Delandfill
Reclaiming Ontario's Closed Landfill Sites

by
Andrea Gail Murphy

A thesis
presented to the University of Waterloo
in fulfillment of the
thesis requirement for the degree of
Master of Architecture

Waterloo, Ontario, Canada, 2013

AUTHOR’S DECLARATION

I hereby declare that I am the sole author of this thesis. This is true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

ABSTRACT

There are over one thousand closed 'small' landfills in Ontario, each with differing circumstances and potential problems. This project proposes a method of addressing such dormant sites in situ, based upon a case study in Hamilton.

Of the four closed landfills within Hamilton city limits, three of them lie in the low lands of the Red Hill Creek Valley. Perched at the source of the Red Hill Creek, the Upper Ottawa Street Landfill introduces unspoken toxins into the ecosystem of the entire valley. As the storm water catchment for the escarpment watershed, the creek serves a critical role in the recreational green belt which divides Hamilton and Stoney Creek. The source of this creek must be celebrated, not fenced off from public access due to landfill hazards.

This proposal investigates beyond material recovery, into the possibilities of resource, ecosystem, and community recovery. Landfill mining, material sorting, and power generation through incineration are employed to reduce landfill volume. As the landfill is consumed, a new landscape is constructed, providing improved flood-prevention at the creek and a sanitary lined landfill for those materials remaining on site.

Creek, forest, and field habitats are restored on site without the threat of contamination from landfill contents. The public can safely view the landfill mining operations from an elevated walkway, having new experiences with every visit. As the boundaries of the closed landfill are stripped away, the source of the Red Hill Creek and the new recreational parkland are made publicly accessible.

Using this design as a reference, the equipment and operations designed for this site can be developed into a province-wide proposal.

ACKNOWLEDGEMENTS

Maya Przybylski, you have gone above and beyond the responsibilities of a supervisor for me, and for that I am extremely thankful. Your thorough review, constant encouragement and productive suggestions have been invaluable to the production of this thesis. Thank you for letting me geek out. And Juno Cohen, thank you for allowing me to intrude into your first months of life.

Terri Meyer Boake, thank you for taking on more than a typical committee member role for me, and being available with feedback when Maya was occupied. Val Rynnimeri, your rich list of precedents has grown my design imagination beyond just the work in this book.

AL, SN, JT, EM, CA, you have been the support system that has kept me grounded through this entire experience. For the laughter, the tears, and the oft-needed encouragement, I thank you.

Dad, thank you for encouraging this little girl's curiousity, for answering her tough questions about how things work, and for discussing complex problems around the dinner table. You have inspired my problem solving skills and taught me to not be afraid to take on big challenges. Thank you, Mom and Dad, for setting the bar high.

DEDICATION

This work is for the generation who will one day dig up my garbage, and find it valuable.

TABLE OF CONTENTS

LIST OF FIGURES

1

INTRODUCTION

"*If our garbage, in the eyes of the future, is destined to hold a key to the past, then surely it already holds a key to the present*." [1]
William Rathje & Cullen Murphy
RUBBISH! What our garbage tells us about ourselves

For as long as there have been human settlements, there has been waste. When dropping trash on the ground became a hazard, landfills were created outside of town as a destination for the unwanted garbage. [2] This method of waste management has been modified and perfected throughout the years into the mega landfills of today.

Landfilling has changed the topographies of thousands of sites across the globe. Most notably, in North America, where land is almost as plentiful as garbage, landfills have grown to be size of cities themselves. [3] These monstrous landfills have effected environments across the continent, while millions of tonnes of buried materials prevent the public from accessing closed sites within their own neighbourhoods. The study of the social performance, resource content, and environmental hazards of closed landfill sites informs how we address these dormant mountains in our own backyards. The following research and design proposal uses these themes to understand the current state of closed landfills, and to develop a valid strategy to remediate and reoccupy closed landfills sites.

THE WASTE CRISIS

The surface of the earth is finite, at about 150 000 000km^2. [4] The population, however, continues to boom past seven billion people, each producing garbage at a unique rate. Depending on the population density, each country responds to their waste in a different fashion.

fig. 1.01 plaque celebrating the rehabilitation of the West Hamilton Landfill

fig. 1.02 the waste crisis exhibited in overflowing garbage cans

Those regions of the world with sparse populations and vast quantities of inarable land often resort to landfilling, whereas densely populated regions with limited areas of land are more creative with disposing of their garbage. No matter how the waste is addressed, the increasing quantity of garbage worldwide simply does not have anywhere to go.

Source reduction methods are prevalent in North America, where the phrase “reduce, reuse, recycle” has been in the public conscience for nearly twenty years. With the integration of the organics program into existing dual-stream recycling programs in regions of Southern Ontario, landfill-bound residential garbage has dropped significantly in volume. [5] Institutional, commercial, industrial, and construction wastes, however, remain bulky and have barely responded to source reduction. [6] As the continent becomes more densely inhabited, the areas appropriate for landfilling dwindle in number. In desperation, we have turned to filling closed mines or barren chasms with compacted garbage, and even sunk barrels of waste in the ocean. Despite these measures, hiding our garbage out of sight is simply not as easy as it once was.

Densely populated regions of the world, like Europe and Asia, utilize incineration and other post-collection volume reduction tactics to control their garbage crises. Where landfilling is not a realistic option, volume reduction is critical in order to keep disposal sites compact. In countries where labour is inexpensive, hand-sorting recyclable goods and deconstructing mixed-material goods is not unusual. The expense of storing waste where the cost of land is extremely high leads to some of the most comprehensive waste reduction strategies worldwide.

The alarming quantity of trash produced annually is addressed by a variety of methods, each with their own rationale, advantages, and disadvantages.

fig. 1.03 large-scale litter

fig. 1.04 failing landfill cap

fig. 1.05 monitoring access points

fig. 1.06 abandoned home

fig. 1.07 visitors prohibited

fig. 1.08 Hamilton's landfill-focussed signage

Depending on local geology, water table depth, climate, value of land, environmental restrictions, or emissions regulations, communities have dealt with their trash in a way all their own. It is through studying these strategies that hybrid strategies can evolve. As we evaluate the successes and failures of waste disposal internationally, new methods can be developed with our improved knowledge.

Every year a greater global population produces a greater amount of garbage, increasing the severity of the crisis. We must apply critical thinking and creative problem solving to the issues of waste reduction and waste treatment starting today.

The complexity of closed landfill sites lies in their multiple challenging conditions which require individual attention. Three main characteristics of closed landfills have been identified here as a way to target the greatest issues facing potential rehabilitation: their social underperformance, potential resource value, and environmentally hazardous conditions.

SOCIAL PERFORMANCE

Landfills that were once on the outskirts of town are now part of suburban communities. Residents often live in ignorance of the true nature of the mute landscape within their neighbourhood. Recreational parks on the surface of closed landfills are an opportunity for education which is often overlooked. More often, the dangerous nature of closed landfills requires them to be fenced off from public access and forbidden to visitors. This void of activity within a community can divide and segregate residents within a greater neighbourhood, or encourage inquisitive adventurers to seek mischief on an unstable site.

RESOURCE VALUE

"Nothing goes in or out of our planetary system except for heat and the occasional meteorite. Otherwise, for our practical purposes, the system is closed, and its basic elements are valuable and finite. Whatever is naturally here is all we have. Whatever humans make does not go "away".

If our systems contaminate Earth's biological mass and continue to throw away technical materials (such as metals) or render them useless, we will indeed live in a world of limits, where production and consumption are restrained, and the Earth will literally become a grave.

If humans are truly going to prosper, we will have to learn to imitate nature's highly effective cradle-to-cradle system of nutrient flow and metabolism, in which the very concept of waste does not exist." [7]

William McDonough & Michael Braungart
Cradle to Cradle: Remaking the Way We Make Things

What we have buried in landfills, is the very nutrients we need in order to survive. There can be no wasted materials, rather, they must be fed back into the material cycle since our resources on Earth are finite. The current design of products to be deconstructed and recycled is the forward-thinking design which will benefit future generations. However, we must also address the products of the past, the ones we have thrown away and buried in landfills. Though it might not be as high-tech as modern cradle-to-cradle product design, landfill mining for material resources is an extension of this widely accepted practice.

The rapid adoption of community curb side recycling and organics collection is a testament to our current desire to reclaim material. But to be truly effective, this proactive passion must be balanced with retroactive action, to address our years of buried

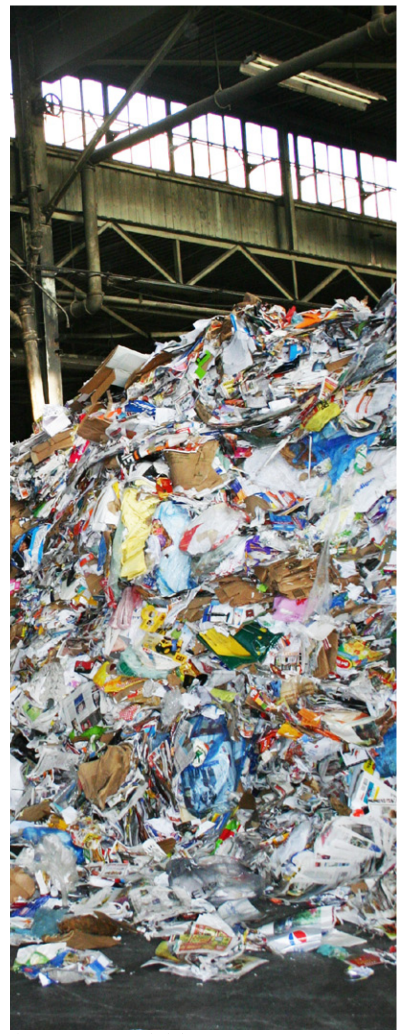


fig. 1.09 recyclable resources

material resources. Material, financial, and physical resources spent on the material recovery process today can only redeem those materials which are currently accessible to the cycle. Our efforts have limited reach without seeking out the landfilled recyclable materials.

The value of these materials have varied over time, but based on the quantity estimates of the Garbage Project (Discussed in Chapter 3), and the current dollar value of a tonne of any given recycled material, potential profit calculations can be completed. Data collected on the value of recycled goods is collected annually and tracked by organizations like Reclay StewardEdge. [8] Each landfill, depending on volume and date of conception and date of closure will be be worth more or less, but the calculations are relatively straight-forward. The analysis has been done for the Upper Ottawa Street Landfill as part of a budget analysis for the design in Chapter 6. The results of this analysis are remarkable: the potential value of buried recyclable materials greatly exceeds the expense of the excavation and sorting process. (See Appendix 1)

fig. 1.10 landfill-adjacent wetland

fig. 1.11 Visitor protection signs

ENVIRONMENTAL HAZARDS

Early landfills were placed straight onto soils or bedrock, often without any kind of liner material to prevent the migration of contaminants from the garbage into the environment. Even with regular maitenance and well-sealed caps, these sites continue to leak liquid matter into the surrounding earth, endangering local groundwater reserves. [9] Surface contamination through erosion and failing cap seals also threatens local ecologies with loose trash or toxic materials. Wetlands have often been the dumping site of trash and municipal waste. In these delicately balanced environments, the introduction of garbage destroys valuable habitat and contaminates gallons of water downstream. The influx of water into the base layer of landfills feeds the uncontrolled

fig. 1.12 cardboard arriving at a material recovery facility

movement of toxins beyond the known perimeter of the landfill site. Without engineered liners, landfills continue to endanger water and land quality as well as bespoil the habitats of animals and plants.

DESIGNING AN OPERATION

Our closed landfills are in a state of crisis. Inspired by their underperformance in communities, their exploitable resources, their need for remediation, and their large quantities, this thesis proposes a designed landfill reclamation operation. To address these conditions, there exist current techniques which are practised independently of each other to resolve parts of the waste crisis. By studying the strengths of these strategies and combining them into a hybrid operation, program opportunities arise for the community, environmental health will improve, and material resources are retrieved.

This thesis proposes to resolve an issue in the most complete and proactive manner, unlike the current passive maitenance methods applied to closed landfills today. Even progressive landfill reuse designs like Freshkills Park in New York leave the garbage in place, and allow the base conditions to go unchecked for years to come. The comfortable municipal response of soccer fields and baseball diamonds is a safe way to address the accessibility concern on closed landfill sites, but fails to respond to the tonnes of waste below the feet of local athletes. Sub-terranian contamination is illegible on the surface of a closed landfill. The value of the recyclable materials buried is not a small sum. The design response to the whole landfill, and all that is buried in it, not just the top surface, is what this thesis undertakes.

The design of the operations is a generic strategy which can be enacted on any of the many closed landfill sites in North America. However, to give the design a sense of site and thoroughly investigate the hybrid technique, the Upper Ottawa Street Landfill in Hamilton, Ontario was selected. This closed landfill represents a generation of sites which operated between the 1950s and the 1980s, receiving mostly residential waste, but also some commercial and industrial garbage. The large capped mound of garbage sits alongside the source of the Red Hill Creek, a vital recreational and environmental corridor within the Niagara Region. Closed off by perimeter fencing, the landfill rises high above the adjacent residential neighbourhood, denying the community access to the creek. This site meets the conditions of a closed landfill which requires urgent intervention.

STRATEGIES

The main strategies employed in the hybrid operation are:
LANDFILL MINING: to reclaim materials, access the base levels of contamination in the landfill, and truly decontaminate the site, the entire mound of garbage is excavated and mined for recyclables
MATERIAL RECOVERY: to sort recyclables, materials for incineration, materials for re-landfilling, and materials which are anticipated to be recyclable in the foreseeable future allows the volume of re-landfilled materials to be reduced and revenue to be gained from the recyclables
WASTE-TO-ENERGY INCINERATION: to incinerate selected materials into ash, producing high temperatures, therein heating a boiler to generate power fed back into the municipal grid for profit
LANDFORMING: to create a landscape overtop of the re-landfilled materials which will accommodate the natural systems on site as well as community spaces
COMMUNITY EDUCATION: to provide the visiting public an experience of the garbage mining and material recycling process, the landfilling and landforming processes, and a recreational trail across the site during operations

ECOSYSTEM REHABILITATION: to encourage wildlife to flourish on a previously barren site without risk of contamination or mutation, inviting the visitors to celebrate viewing the habitat.

SYNTHESIS

The combination of these strategies into a hybrid technique spans seasons and years. The phasing of the operations align with certain program elements through time, creating unique oportunities for interaction between users. For example, the infrastructure for mining the site provides the safe passage of visitors across the site, which in turn allows for educational views and experiences. The site appears different with each visit, in each season, in each phase, and beyond into the years of ongoing park use.

Returning to the wider utility of the system designed to complete this operation, the equipment used on this site is suitable for transportation to another closed landfill for continued use. In this way, a city or a region might use the same strategy and a fleet of similar equipment to mine the resources and reclaim the spaces currently occupied by closed landfills.

It is hoped that through this exploration, a viable method for landfill rehabilitation is uncovered. Its application on a specific site will display the unique potentials of the method at one location, while sparking the public imagination to hypothesize on the further potential of closed landfill sites. Above all, it is intended that this work would challenge the status quo of waste management strategies today, and inspire new thinking about how cities address their closed landfill sites.

NOTES

1. Rathje, William, and Cullen Murphy. 1992. Rubbish! The Archaeology of Garbage. New York: HarperCollins. p11

2. Rathje, William, and Cullen Murphy. 1992. Rubbish! The Archaeology of Garbage. New York: HarperCollins. p33

3. Tammemagi, Hans. 1999. The Waste Crisis. New York: Oxford University Press. p6

4. American Scientific. 1999. Science Desk Reference. New York: Wiley. p180

5. Environmental Commissioner of Ontario. 2011. What a Waste: Failing to Engage Waste Reduction Solutions. Engaging Solutions, ECO Annual Report, 2010/11, Toronto: The Queen's Printer for Ontario. p91-97

6. Westerhof, Jake, interview by Author. 2011. Canada Fibres Ltd. Hamilton Site Visit (October 4).

7. McDonough, William, and Micheal Braungart. 2002. Cradle to Cradle: Remaking the Way We Make Things. New York: North Point Press. p103-104

8. Reclay StewardEdge. 2013. "The Price Sheet." Reclay StewardEdge: Product Stewardship Solutions. Accessed March 11, 2013. http://stewardedge.ca/pricesheet/.

9. Tammemagi, Hans. 1999. The Waste Crisis. New York: Oxford University Press. p7

2

ONTARIO'S LANDFILLS: A CHRONIC CONDITION

Years of depositing our trash in landfills has resulted in alarming numbers of closed landfills across the province; many act as a barrier to community and ecological development. The contaminants and toxins buried in landfills pose a hazard when they rest upon failing or non-existent liners. The materials buried under the sealed landfill cap are valuable resources, as recyclable goods and landfill gas fuel. The key characteristics of closed landfills are:

•they are **NUMEROUS**, tallying over a thousand strong in Ontario

•they are **UNDERPERFORMING**, sitting as vacant zones within a city, or only providing seasonal use as sports fields

•they are **DANGEROUS**, containing unknown toxins, perched upon failing or non-existent liners

•they are **EXPLOITABLE**, containing material resources and landfill gasses.

NUMEROUS LANDSCAPES

Over a thousand closed 'small' landfills in Ontario are currently being monitored by Landfill Inventory Management Ontario, (LIMO). [1] These range in location from rural communities to suburban neighbourhoods, some are even nestled in the hearts of cities. The contents of these landfills are equally various, from agricultural to residential to industrial. The Ministry of the Environment regulations require closed landfills to be constantly maintained and receive exhaustive check ups twice a year. Surface testing and visual diagnostics confirm the relative safety of closed sites, but due to such a range in character, limited financial and human resources, individual attention is not always given. [2]

fig. 2.01 illegal dumping: bagged

NUMEROUS

There are 1325 closed small landfills in Ontario

The images on the opposite page are just a small assortment of the many closed landfills near residential neighbourhoods within Ontario. (Figures 2.02-2.10) The sheer number of sites which need to be addressed requires a generally applicable solution which is able to adapt to the specific needs of any given community. Sites on creeks, near ecologically significant areas, or even those containing known toxins, all need to be treated and rehabilitated in a unique manner. A single method to reclaim closed landfills must recognize the diversity of site situations, while encouraging the reuse of equipment and infrastructure on several sites.

UNDERPERFORMING LANDSCAPES

Especially in cities where land is a precious commodity, landfilling is simply not a viable solution to garbage. As Canadian cities expand, and the suburbs reach the old outskirts of town, closed landfills will inevitably begin to be incorporated into the fabric of the community.

A closed landfill is a volatile landscape consisting of a surface cap covering years of compacted garbage, rising in mounds above the natural surface of the earth. The erosion of the cap due to runoff of the sloping surface is an ongoing maintenance concern. To prevent further erosion from foot traffic or motorized vehicles, most closed landfills are inaccessible to the public.

The necessity of limiting access to closed landfills is not to be denied so long as the surface condition of the sites remains critical. However, pockets within communities cannot remain fenced-off and inaccessible dead zones. If the nature of the topography were to stabilize in whole or in part, these spaces could once again be accessible.

UNDERPERFORMING

Closed landfills in their current state are limiting the productivity and growth on site for both visitors and wildlife.

fig. 2.02 Former West Hamilton Landfill, Hamilton

fig. 2.03 Eastview Landfill Site, Guelph

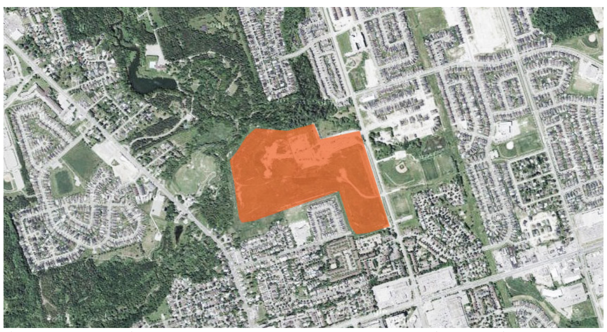


fig. 2.04 Durham Waste Management Facility, Oshawa

fig. 2.05 Riverdale Park West, Toronto

fig. 2.06 Closed Landfill Site, Cornwall

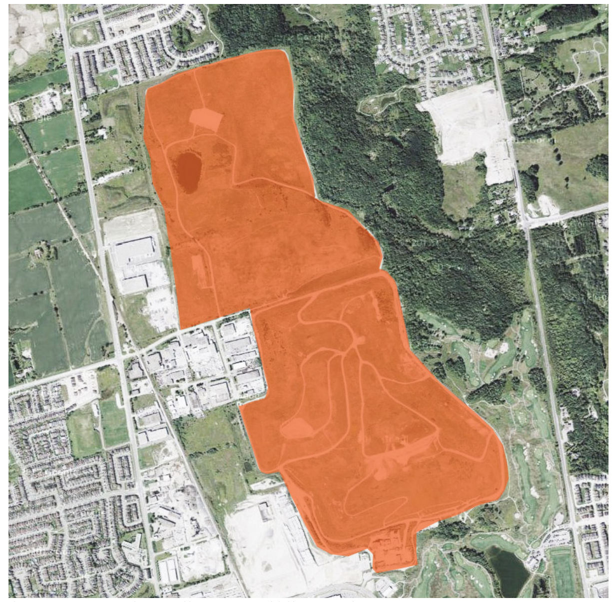


fig. 2.07 Keele Valley Landfill, Maple

fig. 2.08 Thackeray Conservation Lands, Toronto

fig. 2.09 Rennie and Brampton Street Landfills, Hamilton

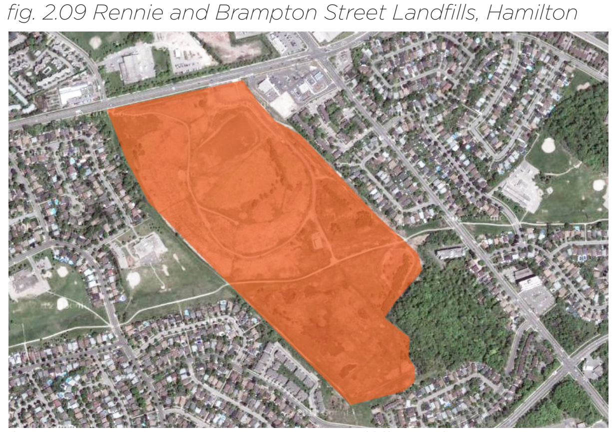


fig. 2.10 Former Ottawa Street Landfill, Kitchener

CLOSED LANDFILL SITES

exist in communities across Ontario, as forbidden zones or recreational parkland. These examples highlight the issue of adjacency when neighbourhoods surround closed landfills. (relative scale)

fig. 2.11 illegal dumping: tires

DANGEROUS

Landfills were often built on sedimentary bedrock which is known to be porous, making an unsuitable leachate seal.

As part of a greater neighbourhood, a closed landfill site provides little or no amenity as a bare open space. Restrictions on public access may allow greater wildlife presence on site, but contaminants threaten the quality of the habitat. Visitors cannot enjoy the landscape or put it to any use as a community space. As a piece of an ecosystem, a closed landfill introduces contaminants into the system, endangering flora and fauna on site and in the greater region. Closed landfills in their current state are limiting the productivity and growth on site for both visitors and wildlife.

DANGEROUS LANDSCAPES

The base liner of a landfill is the single most important component in a sanitary landfill today. In 1991, the US EPA legislated that no new landfill should have less than six layers of base protection including a comprehensive leachate collection system. [3] Leachate is the liquid matter which leaches out of the bottom of a landfill, composed of organic compounds, heavy metals, and various other substances. [4] Unfortunately, landfills built previously were often built on bedrock or on bare soil, allowing leachate from decomposing waste to flow freely into the surrounding earth. Dense soils like clay or impervious geological formations combined with a low water table can be a sufficient natural leachate barrier in unlined landfills. However, roughly half of Ontario has sedimentary bedrock which is known to be porous, making an unsuitable leachate seal.

While the surface cap is reviewed annually, the inaccessible conditions at the bottom of a landfill cannot be maintained. Old sealed sites without an engineered liner are very likely contaminating adjacent soils. Without proactive measures, leachate may continue to mingle with ground water without any indication on the surface. Many of these landfills are in proximity to residential areas, causing elevated toxicity levels in neighbourhoods province-wide. Immediate and aggressive action would be necessary to install a proper liner in a closed landfill.

EXPLOITABLE LANDSCAPES

The contents of a closed landfill are greatly unknown, especially in older, less documented areas. Depending on the breakdown of materials, the value of the buried waste could be estimated in terms of recyclable materials and power generation potential.

The Garbage Project, completed by researchers in the United States, excavated and studied several operational and closed landfills across the US. [5] From this data, it can be estimated that, with our current material recovery facilities, over half of the volume of a closed landfill could be processed and reintroduced to the modern material cycle. This reclamation of materials which were once buried is precisely why this process is known as landfill mining and is practiced internationally with great success.

Landfill mining is not a common method of waste reduction in North America, however, it is not unheard of. At least six American Landfills had been mined to reduce their footprint and waste volume as well as reclaim soils used for daily cover. [6] While gaining access to failing or nonexistent liners, the efforts of removing the waste buried at a closed landfill can expose valuable recoverable resources.

Not every scrap of excavated garbage is recyclable, however. The potential energy of the materials remaining can be estimated based on the anticipated contents of the waste. After removing recyclable and biodegradable materials, some plastics will remain, which have a high mass to energy conversion upon combustion at 13000 btus/lb. [7] Along with construction materials such as old lumber and petroleum-based industrial wastes, the incineration of the mined materials could generate a significant amount of power.

EXPLOITABLE

Over half of the volume of a closed landfill could be processed and reintroduced to the modern material cycle.

fig. 2.12 failing cap at Brampton St. Landfill, Hamilton, Ontario


fig. 2.13 eroding cap at Brampton St. Landfill, Hamilton, Ontario

THE BOTTOM LINE

As the population continues to grow, Canada's waste diversion strategies must profoundly reduce the volume of incoming materials at operational landfills. We now recognize that burying our waste is not a sustainable practice, yet the garbage of previous generations remains untouched, unsorted, and unreachable in closed landfills. The excavation of recyclable materials and their subsequent reintroduction into the material stream is an inevitability. However, until the capital cost of new material prohibits manufacturing from virgin resources, the environmental cost of landfilling trash will be overlooked. The human cost, however, betrays the urgency of the problem. If we persist in our suburban expansion, contaminated closed landfill sites will endanger the wellbeing of neighbourhoods nation-wide.

It is only when we combine the expenses of material, environment, and human health that the crisis is fully understood. The value of the land, once considered less than ideal, is not yet high enough for landfill mining to be a profitable venture. However, when one considers the environmental dangers of liner-less landfills and the potential material and energy value of the waste buried, perhaps the numbers may begin to add up.

NOTES

1. Ontario Ministry of the Environment. 2010. “Landfill Inventory Management Ontario.” Landfill Sites-Ministry of the Environment. October 13. Accessed January 3, 2012. http://www.ene.gov.on.ca/environment/en/monitoring_and_reporting/limo/landfills/index.htm.

2. McKee, Alan, interview by Author. 2011. Upper Ottawa Street Landfill Site Visit (October 13).

3. Tammemagi, Hans. 1999. The Waste Crisis. New York: Oxford University Press. p97

4. Ibid. p107-108.

5. Rathje, William, and Cullen Murphy. 1992. Rubbish! The Archaeology of Garbage. New York: HarperCollins.

6. Strange, Kit, and Dean Petrich. n.d. “Landfill Mining.” Environmental Alternatives. Accessed October 18, 2011. http://www.enviroalternatives.com/landfill.html.

7. Clarke, Marjorie J., Marten de Kadt, and David Saphire. 1991. Burning Garbage in the US. New York: INFORM, Inc. p44

3

THE EXISTING SOLUTIONS

The status of landfills as exploitable, dangerous, and underperforming sites has been challenged by several initiatives practised today. Each approach addresses one portion of the landfill's identity, as a resource, a hazard, or a brownfield. In understanding these existing initiatives, the final design is developed, combining the strengths of each to eliminate the weaknesses of others.

EXPLOITABLE RESOURCES
The Garbage Project: Landfill Contents
Landfill Mining Operations
Material Recovery Facility Design
Garbage Incineration: The Hot Topic

DANGEROUS HAZARDS
Closed Landfill Contaminants

UNDERPERFORMING BROWNFIELDS
Closed Landfill & Waste Reuse Case Studies
Contaminated Site Redevelopment Case Studies

EXPLOITABLE RESOURCES:

THE GARBAGE PROJECT: LANDFILL CONTENTS

Archaeologists have been revelling in the trash heaps of ancient human settlements for decades. Studying what a people chooses to rid themselves of betrays everything from community values and diet to burial practices and religious beliefs. It is through this now commonly accepted practise that the notion of studying modern closed landfills came into practise at the University of Arizona.

In order to better understand our current anthropological condition, The Garbage Project team was created. Beginning in 1987 the team excavated core samples at a number of operational and closed landfills across the United States. [1] The data collected and commentary on the same became part of a number of publications and academic works by various members of the Garbage Project team. A great deal of the knowledge gathered was unexpected, or contrary to widely accepted stereotypes. Thus, in 1992, Rathje and Murphy published the book "Rubbish! The Archaeology of Garbage" for public circulation. Written in highly readable prose, the book successfully entertains and educates while it puts an end to many misconceptions about modern landfills. Unlike several other "doom and gloom" publications about garbage production in North America, the anthropologists provide insight into the human behaviours that have resulted in our current condition, and propose behavioural modifications to curb our mania for disposal. This calm practical approach to the material is refreshing to read and a welcome addition to the collection of works addressing the garbage crisis.

fig. 3.01 sketches of landfilled goods: appliances, fixtures, tires, and industrial wastes

EXPLOITABLE

Quantifying the value of recyclable goods and potential energy within a landfill... is a critical step towards change.

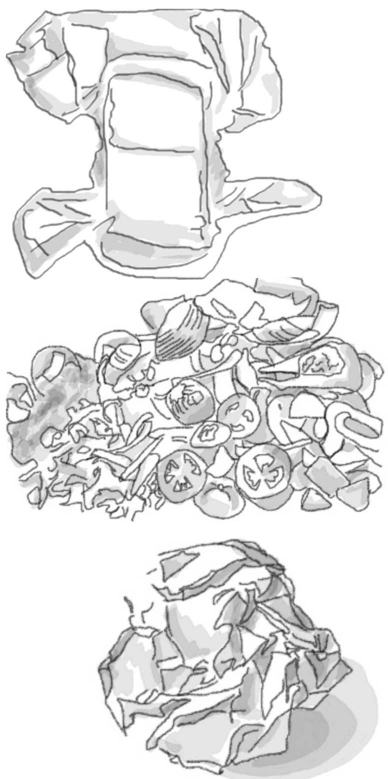


fig. 3.02 sketches of landfilled goods: diapers, organic matter, paper products.

The Garbage Project data which most effects the thesis' proposal is that which chronicles the percentages of material types within a landfill from the 1960s through the 1980s. From this, the value of the buried treasure within a closed landfill can be estimated, which may be surprisingly high. Before the Garbage Project, one might have assumed that disposable diapers and organic wastes would be the lion's share of the buried trash, when in reality, paper products can occupy up to 40% of the volume of a closed municipal landfill. [2]

The revelation of the reality of modern landfill contents greatly affects the potential of landfill mining. The material breakdown provided by The Garbage Project reduces the fear of the unknown and the unwillingness of municipalities to consider excavating their capped landfills. Quantifying the value of recyclable goods and potential energy within a landfill brings the hypothetical into reality. In a world of dollars and cents, where the recycling and garbage industries carry a narrow profit margin, the valuation of landfill contents is a critical step towards change.

fig. 3.03
LANDFILL CONTENTS
based on the research done by the Garbage Project out of the University of Arizona in the late 1980s without breaking ground, it is impossible to know with any certainty what lies beneath a closed landfill. However, any landfill operating within North America from 1950 to 1980 likely contains similar ratios of garbage types as seen in this diagram.

LANDFILL MINING OPERATIONS

Practised widely in countries with the largest population densities in the world, landfill mining reduces the volume of garbage in operating landfills to extend their usable lifetimes. By sifting and sorting the materials in the landfill, valuable materials can be removed and relocated, or incinerated to reduce their volume even further. Source reduction programs like curb-side recycling pick-up, material reuse, organics collection, or residential composting are more common methods of landfill reduction in North America. But, once something has passed into a garbage bag, it is landfill-bound.

Landfills across North America which were closed before source reduction policies came into existence, will of course contain unreachable recyclable materials. To implement a landfill mining operation on a closed landfill instead of an operational landfill could then be a valuable exercise. [3] Instead of simply sorting and mining a landfill during operations to reduce its volume, the same method could be applied to an excavated landfill.

The general method used to mine and sort garbage begins with a trommel screen, into which the garbage is scooped. The rotating drum-shaped screen sifts materials into different scales of particles. Soils are removed from garbage, and large items can be pulled out manually to be sorted by hand. [4] Mid-sized trash then gets shipped to a sorting hall where materials are sorted mechanically and manually into recyclable or incinerator-bound types. The sorting hall is not dissimilar to a material recovery facility, the design of which has advanced in the last twenty years to optimize the recovery process.

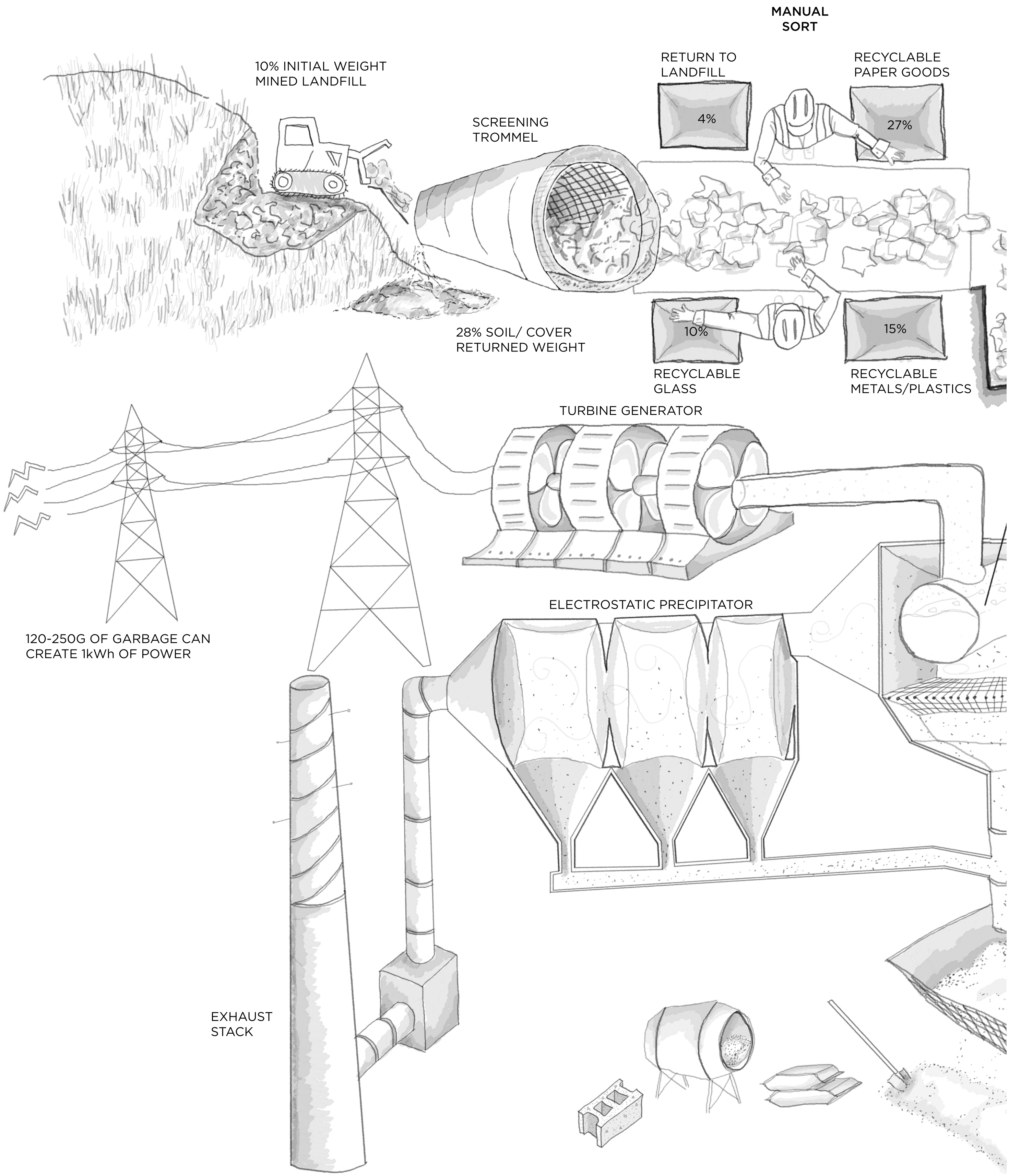

fig. 3.04 a trommel screen sorting recyclable goods in an MRF

Apart from those things removed to be recycled, there will be materials for re-landfill and materials to be incinerated for power. Thus the sorting line will be more complex than a regular material recovery facility design. Identifiable toxic materials or industrial waste would be removed upon first contact at the landfill, but smaller materials would be manually removed on the sorting line to be re-landfilled safely. An on-site incinerator would accept any non-toxic wastes which could not be recycled. The power generated by the incinerated garbage would be fed into the municipal grid.

Materials which may be recyclable in the near future can also be set apart for holding until a material recovery method is found. Collecting similar types of garbage into caches designed for future extraction provides a safe way to potentially recover more materials than we are able to reclaim today. By excavating closed landfills and using a practise normally reserved for land reclamation and waste volume reduction, it is possible to recover materials, generate power, and reclaim currently unrecyclable materials in the future.

EXPLOITABLE

By sifting and sorting the materials in the landfill, valuable materials can be removed and relocated, or incinerated to reduce their volume even further.


MANUAL
SORT
10% INITIAL WEIGHT
MINED LANDFILL
RETURN TO
LANDFILL
4%
RECYCLABLE
PAPER GOODS
27%
SCREENING
TROMMEL
10%
15%
28% SOIL/ COVER
RETURNED WEIGHT
RECYCLABLE
GLASS
RECYCLABLE
METALS/PLASTICS
TURBINE GENERATOR
ELECTROSTATIC PRECIPITATOR
120-250G OF GARBAGE CAN
CREATE 1kWh OF POWER
EXHAUST
STACK

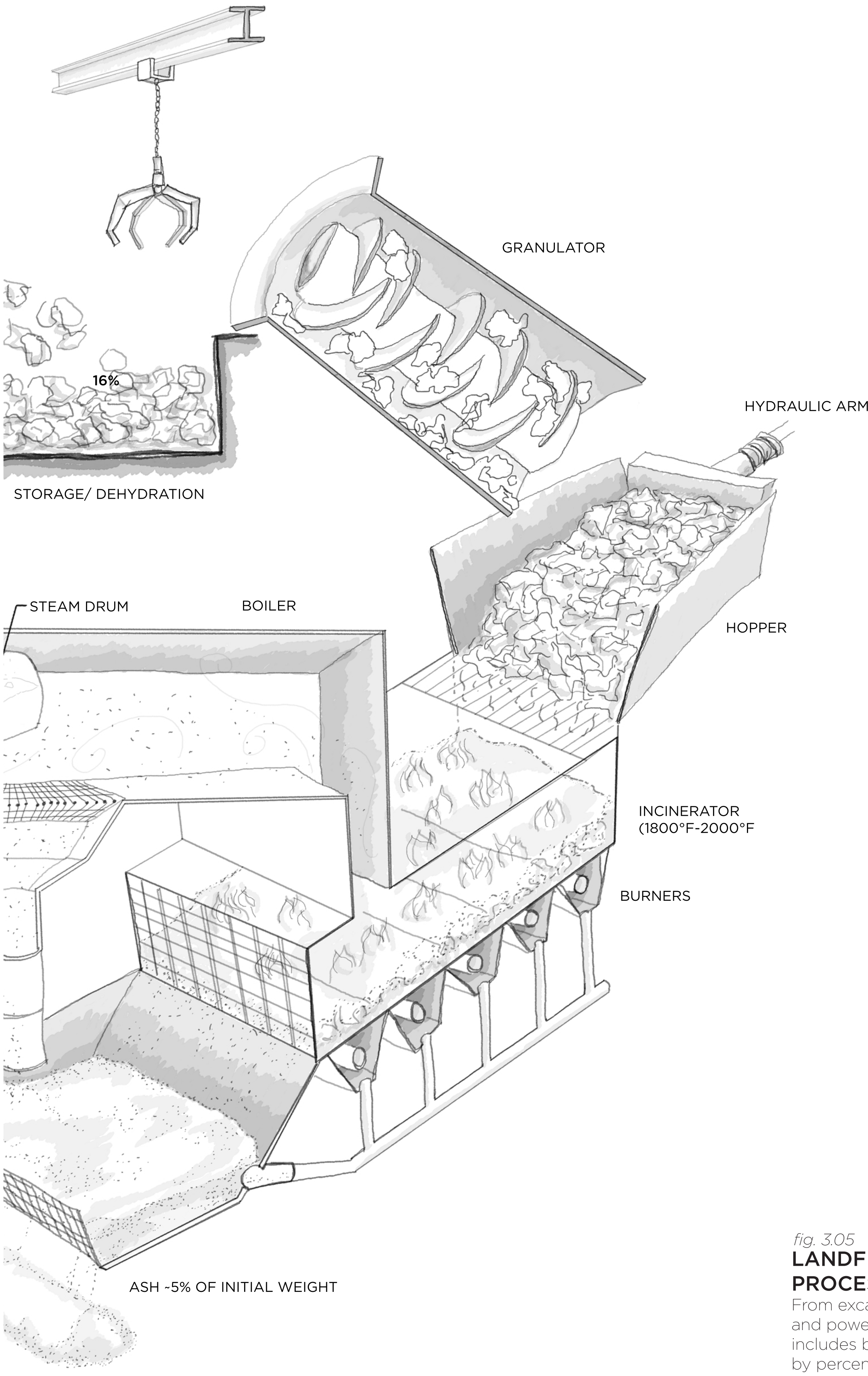


fig. 3.05

LANDFILL MINING PROCESS DIAGRAM

From excavation through to sorting and power generation, this diagram includes basic volume breakdowns by percentage.

fig. 3.06 unloading recyclables

fig. 3.07 recovery equipment

fig. 3.08 multi-layered sorting space

MATERIAL RECOVERY FACILITY DESIGN

From modest beginnings with modest profits gained from collecting cans and bottles during an economic crisis, recycling has grown into a municipal phenomenon. The reuse of glass bottles by a washing and sterilization plant has developed into a many-layered recyclables sorting system to subdivide plastics by type, aluminum, steel, glass, and several grades of paper products. Technology has advanced to a point where nearly half of the sorting of materials can be done mechanically. Manual sorting, however, and visual inspection is still a critical part of the material recovery process.

Based on visits to material recovery facilities in Hamilton and Guelph, and interviews with the lead hands and managers, a number of ideal design concepts have been established. These guidelines are based on the assumption that a facility is being custom-built for material recovery, and not retrofitted. There are, therefore, requirements of the building that need to be considered as well as requirements of the processing system. These requirements will be discussed in detail in this Chapter.

The building itself must be sited in such a way that transport trucks and large vehicles can efficiently access the facility for delivering mixed materials and removing baled materials. The delivery bay must be tall enough to accommodate the dumping height of a tilt-track bin truck or a recycling collection truck. The tipping floor must be heated to prevent ice from forming under the tires of the arriving trucks, and keep the floor safe for workers and loaders moving materials around the facility. Cross-traffic between the trucks and the loaders should be avoided, while limiting pedestrian access to the area keeps employees safe and allows for more efficient delivery.

Lighting within the sorting areas must be sufficient to allow for safe operation of machinery as well as adequate to allow employees to visually sort small objects by material type. Even on the maintenance shift, there must be high lighting levels since the operation of equipment causes trash to get lodged and tangled in the machinery, requiring skilful removal. Despite being a large facility by definition, heating is not necessary to all corners of the building. Costs can be saved by heating only directly where employees are standing at sorting lines, especially since overhead doors are often open to allow trucks to enter or exit the building.

The layout of the sorting process can be done in a variety of ways, depending on the start and desired end points of the materials, as well as the dimensions of the building. To build a custom sorting hall, the most efficient geometry would accommodate a linear conveyor belt, since every turn the materials make is a loss of momentum. [5] Unfortunately not every site can support a long narrow building, and so often the process shifts into strata. By shifting up the vertical plane, gravity is employed in the sorting process and several sorting methods can happen simultaneously in layers. When storage of sorted materials lies directly underneath the manual sorting conveyor belts, employees must simply drop matter down one chute or another to send it to the right storage bin. Thus, a large ceiling height for the overall building is advantageous to stack sorting lines upon storage bins, while each sorting line need not have an excessive ceiling height alone.

Concerning the equipment, the standard practise currently employs many low-power conveyor belts along with optical sorting machines, electrostatic conductors, electromagnets, trommel screens and crushers to subdivide recyclable materials. Steel is removed by electromagnet, aluminum through electrostatic charge, and glass is smashed so it will fall through a screened bin. The simplest and easiest way to sort non-metals and non-glass, however, remains the old-fashioned manual sort. Employees can pass judgement upon plastics and papers at an amazing rate

fig. 3.09 conveyance system

fig. 3.10 sorting machinery

fig. 3.11 manual sorting of recyclables


fig. 3.12

that can only be replicated by an optical sorting machine for plastics. When calibrated correctly, this machine can identify types of plastics and direct a jet of air towards the object, thereby shooting it into a storage bin alongside the conveyor. Tetra packs, yogurt cups, PET bottles, and plastic-coated paper products like milk cartons can all be sorted in this manner, but there are limits to the number of identification types per machine per line. [6] The limitation of proximity to places to throw the trash also restricts the utility of the optical scanners. Thus, typically only one or two types of materials are sorted in this machine, leaving employees to sort the remainder.

Opposite: the key dimensions of the most critical vehicles within a Material Recovery Facility for use in building and site design


fig. 3.13 Compacting, baling, and storing hall within the Guelph Material Recovery Facility in Guelph, Ontario

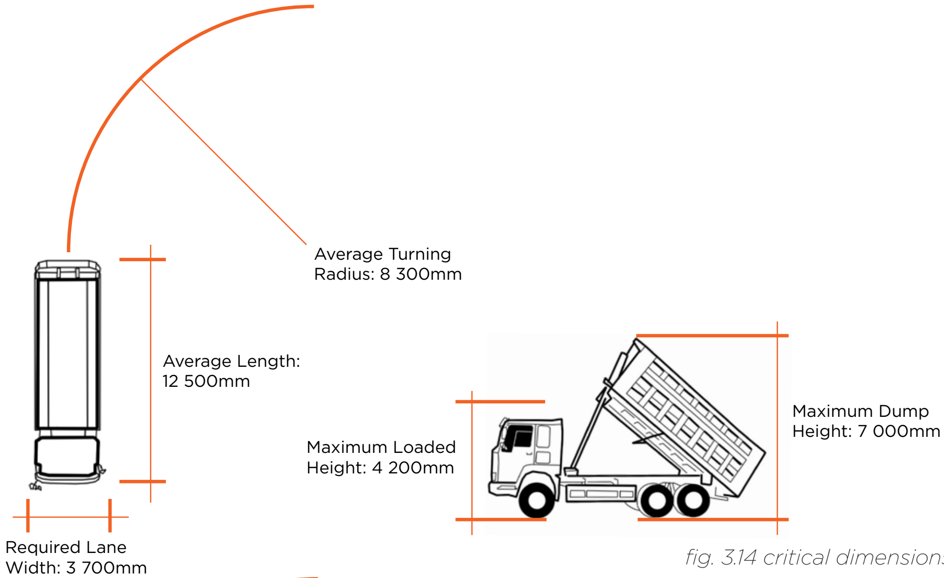


fig. 3.14 critical dimensions of a hydraulic dump truck

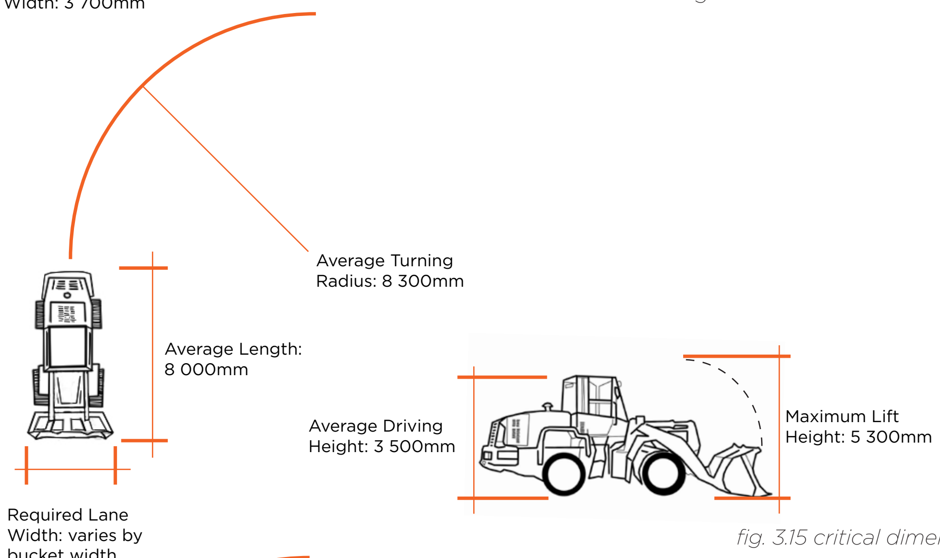


fig. 3.15 critical dimensions of a front end loader

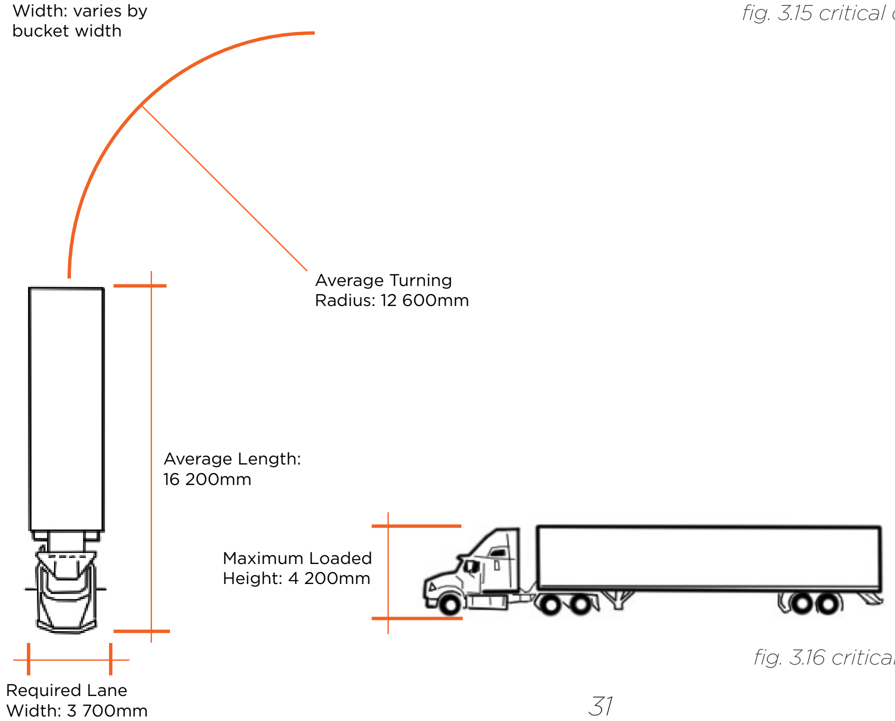
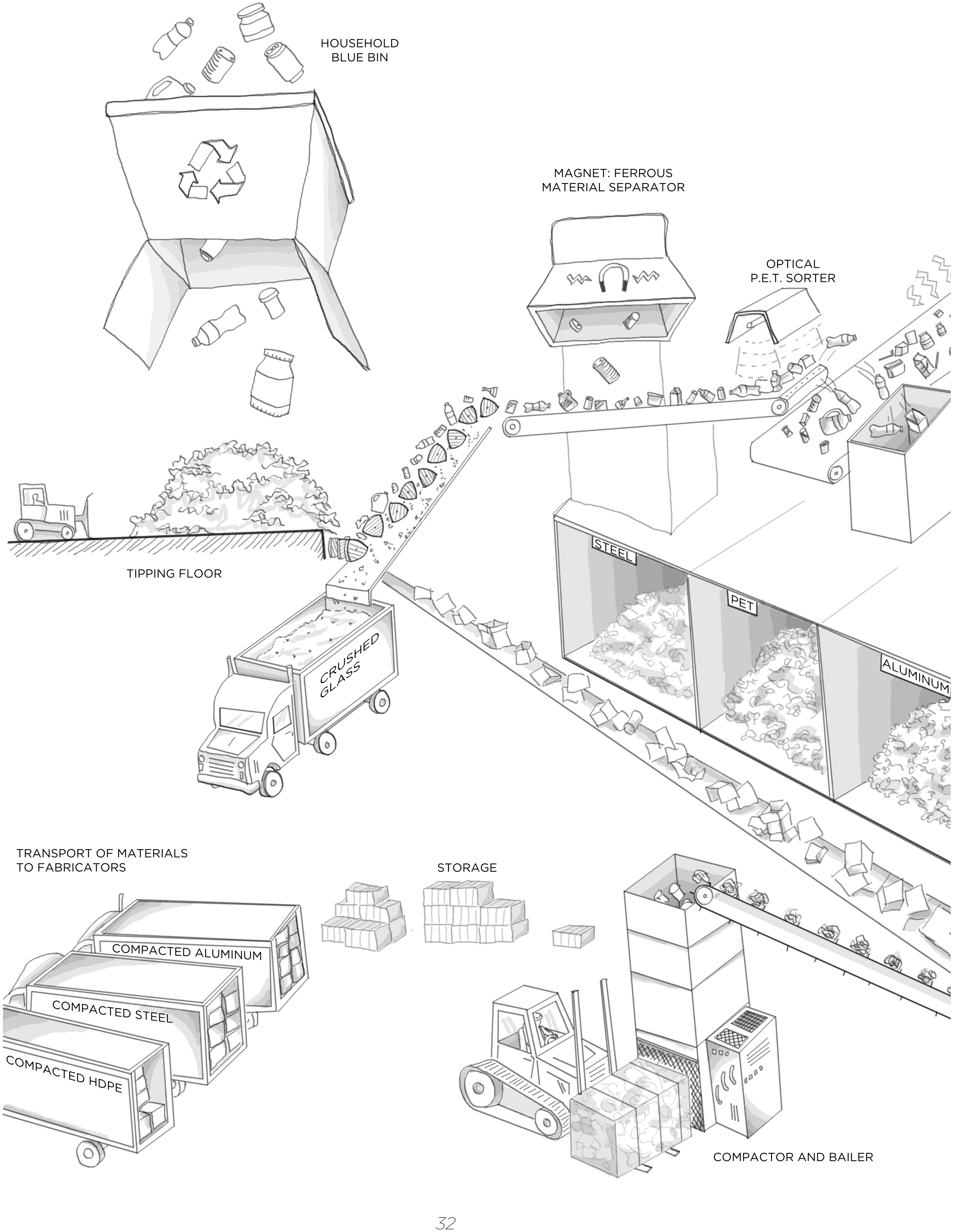


fig. 3.16 critical dimensions of a transport truck


HOUSEHOLD
BLUE BIN
MAGNET: FERROUS
MATERIAL SEPARATOR
OPTICAL
P.E.T. SORTER
TIPPING FLOOR
CRUSHED
GLASS
STEEL
PET
ALUMINUM
TRANSPORT OF MATERIALS
TO FABRICATORS
STORAGE
COMPACTED ALUMINUM
COMPACTED STEEL
COMPACTED HDPE
COMPACTOR AND BAILER

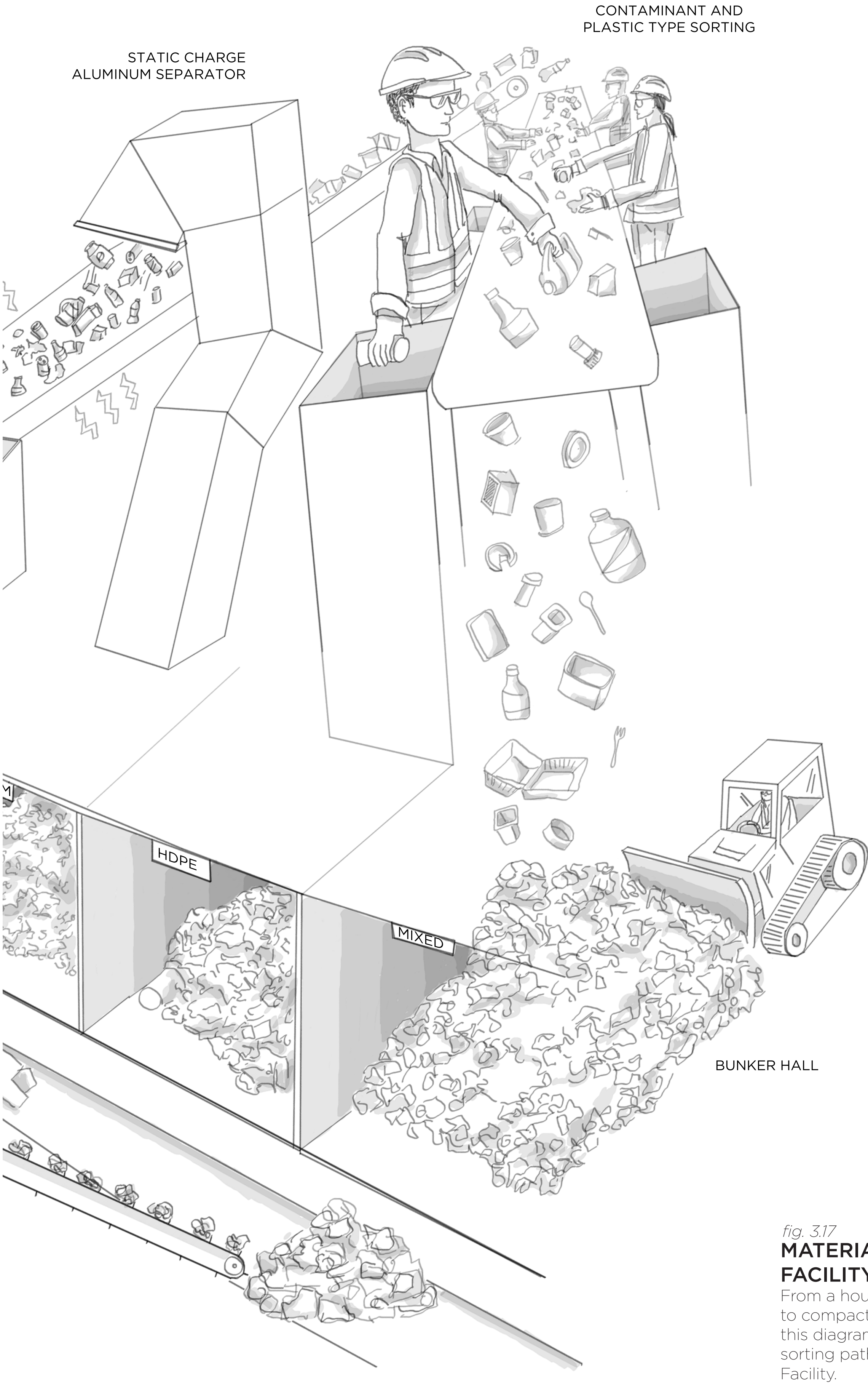


fig. 3.17
MATERIAL RECOVERY FACILITY DIAGRAM
From a household blue bin through to compacted and shipped materials, this diagram indicates one potential sorting path at a Material Recovery Facility.

fig. 3.18 exhaust stack at an organic waste processing facility in Guelph, Ontario

GARBAGE INCINERATION: THE HOT TOPIC

We burn to destroy, to condense, to produce heat and light, even to cook. Fire is both a friend and foe to civilization, and a tool best employed when fully understood. The burning of human waste is an ancient idea: 'we have stuff we don't want that can burn, and we need light and heat to live, so let us burn this trash'. In times before the extensive use of inorganic compounds and chemical manipulation, this method of garbage disposal was fairly clean and constructive to society. With the rapid introduction of synthetic materials, unstable heavy metals, and nuclear wastes, our comprehension of combustion lagged behind our waste type production. Our tendency to burn our waste has waned, as we now prefer to bury our misunderstood garbage, thinking it a safer and more reliable solution. We fear the unknown, and the incineration of garbage has become a taboo subject due to ignorance and fear mongering. However, with strict emissions policies, frequent inspections, and numerous scrubbing and stabilizing measures, the incineration of garbage is safer than a landfill of equivalent capacity. [7]

The first step towards stable incineration is maintaining strict standards of what materials can and can not be burned. The sorting of incoming goods, the scaling of large waste, and limiting compaction all factor into the effectiveness of combustion. Hazardous wastes, bulky objects, and dense oxygen-deprived environments lead to partial combustion, thereby producing greater emissions and heterogeneous ash. A heterogeneous mixture of incombustable materials within incinerator ash reduces the potential for reuse of the ash as a resource. Continuous loading of materials helps maintain consistent conditions within the furnace, without overloading or overheating in cyclic waste loading and ash extraction. [8]

Numerous technologies have reduced the emissions scrubbing process to an art form. Ash transportation and stabilization continues to be studied, with interests leading towards matrix stabilization for use in cementitious materials, potential as pozzolan alternatives, and ash vitrification for containment of toxins. [9] Matrix stabilization is a process in which the ash is mixed into a cement-like material and cured into solid blocks. Certain ash types have been sucessfully used as a pozzolanic alternative, which can replace or offset the cementing material in concrete. For the most toxic ash types, the vitrification process brings the ash to extremely high temperatures causing it to become a glass-like material. All these methods solidify a physically unpredictable material into a stable form. Many new ash treatment methods are controversial, but generally, contained ash protected from wind distribution and worker inhalation is accepted as stable within an engineered landfill.

Despite being perceived as a producer of dangerous air pollutants, incineration plants safely dispose of waste across the globe every day. Our expansive North American continent has provided plenty of sites for our landfills, unlike smaller countries with greater population densities than our own. European countries and Japan have been successfully using incineration to reduce the volume of their waste for years. Facilities have been operational in suburban areas without disturbing the surrounding neighbourhoods. Incineration plant management has been refined to exceed most environmental and safety regulations, as technology speeds ahead of legislature. [10]

Not only are international incinerators reducing the volume of waste sent to landfill, they are also producing much-needed electricity to the city grid. As the trash burns, a steam drum within the furnace produces steam, which then drives turbines and generates electricity. In this way the perceived 'valueless waste' becomes productive for the community. Capitalizing on the secondary production of heat from the incineration process

EXPLOITABLE

International incinerators... are producing much-needed electricity into the city grid.


fig. 3.19 a hopper tower in Hamilton

creates even greater incentive for the use of waste incinerators. Although the process has yet to reach a level of cleanliness that the environmental community can approve of, it is widely accepted that this source of fuel will be available for a long time, as the global population rises and we continue to make un-recyclable garbage.

Incineration technology is advancing daily as experiments are performed around the world. Within North America, some municipalities have elected to try power generation through garbage incineration, and are publishing their experiences. Keeping abreast of current technology will further the public's awareness of incineration technologies and help to educate the masses without instilling fear of pollutants. In a 2012 edition of WIRED magazine, David Wolman investigated one of the most cutting edge technologies being used in Arlington Oregon to particulate trash from a landfill, producing a potent fuel product, and nearly no emissions. What we call incineration today may not exist as we know it by the end of the decade. [11]

Naturally, several materials cannot be burned without risking the release of heavy metals such as cadmium or lead. About 4% of landfilled materials by volume cannot be incinerated safely using our current technology. [12] These materials instead are sealed in highly engineered sanitary landfills.

EXPLOITABLE RESOURCES CONCLUSIONS

Knowing the make-up of a landfill volume by material is an essential asset to the landfill mining process. The data collected by the Garbage project can be used to begin to estimate how much recyclable material is within any landfill of age with the ones studied.

The requirements of a material recovery facility (MRF) can be directly applied to the design of a landfill mining sorting hall. The mechanisms used at an MRF, as well as a modular incinerator, can be combined to efficiently sort and output wastes from closed landfill sites. The added control of sorting incinerator-bound materials helps to produce a more useful and safe resource of the 'waste' ash.

Recycling pre-landfill, landfill mining at open landfills, and incineration as an alternative to landfills are independently functioning strategies to reduce the volume of our current landfills. When engaged together as a new system, they can serve to reclaim resources from closed landfills while reducing the total landfill volume.

fig. 3.20 cap erosion unveils solid waste at Brampton Street Landfill

DANGEROUS HAZARDS:

CLOSED LANDFILL CONTAMINANTS

A sealed engineered landfill can act as an archive, trapping a record of local inhabitants and corporations over generations. By pushing our garbage underground, we are no longer visually reminded of their deteriorating condition. When our landfills are sealed and maintained, the contaminants within are not a threat to the surrounding neighbourhood. Unfortunately, numerous closed landfills do not have proper liners, and many of them are not maintained by a strict program.

Records of waste materials entering landfills have not always been a high priority for municipalities. Even after the 1977 legislation of the waybill system by the Ontario Ministry of the Environment, abuse and oversight have plagued the provincial waste control system. [13] Especially where cities were supported by the success of industrial sectors, it was easier to unquestioningly accept waste instead of risking revenue loss. Therefore, in hundreds of closed landfills across the country, unknown toxins mingle with soils, contaminating hectares of land every year. Even when core samples are taken and tests are run on a site, the results give only a rough estimate at the contaminants contained within the landfill.

Contamination can come from a variety of sources: The decomposition of organic materials produces volatile methane gas, which, when mixed with other gasses is termed "landfill gas". Besides having an unpleasant odour, the gasses may be flammable in high concentrations, posing a threat of fires on closed landfill sites. Several large landfills have successfully collected landfill gas to refine into a fuel, including the Freshkills Landfill on Staten Island, New York. [14] However, smaller sites which have been closed for over twenty years likely have very little gas production, therefore making the containment of landfill gasses not a profitable venture. [15]

Leachate contaminants are those toxins which move in the liquid matter seeping out of a garbage mound. Moving in liquid form, leachate flows into bedrock, soils, and watersheds, posing a threat to ever-enlarging areas surrounding a closed landfill. The typical toxins which may appear in leachate are heavy metals (cadmium, iron, lead, etc) or organic compounds such as PCBs (polychlorinated biphenyls). [16] The presence of high concentrations of these compounds within water would never pass as potable water for human consumption. Leachate does, however, threaten the ecosystems into which it flows. Only robust and adaptable wildlife is able to coexist with leachate contaminants, all other wildlife cannot cope. Current landfills must maintain a comprehensive leachate catchment and treatment systems. Old landfills, however, rely on luck and an impermeable top cap to prevent low-lying liquids from flowing downstream, bearing unchecked toxins into the watershed.

Solid contaminants are less likely to migrate out of a closed landfill, but can easily degrade in the decomposing environment. Sealed containers may be crushed in the landfill compaction process, breaking them open or damaging a seal. Corrosive materials may eat away at steel drums, and what was intended to be sealed away is once again free to leak into the landfill. Water influx either from ground sources or rainfall can move particulate matter throughout a site, contaminating a wider region of the landfill. Current landfills use engineered liners and concrete cells to contain solid hazardous wastes. Without exhaustive records of closed landfill contents, however, complete excavation of the site is the only way to check that solid contaminants are in a dormant state.

DANGEROUS

Numerous closed landfills do not have proper liners, and many of them are not maintained by a strict program

fig. 3.21 murky waters in Cootes Paradise, downstream of the former West Hamilton Landfill

UNDERPERFORMING BROWNFIELDS:

CLOSED LANDFILL & WASTE REUSE CASE STUDIES

Upon sealing a closed landfill, the typical municipal response is to plant the surface with shallow-rooting vegetation. Depending on the slope of the surface and the durability of the seal, the area is typically either fenced off from public access or covered in sports fields. Occasionally, however, more ambitious projects are undertaken to develop these spaces into intensive parkscapes.

Alternately, waste materials can be diverted into intentional landfilling projects. By using inert trash as earthwork fill in landscape design work, large volumes of waste can be safely stored while serving a secondary purpose. This requires foresight on the landscape design team, as well as much scrutiny of the incoming fill materials.

The following six examples vary in scale and location, addressing water adjacency and poor or no base liners, while safely introducing the public into the landscape. Each city confronts site issues with varying budget constraints and design ambitions. Despite several differences, each has successfully integrated the requirements of closed landfills or waste reuse sites and the residential communities in which they exist.

Each case study has been analyzed based on seven qualities of successful landfill reuse projects. The spider graph indicates how each project fares in each quality, ranking from zero to five on the concentric ring scale. The larger the polygon drawn within these bounding points, the more successful the site is as a landfill reuse project.

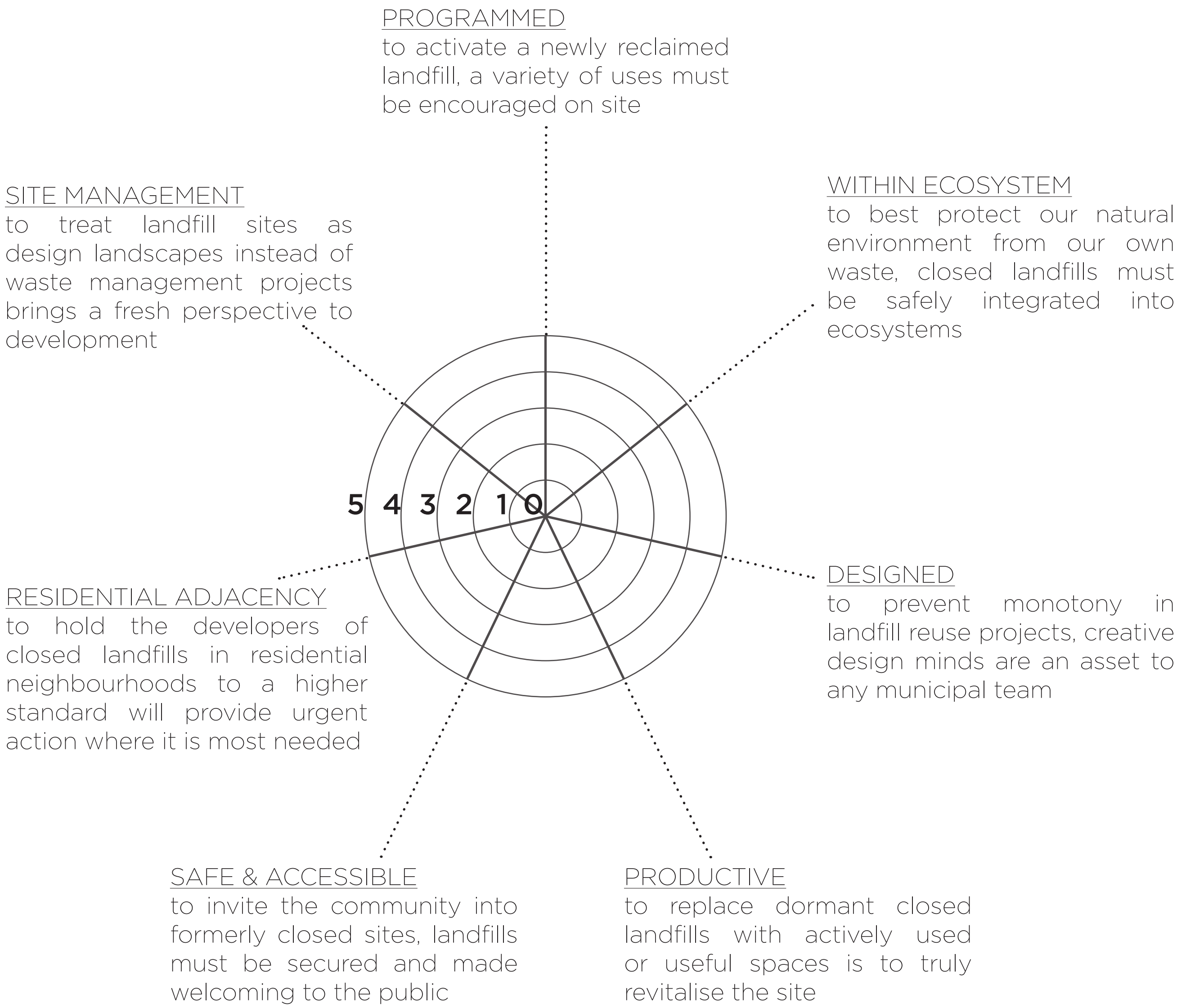


fig. 3.22 How to read the case study analyses spider graphs

FRESHKILLS PARK

fig. 3.23

fig. 3.24

Located on the West bank of Staten Island, the Freshkills New York landfill operated from 1948 to 2001, slowly building up the lowlands on the Arthur Kill into mountains of trash. This unlined landfill was located within a brackish tidal marshland, washing unknown toxins into the river daily. The City of New York held a competition in 2001 to turn the 890 hectare closed landfill into a public park. Proposals included strategies to seal the landfill safely while returning the site to its natural wetland habitat. Field Operations Landscape Architects won the competition with a scheme integrating the technical aspects of methane collection and topographic settlement with design features like interpretive wildlife habitats and recreational playfields. A phased implementation plan will see the vast site change over the next forty years, after which the ecosystem will continue to fluctuate with the tides. [17]

The design for Freshkills Park is multi-functional and contains spaces of all scales for various recreational uses. Due to its massive scale, not all of the site is accessible. Portions of the capped landfill are left to naturalize and feed into the ecosystem. Since such an enormous quantity of waste lies beneath the park, there is a large degree of waste management in the site design. Once the many phases of landscape and remediation work are completed, Freshkills Park will be a thriving success story for closed landfill design projects.

Left: Rendered proposal images from Field Operations displaying the seed fields and bike paths (top), and a smaller more intimate entry parkette complete with undulating play surfaces.

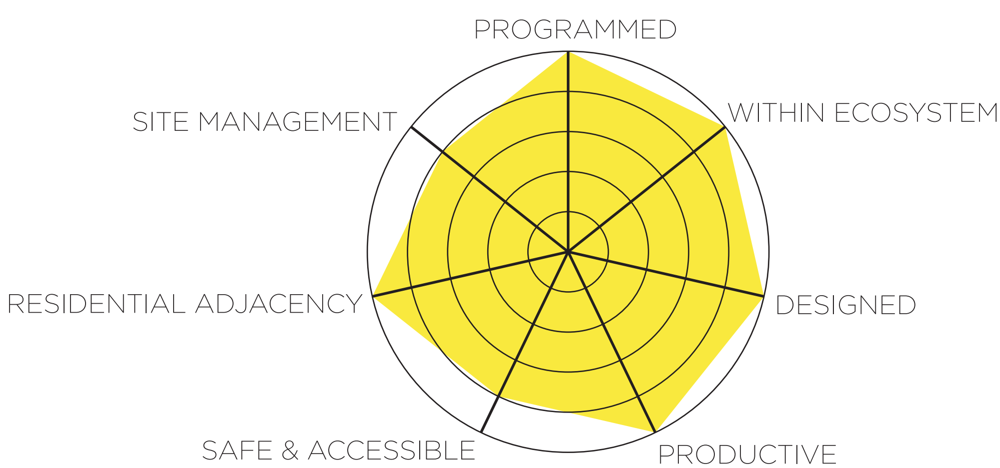


fig. 3.25

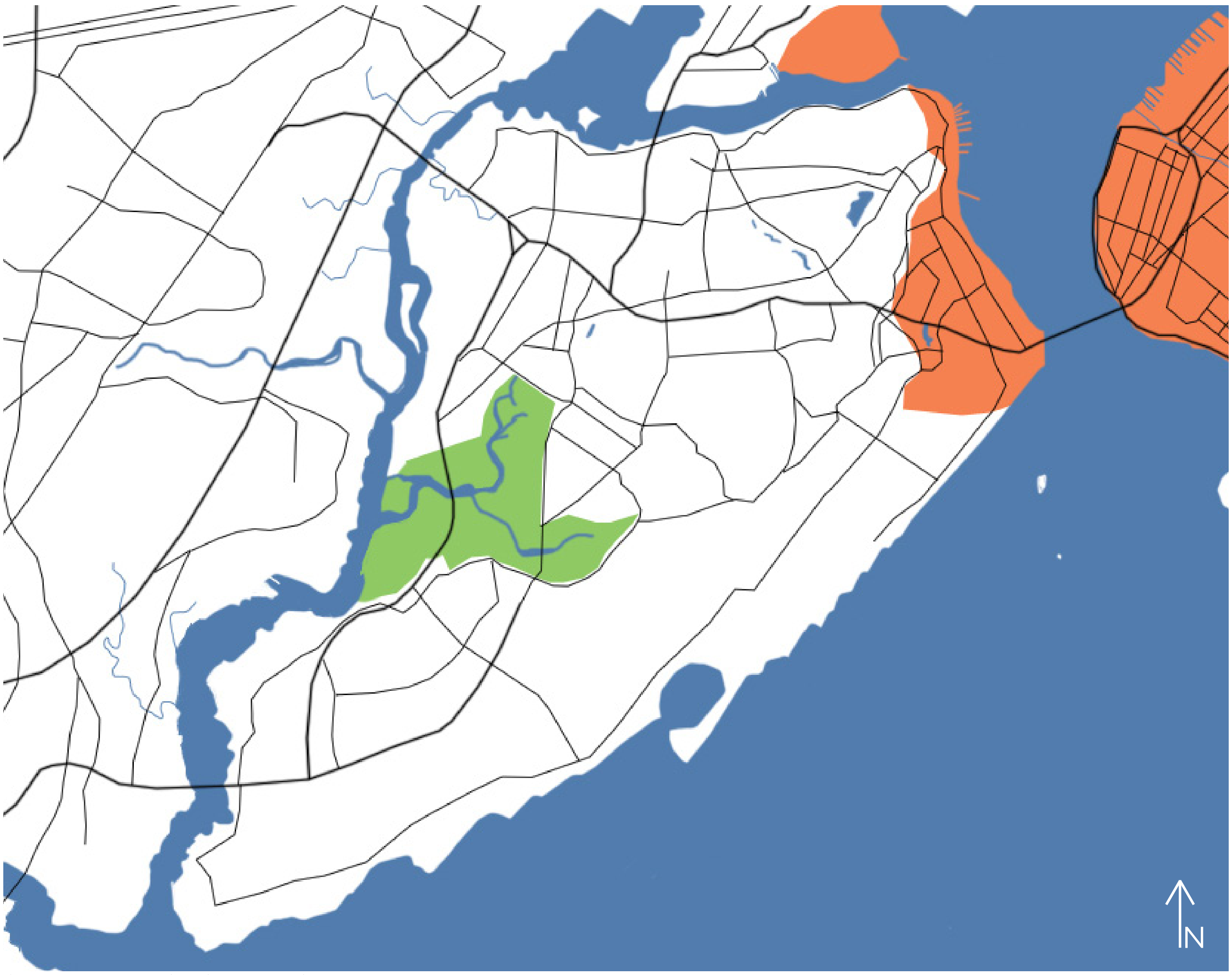


fig. 3.26 Staten Island, New York.

Urban Areas *Water* *Fresh Kills Park*

•well-programmed across a large site
•productively collecting landfill gasses
•combines the interests of human visitors and wildlife inhabitants

•due to enormous scale, some initiatives are more at the engineering level than the human park scale
•some of the park is inaccessible for habitat preservation (only a negative aspect for visitors, not wildlife)

KAY DRAGE PARK

fig. 3.27


fig. 3.28

A typical repurposing project, the old West Hamilton Landfill now exists as a large sports park. Built atop thirty years of municipal garbage, soccer fields and baseball diamonds with accompanying parking lots and washroom facilities occupy the capped surface. [18] Occupancy is limited outside of the busy sports season to minimize erosion of the cap. Despite adjacency to the busy regional Hwy 403, pedestrian traffic continues year-round. Without being particularly creative in rehabilitation method, the municipality has successfully integrated the closed landfill into the community. Where success has been achieved in allowing public access to the site, the maintenance of the oft-liquifacting materials below the fields continues to torment the city.

Kay Drage Park is an example of the unfortunate knee-jerk redevelopment on landfill sites which municipalities initiate regularly. After levelling the top of the capped trash mound, sports fields were installed; an inexpensive and basic program element. The seasonally limited access makes the site accessibility poor, and its emptiness extremely unproductive. This is a very common fate for landfill "parks", destined to be an extension of the waste management program which dominated their sites for years before.

Left: Photographs of the Kay Drage Park entrance gate (top), and the view across the sports fields within the park

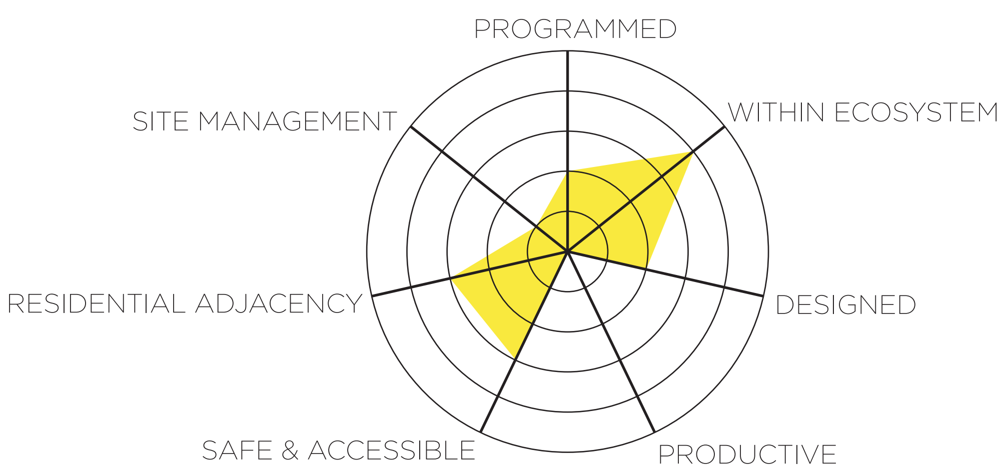


fig. 3.29

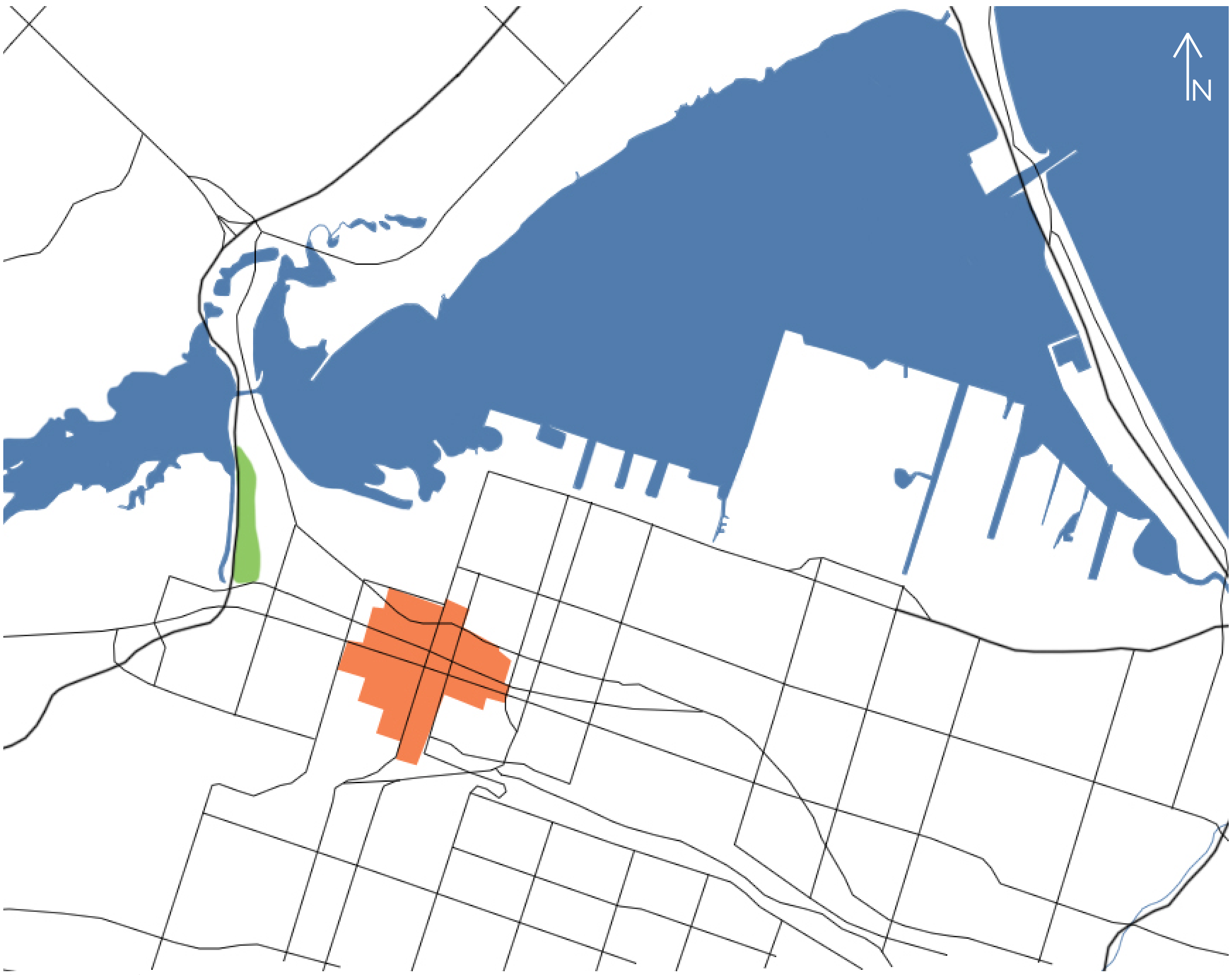


fig. 3.30 Hamilton, Ontario.

Urban Areas *Water* *Kay Drage Park*

•closed-landfill maintenance on site benefits the adjacent Cootes Paradise habitat
•the park is highly used during summer sports seasons

•the program on site is seasonal-use only
•the design is largely as a waste-management initiative: public use appears to be an afterthought
•no productive program appears on site

LESLIE STREET SPIT

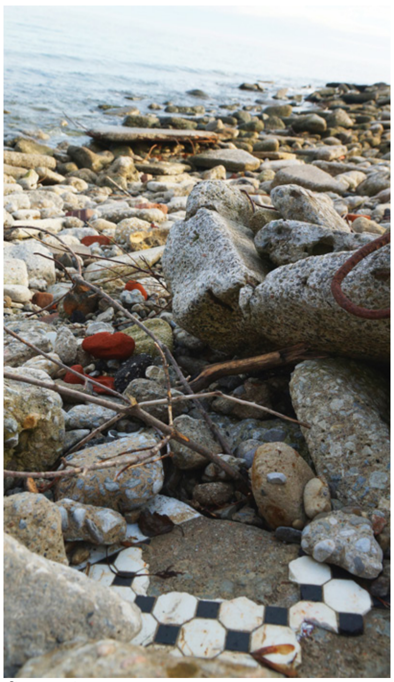


fig. 3.31

Starting in 1959, the Toronto Harbour Commissioners (now Toronto Port Authority) used construction waste and dredgate (dredged materials) from a nearby shipping channel to build up terrain above water level on the North shore of Lake Ontario. Thus, at the Southern terminus of Leslie Street, Tommy Thompson Park was constructed one truckload at a time. The spit is in a constant battle against erosion by Lake Ontario. As it was built up by dredged channel silt, it was strengthened against erosion by crushed construction rubble. Now a favourite bird watching site for local enthusiasts, several proposals have been put forward to improve the wildlife habitat on the spit. Currently the site maintains a weekly schedule of coexistence between the rubble fill trucks and the community of wildlife observers and cyclists. [19]

Tommy Thompson Park has successfully integrated recreational program upon a currently active dumping site. However, the site is closed to the public during the week, and requires a "use at own risk" sign at the gate. Luckily, the park is near industrially zoned land and not adjacent to a residental neighbourhood. The wildlife watching portion of the park has had tremendous success merging with and encouraging the growth of local ecosystems, and the thriving constructed wetland within the park is celebrated by visitors and enthusiasts alike.

Left: Photographs of the construction waste breakwater at Tommy Thompson Park upon the Leslie Street Spit


fig. 3.32

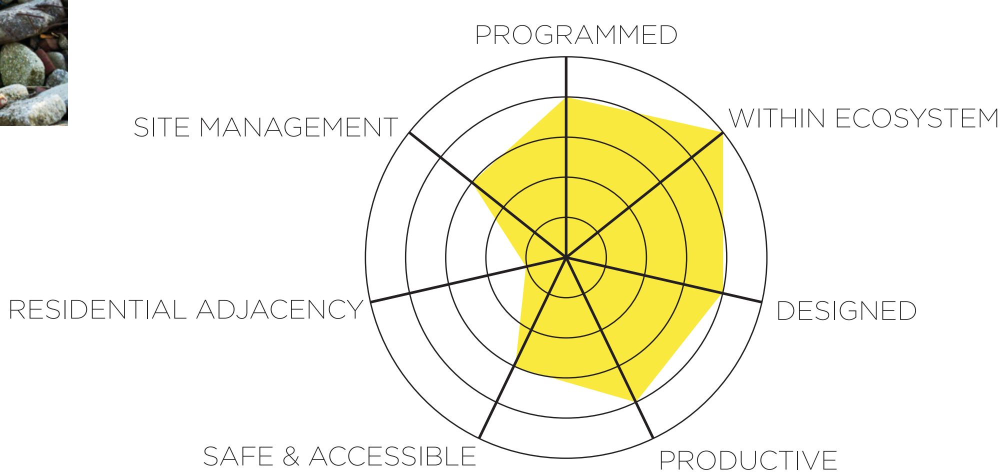


fig. 3.33

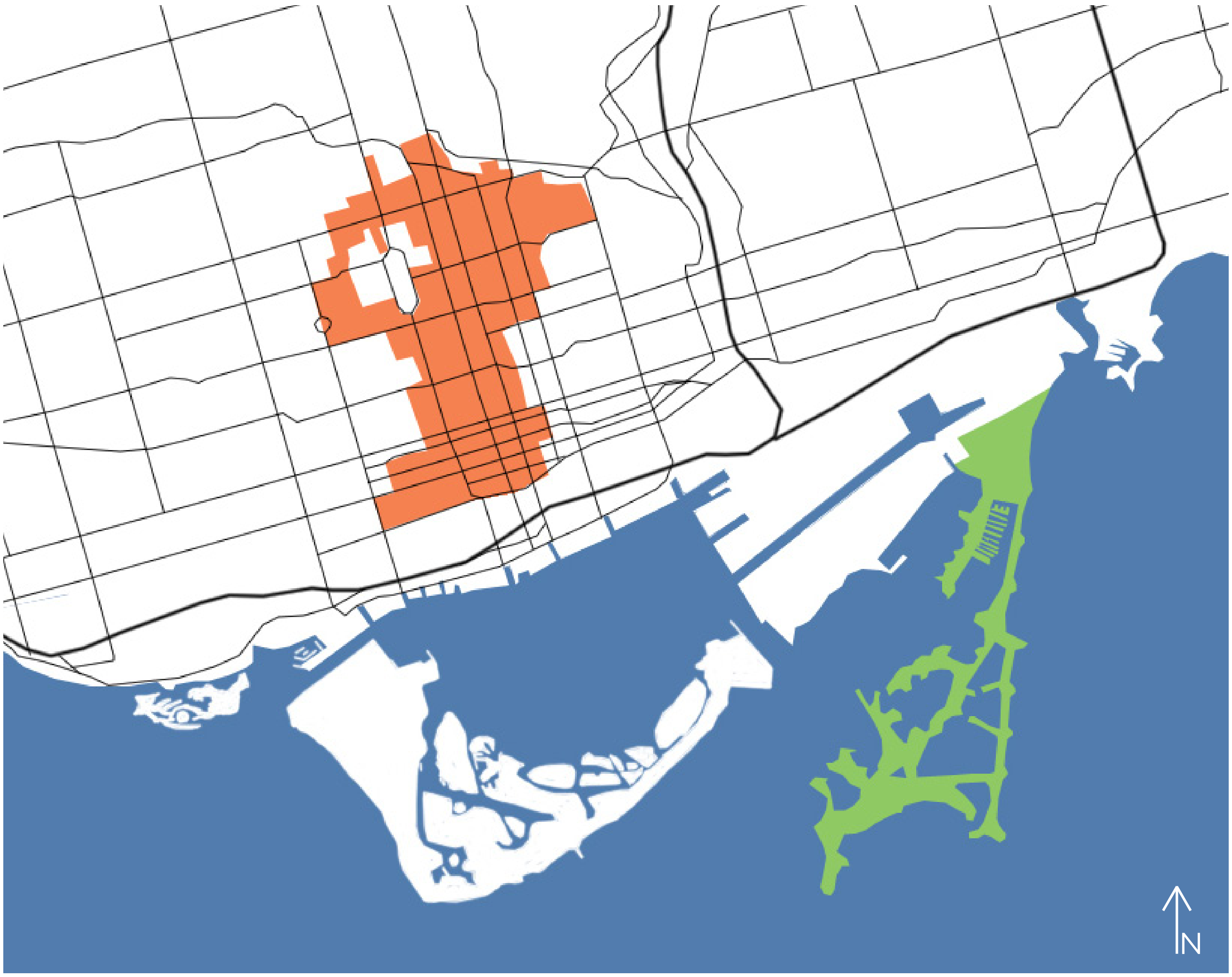


fig. 3.34 Toronto, Ontario.

Urban Areas *Water* *Tommy Thompson Park*

•wildlife-oriented design has helped animals to flourish in the newly constructed habitat
•the site continues to serve a purpose for the construction industry

•the park is not easily accessible for pedestrians to any existing residential neighbourhood
•visitor access is restricted to certain times only

PARC DU COMPLEXE ENVIRONNEMENTAL DE SAINT-MICHEL

Previously the Miron Limestone Quarry, followed by a city landfill, the park now supports recreational uses as well as serving a productive purpose. [20] In the centre of residential Montréal, an estimated 35 million tonnes of municipal garbage were mounded into the empty quarry starting in 1968. [21] The site continues to accept organic waste in the central portion, while the perimeter has been transformed into a 5km recreational loop for pedestrians, runners, and cyclists. The methane produced from the landfill gas on site is processed in the Gazmont power plant and used to supply hot water to Cité des arts du cirque, "TOHU". [22] The site also hosts a material recovery facility, collecting, sorting, and distributing recycled materials in the heart of the city.

This large urban park provides a wide variety of uses, and boasts a beautiful finished landscape, but is solely a recreational circuit around a functioning organics processing facility. The program currently on site is limited by the width of the accesible portion and the safety concerns of inviting the public too close to the ongoing operations. The productivity of the methane conversion plant, however, cannot be underestimated. As it is almost entirely surrounded by residential neighbourhoods, the production of methane on site is surprising. Upon completion, the Parc du Complexe Environnemental de Saint-Michel (CESM) will provide a vital amenity to the surrounding neighbourhood.

fig. 3.35

fig. 3.36

Left: Design site plan for the future park development (top), and a photograph of the Gazmont power plant adjacent to the CESM site.

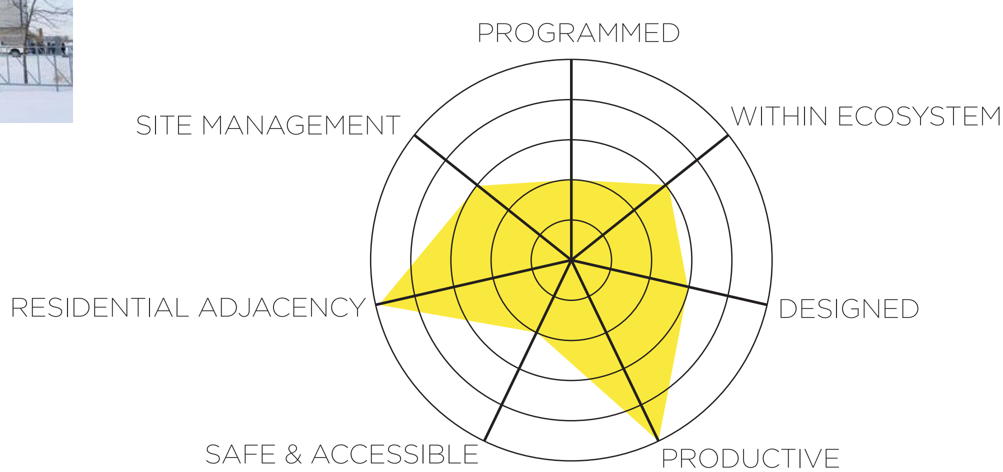


fig. 3.37

fig. 3.38 Montréal, Quebec.

Urban Areas

Water

Parc du Complexe Environnemental de Saint-Michel

+

•the site produces a reliable source of landfill gas

•the park is surrounded by potential users within a residential neighbourhood

−

•visitor access is restricted to a perimeter path

•the program on site is limited to recreational paths

•the purpose of the site is largely for waste-management

MABEL DAVIS DISTRICT PARK

fig. 3.39

fig. 3.40

fig. 3.41

Built on a landfill closed in the 1950s, Mabel Davis Park was opened to the public in 1979, before many modern regulations on landfill site reuse had come into being. The park rapidly deteriorated due to issues of erosion and subsequent leachate leakage. The City of Austin kept the park operational until 2000, when it was forced to close the site for intensive remediation. Eager park builders overlooked many issues of the landfill, thereby endangering site visitors and the surrounding residential community. After five years of work, the park reopened, complete with a much-celebrated skate park and outdoor swimming pool. Runoff, erosion, and leachate continue to be monitored closely to ensure that the park will not put visitors at risk again. [23]

Mabel Davis District Park has an infamous past, but has become much more than the green hill of 1979. The additional program added for the 2005 opening has brought more visitors to the park from the neighbouring community. A large percentage of the mound remains as planted hillside without programmed spaces, dominated by the drainage pools and causeways through the site. Being within a dense residential district in a dry city, this site provides an island of habitat for local wildlife, and has developed into an attraction within Austin, growing as the landscape matures.

Left: Photographs of the Mabel Davis skate park (top), site drainage pool (middle), and site drainage causeway (bottom)

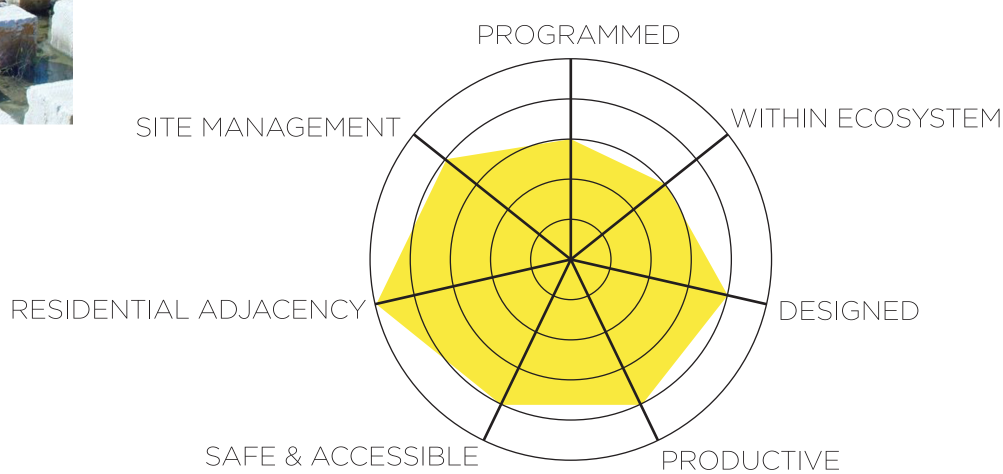


fig. 3.42

fig. 3.43 Austin, Texas.

Urban Areas *Water* *Mabel Davis District Park*

•the site provides much-needed amenities for the community
•the park is surrounded by potential users within a residential neighbourhood

•the park is disconnected from any larger green space system
•site design appears focussed only on one edge of the park

JORDAN VALLEY PARK

In only five years, 1.3 million tonnes of garbage filled the Jordan Valley Landfill in Hong Kong. Closed in 1991, this hillside site was mined for landfill gas before park development began. [24] The park itself opened in 2010, boasting a radio-controlled model car racing circuit, a horticultural education centre, community gardens and children's play areas. [25] Steep terrain and retaining walls surround the park, protecting adjacent residential buildings from landslide threats. Wellness stations and fitness areas for the elderly are integrated within the jogging track, alongside gardens and a greenhouse. [26]

The english publications regarding Jordan Valley Park are mostly from city sources, which may falsely build up the reputation of the project. However, from photos and program lists alone, it is clear that this is a popular park and is well used by local residents. The site is programmed to the edges with very little loose space for unplanned recreation. Since landfill-sourced methane was collected, and the boundary retaining walls are regularly maintained, this site remains true to its original waste-management existence. Within the urbanized hillside region of Hong Kong, this park primarily represents human interests and provides little in the way of wildlife habitat in an otherwise entirely hardscaped neighbourhood.

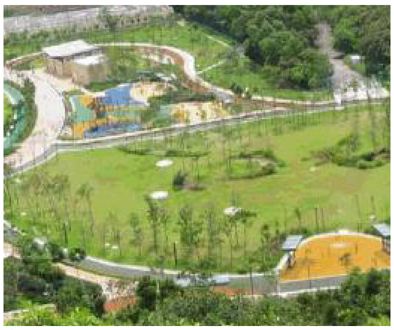


fig. 3.44

fig. 3.45

fig. 3.46

Left: An aerial photo of remote control vehicle track within the park (top), a site map indicating activity zones within the park (middle), and children in the park playground (bottom).

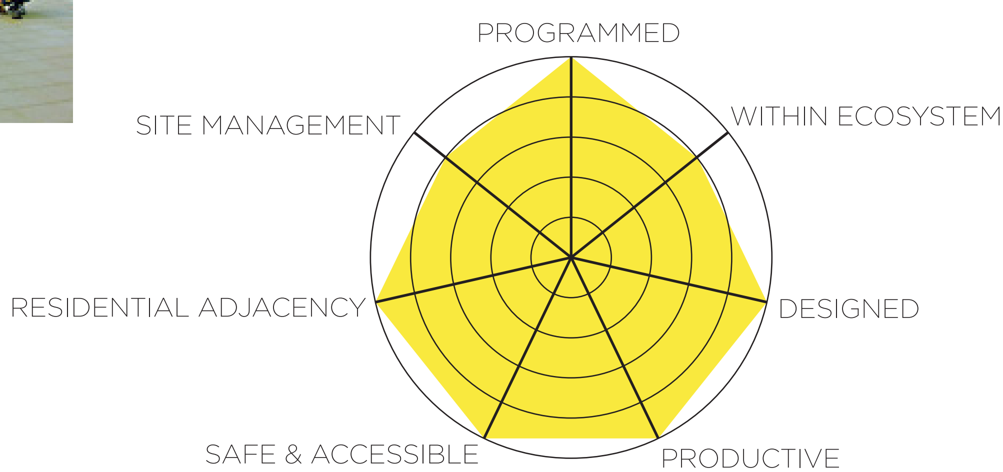


fig. 3.47

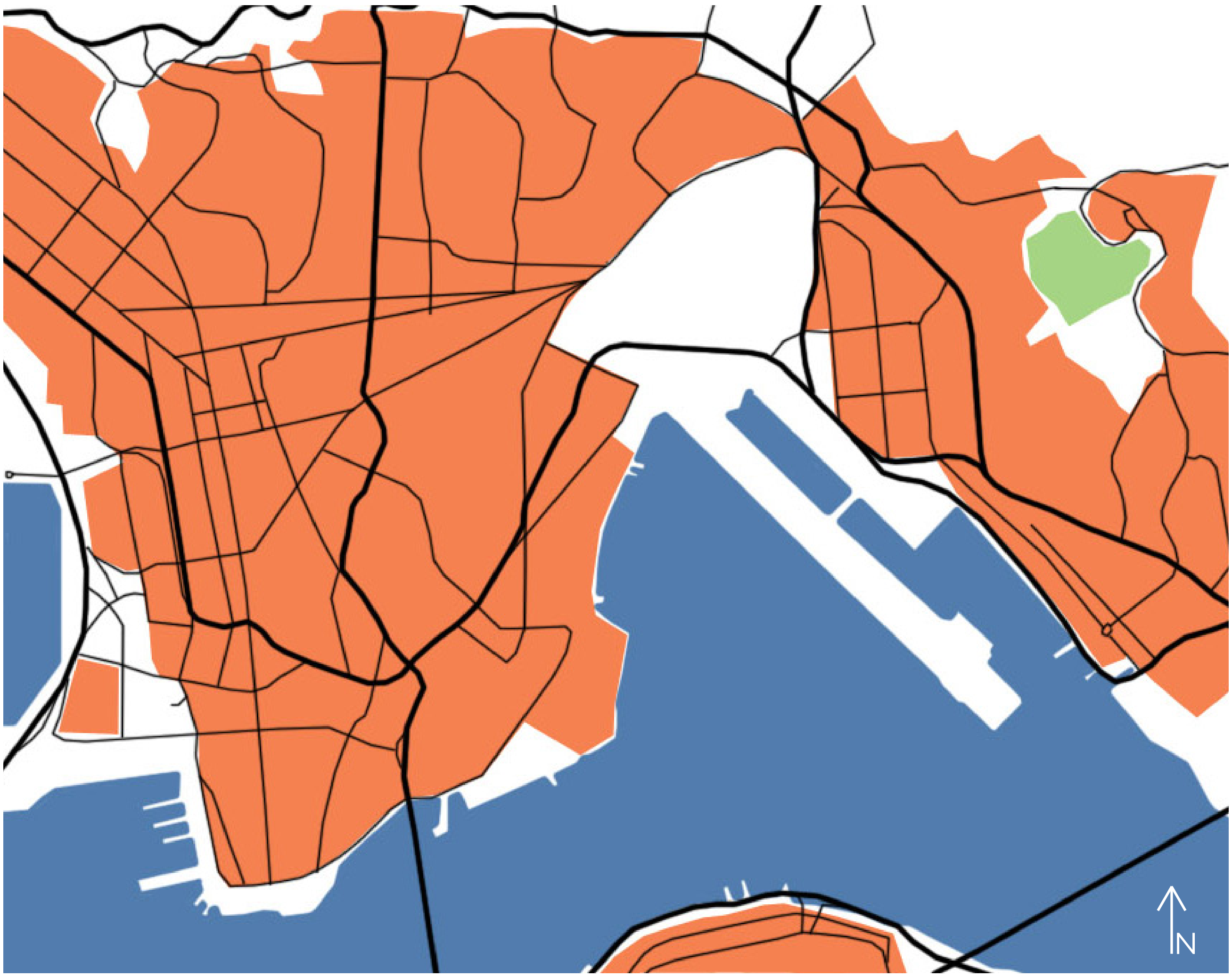


fig. 3.48 Hong Kong, China.

Urban Areas *Water* *Jordan Valley Park*

•the site provides much-needed amenities for the community
•the park is surrounded by potential users within a residential neighbourhood
•every square meter is designed for visitor benefit

•the park is disconnected from any larger green space system
•the perimeter retaining system serves purely waste-management purposes and offers a harsh view to neighbouring residential towers

LANDFILL REUSE CASE STUDY CONCLUSIONS

The most sucCessful reuse projects share a number of qualities which are desirable in all closed landfill redevelopments. These qualities include:

•connecting the new landscape into an existing green space system

•creating a productive end use for the space

•integrating the new landscape with a residential neighbourhood with access points

•ensuring the safety of visitors by protecting them from landfill contents or contaminants

•programming the new space for community uses

•providing new, or extending existing wildlife habitats on site

Each of these inform the design proposal portion of this thesis, seen in Chaper 6.

CONTAMINATED SITES REDEVELOPMENT CASE STUDIES

The increasing value of previously undesirable land has resulted in a push to redevelop contaminated sites across North America. Infrastructural, industrial, and historical sites which had fallen into neglect are being bought on speculation for new projects, or cleaned up for public spaces. Some contaminated sites have seen years of dumping followed by years of oversight. There is a current push to clean up these closed sites due to their adjacency to public or urban spaces. The value of contaminated properties is being inflated by the prevention of further environmental or social harm. The prevalence of redevelopment on such sites indicates that municipalities are eager to reclaim their dormant sites. On occasion, this enthusiasm extends to redevelopment of closed landfills, as evidenced by some of the more successful case studies in Chapter 3.

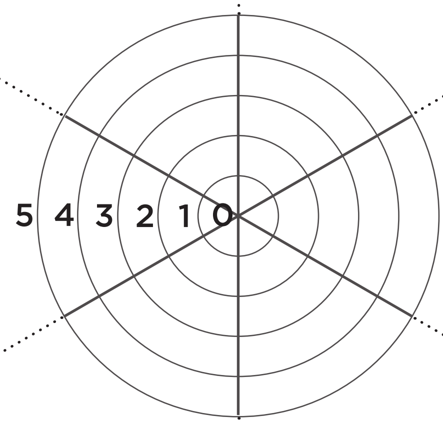
The following case studies exhibit the various forms of decontamination and rehabilitation that sites across North America have employed with great success. Some are in the design and fundraising phase, while others are under construction or already completed. Infrastructural rehabilitation, industrial decontamination, and historical site reoccupation are three goals successfully achieved by these projects.

Each case study has been analysed based on five qualities of successful contaminated site redevelopment projects. The spider graph indicates how each project fares in each quality, ranking from zero to five on the concentric ring scale. The larger the polygon drawn within these bounding points, the more successful the site is as a contaminated site redevelopment project.

PROGRAMMED
to activate a newly redeveloped contaminated site, a variety of uses must be encouraged on site

URBAN INTEGRATION
to best revitalize and rehabilitate contaminated sites, they must be safely integrated into the existing urban fabric.

HISTORIC REHABILITATION
to best protect historic sites from demolition, closed sites must be revitalized with new uses and users



SAFE & ACCESSIBLE
to invite the community into formerly closed sites, developments must be secured and made welcoming to the public

PRODUCTIVE
to replace dormant closed contaminated sites with actively used or useful spaces is to truly revitalise the site

MIXED USERS
to contrast the new visiting public with the previous industrial or infrastructural uses, allowing mixed types of users on site creates increased public awareness

fig. 3.49 How to read the case study analyses spider graphs

fig. 3.50 Bow River embankment

fig. 3.51 Siemens historical building

EAST VILLAGE REDEVELOPMENT

Bordered by historic Fort Calgary, the Bow River, and the thriving downtown core, the east end of Calgary is known for its empty sites and parking lots. Rooted in the earliest european settlement in the city, this new development was designed by Broadway Malyan, and includes a threshold to the city, a new river edge, and a park space adjacent to the fort lands. [27] The rejuvenation of the lands required some contamination remediation from past industrial uses, but many heritage buildings and sites have been adopted into the master plan. The design boasts cultural, commercial, and residential components which are stitched together in a grid of pedestrian-friendly streetscapes. [28] Construction on some phases of the redevelopment are under way, while other parts are slated for much later improvement.

The identification of valuable sites within the city centre successfully initiated this redevelopment project. With public support and financial backing, the East Village will provide ample new public amenity space in Calgary while celebrating their settlement heritage.

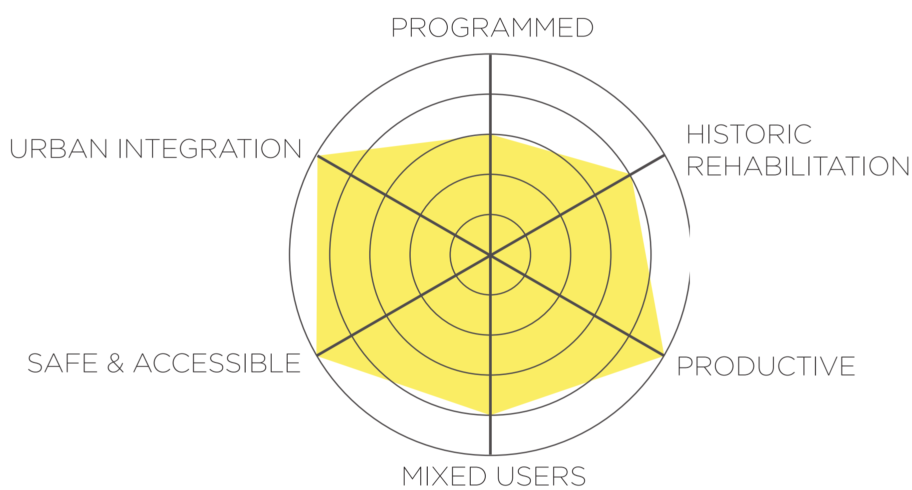


fig. 3.52

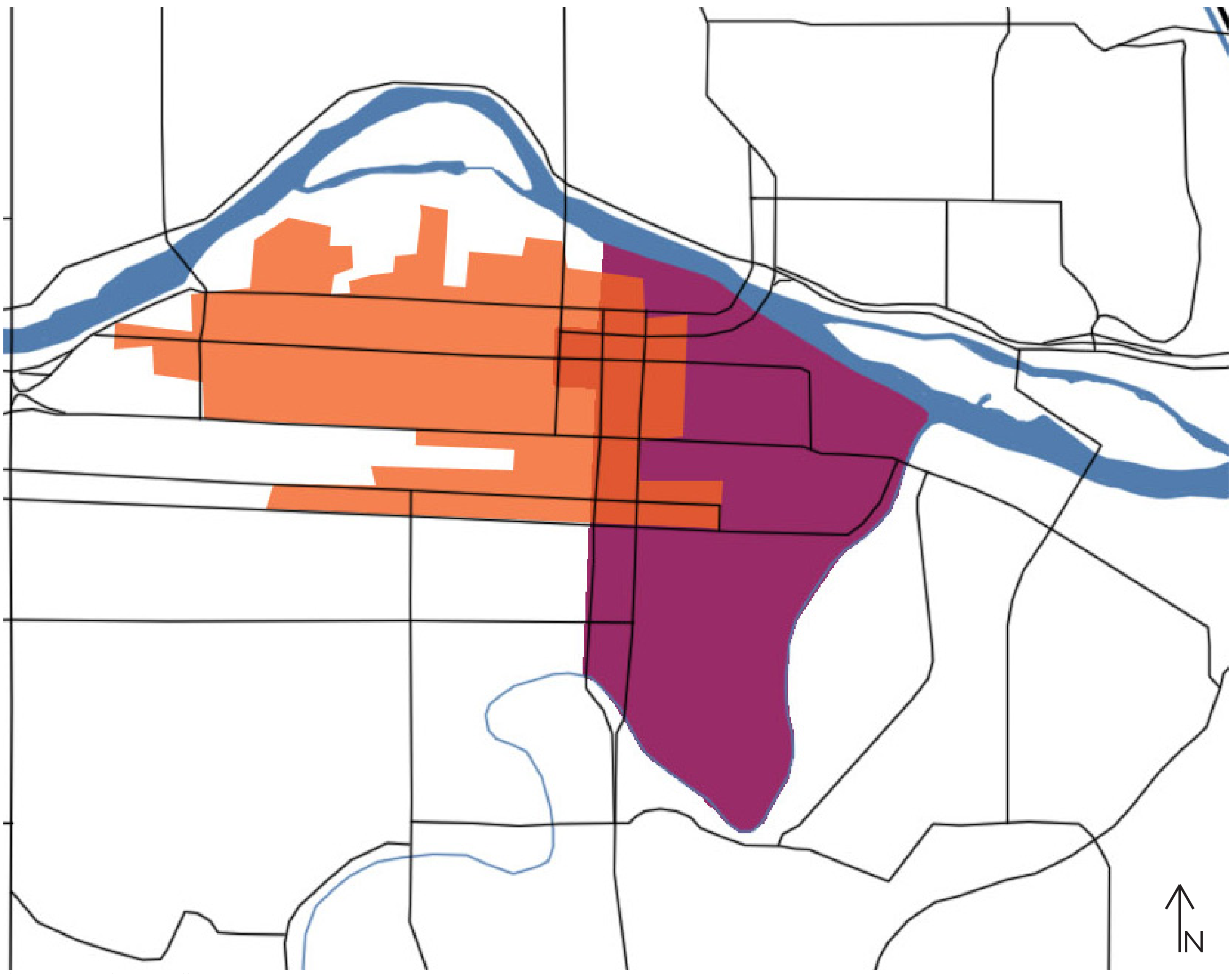


fig. 3.53 Calgary, Alberta.

Urban Areas *Water* *East Village Redevelopment Area*

- rehabilitation of this area will expand the walkable downtown area
- design provides new waterfront experiences for local residents
- improving the neighbourhood will bring in more tenants

- program definition is vague and widely tenant-dependant
- only some specific historic buildings are mentioned in the design plan, the future of all is uncertain

fig. 3.54 Don Lands site design

fig. 3.55 landscape in progress

LOWER DON LANDS

As the Toronto waterfront receives long-anticipated design attention to integrate recreational space on the previous industrial lands, the Port Lands Estuary is being reworked into an urban recreational hub. Thia large planning and development project competition was won by Micheal vanValkenburgh Associates, and is under construction in anticipation of the Pan and Parapan Am games in 2015. [29] The former industrial port lands had been plagued by flood risk, lack of infrastructure, and separation from the downtown core as well as site soil contamination. The ecologically complex proposed design provides public transit route proposals as well as natural and engineered flood-prevention means to protect the new development from the Don River. [30]

This ambitious initiative to reoccupy the forgotten landscape of the Port Lands was expensive and time consuming to complete. The City of Toronto, however, was able to see the value of the previously neglected lands and invested in this redevelopment project for the improvement of their waterfront.

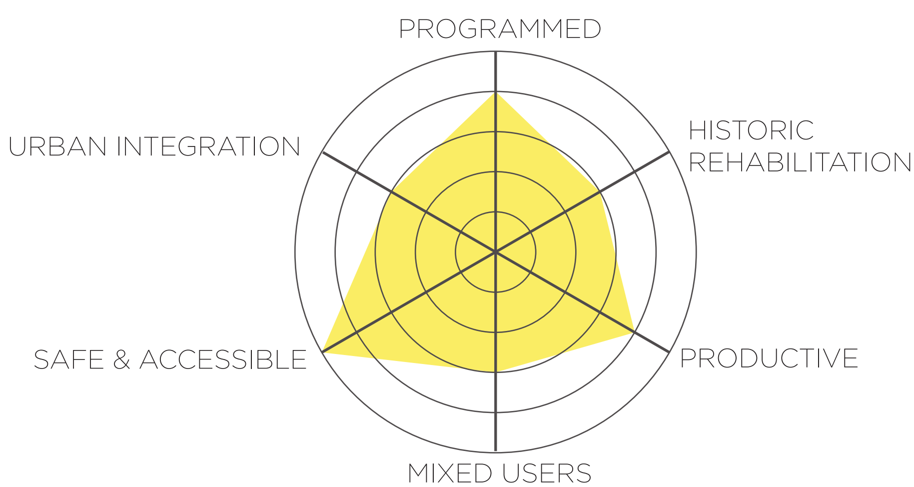


fig. 3.56

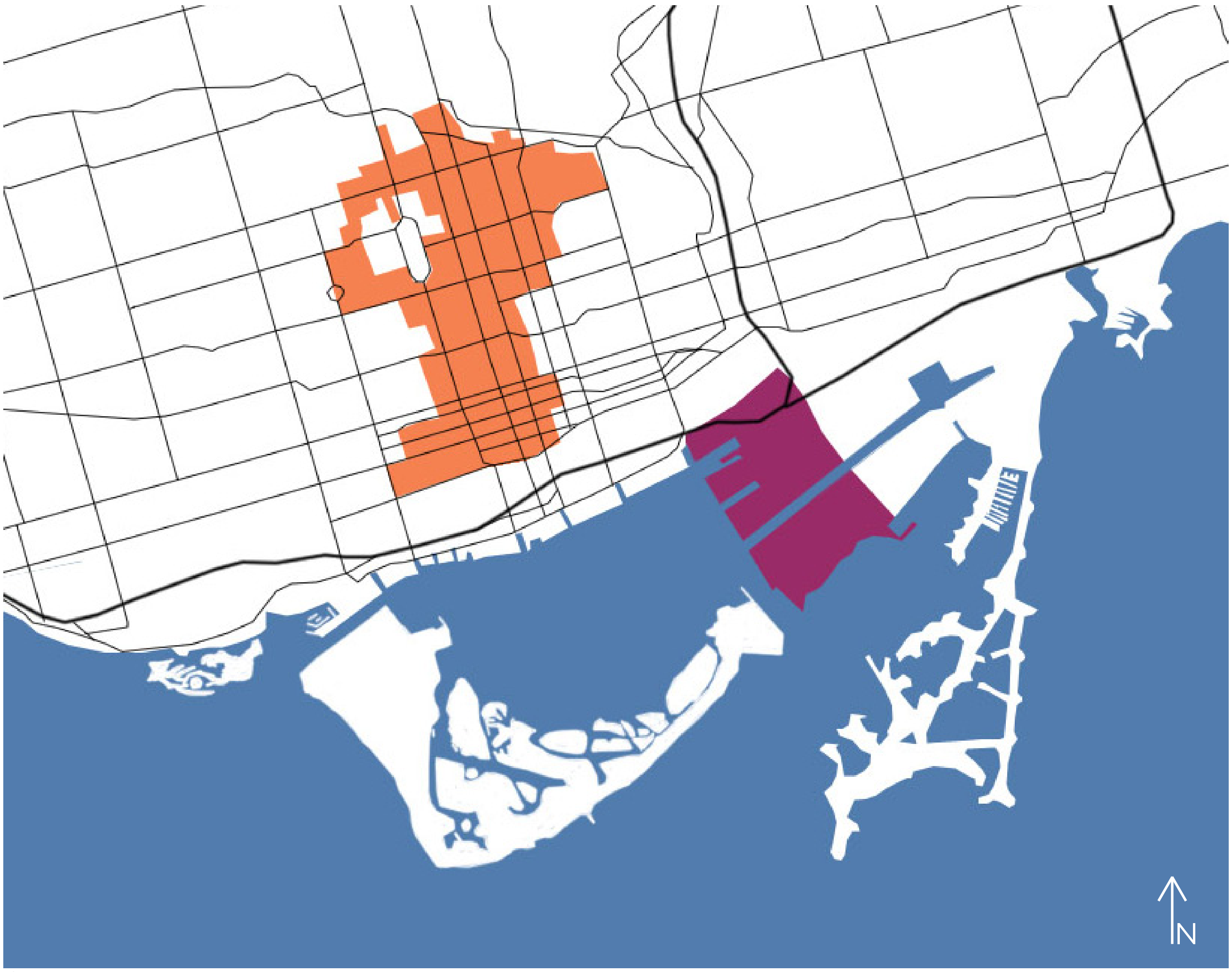


fig. 3.57 Toronto, Ontario.

Urban Areas *Water* *Lower Don Lands*

(+)

•program includes variety of uses and scales
•design provides new waterfront experiences for visitors
•redevelopment will improve site accessibility and increase public use

(−)

•new development remains segragated from neighbourhoods by major roads
•the design proposal does not celebrate the history of the port lands


fig. 3.58 Tannery Design Render


fig. 3.59 Previous Tannery Boilerhouse

THE LANG TANNERY DISTRICT

Built in 1953 as a facility for stretching and tanning leather, this Kitchener factory block lay derelict and abandoned due to oil and heavy metal contamination for years. Starting in 2007, speculators purchased and re-processed the city block, removing toxins and unsightly additions, until only hip leasable spaces remained. [31] The enormous complex now contains a wide variety of office and retail spaces, and is fast becoming a recognizable icon within the downtown core of Kitchener. Much of the city centre contains heritage buildings of quality construction, some of which have been purchased for similar redevelopment, while others lie abandoned. In the wave of loft-condominium redevelopment, this commercial use project provides potential for growth of the city as a workplace.

The Tannery has been a great success in bringing new creative businesses into Kitchener, and encouraging further development. Although it was private speculation and not municipal intervention which initiated the Tannery redevelopment, the city will continue to reap the benefits regardless.

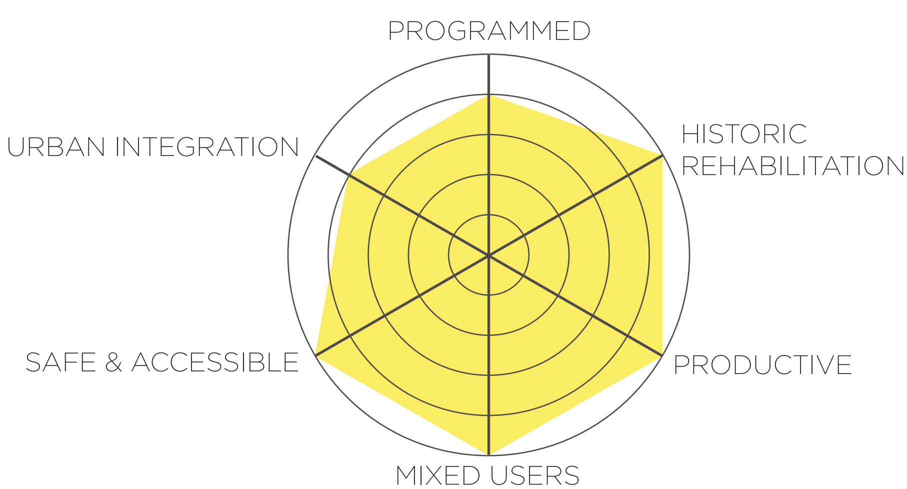


fig. 3.60

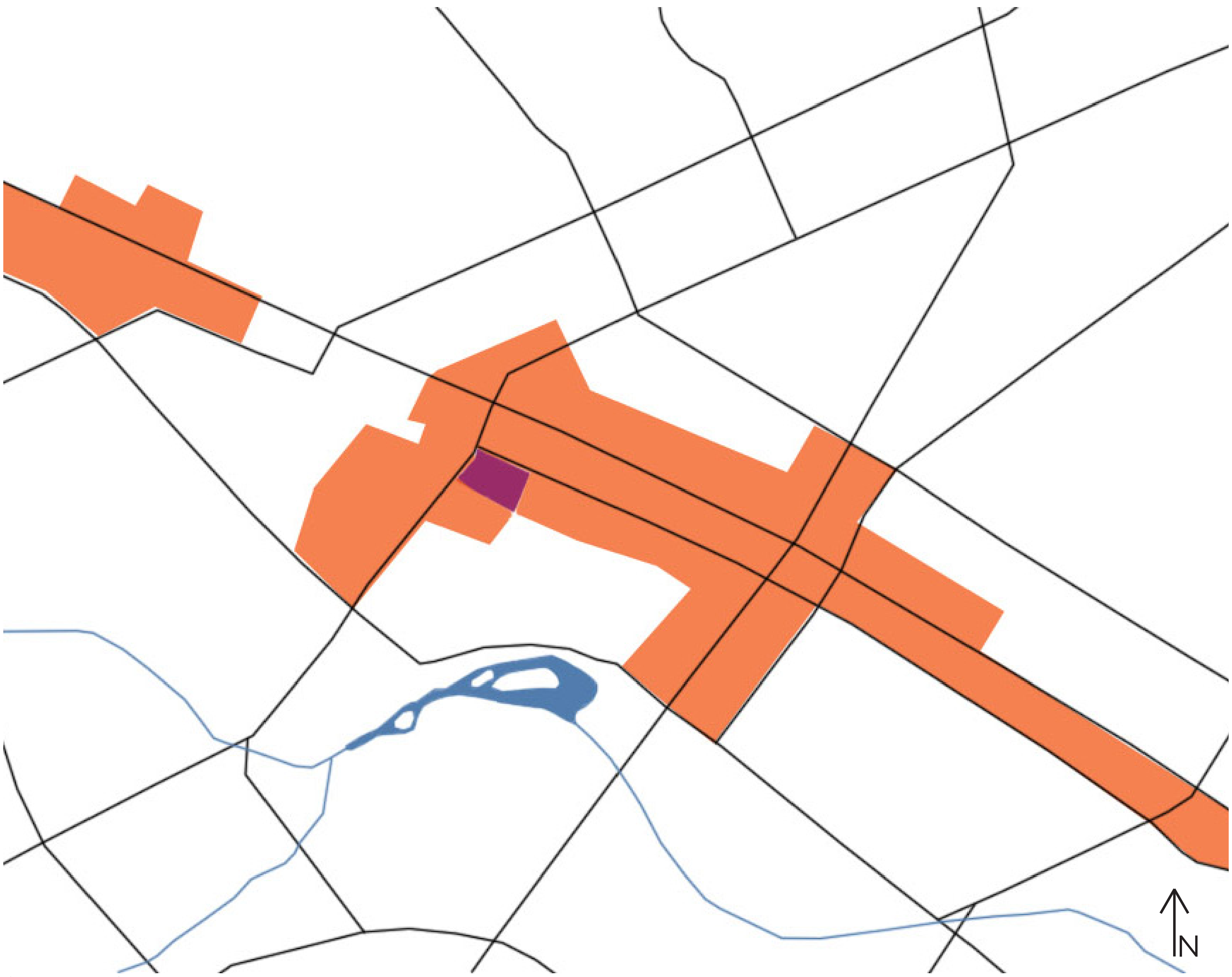


fig. 3.61 Kitchener, Ontario.

Urban Areas *Water* *The Tannery*

•program includes variety of uses and scales
•design provides new destination off of King Street
•redevelopment includes most of the existing historic construction

•program relies heavily on tenant uses

CANNON KNITTING MILLS


fig. 3.62 Cannon streetfront façade


fig. 3.63 interior mill conditions

The Cannon Knitting Mills in Hamilton consists of about five masonry buildings clustered together just outside of downtown Hamilton. Built between 1854 and 1950, the heavy timber interiors are structurally sound, despite the derelict status of the mechanical systems, painted surfaces, and windows. [32] The post-industrial nature of the building and its past uses raise environmental concerns for the future of the building. In the economically depressed district of the city, this facility sat boarded up for years, becoming an insurance nightmare for the owners and a hazard for inquisitive local youth.

Recently the site has been purchased by a developer with assistance from the city. The proposal for the Cannon Knitting Mills is being designed by a local architect in association with community groups. [33]

The real victory of the Cannon Knitting MIlls site is in the identification of the value of the facility by the city itself and the protection afforded the building even while in terrible disrepair. This apparently derelict site in an extremely undesirable location was given a chance to become an institution, a cultural hub, a commercial storefront, a hip residential loft, or any number of potential developments.

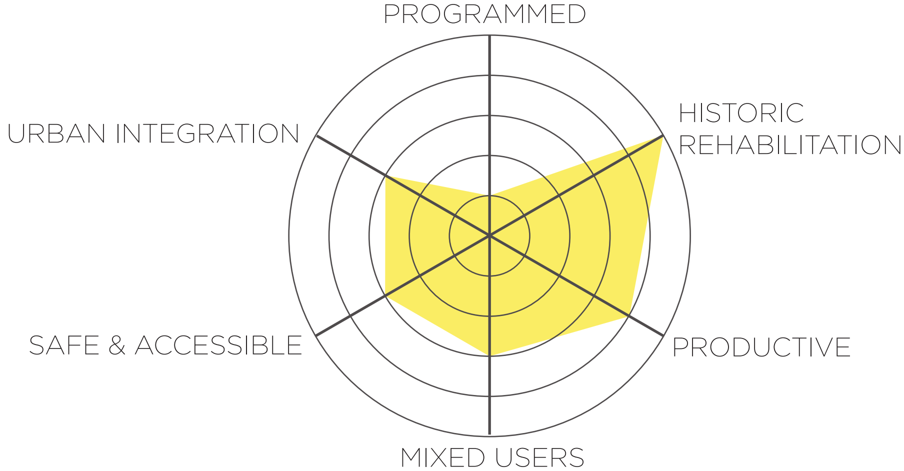


fig. 3.64

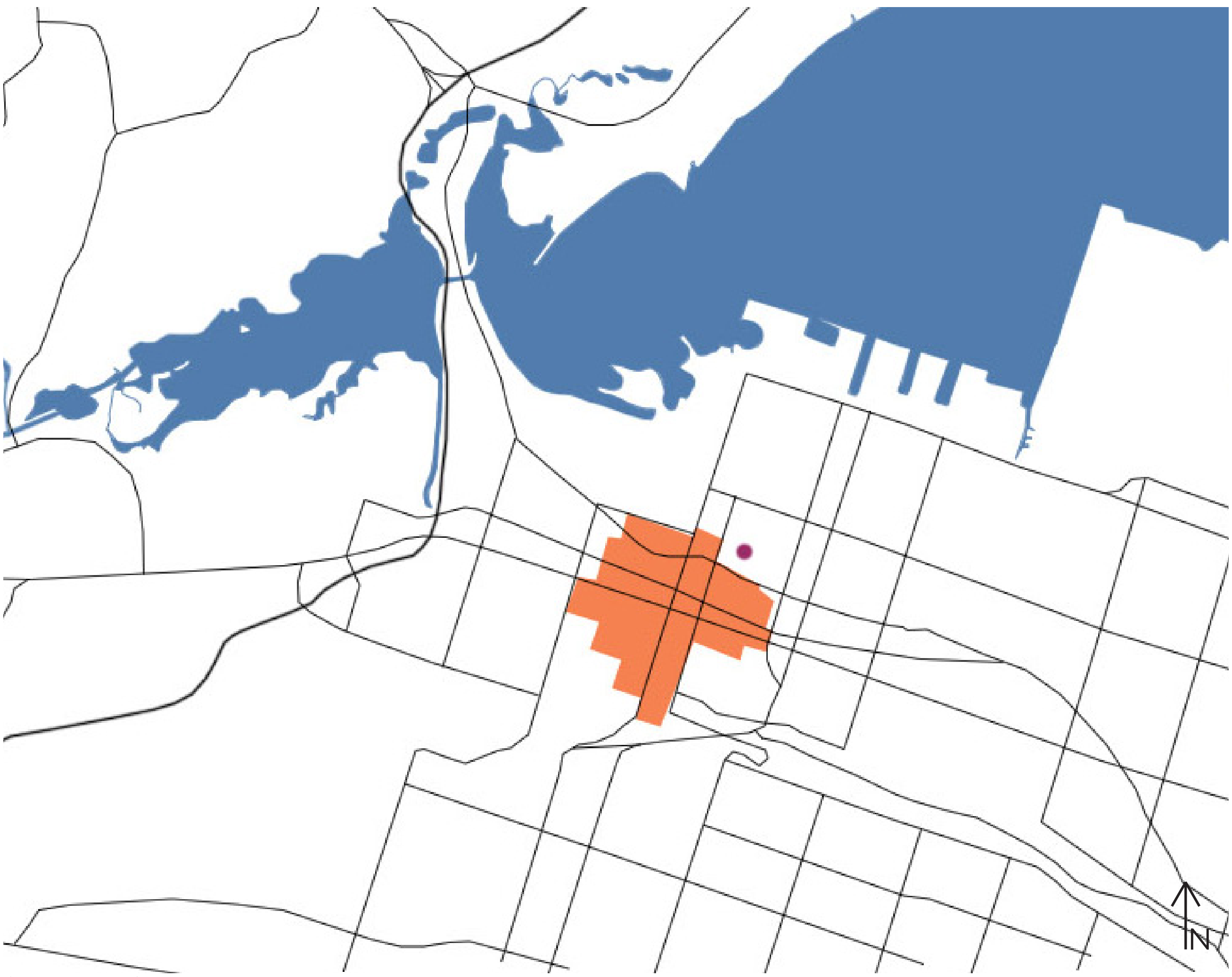


fig. 3.65 Hamilton, Ontario.

Urban Areas *Water* *Cannon Knitting Mills*

•would provide a destination apart from down town
•redevelopment would include most of the existing historic construction
•neighbourhood is in need of revitalization

•program is open-ended and undefined, allowing tenants to design the end-use
•currently the site is restricted-access, preventing local imaginations to develop a proposal

fig. 3.66 aerial photo of the highline

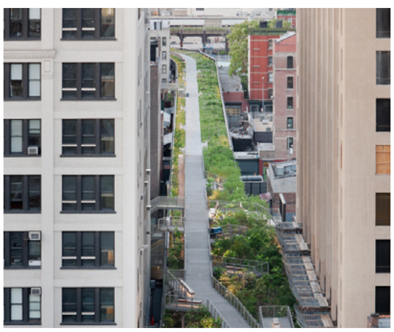


fig. 3.67 aerial photo of the highline

THE HIGHLINE

Over twenty years, a decomissioned elevated freight rail bed in western Manhattan self-seeded into a wild surface, attracting the appreciation of local adventurers and photographers. In 1999 these enthusiasts created the 'Friends of the High Line', a non-profit organization which aimed to protect the infrastructure from demolition. Despite several voices calling for the eyesore to be removed, the City of New York sympathized with the public interest and enabled the rail bed reclamation through the federal rails-to-trails legislation. [34] Through a series of competitions, the City and Friends of the High Line developed interest and creative input towards the final proposal. In the final iteration, the design was phased to allow early access for the community surrounding the park. [35]

The High Line has been reclaimed from the abandoned, contaminated, industrial relic that it had become, into a famous City park, celebrating urban life and social interation. By investing time, effort, and money into the infrastructure, the City revitalized an otherwise forbidden passage through New York. Tourism brought into Manhattan by the High Line is a direct result of the passion of the public voice, forcing the City into recognizing the value of a forgotten rail bed.

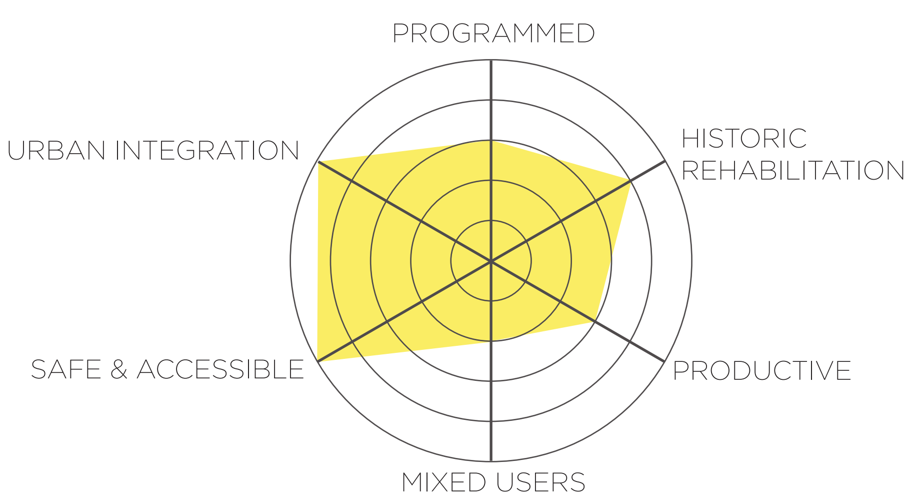


fig. 3.68

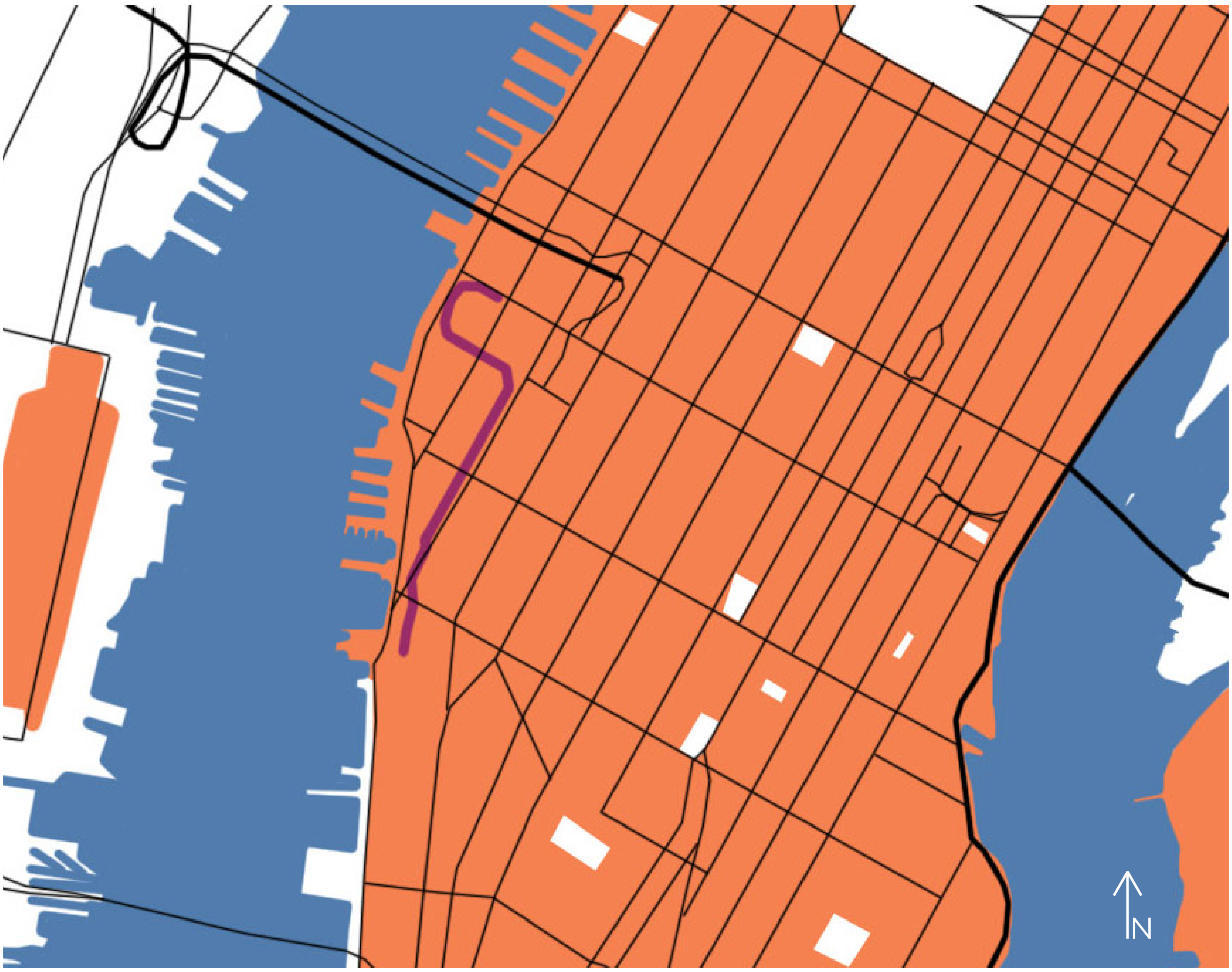


fig. 3.69 New York City, New York.

Urban Areas *Water* *The Highline*

⊕

•elevators and regular access points maintain a connection to the city

•the park is surrounded by potential users within a residential neighbourhood

⊖

•the program for the site is very loose, limiting productivity potential to ad-hoc visitor interventions

•the reinvention of the rail lines is less of a historic site rehabilitation, and more of a park creation


fig. 3.70 view across to Québec City


fig. 3.71 visitors in the landscape

PARC CARTIER-BRÉBEUF

This low area along the Rivière Saint-Charles has been used for dumping and fill in recent years, but has great historical significance to the European settlement in Québec. The small outlet of the Rivière Lairet into the Rivière Saint-Charles is known to be the first over-wintering site of Jacques Cartier in Canada, as well as the site of the first Jesuit residence in Québec. With a history dating back as far as 1535, it is alarming to think that the park had deteriorated into a largely contaminated site void of wildlife and hazardous to human visitors. [36]

Deemed a National Historic Site of Canada in 1972, the site became a major focus for remediation and reclamation efforts. Upon completion, the park was awarded an Award of Excellence from the Canadian Society of Landscape Architects for its ecological development and cultural awareness components. [37] The historical and cultural value of the land, as well as the growing neighbourhood health concerns were deemed incentive enough to remediate the site. The great effort and expense of the project was undertaken for the benefit of the community, recognizing the value of neighbourhood and ecosystem health as well as cultural education.

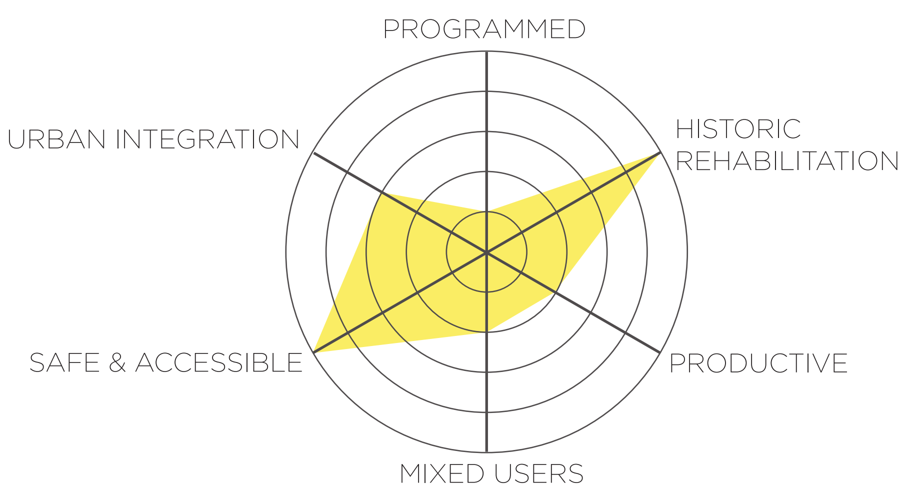


fig. 3.72

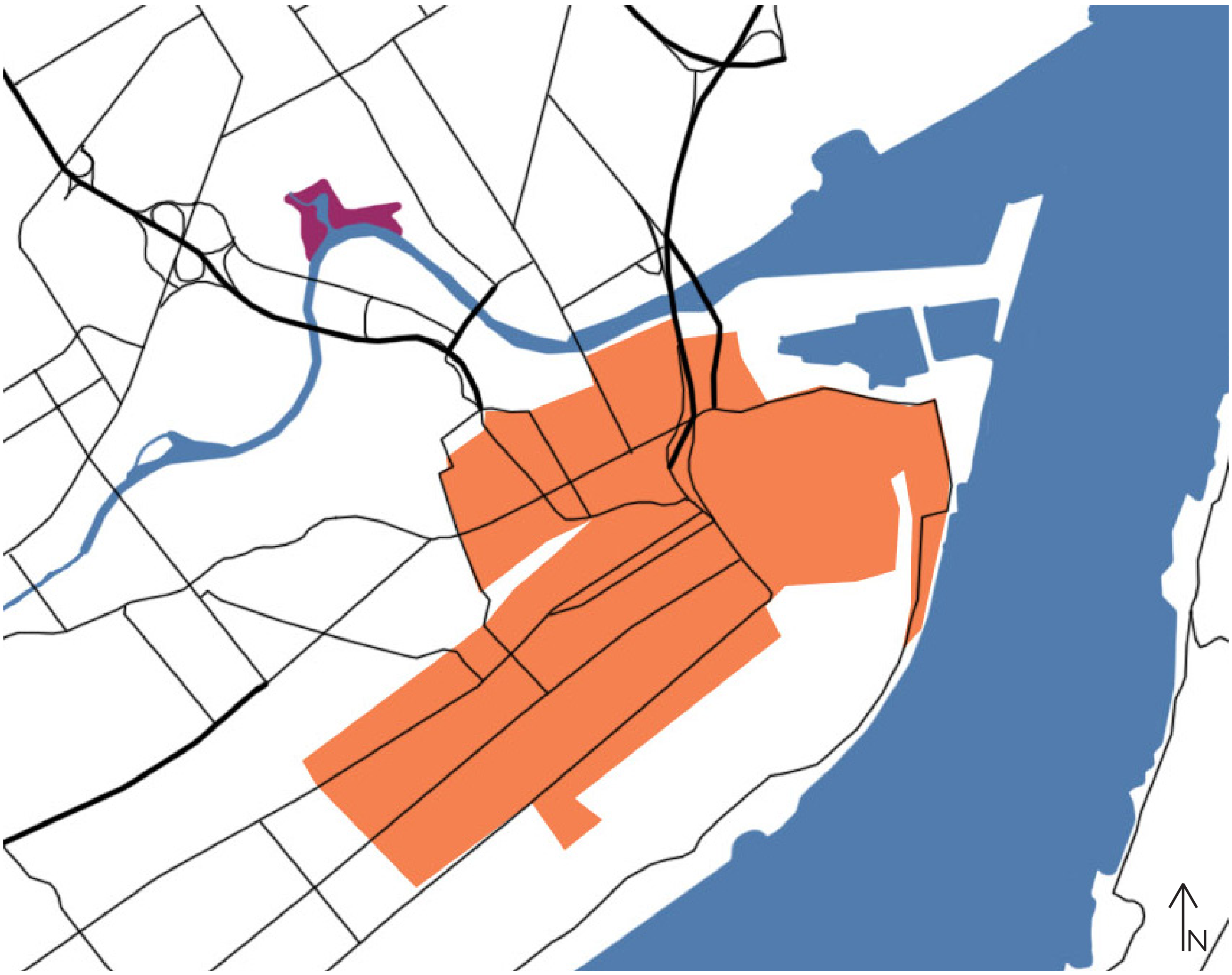


fig. 3.73 Québec City, Québec.

Urban Areas · Water · Parc Cartier-Brébeuf

⊕
- historic rejuvenation was the initiator of this rehabilitation project
- park design was intentionally barrier-free

⊖
- a few monuments are the only program elements in the park
- parkscape is not productive

CONTAMINATED SITE REDEVELOPMENT CASE STUDY CONCLUSIONS

The increased value of properties in previously undesirable areas has created a precedent for redeveloping contaminated lands. In these case studies there are a number of qualities that stand out as examples of successful techniques to redevelop sites. The exemplary qualities include:

•integrating the new development with an existing urban centre

•programming the site to accommodate new use while celebrating any historical presence on site

•creating productive spaces for community use and development

•safely inviting the public into previously toxic sites which have been entirely decontaminated

The redevelopment of contaminated sites is similar to the decontamination projects for the reuse of closed landfills. Despite not always being in historic sites or near urban centres, landfill remediation projects designers can benefit from applying these qualities to their work. For this reason, the final design for the closed landfill in Chapter 6 applies these principles where applicable.

EXISTING SOLUTIONS SUMMARY

Understanding the methods that currently are used to reduce landfill volume on site provides insight into the reclamation process for closed landfills. By combining the strengths of material recovery and waste-to-power incineration in a landfill mining operation, resource recovery would be maximized.

Properly lining landfill sites provides the best protection for communities and ecosystems from landfill contaminants. The excavation of a closed landfill for mining purposes provides access to the under-layers of the garbage, allowing for decontamination measures and the replacement of garbage in new, lined, landfills.

The case studies of closed landfill reuse projects provide insights into successful techniques to revitalize previously restricted sites. The contaminated site case studies show how the value of a toxic site can be increased through redevelopment and decontamination. The methods used in all the projects studied were specific to their sites, but prove useful for designing a reclamation plan for closed landfills.

Lastly, although each solution that we currently employ may have shortcomings, it is the fusion of all the strengths of these techniques that creates a new system of approach for landfill reclamation. This hybrid approach is used in the redevelopment proposal in Chapter 6.

NOTES

1. Rathje, William, and Cullen Murphy. 1992. Rubbish! The Archaeology of Garbage. New York: HarperCollins. p92

2. Rathje, William, and Cullen Murphy. 1992. Rubbish! The Archaeology of Garbage. New York: HarperCollins. p104

3. Krook, Joakim, Niclas Svensson, and Mats Eklund. 2011. "Landfill mining: A critical review of two decades of research." Waste Management, November 13: 513-520

4. Strange, Kit, and Dean Petrich. n.d. "Landfill Mining." Environmental Alternatives. Accessed October 18, 2011. http://www.enviroalternatives.com/landfill.html.

5. Westerhof, Jake, interview by Author. 2011. Canada Fibres Ltd. Hamilton Site Visit (October 4).

6. McDonald, Bruce, interview by Author. 2011. Guelph Material Recovery Facility Site Visit (October 20).

7. Birmingham, Brendan. 1999 . Environmental risks of municipal non-hazardous waste landfilling and incineration. Technical Report Summary, Toronto: Standards Development Branch, Environmental Sciences and Standards Division, Ontario Ministry of the Environment.

8. Clarke, Marjorie J., Marten de Kadt, and David Saphire. 1991. Burning Garbage in the US. New York: INFORM, Inc. p52

9. Clarke, Marjorie J., Marten de Kadt, and David Saphire. 1991. Burning Garbage in the US. New York: INFORM, Inc. p74-75

10. Clarke, Marjorie J., Marten de Kadt, and David Saphire. 1991. Burning Garbage in the US. New York: INFORM, Inc. p41

11. Wolman, David. 2012. "The Trash Blaster." Wired 118-123, 130.

12. Rathje, William, and Cullen Murphy. 1992. Rubbish! The Archaeology of Garbage. New York: HarperCollins. p104

13. Upper Ottawa Street Landfill Study Committee. 1983. The Investigation of the Upper Ottawa Street Landfill Site. Interim Report, Hamilton: Government of Canada. p13

14. City of New York. n.d. City of New York Parks & Recreation, Freshkills Park. Accessed January 4, 2013. http://www.nycgovparks.org/park-features/freshkills-park#tabTop.

15. Rathje, William, and Cullen Murphy. 1992. Rubbish! The Archaeology of Garbage. New York: HarperCollins. p90

16. Upper Ottawa Street Landfill Study Committee. 1983. The Investigation of the Upper ottawa Street Landfill Site. Interim Report, Hamilton: Government of Canada. p7

17. City of New York. n.d. City of New York Parks & Recreation, Freshkills Park. Accessed January 4, 2013. http://www.nycgovparks.org/park-features/freshkills-park#tabTop.

18. Stewart, Scott. 2005. Status Report on City's Closed Landfills. Information Report, Hamilton: Public Works Department. p12-13

19. Toronto and Region Conservation for The Living City. n.d. History of Tommy Thompson Park. Accessed January 9, 2013. http://tommythompsonpark.ca/home/history.dot.

20. City of Montréal. 2013. Environnement: Revalorisation du CESM. Accessed February 20, 2013. http://ville.montreal.qc.ca/portal/page?_pageid=7237,75372019&_dad=portal&_schema=PORTAL

21. Ralph, Jolyon, and Ida Chau. 2013. Miron Quarry, Montreal, Quebec, Canada. February 19. Accessed February 22, 2013. http://www.mindat.org/loc-16409.html.

22. Shaw Media Inc. 2011. "Biothermica gains control of Gazmont power plant; adds stakes from SNC, Caisse." Global Toronto. July 13. Accessed February 20, 2013. http://www.globaltoronto.com/biothermica+gains+control+of+gazmont+power+plant+adds+stakes+from+snc+caisse/4294976427/story.html.

23. Harnik, Peter, Michael Taylor, and Ben Welle. 2006. "From Dumps to Destinations: The Conversion of Landfills to Parks [Forum]." Places 18.1 83-88. p86

24. Philippine Council for Industry, Energy and Emerging Technology Research and Development. 2012. "Example- Electricity Generation Jordan Valley Landfill, Hong Kong." Global Methane Initiative. Accessed February 22, 2013. http://www.pcieerd.dost.gov.ph/images/pdf/gmi/06_lfg%20 technologies_lloyd_2.pdf

25. Government of Hong Kong. 2012. Municipal Solid Waste. August. Accessed February 22, 2013. http://www.gov.hk/en/residents/environment/waste/msw.htm.

26. Government of Hong Kong Leisure and Cultural Services Department. 2010. Jordan Valley Park. Accessed February 22, 2013. http://www.lcsd.gov.hk/parks/jvp/en/index.php.

27. Calgary Municipal Land Corporation. 2013. CMLC Explore Projects. Accessed February 28, 2013. http://www.calgarymlc.ca/explore-projects.

28. Calgary Municipal Land Corporation. 2013. East Village. Accessed February 28, 2013. http://www.evexperience.com/discover.

29. Waterfront Toronto. 2013. Explore Projects: Lower Don Lands. Accessed March 1, 2013. http://www.waterfrontoronto.ca/explore_projects2/lower_don_lands.

30. Micheal vanValkenburgh Associates Inc. 2013. Micheal vanValkenburgh Associates Inc. Accessed March 1, 2013. http://www.mvvainc.com/project.php?id=87&c=urban_design.

31. Gooderham, Mary. 2012. "Making brownfields viable a win-win-win situation." The Globe and Mail.

32. McLeod, Meredith. 2011. "Big plans loom at old knitting mill." The Hamilton Spectator.

33. McLeod, Meredith. 2011. "Big plans loom at old knitting mill." The Hamilton Spectator.

34. Friends of the High Line. 2003. Designing The Highline. Accessed March 5, 2013. http://www.thehighline.org/competition/about.php.

35. Friends of the High Line. 2000-2013. High Line: Design Team Selection. Accessed March 5, 2013. http://www.thehighline.org/design/design-team-selection.

36. Grand Quebec. 2013. GrandQuebec: Parc Cartier-Brébeuf. Accessed March 5, 2013. http://grandquebec.com/capitale-quebec/le-parc-cartier-brebeuf/.

37. Government of Canada. 2012. Federal Contaminated Sites: Success Stories. Accessed March 5, 2013. Grand Quebec. 2013. GrandQuebec: Parc Cartier-Brébeuf. Accessed March 5, 2013. http://grandquebec.com/capitale-quebec/le-parc-cartier-brebeuf/.

4

THE CASE FOR ACTION

THE SCALE OF THE SITUATION

Before the mega-landfill boom of the 1990s, small, localized landfills were standard across the province of Ontario. These sites filled rapidly, were capped, and then closed from public access. Currently, provincial authorities monitor 1325 closed landfills, each with their individual challenges and opportunities. [1] Unnatural mounds of capped trash rise where lowlands, marshes, and old quarries once lay, and ongoing maintenance is required to control erosion and inspect decomposition on every site. Continual fluctuations in the landscape necessitates restrictions on public access, thereby denying communities entrance to whole regions of their neighbourhoods.

With so many sites to address, what can be done?

INTRIGUING CHALLENGES

The problematic issues of closed landfills also create dead zones within cities throughout Ontario. The land is considered unusable and unsafe for public access, and thus is overlooked by municipal officials. [2] Design for these spaces is limited by several factors beyond physical challenges, primarily by the availability of technical, financial, and creative resources. The possibilities of these places, however, are fuelled by their challenging nature. The heterogeneous and unpredictable nature of landfill contents, possible contamination of adjacent soils, expensive maintenance costs, and ongoing erosion control are some of the negative aspects of closed landfills. Despite these unfavourable realities, the numerous potentialities of these dormant trash mounds have inspired this design proposal. In addressing the challenges, certain design agencies are uncovered. These include a great topographic flexibility, a chance to reveal temporal changes to the site, an unlimited variety of local site conditions, and the introduction of contrasting types of users.

fig. 4.01 snails in the Upper Ottawa Street Landfill, Hamilton, Ontario

UNDERPERFORMING

The possibilities of closed landfills are fuelled by their challenging nature.

In our current solid waste management model, mounds of buried garbage register the effects of landfilling through time. Trash is moved around sites, reorganized into structurally stable piles, and begins to decompose and deteriorate in place. The packing and erosion of the landfill chronicles the changing topography of the site. The current conditions render the effects of time legible in the landscape. Since the terrain is entirely manmade, it is thus malleable to topographic design opportunities.

For as many closed landfill sites exist, there are as many variations in site conditions. Where one may have a watercourse, another may have critical residential adjacencies. Every site provides new restrictions and advantages, sparking creativity in design. The contents of each landfill are equally varying. The final topography of a mined site would be greatly affected by the volume of specific types of buried goods. For example, the larger the quantity of recyclable materials buried, the greater the immediate drop in landfill volume. This factor of uncertainty brings a challenging twist to any design proposal on a closed landfill site.

The industrial, dangerous, and foul nature of landfills is in direct opposition to the surrounding residential communities. It is this clash which inspires the injection of the public into these closed places. The current denial of access can be resolved, though it would require intensive reformation. Defying the tradition of concealed sealed landfills is a critical component of this rehabilitation design proposal.

PRIORITIZING ACTIONS

A clear hierarchy must be made with respect to the challenges which this design must overcome. Three key tasks are here numerically prioritized, to maintain a consistant design direction.

1: Above all else, the landfill must be made publicly accessible.

The closed-off regions of cities must be opened up to the communities in which they exist. While bringing controversy to the design, the coexistence of the public and the mining operations on site introduces an educational component to the project. The community is welcomed into the previously dead zone, and is able to experience the landfill mining safely. Waste reduction, recycling (material recovery), landfill mining, and local ecosystems are all made intellectually available to the public on site.

2: The environmental damage caused by landfilling must be reversed.

In excavating closed landfills, we will have the chance to properly seal off toxins from ecosystems which are quickly becoming contaminated. Buried trash requires a highly engineered liner below it to ensure that the garbage and leachate is contained. [3] Unfortunately, many of the closed landfills in Ontario were operating before bottom liners were legislated as mandatory. [4] In mining the landfill, it provides access to install the necessary sanitary liner while the contents can be sorted and processed or contained as required. Natural systems that had been disrupted by the landfill operations can be restored to their original patterns or revised to include the modified landscape. An ecosystem can be recreated on the site which encompasses a sealed sanitary landfill yet allows community and environmental systems to flourish with minimal risk of contamination.

3: The resource value of landfilled materials must be exploited.

While the contents of the landfill are exposed, the materials are easily accessible for sorting and reprocessing. Recyclable materials, once recovered, can be introduced into the material stream.

EXPLOITABLE
There is a financial benefit to the mining of garbage, as well as a savings to be had by limiting virgin material mining.

The value of these goods on the market varies, but there is a financial benefit to the mining of these goods, as well as a savings to be had by limiting virgin material mining. Also contained within the garbage is readily combustible material which, upon incineration, would produce electricity. Despite not being the chief intention of this project, the economic potential of landfill mining cannot be underestimated.

With the combined strengths of the existing strategies covered in Chapter 3, how can we act on these priorities?

IDENTIFYING CRITICAL CONDITIONS

The current state of linerless landfills varies from site to site. All closed landfills, however, are in need of a proper liner to protect the environments surrounding them. The excavation of closed landfills in order to install a base liner is the most effective method to control environmental contamination. Municipal waste management solutions have been quick-fixes and patches compared to the necessary final lining solution. Starting with the worst offenders, closed landfills must be excavated and lined to prevent further contamination of natural and man-made ecosystems.

Reclaiming closed landfill sites requires vast amounts of physical and financial resources. Even working through the closed landfills within one city would take years of work, rotating equipment through the sites and phasing interventions to suit local needs. Provincial authorities need to be able to allocate resources to municipalities in dire need of landfill remediation. In order to begin such a large undertaking, we need to be able to identify the most critical site conditions.

fig. 4.02 the Upper Ottawa Street Landfill from Stone Church Road East

Information about each landfill operated within a Province, Territory, or State should, by legislation, be chronicled in some form. Location, ownership, operations, waste type, and age of landfill are all categories of data held by the Ministry of the Environment in Canada. [5] Unfortunately, further research must be done at an individual level to ascertain information about contents, maintenance regimes, or seal state. A thorough study of site conditions must be undertaken before the critical sites can be identified.

Every closed landfill has issues. Seal maintenance, erosion control, and leachate dispersion are just a few of the many identifiable problems municipal operations teams face when dealing with closed landfills. However, in order to make the greatest difference in site reclamation and decontamination as quickly as possible, the worst offenders must be dealt with first. Each site must be evaluated in the same way, using the same criteria so that the landfills posing the most danger to communities can be identified.

Criteria for judging the severity of problematic closed landfills vary depending on the site conditions. Simply knowing if there is a liner, if there is a leachate collection system, or what the cap material is, is not enough context for analyzing the effect a site may have on a neighbourhood. Landscape, ecology, and community conditions must also be considered in this census.

The following list of conditions is necessary to identify the most critical closed landfill sites in a region compiled from spatial, environmental, and technical research. Figure 4.02 on the following page gives a visual representation of the sliding scale between critical and less urgent conditions.

DANGEROUS

The excavation of closed landfills in order to install a base liner is the most effective methos to control environmental contamination.

fig. 4.03 view beyond the Red Hill Creek from the top of the Upper Ottawa Street Landfill

CLOSED LANDFILL CONDITIONS

CRITICAL

LINER CONDITION	WITHOUT LINER	landfill built on permeable soils: *leachate migration is of greater concern*
	WITH LINER	liner in poor condition or constructed of unreliable materials: *leachate migration is of greater concern*
ANNUAL PRECIPITATION		landfill in an area of high annual precipitation: *leachate migration is of greater concern*
WATER TABLE DEPTH		landfill in an area with a high water table: *leachate migration is of greater concern*
ADJACENT ECOLOGIES		landfill in close proximity to a water source or flowing water, environmentally significant areas or habitats: *contamination of ecologically sensitive areas is of greater concern*
CONTENTS KNOWLEDGE	KNOWN	contents are known to be toxic or in unreliable containers: *contamination of adjacent areas is of greater concern*
	UNKNOWN	contents are entirely unknown, possibly toxic: *contamination of adjacent areas is of greater concern*
ADJACENT RESIDENTIAL CONDITIONS		landfill in close proximity to a residential neighbourhood: *contamination of residential areas is of greater concern*
PUBLIC ACCESS		landfill site entirely forbidden to the public: *barring the public from a portion of their neighbourhood is a concern*

LESS CRITICAL

landfill built on relatively impermeable soils:
leachate migration is less likely

liner in decent condition or constructed of relatively reliable materials: *leachate migration is less likely*

landfill in an area of low annual precipitation:
leachate migration is less likely

landfill in an area with a low water table:
leachate migration is less likely

landfill in a stable, closed environment:
contamination of ecologically sensitive areas is less likely

contents known to be relatively inert and stable:
contamination of adjacent areas is less likely

landfill in industrial or rural conditions:
contamination of residential areas is less likely

landfill site is partially or wholly open to the public:

fig. 4.04
CRITICAL CONDITIONS
at closed landfills are caused by a number of issues, listed on the left. Each has varying severity, resulting in the increase or decrease of urgency of action at a site. When closed sites have several critical conditions, immediate intervention is necessary. An earlier breakdown of this information was published in the proceedings of the 2013 Reclaim & Remake Conference.

What is buried beneath the sealed caps, however, remains largely a mystery. Depending on the age of the landfill and the quality of the records kept, the types and quantities of garbage buried may not be easily available. [6] The landfilled materials could range from valuable to dangerous: recyclable goods that could be extracted and returned to the material cycle, or industrial wastes contaminating adjacent soils. Each landfill is a different situation; to excavate would provide opportunities but risk uncovering contaminated sites.

UNEARTHING DESIGN STRATEGIES

In order to best expose the contradictory occupancies, the site will simultaneously be open to both landfill mining operations and recreational community functions. The interactions between the two occupancies will be delicately choreographed to limit risk to the public, while exposing as much of the mining process as possible. As their paths cross over and under each other, the boundaries blur between public spaces and industrial work site. The abrasive edge creates potential educational moments along the public route, therein both introducing public access to the formerly closed landfill, and informing the community about the process of landfill mining.

As the mining moves throughout the site, the public route may change to accommodate safety concerns, providing visitors new experiences. Once a region has been excavated and reformed, it will be made accessible. Through time, the landscape will change; at the pace of the garbage being removed and topography relocated, at the speed of the changing seasons, and other site specific phenomena. Exploiting these changes through design decisions, the site can be read differently at every visit. Every human and natural system within the landscape has a different pace, inscribing a variety of patterns on site over the

fig. 4.05 the Red Hill Creek as it passes through the Upper Ottawa Street Landfill

course of a month, a year, or ten years. What may initially have been the shifting nature of a landfill becomes the rhythm of a new accessible parkland.

NOTES

1. Ontario Ministry of the Environment. 2010. "Landfill Inventory Management Ontario." Landfill Sites-Ministry of the Environment. October 13. Accessed January 3, 2012. http://www.ene.gov.on.ca/environment/en/monitoring_and_reporting/limo/landfills/index.htm.

2. McKee, Alan, interview by Author. 2011. Upper Ottawa Street Landfill Site Visit (October 13).

3. Tammemagi, Hans. 1999. The Waste Crisis. New York: Oxford University Press. p97

4. Ontario Ministry of the Environment. 2010. "Landfill Inventory Management Ontario." Landfill Sites-Ministry of the Environment. October 13. Accessed January 3, 2012. http://www.ene.gov.on.ca/environment/en/monitoring_and_reporting/limo/landfills/index.htm.

5. Ontario Ministry of the Environment. 2010. "Landfill Inventory Management Ontario." Landfill Sites-Ministry of the Environment. October 13. Accessed January 3, 2012. http://www.ene.gov.on.ca/environment/en/monitoring_and_reporting/limo/landfills/index.htm.

6. Upper Ottawa Street Landfill Study Committee. 1983. The Investigation of the Upper ottawa Street Landfill Site. Interim Report, Hamilton: Government of Canada. p13

fig. 4.06 the overgrown landfill gas flaring facilty at the Upper Ottawa Street Landfill

fig. 5.01 Hamilton located in southern Ontario

fig. 5.02 Trenholme located in Hamilton

5

SITE CONDITIONS: WE MUST MOBILIZE

The Upper Ottawa Street Landfill in Hamilton is a closed landfill entirely fenced off from the community in which it lies. On the edge of the Niagara escarpment, the closed landfill sits at the source of the Red Hill Creek. This site is in critical condition, lacking a liner, lying on the edge of a creek, adjacent to a residential neighbourhood, and closed off from the local community.

The Upper Ottawa Street Landfill opened in 1950, and accepted residential, commercial, and industrial wastes until it was closed in 1980. Nearly three million cubic metres of garbage was laid directly on shale bedrock over thirty years. Due to lax regulations and documentation of incoming materials, there is very little knowledge of the contents of the landfill. What is known, however, is that waste from the steel manufacturing industry was deposited in the Upper Ottawa Street Landfill starting in the 1970s.

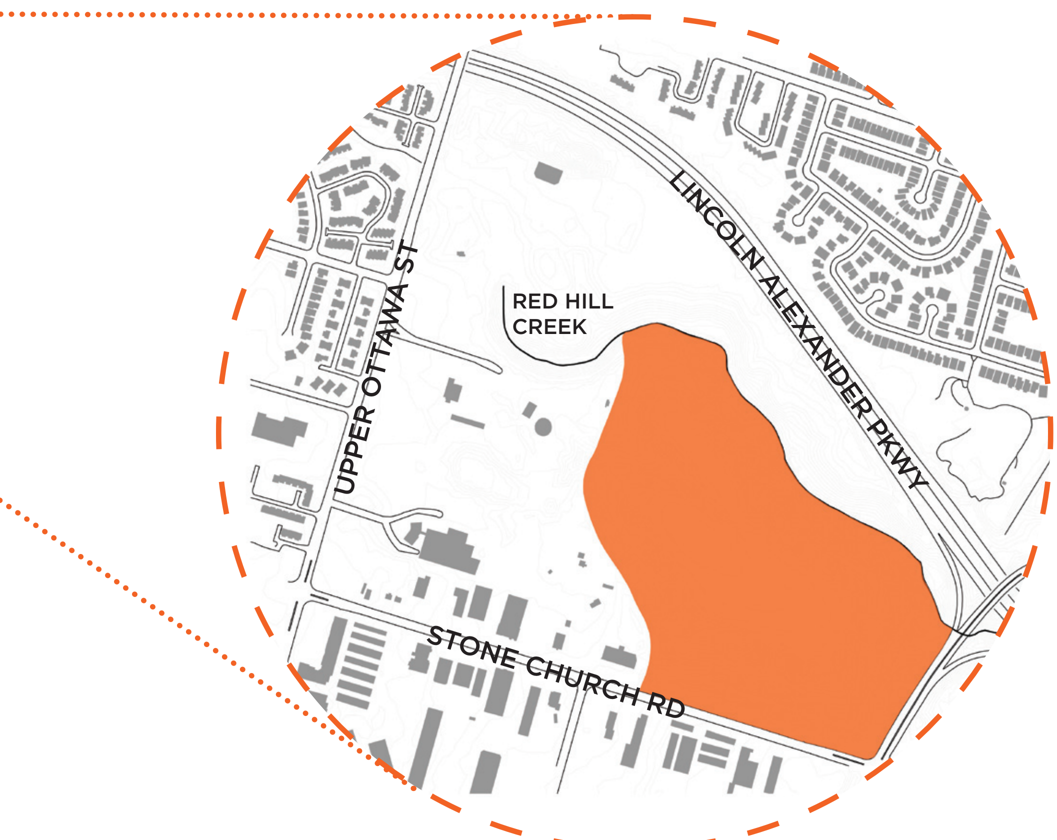


fig. 5.03 the Upper Ottawa Street Landfill located in Trenholme

fig. 5.04 Central Park, NYC total footprint 3 411 500m^2

fig. 5.05 Upper Ottawa Street Landfill total footprint 219 010.8m^2

OUR NEIGHBOUR, THE TIME BOMB: THE UPPER OTTAWA STREET LANDFILL


fig. 5.06 Upper Ottawa Street Landfill estimated maximum depth 27.9m

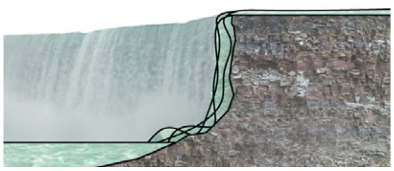


fig 5.07 Niagara Falls total height 51m

The Upper Ottawa Street Landfill, at the source of the Red Hill Creek, received residential and commercial waste for twenty-eight years until it was closed in the fall of 1980. [1] A fenced-off mound rising almost 30m above street level blocks the creek headwater from the Red Hill community. Only in the latter part of its lifetime did the authorities note the types of waste entering the landfill, so the extent of the toxicity of the buried waste is unknown. [2] Several studies have been done to analyze the state of the creek due to the dumping on this site, including air, water, and soil contamination tests. The Upper Ottawa Street Landfill is dangerous.

The Upper Ottawa Street Landfill was built on sedimentary bedrock, primarily dolomite and shale, surfaces known to have numerous horizontal fissures through which leachate may seep easily. In a 1982 study of the ground water surrounding the closed landfill, the toxins from the landfill were found nearly 500m east of Dartnall Rd. Research indicated that at that rate, the leachate may have crept as far as 2km east of the site by 2012. Albion Falls, a popular tourist destination, considered the must-see waterfall in Hamilton, lies well within that 2km radius. [3] Despite recent modifications to the concrete retaining wall on the North edge of the site, leachate will continue to migrate out of the landfill until more drastic measures are taken. In order to protect the many visitors to the Red Hill Valley and Albion Falls, this landfill must be lined properly and not rely only on retrofitted leachate collection sewers. In order to access the bedrock surface, the entire mound of garbage would have to be excavated.

DANGEROUS

The leachate may have crept as far as 2km south and east of the site by 2012

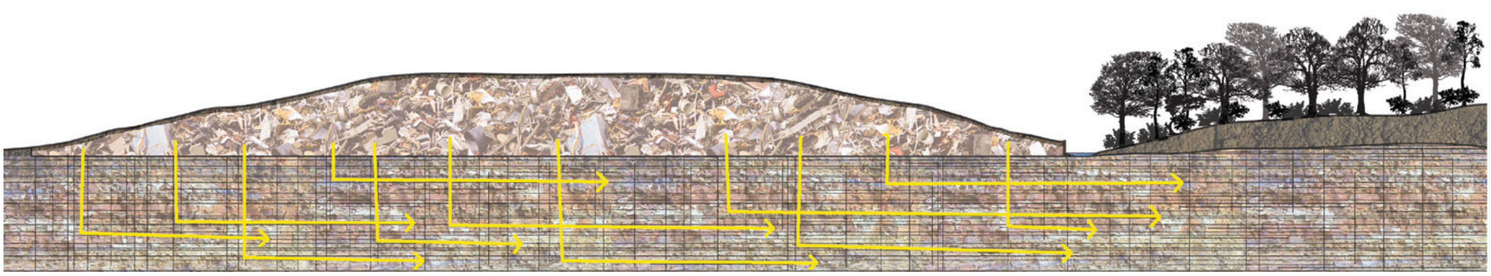


fig. 5.08 site-section diagram indicating leachate travel paths from the Upper Ottawa Street Landfill towards Albion Falls

fig. 5.09 The estimated extent of downstream contamination from the Upper Ottawa Street Landfill: 1800-2000m

- T *Templemead School*
- B *Blessed Kateri Tekakwitha Catholic Elementary School*
- C *Cecil B. Stirling School*
- L *Lincoln Alexander School*
- Li *Lisgar Jr. Public School*
- Ba *Barton Secondary School*
- R *Richard Beasley Jr. Public School*
- A *Académie Catholique Mère-Teresa*
- S *St. Daniel's School*
- J *Janet Lee Public School*
- *King's Forest Golf Course*
- *Mohawk Sports Park*
- A *Albion Falls Tourist Area*

DANGEROUS

Water carries contaminants downstream, endangering recreational parks and ecological systems.

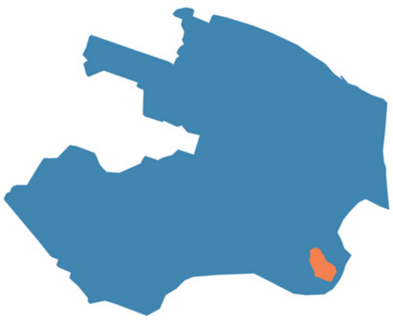


fig. 5.10 The Upper Ottawa Street Landfill watershed is 2 852 ha of urbanized land

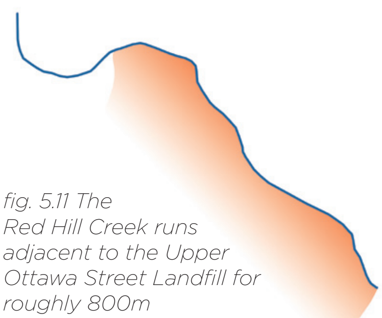


fig. 5.11 The Red Hill Creek runs adjacent to the Upper Ottawa Street Landfill for roughly 800m

The City of Hamilton is generally divided into the regions below and above the Niagara escarpment. The upper community is locally referred to as "the Mountain". Before the urbanization of the Mountain, the area naturally drained into Red Hill Creek, which in turn powered the Albion Mill as it flowed towards Lake Ontario. [4] The catchment of the Red Hill Creek, now encompasses the greater Mountain region as well as a corridor of lower Hamilton and Stoney Creek. As the Mountain is now heavily developed, rain water drains into underground stormsewers, and is fed into the creek at strategic locations. One such stormwater culvert is within the Upper Ottawa Street Landfill site.

The Red Hill Creek drops down Albion Falls, passes through the Red Hill Valley, into Burlington Bay, and on to Lake Ontario. The creek acts as a natural boundary between Hamilton and Stoney Creek and has been recognized the corridor as an environmentally significant area. [5] Until 2007, the valley was purely a greenbelt, accommodating all manner of recreation including trails, parks, and sports fields. Since the construction of the Red Hill Valley Parkway, the previously natural zones have become highly engineered to accommodate the elevated roadway and prevent valley erosion. At the top of this valley, on the boundary of the environmentally significant area, lies the closed Upper Ottawa Street Landfill. Like the rest of the Valley post-Parkway, this site has been entirely crafted by man and has the potential to develop as an extension to the existing greenbelt.

Almost three thousand hectares of the Red Hill Creek watershed collects storm water which must pass alongside the Upper Ottawa Street Landfill before flowing into Lake Ontario. The large volume of water which comes into contact with the closed landfill carries contaminants downstream, endangering recreational parks and ecological systems. The Upper Ottawa Street Landfill is dangerous.

fig. 5.12 the Red Hill Creek Valley section from Landfill to Lake

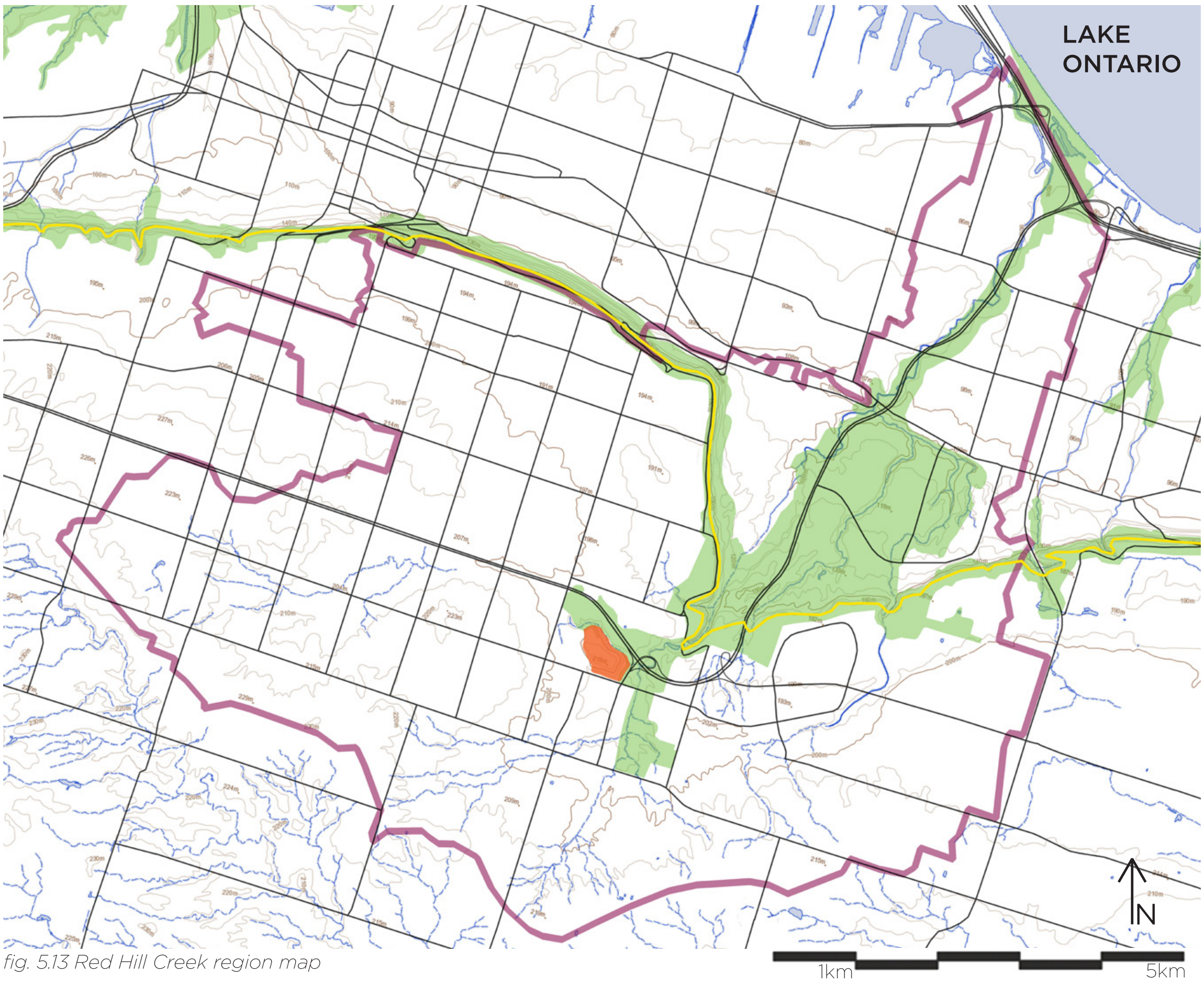


fig. 5.13 Red Hill Creek region map

Niagara Escarpment *Red Hill Creek Watershed* *Environmentally Significant Area* *Upper Ottawa Street Landfill*

KING STREET EAST

QUEENSTON ROAD

BURTON STREET EAST

QUEEN ELIZABETH WAY

LAKE ONTARIO

fig. 5.14 fencing surrounding Roads and Public Works storage barn and yard

fig. 5.15 community access from Upper Ottawa Street

fig. 5.16 municipal office adjacency

UNDERPERFORMING
93% of the Trenholme block site area is publically inaccessible.

A GAP IN THE NEIGHBOURHOOD, AN END OF A TRAIL

The forbidden block of Trenholme (bounded by the Lincoln Alexander Parkway, Upper Ottawa Street, Dartnall Road, and Stone Church Road) borders on industrial and residential neighbourhoods, as well as protected parkland. Between the several municipal uses on site, and the landfill fencing, very little of the block is publicly accessible. Small commercial and industrial shops line a stretch of Stone Church Road: the only privately owned land within the block. A number of trails terminate upon arrival at the site and skirt the landfill on the road. Razor-wire-topped chain link fence addresses Stone Church Road, Dartnall Road, and the Lincoln Alexander Parkway. Most of Upper Ottawa Street is fronted by the Municipal Traffic Operations Centre, the Forestry Department, and a Roads and Public Works storage barn and yard. The Upper Ottawa Street Landfill is underperforming.

The Red Hill Creek source is not only buried in by garbage, but also within the depths of the site. Inaccessibility is a simply resolved issue which brings up the greater problem: public safety once on site. The introduction of community visitors will bring safety challenges to the design but can ultimately provide new opportunities for education and recreation which were previously unavailable.

Particularly at the Upper Ottawa Street Landfill, where the "environmentally significant" designated land is being contaminated by a closed landfill within city limits, landfill mining and land restoration is an urgent necessity. As well, the neighbouring communities are denied access to the source of the Red Hill Creek, and Valley visitors are faced with a crude trail terminus as their welcome. The remediation of the Upper Ottawa Street Landfill will bring much needed relief to the Red Hill Creek ecosystem, introduce the site into the greater community, and tie together the recreational programs surrounding the site.

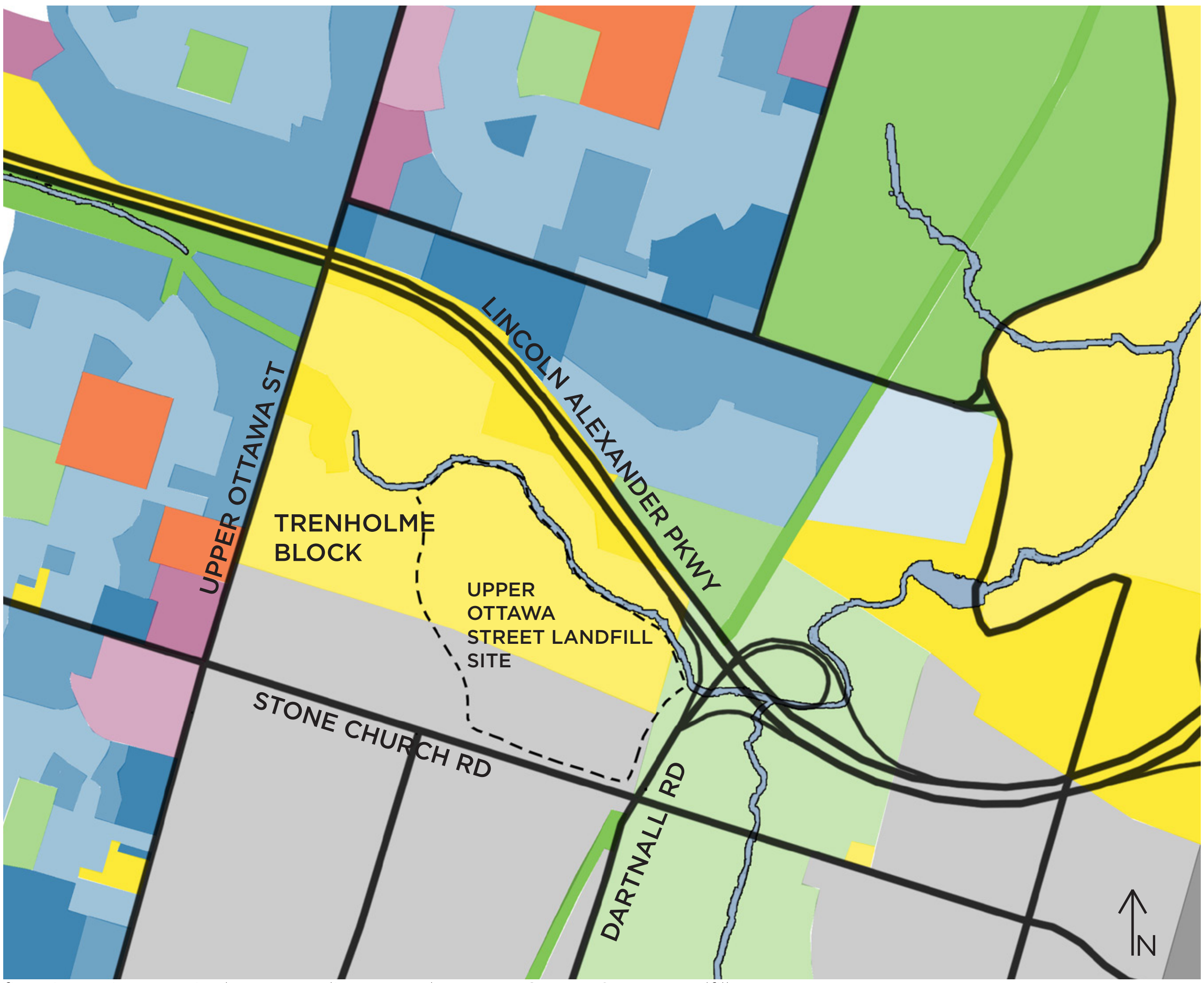


fig. 5.17 Zoning map in the areas adjacent to the Upper Ottawa Street Landfill

Parkland *Residential* *Agricultural* *Institutional* *Commercial* *Industrial*

fig. 5.18 creek side bicycling trails

UNDERPERFORMING

The southern identity of the Red Hill Creek is overshadoweed by the fenced-in closed landfill

fig. 5.19 Windemere Marsh bridge

Trails for hiking, biking, and walking meander through the Red Hill Valley from Albion Falls to the QEW. Public parkland, sports fields, and golf courses line the valley on lands once in the creek floodplain. [6] Rosedale Park, for example, sits atop a Combined Sewer Overflow facility which discharges a pungent aroma across the ball diamonds and bocce grounds. At the outlet of the creek, a bridge at Globe Park allows access to the Waterfront Trail in Confederation Park alongside Lake Ontario. To the south, a rail trail terminates just shy of the Upper Ottawa Landfill site, nearly connecting Hamilton to Caledonia. The southern identity of the Red Hill Creek is overshadowed by the fenced-in closed landfill. A true entrance, gateway, or threshold to the recreational greenbelt of the Valley is lacking on the escarpment. The Upper Ottawa site is an opportunity to create this gateway, but as a closed landfill site it remains underperforming. Visitors must instead begin at Albion Falls, ignorant of the nature of the source of the creek, never experiencing the top of the escarpment before dropping into the Valley below.

By opening the Upper Ottawa Street Landfill site to the public, and reclaiming it as creek-side parkland, a threshold may be created to introduce visitors to the creek at the source. Reconnecting trails through and across the site can provide access to previously forbidden areas, while presenting opportunities for recreation within the former landfill site. The Mountain identity is entwined in the pattern of the Red Hill Valley: without the escarpment there would be no waterfalls, no valley at all. Thus, the experience of the Red Hill Valley should extend up into the escarpment community at the former Upper Ottawa Street Landfill site.

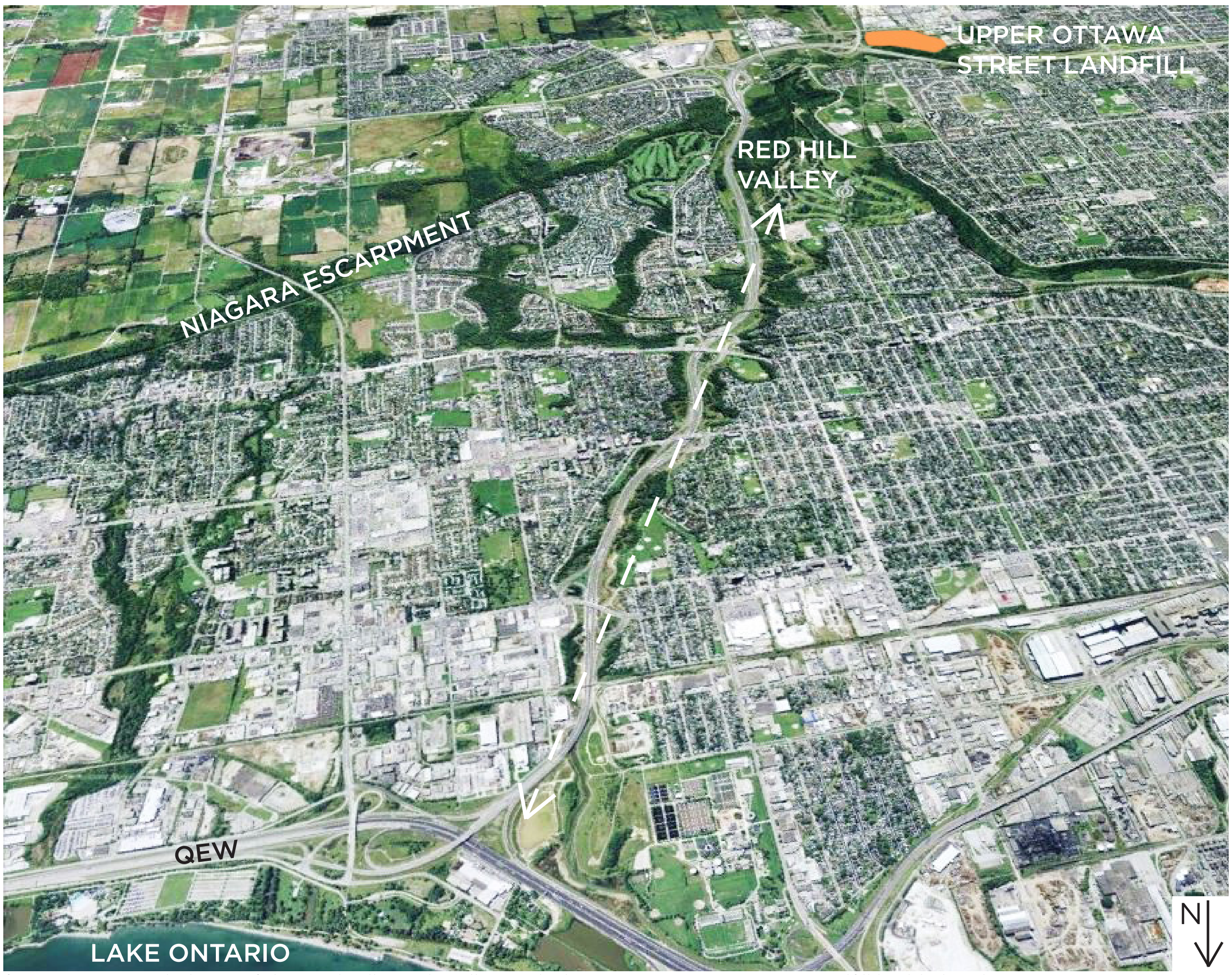


fig. 5.20 An aerial photo of the Red Hill Creek Valley, with the Upper Ottawa Street Landfill highlighted in orange

fig. 5.21 Upper Ottawa Street Landfill estimated total volume 2 975 975.64m^3

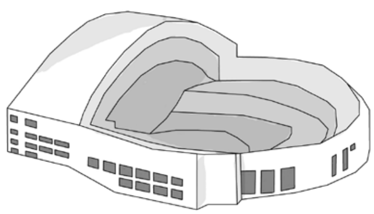


fig. 5.22 Rogers Centre interior volume 1 600 000m^3

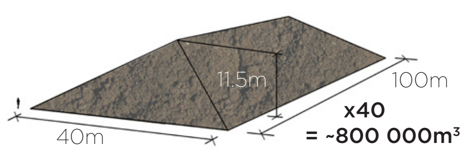


fig. 5.23 The equivalent quantity of cover soil in the Upper Ottawa Street Landfill

BURIED TREASURE

When the landfill was closed in 1980, recycling programs had not yet started in Hamilton, and in the preceding twenty eight years, plenty of recyclable materials would have been buried at this landfill. Based on data collected by the Garbage Project on landfills of similar age, it can be estimated that the Upper Ottawa Street Landfill would consist of, about 30% paper waste, 20% metals, 5-10% plastics, and 10% glass. [7] Almost three quarters of the volume of the landfill is capable of being reintroduced to the material stream, but currently remains trapped underground. Excavating the site and sorting the contents would recover approximately 1 547 500m^3 of valuable recyclable materials, thereby preventing the extraction of more virgin materials for recyclable goods.

Apart from the recyclable materials and recovered soils, the remaining volume of the waste would be approximately 16% of its original, and would require re-landfilling in an appropriate manner In some landfill mining operations, this remaining garbage is compacted and placed in a new, lined, sanitary landfill in the same place as the original site. This solution is environmentally sound, and can remain stable with regular maintenance for many years. Perhaps given enough time, the recycling process will evolve to a point which will enable the owners to once again mine the smaller landfill and reclaim even more waste than the original sort. For this reason, the remainder materials should be sorted into caches of various types of garbage: those which are likely to be recyclable in the near future, and those which are destined to be landfilled forever. Accessibility to the caches to be excavated in the future must be an integral part of the landscape design, never endangering the creek or the public. The Upper Ottawa Street Landfill is exploitable.

fig. 5.24.1 incinerator-bound

fig. 5.24.2 cover soil

fig. 5.24.3 return to landfill

fig. 5.24.4 aluminum

fig. 5.24.5 glass

fig. 5.24.6 steel

fig. 5.24.7 paper

fig. 5.24.8 plastic

EXPLOITABLE

The estimated recoverable volume of recyclable materials from the Upper Ottawa Street Landfill is nealy equal to the interior volume of the Rogers Centre

fig. 5.24 estimated volume of materials within the Upper Ottawa Street Landfill

fig. 5.25 Chedoke Creek

NUMEROUS

Each of the other closed landfills adjacent to waterways in Hamilton has seen continuous maitenance and integration into the community.

fig. 5.26 Ball Diamond at the former West Hamilton Landfill

ONE OF MANY RED HILL CREEK LANDFILLS

Despite being one of a number of closed landfills adjacent to a waterway, the Upper Ottawa Street Landfill remains of minor concern to the City. Each of the other closed landfills along a creek in Hamilton has been remediated in one way or another. Any of the Rennie Street, Brampton Street, or West Hamilton Landfills would serve as a comparable circumstance to argue the need for intervention at the Upper Ottawa Street Landfill. (See Appendix 2) Each of these other sites has seen continuous maintenance and integration into the community with public access and recreational use on the capped surface. The Upper Ottawa Street Landfill site must be brought to a level of remediation that not only meets, but exceeds that of the other local closed landfills.

CRITICAL SITE CONDITIONS SUMMARY

The Upper Ottawa landfill, as one of the numerous closed landfills on the Red Hill creek, is dangerous, exploitable, and underperforming.

UNDERPERFORMING:
As a neighbour to a large residential community, the Upper Ottawa Street Landfill offers no public access or amenity. The fenced-off municipal yards provide an uninviting street face on Upper Ottawa Street, while Stone Church Road is simply addressed with chain-link fence alongside the sidewalk. While other municipally-maintained closed landfills have been rehabilitated into parks, the Upper Ottawa Street Landfill remains underperforming within the community.

DANGEROUS:
The location of the landfill on the edge of the Red Hill Creek, its lack of liner, and permeable bedrock base, endanger the creek ecosystem and contaminate local groundwater. The proximity of a residential neighbourhood to the site also threatens the health of the community, who are widely unaware of the landfill conditions just across the street.

EXPLOITABLE:
Since the landfill was closed before recycling was commonplace in Hamilton, a large percentage of the materials buried within the Upper Ottawa Landfill are recyclable and reclaimable. The shear size of the landfill also provides a higher resource-to-equipment ratio when considering the expense of mining this landfill for recyclable materials.

NOTES

1. Stewart, Scott. 2005. Status Report on City's Closed Landfills. Information Report, Hamilton: Public Works Department. p11

2. Upper Ottawa Street Landfill Study Committee. 1983. The Investigation of the Upper ottawa Street Landfill Site. Interim Report, Hamilton: Government of Canada. p13

3. Upper Ottawa Street Landfill Study Committee. 1983. The Investigation of the Upper ottawa Street Landfill Site. Interim Report, Hamilton: Government of Canada. p57

4. Peace, Walter G. 1998. From mountain to lake: the Red Hill Creek Valley. Hamilton: W.L. Griffin Printing Limited. p136

5. City of Hamilton- Planning and Economic Development. 2013. Environmentally Significant Areas Impact Evaluation Group (ESAIEG). Accessed January 23, 2013. http://www.hamilton.ca/CityDepartments/PlanningEcDev/Divisions/Planning/CommunityPlanning/NaturalHeritage/ESAIEG/.

6. Ecologistics Limited. 1981. Red Hill Creek Valley- Proposed Recreational Master Plan. Master Plan, Hamilton: Regional Municipality of Hamilton Wentworth. p25b

7. Rathje, William, and Cullen Murphy. 1992. Rubbish! The Archaeology of Garbage. New York: HarperCollins. p104

6

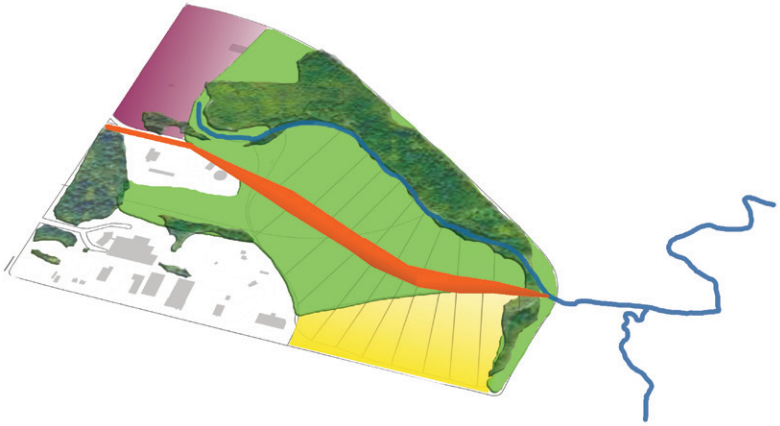
DESIGNING FOR RECOVERY

In presenting a strategy of delandfilling the Upper Ottawa Street Landfill, the key objects and infrastructures are first introduced. These components are: an infrastructural wall, a material recovery facility, and formed terrain. Once these are schematically understood, an examination will be made of the rehabilitation and programmatic potentials of these elements when they are integrated on site as a system. The particular design proposal combines the key components over time to produce public amenity, a healthy ecosystem, and recover valuable materials on site, keeping with the original project priorities set out in Chapter 4.

Behind the fences at the Upper Ottawa Street Landfill lies much more than just buried garbage. The site has a triple identity; it is a landfill, a creek source, and a forbidden landscape. The design for this site, aims to embrace these found conditions. While addressing the nature of the landfill, the creek, and the landscape, design elements respond to each other in a reciprocal manner.

The Upper Ottawa Street Landfill is currently a danger to the ecosystem and community in which it lies. To rehabilitate this site will protect the well-being of the surrounding natural and constructed landscapes. The new reduced-volume sanitary landfills on site will be lined and sealed to protect the site from further contamination.

The closed site is underperforming with respect to the adjacent residential neighbourhood, and the Red Hill Valley recreational corridor. By opening up the site to the public, reconnecting trails, and creating a new Red Hill Creek threshold, the design will actively participate in the community.



INTROVERT TURNED EXTROVERT

The block which is currently mute on the streetscape will address both the residential and industrial neighbourhoods which it faces. A threshold and gateway to the creek parkland is introduced to the west (purple), while small industrial land is created to the south (yellow). Along the creek, pathways provide public acess to the previously forbidden landscape.

THE LANDFILL MINING OPERATION

To accomodate the mining of the landfill (yellow), a critical passage through the site along the ridge of the landfill is introduced. Along this spine lies the sorting, compacting, and transporting components of the material recovery facility, while it also accomodates public access and educational components. (orange)

EXISTING KEY ELEMENTS

The topography of the landfill (yellow), a portion of the Red Hill Creek (blue), and forested land (green) are already existing on the site.

BASE SITE PLAN

The Upper Ottawa Street Landfill is surrounded by industrial land to the south, a mature residential community to the west, and a divided highway to the north, which further alienates the site from more residential neighbourhoods.

fig. 6.01 Existing to Designed Site Diagram

As a cache of resources, the Upper Ottawa Street Landfill is highly exploitable. Even using the most pessimistic assumtions of the volume of recyclable waste available, the site is rich with potential revenue (see Appendix 1). The design of the mining operation maximises material reclamation while keeping the visiting public at a safe viewing distance.

The facilities used to sort the mined garbage are transportable, designed to move across the site as it is mined, and then travel to another closed landfill to begin mining there. The singular design for this site can be used to address the numerous similar sites across the region, the province, and the continent.

EXPLOITING THE LANDFILL: RESOURCE RECOVERY

Employing the strategies covered in Chapter 3, the landfill reclamation design is a hybrid operation.

The principle of garbage excavation, and the separation of cover soils from waste is borrowed from LANDFILL MINING. Waste from that screening goes into a sorting facility, the design strategy of which is borrowed from MATERIAL RECOVERY FACILITY design. The sorted materials are then either compacted and shipped out for reuse, set aside for re-landfill, stored on site for future reycling, or incinerated. The heat from the incinerator fuels a boiler, which in turn drives a generator of electricity, which is a strategy borrowed from WASTE-TO-ENERGY incinerator plants.

First, to mine the landfill for recyclable materials, a phasing plan is created and a set of infrastructural objects are designed. These, combined, aid in the exploitation of the previously dormant site.

MINING OPERATIONS

In order to accomodate both the community and landfill mining occupancies, the excavation of the landfill must be completed in phases. Assuming a maximum of five years of mining operations, and a phase duration of roughly a year, excavation patterns begin to emerge.

The initial division is the highline of the landfill, splitting the site into North and South portions. This spine becomes the main corridor through the site for both mining and recreational purposes.

The sorting, compacting, and storage capacity of the facilities have been designed for 155 925m^3 of excavated garbage every three months. This estimation is based on the research in Chapter 3. Based on this value, the landfill can be divided into portions of various dimension, all containing the same volume. From above, the landfill is banded in varying widths, depending on the distance from the wall to the edge of the landfill, and the suspected depth of the landfill at that location. These bands will then inform further landscape design moves.

Two methods of banding are logical: dividing the seasonal segments seperately on the North and South sides of the spine, or directly across the site. Due to the prohibitively narrow bands on the second layout, and the design interest of the first, the first segmentation plan was selected.

The order in which the site is mined greatly effects the progress of public accessibility at creekside. Considering the relocation of mined material, early creek access, and required facility locations, potential phasing patterns develop as follows.

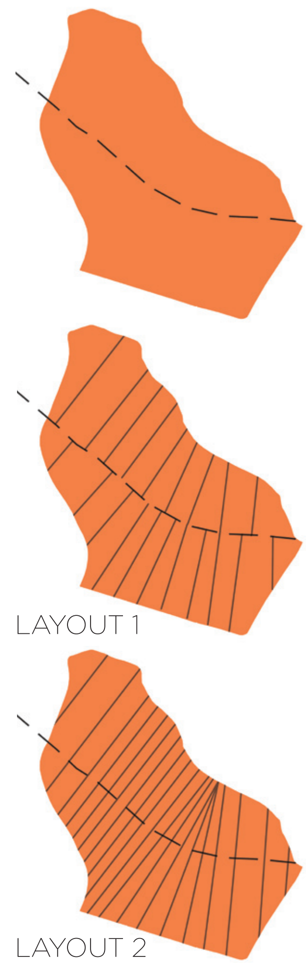


fig. 6.02 The Upper Ottawa Street Landfill segmenting layouts

fig. 6.03 Segments of various shapes and sizes each representing equal volumes of garbage

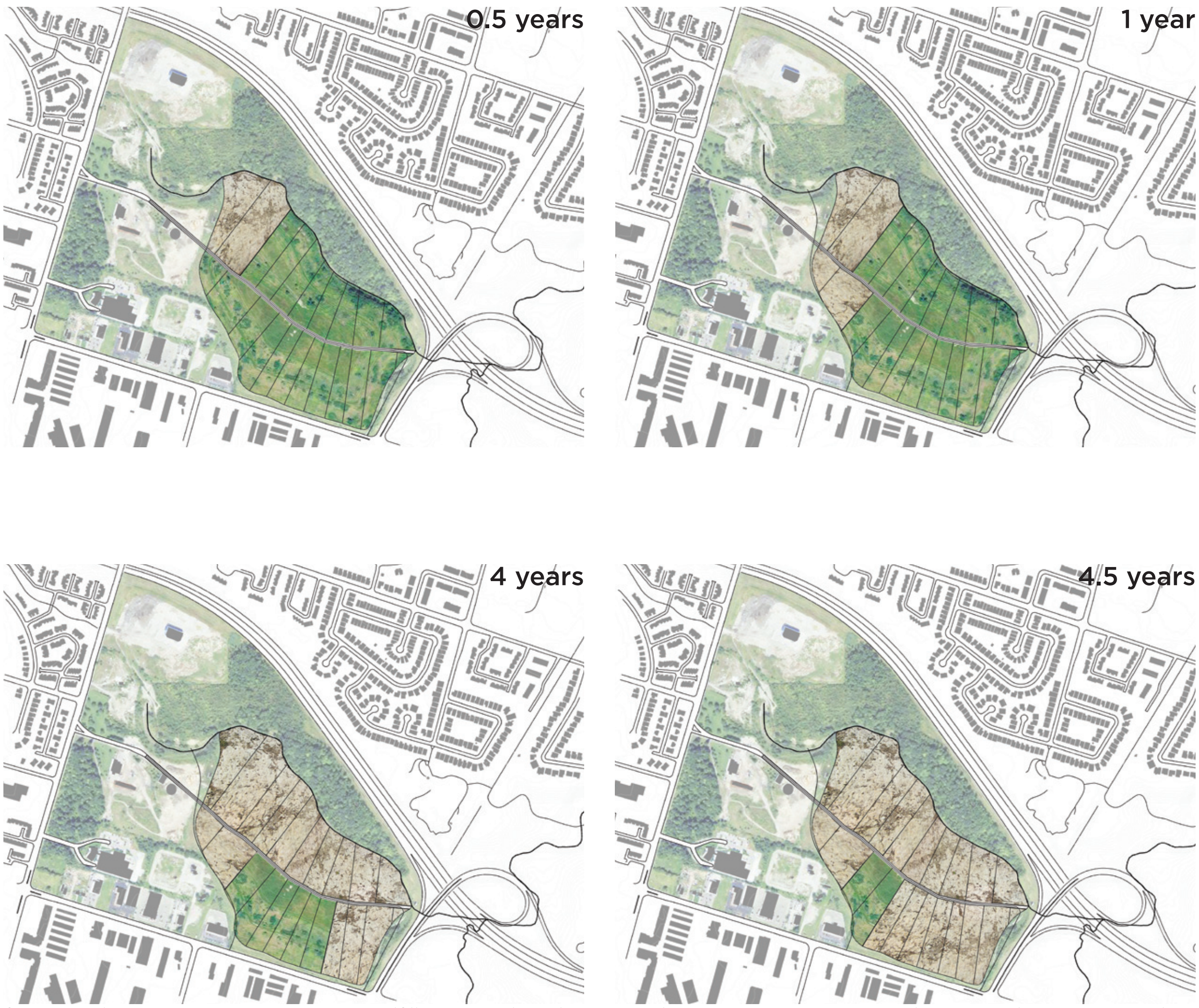
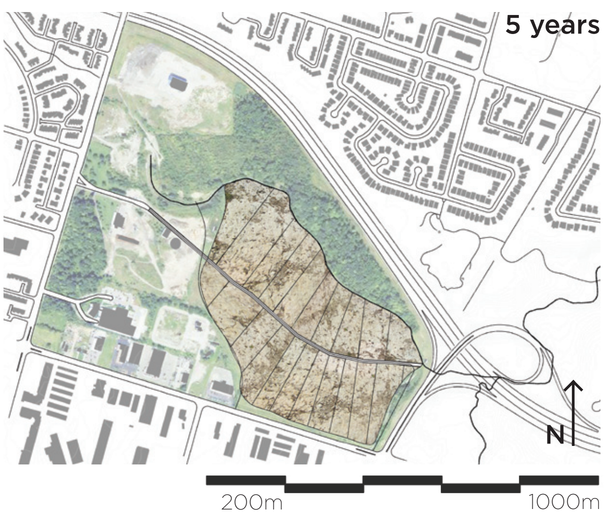
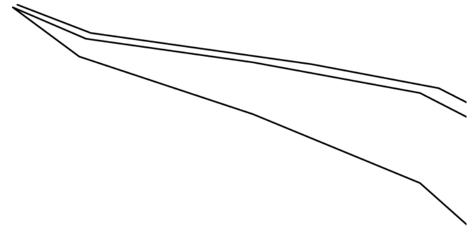


fig. 6.04 The Upper Ottawa Street Landfill as mined in phases, each segment representing three months' mining work



MINING PHASING ORDER

The most ideal mining order must accomodate creekside access while providing ample working space to store recovered soil. This pattern clears the creek side of the site within three years. The two southern segments mined in the first year also provide enough area for operations until more landfill volume has been cleared.



INFRASTRUCTURE FOR RECOVERY

Three components work together to mine the landfill.: the infrastructural wall, the material recovery facility, and the terrain formed overtop of new sanitary landfills.

The multifunctional wall serves to retain the garbage while mining, as well as providing a transportation corridor through the site with a safe pedestrian trail. The interior of this wall becomes storage for mined materials as the garbage is processed.

The sorting and processing of the landfill contents is completed by a modular mobile material recovery facility. The sorting, compacting, incineration of trash all happens within these efficient spaces. By plugging into the infrastructural wall, the material recovery system can access trucking and storage at any point along the length of the landfill.

The third recovery system is that which follows the mining operation, recreating a landscape for community and environmental benefit. Those materials which cannot be safely recycled or incinerated, and are unlikely to be recyclable in the near future, must be re-landfilled on the site. These new sanitary landfills are lined and sealed in accordance to legislature and create the topography of the new landscape on site.

Surrounding the sanitary landfill sites are pockets of recreational and natural spaces. These planned landscape features are created behind the landfill mining process, as soon as a segment has been cleared of trash. This way, parts of the parkland can be opened to the public and inhabited by wildlife, even while other segments remain to be mined.

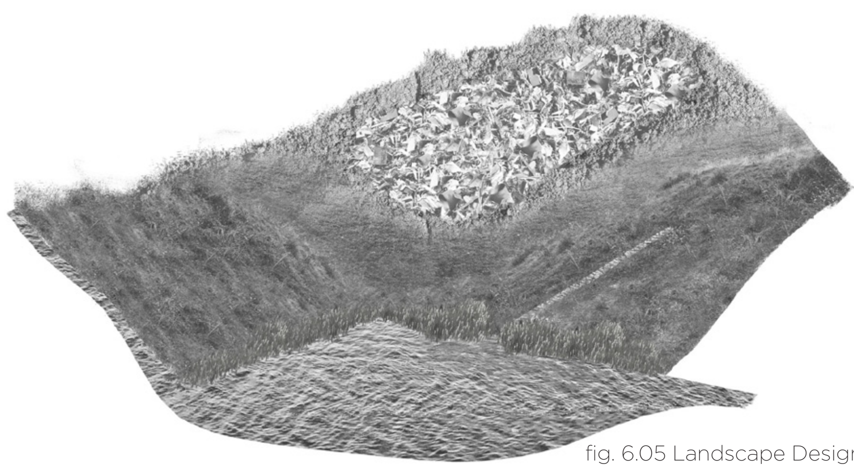


fig. 6.05 Landscape Design

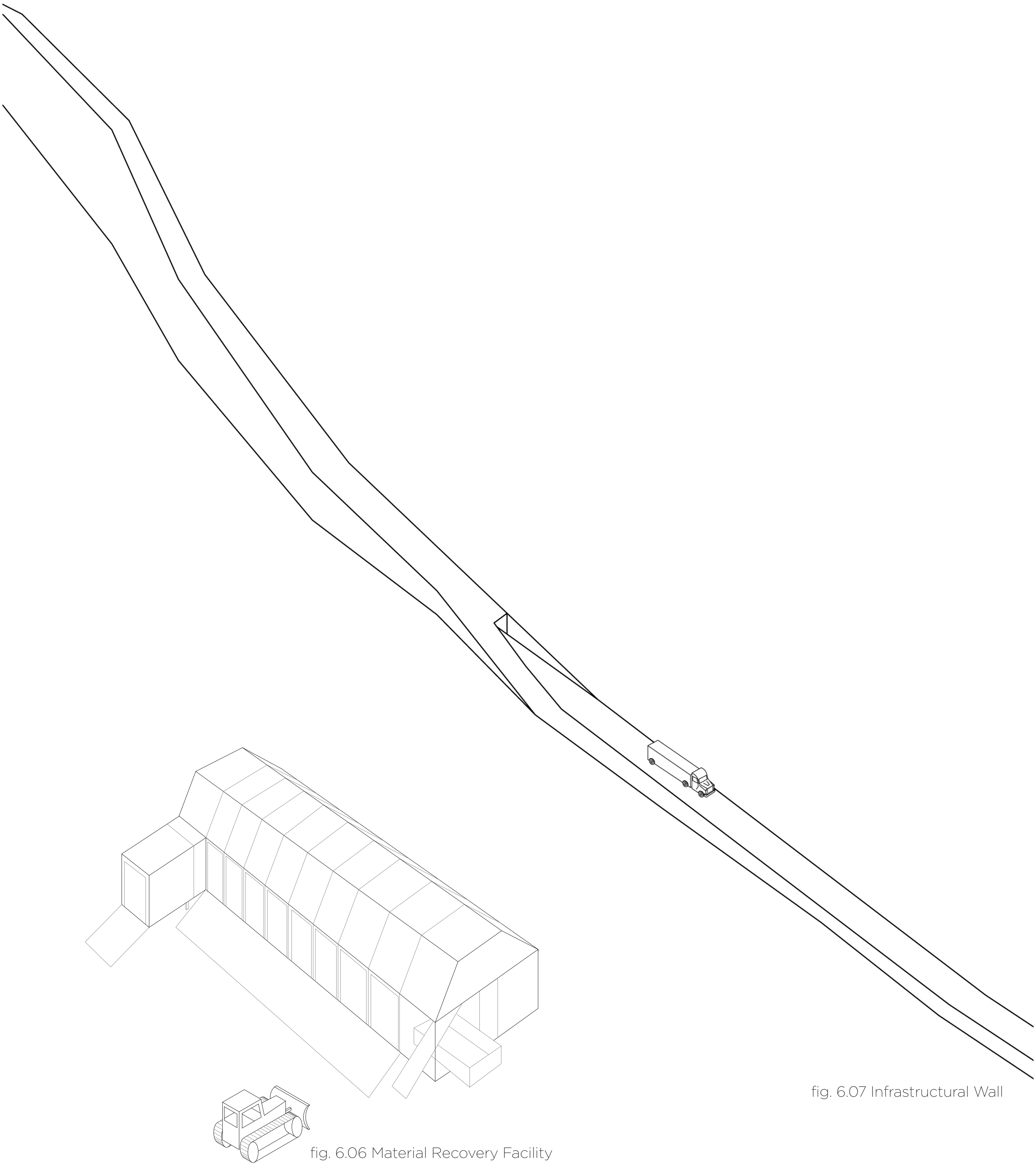


fig. 6.07 Infrastructural Wall

fig. 6.06 Material Recovery Facility

CREATING THE WALL

When excavating the garbage from the landfill, the materials can be very unstable. To mine the entire mound without any retaining structures would require a full five years of continued forbidden-to-visitors status. Since it is the goal of this project to simultaneously occupy the landfill with visitors and mining operations, the landfill must remain relatively stable during the excavation. As well as providing a safer environment on the surface, the retaining structure allows for the public to pass very close to the mining process. The overlooking pathway on top of the retaining wall introduces the community to their garbage in a way they have never encountered. Safety and education are intertwined in the retaining structure.

To begin the mining operation along the spine of the landfill, the retaining wall must first be installed. Cutting through the entire depth of the mound, a sub-surface causeway is created, providing access across the length of the site. This causeway is used as a trucking corridor, allowing materials to be moved off site in a contained manner, safely away from pedestrians and the rough shale surface under the landfill. Intermediate levels of the structure provide structural rigidity and serve as storage space for some mined materials.

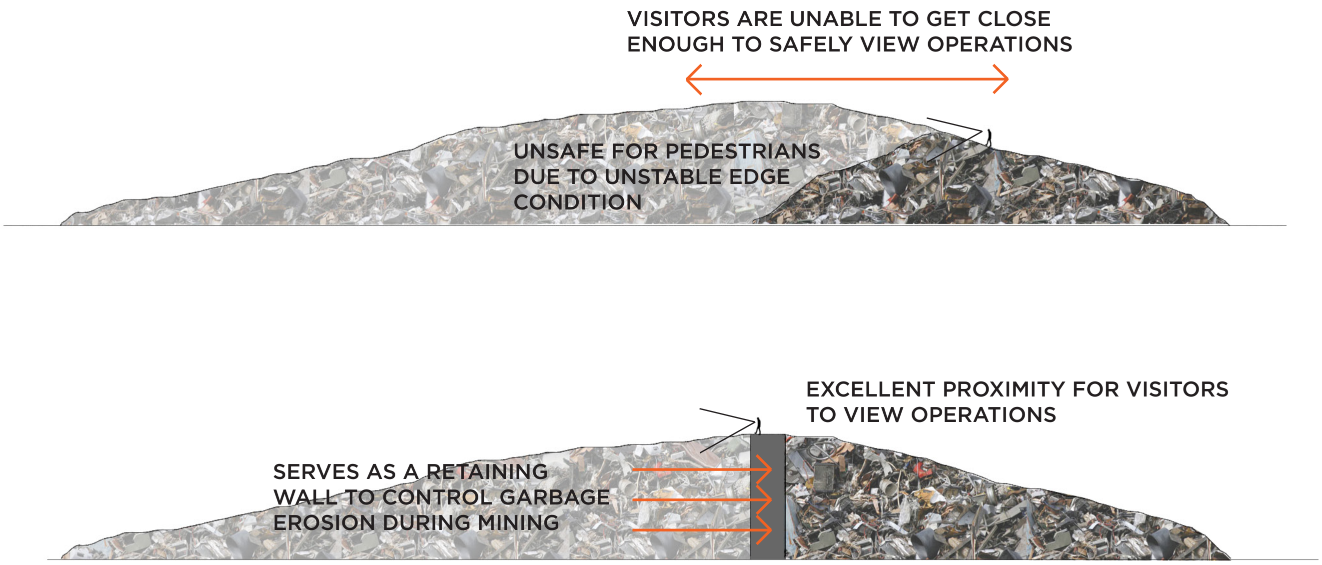


fig. 6.08 A retaining wall provides erosion control and visitor access during landfill mining

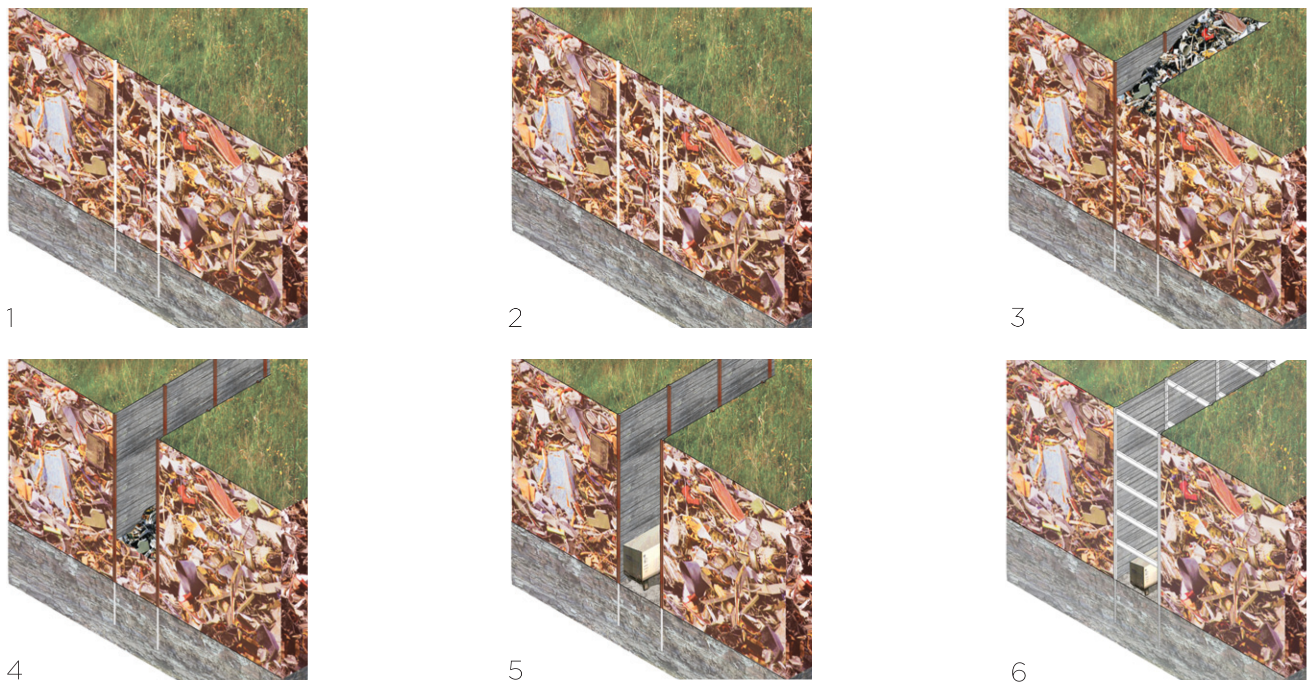
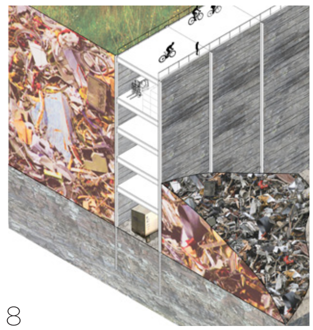
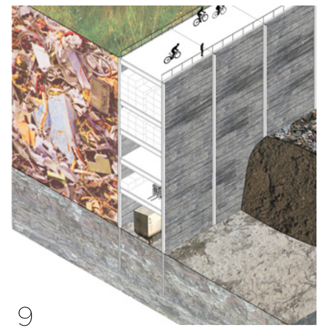


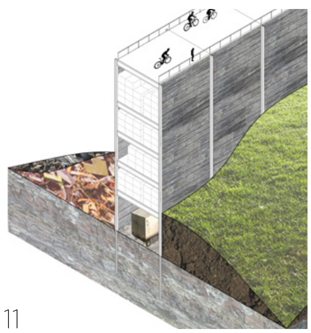
fig. 6.09 Stages of the infrastructural wall:
1) Auger holes through the landfill, to the bedrock below
2) Install screw piles into bedrock as secure foundations
3) Affix weathering steel columns to the piles, and commence mining along the interior path, inserting bracing to keep the landfill back
4) Continue mining, laterally bracing the columns against each other across the width of the trench
5) Once the trench is fully excavated, vehicles may travel through the site
6) Insert interior structure

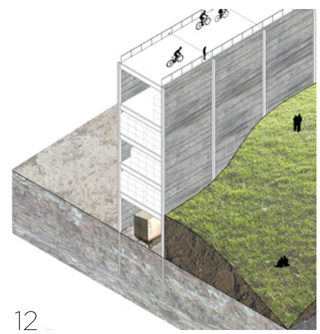

7


8

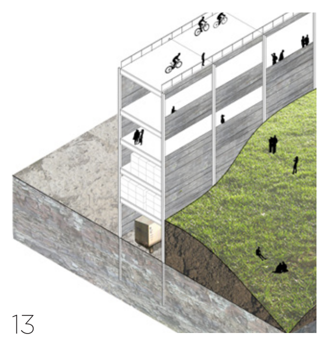

9


10


11


12

7) Platforms span interior structure to creatr storage space and a pedestrian surface
8) Mining in the main body of the landfill continues, feeding into the storage space within the wall
9) New sanitary landfills are constructed alongside the wall
10) Landscape is installed behind the mining operations, creating an undulating public park surface
11) North and South of the wall is mined
12) All mining is completed
13) Stored materials are uncached due to new recycling advances, allowing more public use of wall interior.


13

WALL CLADDING SYSTEMS

The infrastructural wall will first be a retaining wall, holding back garbage while the excavation is in process. The boards will be dropped into place as the corridor is excavated, and bolted into the structural steel columns.

As the garbage is removed from alongside the retaining wall, the board surface will be removed. In its place, panelized cladding will be added to the exterior of the wall. Depending on the use of the space behind the cladding, the panel can be glazing, perforated metal, weathering steel, concrete structural insulated panels, or even a rock climbing surface. Some areas are left open as viewing platforms with railings. Most of the surface is covered with opaque panels to conceal the storage space beyond. The perforated panelling serves to ventilate the spaces, since most of the interior of the infrastructural wall is not conditioned space. Only the areas used by the public will be conditioned, and sealed from the elements.

The panelized nature of the cladding allows for parts of the wall to be at different stages of exposure simultaneously. This is the case as the garbage is excavated, and the cladding goes up. Similarly, when the storage of future recyclables is no longer necessary, the cladding can be removed from the wall. Over time, then, the surface of the infrastructural wall will solidify and deconstruct.

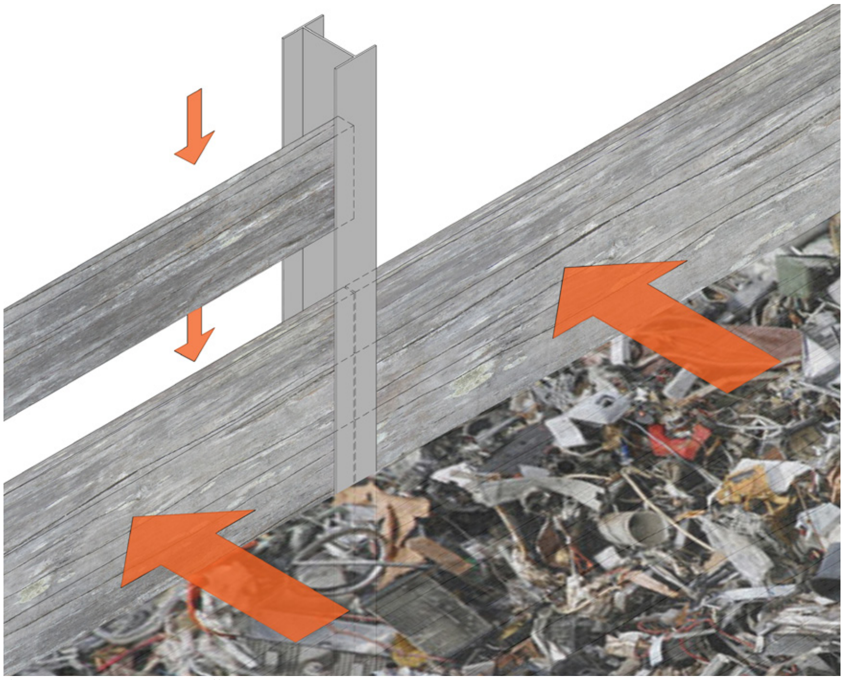


fig. 6.10 retaining wall construction

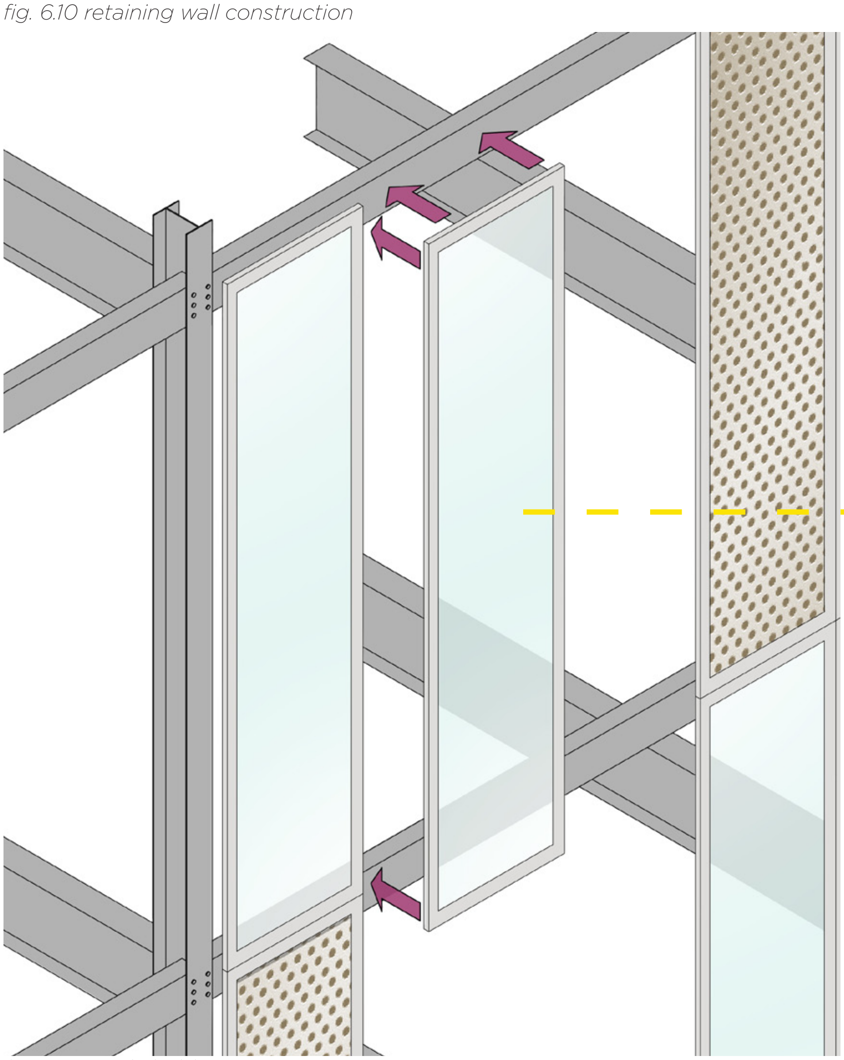


fig. 6.11 panel cladding construction

fig. 6.12 glazed panels

fig. 6.13 concrete panels

fig. 6.14 weathering steel

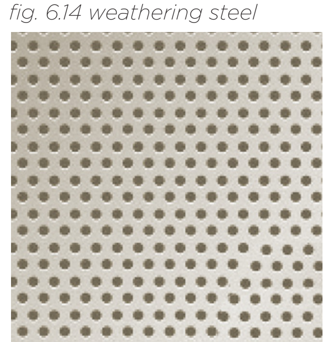


fig. 6.15 perforated metal

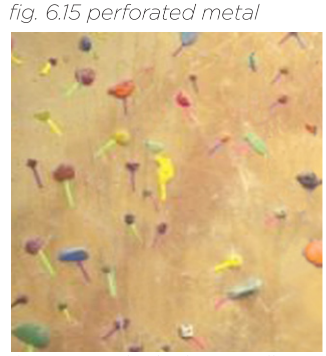


fig. 6.16 rock climbing wall

MATERIAL RECOVERY ON THE MOVE

The equipment and systems of the recovery process are usually statically installed in a material recovery facility (MRF). The mining of a landfill, however, ranges over the surface of the site. To build a traditional MRF on the site and move all the garbage to the facility would require restricted public access for the duration of the mining operation, as well as a great deal of equipment. Also, at the end of the landfill mining operation, the MRF would no longer be needed, and its decommissioning and relocation would be an additional expense.

Instead, this mobile, componential MRF is able to move across the site with the progression of operations, and can be transported easily to another landfill for continuous use. This design consists of the structure of five tractor trailer beds, and uses a sixth trailer to move the remaining connecting components. Most of the equipment and structure of the MRF is constructed on the trailer so it can easily travel with minimal reconstruction. By arranging the trailers in order, the spaces align to form a functioning sorting, compacting, storing, and incinerating facility.

Trailer 1: The first trailer to be placed contains temporary ash storage and an electrostatic precipitator which pulls the airbourne ash from the incinerator and deposits it in the temporary storage area.

Trailer 2: Plugging into the first, this trailer contains the modular incinerator as well as spaces to feed trash into and ash out of the incinerator itself.

Trailer 3: Alongside the incinerator trailer is a gap in which a conveyor system is installed, bridging the third trailer to the second. Within trailer 3 are push-through storage bunkers for sorted materials bound for compaction or incineration.

Trailer 4: Backing into trailer 2 is the compaction and delivery unit, containing a conveyor belt to lift materials into the compactor, which creates prismatic bales ready to be loaded into trucks.

Trailer 5: Like trailer 3, this unit sits beside trailer 4 with a conveyor belt between to move materials to the compactor push-through. This trailer itself contains more push-through storage bunkers for sorted recyclables.

Trailer 6: The sorting level structure and conveyor belt components are transported in the sixth trailer, which serves only to deliver materials, not as a platform structure.

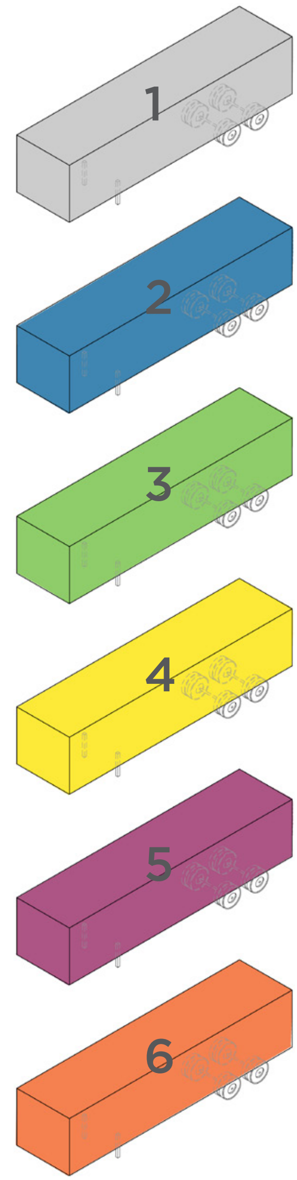


fig. 6.17 six trailer beds containing the material recovery facility sit assembled for transport

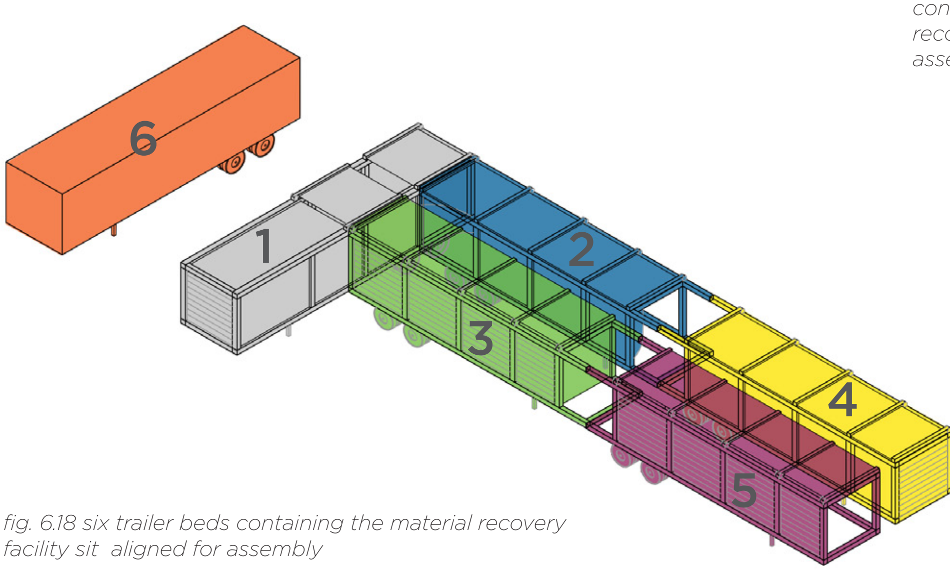


fig. 6.18 six trailer beds containing the material recovery facility sit aligned for assembly

SORTING HALL CHOREOGRAPHY

Garbage mined from the landfill is pushed onto a conveyor by a bulldozer. The first conveyor belt contains the crushing equipment which is designed to allow most materials to flow over the surface, while glass will shatter and fall into the container below. The long upper conveyor belt passes nearly the entire length of the facility, carrying trash past the manual sorters and mechanical sorting devices. Materials are sorted into bunkers on the lower level and stored there.

One bunker at a time, materials are pushed onto a lower conveyor belt which leads to a central push-through staging area for the compactor. Once the materials are on the staging floor, a bulldozer pushes them onto the conveyor belt up into the compactor. As materials come out of the compactor, they are baled and stored. Forklifts transport baled recyclable materials into trucks, or future recyclable materials into the infrastructural wall for caching.

Materials slated for incineration are pushed through the bunker, and directly into a modular incinerator. Heat from the incinerator produces steam which drives the upper-level generator. Ash from the incineration process is pushed out the far side of the equipment, or caught in the electrostatic precipitator should it be airbourne.

At the end of the upper conveyor belt, materials not sorted out for recovery are dropped into a bunker for re-landfill. Before being returned to a landfill, these materials will be compacted to further reduce the landfill volume.

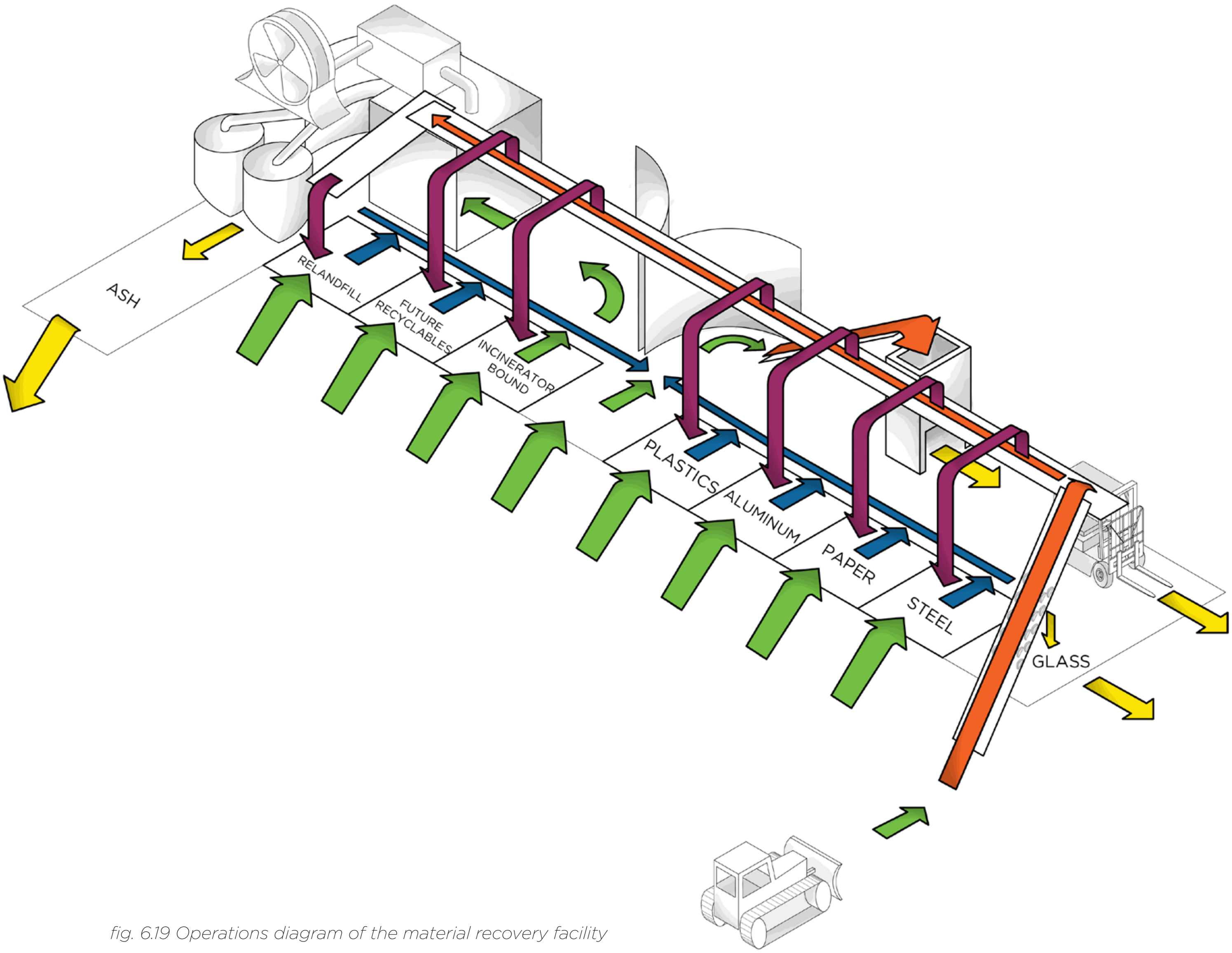


fig. 6.19 Operations diagram of the material recovery facility

- Bulldozers push materials into the facility
- Conveyor belts feed materials onto the sorting line and into the compactor
- Materials are manually or mechanically sorted into bunkers to await compaction or incineration
- One bunker at a time, materials are pushed onto a conveyor belt and fed into the compactor
- Outgoing materials leave compacted and baled or in bins for transport

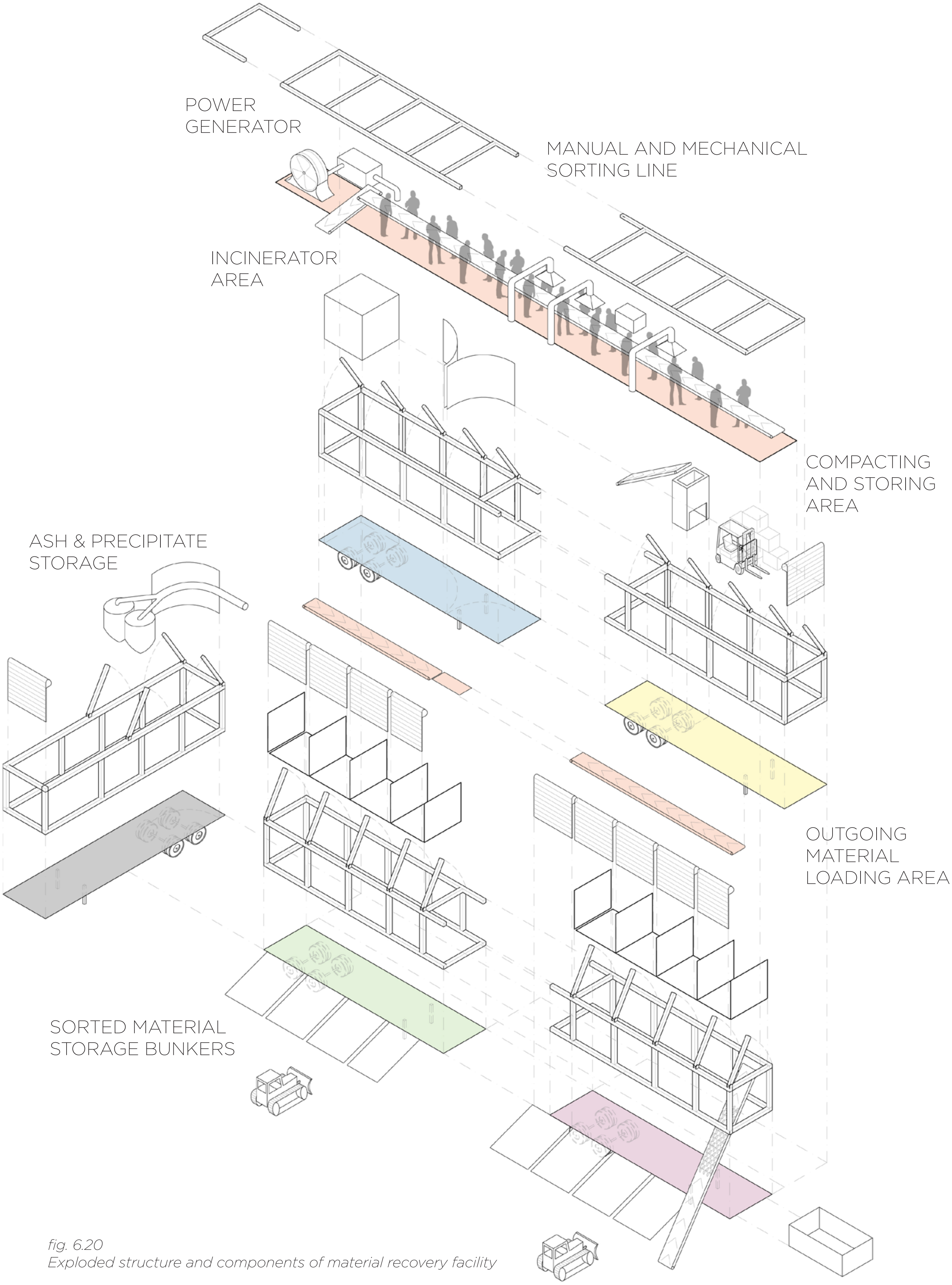


fig. 6.20
Exploded structure and components of material recovery facility

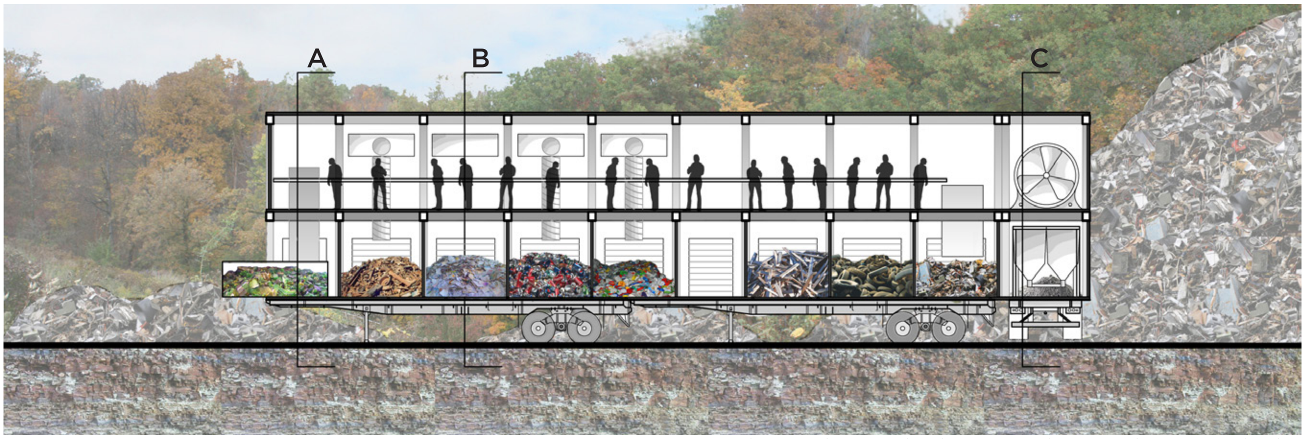


fig. 6.21 longitudinal section of material recovery facility

UNPACKING THE MRF

The structural frames of the MRF are primarily the external structure of the five trailers. To construct the upper level, however, the top beams of these trailers tip up to support a roof frame which is transported in the sixth trailer. Sloped transparent panels are affixed as walls to provide ample daylighting for the sorting process. Spanning panels are laid between the two trailers to serve as the sorting line floor.

Conveyor belts and equipment from each trailer are set up and supplemented with equipment from the sixth. Once in place, the MRF can begin accepting materials from the landfill, and sending the sorted materials into the neighbouring infrastructural wall for redistribution.

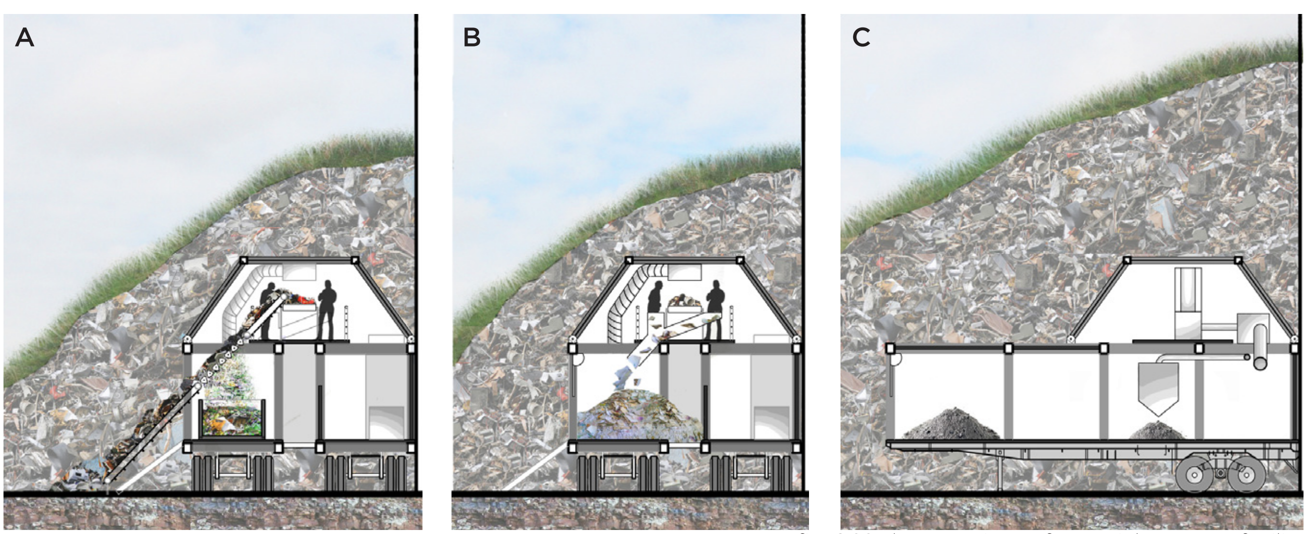


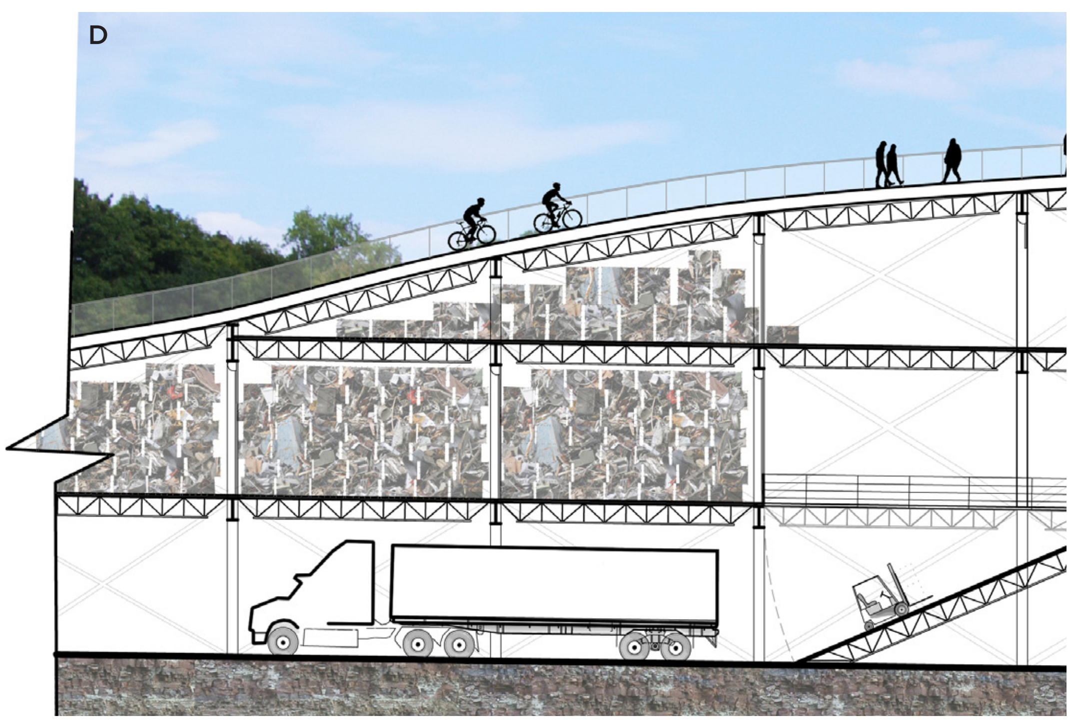
fig. 6.22 short sections of material recovery facility

WALL AND MRF INTERACTION

At strategic locations along the wall, the MRF can be parked, allowing the base of the wall to be opened and trucks to reverse into the loading bay area of the MRF. From the same loading bay area, potentially recyclable materials are brought by forklift up narrow ramps into the storage compartments within the wall.

At least two MRFs will be required to sort the volume of garbage required to be sorted every three months. Therefore, a number of plug-in locations will be opened and closed during operations, to accomodate the moving of the mining and the filling of the storage within the wall.

Visitors to the site are able to overlook the mining and sorting processes but remain safely atop the wall. This does not allow the public views to the trucking or storing operations below, which provides uninhibited movement to equipment within the wall. By keeping the public out of the way of the forklifts and transport trucks, storage and transport can be most efficient and safe.



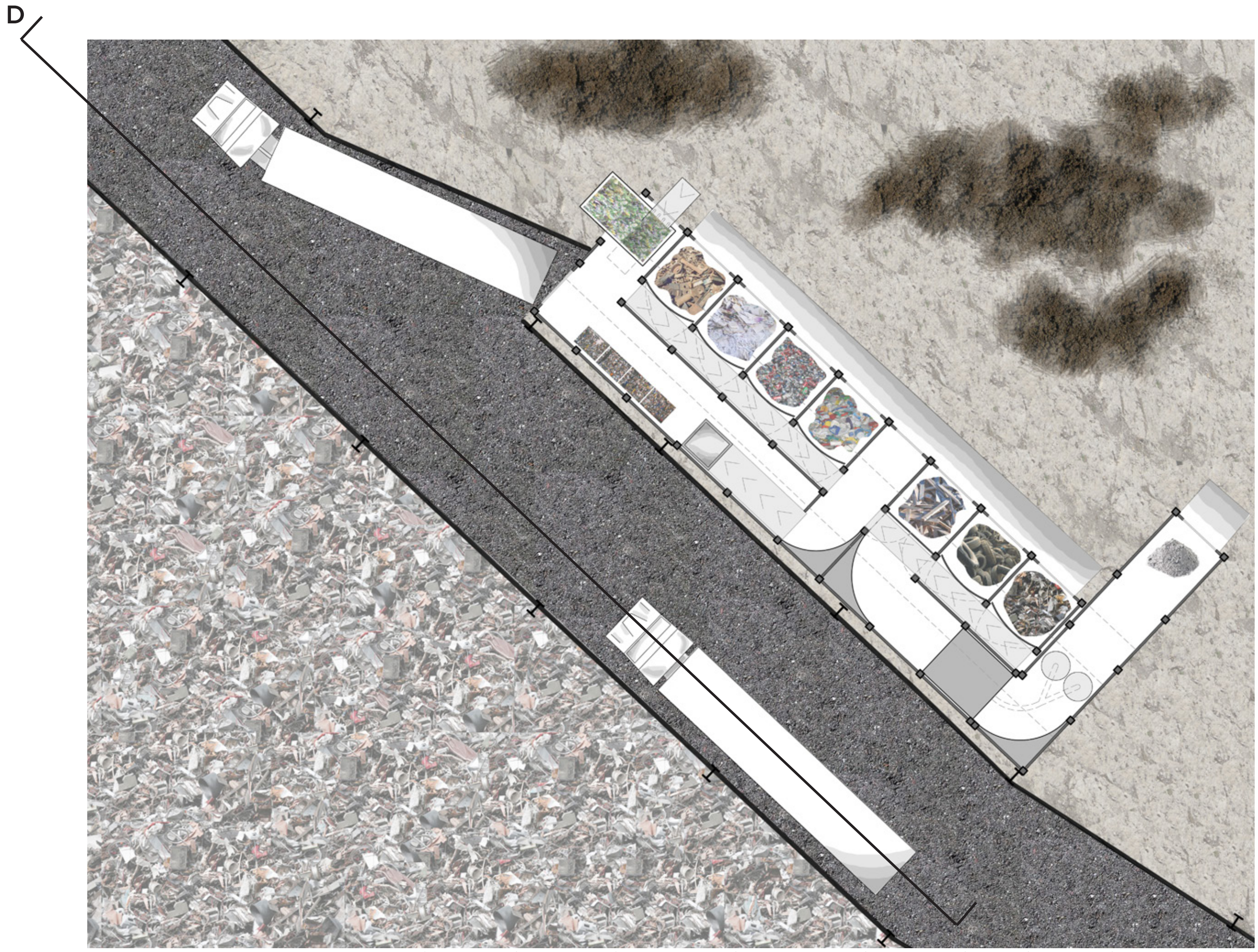


fig. 6.23 Plan view of interaction between trucking corridor and material sorting facility

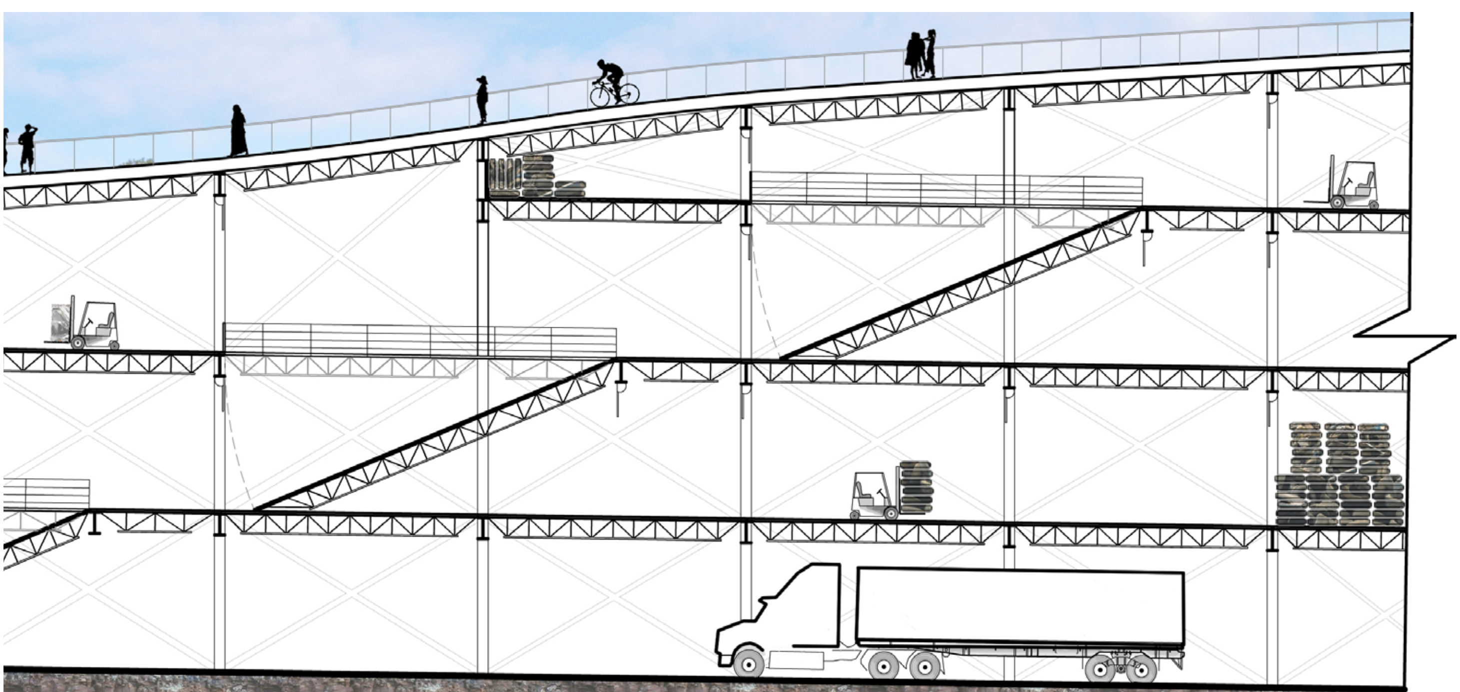


fig. 6.24 Sectional view showing caching of future recyclable materials within wall structure above trucking corridor


fig. 6.25 Vignette into the new landscape from the interpretive centre


fig. 6.26 Key Plan

LANDFORMING

As the first above-ground stretch of the Red Hill Creek, this site provides creek side access and experiences to the public. Connecting into the existing network of trails in the Red Hill Valley, paths traverse the site and interact with the creek in ways previously unavailable. Tracing the lines of the mining operations, the topographic landscape intersects with the creek at distinct points. The terrain created on site is constructed on the surface of the new sealed sanitary landfills. These deposits are non-reclaimable sorted materials collected from the material recovery process. Between these rises, low lying spaces open towards the creek. These rooms in the landscape act as floodable wetlands during extreme events, but register even the seasonal change of water level upon the shallow sloped surface. Where a pool was in spring, a dry reed bed lies in summer, and a small lake swirls in a storm. The visitor may interact with the wetland in order to better understand the value of such habitats in relation to water flow and water quality.

Beyond the educational value of encountering the creek source, several recreational opportunities present themselves. Gathering spaces, an outdoor amphitheatre, picnicking pavilions, bird watching sites, an outdoor skating rink, and an outdoor event venue coexist in separate moments on the same creek bank. Paths connect the rooms within the site to the greater network of trails within the Valley and the region.

The infrastructural wall, the material recovery facility, and the land formation created atop the new sanitary landfills are all key players in the systematic reclamation of the Upper Ottawa Street Landfill. Armed with the schematic understanding of how these components function individually, the complete investigation of the larger system potentialities on site can begin.


fig. 6.27 Aerial view of initial landfill mining stages on The Upper Ottawa Street Landfill


fig. 6.28 Key Plan

PHASED MINING

By mining the landfill in phases, the material recovery, ecosystem, and community are able to benefit. The controlled volume of materials mined in each season requires a set amount of resources, personnel, and equipment on site at any time. This allows municipalities to plan the movements of the operations across more than one landfill over years of use. The progress is also more predictable when choreographed instead of simply consuming the mound freely over time.

The progression of mining on site clears the creek bank in a linear pattern starting closest to the surfacing of the Red Hill Creek at the north-western edge of the site. As the mining moves farther along, remedial interventions are introduced to the creek and re-landfill areas. By mining and remediating in tandem, the water quality and habitat provision will be greatly improved after just one year of operations.

Finally, the greatest benefit to phasing the landfill excavation is that it provides the best opportunity for safe, controlled public access. The coexistence of mining and recreational paths on site creates educational moments and unexpected views. Visitors are confronted with their own garbage and the grime of landfills and material recovery, of which they were previously unaware. Spaces within the newly constructed landscape are developed to draw in the visitor even further, creating spaces in which the community will linger, participate, and enjoy their neighbourhood.

Even after the mining is complete, the stored materials within the wall will remain for several years. In the un-caching process, the site will come alive again with trucks and equipment, without disturbing the flow of the community overhead. The wall use will change as former storage spaces become available for public use, and new program is introduced.

The lifetime of this site is an ever-changing series of phases.

Through the design of the wall and the material recovery facility, combined with the phasing of the operation, the exploitation of the landfill is made possible. The hazardous nature of the mined materials is addressed through the third infrastructural component: landforming serves to decontaminate the landscape, while the relocation of waste into sanitary landfills creates topography on site. The integration of the key infrastructures must also address the remaining issue of site performance, with respect to ecosystem recovery and community access on site.

fig. 6.29 Upper Ottawa Street frontage

AN UNDERPERFORMING LANDSCAPE

The Upper Ottawa Street Landfill is underperforming both in the social realm, in failing to address the community in which it lies, and in the ecological realm, in failing to address the Red Hill Creek. This proposal prioritizes the recovery of both of these shortcomings, in providing public access and encouraging ecosystem recovery.

fig. 6.30 Stone Church Road frontage

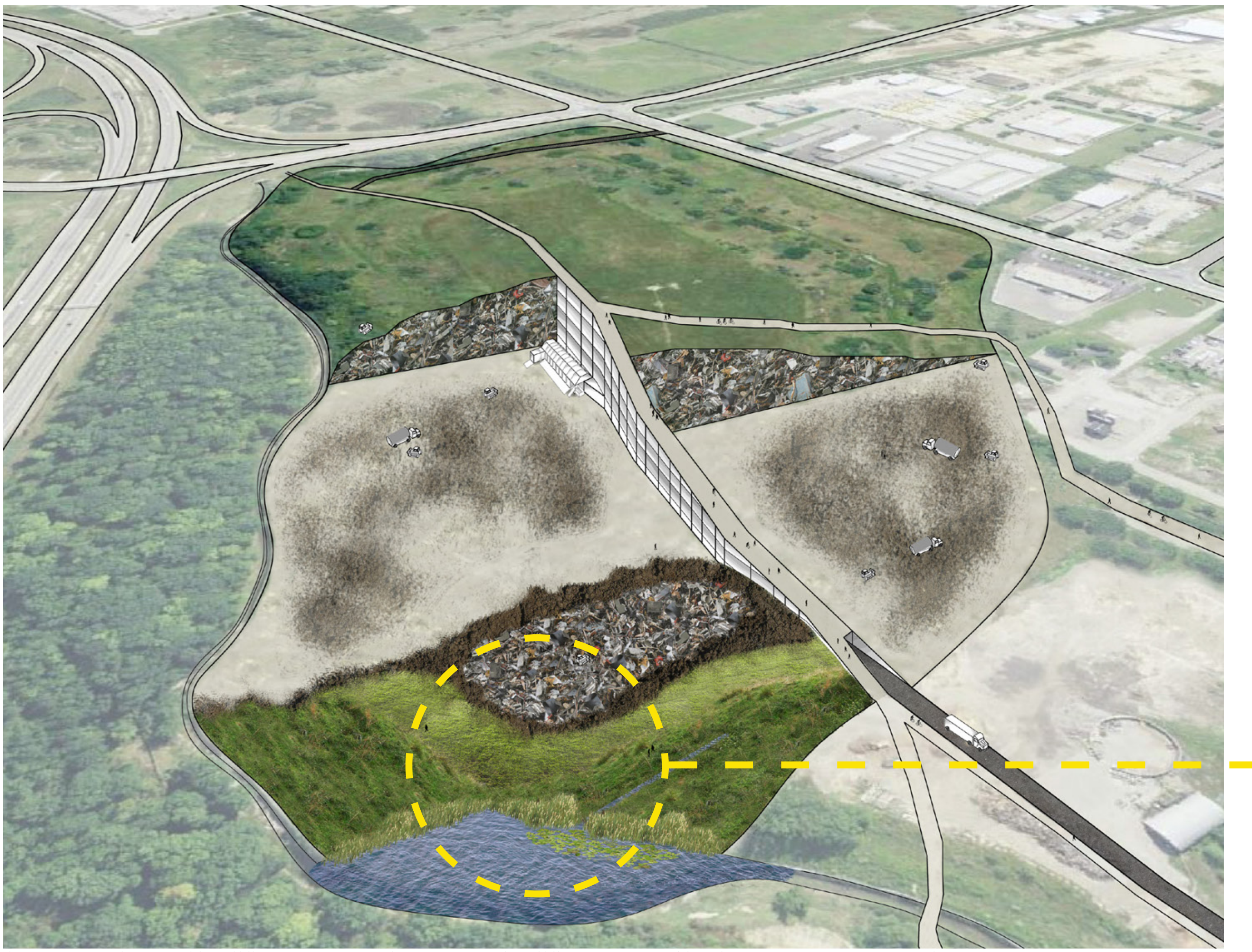


fig. 6.31 Aerial view of landfill mining, secondary sanitary landfill creation, and landscape intervention on The Upper Ottawa Street Landfill

fig. 6.32 Key Plan

ECOSYSTEM RECOVERY

Through evaluating the strengths and weaknesses of the case studies covered in Chapter 3, the site rehabilitation design includes several strategies of successful parks.

The inclusion of new sanitary landfills into the topography of the landscape is a method of LANDFORMING similar to the creation of the Leslie Street Spit. The landscape benefits from the structure provided by the waste materials. The opportunity for COMMUNITY EDUCATION on site is fulfilled with visitor paths and lookouts, not dissimilar to those at Freshkills Park. Where most park interpretive centres forcus on wildlife and natural history, the inclusion of the landfill mining operations educational component brings another level of understanding to the Hamilton community. Finally, the creation of creekside habitats and flood prevention pools will act in a broader ECOSYSTEM REHABILITATION, which will effect the wellbeing of the entire Red Hill Creek. In the same way that the development of habitat within the Leslie Street Spit benefits a much larger region of Toronto, the rehabilitation of the Upper Ottawa Street Landfill will affect the entire Red Hill Valley.

As the landfill is mined, the cleared land can be rehabilitated into the final landscape. Over the relandfilled mounds, soil and planting will occur. Most importantly, at the creek edge, overflow ponds are constructed featuring native plant species and earthworks to prevent soil erosion. As the creekside is reconstructed, the wildlife can return to the source of the Red Hill Creek

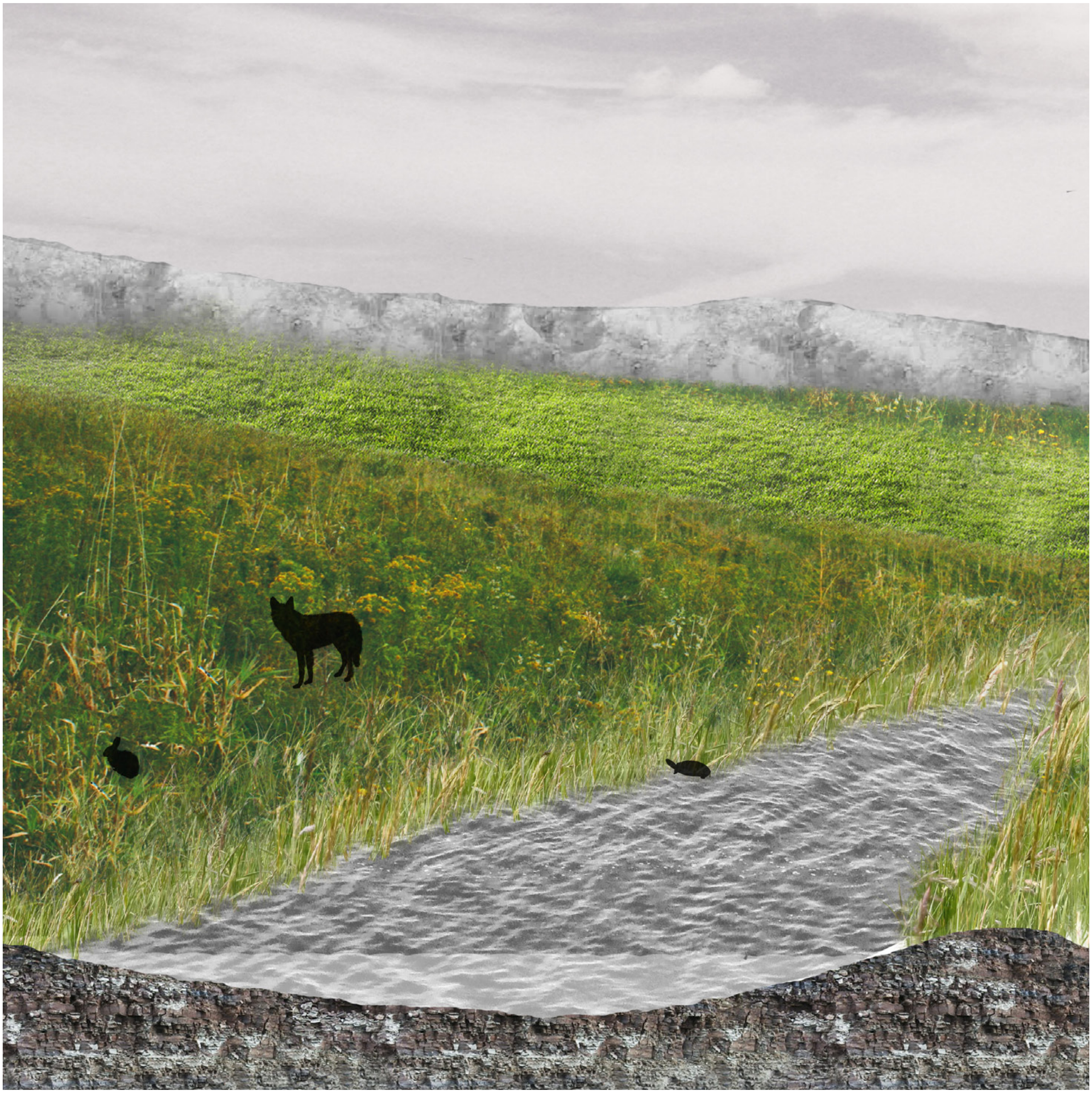


fig. 6.33 Creekside vignette of wildlife within the flooded landscape during the rainy season

fig. 6.34 Key Plan

ECOSYSTEM REHABILITATION

By replacing the sparse, failing clay landfill cap with topsoil, indigenous plant life will return in abundance to the Trenholme site. This in turn will provide healthy habitats for burrowing animals and creek-side reptiles and amphibians. Without the risk of ingesting toxins, small creatures will be able to safely breed and populate the site. The increase in prey population will bring omnivorous predators into the region, rounding out the animal ecosystem. Healthy creek, forest, and field conditions will encourage the expansion of the endangered Carolinian habitat into the suburban block.

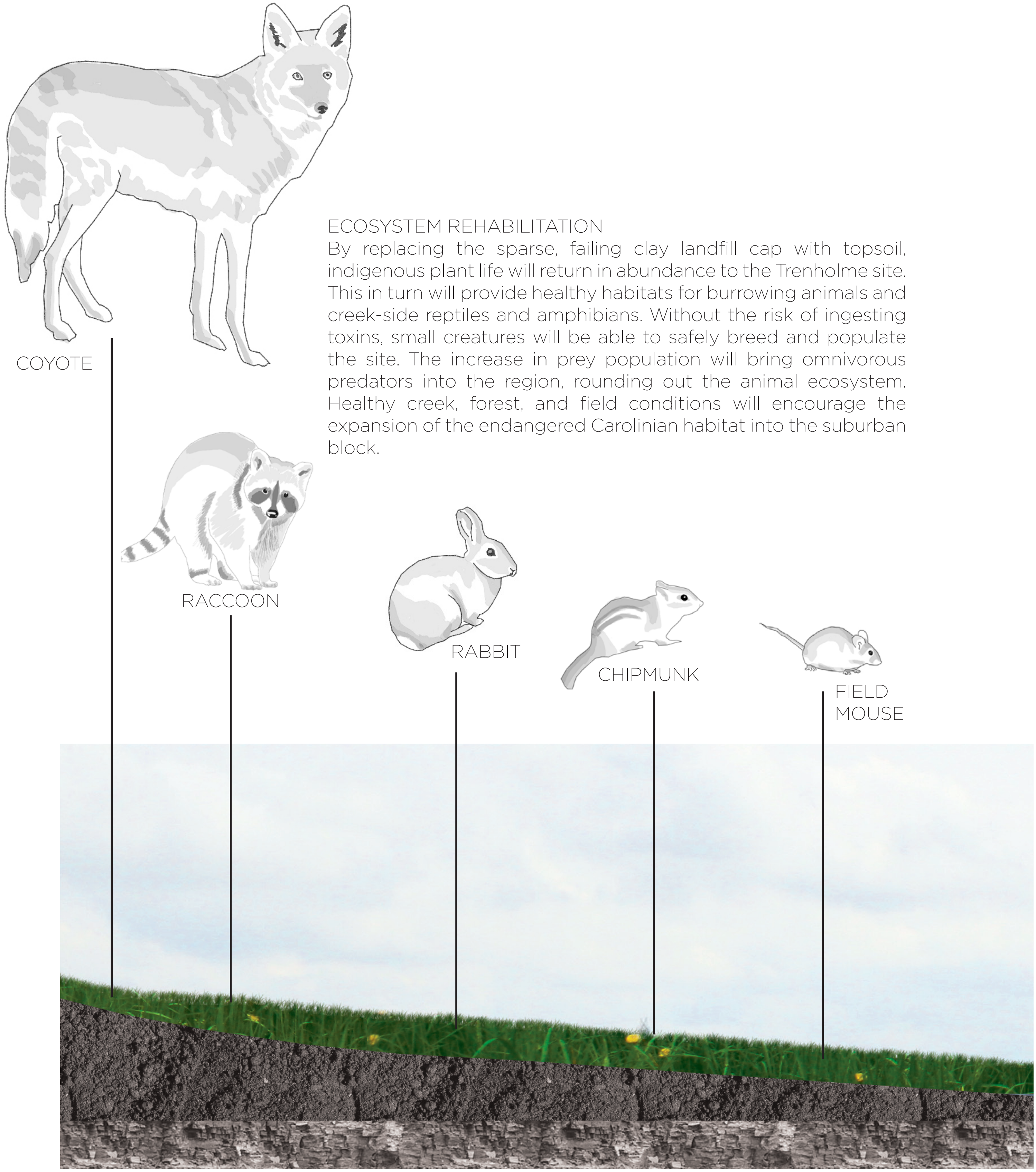


fig. 6.35 Site section indicating new, clean habitats for Carolinian animals: field, creek, and forest habitats.

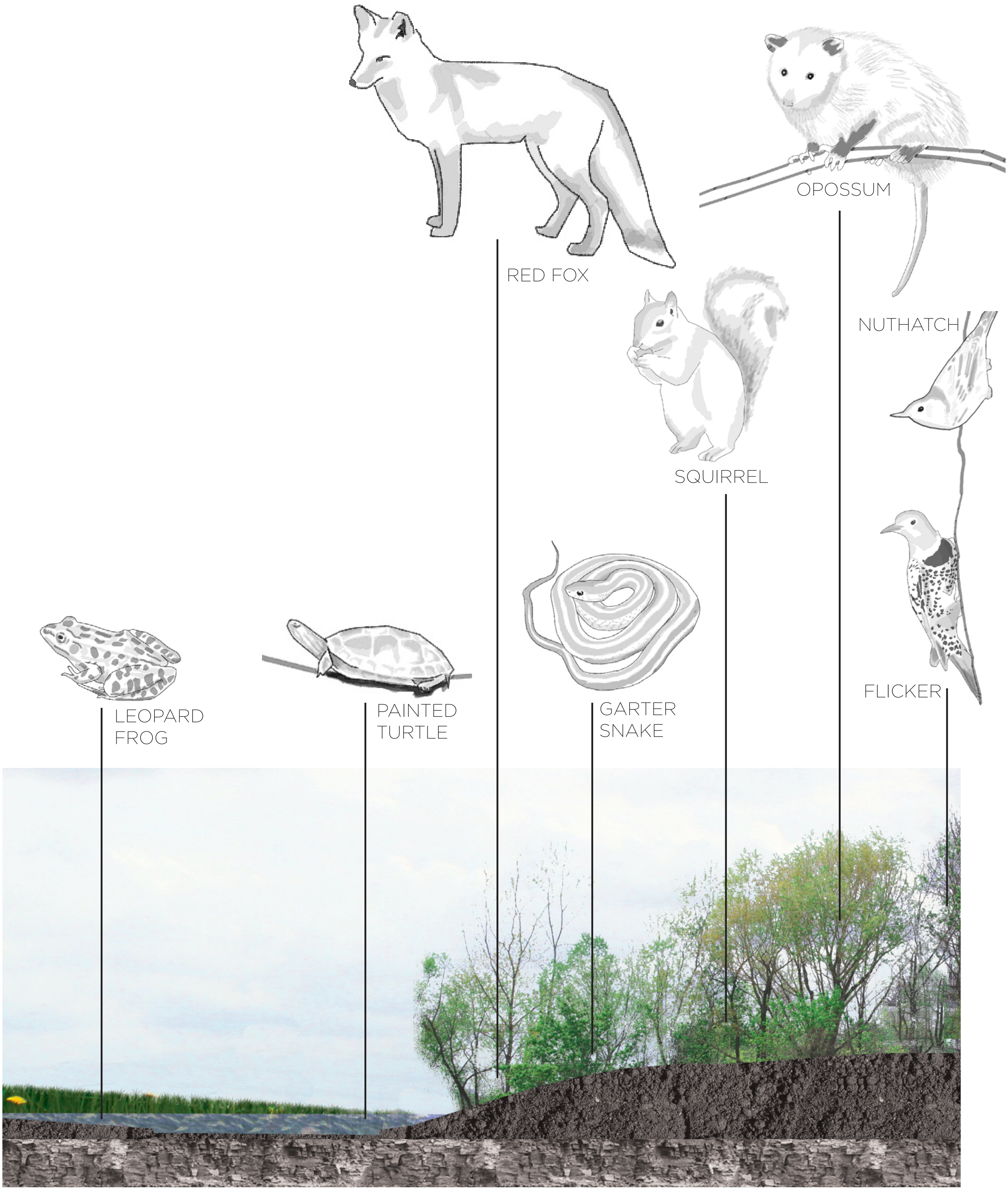

RED FOX
OPOSSUM
NUTHATCH
SQUIRREL
LEOPARD FROG
PAINTED TURTLE
GARTER SNAKE
FLICKER

fig. 6.36 Aerial view of final landfill mining, secondary sanitary landfill creation, and landscape intervention on The Upper Ottawa Street Landfill

fig. 6.37 Key Plan

COMMUNITY EDUCATION

Throughout the installation of the new parkscape, community spaces will be constructed. Educational features on the wildlife, flood-prevention measures, landfill mining operations, and Red Hill Creek ecosystem will be placed along trails and paths for visitors. Views of the ongoing excavation and sorting processes offer visitors and ongoing experience of the waste and recycling industry. Creekside signage alerts the visitor to important components in the rehabilitation scheme and wildlife habitat.

The gathering of visitors on site also educates the neighbourhood about the closed landfill as a part of the community. By opening up the site to the public, and inviting them to enjoy the creek and park, the need for community spaces on site is created.

fig. 6.38 Creekside vignette with community gathering, learning, and interacting with the new landscape during the dry season

fig. 6.39 Key Plan

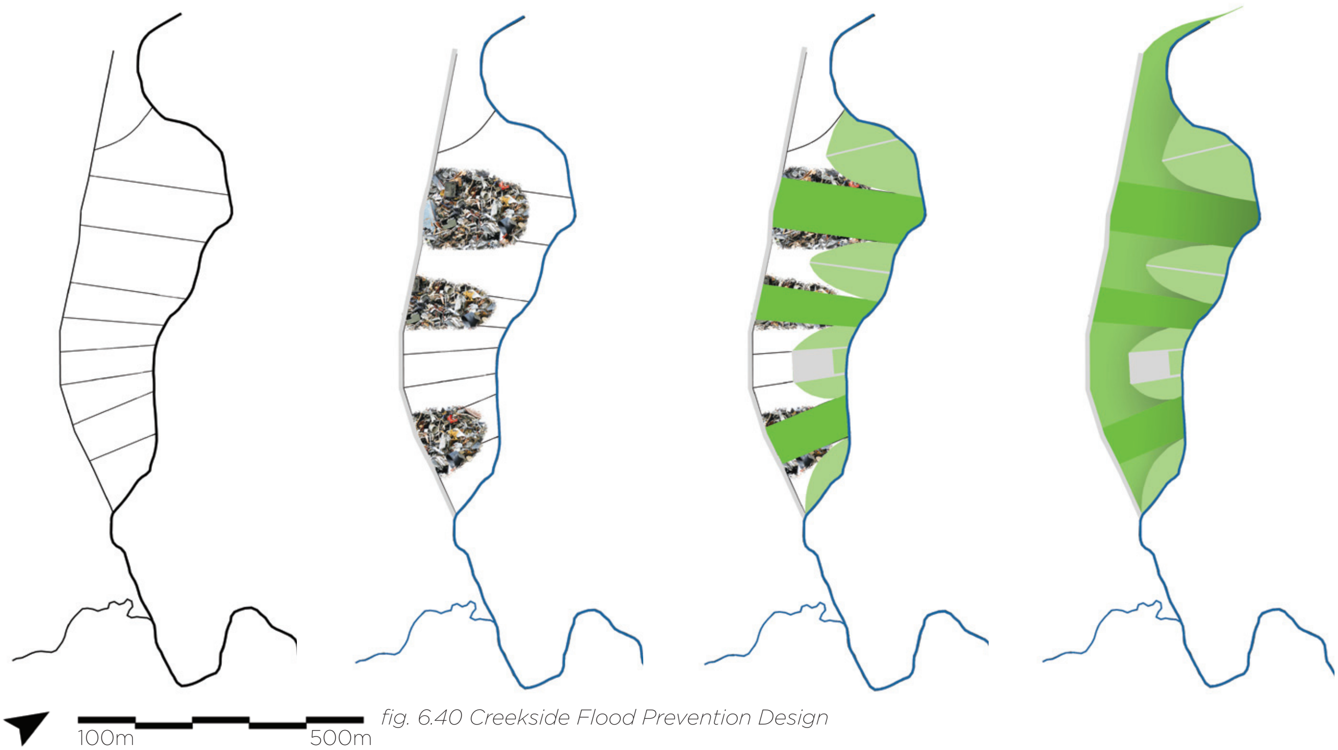


fig. 6.40 Creekside Flood Prevention Design

LANDFORMING: FLOOD PREVENTION

Since the construction of the Red Hill Valley Parkway, downstream from the landfill site, the flooding of the Red Hill Creek has become a visible event. In its natural state, the creek bed was flexible, stretching its banks during storms to accommodate the extreme water flow rate and velocity of the flood condition. With the introduction of infrastructural interventions within the Valley, the creek bed was redesigned by engineers to follow a path safely away from the piers of the elevated Parkway. This new path, however, does not best accommodate the preferred runoff route to Lake Ontario in storm events.

Most days of the year, the erosion-controlled man-made edges of the valley contain the leisurely Red Hill Creek. Storm water holding tanks sit empty under sports fields adjacent to the valley. Thousands of vehicles traverse the distance from the Lincoln Alexander Parkway to the Queen Elizabeth Way without ever knowing that a creek exits under their tires. Hikers, bikers, and dog-walkers use the trails in and around the valley, encountering glimpses of concrete culverts and gabion baskets alongside the creek.


fig. 6.41 Flood Damage

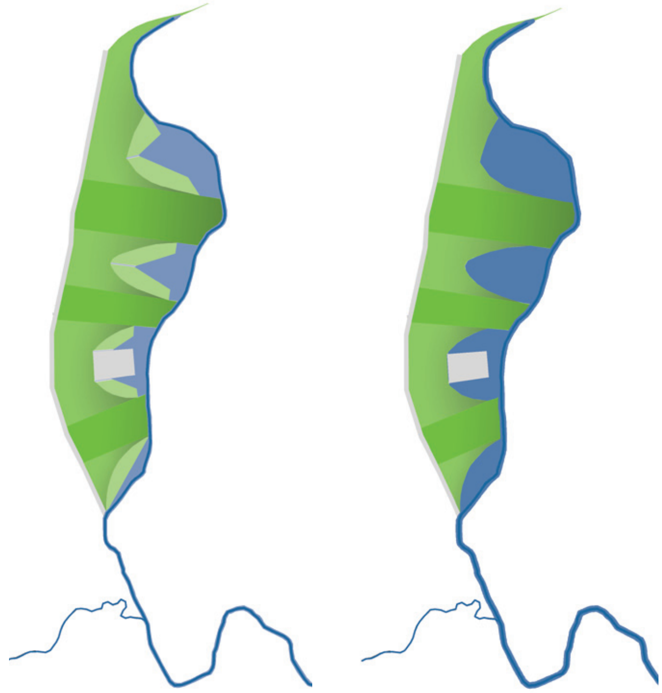


fig. 6.42 Creekside Flood Conditions

During storm events, however, every storm water holdings tank rapidly fills with the water collected from community sewers. The water from the Mountain catchment rushes into the creek along with the natural surface runoff from the adjacent recreational land.

These new erosion prevention interventions no longer allow the creek to swell along its whole length, thereby increasing the velocity of the flood water as it passes downhill. Certain areas with less flood prevention quickly become swollen points along the creek. The unfortunate trail-users confront a raging river where a creek previously flowed. The greatest shock of all is for those motorists on the Parkway who become increasingly aware of the creek previously passing beside the road. Sheets of creek water overflow onto the surface of the Parkway. [1] Traffic slows to a crawl until the police close the flooded portions of the road, and direct traffic back out of the Valley. The Red Hill Creek once again claims its Valley from the grip of the Parkway.

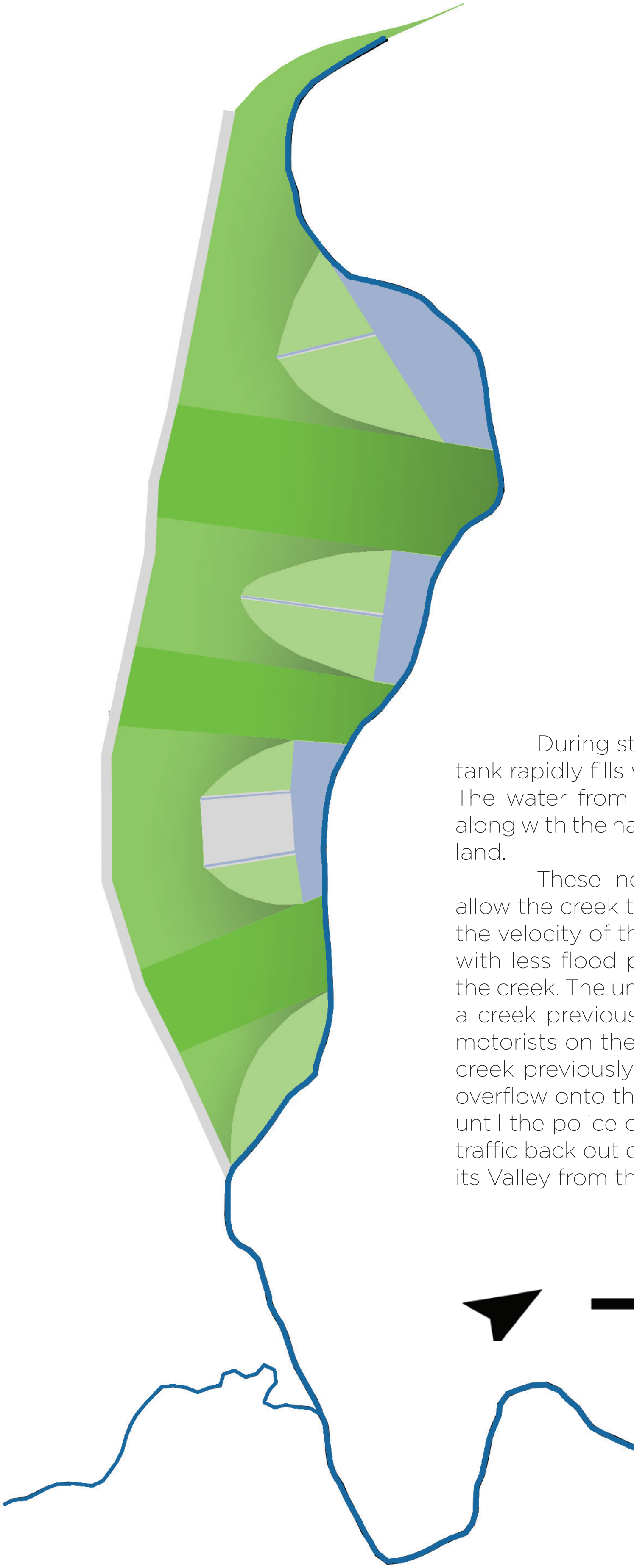


fig. 6.43 Typical Creekside Plan


fig. 6.44 Windemere Marsh reeds


fig. 6.45 Windemere Marsh willow


fig. 6.46 Red Hill Creek at Windemere Marsh

The holding tanks of lower Hamilton and Stoney Creek do nothing to reduce the speed or volume of storm water arriving in the Creek from the Mountain storm water catchment basin. Water crashes unchecked over Albion Falls and into the Valley in full force. From storm water culvert to falls, the Upper Ottawa Street Landfill site occupies most of the edge of the creek. Most of the region feeding into the storm water culvert on site is hard surfaced, increasing the volume of runoff compared to porous soft surfaced areas. During a storm event, the outflow of the culvert on site is estimated to be 41.3 m^3/s. [2]

As the landfill is mined, the purpose of the concrete dividing wall is removed. With the deconstruction of the concrete wall, the creek route is once again free to be manipulated by weather conditions. Ample swelling space must be designed into the landscape of the Upper Ottawa Landfill site for the few days annually when the creek floods. Not only should the creek be free to expand, but an attempt must be made to slow and retain some volume of water on site during an extreme event. An intervention at this site would help prevent Parkway flooding further downstream.

The introduction of a wetland ecosystem back into the Red Hill Creek has been of interest for several years. Most of the low lying land adjacent to the length of the creek was turned into city landfill as Hamilton flourished in the mid-twentieth century. The outlet of the creek at the Windemere Basin has been reclaimed by wetland at the base of mounds of capped trash in the Rennie and Brampton Street Landfills. The landfill at the source of the creek has not yet been addressed in such a manner. Since the water contamination levels are so variable at the end of the creek, no human contact can be made with the water despite its proximity to a public park. Unfortunately, the potential cleansing abilities of the marsh wildlife are not beneficial to the creek itself, but only the Windemere Basin, the Burlington Bay, and Lake Ontario. The water quality must be addressed before it travels through the entire environmentally significant Red Hill Valley.

Storm water travels directly from the street surface to the lake, only treated by the naturally occurring organisms in the creek and along the banks of the valley. For this reason, the path of the creek through the site will be lined with flora that are known to improve water quality. As the volume of the creek expands, the water mingles increasingly with wetland plants, extracting toxins from the water and soils. The soft surface of the land provides absorption for some water volume, and retention to reduce the flow downstream.

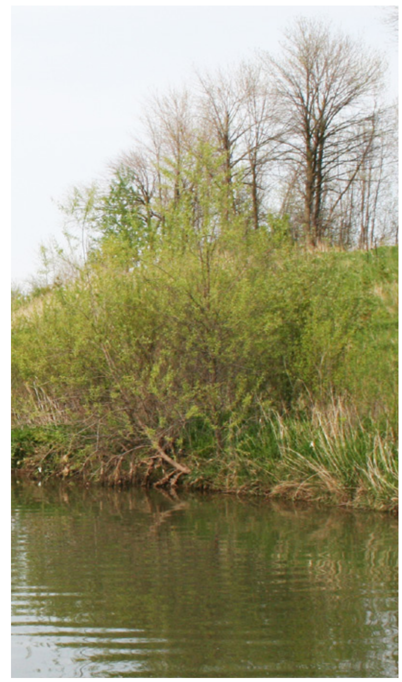


fig. 6.47 Red Hill Creek edge at Brampton Street Landfill

COMMUNITY RECOVERY

Integrated into the ecological recovery efforts is the introduction of the community into the site, addressing the current underperforming social status of the landfill. The opportunities for community program occur on site through the interaction of the ongoing activities and their supporting infrastructure.

ACTIVITIES + OBJECTS = PROGRAM OPPORTUNITIES

	ACTIVITIES	OBJECTS	PROGRAM OPPORTUNITIES
WASTE	MINING WASTE RETAINING GARBAGE DECONTAMINATION STORAGE RE-LANDFILLING	INFRASTRCUTURAL WALL RETAINING COMPONENTS MATERIAL RECOVERY FACILITY FUTURE RECYCLABLE STORAGE NEW SANITARY LANDFILLS	VISITOR EDUCATION VISITOR OVERLOOK ROCK CLIMBING WALL MOVIE PROJECTION WALL
ECOLOGY	LANDSCAPING LANDFORMING HABITAT BUILDING	FLOOD POOLS COMMUNITY PARK SPACE	INTERPRETIVE CENTRE WILDLIFE VIEWING PLATFORM CREEKSIDE HIKING
COMMUNITY	COMMUNITY RECREATION COMMUNITY GATHERING	VISITOR PATH VISITOR CENTRE PUBLIC ICE RINK PUBLIC WORKS YARD	PLAYGROUND AMPHITHEATRE

Interaction Timeline: The combination of waste operations, habitat forming, and community landscape building over the passage of time creates opportunities for program

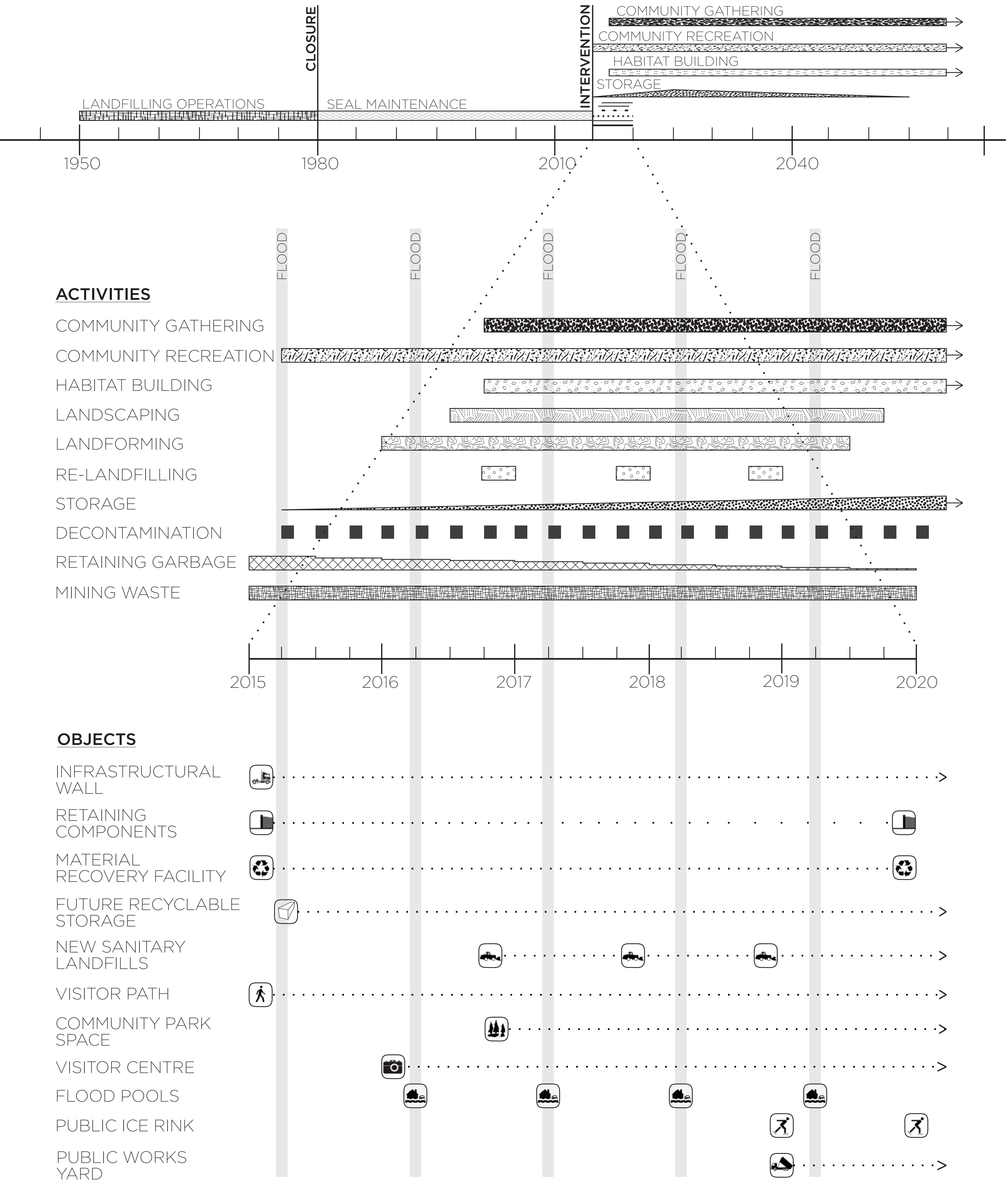


fig. 6.48 Upper Ottawa Street Landfill timeline

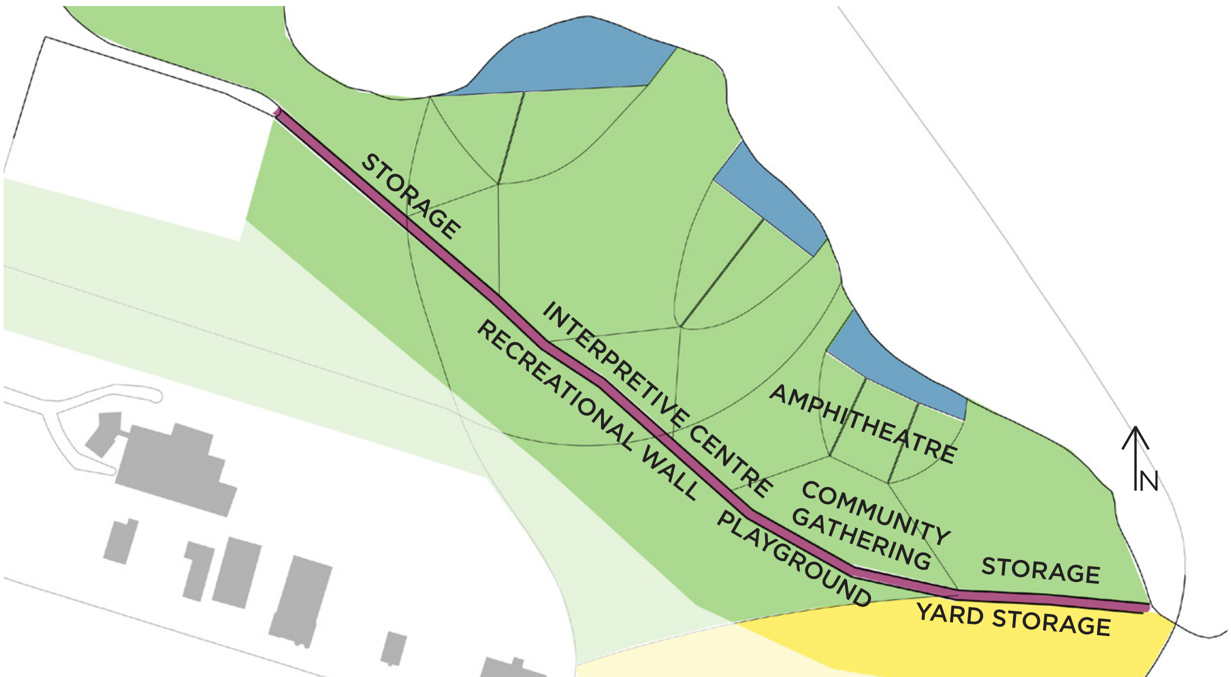


fig. 6.49 Wall program opportunities diagram

community park space *infrastructural wall* *municipal yard*

COMMUNITY INFRASTRUCTURE

The infrastructural wall that operates for the mining and storing of materials also acts as a conduit for pedestrians across the site, at the level of the landfill cap. Atop the wall, a path for cyclists, and pedestrians provides safe access to the site during mining operations below, allowing recreational activities to begin early in the phased intervention. The opening of the trail connects the community to the extended Red Hill Valley trails and Hamilton-Caledonia rail trail. From the top of the wall, views to the landfill, the new habitat, and the entire community are available to visitors, neighbours, and wildlife enthusiasts.

Within the wall, an integrated landfill mining interpretive centre provides visitors with an educational experience, offering information on the history of the Upper Ottawa Street Landfill, and the ongoing mining operation. Also within the wall, at regular intervals, is vertical circulation for safety and accessibility. Restrooms and utility hook ups for the entire park are located within the wall, leaving the landscape otherwise unbroken by structure.

Upon the wall, a rock climbing surface provides the community a new recreational activity. The wall also serves as a projection surface for neighbourhood gatherings and as an outdoor amphitheatre backdrop. As the material storage within the wall is removed, and the cladding changes on the surface of the wall, a ground-level childcare facility is introduced. The public playground serves the residential neighbourhood, while the day care centre is used by local commercial employees.

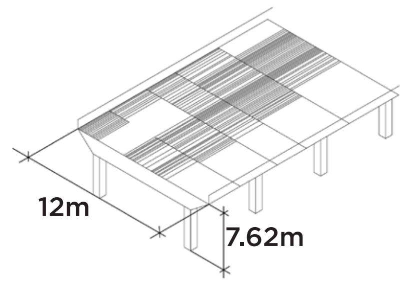


fig. 6.50 the high line

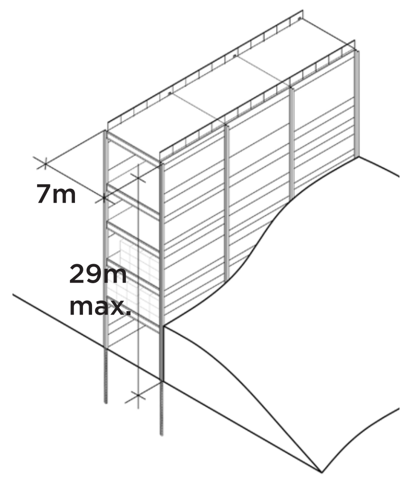


fig. 6.51 infrastructural wall

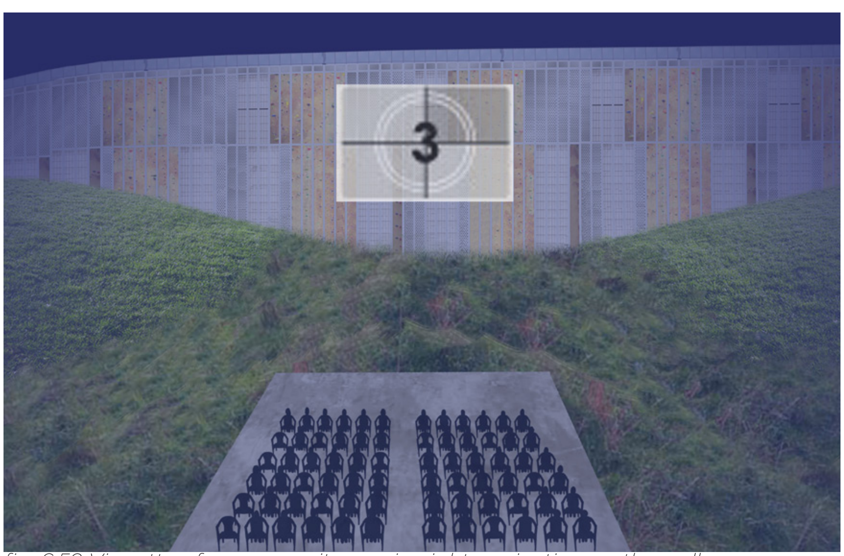


fig. 6.52 Vignette of a community movie night, projecting on the wall


fig. 6.53 Key Plan

fig. 6.54 Sectional perspective of park spaces, accessible through the wall

fig. 6.55 Key Plan

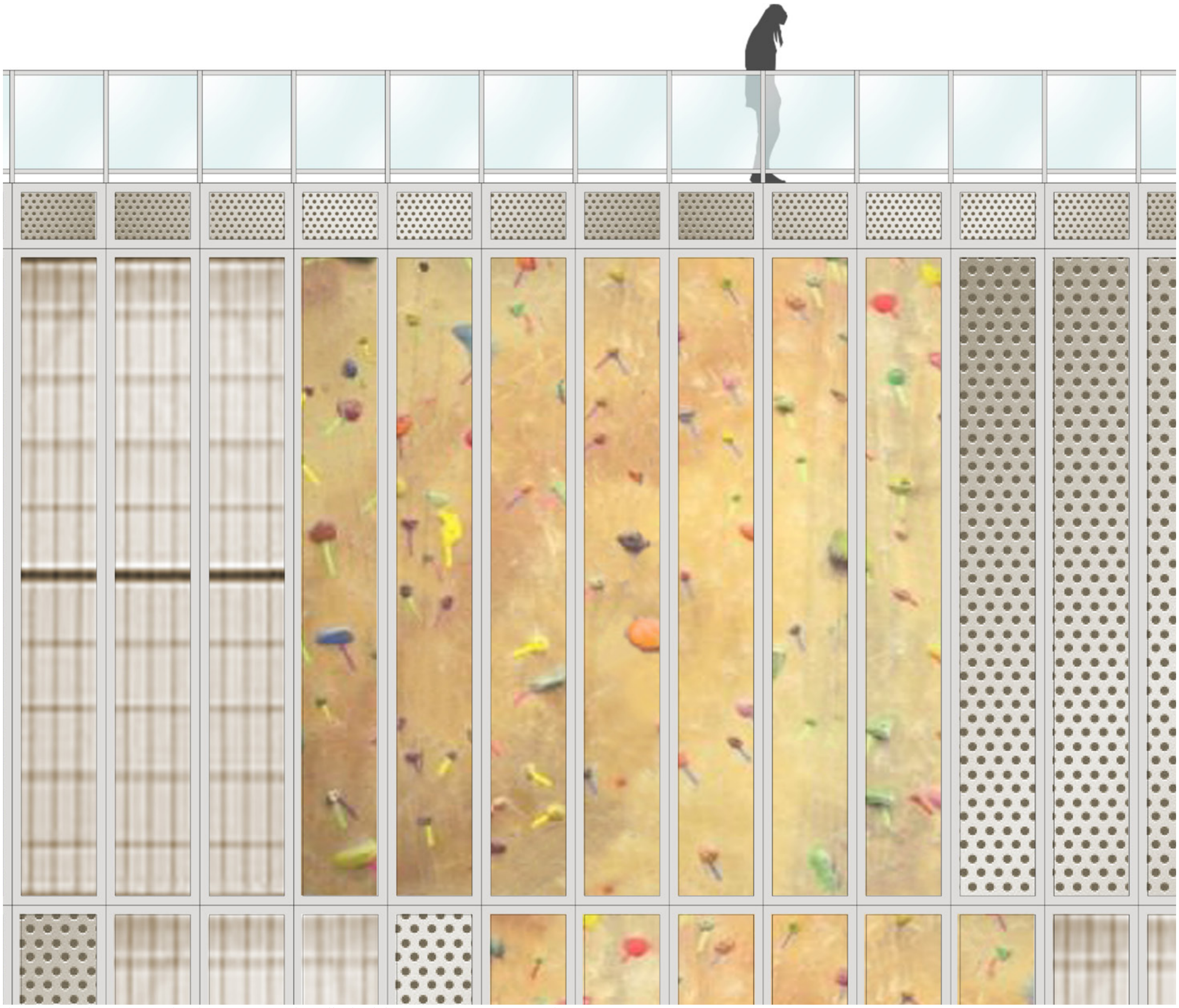
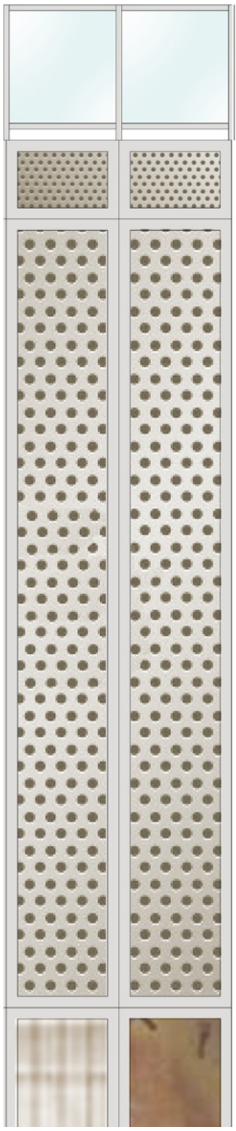


fig. 6.56 elevation of infrastructural wall cladding components, informing program opportunities



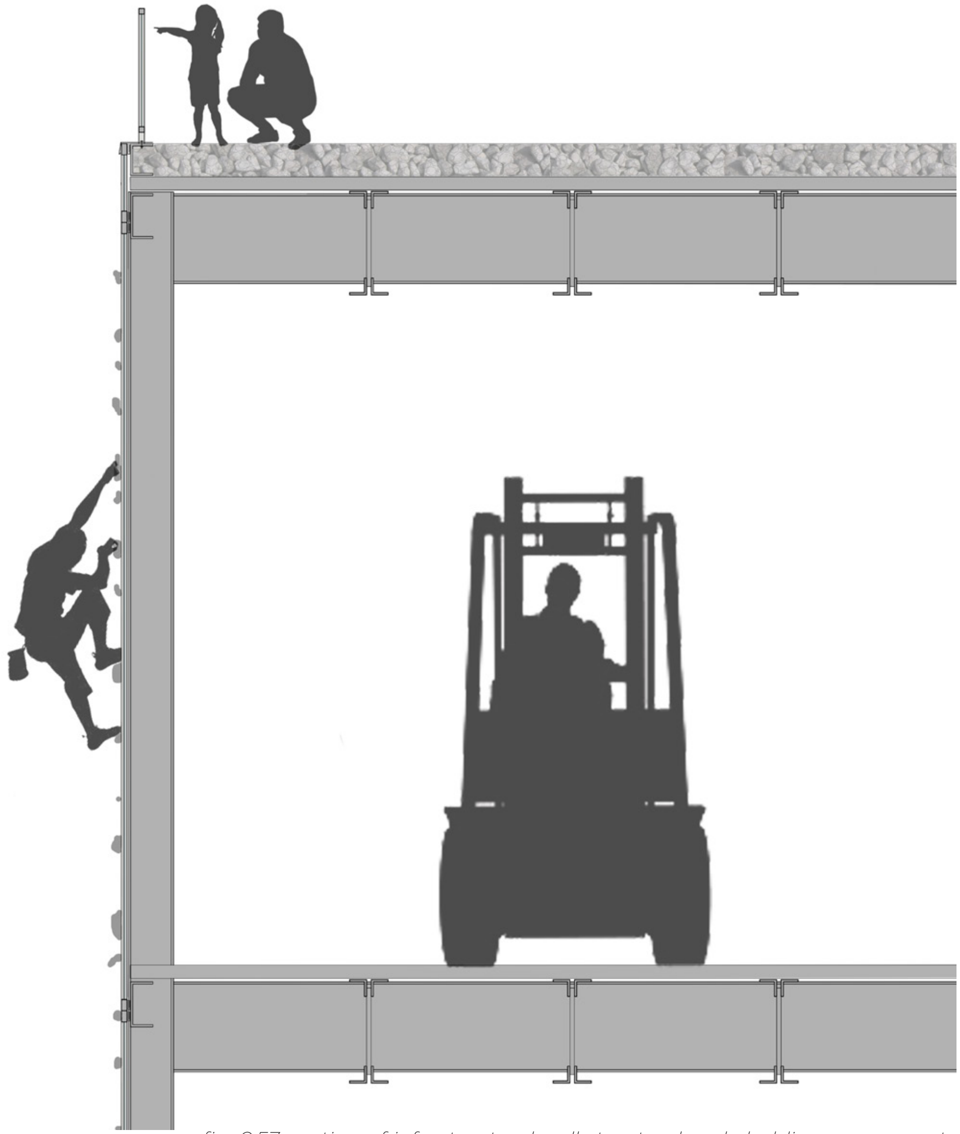


fig. 6.57 section of infrastructural wall structural and cladding components

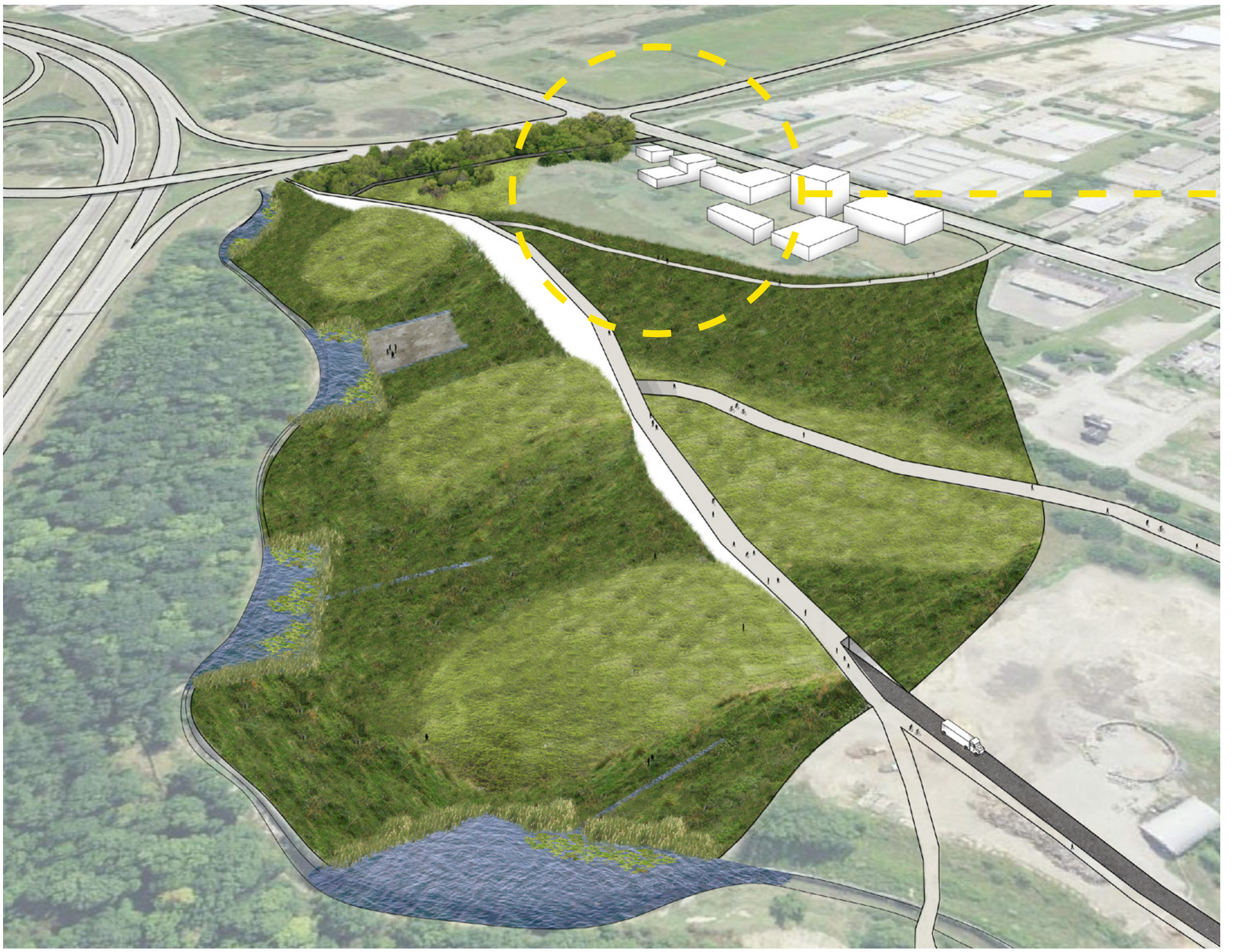


fig. 6.58 Aerial view of completed landscape intervention and small commercial frontage on The Former Upper Ottawa Street Landfill

fig. 6.59 Key Plan

STONE CHURCH ROAD PROGRAM

The majority of the street frontage of the Trenholme block is owned by the municipality, as landfill, or as city facilities and public works yards. Once the landfill has been mined, the southern portion of the site which fronts onto Stone Church Road is free to be developed. Unlike the north side of the site, which contains the Red Hill Creek, the south side faces small industrial and commercial lands on a busy road. Therefore, to give a street presence to the site, small commercial or industrial use buildings will line Stone Church Road.

The residential neighbourhood west of the Trenholme block is currently blocked from the park site by a road maitenance yard and the municipal forestry yard. By moving these uses to the area behind the Stone Church Road industry, they gain the use of the trucking corridor, and have access to storage space within the infrastructural wall. Meanwhile, the old yards will be remediated with indigenous plantings, and traversed by accessible trails linking the neighbourhood to the new park. This area becomes the new threshold to the Red Hill Valley.

fig. 6.60 Sectional perspective of new municipal yard and storage use south of the infrastructural wall

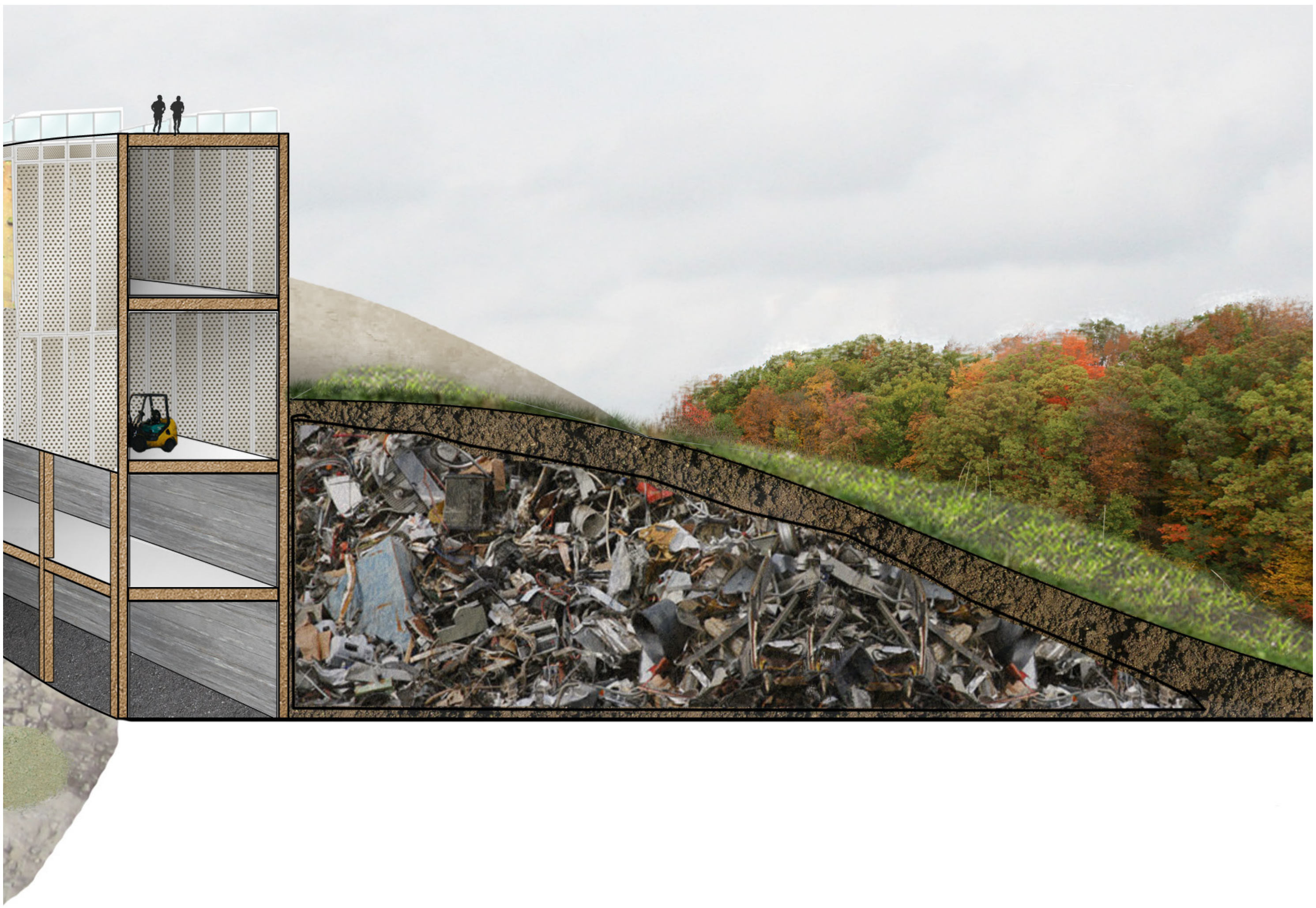
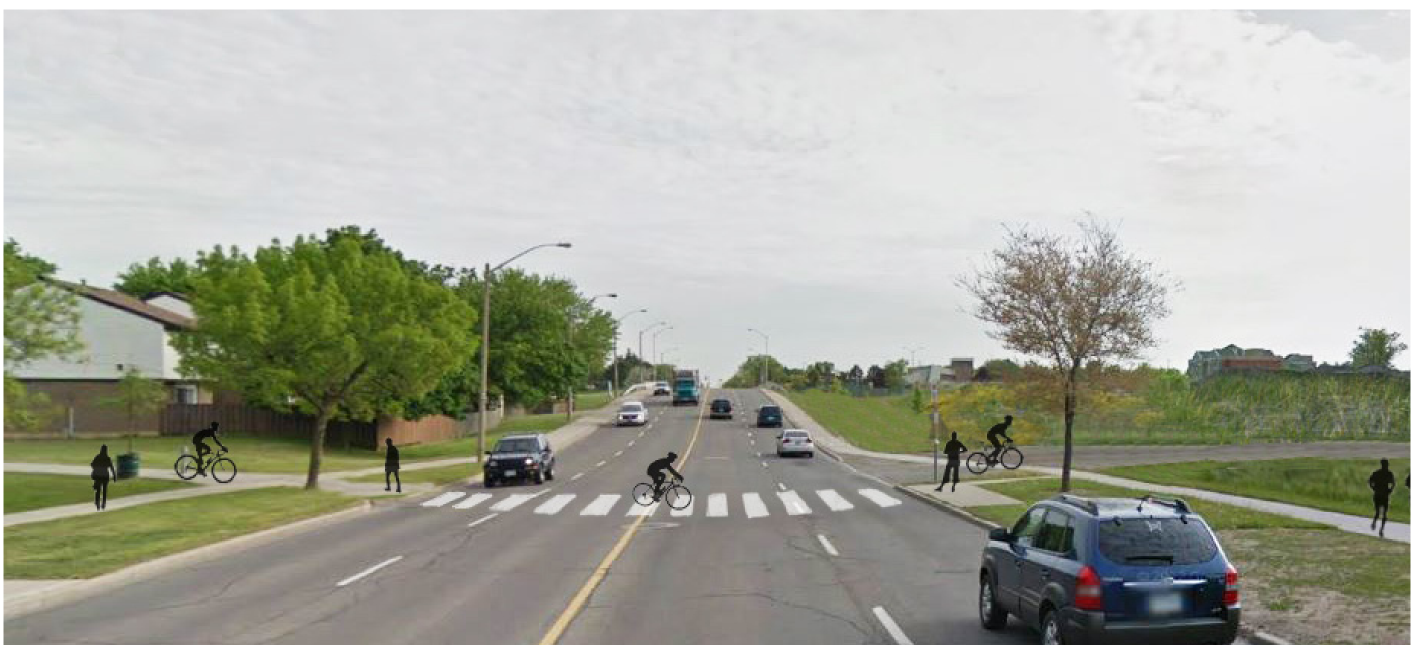


fig. 6.61 Key Plan

THE THRESHOLD

Entering the site from the West by car, bike, or on foot is available at any time during the operations of the mining, and onward into the future. Addressing the residential neighbourhood across Upper Ottawa Street, the visitor is first confronted with the interpretive centre. To be accommodating to the community, a play space is integrated into the entry to the parkland to be shared by all visitors and pedestrians alike. Parking is provided for visitors from farther away, to be used as a trailhead for the entire Red Hill Valley System.

Nearby but safely out of bounds is the operating entrance to the mining operations. Visitors may cross paths with trucks and other large equipment deeper into the site, while the proximity of



the entries maintains accountability to the community in which the landfill was built. The interpretive centre contains materials for visitors of all ages, with interactive displays and photographs of the site throughout its lifetime, up into the mining operations. Persons venturing into the site will gain an appreciation of the gravity of the waste production problem, and the resource reclamation efforts. Also housed in the interpretive centre is material on the greater ecosystem of the Red Hill Creek Valley, and how this one site fits into the larger region. From the Carolinian forests of Southern Ontario, to the Valley, from Lake Ontario to the Creek, the destiny of this site is linked into both large and small chains of cause and effect.

fig. 6.62 Vignette of threshold interpretive centre, showing connection to existing neighbourhood trail and street frontage

fig. 6.63 Key Plan

THE AMPHITHEATRE

The largest room of the proposed landscape is the amphitheatre. The dished terrain provides naturally inclined seating for ideal acoustic and viewing standards. The stage area acts as a surface for performance, ceremony, or skating, depending on the season. Large public concerts may use several rooms for different shows. Ceremony planners book the pavilion for private use, enjoying the relative privacy of the bowl-shaped landscape. In extreme storm events, the community and the media congregate on the pad to see the writhing waters of the creek in flood, surrounding their platform of safety. The raised surface is flooded in winter, and lights strung up as the neighbourhood gathers nightly to skate together alongside the Red Hill Creek. Games of pick-up hockey are a daily occurrence during the holiday season, a crowd gathering to cheer on the underdogs.

fig. 6.64 Vignette into the new landscape from the elevated walkway looking into the amphitheatre

fig. 6.65 Key Plan

TRAILS

Public paths for cycling, hiking, and walking extend from the residential neighbourhoods to the West, across the Lincoln Alexander Parkway. to the Albion Falls trail. The Rail Trail which currently ends at Stone Church Road is invited into the site and connected to the trail stub on the North side of the Lincoln Alexander Parkway. A pathway leads from the elementary school directly into the site for field trips, educational site visits, and active games in the park. An informative stroll across the former peak of the landfill exposes the visitor to interpretive materials, educating them on matters of material, landscape, and creek recovery. This path will be maintained throughout the entire mining operation thereby allowing the visitor to experience the industrial grit of the landfill, the construction of the new landscape, and the fine grain of the ecosystem within which the whole site acts.

fig. 6.66 Vignette of bicyclists on Rail trail connection

fig. 6.67 Trail map of the new Trenholme block

infrastructural wall path
landscape/creek park trails
Hamilton-Caledonia rail-trail

DEPLETING THE CACHES, READING THE WALL

After the landfill has ben remediated, the new sealed landfills and the future recyclables in storage are all that remain of the landfill mining operation. As technology advances and material recovery improves, the cached materials will be removed from their stored spaces and trucked to recovery facilities. During this process, the spaces cleared of materials are reclaimed for municipal storage or public programming, which is indicated on the exterior by a change in cladding.

fig. 6.68 Vignette of the future wall, partially transparent, with new cladding and gaps, with the elevated walkway remaining and new program used within

By the time all the cached materials have been removed, the surface of the wall will no longer read as a solid mass: cladding will be in only the locations of program. This is yet another reading of the passage of time on site.

fig. 6.69 Key Plan

INTEGRATED DESIGN REVIEW

This design proposal is rooted in the three main infrastructural elements, the wall, the material recovery facility, and the landforms. These three components work as a system to reclaim materials from the landfill, while recovering the site for community members, and rehabilitating the ecosystem. The system works to recover the Upper Ottawa Street landfill over the course of five years and beyond, allowing visitors to register the change of the site through the seasons, over the duration of the mining, and in the redevelopment of habitat. The passage of time reveals the ever-changing nature of the closed landfill and its transformation into the new park space.

The individual challenges of the Upper Ottawa site could have been addressed individually, one at a time, by specific methods for each issue. However, the hybrid approach, of integrating landfill mining, landforming, and habitat recreation into a unified system provides efficiencies in site access, while creating unique opportunities for systems to inform each other. By achieving the priorities of site accessibility, ecosystem recovery, and material reclamation, the proposal for the Upper Ottawa Street Landfill is able to address the identified underperforming, dangerous, and exploitable site conditions.

NOTES

1. Caton, Hilary. 2012. "UPDATED: Severe thunderstorm watch issued for Hamilton." The Hamilton Spectator July 23.

2. Islam, Monirul, interview by Author. 2012. (August 29).

7

CONCLUSION: FUTURE RAMIFICATIONS

The design of this rehabilitation of a closed landfill site in Hamilton represents one viable solution to the large number of closed landfill sites in Ontario. Although the design is site-specific, the principle strategies are valid when applied to any site. Those principles are:
LANDFILL MINING, to reclaim the buried resources,
MATERIAL RECOVERY, to return recyclable materials to the material cycle,
WASTE-TO-ENERGY INCINERATION, to produce power from materials with a high potential energy,
LANDFORMING, to integrate relandfilled materials into the terrain of a new, safe, public space,
COMMUNITY EDUCATION, to capitalize on the opportunity presented by closed landfills within residential neighbourhoods,
and ECOSYSTEM REHABILITATION, to remedy the ecological damage that closed landfills have produced.

Components of this design, such as the material recovery facility on tractor trailer beds were created with the mass-utility of this design in mind. Applying these same design strategies to sites across Ontario, with a fleet of equipment, could systematically eliminate the threat of closed landfills in twenty-five years.

The extended implementation of this landfill reclamation method across a greater region would act as a larger system, linking the individual sites in a common goal. This design proposal stands alone, as a first of its kind, but would respond differently were the entire closed landfill population of the Greater Hamilton region to be mined. For example, the variation in size and toxicity of the landfills, as well as the threat to local communities and ecosystems may demand the complete removal of waste from site and not allow the storage of future recyclables within the new landscape. Or perhaps in a region where urban densification is mandated, a public park would not be an appropriate reuse for the entire surface of the reclaimed site. In these situations, the connection between the mined sites is used to the advantage of individual circumstances. For example, on a large, easily accessed site in a semi-industrial neighbourhood, like the Upper Ottawa Street site, it would be possible to store and cache more future recyclable materials from other reclaimed sites within the region. This potential collaboration between local landfill rehabilitation projects not only makes a more appropriate use of larger sites as caches, but also allows the retrieval of future recyclables to be better coordinated. In freeing up smaller, more precious landfill sites for public use, the infrastructure on larger sites accommodates more materials, thereby giving a greater purpose to the large scale of the storage space.

Not only will the regional operation work to make future recyclable caching more efficient, but the sharing of data between sites will encourage the future of landfill reclamation. By tracking the volume of excavated materials as they are sorted, the argument for resource recovery will be strengthened. The estimated volume of recoverable materials within the Upper Ottawa Street Landfill that appears in the budget in Appendix 1 is the best guess possible without excavation. The confirmation of the large percentage of valuable materials buried in closed landfills will provide an even greater incentive for province-wide action.

The undertaking of such a project would be in the best interests of the province, and municipalities, though their current passive solutions prove they are unlikely agents of change. It is in private industry, where corporate gain is chief, that the potential of this project may take root. After mining is complete, however, the ongoing operations and maintenance of the site would be municipal, as with most local parks.

Starting with the closed landfills sites which are deemed most critical based on the evaluation of site conditions covered in Chapter 4, a city would be able to, over time, rehabilitate underperforming land. Even current recreational parks on landfill surfaces could be mined, once suitable alternate play fields are established. For example, in order to reclaim the materials under a play field landfill, another local closed landfill site might be rehabilitated into a new recreational park space to allow an easy shift of tournaments and league play to the new site. The design in Chapter 6 purposefully avoids play fields as a program element, due to its close proximity to ample sports field space, not because it is an invalid community park use. In the massive operation to reclaim space and materials from closed landfills, all closed landfill sites should be considered, not just the eye sores.

Municipalities like Hamilton contain a balanced number of suburban and rural closed landfills, whereas the City of Toronto, or Bruce County face mostly one or the other locale. The designed reclamation strategy employed in Chapter 6 is primarily concerned with suburban sites, but is equally possible on rural sites. The new landscape design for a rural rehabilitation operation would be much looser in program than a suburban one. Urban closed landfills, however, require a much more strict site presence, restricting trucking and equipment routes and demanding much more program out of the final site design. With the decontamination of an urban site complete, the new development of the land is able to be turned over to the neighbouring community. Mining infrastructure can be adapted to suit a new use, or be deconstructed and reused on another site. The mining method proposed in Chapter 6, then, must be modified if it were to accommodate a truly urban site. The operations equipment and recovery strategies, however, are equally useful to all scales of site. The strategies are universal, but the details would be altered to suit each unique site.

Until the value of the land, the materials, and the wellbeing of communities and ecosystems trumps the perceived expense of digging up our closed landfills, nothing will be done. Although not all these things have a price in dollars and cents, they each demand more action on closed landfill sites. Our years of passive maintenance measures are not helping the underlying issues, only drastic action such as landfill mining will undo what we have done through previous half-measures.

A1

U.O.S.L. FINANCIAL FEASABILITY STUDY

The data used for the calculations in this study are accumulated from landfill volume studies conducted by the author, landfill contents studies undertaken by the Garbage Project, recycled goods value statistics collected by Reclay StewardEdge, and MRF expenses estimated using material from interviews with MRF operators. All numbers are estimations based on the best information available, and are conservative where accuracy is unlikely. The quantity of recyclables available is estimated in an extremely pessimistic manner, to ensure that the material revenue is not exaggerated. Wherever possible, current data is used, so these values represent 2013 Canadian dollars.

The Upper Ottawa Street Landfill represents a site rich with recyclable materials, which may not be true of other closed landfills. Sites which closed before the 1980s represent the era before widespread recycling. Those landfills which operated after the common use of plastics, aluminum, steel, and glass containers but before the recycling movement are rich caches of resources. The study of the potential revenue which can be made off the mined materials, is then optimistic in comparison with closed landfills of a different age. However, the 1950s-1980s generation of landfills is a highly populated one. Thus, this feasability study, despite being landfill- and era-specific, remains a testament to the value of landfill-mining operations.

BUDGETED INCOME (PRIVATE)		metric tonnes of material	value	TOTAL
Recyclables Sold				
	steel	460,000	$255	$117,300,000
	aluminum	164,000	$1,595	$261,580,000
	glass	306,000	$21	$6,426,000
	plastics	12,000	$37	$444,000
	paper	220,000	$75	$16,500,000
Grants				
	municipal		$1,525,000	
	provincial			
	federal		$350,000	$1,875,000
Power fed into Grid				
		230,000,000	500,000,000 kWh	$40,000,000
				$444,125,000

BUDGETED EXPENSES (PRIVATE)	Mining Operation (5 years)	Environmental Recovery	Landscape Creation	TOTAL
Labour	$16,650,000	$3,500,000	$2,500,000	$22,650,000
excavation	$12,000,000			$12,000,000
grading		$250,000	$110,000	$360,000
planting			$250,000	$250,000
Equipment**	$5,000,000	$500,000	-	$5,500,000
Fuel/ Power	$1,600,000	$500,000	-	$2,100,000
Materials	$15,000,000	-	$5,000,000	$20,000,000
Fees & Construction	$15,000,000	$3,000,000	$12,000,000	$30,000,000
TOTAL	$65,250,000	$7,750,000	$19,860,000	$92,860,000

** cost shared with a proposed 6 other sites

QUALITATIVE ONGOING ANNUAL OPERATIONS BUDGET (MUNICIPAL)

The municipality will maintain the site and interpretive facility mostly on their existing landfill maitenance budget, but also on park and recreation funds, supplemented by site-specific revenue. All city yard lands sacrificed for the opening of the Upper Ottawa St. frontage will be replaced on site behind the Stone Church Rd. new commercial/industrial frontage.

EXPENSES	REVENUE
Interpretive Centre	Site Rentals
Park Maintenance	Special Event Admission
Trail Maintenance	Event Sponsorship

A2

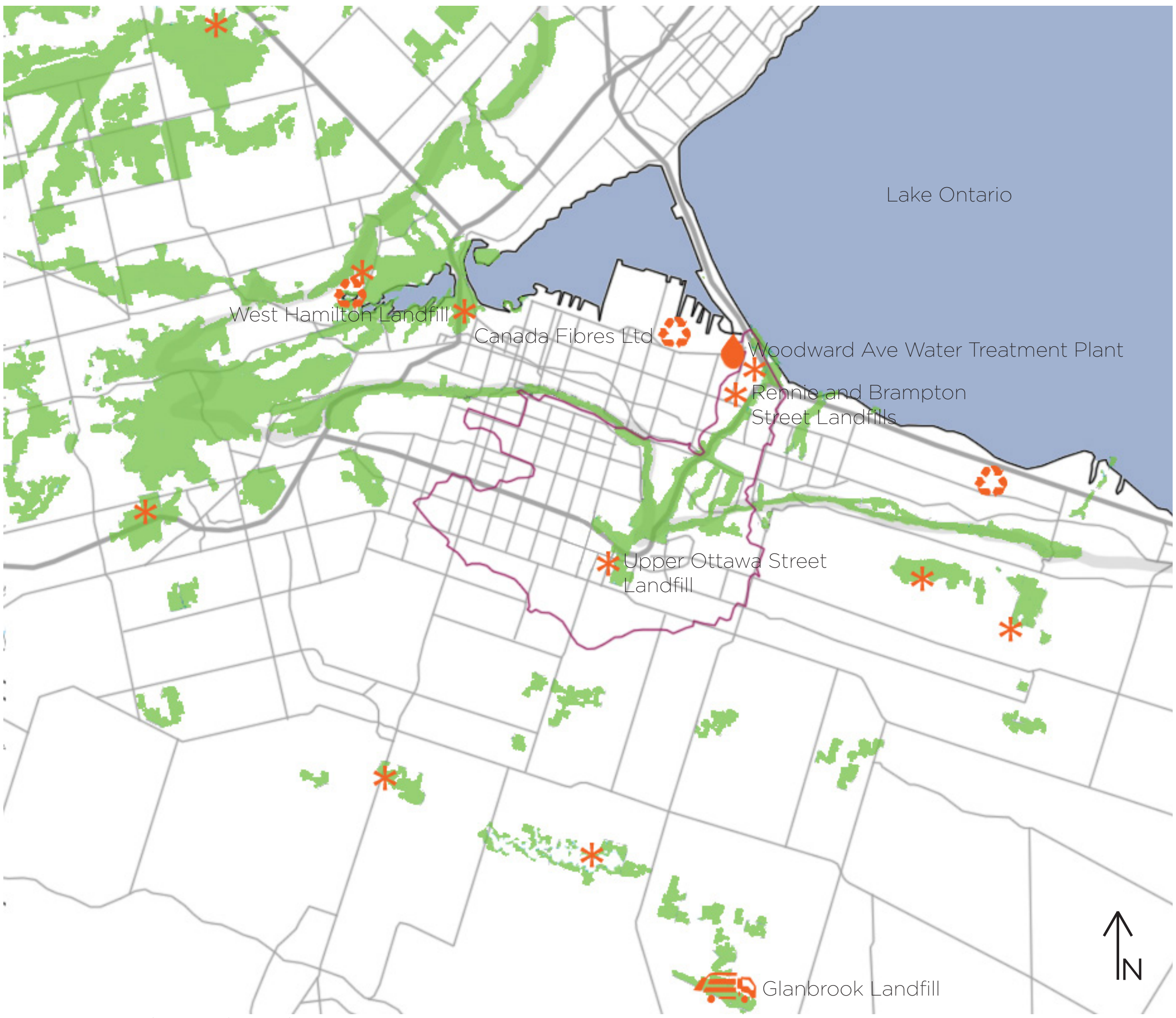
UPPER OTTAWA ST. LANDFILL CULTURAL CONTEXT

KEEPING UP WITH THE NEIGHBOURS: HAMILTON'S CLOSED LANDFILLS

There are thirteen closed landfills within greater Hamilton, four within the city proper, and three of those lie on the banks of the Red Hill Creek. Almost every landfill site is within or adjacent to an environmentally significant area as recognized by Hamilton authorities. [1] The municipality has been addressing concerns regarding these capped trash mounds on an as-needed basis, preferring passive solutions to more aggressive methods of contamination-prevention. [2] The sites which have seen the most intervention lie along creeks feeding into the Burlington Bay, with the exception of the 'dormant' Upper Ottawa Street Landfill. When compared to the treatment of the West Hamilton Landfill along the Chedoke Creek, or the Rennie Street and Brampton Street landfills at the outlet of the Red Hill Creek, the Upper Ottawa Street Landfill appears greatly neglected.

a 2.01 gooseneck vents in the Brampton St. Landfill

The Rennie Street and Brampton Street landfills were initiated as separate entities in the early 1950s, yet by the time they were closed in 1971 they had grown together into one shared remediation problem. [3] Side by side near the Windemere basin, they accepted mostly domestic waste, though it is presumed that some industrial waste is contained in the mounds due to missing records. It is known that sludge from the neighbouring waste water plant and sand from local foundries were deposited at the Brampton Street facility. [4] Containment of contaminants is a top priority for landfills within such close proximity waterways, therefore, the modification of capping material on the closed sites was carefully monitored during the construction of the Red Hill Valley Parkway. At the base of the closed landfills, the Creek had been relocated and redesigned in an attempt to limit contamination and prevent the natural erosion of the engineered



a 2.02 Regional map of Hamilton

Water *Red Hill Creek Watershed* *Designated Environmentally Significant Lands*

Water treatment Plant *Operational Landfill* *Material Recovery Facility* *Closed Landfill*


a 2.03 soccer field at Kay Drage Park


a 2.04 Chedoke Creek

capped mounds. Sports fields and bike trails are open on the sites as remedial work reaches a level of completion which allows public access. Signage stands at the park perimeter strongly discourages interaction with the creek water, while the compact trash underfoot goes unnoticed.

The West Hamilton Landfill is the largest closed landfill within Hamilton proper at 23 hectares. Tucked alongside the Chedoke creek and the York Boulevard highlands, the landfill was operational from the 1940s until the mid 1970s. [5] The domestic, industrial, and commercial wastes below ground are now capped and covered by the soccer fields and baseball diamonds of Kay Drage Park, and paralleled by Highway 403. The city has spent millions of dollars on attempts to prevent contamination of the groundwater, the subterranean storm water sewers, the Chedoke Creek, and ultimately the marshlands of Cootes Paradise. The remedial works at the West Hamilton Landfill have lead to the sealing of sewers running beneath the landfill, several large excavation projects to re-cap the mounds, and many erosion-prevention measures to prevent leachate from reaching the creek. [6] Based on the extraordinary measures taken at Kay Drage Park, it is clear that the city values the health of the Chedoke Creek and the public's interest on the landfill site in a way far beyond that of the Upper Ottawa Street Landfill site.

FEEDING AN ENVIRONMENTALLY SIGNIFICANT ECOSYSTEM: THE RED HILL VALLEY

The Red Hill Valley, as it snakes its way from the Niagara Escarpment to Lake Ontario provides one of the last continuous green paths from Mountain to Lake within greater Hamilton. [7] Perched at the southern end of this corridor is the Upper Ottawa Landfill, feeding contaminants into the ecosystem as it effectively bars escarpment neighbourhood members from entering the Valley. The site of the closed landfill is in denial of its interaction with the greater downstream circumstance. It must actively participate in the natural, recreational, hydro-geological, and historical systems of the entire Escarpment and Red Hill Creek regions.

A NATURAL SYSTEM

As an ecological corridor, the creek valley is home to several wildlife species unable to live elsewhere in Hamilton. [8] The region falls within the range of the ever-shrinking Carolinian landscape, home to a number of endangered and rare species. The Carolinian forests of southern Ontario are dwindling at an alarming rate as urbanization encroaches on historically untouched land. [9] The Red Hill Creek Valley contains many flora and fauna species familiar to the Carolinian forest, despite being surrounded by built-up industrial and residential lands, and being traversed by numerous transit routes. Recent human interventions have both helped and hindered aspects of the Carolinian ecosystem, modifying the landscape to suit human desires. Planting schemes which include only naturally occurring species along with the removal of invasive plants continue to help the valley flourish, but the infrastructural interventions within the valley, cause far greater damage to the forest than these planting initiatives can repair. The Upper Ottawa Street Landfill is one of several infrastructural projects within the Creek watershed. By changing creek routes and flood beds

a 2.05 muskrat at Windemere Basin

while manipulating the velocity and flow rate of the creek, human development puts the established habitats at risk of deteriorating.

Where once passenger pigeons, rattlesnakes, and soft shelled turtles flourished, only the most adaptable species remain. The Red Hill Creek Valley remains home to many rare species of birds of prey and waterfowl, as well as herons, kingfishers, and common song birds. [10] The storm water which now floods the creek has increased the flow rate of the water, thereby reducing the fish population. Fish eggs and insect larvae are swept downstream from the natural nesting grounds, limiting the number which hatch, while denying those that do a food source. [11] Amphibious creatures continue to inhabit the creek, but unknown toxins from storm water overflow and landfill leachate continue to threaten their capacity to reproduce.

Though it can never return to its original diverse splendour, the ongoing deterioration of the Red Hill Creek Valley ecosystem should not be abided, and the prevention of further destruction of the Carolinian habitat is of critical importance to any new development within the region. [12] By bringing the Upper Ottawa Street Landfill site actively into the Valley system, this intervention will improve the water quality, velocity, and flow to help habitats thrive in the Valley below.

a 2.06 access point and cyclists at Brampton St. Landfill

A HISTORICAL SYSTEM

As one of the largest natural escarpment-to-lake valleys along the south shore of Lake Ontario, the Red Hill Valley has played a consistent role in the human inhabitation of the region for thousands of years. As a First Nations trail, the valley was one of many routes traversing the Niagara peninsula. [13] Archaeological teams have unearthed evidence of hunting, dwelling, and ceremonial areas within the Red Hill Creek watershed. [14] Since the creation of the King's Forest Golf Course in the 1960s, along with infrastructural and landscape interventions in the following years, the information potential of any artifacts found today is negligible. [15]

The fertile lands of the Niagara region were farmed by the First Nations and European settlers alike. Upon the arrival of United Empire Loyalists from the south during the American Revolution, homestead farms were settled within the Red Hill Creek watershed. Censuses and land surveying tracked the growing population in the area, destined to be named Barton Township in 1791. [16] A farming community developed on the escarpment and along the creek valley, including a school house, churches, and several mills powered by the creek itself. When the War of 1812 pushed as far West as Red Hill Creek, the Battle of Stoney Creek was fought on the farms of Red Hill settlers. [17] The farming neighbourhood continued to flourish and merge with other Hamilton townships, developing a comprehensive community from the farms on the escarpment to the small industry at the lake.

Respect for the historical significance of the Red Hill Creek Valley has waned in the face of infrastructural progress and efficiency of transportation routes. Modern development and historical interpretation and appreciation can coexist in the watershed; each deserves a place in the Red Hill Valley story.

a 2.07 Red Hill Creek

a 2.08 Albion Falls

a 2.09 Cootes Paradise

NOTES

1. City of Hamilton- Planning and Economic Development. 2013. Environmentally Significant Areas Impact Evaluation Group (ESAIEG). Accessed January 23, 2013. http://www.hamilton.ca/CityDepartments/PlanningEcDev/Divisions/Planning/CommunityPlanning/NaturalHeritage/ESAIEG/.

2. McKee, Alan, interview by Author. 2011. Upper Ottawa Street Landfill Site Visit (October 13).

3. Stewart, Scott. 2005. Status Report on City's Closed Landfills. Information Report, Hamilton: Public Works Department. p9

4. Stewart, Scott. 2005. Status Report on City's Closed Landfills. Information Report, Hamilton: Public Works Department. p9

5. Stewart, Scott. 2005. Status Report on City's Closed Landfills. Information Report, Hamilton: Public Works Department. p12-13

6. Stewart, Scott. 2005. Status Report on City's Closed Landfills. Information Report, Hamilton: Public Works Department. p12-13

7. Regional Municipality of Hamilton-Wentworth. 1998. Red Hill Creek Watershed Action Plan. First Generation Plan, Hamilton: Transportation and Environment Offices. p16

8. Regional Municipality of Hamilton-Wentworth. 1998. Red Hill Creek Watershed Action Plan. First Generation Plan, Hamilton: Transportation and Environment Offices. p16

9. The Centre for Land and Water Stewardship. 1994. The Uniqueness of Carolinian Canada. June. Accessed January 22, 2013. http://www.carolinian.org/FactSheets_CCUniqueness.htm.

10. Peace, Walter G. 1998. From mountain to lake: the Red Hill Creek Valley. Hamilton: W.L. Griffin Printing Limited. p92

11. Peace, Walter G. 1998. From mountain to lake: the Red Hill Creek Valley. Hamilton: W.L. Griffin Printing Limited. p92

12. Regional Municipality of Hamilton-Wentworth. 1998. Red Hill Creek Watershed Action Plan. First Generation Plan, Hamilton: Transportation and Environment Offices. p16

13. Peace, Walter G. 1998. From mountain to lake: the Red Hill Creek Valley. Hamilton: W.L. Griffin Printing Limited. p10

14. Peace, Walter G. 1998. From mountain to lake: the Red Hill Creek Valley. Hamilton: W.L. Griffin Printing Limited. p118-123

15. Peace, Walter G. 1998. From mountain to lake: the Red Hill Creek Valley. Hamilton: W.L. Griffin Printing Limited. p124

16. National Library of Canada. 2005. Cultural Landmarks of Hamilton-Wentworth: Chronology of the Regional Municipality of Hamilton-Wentworth. April 5. Accessed January 24, 2013. http://epe.lac-bac.gc.ca/100/200/301/ic/can_digital_collections/cultural_landmarks/twps.html.

17. Peace, Walter G. 1998. From mountain to lake: the Red Hill Creek Valley. Hamilton: W.L. Griffin Printing Limited. p133

REFERENCES

Abalos, Inaki, and Juan Herreros. 2000. Abalos & Herreros. Barcelona: ACTAR.

American Scientific. 1999. Science Desk Reference. New York: Wiley.

Birmingham, Brendan. 1999 . Environmental risks of municipal non-hazardous waste landfilling and incineration. Technical Report Summary, Toronto: Standards Development Branch, Environmental Sciences and Standards Division, Ontario Ministry of the Environment .

Calgary Municipal Land Corporation. 2013. CMLC Explore Projects. Accessed February 28, 2013. http://www.calgarymlc.ca/explore-projects.

—. 2013. East Village. Accessed February 28, 2013. http://www.evexperience.com/discover.

Caton, Hilary. 2012. “UPDATED: Severe thunderstorm watch issued for Hamilton.” The Hamilton Spectator July 23.

Citizens at City Hall (CATCH). 2010. “CATCH Articles.” CATCH: Citizens at City Hall. July 9. Accessed August 29, 2012. http://www.hamiltoncatch.org/view_article.php?id=798.

City of Hamilton- Planning and Economic Development. 2013. Environmentally Significant Areas Impact Evaluation Group (ESAIEG). Accessed January 23, 2013. http://www.hamilton.ca/CityDepartments/PlanningEcDev/Divisions/Planning/CommunityPlanning/NaturalHeritage/ESAIEG/.

City of Montréal. 2013. Environnement: Revalorisation du CESM. Accessed February 20, 2013. http://ville.montreal.qc.ca/portal/page?_pageid=7237,75372019&_dad=portal&_schema=PORTAL.

City of New York. n.d. City of New York Parks & Recreation, Freshkills Park. Accessed January 4, 2013. http://www.nycgovparks.org/park-features/freshkills-park#tabTop.

Clarke, Marjorie J., Marten de Kadt, and David Saphire. 1991. Burning Garbage in the US. New York: INFORM, Inc.

Coulter, Sandy, and Paul Dewaele. 2009. "Landfill Mining." Solid Waste & Recycling Magazine, April.

Ecologistics Limited. 1981. Red Hill Creek Valley- Proposed Recreational Master Plan. Master Plan, Hamilton: Regional Municipality of Hamilton Wentworth.

Environmental Commissioner of Ontario. 2011. What a Waste: Failing to Engage Waste Reduction Solutions. Engaging Solutions, ECO Annual Report, 2010/11, Toronto: The Queen's Printer for Ontario.

Friends of the High Line. 2003. Designing The Highline. Accessed March 5, 2013. http://www.thehighline.org/competition/about.php.

—. 2000-2013. High Line: Design Team Selection. Accessed March 5, 2013. http://www.thehighline.org/design/design-team-selection.

Gooderham, Mary. 2012. "Making brownfields viable a win-win-win situation." The Globe and Mail.
Gourlay, K.A. 1992. World of Waste: Dilemmas of Industrial Development. London: Zed Books Ltd.

Government of Canada. 2012. Federal Contaminated Sites: Success Stories. Accessed March 5, 2013. Grand Quebec. 2013. GrandQuebec: Parc Cartier-Brébeuf. Accessed March 5, 2013. http://grandquebec.com/capitale-quebec/le-parc-cartier-brebeuf/.

Government of Hong Kong Leisure and Cultural Services Department. 2010. Jordan Valley Park. Accessed February 22, 2013. http://www.lcsd.gov.hk/parks/jvp/en/index.php.

Government of Hong Kong. 2012. Municipal Solid Waste. August. Accessed February 22, 2013. http://www.gov.hk/en/residents/environment/waste/msw.htm.

Grand Quebec. 2013. GrandQuebec: Parc Cartier-Brébeuf. Accessed March 5, 2013. http://grandquebec.com/capitale-quebec/le-parc-cartier-brebeuf/.

Harnik, Peter, Michael Taylor, and Ben Welle. 2006. "From Dumps to Destinations: The Conversion of Landfills to Parks [Forum]." Places 18.1 83-88.

Hertzman, Clyde, Mike Hayes, Joel Singer, and Joseph Highland. 1987. "Upper Ottawa Street Landfill Site Health Study." Environmental Health Perspectives, Vol 75: 173-195.

Islam, Monirul, interview by Author. 2012. (August 29).

Kay, James, Henry A. Regier, Michelle Boyle, and George Francis. 1999. "An ecosystem approach for sustainability: adressing the challenge of complexity." Futures 31 721-742.

Krook, Joakim, Niclas Svensson, and Mats Eklund. 2011. "Landfill mining: A critical review of two decades of research." Waste Management, November 13: 513-520.

McDonald, Bruce, interview by Author. 2011. Guelph Material Recovery Facility Site Visit (October 20).

McDonough, William, and Micheal Braungart. 2002. Cradle to Cradle: Remaking the Way We Make Things. New York: North Point Press.

McKee, Alan, interview by Author. 2011. Upper Ottawa Street Landfill Site Visit (October 13).

McLeod, Meredith. 2011. "Big plans loom at old knitting mill." The Hamilton Spectator.

Micheal vanValkenburgh Associates Inc. 2013. Micheal vanValkenburgh Associates Inc. Accessed March 1, 2013. http://www.mvvainc.com/project.php?id=87&c=urban_design.

National Library of Canada. 2005. Cultural Landmarks of Hamilton-Wentworth: Chronology of the Regional Municipality of Hamilton-Wentworth. April 5. Accessed January 24, 2013. http://epe.lac-bac.gc.ca/100/200/301/ic/can_digital_collections/cultural_landmarks/twps.html.

Natural Resources Canada. 2010. Energy Efficiency Trends in Canada 1990 to 2008. Energy Publication, Ottawa: Government of Canada.

Ontario Ministry of the Environment. 2010. "Landfill Inventory Management Ontario." Landfill Sites-Ministry of the Environment. October 13. Accessed January 3, 2012. http://www.ene.gov.on.ca/environment/en/monitoring_and_reporting/limo/landfills/index.htm.

Peace, Walter G. 1998. From mountain to lake: the Red Hill Creek Valley. Hamilton: W.L. Griffin Printing Limited.

Pearce, Dan. 1998. “Brampton Incinerator.” Solid Waste & Recycling Magazine, Oct 1.

Perry, Ann. 2003. “Two sides of garbage incineration.” Toronto Star B1.

Philippine Council for Industry, Energy and Emerging Technology Research and Development. 2012. “Example- Electricity Generation Jordan Valley Landfill, Hong Kong.” Global Methane Initiative. Accessed February 22, 2013. http://www.pcieerd.dost.gov.ph/images/pdf/gmi/06_lfg%20technologies_lloyd_2.pdf.

Ralph, Jolyon, and Ida Chau. 2013. Miron Quarry, Montreal, Quebec, Canada. February 19. Accessed February 22, 2013. http://www.mindat.org/loc-16409.html.

Rathje, William, and Cullen Murphy. 1992. Rubbish! The Archaeology of Garbage. New York: HarperCollins.

Reclay StewardEdge. 2013. “The Price Sheet.” Reclay StewardEdge: Product Stewardship Solutions. Accessed March 11, 2013. http://stewardedge.ca/pricesheet/.

Regional Municipality of Hamilton-Wentworth. 1998. Red Hill Creek Watershed Action Plan. First Generation Plan, Hamilton: Transportation and Environment Offices.

Shaw Media Inc. 2011. “Biothermica gains control of Gazmont power plant; adds stakes from SNC, Caisse.” Global Toronto. July 13. Accessed February 20, 2013. http://www.globaltoronto.com/biothermica+gains+control+of+gazmont+power+plant+adds+stakes+from+snc+caisse/4294976427/story.html.

Stewart, Scott. 2005. Status Report on City’s Closed Landfills. Information Report, Hamilton: Public Works Department.

Strange, Kit, and Dean Petrich. n.d. “Landfill Mining.” Environmental Alternatives. Accessed October 18, 2011. http://www.enviroalternatives.com/landfill.html.

Tammemagi, Hans. 1999. The Waste Crisis. New York: Oxford University Press.

The Centre for Land and Water Stewardship. 1994. The Uniqueness of Carolinian Canada. June. Accessed January 22, 2013. http://www.carolinian.org/FactSheets_CCUniqueness.htm.

Toronto and Region Conservation for The Living City. n.d. History of Tommy Thompson Park. Accessed January 9, 2013. http://tommythompsonpark.ca/home/history.dot.

Upper Ottawa Street Landfill Study Committee. 1983. The Investigation of the Upper ottawa Street Landfill Site. Interim Report, Hamilton: Government of Canada.

Walker, Roger. 2011. Density of Materials. April 4. Accessed May 29, 2012. http://www.simetric.co.uk/si_materials.htm.

Waterfront Toronto. 2013. Explore Projects: Lower Don Lands. Accessed March 1, 2013. http://www.waterfrontoronto.ca/explore_projects2/lower_don_lands.

Westerhof, Jake, interview by Author. 2011. Canada Fibres Ltd. Hamilton Site Visit (October 4).

Wolman, David. 2012. “The Trash Blaster.” Wired 118-123, 130.