickel-copper ore in what is known as the Sudbury Basin.[4] Striae or striations on rounded rocks are a result of ice sheets melting towards the end of the Pleistocene epoch. This is a major contributing factor to the 330 lakes found in Sudbury, the most lakes within a municipality in Canada.[5] These events that occurred 1.9 billion and 11 thousand years ago have significantly influenced the known history of human interference in the area.

1. Khan Acadamy. *Ecological Succession.* Web log. Khan Academy (blog), 2021.
2. Ross, Nicola. *Healing the Landscape - Celebrating Sudbury's Reclamation Story.* Sudbury, ON: VETAC, 2001
3. University of Waterloo. *Shatter Cones at Sudbury, Ontario, Canada (46°36'N, 81°11'W).* Wat on Earth. University of Waterloo, March 26, 2018.
4. Long, D.G.F. 2009. *The Huronian Supergroup; in A Field Guide to the Geology of Sudbury, Ontario*. Ontario Geological Survey, Open File Report 6243.
5. Pearson. D.A.B, J.M. Gunn, W. Keller. *The Past, Present and Future of Sudbury's Lakes*. Sudbury, Ontario, Canada: Laurentian University, 2012.

In 1871 the visible impact of invasive human activity began with the introduction of the logging industry. Taking advantage of what once was a dense forest of massive red and white pines, loggers devastated the area until only a few dried stumps remained. Following the logging industry, the Canadian Pacific Railroad forged its tracks from the east to the west in Canada, setting up short-term working camps that would establish many of the cities found across Canada today. The happenstance that William Ramsey should make a miscalculation; the CPR blasted through what is now Sudbury, discovering a rich mineral deposit. This would forever change the landscape, as what was originally a collection of small railway and logging camps would become the largest mining hub in the world for nickel-copper ore by 1911.[6] The prosperity of the mining industry in Sudbury would lead to a well-established northern hub of 164,689 people by 2016.[7]

The notable population growth has required a significant amount of infrastructure and services to support this northern population. "Unfortunately, a long history of industrial pollution, inadequate sewage disposal systems, urban runoff and a lack of public understanding about the impact of lakeshore development have seriously degraded many lakes."[8] When changing the ground topography and material, it is important to consider the effects of the movement of water on its surface.[9]

There is no better teacher than the beaver when it comes to hydrology. The beaver carries a sense of wisdom that we can only aspire to be as builders. In Indigenous teaching, the beaver, or Amikwag, is a builder of consent and diplomacy that creates shared spaces and brings with it more life. By building dams, lodges, and canals, the beaver also creates habitat for other living species or relatives through a relational sense of space.[10] The design proposal will strive to enhance its surrounding ecosystems, with a key question in mind:

How can architecture be a mediary for clean water environments?

6. SARA Group. *Sudbury Area Risk Assessment - Chapter 2.0 History of the Sudbury Smelters Volume 1*. Sudbury, Ontario, Canada: SARA Group, January 2008.
7. Statistics Canada. 2017. *Greater Sudbury [Census metropolitan area]*, Ontario and Saskatchewan [Province] (table). Census Profile. 2016 Census. Statistics Canada Catalogue no. 98-316-X2016001. Ottawa. Released November 29, 2017.
8. Pearson. D.A.B, J.M. Gunn, W. Keller. *The Past, Present and Future of Sudbury's Lakes*. Sudbury, Ontario, Canada: Laurentian University, 2012.
9. Pepin, Antoinette L. *The relative importance of hydrology and substrate in the vegetation dynamics of restored freshwater wetlands*. George Mason University. ProQuest Dissertations Publishing, 1998.
10. Simpson, Leanne Betasamosake. *A Short History of the Blockade: Giant Beavers, Diplomacy, and Regeneration in Nishnaabewin*. Edmonton, Alberta: University of Alberta Press, 2021.

Although we see many examples of development that dominate the landscape with no regard for the importance of its hills and valleys, there are distinctive projects that consider the ground on which they lay and their relationship with the ecosystems around them. The Vale Living with Lakes Center is a local example of a building that is sensitive to its surroundings. As a research center for environmental science located on Ramsey Lake's shore and near the Laurentian University campus, the center fosters a culture of collaboration through partnerships with scientists, universities, government agencies, and industries. The center focuses on protecting and managing northern aquatic ecosystems, and as a testament to their practice, the building uses award-winning energy and water-saving technologies. Integrated into the Ramsey Lake shoreline, this building positively influences the landscape it is charged with studying and improving. [11]

The serpentine form of the building takes advantage of the existing topography to maximize daylight and protect against dominant winds. Green roofs, permeable pavers, and an infiltration basin assist in water filtration and help remediate the vital riparian zone. This project has succeeded in restoring the original ecologies that were once found along the shorelines of Sudbury, continuing the story of reclamation and transforming the City of Greater Sudbury.

Another project serving as a precedent to this thesis is the Borden Park Natural Swimming Pool by gh3* architects . Located in Edmonton, the seasonal pavilion provides a naturally filtered pool large enough to accommodate 400 people. The water passes through stone, gravel, sand, and botanic filtering processes. However, the true brilliance of this project is its aesthetically integrated design. The materials chosen for the building mirror the materials necessary to cleanse the water. The simple, straight, and rigid lines of the building contrast the natural flowing movement of the water, making them all the more pronounced.[12]

The site chosen for the thesis project is strategically located on the northwest shoreline of Ramsey Lake. Within the Ramsey watershed master plan, this site is one of 7 chosen to be fitted with a stormwater management facility.

11. Architizer. *Vale Living with Lakes Centre*. Architizer Inc, 2021.
12. Joel Di Giacomo. *Borden Park Natural Swimming Pool*. gh3* (gh3*, September 16, 2021), https://www.gh3.ca/work/natural-swimming-pool-02.

The estimated 6-8 million dollar facility would require digging 5,708m² of the shoreline to build an underground concrete basin that catches the stormwater from two adjacent runoff pipes and then release it into Ramsey Lake slowly.[13] However, there is an opportunity for an intervention that provides the same stormwater management benefits, while being less invasive.

The water pavilion will serve as a transitional space from urban development to the shore of Ramsey Lake. The materials and atmosphere are meant to serve as a space to reflect on the industrial past, with key views facing the water.

A chemical-free pool will also be incorporated within the facility. Before entering the pool, stormwater runoff will flow into a two-step natural filtration process of sand, gravel, stone, and Botanics. The cleansed water is purposely located alongside Ramsey lake to illustrate the difference in water quality. In addition, the pavilion will educate visitors on the importance of watershed planning and the impact of human activity on urban lakes.

13. Aquafor Beech Limited. Ramsey Lake Subwatershed Study and Master Plan - Phase 2 Report. City of Greater Sudbury, February 2020.

Part I

Land

A Brief History of Sudbury

From a dense forest of red and white pine trees to a devastated moon like landscape, Sudbury's unique history is visible throughout the land. When taking a closer look at it's unique landscape, we can begin to piece together the story that is Sudbury. If we look close enough, a clear timeline can be drawn.

1.5 billion years ago...

Shatter cones can be found all around Sudbury giving evidence to a meteorite impact during the Paleoproterozoic era.[1] This is known as the Sudbury Event and is the reason for the mineral rich deposits of nickel-copper within the Sudbury Igneous Complex (SIC).[2] The event was "one of the most violent periods of explosive volcanic activity ever recorded in the rocks of the earth's crust."[3] The impact also triggered volcanic activity, which is said to be the origin of the moon like landscape. The igneous complex contains the largest known deposit of nickel-copper ore in the world and is the origin of much of the nickel circulating today. The 60 x 30 km elliptical shape of the basin can be drawn by tracing the mines established along its edge. (Falconbridge on the west, Garson and Creighton on the south, and Levack on the northeast).[4]

10 thousand years ago...

Striae or striations on rounded rocks are a result of a continental glacier that once covered the majority of the northern hemisphere. The Laurentine Ice Sheet covering the Sudbury area was approximately two kilometers thick and reached the northern United States. The movement of these ice sheets drastically changed Sudbury's physical appearance. It is estimated that the glacial activity eroded the topography tens of meters. As the ice sheets melted towards the end of the Pleistocene epoch, 10 000 years ago, they left behind scoured basins and debris that trapped water.[5] This is a major contributing factor to the 330 lakes now found in Sudbury, the most lakes within a municipality in all of Canada.[6]

1. University of Waterloo. *Shatter Cones at Sudbury, Ontario, Canada (46°36'N, 81°11'W).* Wat on Earth. University of Waterloo, March 26, 2018.
2 . Long, D.G.F. 2009. *The Huronian Supergroup; in A Field Guide to the Geology of Sudbury, Ontario*. Ontario Geological Survey, Open File Report 6243.
3. E.C Speers, *The Age Relation and Origin of the Common Sudbury Breccia*. Journal of Geology 65 (1957): 513.
4. Saarinen, Oiva W. *From Meteorite Impact to Constellation City: A Historical Geography of Greater Sudbury* (Waterloo, Ontario, Canada: Wilfrid Laurier University Press, 2013), 7.
5. Ibid., p.1.
6. Pearson. D.A.B, J.M. Gunn, W. Keller. T*he Past, Present and Future of Sudbury's Lakes.* Sudbury, Ontario, Canada: Laurentian University, 2012.

A new pattern for water drainage was developed as the ice sheet retreated toward the south and southwest. "The trend of striae and grooves to the south and southwest, paralleling the oval shape of the Sudbury Structure, indicate that the local topography influenced the movement of glacial ice."[7] The rivers and lakes formed during this time would become a primary mode of transportation for the Aboriginal community, and later, explorers and surveyors establishing colonial settlements.[8]

Although the ice sheets left the Sudbury landscape with mostly exposed bedrock, some areas were left deposited with ground moraine (or till) less than 1 meter thick. These areas are not ideal for agriculture but are ideal for blueberry patches.[9] In terms of surficial geology, there are areas containing glaciofluvial deposits of silt and sand.[10] However, soils have had little time to mature since the last ice sheet.

Gradually after the Laurentine Ice Sheets melted, the land revegetated with spruce, poplar, and later, jack pine, white birch and alder (boreal forest). As the climate continued to warm, these species were replaced by white pine, hemlock and beech (Great Lakes - St. Lawrence Forest). This transition began approximately 7,700 years ago and continues to be the dominant species today.[11]

1871...

Although there is some mention of the Anishinaabe people sparsely populating the land and activity from the Hudson Bay's fur trade, the visible impact of invasive human activity began with the introduction of the logging industry in 1871.[12] "Aboriginal agriculture had little impact on the forest cover. The first surveyors in the Sudbury area found a surface cover that showed evidence of previous forest fires, followed by a later successional regrowth of birches and poplars."[13] That quickly changed when logging became the dominant industry of the area until 1927. Taking advantage of what once was a dense forest of massive red and white pines they devastated the area until only a few dried stumps remained.[14]

7. Saarinen, Oiva W. *From Meteorite Impact to Constellation City: A Historical Geography of Greater Sudbury.* (Waterloo, Ontario, Canada: Wilfrid Laurier University Press, 2013), 7.
8. Pearson. D.A.B, J.M. Gunn, W. Keller. T*he Past, Present and Future of Sudbury's Lakes. Sudbury.* Ontario, Canada: Laurentian University, 2012.
9. Saarinen, Oiva W. *From Meteorite Impact to Constellation City*, 14.
10. Ibid., 18.
11. Ibid., 15.
12. SARA Group. *Sudbury Area Risk Assessment - Chapter 2.0 History of the Sudbury Smelters Volume 1*. Sudbury, Ontario, Canada: SARA Group, January 2008.
13. Saarinen, Oiva W. *From Meteorite Impact to Constellation City*, 16.
14. Ross, Nicola. *Healing the Landscape - Celebrating Sudbury's Reclamation Story.* Sudbury, ON: VETAC, 2001

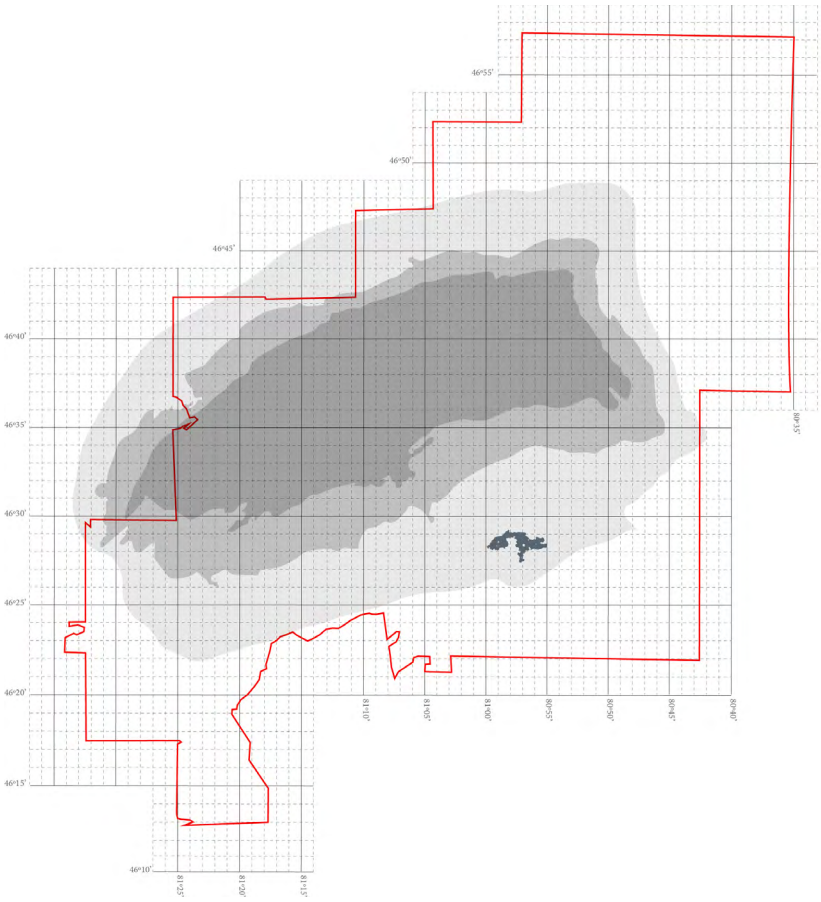


Figure 1 | The Sudbury Basin

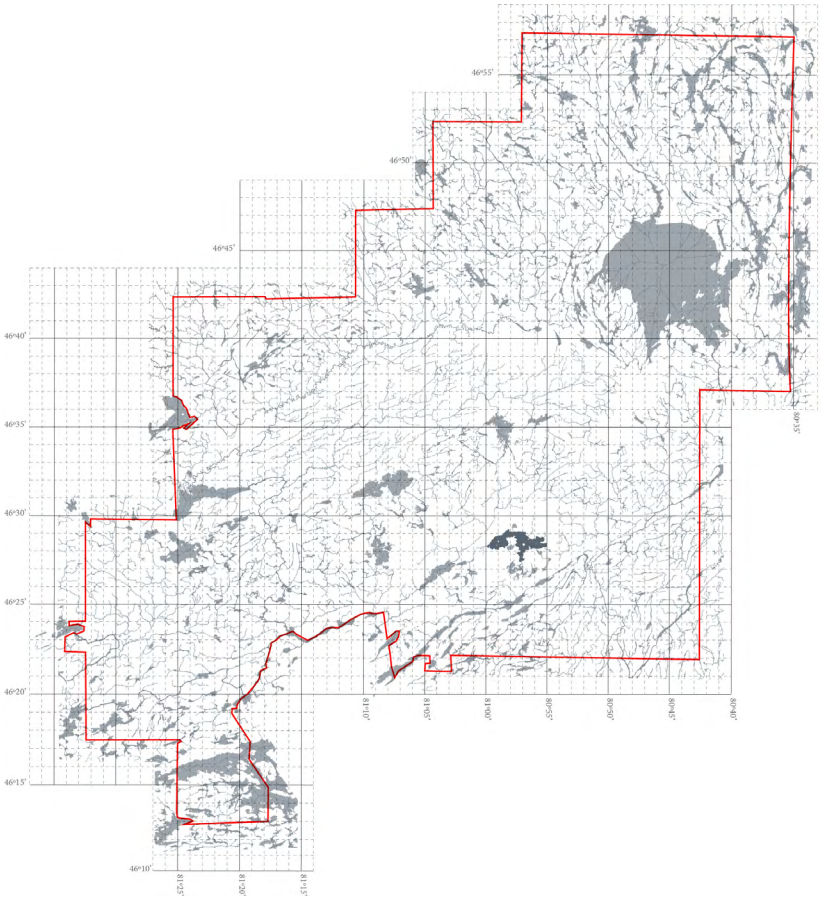


Figure 2 | 330 Lakes, the most lakes within a municipality

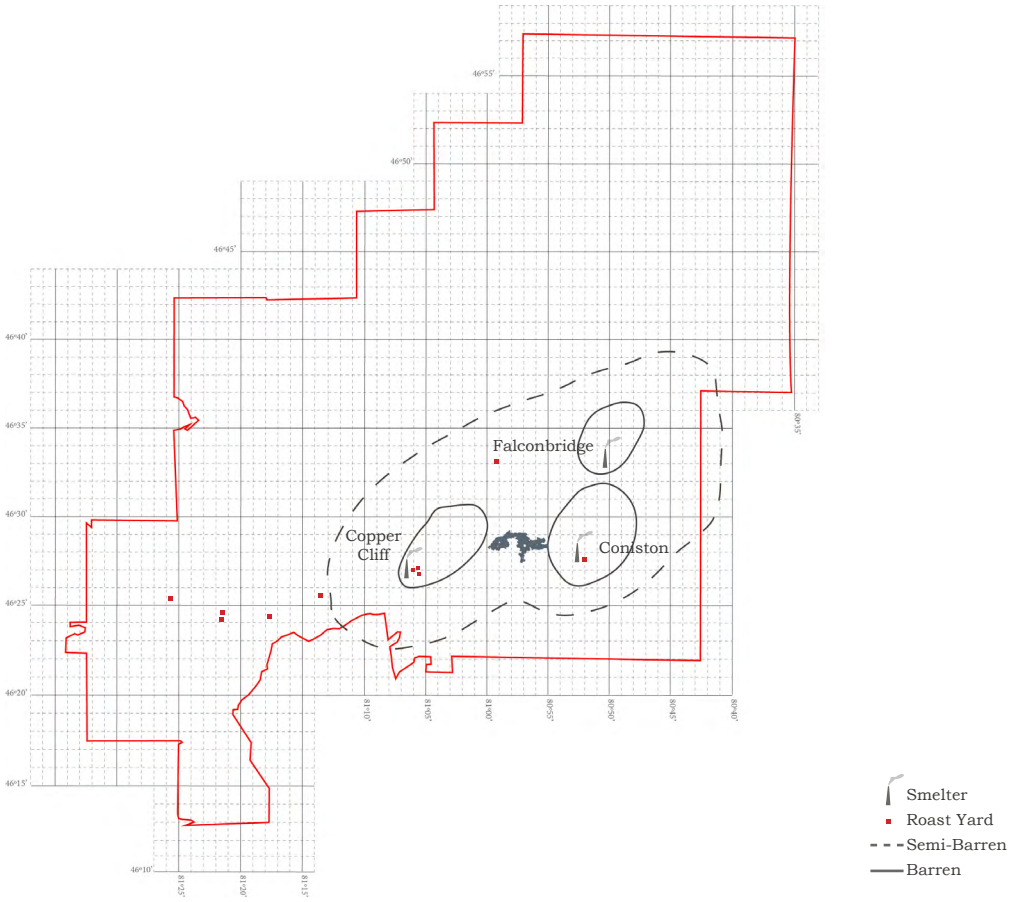


Figure 3 | Barren Land

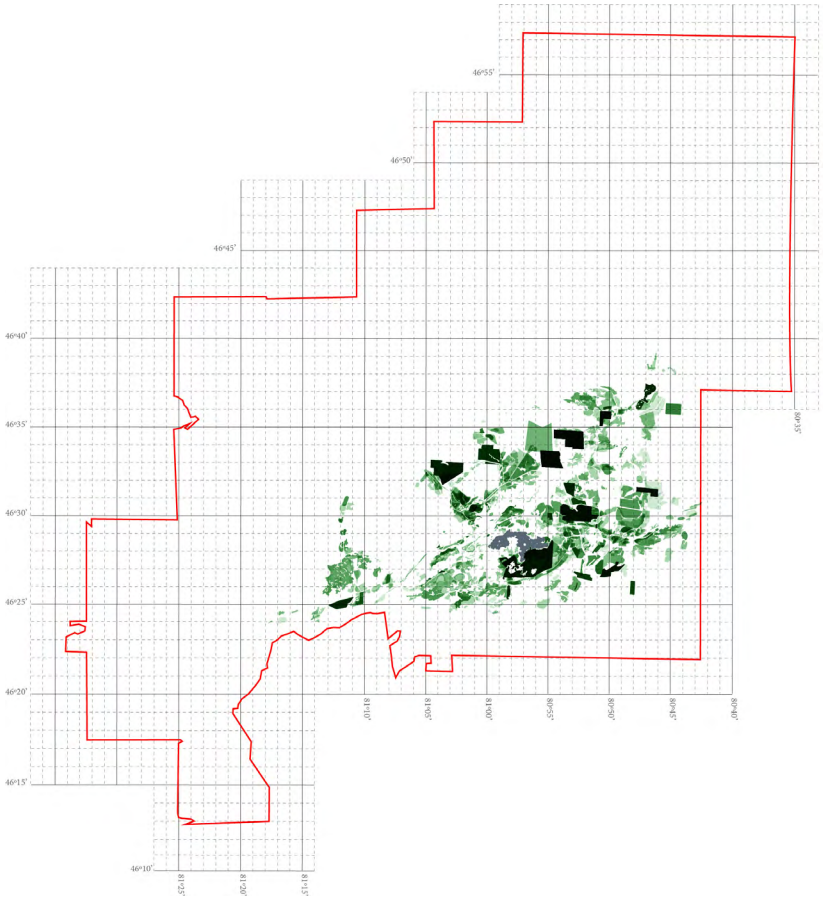


Figure 4 | Re-Greening

1883...

Following the logging industry, the Canadian Pacific Railroad forged its tracks from the east to the west in Canada, setting up short-term working camps that would establish many of the cities found across Canada today. The happenstance that William Ramsey should make a miscalculation; the CPR blasted through what is now Sudbury, discovering the rich mineral deposit of the igneous complex.[15] Today, the city of Greater Sudbury is home to 164,689 residents and is a central hub for Northern Ontario.[16]

1888...

Once the extraction of the nickel-copper ore was economically viable, prospectors from all around came to try their luck. The next century would see over 100 mines in operation. "Between 1890 and 1930 approximately 28 million tonnes of ore were smelted, primarily at roast yards, and after 1920, mechanically roasted at the smelters [….] By the end of the 1920s, Inco held an astonishing 90% of the world's nickel market"[17] This would forever change the landscape of Sudbury, as what was originally a collection of small railway and logging camps, would become the largest mining hub in the world for nickel-copper ore.

Conclusion

The geological, glacial, and vegetative history discussed above have had a tremendous impact on Sudbury's industry dependent economy, settlement pattern and physical appearance. When each piece is layered together, we begin to understand the shape and raison d'être for this northern hub called Sudbury.

15. SARA Group. *Sudbury Area Risk Assessment - Chapter 2.0 History of the Sudbury Smelters Volume 1.* Sudbury, Ontario, Canada: SARA Group, January 2008.
16. Statistics Canada. 2017. *Greater Sudbury [Census metropolitan area],* Ontario and Saskatchewan [Province] (table). Census Profile. 2016 Census. Statistics Canada Catalogue no. 98-316-X2016001. Ottawa. Released November 29, 2017.
17. Saarinen, Oiva W. *From Meteorite Impact to Constellation City: A Historical Geography of Greater Sudbury.* (Waterloo, Ontario, Canada: Wilfrid Laurier University Press, 2013), 22.

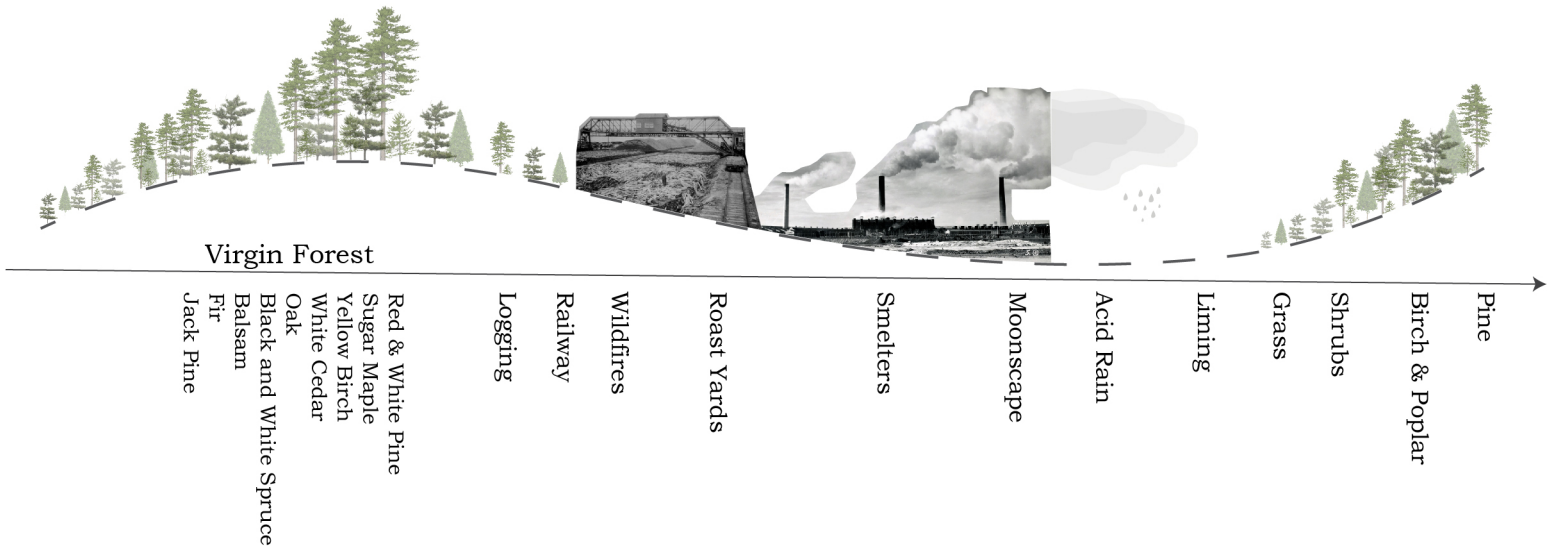


Figure 5 | Sudbury vegetation coverage throughout history

Re-greening the Moonscape

After a century of devastating industrial activity, including logging and smelting, Sudbury's landscape was a barren black moon-like landscape. It is difficult to imagine now that the re-greening has begun to take root, but just 50 years ago, there were 84,0000 hectares of barren & semi-barren land. The logging industry removed most large trees, while the remaining stumps and shrubs were scoured either by fire or by the mining industry for roast beds. With little vegetation, the soil quickly eroded. Soon after, technology for smelting was developed and tall smokestacks were able to spread sulphur dioxide, a by-product of processing nickle-copper ore, kilometers away from its refining site. As a result, the exposed red granite rock was covered with a thick sulphur coating, turning it black. The black rock became a signature landscape feature of Sudbury and was dubbed the 'moonscape', to much of the community's dismay.

During the 1970s, when the environmental devastation was at its peak, many scientists from Laurentian University were inclined to study the potential of revegetation. However, it wasn't until the City of Sudbury decided to diversify the economy that the 'beautification' of Sudbury began. The reliance on the boom and bust economy of the mining industry was starting to take its toll, and Sudbury wanted to establish itself as a city with diverse economies instead of being transient and unofficial. The mining companies, who tried to encourage people to stay in Sudbury in times of slow production, supported the objective. With strong stakeholder commitments, the trials for environmental rehabilitation began.

When biologists began to conduct experiments for the re-greening of Sudbury, some of the only surviving vegetation was acid and metal tolerant grasses. They found that acidity, along with metal toxicity, lack of moisture, low fertility and frost heave all played a role in inhibiting new vegetation growth. It wasn't until Laurentian University got involved that the solution of liming made for a promising transformation.

18. Ross, Nicola. *Healing the Landscape - Celebrating Sudbury's Reclamation Story.* Sudbury, ON: VETAC, 2001

The technique called liming, allowed new growth to establish on the barren polluted lands. With this technique, "crushed limestone neutralized acidic soil, inhibited the uptake of metals, enhanced bacterial activity and seemed to allow some types of vegetation to thrive."[18] This was a milestone in the re-greening efforts, leading to a United Nations Local Government Honors Award at the 1992 Earth Summit in Rio de Janeiro.

Today, 50% of the semi-barren to barren landscape is reclaimed. The reappearance of grass, birds, trees, wildflowers and butterflies are all signs of a return of diversity of native species. The re-greening program would not have been possible without a collective effort from all community stakeholders. The first test site was located on a barren hill behind St. Hubert School in the west end of Sudbury. These trees, which were planted in 1975, stand tall today and serve as a memento for the story of reclamation. Thanks to community efforts and industry support, the once 84,000 hectares of semi-barren and barren lands have been populated with over 11 million trees. The regeneration of the Sudbury landscape was possible because of the collaboration of dozens of community groups, mining industry giants, volunteers, and businesses.

Figure 6 | Moss growing on blackened rock

Seedlings in a Dark Space

To this day, Vale (formerly Inco) still grows seedlings in its underground facilities. Creighton Mine is Inco's oldest mine, reaching depths of 1,400 meters underground and has been sourcing Nickel, Copper and Platinum-group metals for over a century. Surprisingly, it is also home to a seedling nursery. It's an unexpected sight, but by providing proper lighting and ventilation, Vale has been able to grow seedlings for the re-greening program over the past 20 years. "Inco grows 50,000 subterranean seedlings a season of red pine and jack pine more than a kilometer down the 2.3km mine shaft."[19] The nursery is located in a burrowed tunnel that has already been mined for minerals but is still accessible by hoist. The ambient rock temperature creates a hot and humid environment with a consistent 25C, which is ideal for growing seedlings. Since the facility was already available and the temperature stable, the additional cost of electricity, fertilizer and water is minimal.

The seedlings take three months to germinate. The 5-inch pallets containing the plants are then brought to the surface and planted. This is part of Vale's responsibility to reclaim the land after decades of intense pollution. There is also an above-ground greenhouse that operates year-round at Copper Cliff. However, this facility is more costly because it has to be heating during the sub-zero winter. The underground facility is 10 feet wide and 600 feet long and requires 2,000 litres of water and fertilizer per day, which is dispensed from tanks set up on timers. There are also 30, 1,000-watt light bulbs that follow a set rhythmic pattern for optimal growth. The lights are typically turned on at night to avoid peak energy time and save on cost.

19. Torstar Syndication Services. *Nickel Giant's Greenest Underground Adventure.* Mining Matter.
20. Ibid.

Vale chose to grow red pine, and jack pine rather than white pine because they grow faster and do well in poor soils like sand, gravel and clay, native to the forest in the Sudbury area. The pellets and the seeds are only 2 cents each and are purchased from New Brunswick company Jiffy Products Ltd. Dave Taylor, a superintendent of Vale's natural environment group has been quoted saying "The idea is to put things back to the way they were, back to their natural state."[20] Mining companies are now legally required to have closure plans. The push from government and activist groups and the understanding of Vale's role within the community has led to a change in the Sudbury landscape.

Figure 7 | Seedlings growing underground in Creighton Mine

Between a Rock and a Wet Place

For all the progress made, the story of reclamation is far from over. As soil thickens on sulphur-stained rocks around the perimeter of the city, urban development within the city is giving rise to new challenges. The thesis is not deaf to the strain of the growing population on current infrastructure and the increasing pressures for new infrastructure investments. However, a strong case can be made against the methods of development currently being imposed on the land. Methods like blasting rock and adding aggregates to level the ground can severely disrupt the hydrology system. The peaks and valleys that make up the unique landscape of Sudbury allow for water to flow to its many wetlands and lakes. However, the city is currently allowing developers to change the form of the land without placing a value on the issues that will follow due to the altered topography. The destruction of natural features for short-sighted ventures will inevitably lead to much more expensive infrastructure requirements, especially regarding stormwater management.

Rock outcroppings of the Canadian Shield are a common landscape feature of Sudbury, though it is not uncommon to see these topographical features with portions missing, creating 10m+ vertical rock walls. The saying 'as above, so below' is well known. However in Sudbury, the saying goes 'as below, so above', and miners love to blast. Blasting is a common practice used in underground mining to burrow tunnels deep beneath the surface to reach the valued ore bodies. This practice is deeply rooted in the mentality of Sudburians and has found its way above ground. One of the most jarring examples of this can be seen on the Kingsway road (see figure 8). The rock being blasted is one of the highest points in Sudbury and separates two significant watersheds. From an aerial perspective, it seems that the purpose of this blasting is to gain a few square meters of retail space along a busy commercial street. When zooming out to get a full view of the area, you can see how it acts as a wall separating two low lying levels of land: the junction watershed to the north and the Ramsey Lake watershed to the south. It may seem like a stretch, but if blasting continues, there runs the risk of dismantling the barrier between the two watersheds. The damages relating to flooding would be disastrous.

21. The City of Calgary. *Principles for Stormwater Wetlands Management in the City of Calgary.* City of Calgary, 2009.
22. UACDC. *Low Impact Development - A design Manual for Urban Areas.* UACDC, Arkansas, 2010.

Given Sudbury's history of exploitative extremes, one can't help but be weary of the changes taking place through leveling the topography.

There is already flooding occurring on the Kingsway (see figure 9). The flooding is due, in part, to the modified topography nearby that has redirected the water. It is also due to the amount of impervious surface in the area. Impervious surfaces include road pavement, buildings, concrete, asphalt, rooftops, and severely compacted soil areas that do not allow water to infiltrate its surface,[21] resulting in water runoff. Integration of softscapes, such as vegetated areas, bioswales and permeable pavers, would allow water to infiltrate, filter, store and evaporate close to its source.[22]

Figure 8 | Blasted rock on the Kingsway

Figure 9 | Flooding on the Kingsway

Part II

Water

City of Lakes

Sudbury has the distinct privilege of having more lakes than any other municipality in Canada.[1] Historically, the water system in the area was used as a mode of transport. The logging industry would also use rivers and lakes to float large pieces of lumber down to lake Huron. The lumber drive was especially valuable after the Great Chicago Fires of 1871 when wood was needed to rebuild the city.[2] The mining industry and local municipalities have also utilized the abundant amount of water to generate electrical power. It is also a source of drinking water for the inhabitants of the area.[3]

Through the re-greening process, we have learned that **healthy land leads to healthy water**. By eliminating much of the metals in the air and improving soil thickness, the quality of lakes also improved. This is an important lesson and a key aspect of the thesis project. By improving the land, the water was also positively impacted. The two are linked and share many relations. They are interrelated and what we do to one impacts the other. "Land use changes within an urban watershed result in changes to stormwater quantity (runoff volume, peak flow magnitude and distribution) and quality."[4] That is why it's important to think holistically when planning an architectural project.

The notable growth in population has required a significant amount of infrastructure and services to support this northern population. "Unfortunately, a long history of industrial pollution, inadequate sewage disposal systems, urban runoff and a lack of public understanding about the impact of lakefront development have seriously degraded many lakes."[5] When changing the ground topography and material, it is important to consider the effects on the movement of water on its surface.[6]

1. The City of Greater Sudbury. *Lakes*. City of Greater Sudbury, 2021. https://www.greatersudbury.ca/play/beaches-and-lakes/lakes/ (accessed, December 4th, 2021)
2. Pearson. D.A.B., J.M. Gunn, W. Keller. *The Past, Present and Future of Sudbury's Lakes.* Sudbury, Ontario, Canada: Laurentian University, 2012.
3. Saarinen, Oiva W. *From Meteorite Impact to Constellation City: A Historical Geography of Greater Sudbury* (Waterloo, Ontario, Canada: Wilfrid Laurier University Press, 2013), 18.
4. The City of Calgary. *Principles for Stormwater Wetlands Management in the City of Calgary.* City of Calgary, 2009. p. 15.
5. Pearson. D.A.B., J.M. Gunn, W. Keller. *The Past, Present and Future of Sudbury's Lakes.* Sudbury, Ontario, Canada: Laurentian University, 2012.
6. Pepin, Antoinette L. *The relative importance of hydrology and substrate in the vegetation dynamics of restored freshwater wetlands.* George Mason University. ProQuest Dissertations Publishing, 1998.

Currently, we are seeing the urban development of the city impact lakes in negative ways. Things like phosphorus from lawns, sewage seepage, and salt from roads are washing into the lakes. This is called urban runoff, and the City of Sudbury has minimal interventions to help mitigate these toxins from entering the lake. However, watershed protection is identified as a priority within the City of Greater Sudbury's Official Plan.[7]

Introducing the Ramsey Lake Watershed

Sudbury is located within three watersheds, the Junction Creek watershed, the Wahnapitae watershed and the Ramsey Lake watershed. The Ramsey Lake watershed is in the southeast of the city and hosts valuable lake shore properties. It is around 4,246 hectares[8] and primarily drains into Ramsey Lake. Other lakes within the watershed include Lake Laurentian, Bethel Lake, Minnow Lake, and Perch Lake. "The Ramsey Lake subwatershed outlets to the larger Junction Creek watershed system via Lily Creek near Paris Street at the west end of the study area."[9] However, all of Greater Sudbury's 25 watersheds, containing 330 lakes, eventually drain into Lake Huron.[10]

This project will focus on the Ramsey lake watershed, which supplies 40% of the drinking water to Sudbury residents. Unfortunately, the watershed is at risk due to urban development and runoff. The intake pipe, made of concrete and stainless steel and measuring 1.5 meters in diameter, is located approximately 300 meters from shore near the David Street Waterworks building.[11] This building has been used to treat Ramsey Lake's water since 1896 and is a protected heritage site.[12]

7.*City of Greater Sudbury Official Plan.* Planning Services Division, Growth and Infrastructure Department & City of Greater Sudbury. City of Greater Sudbury, 2022.
8. Aquafor Beech Limited. *Ramsey Lake Subwatershed Study and Master Plan - Phase 2 Report.* City of Greater Sudbury, February 2020.
9. Ibid., p.13.
10. Greater Sudbury. *Watershed Study.* Greater Sudbury, accessed April 27, 2022, https://www.greatersudbury.ca/live/environment-and-sustainability1/lake-health/watershed-study
11. City of Greater Sudbury. *The David Street Drinking Water System.* Greater Sudbury Source Protection Area Assessment Report. City Of Greater Sudbury, 2017.
12. Greater Sudbury Heritage. *David Street Waterworks.* City of Greater Sudbury, 2013.

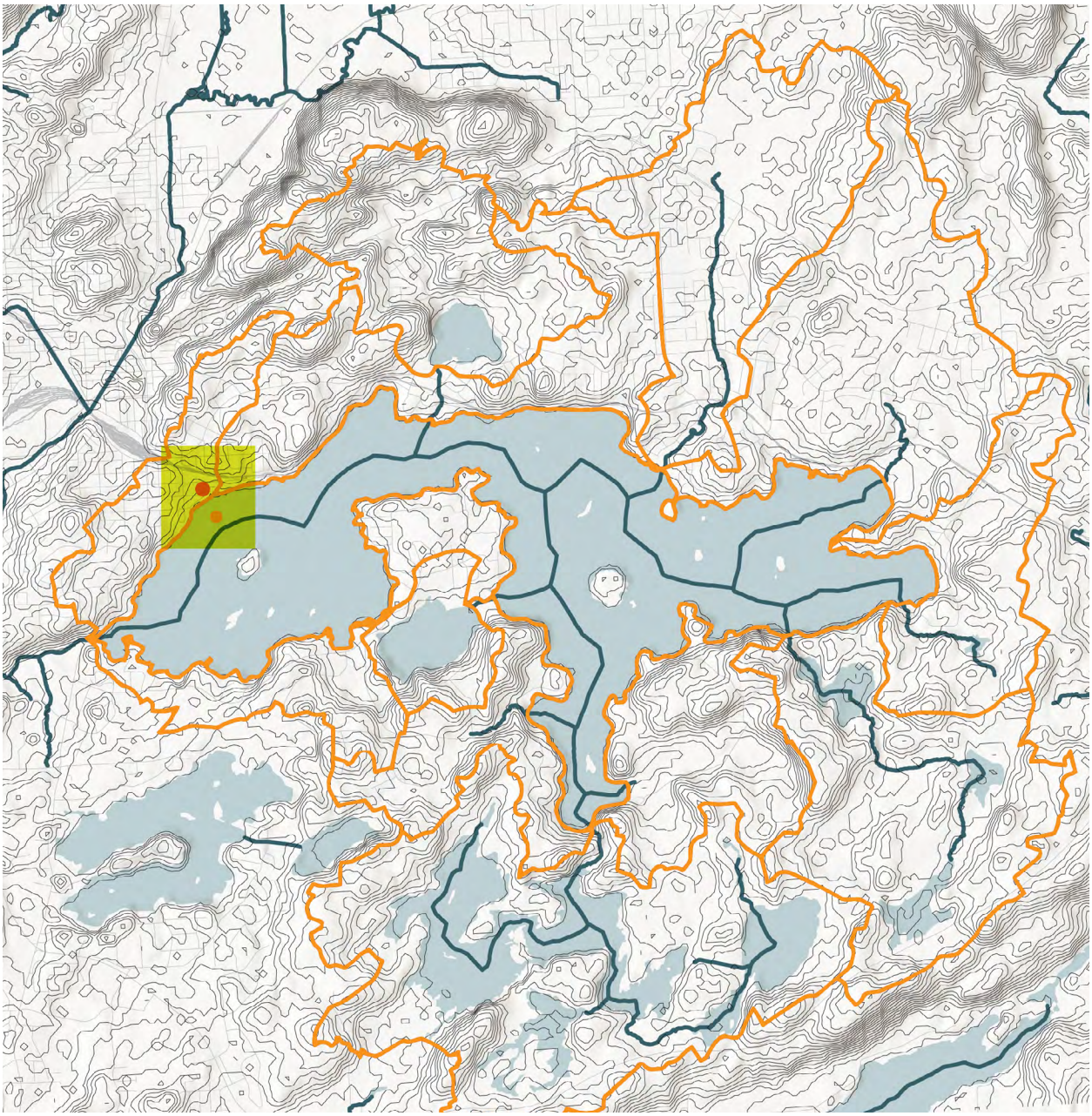
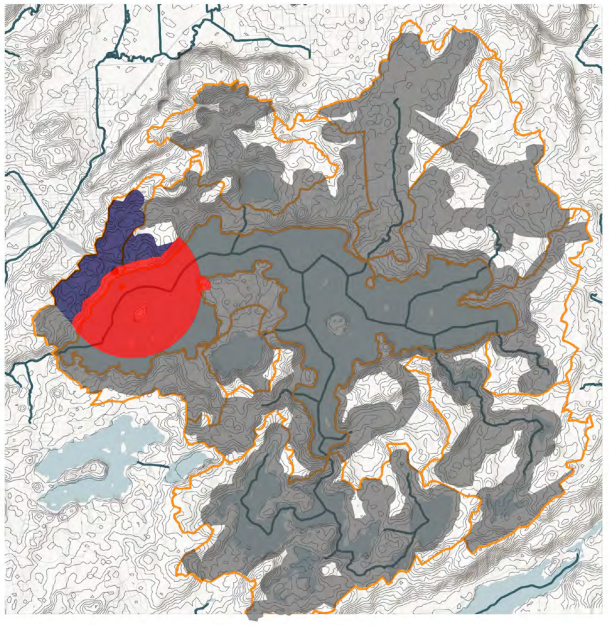


Figure 10 | Ramsey Lake watershed including the location of the surface water intake pipe, the water treatment plant and thesis site

13. City of Greater Sudbury. *The David Street Drinking Water System - Part 3.* Greater Sudbury Source Protection Area Assessment Report. City Of Greater Sudbury, 2017.

Three zones within the Ramsey Lake watershed have been designated as intake protection zones 1, 2 and 3. The classification depends on the area's potential impact to the water source point. There is also a map designating the Ramsey Lake watershed issues contribution area. **When comparing the two maps, it is clear that mitigation efforts are necessary to better protect the intake pipe.**[13]



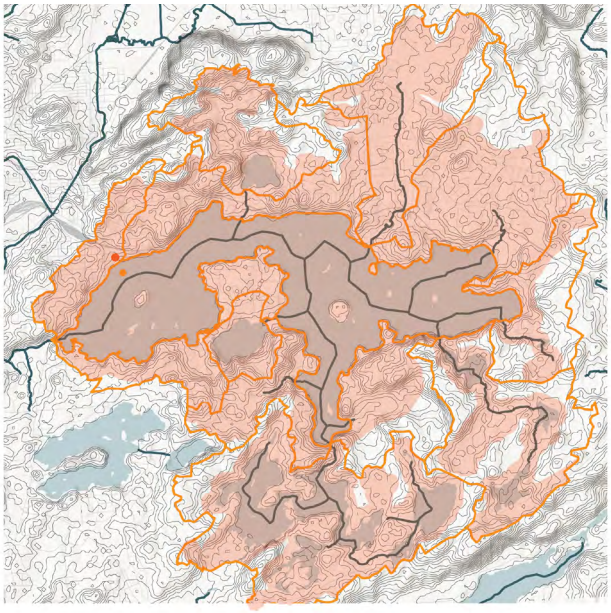


Figure 11 & 12 | Intake protection zones & Ramsey Lake issues contributions area

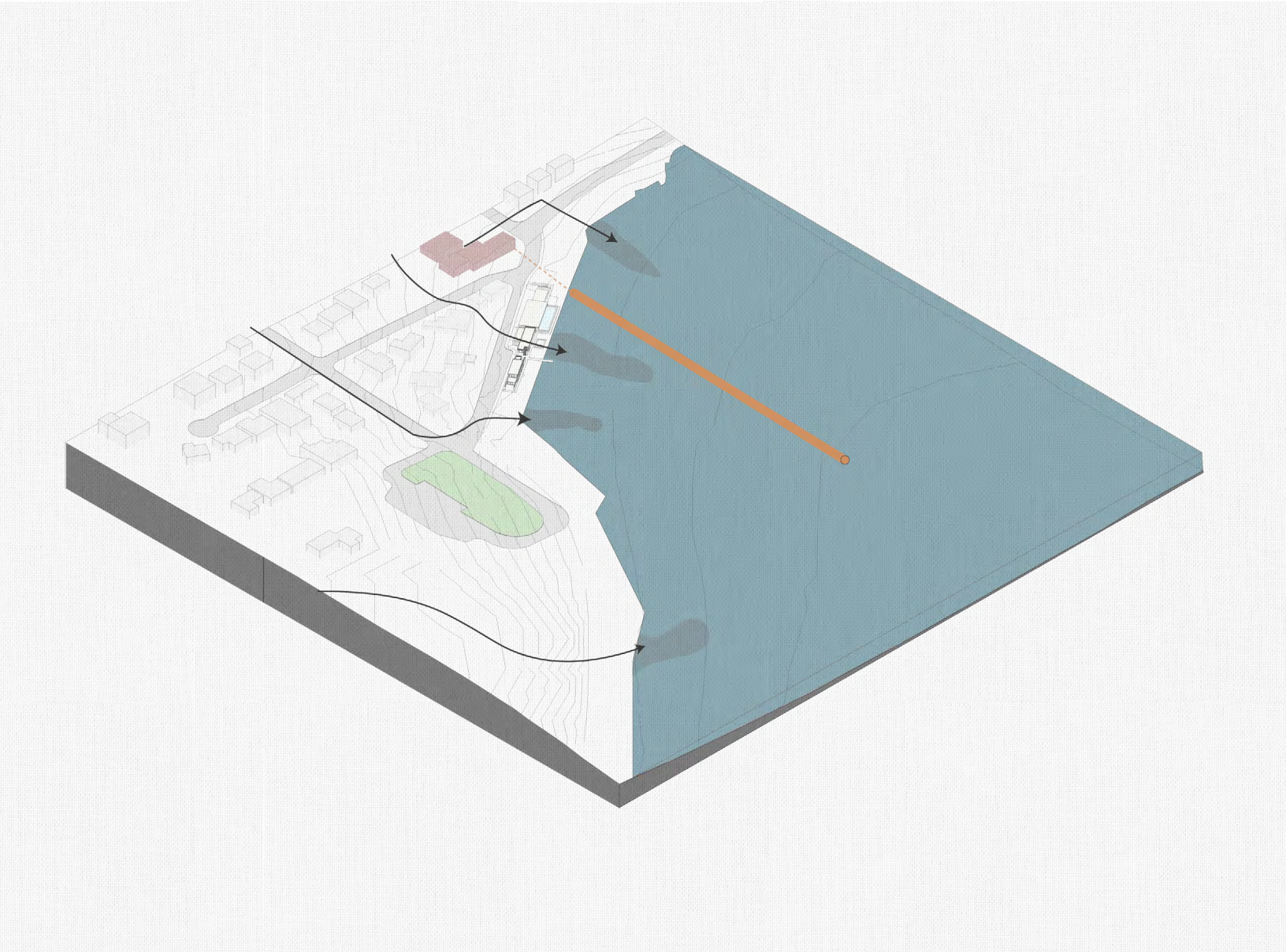


Figure 13 | Ramsey Lake urban runoff outfall points

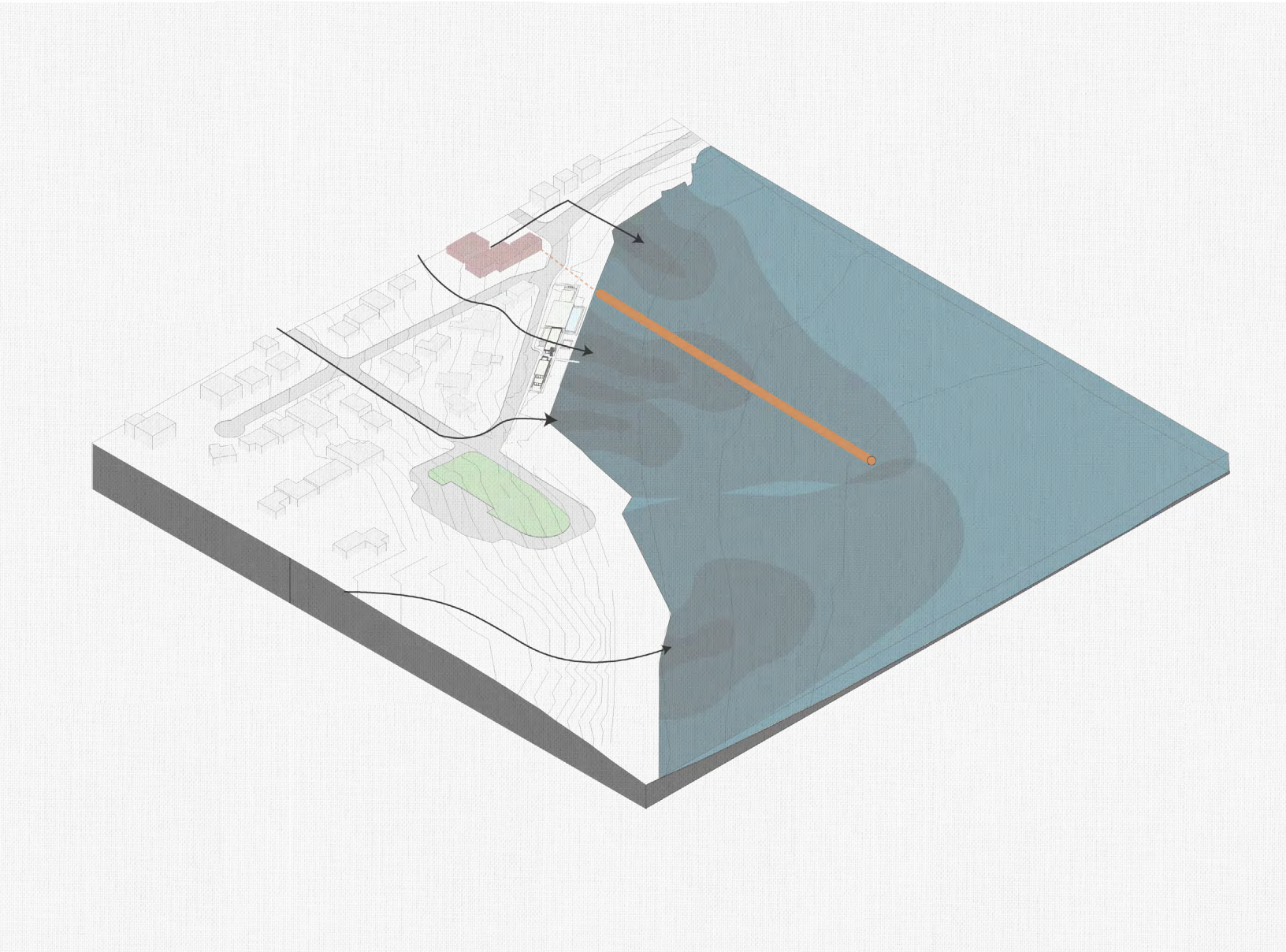


Figure 14 | Urban runoff outfall points resulting in a ‘black lake’

Ramsey Lake

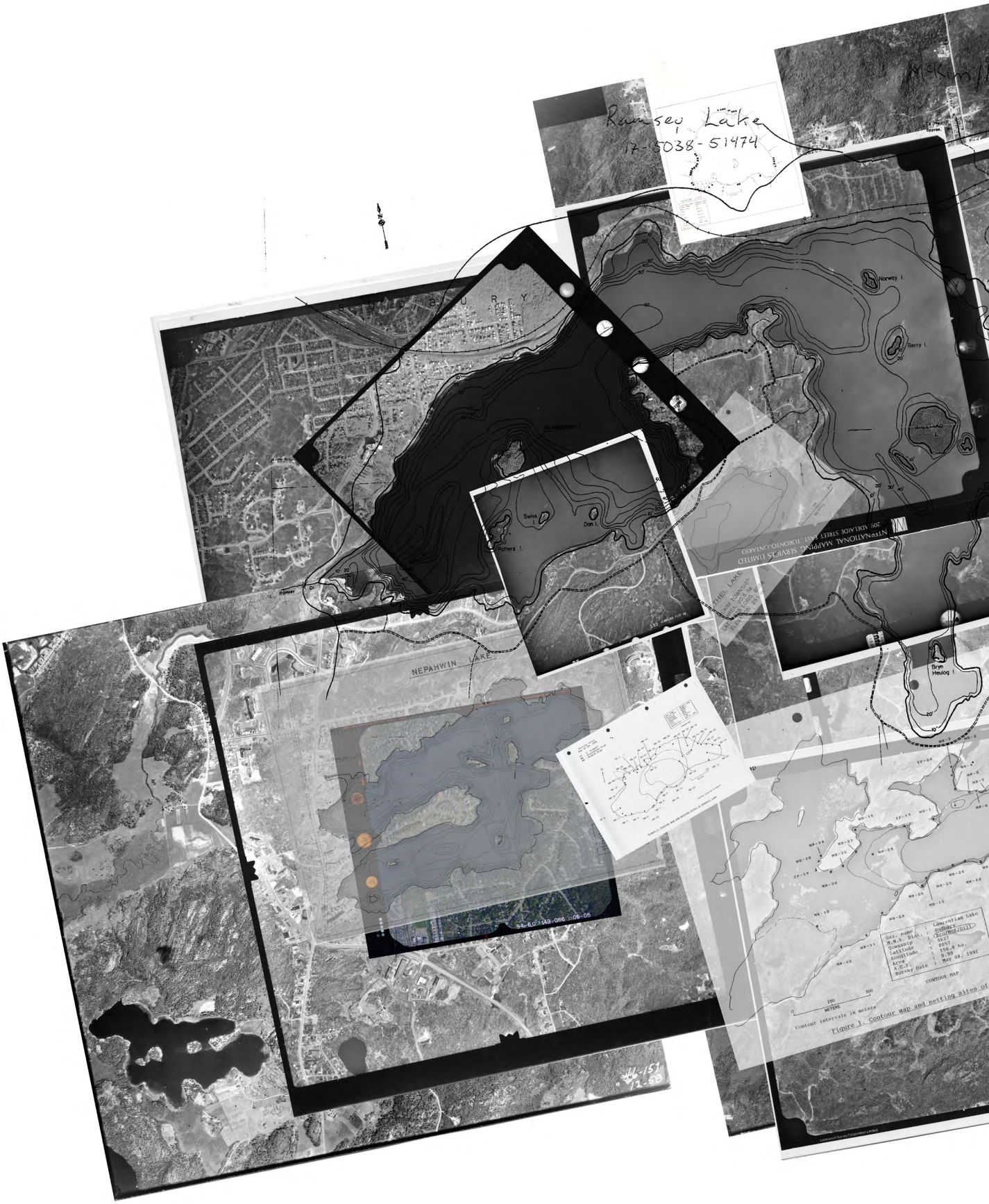
Although lakes in the area have suffered significantly from years of smelting activity, the re-greening program and many other efforts have managed to bring many lakes back from their polluted and acidic states. Despite these efforts, new challenges face our lakes, especially urban lakes. The City of Greater Sudbury has reported increasing incidents of blue-green algae blooms and beach closures in the last five years.[14] The algae blooms are caused by an increase in minerals and organic nutrients, such as phosphorus, which promotes the growth of plants (especially algae). However, this also reduces the dissolved oxygen content, affecting other organisms and leading to an anoxic and lifeless 'black lake'.[15] Therefore, lake water quality is a top priority and concern for residents. Lakes in an urban setting are negatively impacted by human activity. "Urban stormwater runoff is one of the leading sources of water quality impairments in lakes and rivers."[16] Urban stormwater runoff raises water temperatures and contains contaminates including; suspended solids, nutrients, bacteria, heavy metals, oils and grease, road salt, phosphorus.

Ramsey Lake offers many recreational opportunities right in the heart of the city. The activities favor both winter and summer equality and include, swimming, skating, fishing, biking, bird watching, walking and more. As noted, Ramsey Lake also supplies approximately 40% of the City of Greater Sudbury's drinking water servicing the south, west and downtown areas of Sudbury while the remaining amount is supplied by the Wahnapitae River.[17]

The attractiveness of lake side living was sparked after the first world war when a trend towards cottages took hold. The trend has continued and as of 2003, approximately 7000 people or 4% of the city's population, lived on a lake.[18] More recently urban lakes are being seen as an asset to quality of life and recognized for their scenic and ecological value. The City of Greater Sudbury is changing from a city of rocks to a city of lakes, which covers 12.2 per cent of its surface.[19]

14. City of Greater Sudbury. *The David Street Drinking Water System - Part 3.* Greater Sudbury Source Protection Area Assessment Report. City Of Greater Sudbury, 2017.
15. The City of Calgary. Principles for Stormwater Wetlands Management in the City of Calgary. City of Calgary, 2009.
16. Coalition for a Liveable Sudbury. Water Primer. Coalition for a Liveable Sudbury, 2020.
17. Saarinen, Oiva W. From *Meteorite Impact to Constellation City: A Historical Geography of Greater Sudbury* (Waterloo, Ontario, Canada: Wilfrid Laurier University Press, 2013)
18. Ibid.,
19. City of Greater Sudbury. *The David Street Drinking Water System - Part 3.* Greater Sudbury Source Protection Area Assessment Report. City Of Greater Sudbury, 2017.

Figure 15 | Photos of Ramsey Lake outfall points


Ramsey Lake
17-5038-51474
Norway I.
Berry I.
Swiss I.
Dan I.
Potters I.
Bryn Heulog I.
NEPAHWIN LAKE
NATIONAL MAPPING SERVICES LIMITED
205 ADELAIDE STREET EAST, TORONTO, ONTARIO
Figure 1. Contour map and netting sites of
CONTOUR MAP
Contour intervals in meters

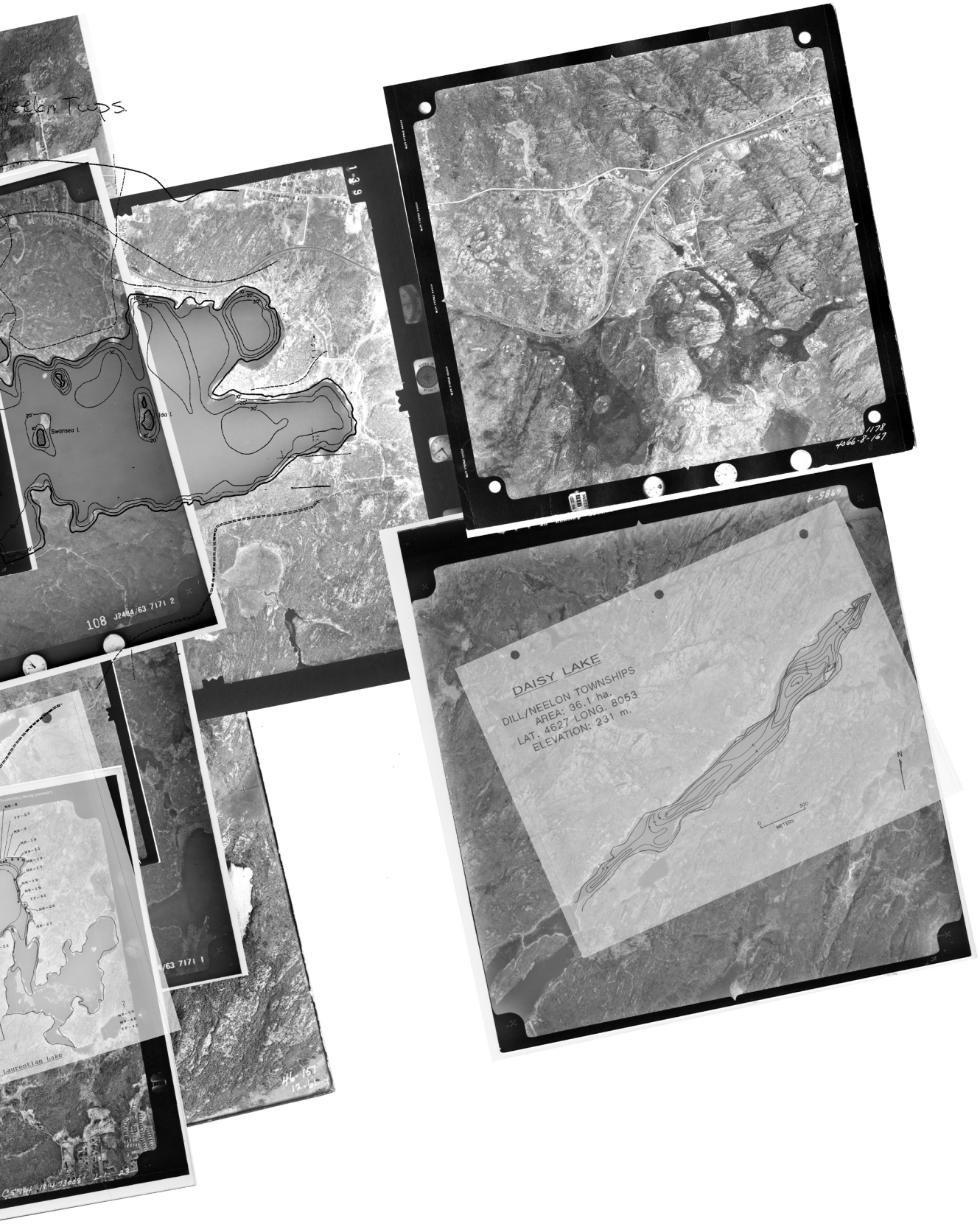


Figure 16 | Sudbury, a city of lakes

Part III

Where Land and Water Meet

Wetlands

Wetlands are an important ecological feature of the hydrology regime in Sudbury. Wetlands make up 4.3% of the city of Greater Sudbury.[1] However, this invaluable landscape feature is continuously being filled in with aggregates to make way for urban sprawl. "In urbanizing watersheds, natural wetlands will inevitably be impacted due to changes in the hydrological regime and water quality associated with urban development."[2] Wetlands are also being overwhelmed by stormwater runoff. The increase in impervious surfaces, including roads, sidewalks, parking lots and buildings within the urban watershed, is leading to an increase in stormwater runoff and deteriorating water quality.[3]

Wetlands play an essential role within the hydraulic cycle. A wetland functions as a nutrient sink that prevents floods by temporarily storing water. Wetlands are also very effective at filtrating water and providing habitat for many different creatures. However, with the increase of urban development, these wetlands are feeling the pressures as they take on the role of managing stormwater for much of the city's urban runoff. Due to loss of natural wetland areas and increased demand for stormwater management, cities are now finding ways to re-establish or construct new wetlands. The City of Calgary has paved the way in Canada for constructed and engineered wetlands. [4]

A constructed stormwater wetland is specifically designed to manage stormwater. If designed well, the constructed stormwater wetland can also provide ecological value and amenities. Achieving a balance between ecological function, amenity and stormwater management is an objective for the thesis project. The final design will depend on the stakeholders and the constraints of the site. It is important that ecological integrity isn't compromised for the sake of stormwater management functions. Some issues pertaining to urban runoff include high sediment loads, high nutrient loads, which result in eutrophic conditions, and surges of water volumes. These issues can interfere with the natural balance of the wetland ecosystem. To mitigate against these threats, proper buffer zones will surround the wetland, creating what is called a treatment train.[5]

1. Saarinen, Oiva W. *From Meteorite Impact to Constellation City: A Historical Geography of Greater Sudbury* (Waterloo, Ontario, Canada: Wilfrid Laurier University Press, 2013).
2. Ibid., p. 20.
3. Ibid.
4. The City of Calgary. *Principles for Stormwater Wetlands Management in the City of Calgary.* City of Calgary, 2009.
5. Ibid.

There are countless benefits to a well-designed constructed wetland. Firstly, the vegetation can prevent soil erosion along a shoreline. The plantings also aid in removing suspended solids from the water. The runoff from an urban setting, is highly likely to contain pollutants. By establishing an effective biotic wetland community, the filtering and treatment of water is maximized. "Suspended organic and inorganic particles tend to adsorb pollutants, such as heavy metals, nutrients, hydrocarbons and bacteria (Stockdale 1991). If the suspended particles are deposited in the wetland, the pollutants can becomes incorporated into the soils. Over a period of time, pollutants that have accumulated in the soil can appear throughout the wetland environment via chemical transformation, vegetative uptake and re-suspension."[6] Plants like cattails, algae and even spongy soils are great filters for absorbing metals and sulphur from suspended solids.[7]

Wetlands also add to the diversity of the environment and have an aesthetic appeal that attracts users. Fauna within a diverse and productive wetland includes invertebrates, fish, amphibians, reptiles, birds, and mammals. Flora at all levels of the wetland is also important, whether they are floating, rooted, emergent, submerged, herbaceous or woody. There are also many opportunities for recreational and educational activities like bird watching, photography, cycling, walking/jogging, picnicking and arts and crafts. However, when allowing users to activate the site, it is crucial to protect the sensitive ecology by providing educational and informative signage and restricting access to certain areas. A boardwalk is a great tool to guide traffic movement while being a structure of minimal impact to the fauna and flora inhabitants.

6. Ibid., p.11.
7. Saarinen, Oiva W. *From Meteorite Impact to Constellation City: A Historical Geography of Greater Sudbury* (Waterloo, Ontario, Canada: Wilfrid Laurier University Press, 2013).

Seasonality

The Sudbury region is located within "steepest north-south temperature gradients in Canada".[8] There are four pronounced seasons with significant temperature differences varying from 30 degrees in the summer to -30 degrees in the winter. The seasonality of the area provides many different recreational opportunities. Design should accommodate both summer and winter and be resilient to frost action.

The prevailing winds come from the north and southwest, evidenced by smokestack emissions. The growing season is from April 25 to October 25, the longest growing period in Northern Ontario.[9] Due to climate change, it is predicted that Sudbury will experience weather similar to what the Cleveland area now experiences within the next century.[10] Climate is expected to become warmer and drier overall. However, it will also become more variable and volatile. Extreme weather events are predicted, which will lead to surges of stormwater runoff.[11]

Site

The site chosen for my design is within the riparian area of Ramsey Lake. "A riparian area is defined as the strip of moisture-loving vegetation growing along the edge of a natural water body. The exact boundary of the riparian area is often difficult to determine because it is a zone of transition between the water body and the upland vegetation."[12] A healthy riparian zone is important because it protects water quality, provides habitat for wildlife and has an aesthetic and recreational value.

8. Liu, Kam-biu. *Postglacial Vegetational History of Northern Ontario: A Palynological Study.* (Ph. D. thesis, University of Toronto, 1982), 1-352. Liu's studies involved the study of Loon and Nina Lakes near Sudbury.
9. Chapman and Thomas. *The Climate of Northern Ontario*. p. 8 and 14.
10. Pearson, D.A.B., J. Roger Pitblaso. *Geological and Geographic Setting.* in Gunn, Restoration and Recovery of an Industrial Region, 10-11; Savageau and D'Agostino, Places Rated Almanac, 286.
11. *City of Greater Sudbury Official Plan.* Planning Services Division, Growth and Infrastructure Department & City of Greater Sudbury. City of Greater Sudbury, 2022.
12. Government of Canada. *Riparian Area Management* (Gouvernement of Canada, July 29, 2020), https://agriculture.canada.ca/en/agriculture-and-environment/soil-and-land/riparian-area-management.
13. The City of Greater Sudbury. *Shoreline Classification of Ramsey Lake.* The City of Greater Sudbury. Lakefront Living. https://www.greatersudbury.ca/live/environment-and-sustainability1/lake-health/lakefront-living/ accessed March 21st, 2022.

Shoreline Classification

The Lake Water Quality Program has created a shoreline classification system to rank the quality of the shoreline of many urban lakes within Sudbury. The shoreline areas with the least disturbed natural features (aquatic and vegetation) are demarcated using a green contour. In contrast, the shorelines with human interferences are yellow, orange or red, depending on the amount of invasive activity.[13] The site of the old canoe club is classified as orange, which in not ideal.

Figure 17 | Shoreline Classification of Ramsey Lake.

Green...

- buffer zone assisting in the filtration of fertilizers, pesticides and waste that come from lawns and driveways.
- no hard structures
- dense buffer of native and aquatic vegetation, preventing erosion by stabilizing the soil.

Yellow...

- no hard structures
- no buffer zone (grass goes right to the shoreline increasing the likelihood of run-off from lawns)
- little vegetation to prevent erosion from waves and ice action.

Orange...

- not ideal
- contains hard structures
- though there have been attempts to soften the shoreline with a buffer zone and vegetation.

Red...

- least ideal shoreline
- contains hard structures
- no buffer zone or vegetation in or around the shoreline
- Property is nearly completely developed.

Modification to Original Shoreline

The shoreline of Ramsey Lake near the site has been modified many times throughout the century. Therefore, it is difficult to know precisely its natural state, but by analyzing areas with similar climatic and environmental conditions, we can get a better idea of the major alterations to the shoreline.

By reviewing old photos, we can begin to examine the changes this site has witnessed in the last decades. In figure 19, we can see a rusted metal wall that once retained the shoreline. A gravel walking path was directly parallel to the shoreline. When the photograph was taken, the trees on the site were still fairly small, measuring approximately 5m. In the distance, we can see the old St-Joseph Hospital and the infamous Copper Cliff smoke stack.

In the distance, we can also see a white flat-roofed structure lightly placed along the shoreline. The area was once home to the Sudbury Seaplane base (figure 18). The structure was used for base plane storage. Adjacent to the white Seaplane base was a two-story house. Both no longer exist. Today a gabled roof rectangular building, once used as the Sudbury Canoe Club, stands.

In recent photos, we can see that the metal retaining wall was replaced with pieces of blasted rock (figure 20). The rocks along the shoreline have created a harsh transition from land to water, with little filtration benefits. The 3 meter rock buffer separates the public from the water, making it difficult to access the lake. Therefore, there is a lack of connection to the water. To soften the edge, the rocks will be removed, and a wetland will be constructed. The vegetation will filter and remove contaminants from surface water runoff. The goal is to build a shoreline that provides ecological value while integrating amenities.

Figure 18 |Historic photo of Seaplane base

Figure 19 |Historic photo of site shoreline

Figure 20 |Current site shoreline

Stormwater Management Facility

The site chosen for the thesis project is strategically located on the northwest shoreline of Ramsey Lake. Within the Ramsey watershed master plan, this site is one of 7 chosen to be fitted with a stormwater management facility. The estimated 6-8 million dollar facility would require digging 5,708m2 of the shoreline to build an underground concrete basin that catches the stormwater from two adjacent runoff pipes to then gradually release it into Ramsey Lake.[14] However, there is an opportunity for an intervention that not only slows the water but also filters it. The proposed design will be less invasive and disruptive to the shoreline while still providing the same benefits.

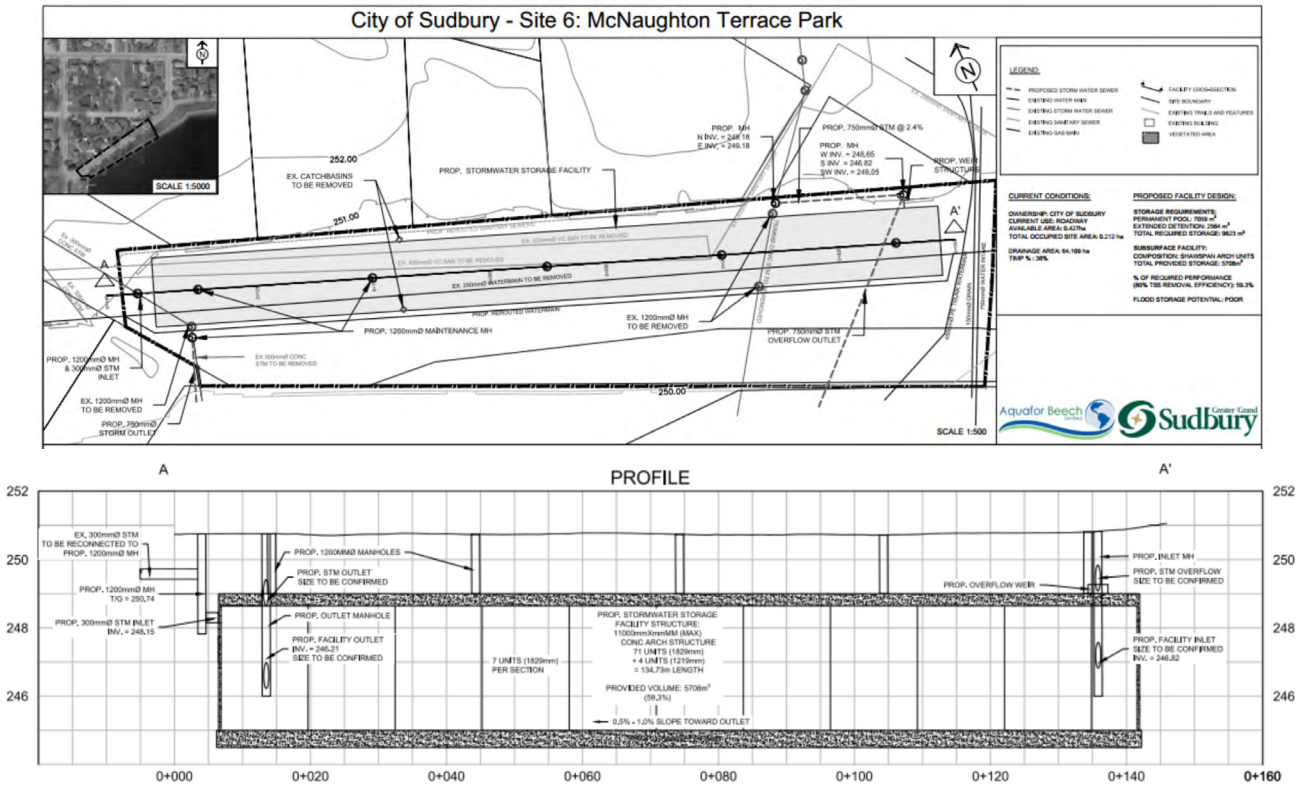


Figure 21 | The City of Greater Sudbury's proposed stormwater management facility on McNaughton Terrace Park, site 6

14. Aquafor Beech Limited. *Ramsey Lake Subwatershed Study and Master Plan - Phase 2 Report.* City of Greater Sudbury, February 2020.
15. Nickel District Conservation Authority. *Watershed Inventory.* (Sudbury, ON: Nickel District Conservation Authority 1980), 4.5-4.26.

The Old Canoe Club

The old canoe club, described as 'the old white shack with the blue tin roof' was used by club paddlers until talk of a new facility to the south of the lake in 2016. In 2020 the much larger Northern Water Sports Centre was ready to replace the Sudbury Canoe Club. The old canoe club is currently used for storage. The better part of the building is used by Bell Park to store maintenance equipment. A section of the building is reserved for storing bikes by the Sudbury Cyclists Union. There is still also a small room on the second level that is used as a meeting space.

The old building experiences extreme flooding, especially in the spring when water levels are highest. "The valley and downtown Sudbury are low-lying and highly flood-prone, damage from flooding has been a major occurrence in Greater Sudbury on at least forty-six occasions between 1890 and 1979."[15]

Aggregates such as crusher dust, gravel and large rocks were added to extend the shoreline. Due to the flood-prone nature of the site, the thesis project proposes to remove the old canoe club. The site will be remediated into a healthy riparian zone that assists in the natural filtration of runoff. Since the soils are most likely contaminated by heavy metals, and because of the proximity to the water intake pipe, there will be minimal disturbance to the existing aggregates. Instead of removing the foreign aggregates, metal tolerant plants mentioned earlier will be used to remediate the site from existing industrial pollutants.

Figure 22 | Flooding of Old Canoe Club

David Street Waterworks

The David Street Waterworks was built in 1896 and was originally a steamed-powered electricity plant, one of the first in Sudbury. Today, it serves as a water plant for the city and still contains much of the historical mechanical equipment on display for visitors. The neoclassical-inspired building is an important landmark expressing Sudbury's history. "The building also speaks to the public health issues that the growing Town of Sudbury was facing at the turn of the century"[16], making it a symbol of clean drinking water. The building is a stone's throw away from the thesis project site and is in line with the intake water pipe. It is well integrated within the neighbourhood. The thesis project will provide moments where views of the David Street Waterworks and the intake pipe are visible to further educate the public.

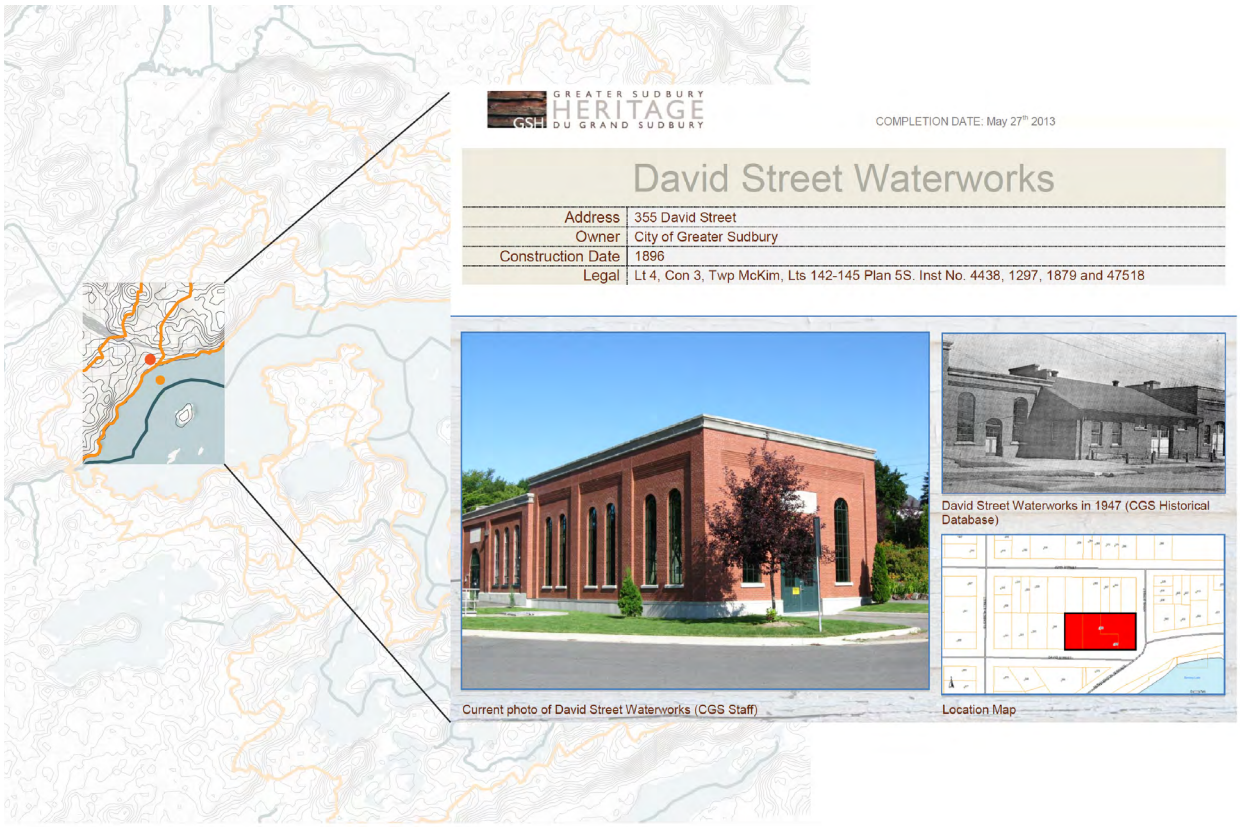


Figure 23 | David Street Waterworks

Docks

There are few differences between a good dock and a poor dock. However, small changes can lead to much different results. For this thesis project, it will be important to incorporate a boardwalk and dock that are minimally invasive in order to protect and maintain the newly established wetland. These structures are also intended to be used as examples of best practices for neighbouring properties.

A key factor to a successful dock is its ability to be in harmony with land and water. Part of the building program will incorporate a space where workshops can be held to teach residents how to build ecologically sensitive structures on their properties. It is also important to consider the existing ecology of the shoreline. "The body of water fronting your property exists because of a delicate balance in nature that has evolved over many millennia. That narrow band of earth known as the shoreline – an interdependent conglomerate that includes the water and both exposed and submerged lands – is the most ecologically sensitive piece of the planet most of us are likely to encounter."[17] Therefore, it is easy to disrupt the balance of this ecosystem which consists of many plants and animals that depend on the shore area and negatively impact its water quality.

This thesis project aims to minimize the impact of structures along the shoreline while still allowing visitors to enjoy the lake's qualities and recreational opportunities.

16. *David Street Waterworks.* Greater Sudbury Heritage, May 2013.
17. The Dock Primer. *A Cottager's Guide to Waterfront-Friendly Docks.* Fisheries and Oceans Canada. 2020.

Lessons Learned

Although the site has been subject to many modifications, an effort to preserve the trees, plants and wildlife that are currently there will be a primary focus. However, modifications to the site will be made in order to rehabilitate the natural ecosystem. The proposed project will reshape the area to benefit its natural ecological rights. The site development will create more habitat and clean water for all species to thrive.

Vale Living with Lakes Center

Although we see many examples of development that dominate the landscape with little regard to the importance of its hills and valleys, there are distinct projects that consider the ground on which they lay and their relationship with the ecosystems around them. The Living with Lakes Center is a local example of a building that is sensitive to its surroundings. As a research center for environmental science located on Ramsey Lake's shore and near the Laurentian University campus, the building's scholars foster a culture of collaboration through partnerships with scientists, universities, government agencies, and industries. The center focuses on protecting and managing northern aquatic ecosystems, and as a testament to their practice, the building uses award-winning energy and water-saving technologies. Integrated into the Ramsey Lake shoreline, this building positively influences the landscape it is charged with studying.[18]

The form of the building takes advantage of the existing topography to maximize daylight and protect against dominant winds. Green roofs, permeable pavers, and an infiltration basin assist in water filtration and help remediate the vital riparian zone. This project has succeeded in restoring the original ecologies that were once found along the shorelines of Sudbury, continuing the story of reclamation and transforming the City of Greater Sudbury.

18. Architizer. *Vale Living with Lakes Centre.* Architizer Inc, 2021.

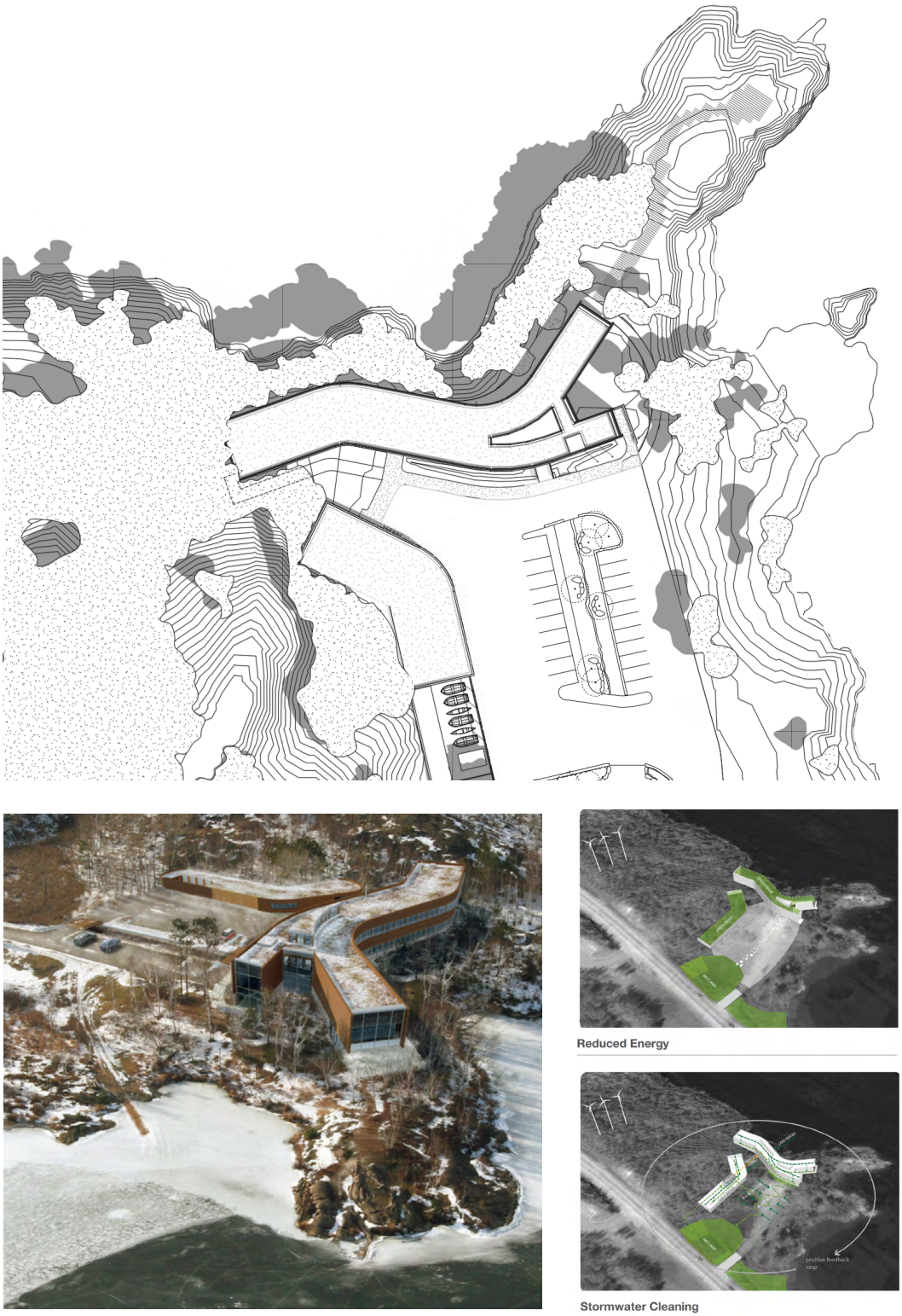
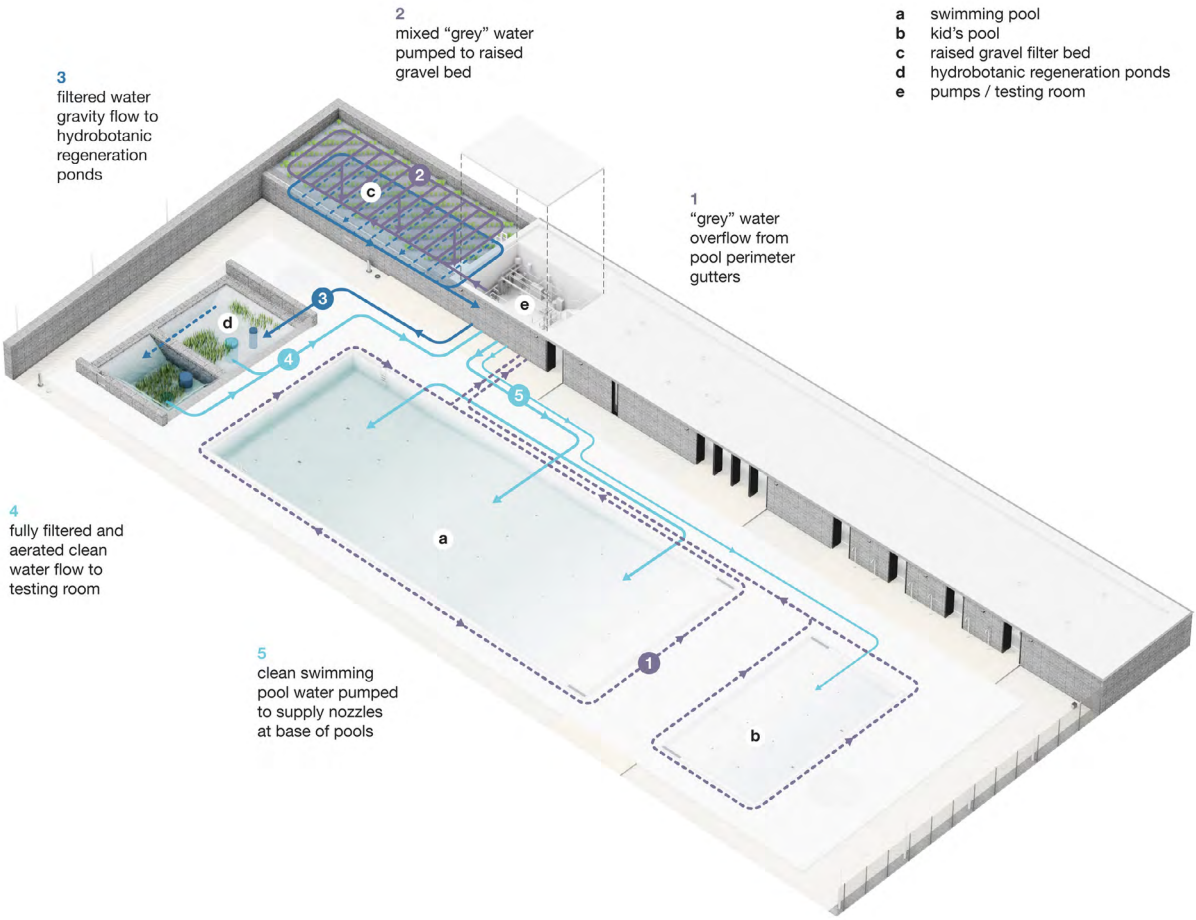


Figure 24 | Vale Living with Lakes Centre case study.

Borden Park Natural Swimming Pool

Another project serving as a precedent to this thesis is the Borden Park Natural Swimming Pool by gh3* architects. Located in Edmonton, the seasonal pavilion provides a naturally filtered pool large enough to accommodate 400 people. The water passes through stone, gravel, sand, and a botanic filtering process. However, the true brilliance of this project is its aesthetically integrated design. The materials chosen for the building mirror the materials necessary to cleanse the water. The simple, straight, and rigid lines of the building contrast the natural flowing movement of the water, making them all the more pronounced.[19]



19. Di Giacomo, Joel. *Borden Park Natural Swimming Pool.* gh3* (gh3*, September 16, 2021), https://www.gh3.ca/work/natural-swimming-pool-02.
20. Simpson, Leanne Betasamosake. *A Short History of the Blockade: Giant Beavers, Diplomacy, and Regeneration in Nishnaabewin.* Edmonton, Alberta: University of Alberta Press, 2021.

Figure 25 | Borden Park Natural Swimming Pool case study.

Amikwag

When it comes to hydrology, there is no better teacher than the beaver. The beaver carries with it a sense of wisdom that we can only aspire to be as builders. In Indigenous teaching, the beaver, or Amikwag, is a builder of consent and diplomacy that creates shared spaces and brings with it more life.

> "Amikwag build dams. Dams that create deep pools and channels that don't freeze, creating winter worlds for their fish relatives. Deep pools and channels that drought-proof the landscape. Dams that make wetlands full of moose, deer and elk food, cooling stations, places to hide calves, and muck to keep the flies away. Dams that open spaces in the canopy so sunlight increases, making warm and shallow aquatic habitat around the edges of the pond for amphibians and insects. Dams that create plunge pools on the downstream side for juvenile fish, gravel for spawning, and homes and food for birds. And who is the first back after a fire to start the regeneration? Amikwag."[20]

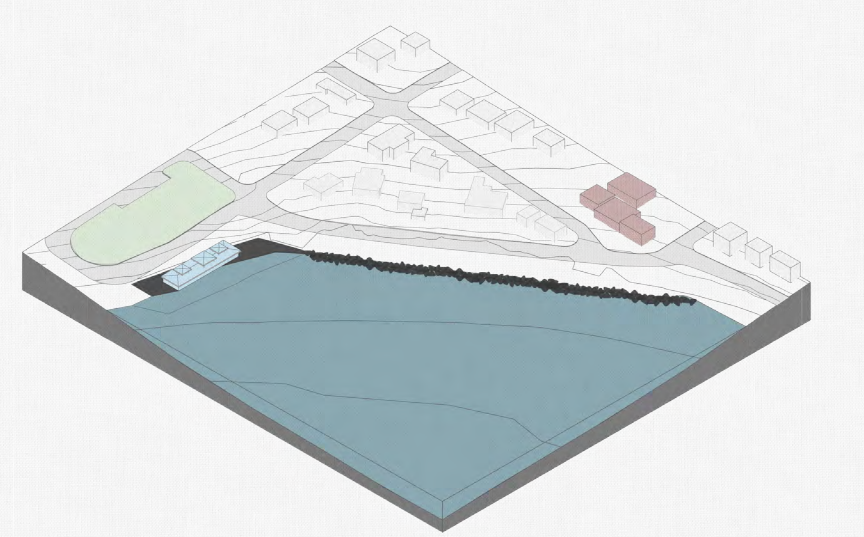
By building dams, lodges, and canals, the beaver also creates habitat for other living species or relatives through a relational sense of space.

20. Simpson, Leanne Betasamosake. *A Short History of the Blockade: Giant Beavers, Diplomacy, and Regeneration in Nishnaabewin.* Edmonton, Alberta: University of Alberta Press, 2021.
21.Gavel, Luke, Osborne MacDonald, and Philip Matthews. Bear River Solar Aquatics Waste Water Treatment Plant, 1997. https://www.collectionscanada.gc.ca/eppp-archive/100/200/301/ic/can_digital_collections/west_nova/bearriver.html#:~:text=The%20Bear%20River%20Solar%20Aquatics,as%20bacteria%2C%20snails%20and%20fish.

Bear River, Nova Scotia

The Bear River Solar Aquatics Wastewater Treatment Facility was built in 1995 and is the first solar aquatic treatment facility in Canada, earning the "1995 Sustainable Communities Award." It hosts a dozen 5 x 6 feet solar tanks that act as miniature ecosystems. These tanks purify the water using algae, zoo plankton, phytoplankton, snails, fish and specially selected plants that break down solid wastewater components and organic compounds. The wastewater is gravity fed from one tank to the next underneath a greenhouse structure. The wastewater is processed through many natural filtration systems until it meets or exceeds the Nova Scotia environmental standards. Tours of the facility are available to the public.[21]

Figure 26 | The Bear River Solar Aquatics Wastewater Treatment Facility case study



Site Strategies

Figure 27 | Current Site Conditions

- As previously mentioned, the site chosen for the thesis project is along the north-east shoreline of Ramsey Lake, adjacent to McNaughton Terrace. The shoreline is obstructed with a 3m buffer of crushed rock. The west of the site is where the old canoe club stands and is prone to flooding.

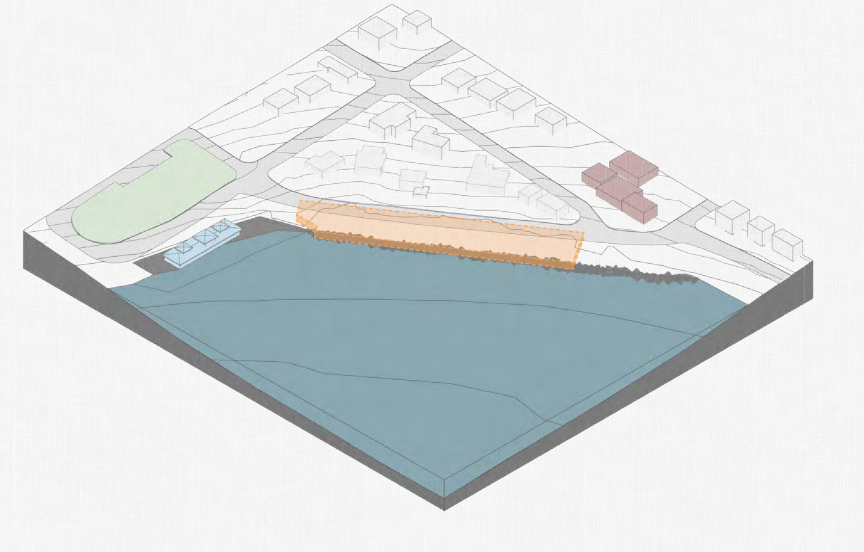


Figure 28 | Stormwater Management Facility

- The same location of the proposed building is where the City of Greater Sudbury is proposing a Stormwater Management Facility. The proposed design will be less invasive and disruptive to the shoreline while still providing the same benefits.

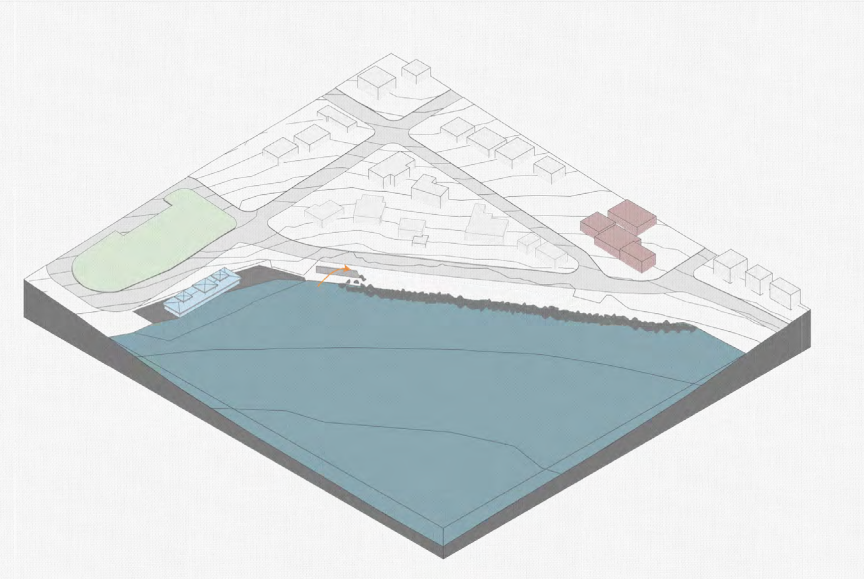


Figure 29 | Reclaiming the Shoreline

- The first step to reclaiming the shoreline will be to remove the 3m buffer of blaster rock.

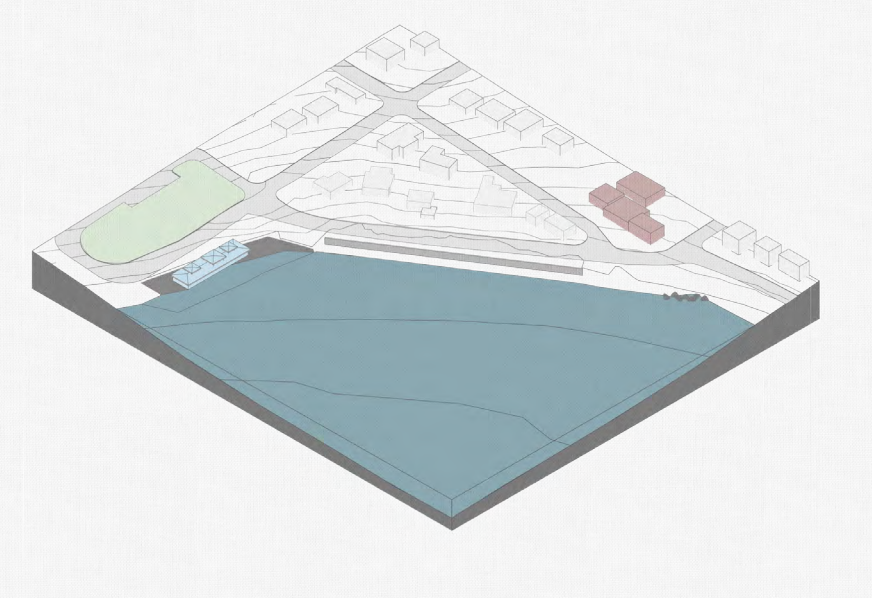


Figure 30 | Gabion Walls

- These rocks will be crushed smaller and used within the gabion walls of the building, similar to the Borden Park Natural Swimming Pool.

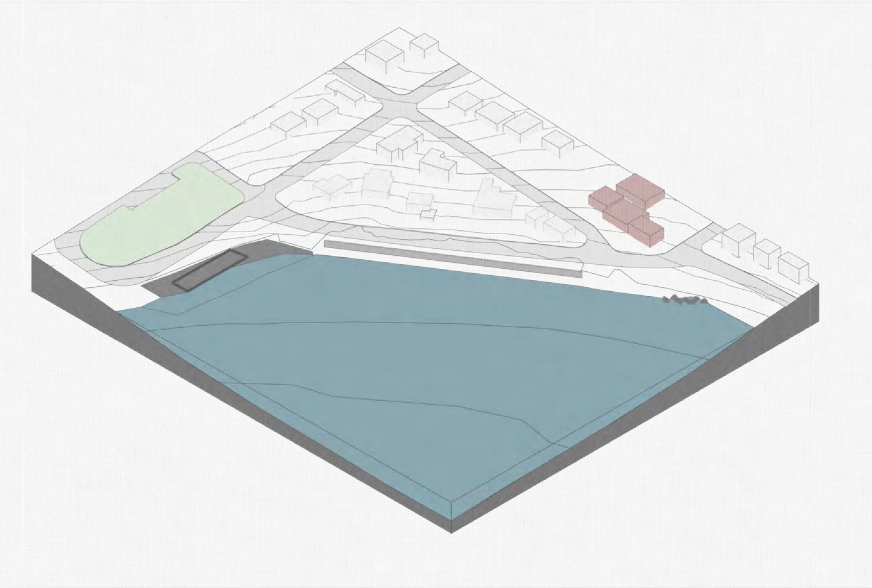


Figure 31 | Removing the Old Canoe Club

- The thesis project also proposes removing the old canoe club, as it falls within the flood plane and is subject to frequent flooding.

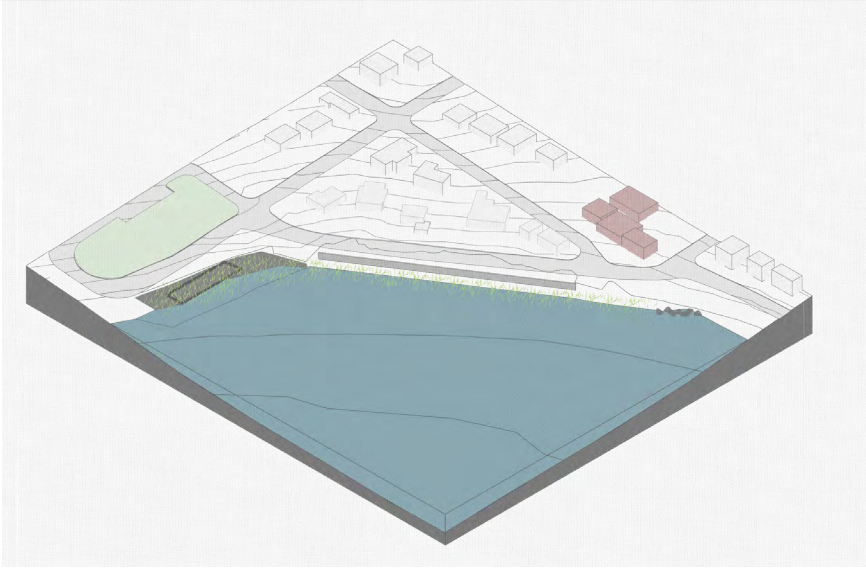


Figure 32 | Re-establishing a Wetland

- The site will then be planted in phases with metal tolerant wetland species, in order to decontaminate existing soils and began to establish a healthy ecosystem that filters water.

Part IV

Design Proposal

Introduction

The design proposal attempts to create an architecture that acts as a mediary for clean water environment. Strategically sited, the project acts as a threshold between the urban condition and Ramsey Lake. Given the increase in polluted urban runoff, the programmatic choices and landscape design aid in the regeneration of the shoreline and the filtering of water at a key location within the Ramsey Lake watershed.

In order to better protect the nearby water intake pipe that supplies 40% of Greater Sudbury's potable water, several interventions along the shoreline have been proposed. These include bioswales, a constructed wetland, pollinator gardens and a naturally filtered pool.

The project also places a high value on all users of the site. It allows native flora and fauna to thrive by creating biodiverse habitats. The building also provides many social and recreational amenities for locals and tourists.

This project is also an example of an architecture that acts as a tool to enhance its surroundings. The building program includes a swimming pool, a filtering machine and an educational gallery, all of which come together to teach the public the importance of watershed planning and clean water environments.

The next pages will explain more thoroughly the programmatic choices, clean water interventions and the visitors' experience. The site was treated with people and nature in mind with the hope of creating a more symbiotic relationship between the two.

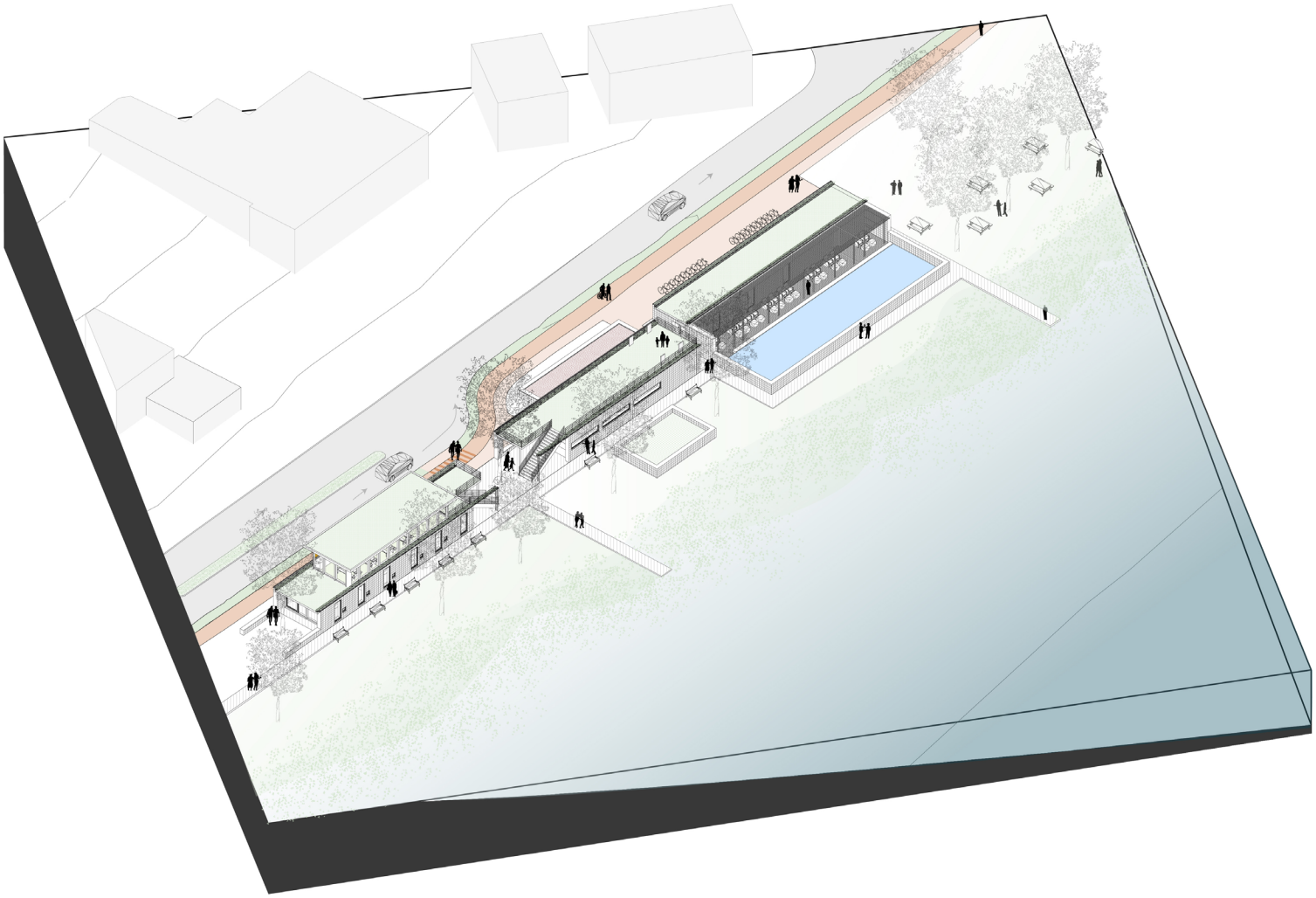


Figure 33 | Building Axonometric

Programmatic Choices

As previously mentioned, the site has been strategically chosen at a key moment within the Ramsey Lake watershed. Following the choice of site adjacent to the old canoe club and within Sudbury's Bell Park, the programs incorporated within the building align with the goal to act as a mediary for clean water environments. The programmatic choices are also in line with the objectives set out by the Greater Sudbury Official Plan, which include: diversifying the economy through tourism, infrastructure investments, providing passive and active recreational opportunities, promoting health and well-being, and emphasizing watershed-based planning.[1]

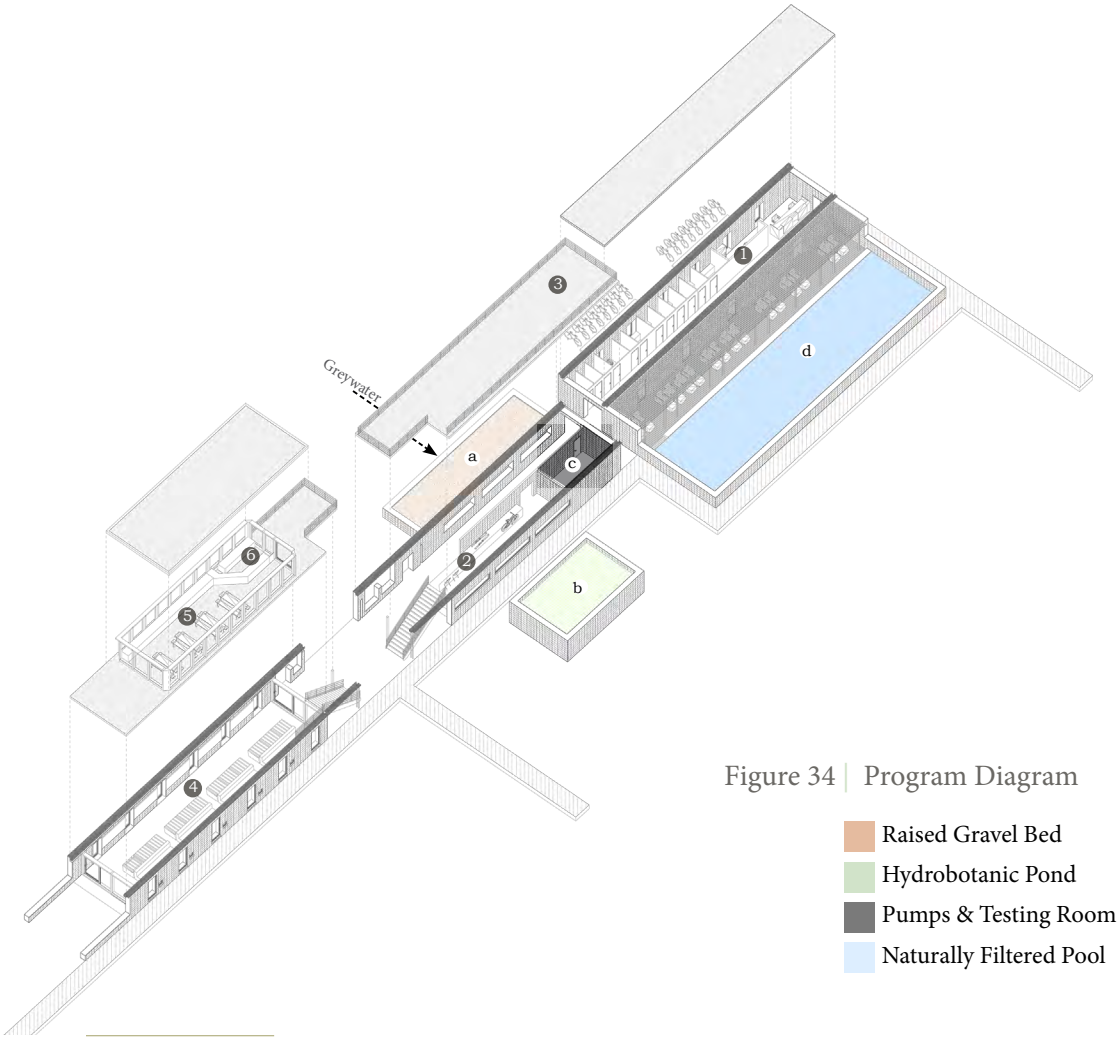


Figure 34 | Program Diagram

1. *City of Greater Sudbury Official Plan.* Planning Services Division, Growth and Infrastructure Department & City of Greater Sudbury. City of Greater Sudbury, 2022.

❶ *Naturally Filtered Swimming Pool*

A large portion of the building is dedicated to a naturally filtered swimming pool. Supporting programs include change rooms, washrooms, reception, towel service and a staff room. Visitors can experience the clean water first hand in the seasonal open air facility. During the winter, the pool area will be closed, however, visitors will still have access to the change rooms and washrooms.

Figure 35 | View of naturally filtered swimming pool from under the pergola

- Visitors taking a morning swim in late June.

❷ *Rental Services*

The center of the building is dedicated to rental services. The rentals include bikes, snowshoes, cross-country skis and skates. The landscaping connects to the various path found within the Ramsey Lake watershed and is meant to encourage active transportation.

❸ *Educational Signage*

Throughout the site, signage will be provided to further educate visitors. A key moment for these educational signs will be on the roof where visitors will have a better view of the entire site. Here, visitors will learn more about the filtering process as well as the David Street Waterworks Heritage building and the water intake protection zones.

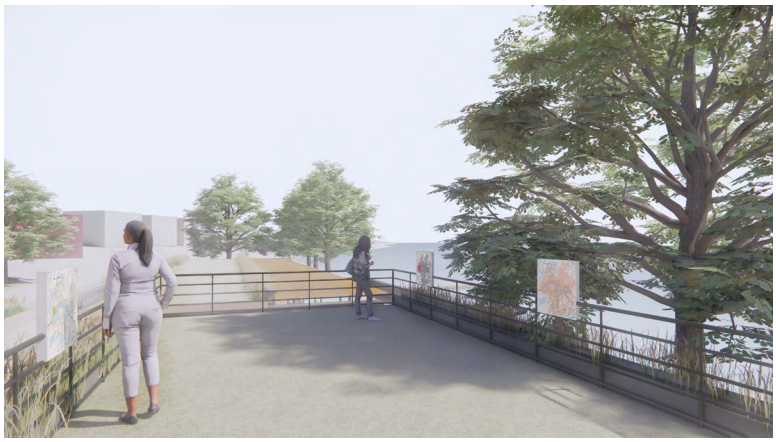


Figure 36 | View of the educational signage on roof top

- Visitors can read about the various clean water interventions from a vantage point.

Figure 37 | Street view of seedling nursery entrance and north façade

- Gabion walls are constructed using welded-cage baskets to insure structural rigidity.

❹ *Seedling Nursery*

A program chosen to be integrated within the design is a nursery for wetland plants. The nursery is integrated within the educational portion of the building and serves+ as a learning tool for visitors. As visitors pass through the building, they can collect a plant and then sow it within the newly established wetland along the shoreline. Through active participation, visitors can continue the story of reclamation along Ramsey Lake's edge.

There are also important technical reasons for this programmatic decision. According to Calgary's Principles for Stormwater Wetland Management, nursery-grown seedlings are the best strategy for re-establishing a wetland to a broad area. It is also recommended to use sandbank materials from existing wetlands. However, due to the pressures that these wetlands already face, 20 to 30 cm of topsoil or peat will be used to re-establish a substrate. To prevent weed invasion, it is also recommended that plant coverage should occupy 80% of the vegetated zone.[2] To ensure plant density, the establishment of wetland along the shoreline of Ramsey Lake will be done in phases. The size of the planting zone will depend on the capacity of the nursery. Throughout the years, the citizens of Sudbury will be able to witness the gradual growth of vegetation along the shoreline, similar to the re-greening program. This process will also educate visitors of the "role wetlands play in addressing pressures and demands that population growth and industrial development are having on the local and regional water supply."[3]

❺ ❻ *Meeting Space and Café*

Above the seedling nursery, there is a light glass façade structure with excellent view of Ramsey Lake. This space can be used for meetings or to accommodate a classroom of students for lunch who are visiting the educational amenities. The space also hosts a café for anyone who might choose to purchase their lunch after a vigorous day on the lake.

2. The City of Calgary. *Principles for Stormwater Wetlands Management in the City of Calgary.* City of Calgary, 2009.
3. Ibid., p. 34.

Figure 38 | Interior view of the seedling nursery and gallery

- Visitors sitting on bench looking out at Ramsey lake and reading the informative displays.

Figure 39 | Interior view of the meeting space and café above the seedlings nursery

- Visitors enjoying coffee and looking out at Ramsey Lake while the sun sets on autumn leaves.

Active Transportation

There are approximately 3,600 lane kilometers of roadway throughout Greater Sudbury.[4] It is no secret that this northern hub is largely dominated by cars. The dependence on cars is partly due to the constellation-like settlement pattern of the city, where smaller communities are required to travel into the central urban core. The challenging topography has also influenced the road layout, which has led to a less than ideal bus route system. I hesitate to mention the colder climatic conditions during the winter. All these reasons have compounded and have led to the car dominating as the primary mode of transportation.

However, the City of Greater Sudbury is beginning to make efforts to encourage and implement active transportation routes. The awareness that alternative modes of transportation can improve well-being, air quality, reduce costs, build resiliency to climate change and minimize the impact of non-permeable surfaces on the watershed has been growing throughout the city.

In order to encourage active transportation, the proposed thesis project will begin to link many of the existing trails. A section of the building will be dedicated to equipment rentals. Tourists and Sudburians will have the opportunity to rent skates, cross-country skis, snowshoes and bikes depending on the season. These active modes of transportation can be enjoyed on or around Ramsey Lake and allow users to explore the entire Ramsey Lake watershed.

The Elgin Greenway

The Downtown Sudbury Master Plan has proposed the Elgin Greenway project to promote a green, walkable path within the downtown core. The path is being offered along Elgin Street and has the opportunity to connect to the thesis project site. The path will link tourists from Science North to many businesses downtown while promoting active transportation.

4. City of Greater Sudbury Official Plan. Planning Services Division, Growth and Infrastructure Department & City of Greater Sudbury. City of Greater Sudbury, 2022.

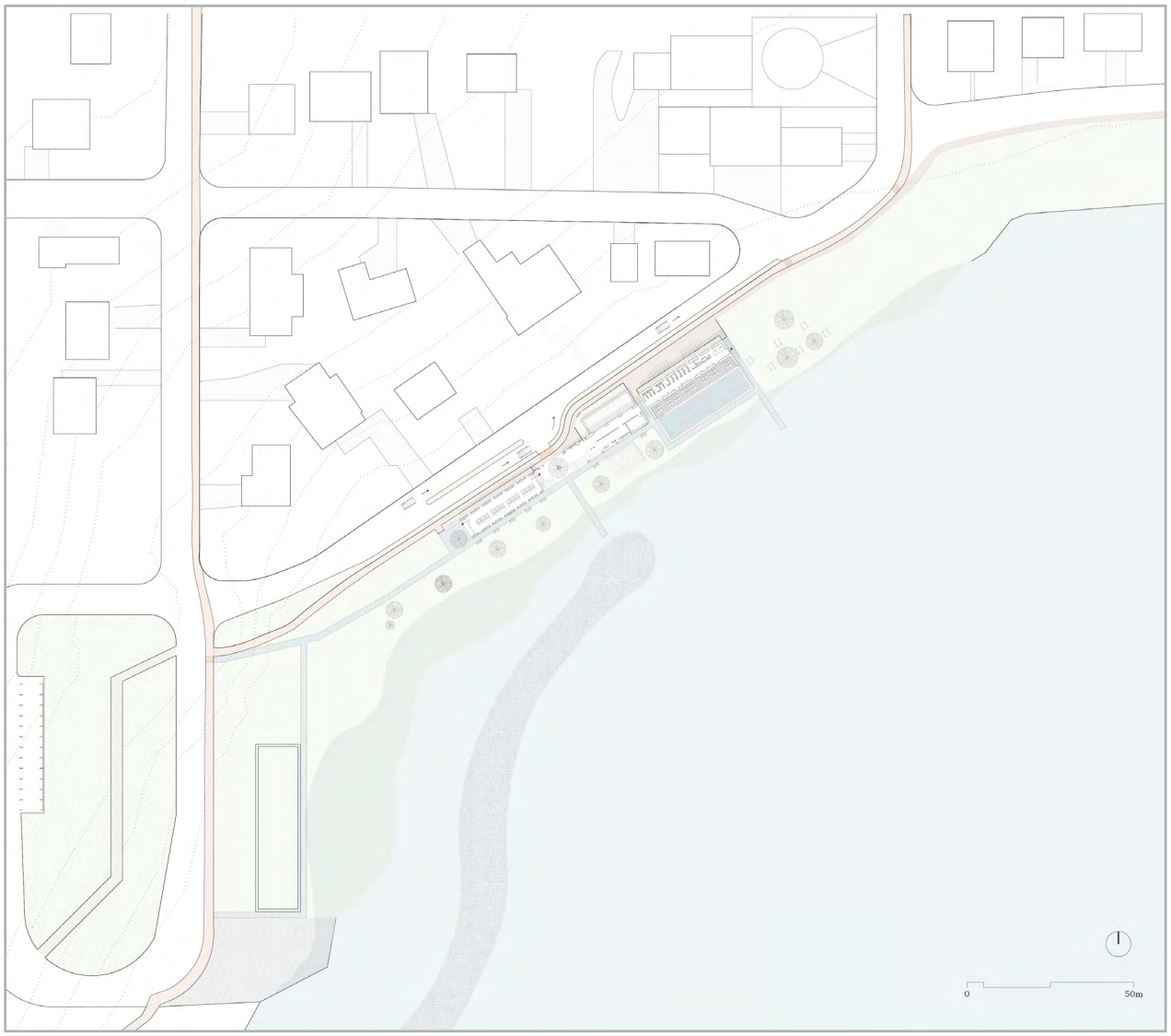


Figure 40 | Site Plan

Site Plan

- Bioswales
- Bike Path
- Boardwalk
- Boat Launch
- Skating Path

Ramsey Lake Skating Path

The Ramsey Lake Skating Path is a 2 km path connecting Science North to the old canoe club. The City maintains the trail from November 1 to April 30, unless weather dictates otherwise. The thesis project will provide skate rentals and seating for changing foot gear. The design will be considerate of the existing path and access points. A change in entrance may be required to accommodate the new wetland. However, an accessible entrance that provides enough space for current activities like loading and unloading warming huts will be integrated within the design.

Ramsey Lake Bike Path

There is also a bike path that loops around Ramsey Lake. The path is approximately 28 km and passes through the different conditions within the Ramsey Lake watershed. The Rainbow Routes Association is responsible for the maintenance and operations of these trails and have worked to enhance the network of over 30 wilderness and urban trails. [5]

Figure 41 | Exterior view of entrance to seedling nursery and gallery

- Gabion walls of the building extend and provide seating. Various activities around the building are taking place such as biking, walking and meditating.

5. Rainbow Routes. Parc Bell Park. Rainbow Routes. https://static1.squarespace.com/static/577a997215d5db17f-979fe0c/t/5792782729687f9d5b37a829/1469216808220/Back+Map+Lilly+Creek++Bell+Park+and+Ramsey+Lake.pdf. Accessed March 22nd, 2022.

Materiality and Atmosphere

The project will propose a pavilion that acts as a threshold between urban development and Ramsey Lake. The remediation of the site will require removing some aggregates and crushed rocks added to the shoreline. The materials found on the site can be used within the construction of the building.

Gabion Walls

Crushed rocks have been added to the shoreline to protect against erosion and extend the land for the old canoe club and walking path. Many of the crushed rocks will be removed from the shoreline to make way for vegetation and other interventions that support a healthy riparian zone. The stones that are removed will be used in making welded-cage gabion walls. The crushed rocks are indicative of Sudbury's mining industry.

Atmosphere

The pavilion will also serve as a transitional space from urban development to the shore of the lake through a series of layered spaces. The materials and atmosphere are meant to serve as a space to reflect on the industrial past, with key views facing the water.

When passing through the building, the dark atmosphere and low ceiling are meant to evoke a similar feeling of being in an underground mining tunnel. The sound of water in the distance guides visitors to the exterior, who will experience great relief when entering the open space and seeing the large expanse of water for the first time. The contrast between the two areas, dark and heavy to bright and light, should lead to an even greater appreciation of Ramsey Lake. When passing through the hallway, small openings in the gabion walls will offer glimpses of the water, increasing the urge to get outside the building and view the lake. Small intimate spaces with benches will be found along the path to give the visitors an opportunity to sit and reflect. The dense rock-filled walls and small enclosed space is similar to a mining tunnel underground, an important and meaningful identifying space to Sudbury. All the while, the sound of water in the background reminds the visitor of the natural beauties the city also has to offer.

Figure 42 | Exterior view of central entrance built around an existing tree

- Visitors can access the café and meeting space above.

Clean Water Interventions

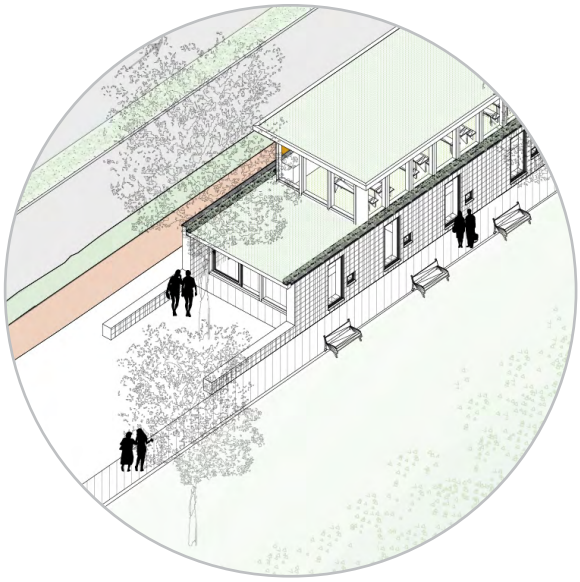


Figure 43 | Pollinator Gardens & Bioswales

- The roofs and landscaping will be planted with pollinator gardens. Bioswales is also incorporated next to the road to prevent salt and other car associated pollutants from entering the lake. These methods along with the wetand and naturally filtered pool work together to create what is known as a 'treatment train', mentioned previously.

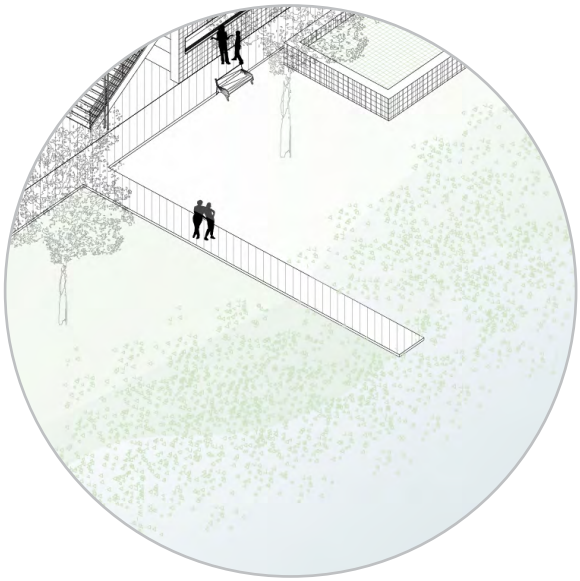


Figure 44 | Re-Introducing Wetlands

- Plants from the seedling nursery will be used to gradually re-establish a wetland along the shoreline, in which the multiple benefits have been stated previously.

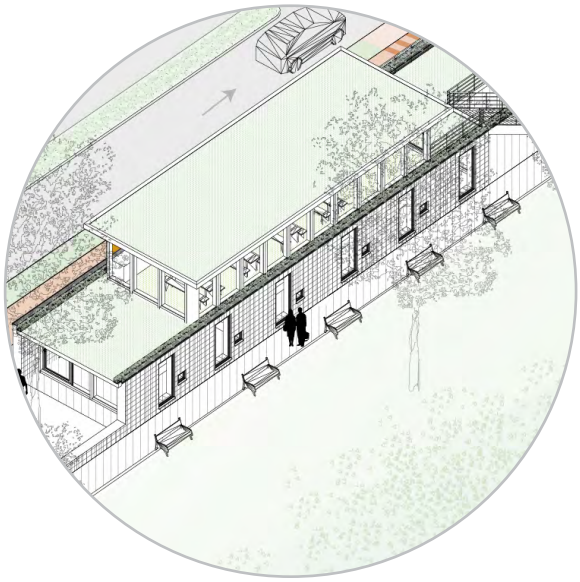


Figure 45 | Re-using Site Materials

- The gabion walls use the crushed rock originally found along the shore line. To re-establish the wetland, these rocks were moved and found their way into the construction of the building.

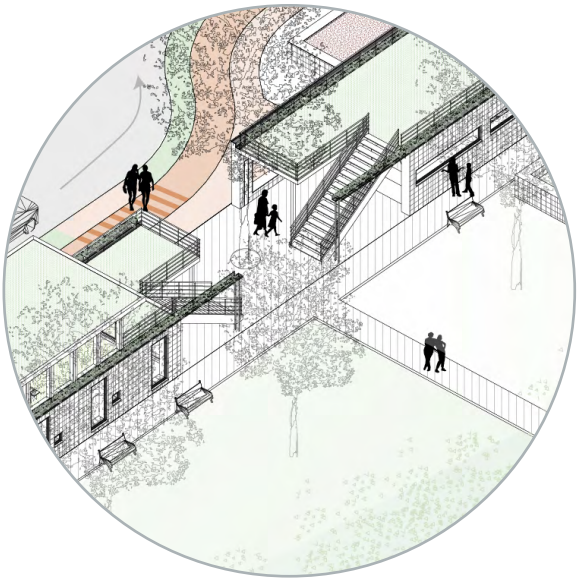


Figure 46 | Minimal Disturbance to Existing Trees

- The majority of the trees on the site were left undisturbed. The building was planning around the existing trees, leaving a 3m radius between the trunk of the tree and the foundation of the building.

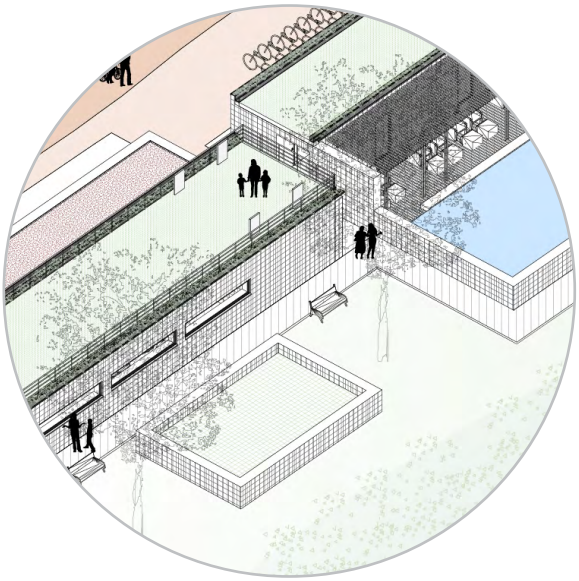


Figure 47 | Natural Swimming Pool

- Grey water from adjacent stormwater runoff will be cycled through a natural filtration system and into a swimming pool where visitors can experience the clean water first hand.

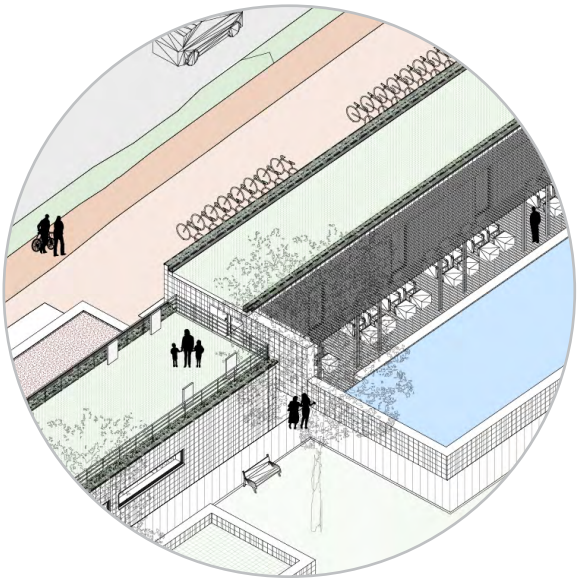


Figure 48 | Active Transportation

- The center of the building is dedicated to rental services. The rentals include bikes, snowshoes, cross-country skis and skates. The landscaping connects to the various paths found within the Ramsey Lake watershed and is meant to encourage active transportation.


Seedling Nursery
83 m

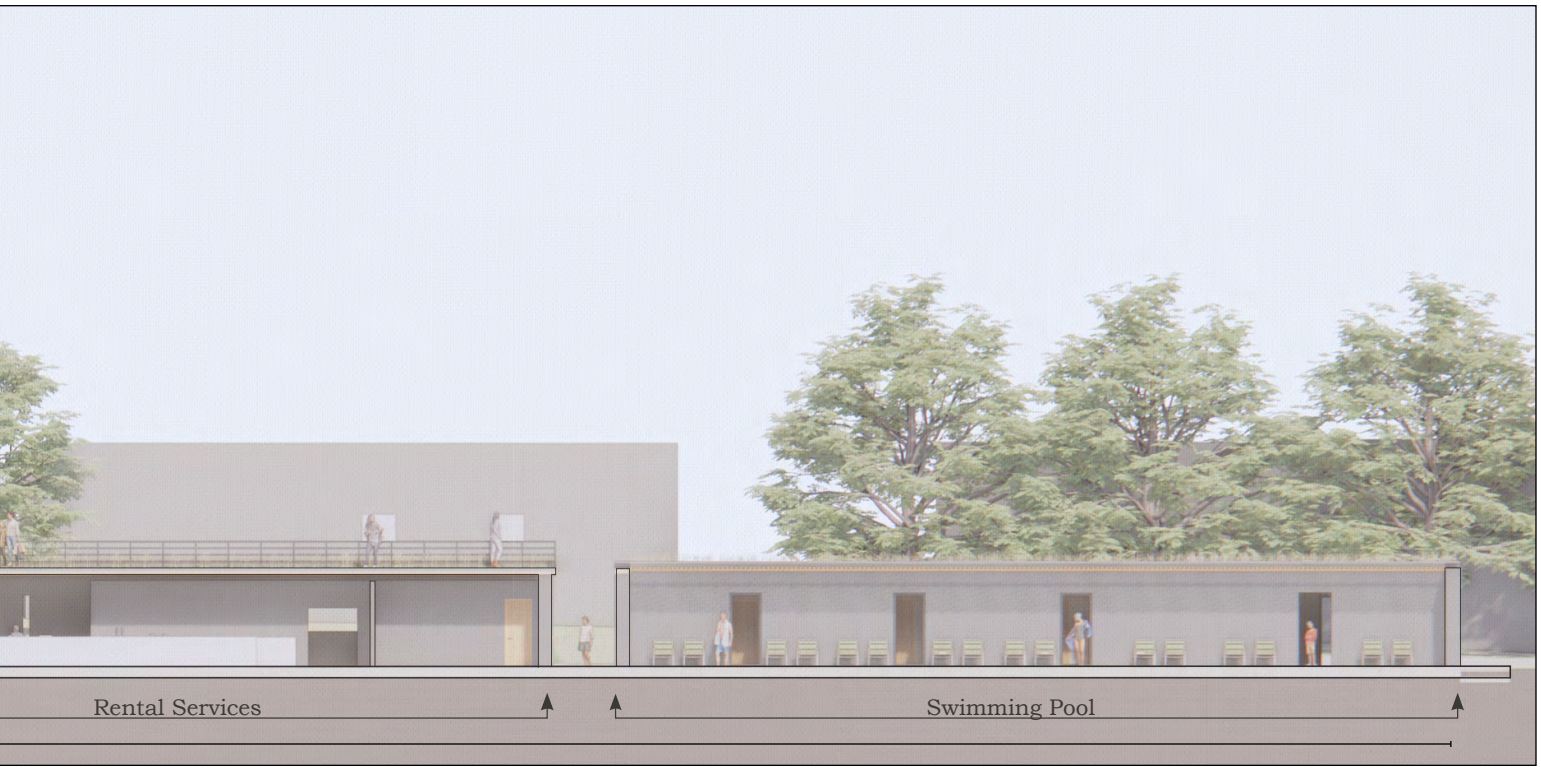


Figure 49 | Longitudinal Section

- This drawing allows for a better understanding of programmatic relationships and the movement of people through the building.

- The journey through the building allows for a passive education on healthy water environments. From east to west, visitors learn about wetlands and watersheds, the mechanics of the filtering process and finally the experience of clean water.

- From east to west, the whole facility measures 83 m long and 6 m wide.

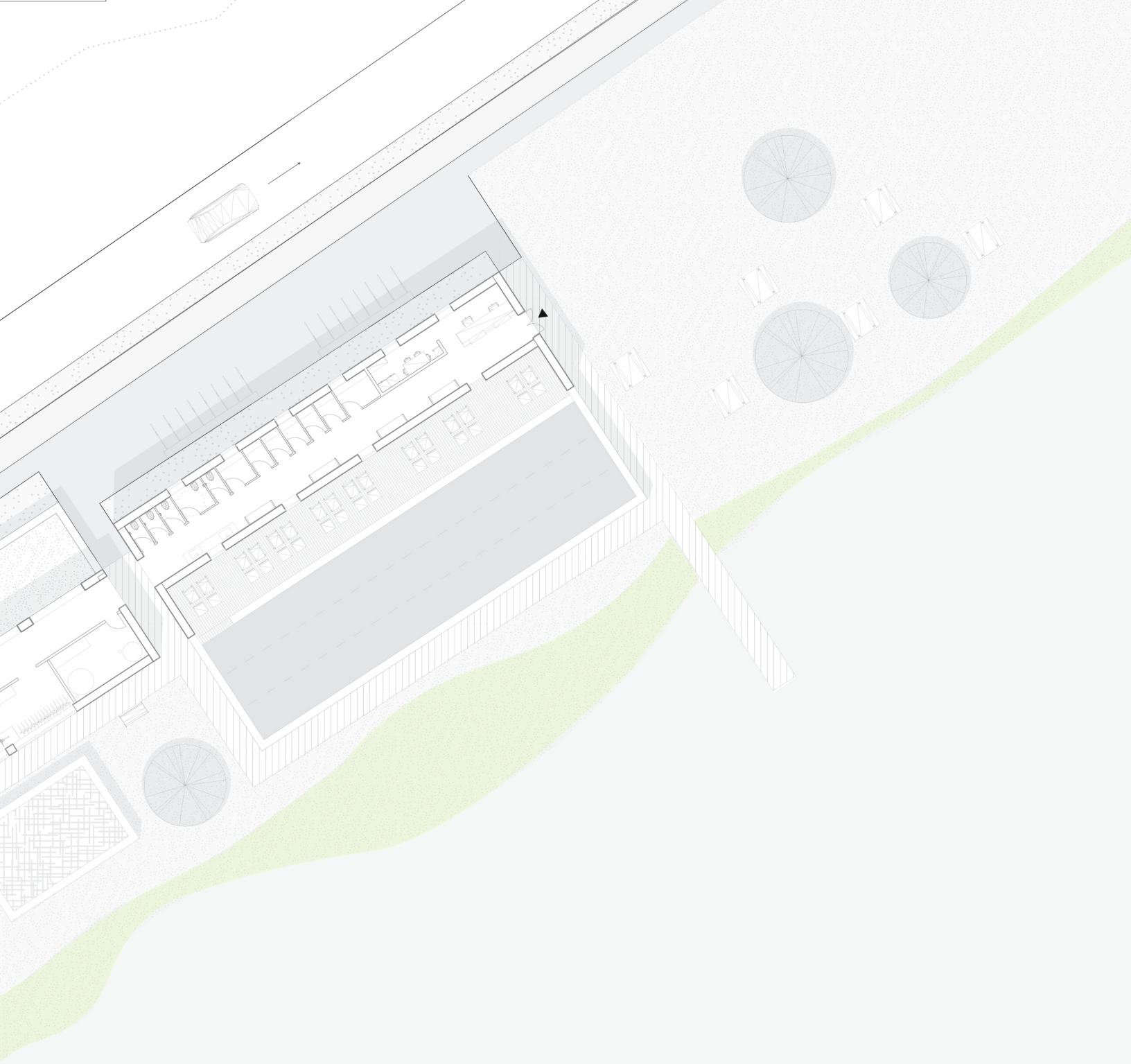


Figure 50 | Floor plan with site context

Re-established wetland
(where land and water meet)

0

50m

Visitor Scenarios

Path of Circulation
Cone of Vision

Figure 51 | Renting Skates

- Visitor gets dropped off at north entrance.
- They rent a pair of skates from the rental services.
- They access the skating path using the boardwalk.
- Changing their skates at the edge of the ice, they skate the 2km path to Science North.

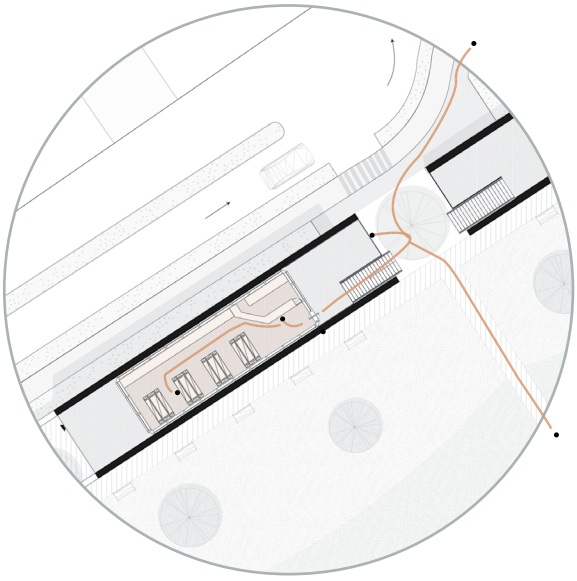


Figure 52 | Meeting & Eating

- Visitors enjoying various activities on the ground level can come grab a bite to eat and at the café.
- The space can also be used for meetings by various community groups in the City of Greater Sudbury.
- The picnic tables can accommodate 32 people, the perfect size for a class visit.

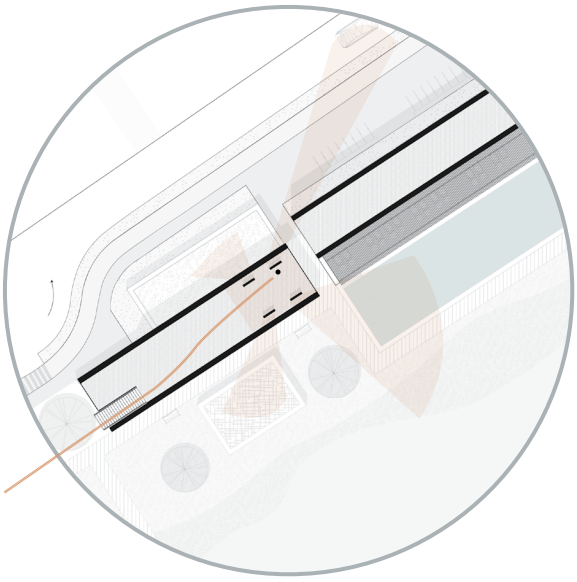


Figure 53 | Learning from Above

- Visitors can access the roof above the rental services to get a birds eye view of Ramsey Lake.
- Educational signage gives more information about the natural filtering process as well as the David Street Waterworks Heritage Site, which can all be seen from the respective vantage points where the sign is placed.

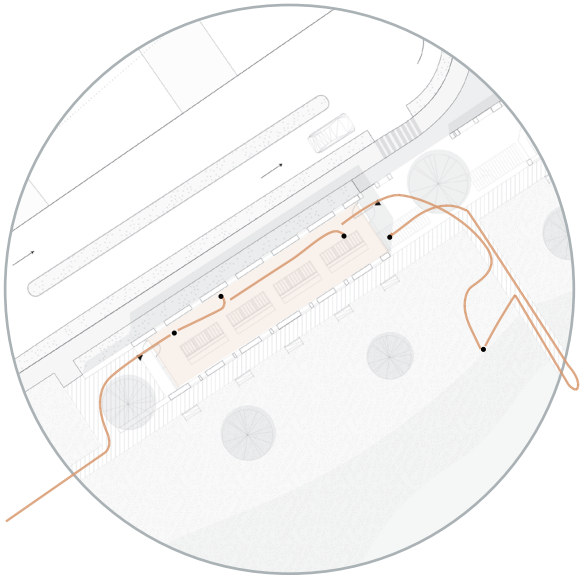


Figure 54 | Planting a Seedling

- Visitor enters the seedling nursery through the west entrance.
- Visitor views the educational display along the north wall and learns about the importance of watershed planning.
- As visitor leaves, they grab a seedling.
- Using the boardwalk to access the re-established wetland, the visitor plants a seedling of their own.
- The visit ends with lunch in the upstairs meeting room/café.

Figure 55 | Biking the Ramsey Lake Watershed

- Visitor uses south boardwalk to access the rental services.
- The visitor decides to rent a bike which is handed to them at the end of the hallway.
- They bike the 28k trail around Ramsey Lake and learn more about the Ramsey Lake watershed.
- The user then returns the bike to the exterior bike rack.
- Finally, the visitor ends his journey with a sandwich at the upstairs café.

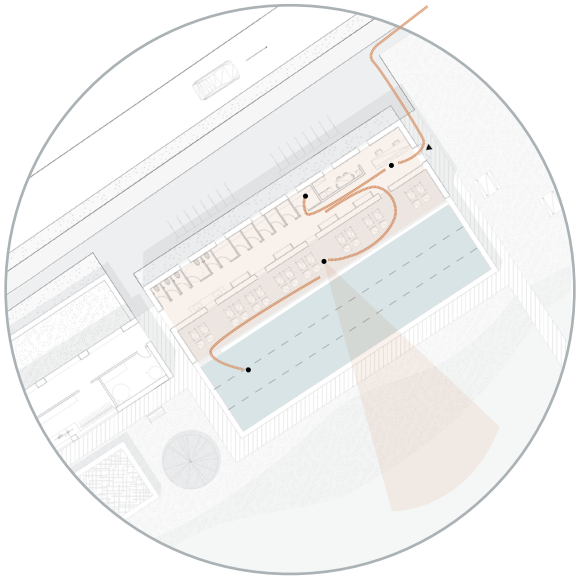


Figure 56 | Swimming in Naturally Filtered Water

- Visitor enters naturally filtered pool facility through east entrance.
- Visitor is greeted by reception and purchases a day pool pass and a towel.
- The visitor then changes in one of the change rooms along the hallway.
- After changing they enter the enclosed open air pool area.
- The visitor then enters the naturally filtered pool with a view to the lake, giving a visual opportunity to compare the two.


Residential
Road
Drop Off
Bike
Bioswale
Pollinator
Garden
Proposed Watershed Management Facility

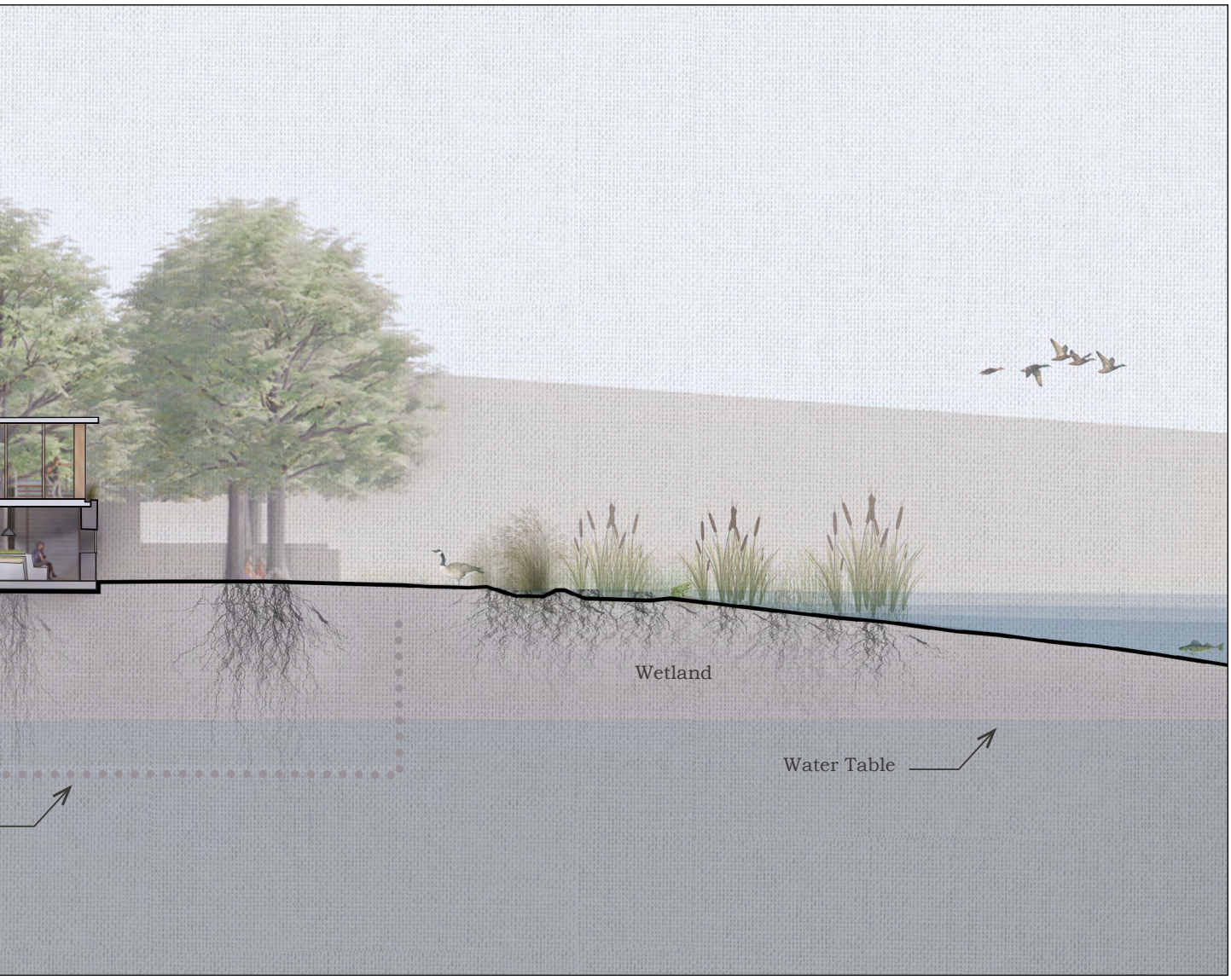
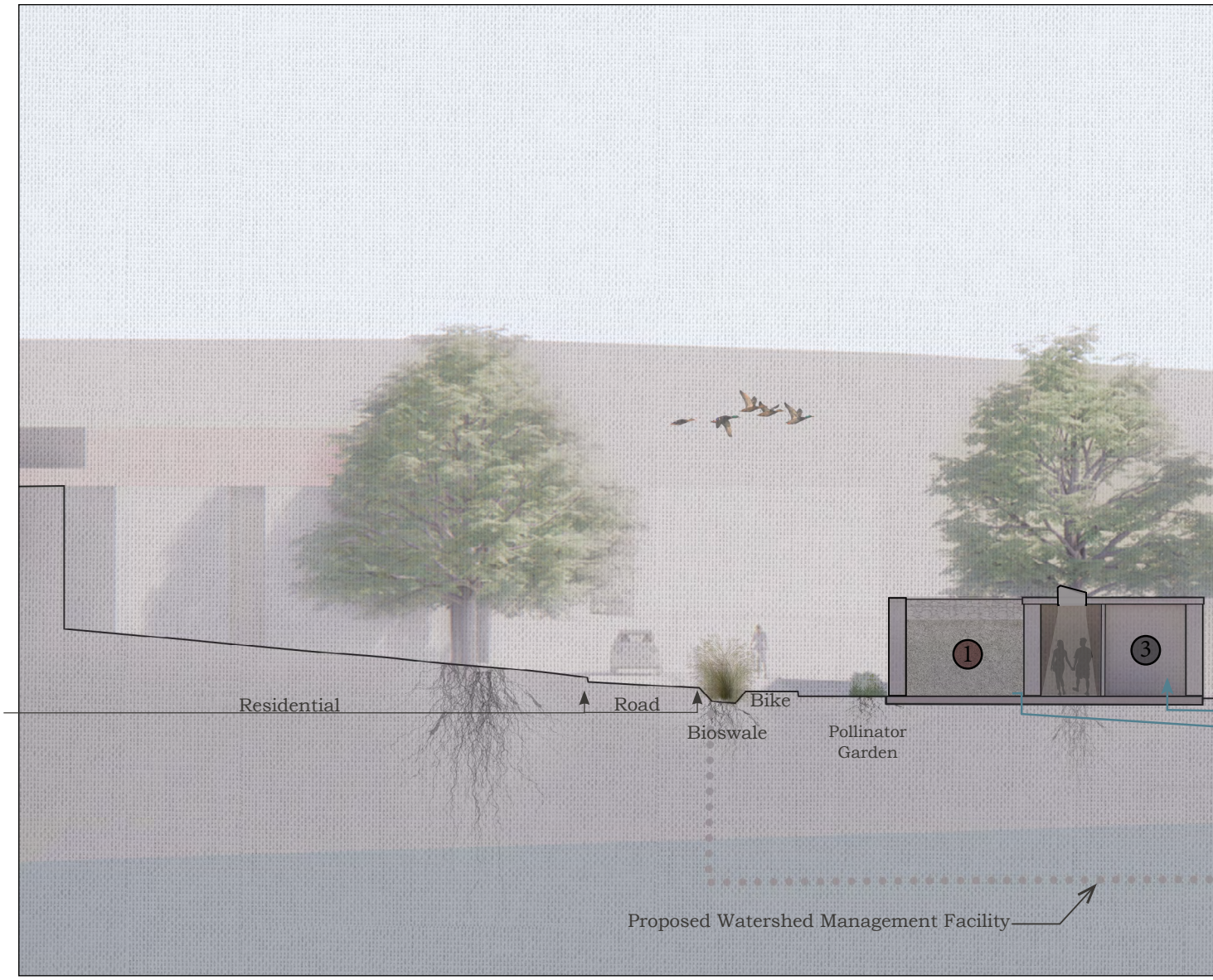


Figure 57 | Transverse section from Bell Park to the lake

- In this section, we began to see the relationship of the building within its ecosystem. Bioswales provide initial protection from residential and road runoff. However, the wetland filters the majority of the water and sediment loads. The wetland also stabilizes the shoreline, preventing erosion. The dotted line shows the City's proposed watershed management facility and its intersection with the water table.


1
3
Residential
Road
Bike
Bioswale
Pollinator
Garden
Proposed Watershed Management Facility

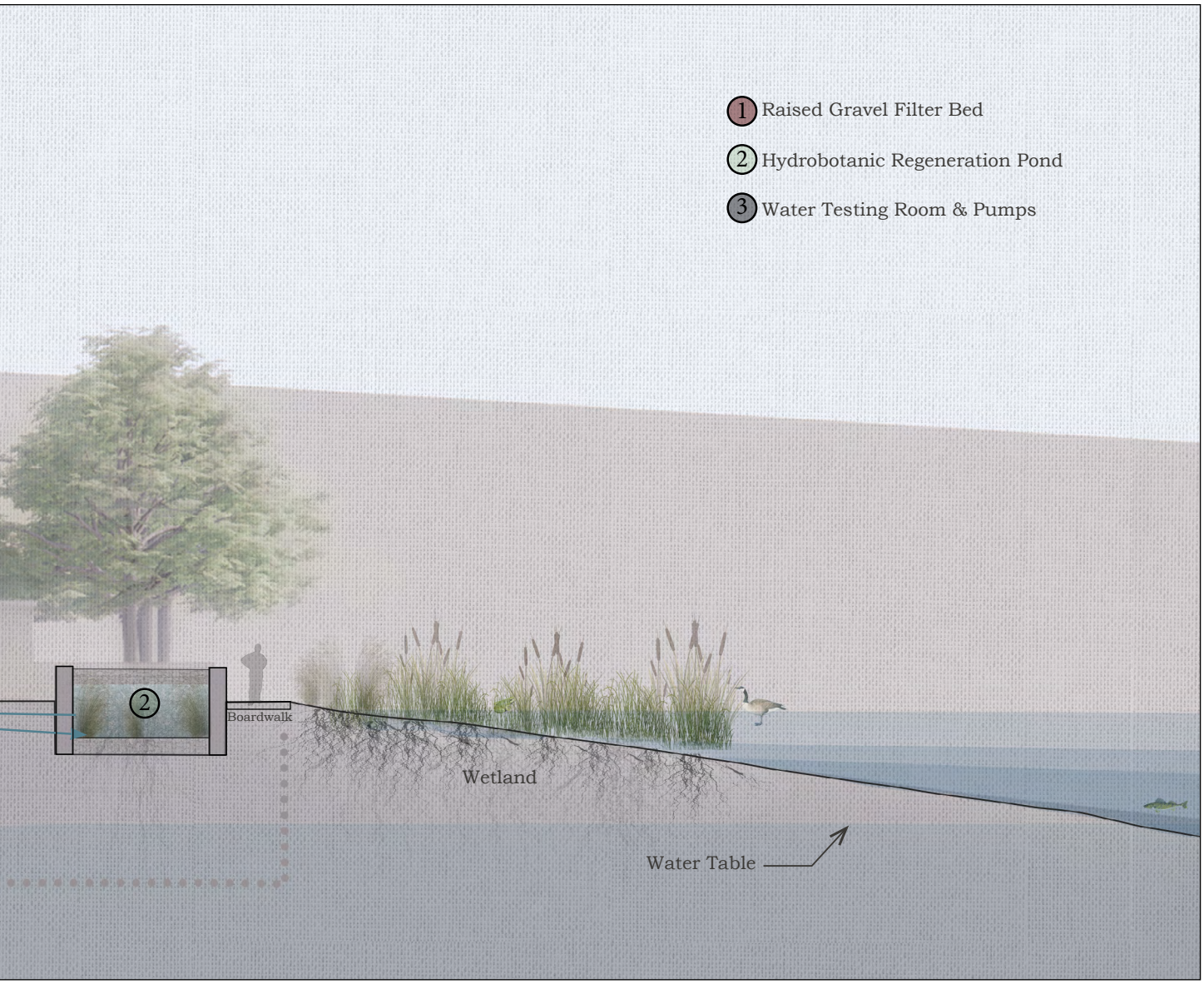
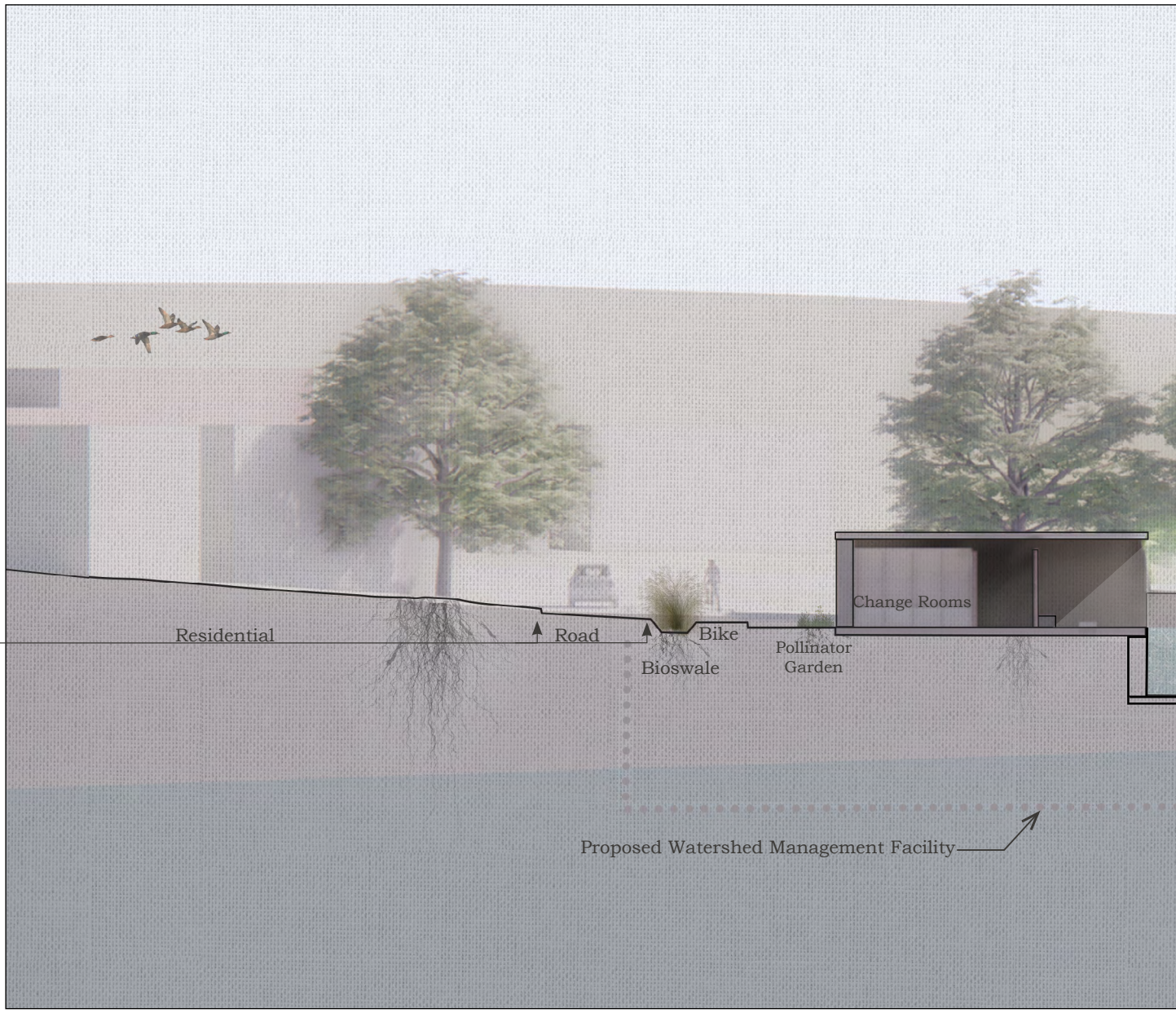


Figure 58 | Transverse section through the building and the hydrobotanic pond

- To the left of the building is a raised gravel bed that filters larger particles. The water is then gravity fed to the hydrobotanic regenerative ponds to the right. The filtered water is then pumped into the testing room in the center before being pumped into the swimming pool. This system uses grey water from the site, which is then cyclically passed through these filtering processes.


Residential
Road
Bike
Bioswale
Pollinator
Garden
Change Rooms
Proposed Watershed Management Facility

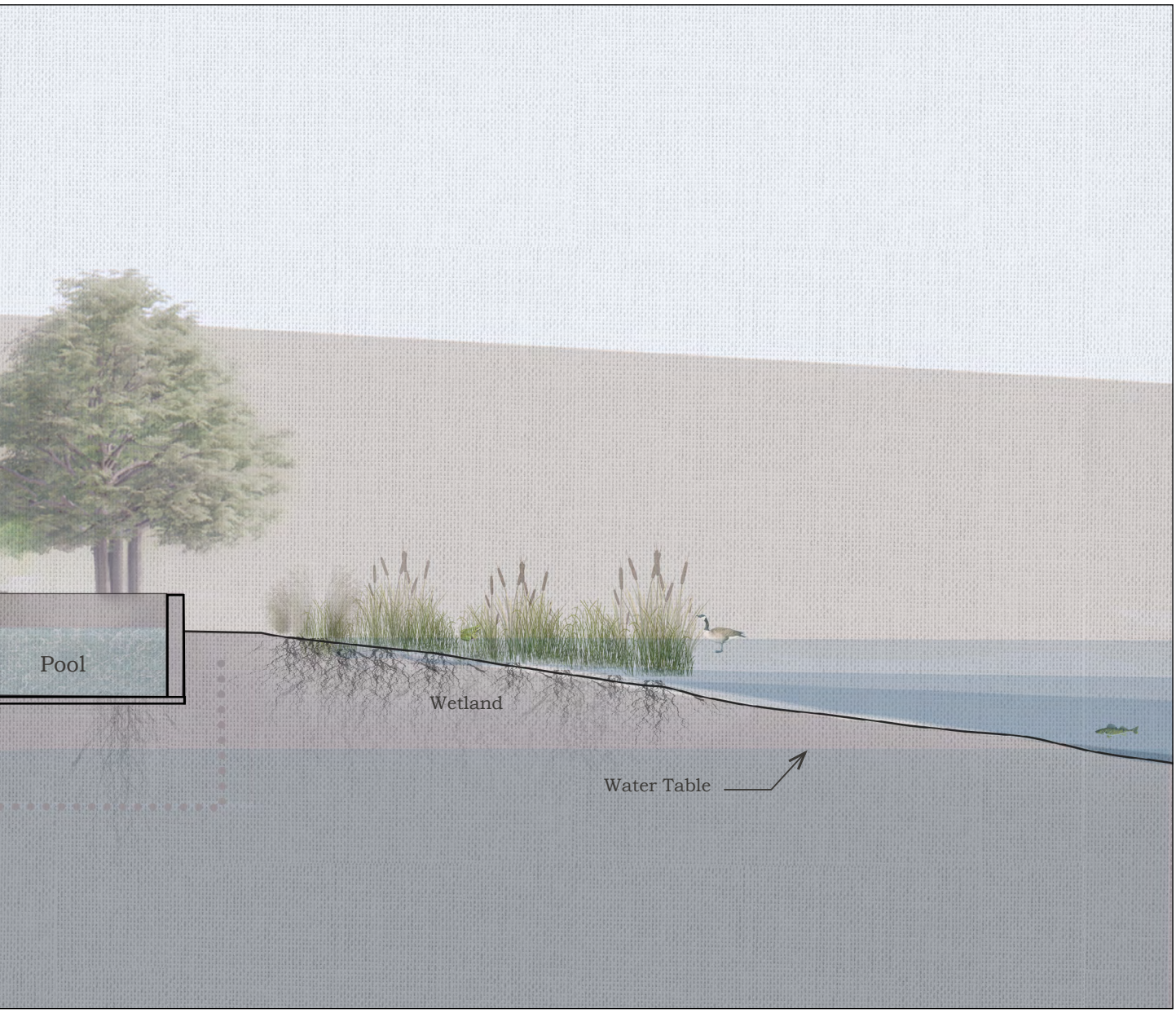


Figure 59 | Transverse Section through the change rooms and swimming pool

- Here we can see the pool on the right and change rooms on the left. After learning about the importance of filtering water, the visitors can then experience the close proximity of the pool to the lake. This relationship is meant to serve as a comparison and encourage people to protect Ramsey Lake, an indispensable natural amenity.

Epilogue

Conclusion

Ramsey Lake is in the heart of the City of Greater Sudbury. It provides countless amenities for Sudburians. It is also home to many different plant species and wildlife. Ramsey Lake is meant to exist in dynamic equilibrium with its surrounding conditions. However, urban development within the Ramsey Lake watershed has imbalanced these natural ecological functions.

Planning our city with watersheds in mind would result in better water quality, less dependency on chemical filtration and a more diverse and resilient ecosystem. A diverse native plant life has the potential to protect against erosion, build soil, prevent flooding, create habitat for other species and filter contaminants in water.

The proposed project is within the riparian zone of Ramsey Lake, where land and water meet. This project aims to educate visitors about their impact on urban lakes and showcase how architecture can serve as a tool to help reclaim the natural ecological functions of a given site.

The architectural programs, or uses, are strategically chosen to passively educate visitors as they enjoy various amenities. Bringing people closer to the flora and fauna of the site, while allowing them to participate in its regeneration, will strengthen their relationship with nature and encourage them to become stewards of the land.

After learning about the importance of watershed planning and wetlands, visitors can then experience naturally filtered water in the swimming pool. The pool's proximity to the lake compares filtered water and water polluted by urban run-off. The hope is that visitors leave the building and the landscape encouraged to protect Ramsey Lake, an indispensable natural amenity, for now, and for future generations.

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