FROM POWERING A CITY TO FUELING ITS CITIZENS, VERTICAL URBAN FARMING IN A NEW LIGHT

by
Erin Kirkland

A thesis submitted to the Faculty of Graduate and Postdoctoral Affairs in partial
fulfillment of the requirements for the degree of

Master of Architecture

Carleton University
Ottawa, Ontario

© 2020
Erin Kirkland

ABSTRACT

This thesis explores the role that architectural interventions can play in engaging the public with their food supply. It is an adaptive reuse proposal for the Rosedale Power Plant located in downtown Edmonton, Alberta. The proposal addresses the history of the site, which has seen a number of uses, including agriculture and power generation, before its relative abandonment in the 1990s. The proposal includes the adaptation of aquaponic systems to leverage water and light in unique ways, with the goal of drawing community back to the site and enabling people to engage with their food from seed to serving. Community gardens and other programs such as market stalls, a grocery store, a community kitchen and dining space, classrooms and event spaces, highlight the public ambitions of the project to improve food security and food literacy in the urban environment.

ACKNOWLEDGEMENTS

There are so many people who have helped along my journey to completing my master's and over the last year in writing my thesis. To all the people I have spoken with in person and digitally, I am very grateful for your help and input. I'd like to thank my advisor, Lucie Fontein, for her incredible guidance, insight, and support through the whole thesis process. To my friends and classmates, over the last eight years, this whole experience was special in large part because of you. A special thank you to Alicia Gilmore, Marie MacInnis, Patrick Lefebvre, Jennifer Kalman, Meghan Lamb, Nastassia Usenka, and Tasia Craig for lending a helping hand. Finally, I would like to thank my parents for their endless support, I could not have achieved this milestone without you!

TABLE OF CONTENTS

Image List	1
Introduction	3
Site	5
Potential of the Site	
Urban Farming	16
Case Studies	
The Role of Light within the Facility	27
Powering the New Facility	32
Design	37
Conclusion	48
Scenarios	49

IMAGE LIST

Figure 1 Map of Rossdale Site with Overlaid Historical Site Information.

Figure 2 Yesterworld. "Rossdale Power Plant." #LostYEG: Lost Edmonton, November 17, 2015. <https://lostyeg.wordpress.com/2015/11/16/rossdale-power-plant/>.

Figure 3 Marshall, Debbie, and Heather Marshall. Candles to Kilowatts: The Story of Edmonton's Power Company. Edmonton: Duval House Pub., 2002.

Figure 4 https://upload.wikimedia.org/wikipedia/commons/8/82/Epcor_Rossdale_Power_Plant_September_2007.jpg

Figure 5 Unknown. "Reimagining Rossdale." Reimagining Rossdale. Blogger, April 29, 2016. <http://www.iheartedmonton.ca/2016/04/reimagining-rossdale.html>.

Figure 6 Photo of Existing Site

Figure 7 Photo of Existing Site

Figure 8 Photo of Existing Site

Figure 9 City Map of Existing Community Gardens and Markets

Figure 10 Map of site access

Figure 11 Photo of Existing Powerplant Interior by Dan Rose, Edmonton Historical Board

Figure 12 Photo of Existing Powerplant Interior by Dan Rose, Edmonton Historical Board

Figure 13 Photo of Existing Powerplant Interior by Dan Rose, Edmonton Historical Board

Figure 14 Hydroponic Diagram

Figure 15 Aquaponic Diagram

Figure 16 Gunseli Yalcinkaya, "IKEA and Tom Dixon Announce Urban Farming Collection," Dezeen (Dezeen, November 29, 2018), <https://www.dezeen.com/2018/11/29/ikea-tom-dixon-urban-farming-gardens/>

Figure 17 Gunseli Yalcinkaya, "IKEA and Tom Dixon Announce Urban Farming Collection," Dezeen (Dezeen, November 29, 2018), <https://www.dezeen.com/2018/11/29/ikea-tom-dixon-urban-farming-gardens/>

Figure 18 Valode & Pistre Architectes Atlav AJN, "The World's Largest Urban Farm Opens Next Year in Paris," ArchDaily (ArchDaily, September 3, 2019), https://www.archdaily.com/923857/the-worlds-largest-urban-farm-opens-next-year-in-paris?ad_source=search&ad_medium=search_result_all

Figure 19 Katerina Bozhinova, "Former Steel Mill Turns into a Green Paradise," Food Tank, August 1, 2018, <https://foodtank.com/news/2018/07/gotham-greens-expands-baltimore-viraj-puri/>

Figure 20 "Crop One." Crop One. Accessed December 10, 2019. <https://cropone.ag/>.

Figure 21 Goldsmith, Sara and Johanna Agerman Ross. 2012. Vitamin Green. London;New York: Phaidon Press. Page 181

Figure 22 Alan Jeffries, Brian Schildhorn. Bloomberg. Accessed December 10, 2019. <https://www.youtube.com/watch?v=AGcYApKfHuY>.

Figure 23 "Our Story." Gotham Greens. Accessed December 10, 2019. <https://www.gothamgreens.com/our-story/>.

Figure 24 Hegen, Tom. "THE GREENHOUSE SERIES: Tom Hegen Fotodesign." Tom Hegen Fotodesign. Accessed December 10, 2019. <http://tomhegen.de/fotodesign/the-greenhouse-series/>.

Figure 25 Locatelli, Luca. "Hunger Solutions." 2018 Luca Locatelli OTS-EJ | World Press Photo. Accessed December 10, 2019. <https://www.worldpressphoto.org/collection/photo/2018/28836/5/2018-Luca-Locatelli-OTS-JJ>.

Figure 26 Elwood D. Bickford and Stuart Dunn, Lighting for Plant Growth (Kent, OH: Kent State Univ. Press, 1978), p.81,121)

Figure 27 Lighting Study

Figure 28 Lighting Study

Figure 29 Building Axonometric

Figure 30 Systems Bay Axonometric

Figure 31 Site Plan

Figure 32 Ground Floor Plan

Figure 33 Basement Plan

Figure 34 Mezanine Plan

Figure 35 Greenhouse Section

Figure 36 Power Plant Section

Figure 37 Classroom Vignette

Figure 38 Entry Vignette

Figure 39 Vignette of Community Kitchen

Figure 40 Vignette of Greenhouse

Figure 41 Vignette of Food Hall

Figure 42 Vignette of Cafe amongst Fish tanks

Figure 43 Vignette of Event Space

INTRODUCTION

I grew up in a household in Edmonton where we talked about food a lot. My mom is a Registered Dietitian so we spent lots of evenings cooking together and eating as a family around the table. We would often talk not only about the importance of the food itself, but also where it came from, how it was made and how we were able to share it. I also spent many summer afternoons down the street, gardening with my grandma, and then helping her cook Sunday dinner with the vegetables we had picked that afternoon. As I have moved out on my own I have noticed that access not only to fresh food but also to information about where food comes from is harder to come by. As a society we are becoming more dissociated with where and how our food is grown and prepared. This has several negative health implications.

According to the Public health Agency of Canada "Poor nutrition has become the leading cause of poor health among Canadians".

"Ultra-processed foods have become ubiquitous, home economics and family studies classes have been de-prioritized in schools, family meals are less frequent, and people are spending less time on food procurement and preparation activities due to constraints on time 3

and a societal emphasis on convenience. These changes have contributed to a generation of children and youth with low levels of food literacy.”¹

This brings me to my thesis question: How can an architectural intervention be used to reengage people with their food supply in an urban environment. FRESH, Edmonton’s Food and Urban Agriculture Strategy, identifies “a need to increase the capacity and opportunities for people to build and sustain [food] relationships and networks, improve partnerships among new and existing organizations, increase consumer knowledge, increase participations in food growing, preserving and preparing activities and generally raise awareness for all citizens.”²

I believe that architecture can play a crucial role in the development of urban agriculture and people’s engagement in their food growth and production. Carefully considering how we are engaging with food in the urban environment can have a profound impact on the health of our society. This thesis explores the way that an architectural proposal can foster a positive engagement with food production and consumption.

1 Corey Mintz, “Too Many Kids in Ontario Are Food Illiterate - and It’s Costing Us Big,” TVO.org, November 25, 2019, <https://www.tvo.org/article/too-many-kids-in-ontario-are-food-illiterate-and-its-costing-us-big>)

2 City of Edmonton, FRESH Edmonton’s Food and Urban Agriculture Strategy (p.30)

SITE

In order to test this theory, I have chosen an urban site in Edmonton: the former Rossdale Power Plant, optimally located in downtown Edmonton along the North Saskatchewan River immediately next to the new Walterdale bridge. It lies on a flood plain 10 meters above the riverbed and 60 meters below the mean city level. It is easily accessible to those in the downtown core and for those in and around the University of Alberta. The site has a long history that dates back thousands of years to early indigenous settlements. Archeological records reveal activity that followed related to fur trade, residential settlement and early industrial development.³ Documentation of the site begins more clearly in the early 1800s when the Hudson's Bay Company began using the site and constructed the first Edmonton House. It reinforced a rich history of agricultural use of the land and included many anecdotal tales of the growth of barley, root vegetables, berries and greens over the following centuries.⁴

In the last century the Rossdale flats have been used primarily for power generation. Power was first generated on the site in 1903. Over the years the power plant has taken a variety of forms as demonstrated by the timeline of images below.

3 City of Edmonton, River Crossing Business Plan., (p. 16)

4 City of Edmonton, Rossdale Historical Land Use Study (Commonwealth Historic resource Management Limited.,) p.vi, 28, 62-64, 139)

Figure 1

“The Rossdale Power Plant is a good example of the architectural design style, and construction methods that were used in the late 1920s and early 1930s.”⁵ The building that remains today was designed by Maxwell

5 Debbie Marshall and Heather Marshall, Candles to Kilowatts: The Story of Edmonton's Power Company (Edmonton Ducal House Pub.), p.34)

Dewar and constructed in the 1930s.⁶

As the need for power grew in the late 30s and early 40s, Edmonton was forced to find a way to keep up with demand. A major addition to the original building was approved by city council in March of 1940.⁷ There was another expansion of the capacity of the building approved in September of 1945 as the city and its demands for power continued to grow. Up until this point the city used coal boilers. Even through expansion during this time, the building retained a consistent character.⁸

"Great strides were made in the production of electricity during the 1950s. Edmonton's power department became the leaders in the industry by installing the very latest turbines, boilers, underground distribution systems, oil-filled cables, aerial towers, and wires that carried previously unheard of amounts of electricity."⁹ Construction began in 1951 and was completed in 1953, upgrading the capacity of the power plant yet again, this time including a "new Parsons 30,000-kW turbo-generator and a gas and oil fired boiler".

6 City of Edmonton, River Crossing Business Plan., (p. 15)

7 Debbie Marshall and Heather Marshall, Candles to Kilowatts: The Story of Edmontons Power Company (Edmonton Ducal House Pub.,) p.38)

8 City of Edmonton, River Crossing Business Plan., (Pg. 15)

9 Debbie Marshall and Heather Marshall, Candles to Kilowatts: The Story of Edmontons Power Company (Edmonton Ducal House Pub.,) p.49)

In the 1970's Edmonton Power began to expand beyond the capabilities of the Rosedale Power Plant. A new power plant was under construction in Cloverdale with plans for a third power plant in Genessee Alberta. 1973 was also the beginning of the energy crisis and the first time that Edmonton Power began advocating for energy efficiency rather than "living better electrically".¹⁰

Following the expansion of the city's power generation capabilities to other locations, the Rosedale Power plant became obsolete. By 1992 the decommissioning of the power plant had begun with many of the boilers and generators being removed. By 1998 the building stood empty with the exception of three operational units.¹¹ City council approved plans by EPCOR to make changes to the power plant including partial demolition of the Low Pressure Plant and changes to the appearance of the High Pressure plant to match the new addition. However, once this plan was made public many felt that the low pressure plant was worth preserving. In addition, there were a number of archaeological finds that had been made on the site that emphasized the historical importance of the site. The province of Alberta designated the Low Pressure Plant,

10 Debbie Marshall and Heather Marshall, *Candles to Kilowatts: The Story of Edmontons Power Company* (Edmonton Ducal House Pub.,) p.77)

11 Debbie Marshall and Heather Marshall, *Candles to Kilowatts: The Story of Edmontons Power Company* (Edmonton Ducal House Pub.,)

Administration Building and Number 1 Pumphouse as historical resources. Soon after EPCOR announced that it was no longer interested in repowering the plant.¹²

On a more personal note, this power plant has immediate significance to my family. In 1952 my grandfather William (Bill) D. Kirkland became superintendent of Rosedale and became General Manager of Edmonton Power in 1970 until he retired in 1974.¹³ I never met my grandfather as he passed away before I was born. However, my father has told me many stories of going to work with his dad at the Rosedale Power Plant. He has also often described Bill's passion for his work and his dedication and loyalty to the City of Edmonton and Edmonton Power in particular. He was constantly proactively seeking out solutions for Edmonton's power generation that would take the city into the future. As we move away from fossil fuels and towards new more sustainable means of power generation, I think he would be excited about giving this historical building a new life that contributes to more sustainable energies for the community in a number of different ways.

12 Debbie Marshall and Heather Marshall, *Candles to Kilowatts: The Story of Edmonton's Power Company* (Edmonton Ducal House Pub.,) p.103-105)

13 Debbie Marshall and Heather Marshall, *Candles to Kilowatts: The Story of Edmonton's Power Company* (Edmonton Ducal House Pub.,) p.71)

Figure 7

Figure 8

POTENTIAL OF THE SITE

Since its decommissioning, the Low Pressure Plant and Pumphouse 1 have sat empty. The administration building remains in use by EPCOR. Given its excellent location within the city there has been consistent demand for the building to be given a new life and engage more with the community. It is directly connected to paths along the river valley and within walking distance of the downtown core and Alberta Legislature grounds. Immediately across the river is the Kinsmen Sports Centre with excellent indoor and outdoor sports facilities. There are also views from the University of Alberta and its surrounding communities onto the site. The site can be accessed in a number of different ways including by foot, bike, vehicle or public transit. A gondola project has been proposed by Prairie Sky Gondola meant to connect both the Strathcona neighbourhood and the downtown core of Edmonton to the River Valley, which sits at a lower elevation than the rest of the city. The intention is to integrate the gondola with the public transit system. A station has been proposed immediately next to the Rosedale Power Plant which would increase traffic onto the site significantly.¹⁴

14 "Prairie Sky: Urban Gondola Edmonton," Prairiesky, accessed December 19, 2019, <https://www.prairieskygondola.com/>

The Business Plan released in September of 2019 identifies a vision for the area that includes the following:¹⁵

- “Place of connection, linking people between the destinations that surround it.”
- “Place of convergence, where unique people cultures and natural landscapes of Edmonton come together.”
- “Place to cherish, that has been the heart of trade, travel, kinship, spirituality, community, and culture for thousands of years.”
- “Place of community, where diverse people live interact, and enjoy a highly livable, sustainable, vibrant environment. ”
- “Place that communicates, in which stories of our past, present, and future are told.”

The building itself has incredible potential for adaptive reuse. The expansive 4 story spaces with a lattice work of steel structure in combination with the perforated concrete slabs suggest traces of the boilers and turbines that used to fill the room. The now empty structure fills with sunlight during the day and highlights the soaring space’s unique textures that have evolved over its long history. There is so much opportunity to bring new life and activity into the space and reintroduce this building to the community.

15 City of Edmonton, River Crossing Business Plan., (Pg. 6)

Figure 11

Figure 12

Figure 13

According to the River Crossing Business Plan, there was work done to stabilize the building in 2015 including replacement of the Boiler Hall Roof. Additional investment and renovations are required to be able to allow people to regularly inhabit the building, including the replacement of the Turbine Hall roof.¹⁶ Based on the history of the site and its location within the city of Edmonton, I think it makes an excellent site for engaging people in the process of urban farming.

URBAN FARMING

In order to implement and fully engage the potential of vertical urban farming it is important to first understand how the systems function. I am interested in introducing urban farming into the power plant through a number of different systems and methods. One important distinction to understand is the difference between community and communal gardening.

Community garden: "a garden (esp. in an urban area) maintained by the members of a community; (now) spec. (a) North American one divided into allotments; (b) one collectively maintained by a community both for recreational purposes and as part of a programme of social and environmental regeneration."¹⁷

¹⁶ City of Edmonton, River Crossing Business Plan., (Pg. 16)

¹⁷ "community, n.". OED Online. December 2019. Oxford University Press. <https://www.oed.com/view/Entry/37337?redirectedFrom=community+garden> (accessed December 11, 2019).

Community gardening is a model where there is a large plot of land divided into smaller sub plots. Individuals are each assigned a sub plot and responsible for all the care and maintenance of their plot. This typically includes planting, watering, weeding and harvesting. The advantage is that the yields/harvest from the individual's plot is theirs to keep.

Communal: "Participated in or shared by the whole community or by members of a group; owned in common; collective."¹⁸

In a communal gardening model, there is an organization that maintains the gardens and the yields are distributed amongst community. One way of distributing the yields from a communal garden is through a food box where a fee is charged and individuals receive a box with produce from that week's harvest. The communal garden model gives a bit more certainty to the consumer because they are not responsible for maintaining the garden and are less likely to end up without any yields from the garden. However, this can also be a more expensive model than traditional community gardening and can therefore not be as effective at addressing issues of food security and affordability as traditional community gardens. Depending on its set up, communal gardening can also limit the community's access to the process.

18 "communal,adj.".OEDOnline.December2019.OxfordUniversityPress.
<https://www.oed.com/view/Entry/37287?redirectedFrom=communal>
(accessed December 11, 2019).

My intention in this project is to include both community and communal modes of gardening and my primary exploration will be new ways of designing communal gardens to engage community. In order to design communal gardens in an urban environment I looked at different methods of vertical urban farming, specifically hydroponics and aquaponics.

Hydroponics: "The process of growing plants without soil, in beds of sand, gravel, or similar supporting material flooded with nutrient solutions."¹⁹

I explored a number of different hydroponic systems and determined that I am most interested in systems that can be used without any sand or gravel material allowing for light to more easily move through the system. The diagram below is of an adaptation of a lay-flat system.²⁰ It allows for growth of the plants in tubes that don't include any aggregate material around the roots. It can also be used at small scales for home use as well as large industrial scales, which lends itself well as an educational opportunity to demonstrate and encourage home systems. It requires minimal maintenance. Seedlings need to be planted and harvested like in any other hydroponic system, and then nutrient levels in the water are monitored to ensure that there are enough nutrients in the system to

¹⁹ "hydroponics,n.".OEDOnline.December2019.OxfordUniversityPress.
<https://www.oed.com/view/Entry/90059?redirectedFrom=hydroponics>
(accessed December 11, 2019).

²⁰ James Sholto Douglas, *Advanced Guide to Hydroponics (Soilless Cultivation)* (London: Pelham, 1976), p.148-149)

sustain the plant growth. It uses a pump to pump water up through the system to the plants and then is often set up so that gravity can move the water back into the tank. Another advantage with hydroponics systems is that water coming out of the system can be as clean if not cleaner than the water entering the system.²¹ This presents interesting opportunities to engage with the river or even with the water treatment facility located next to the Rosedale Power Plant.

Some possible challenges to consider in designing spaces to house hydroponic gardens is that the space must be kept quite clean. Because these environments are used to grow without the use of any pesticides, it is important to keep growing areas clean and sealed off to prevent contamination. Traditionally this has meant little public access to growing spaces. If pests are able to enter into the growing spaces, they are very challenging to control without the use of pesticides. Pollination is also another factor to consider. Depending on the types of crops being grown hydroponically, pollination may be required. This can be done by pollinating by hand or can also be accomplished by introducing bees into the system. Alternatively, many hydroponic facilities grow produce that does not require pollination, this being primarily leafy greens.

21 Swathi Chaganty, "Going Beyond Organic with Vertical Hydroponic Farming," Food Tank, January 2, 2018, <https://foodtank.com/news/2017/12/sonia-lo-crop-one-interview/>

Figure 14

Aquaponics: "A system of aquaculture combined with hydroponics, in which the effluent from the farming of fish or other aquatic animals supplies the nutrients for plants grown hydroponically, which in turn purify the water."²²

Aquaponics is a closed loop system with the plant growing component of the system working the same as hydroponics with the addition of fish. In this system the fish are fed, their waste becomes the nutrients for the plants, and the plants aerate the water to return it back to the fish tanks. The fish in aquaponics systems can also be edible species meaning that this adds another food source to the system. In particular, trout and tilapia are most commonly and successfully used in aquaponics systems. Optimum ratios of fish

²² "aquaponics, n.". OED Online. December 2019. Oxford University Press. <https://www.oed.com/view/Entry/335003?redirectedFrom=aquaponics> (accessed December 11, 2019).

to plant have been identified as 1:2 although ratios anywhere from 1:1 to 1:4 in commercial setups have been used. Another important factor is the feeding rate, approximately 1000g of feed per day will result in 10-14m² of hydroponics production. There is also generally between 10 L to 25 L of water per fish depending on the speed of water flow and quality of aeration.²³ Challenges in aquaponics and hydroponics systems are similar and remain related to pests and pollination as discussed earlier.

23 How Many Plants Per Fish to Grow in Aquaponics? [Ratio & Factors]." Leaffin, May 12, 2019. <https://www.leaffin.com/aquaponic-fish-plant-ratio/>.

CASE STUDIES

The following are a selection of case studies that I explored. The case studies fit into two primary categories, urban farming that engages community in some way, and hydroponic farming facilities that function at a large agricultural scale.

Case Study 1 – Urban Farm by Ikea and Tom Dixon

This case study most closely accomplishes the same things that I am looking to in terms of types of urban gardens and public engagement. However, at the moment it is only functioning at the scale of a booth or pavilion with the Chelsea Flower Show in May of 2019.²⁴

“It will feature a garden that is divided into two levels. The base garden will include a ‘horticultural laboratory’ where hydroponic technology will be used to grow ‘hyper-natural’ plants. The raised level – described as a ‘botanical oasis’ – will have a canopy-like ecosystem of trees and plants chosen for their medicinal, health and environmental properties.”²⁵

24 Günseli Yalcinkaya, “IKEA and Tom Dixon Announce Urban Farming Collection,” Dezeen (Dezeen, November 29, 2018), <https://www.dezeen.com/2018/11/29/ikea-tom-dixon-urban-farming-gardens/>

25 Günseli Yalcinkaya, “IKEA and Tom Dixon Announce Urban Farming Collection,” Dezeen (Dezeen, November 29, 2018), <https://www.dezeen.com/2018/11/29/ikea-tom-dixon-urban-farming-gardens/>

Figure 16

Figure 17

Case Study 2 – Paris Agropolis Farm

This project is being designed for a large roof top in Paris. The designers believe that its sheer size will make it more profitable and viable than similar projects that have been completed on smaller roof tops. It is an interesting hybrid between traditional farming and hydroponic interior farming because it uses some of the technology including aeroponics, and in vertical growing towers like interior farms, but in an uncontrolled open-air environment.²⁶ The Agropolis' aim is to lower some of the overhead costs and energy use by designing the system for an uncontrolled environment. It remains to be seen how the farmers will manage pests in this situation. Also, questions arise concerning the viability of a farm that will only be operable seasonally and is sensitive to changes in climate throughout the

26 Adele Peters, "The World's Largest Rooftop Farm Will Open Soon in Paris," Fast Company (Fast Company, August 16, 2019), <https://www.fastcompany.com/90390987/the-worlds-largest-rooftop-farm-will-open-soon-in-paris>

year. A primary aim of the project is to reconnect people with their food sources,²⁷ however it is unclear how much access the general public will have to the actually growing spaces.

Case Study 3 – Gotham Greens

Gotham greens is an example of a hydroponic urban farm that aims to create jobs within the community. It is located in Baltimore and is located on the roof of a 100,000 square-foot steel plant. "Baltimore will be the third city for the agtech startup after New York City (NYC) and Chicago. The expansion will create 60 new jobs and offer fresh greens like arugula, lettuce,

27 Eric Baldwin, "The World's Largest Urban Farm Opens Next Year in Paris," ArchDaily (ArchDaily, September 3, 2019), https://www.archdaily.com/923857/the-worlds-largest-urban-farm-opens-next-year-in-paris?ad_source=search&ad_medium=search_result_all)

Figure 19

and basil to Mid-Atlantic food co-ops, restaurants, and other food customers. The facility will use 100 percent renewable energy and recycled irrigation water.”²⁸

Case Study 4 – Crop One

Crop one is a vertical urban farming company located in Millis Massachusetts. It uses hydroponic systems, but what is most interesting about their system is that they also use a seed to harvest model, meaning that while many other companies buy third party seedlings for their hydroponic farms, Crop One is able to grow the plants in all phases in their facility. “[Crop One Holdings] vertical farming units grow modularly and use custom-engineered hydroponic systems to produce their leafy vegetables. They can substitute up to 19 acres of

²⁸ Katerina Bozhinova, “Former Steel Mill Turns into a Green Paradise,” Food Tank, August 1, 2018, <https://foodtank.com/news/2018/07/gotham-greens-expands-baltimore-viraj-puri/>

farmland with 29.72-square-meter (320-square-feet) growing units. The units use 1/2500th of the amount of water typically used by field-based growing, and due to their farms' proximity to their urban consumers, they also have a reduced carbon footprint. The COH's FreshBox Farms produce are available in 30 locations in the Greater Boston Area within the 100 miles radius from the farm."²⁹ In researching Crop One I was most interested in all of the technical components involved in their set up as well as the phases required in a hydroponic system.

Figure 20

29 Swathi Chaganty, "Going Beyond Organic with Vertical Hydroponic Farming," Food Tank, January 2, 2018, <https://foodtank.com/news/2017/12/sonia-lo-crop-one-interview/>

Based on the case studies above, my proposal will include an interior community garden with traditional modes of gardening, a communal garden using an aquaponic system, and a communal hydroponic garden that people can engage with more directly. It will be important to identify degrees of public access to maintain cleanliness within the aquaponic components of the programme while still engaging the public in all stages with public spaces around the more controlled spaces, designing new means of engagement. All of this programme will be in an interior condition to allow for use year-round. Traditional gardening methods can also be explored with the expansion of community gardens on the site following the phytoremediation of the soil.

THE ROLE OF LIGHT WITHIN THE FACILITY

I believe that a key to creating urban farming environments that are more engaging for the public is to leverage the light and the water in the hydroponics or aquaponics system in new atmospheric ways. Urban farms are typically very sterile and controlled environments with little public visibility or access.

The following set of images displays the exteriors of a number of different hydroponic facilities in North America. These are often still located out of the city and not very accessible to people in the denser urban environment. However, even when they are

geographically located more centrally within a city they are often in industrial buildings that are very closed off to the public.

Figure 22

Figure 23

Figure 21

The following images by Tom Hegen and Luca Locatelli are of existing hydroponic facilities located in the Netherlands. They are from two photography projects aimed at drawing attention to the developments made and success in regards to vertical urban farming and hydroponic farming. There is significant potential in both the unique quality of light in the interior and the opportunity for a type of beacon in an urban environment.

Figure 24

Figure 25

As you will notice in the above photographs, artificial lighting within hydroponics and aquaponics systems is often a purple hue. After doing research about the specific lighting used there is a very specific reason for this. The following graphs taken from *Lighting for Plant Growth* by Bickford and Dunn show the rate of absorption of the different wavelengths of light within the visible spectrum.³⁰ They show that monochromatic red and blue light is most easily absorbed by the plants and therefore the most efficient way of lighting plant spaces. Blue light is the most effective during early stages of plant growth and the development of foliage. Red light is most effective during later phases of growth to promote the flowering of plants. The shift in light helps to simulate the hue of natural light in more overt ways over the course of the growing season. These light changes can contribute to people's understanding of the phases of crop growth.³¹

30 Elwood D. Bickford and Stuart Dunn, *Lighting for Plant Growth* (Kent, OH: Kent State Univ. Press, 1978), p.81,121)

31 Brian Albert, "Why Do Plants Grow Better in Blue Light?," Hunker (Hunker.com, July 17, 2017), <https://www.hunker.com/13427722/why-do-plants-grow-better-in-blue-light>

As indicated earlier in this document the Rossdale flats are a significant site within the city of Edmonton. They are centrally located with a rich history contributing to Edmonton's growth over a number of centuries. The hydroponics produce a unique coloured light that can act in a beacon-like manner and give a new identity to the site as well as a strong sense of place and orientation within the city. "Color in lighting design has the distinct ability to contribute identity and orientation to a place. On a large urban scale, color can be utilized in master plans as a sort of visual compass that orients the visitor within the greater site while simultaneously highlighting places of importance."³²

In northern climates such as that of Edmonton during the winter the days become much shorter. Particularly for children in school most of the day and adults working traditional business hours it means that they see very limited daylight during the winter months. As architects, designing with fenestration able to provide ample daylight to interior spaces is important to help provide natural light to those who spend most of their days inside.³³ This design addresses these needs in the community garden arm of the building, allowing ample light in for the plants and people to enjoy. In addition, access to green plant life being grown year-round becomes an uplifting novelty amongst

32 Descottes Herv and Cecilia E. Ramos, *Architectural Lighting: Designing with Light and Space* (United States: Princeton Architectural Press, 2013), p.46)

33 Mohamed Boubekri, *Daylighting, Architecture and Health: Building Design Strategies* (Oxford: Elsevier Ltd., 2008), p.62)

the surrounding blanket of white snow. From a more clinical application Seasonal affective disorder (SAD) affects many Canadians each year. It is most commonly treated with a bright white full spectrum light.³⁴

In order to combat SAD high levels of light are required. Where there isn't enough natural light it can be supplemented with electric light. Based on a study completed in 2018 blue light, similar to that used in hydroponic lighting can be as effective as full spectrum light in treating SAD.³⁵ Thus the bright light used for the growth of the plants can also be beneficial to visitors suffering from SAD.

During her research and discussions with children in public schools using the "earthbox" Dr. Noreen Willows discussed the impact that the light had within the school spaces. Old public schools can be very dark, particularly during the short winter days. The bright full spectrum light served as a type of beacon that the children were drawn to and gathered around.³⁶ The bright full spectrum lights in addition to the natural light needed to grow the plants can become a beautiful way to draw a community together.

34 Mohamed Boubekri, *Daylighting, Architecture and Health: Building Design Strategies* (Oxford: Elsevier Ltd., 2008), p.60)

35 Ybe Meesters, Wianne B. Duijzer, and Vanja Hommes, "The Effects of Low-Intensity Narrow-Band Blue-Light Treatment Compared to Bright White-Light Treatment in Seasonal Affective Disorder," *Journal of Affective Disorders* 232 (2018): pp. 48-51)

36 Discussion with Dr. Noreen Willows, regarding her research in Community Nutrition on August 27, 2019

Figure 27

Figure 28

POWERING THE NEW FACILITY

Given the history of the site as a power plant generated by both coal and natural gas, I think it is important that in addition to sustaining the surrounding community through the food produced, the consumption of energy by the building is also carefully considered. There are two main factors in terms of energy consumption that will need to be addressed. The most energy intensive components of the system will include both the electricity needed to run pumps and LED lights for the aquaponic systems as well as the heating and cooling required to maintain a consistent temperature throughout the year. The energy required to keep the space at a relatively consistent temperature throughout the year will be most energy intensive during the winter months.

The first source of power generation is solar power located in two different locations on site. This will be achieved through traditional photovoltaic cells located on the roof of the boiler house. The second

type of photovoltaic technology used on site will be a newer technology developed specifically for large greenhouses and applications requiring high levels of light transmission. Based on research of products on the market or in late phases of research there is transparent photovoltaic glass that allows for 75% light transmission³⁷, the amount required for successful plant growth in greenhouses applications. The transparent photovoltaic glass is located on the roof and the south façade of the community garden arm. A second source of currently untapped energy is geothermal. Geothermal energy has been used in Iceland to heat greenhouses and temper fish-breeding since the 1960's.³⁸ It has created an affordable means of producing fresh produce with greenhouses that are heated and powered with geothermal energy year-round even though Iceland is in a cold and dark climate.³⁹ Although Alberta is not a traditionally rich geothermal zone, others have explored the possibility of harnessing this type of energy in previous studies of the Rosedale Flats' rejuvenation,⁴⁰ specifically, a system referred to as geothermal gradients, which on average generate 30°C increase for every kilometer

37 "Solar Glass," Brite Solar, accessed March 28, 2020, <https://www.britesolar.com/products/solar-glass/>

38 Jón Steinar Gudmundsson, "Utilisation of Geothermal Energy in Iceland," *Applied Energy* 2, no. 2 (1976): pp. 127-140, [https://doi.org/10.1016/0306-2619\(76\)90032-5](https://doi.org/10.1016/0306-2619(76)90032-5), p.127-128)

39 "How Geothermal Energy Revolutionised Iceland's Greenhouses." BBC Earth Lab, June 13, 2018. <https://www.youtube.com/watch?v=3KepmDQfEHg>.

40 Michael Zabinski. *Generating an Oasis: Architecture of Climatic Engagement for a Northern City*, (2014), p.17-18)

of drilled depth.⁴¹ As a result of Alberta's vast oil and gas sector, the required tools and knowledge to drill infrastructure for the geothermal energy systems are readily available. As the province continues to discuss the transition of its work force from fossil fuels to renewable energy sources, this project could become an example of new ways to use existing skills and resources within the province.

Water can be heated in a reservoir drilled down within the earth, and pumped up to a heat exchanger to heat water that would be circulated within the buildings systems.⁴² The warm water running through the various systems in the building also creates a stable thermal mass that can help to maintain a consistent temperature within the building.

41 Peter Gevorkian, *Alternative Energy Systems in Building Design* (New York: McGraw-Hill, 2010), p.333)

42 Michael Zabinski. *Generating an Oasis: Architecture of Climatic Engagement for a Northern City*, (2014), p.18)

Figure 29 35

Figure 30 36

DESIGN

In parallel with the research I pursued about urban farming facilities I also studied public programming that would supplement the growing spaces. In order to better understand what those public spaces could look like and accomplish I consulted a number of dietitians as well as the City of Edmonton. The community and communal farms address food production components. Following the growth of the food, mechanisms for food distribution become important. Back of house preparation spaces for the produce and a market space to sell produce on site are needed. Community kitchens for people to be able to come together to learn more about the preparation of food and a community dining hall are important to create an environment for people to share and celebrate food around a table together. Classrooms on site can be used for field trips, summer camps or evening classes so that people of all ages can come and learn more about nutrition and food production. And finally placing event spaces within the building to celebrate the unique and exciting qualities of the aquaponics will help to draw a wide range of people into the building beyond those seeking food and farming learning opportunities.

The following section describes how each of these program and design elements have come together. The primary access point of the building has been shifted to the end of the new greenhouse arm drawing people

off of the street from both the pedestrian bridge to the south and from the memorial to the north of the site into the interior community gardens. The ground level is intentionally left open to allow for markets and flow through the space. The two upper levels house community garden beds that are lit by blue and red LED lights that bleed down into the ground level as well as creating the glowing beacon effect on the site. The lights also function to extend the light during short winter days and optimize growing conditions for the community gardens. The doors have been designed to be open during the summer to let fresh air move freely through the space. The steel structure is an extension of the building's interior grid. It brings a sense of scale from the interior of the powerplant outside and it also exposes the hidden steel structure beyond the brick façade. The paved space behind the arm can be used as outdoor market space in the summer and parking in the winter, strategically located next to the grocery store. The landscape south of the greenhouse is filled with rows of outdoor community garden plots that can be tended to by community members to grow their own produce during the summer. Water moves through the greenhouse and is drained into troughs that run along the length of the community gardens. Taps are distributed regularly along the troughs for easy access to water to maintain community crops. The water runs into a larger stream along the walking path where it runs back into the river.

At this same location on the site, there are pipes that bring water overhead and back into the river via a waterfall, thus creating a grand threshold onto the site from the east side primarily accessed by pedestrians and cyclists using the network of paths along the river valley. At this same location there are also stairs that reach down to the river allowing people to engage with the river year-round.

The greenhouse leads you into the powerplant. The power plant houses two different aquaponic systems, as well as community programming. The programme has been designed to address a number of goals set out by FRESH, Edmonton's Food and Urban Agriculture study. Large vertical hydroponic columns are located to the right of the entrance. The spaces that house the crops have been specifically designed to maximize visibility while maintaining clean controlled environments for growing. They can be viewed from ground level and from the classrooms in the mezzanine of the boiler house. The outdoor roof garden can also be accessed from the boiler house mezzanine where wild food gardens are scattered amongst gathering spaces on the roof of the turbine hall.

As you pass through the boiler house and enter the turbine hall the lights from the overhead crops draw you through the water columns and into the food hall. A row of small kitchens for Startup restaurants and local chefs line the east side of the turbine hall with ample

space for seating. The light passes through the plants above, casting unique shadows below as if you were sitting under a tree. The food hall is able to support the local food economy and “enliven the public through a diversity of food activities”⁴³.

You pass through another series of water columns and enter into the community kitchen. The crops overhead, housed in clear acrylic tubes now run perpendicular to the movement through space. The kitchen spaces are located along the east wall with large preparation tables in the centre of the space available for use by the public. A range of different cooking classes can take place here which will help “provide food skill education and information”⁴⁴. This can include cooking classes for junior high and high school students in the area, introductions to cooking for university students, meal prepping for families, and a venue for new immigrants to learn about cooking with western ingredients or techniques and sharing their recipes and cooking with others in the community.

Located at the end of the turbine hall is a large event space that also opens back up to the boiler house and reveals the river.

43 City of Edmonton, FRESH Edmonton’s Food and Urban Agriculture Strategy

44 City of Edmonton, FRESH Edmonton’s Food and Urban Agriculture Strategy

The fish component of the aquaponic system is housed on the lower level, along with all other mechanical and water filtration systems. The pipes overhead distribute water between tanks, and pumps deliver water and nutrients to the plants above. The freshly aerated water from the plants circulates back into the fish tanks. As needed, water is added and removed from the system to create consistent water levels, quality and temperature.

The basement of the boiler house is also accessible to the public. It is an aquarium like experience with space to watch the fish and sit and enjoy a coffee or read a book. There are also prepping spaces to clean fish and package both produce and fish for sale located below the grocery store and loading dock at the northernmost end of the building. Their adjacency to the elevator means easy transportation up to the loading dock and grocery store for use on site or delivery to stores or homes in the city, thereby continuing to “grow local food supply and demand”⁴⁵.

45 City of Edmonton, FRESH Edmonton’s Food and Urban Agriculture Strategy

1 SITE PLAN

Figure 31

Figure 32 43

Figure 33 44

BASEMENT PLAN

Figure 34 45

Figure 35

Figure 36

CONCLUSION

Over the course of the past year I have explored the history of the Rosedale power plant and its potential to become a hub within the community for food growth, distribution, education and consumption. The design carefully considers the intervention within in the context of the city in a number of ways, including its integration into the city's river valley network, as a beacon in the core, and as an infrastructural element in its mission to improve urban agriculture. As someone who was raised in Edmonton and has been able to explore a number of different cities since pursuing my educational career in architecture, this thesis has become an opportunity for me to revisit my roots and learn more about the places and people that surrounded me during my most formative years. It also reflects the aspirations that I have for the future of the city as it continues to evolve, in honouring its industrial roots and becoming a leader in sustainable design and supporting new ways to come together as a community.

SCENARIOS

The following stories represent 8 of many different possible users of the site.

Molly is a grade 3 student from Grandin Elementary School in downtown Edmonton. Her class is visiting the Rossdale Building for the day for a field trip. Their bus drops them off behind the community garden and they start their day by helping to plant some seeds in one of the community-garden beds. After they walk through the rest of the community gardens, they enter into the boiler house and head into the food hall for lunch as a group. After lunch they head upstairs to the classrooms, there they learn more about the hydroponics in the building as they look out onto the vertical hydroponic columns. After their chat in the classroom Molly and her classmates head out to the rooftop garden where they pick from the berry bushes and play games as a

Figure 37 49

group in the open spaces before heading back home at the end of the day. Molly has been really excited for this field trip because her older brother Derrick is in grade 7 and comes to the building every week for foods class. He always tells Molly how much he loves visiting the building, and brings home the dishes that he made that day to share with his sister.

As Derrick and his classmates get off the bus, they hurry from the cold dry winter air into to the delightful contrast of warmth and humidity that greets them beyond the door of the greenhouse community gardens. As they cross into the boiler hall the students are drawn around the corner by the smell of the food in the food hall and community kitchen beyond where they meet their instructor for the afternoon. Each week they spend the afternoon learning new cooking techniques and preparing a new recipe using the community kitchen

Figure 38 50

Figure 39

facilities on site. Once a month, the students meet with one of the farming staff to pick some of their own produce for that day's recipe.

Amira immigrated to Canada last year, she lives with her partner and two children in North Edmonton and comes to the building regularly for community cooking and meal prep classes. Amira has met a number of other parents from the area and it has helped her develop a new community in Edmonton. There are families from a number of different neighbourhoods and ethnic backgrounds that are able to share their unique recipes and cooking techniques. Amira is hoping that next summer she will be able to have her own plot in the community gardens outside to grow some of her own produce as well. Her family also qualifies for a subsidized food box that includes fresh produce and fish that is delivered to her home weekly.

Figure 40

Daniel and his partner live in a condo downtown. They love their downtown lifestyle but have always wanted to be able to grow more of their own food. This year they entered the lottery to be able to use a plot at the Rossdale Power Gardens and were successful in their application. They come a couple of times a week to maintain their garden. The taps along the trough provide easy access to water for the crops. The intricate metal panels protect their food from animals living along the river. The sound of the water flowing along the trough's creates a soothing auditory backdrop while they do their planting and harvesting. The lights strung overhead and the glow of the greenhouse behind create a beautiful ambience when they walk amongst the gardens in the evening. After they have finished taking care of their plot for the day, they often 52

Figure 41

spend time grabbing a coffee from the café in the old pumphouse and enjoying the views of the North Saskatchewan River.

Martha is a senior who lives independently in a nearby condo. She loves to walk along the river valley and often stops at the Rossdale Power Garden for a coffee or lunch and to meet with friends. She also enjoys picking up fresh fish and produce from the market during the week. On the weekends she brings her grandchildren to the market where they shop from a variety of local vendors and she spoils them with a sweet treat.

Cheng just graduated from the University of Alberta's Bachelor of Design program. He is starting up his own business and often spends his days working at the Rossdale Power Gardens. The large tables in the prep space of the community kitchen are often free during

Figure 42

the day and make for a perfect, well lit work space. As he sits and works in the community kitchen, he is enveloped with the smell of the produce being grown above and wafting through the screen overhead. When he is looking for a change of scenery he heads down to the café in the aquarium and works with a fresh cup of coffee surrounded by the glow of the fish tanks. He often grabs lunch upstairs from the food hall and picks up a few groceries from the store before he heads home for the day.

Adam and Sarah are celebrating their wedding at the Rossdale Power Gardens. Their ceremony is set at the south end of the Boiler House with the light from the south pouring in though the windows and in front of the backdrop of towers of greenery. Following the ceremony, the smell of dinner draws their guests into the Turbine Hall where they sit under the purple

grow lights overhead and share a meal. The couple and their wedding party go outside to take pictures in front of the waterfall. Meanwhile the event spaces are converted into a grand party space. As the sun sets the purple glow of the interior intensifies and the music grows louder. The doors of the event space open up to the river beyond letting in the fresh air. The couple and their friends and family dance well into the night celebrating their union. They spill out onto the patio enjoying the crisp evening air, the fresh smell of the gardens, the soothing sound of the waterfall, and beauty of river beyond.

Figure 43 55

BIBLIOGRAPHY

- Albert, Brian. "Why Do Plants Grow Better in Blue Light?" Hunker. Hunker.com, July 17, 2017. <https://www.hunker.com/13427722/why-do-plants-grow-better-in-blue-light>.
- Baldwin, Eric. "The World's Largest Urban Farm Opens Next Year in Paris." ArchDaily. ArchDaily, September 3, 2019. https://www.archdaily.com/923857/the-worlds-largest-urban-farm-opens-next-year-in-paris?ad_source=search&ad_medium=search_result_all.
- Bickford, Elwood D., and Stuart Dunn. *Lighting for Plant Growth*. Kent, OH: Kent State Univ. Press, 1978.
- Boubekri, Mohamed. *Daylighting, Architecture and Health: Building Design Strategies*. Oxford: Elsevier Ltd., 2008.
- Bozhinova, Katerina. "Former Steel Mill Turns into a Green Paradise." Food Tank, August 1, 2018. <https://foodtank.com/news/2018/07/gotham-greens-expands-baltimore-viraj-puri/>.
- Chaganty, Swathi. "Going Beyond Organic with Vertical Hydroponic Farming." Food Tank, January 2, 2018. <https://foodtank.com/news/2017/12/sonia-lo-crop-one-interview/>.
- City of Edmonton, Food and Urban Agriculture Advisory Committee. *Fresh Edmonton's Food and Urban Agriculture Strategy*. 2012
- City of Edmonton. *River Crossing Business Plan*. 2019
- City of Edmonton. *Rossdale Historical Land Use Study*. Edmonton: Commonwealth Historic Resource Management Ltd., 2004.
- Descottes Herve, and Cecilia E. Ramos. *Architectural Lighting: Designing with Light and Space*. United States: Princeton Architectural Press, 2013.
- Gevorkian, Peter. *Alternative Energy Systems in Building Design*. New York: McGraw-Hill, 2010.
- Gudmundsson, J, and J Gudmundsson. "Utilisation of Geothermal Energy in Iceland." *Applied Energy* 2 (April 1, 1976): 127–140. <http://search.proquest.com/docview/22729706/>.
- "How Geothermal Energy Revolutionised Iceland's Greenhouses." BBC Earth Lab, June 13, 2018. <https://www.youtube.com/watch?v=3KepmDQfEHg>.
- Marshall, Debbie, and Heather Marshall. *Candles to Kilowatts: The Story of Edmonton's Power Company*. Edmonton: Duval House Pub., 2002.
- Meesters, Ybe, Wianne B Duijzer, and Vanja Hommes. "The Effects of Low-Intensity Narrow-Band Blue-Light Treatment Compared to Bright White-Light Treatment in Seasonal Affective Disorder." *Journal of Affective Disorders* 232 (May 2018): 48–51.
- Mintz, Corey. "Too Many Kids in Ontario Are Food Illiterate - and It's Costing Us Big." TVO.org, November 25, 2019. <https://www.tvo.org/article/too-many-kids-in-ontario-are-food-illiterate-and-its-costing-us-big>.

- Peters, Adele. "The World's Largest Rooftop Farm Will Open Soon in Paris." Fast Company. Fast Company, August 16, 2019. <https://www.fastcompany.com/90390987/the-worlds-largest-rooftop-farm-will-open-soon-in-paris>.
- "Prairie Sky: Urban Gondola Edmonton." Prairiesky. Accessed December 19, 2019. <https://www.prairieskygondola.com/>.
- Sholto Douglas, James, 1920. Advanced Guide to Hydroponics (Soilless Cultivation). London: Pelham Books, 1976.
- "Solar Glass." Brite Solar. Accessed March 28, 2020. <https://www.britesolar.com/products/solar-glass/>.
- Staff, Editorial. "How Many Plants Per Fish to Grow in Aquaponics? [Ratio & Factors]." Leaffin, May 12, 2019. <https://www.leaffin.com/aquaponic-fish-plant-ratio/>.
- "Transparent Solar Panels." n.d. United Kingdom. Accessed March 28, 2020. <https://www.greenmatch.co.uk/blog/2015/02/transparent-solar-panels>.
- Yalcinkaya, Günseli. "IKEA and Tom Dixon Announce Urban Farming Collection." Dezeen. Dezeen, November 29, 2018. <https://www.dezeen.com/2018/11/29/ikea-tom-dixon-urban-farming-gardens/>.
- Zabinski, Michael. Generating an Oasis: Architecture of Climatic Engagement for a Northern City, 2014.