Terra Incognita: Speculative Landfill Futures

Emma Petersen

A thesis submitted in partial fulfillment of the requirements for the degree of

Landscape Architecture

University of Washington

2022

Committe:
Ken Yocom
Jeff Hou

Program Authorized to Offer Degree:

Landscape Architecture

University of Washington

Abstract

Terra Incognita: Speculative Landfill Futures

Emma Petersen

Co-chairs of the Supervisory Committee:
Professor Ken Yocom, Department of Landscape Architecture
Professor Jeff Hou, Department of Landscape Architecture

The amount of Municipal Solid Waste (MSW) the world produces far exceeds our current infrastructural capacity. The things we throw away, while arguably benign individually, are dangerous once accumulated in large quantities. Instead of fearing this increase of waste and lack of solutions, we should use it as a catalyst to promote new policies and strategies to change waste management systems. ***What kind of design opportunities will post-closure landfills present in the future?*** The possible future in which this thesis explores combines elements of the probable and plausible but radically reimagines the perceptions, policies, and economics surrounding our current waste management systems – creating the possible. Taking inspiration from ***Ecotopia,*** the setting for the Cedar Hills Regional Landfill re-design imagines a world in which people value waste as a resource and public utility, believe in circularity, and feel a responsibility to heal that which we have polluted. Keeping waste local and processing it in a sustainable way is a priority. The CHRLF of the future combines **enhanced landfill mining** with **waste to energy** and **waste to material** technology to create a circular system in which both incoming waste and buried waste are a resource. People feel a responsibility to remove the harmful toxins they have buried in the earth and try to restore the superfund site. **Sorting and composting** waste before the incineration process, gives waste a chance at a second life. Much of waste sent to landfills is biodegradable food material that was never sorted in the first place. With an industrial composting facility directly to the south of the CHRLF, the nutrients in this material can be used again. **Combining this compost with fly ash from incineration**, will create a soil mixture that will then be placed back inside the landfill. The whole site can then be used as a research facility, a giant experiment, to conduct **phytoremediation trials** to begin the healing process. The CHRLF can then become a model for what landfills of the future can become.

keywords: waste, landfill, sanitary landfill, landfill mining, resource recovery, phytoremediation, speculative futures, landscape architecture

TERRA INCOGNITA

SPECULATIVE LANDFILL FUTURES

EMMA PETERSEN

I acknowledge that we are on the traditional land of the First People of Seattle, the Duwamish People past and present and honor with gratitutde the land itself and the Duwamish Tribe.

I want to give the most sincere thank you to Ken Yocom and Daniel Winterbottom- thank you for the most meaningful conversations I could ever have about trash, knowing when to push, knowing when to step back, and encouraging every idea.
Thank you to Jeff Hou for making my graduation possible.
Thank you to my brother Max for so many things that if I tried to list them I would have to write a second thesis.
Thank you to my parents for always supporting and believing in me, none of this could have happened without you.
And lastly a huge thank you to my cohort for 3(+) incredible years both in person and on zoom - landscape architecture is lucky to have you, and I am lucky to know you.

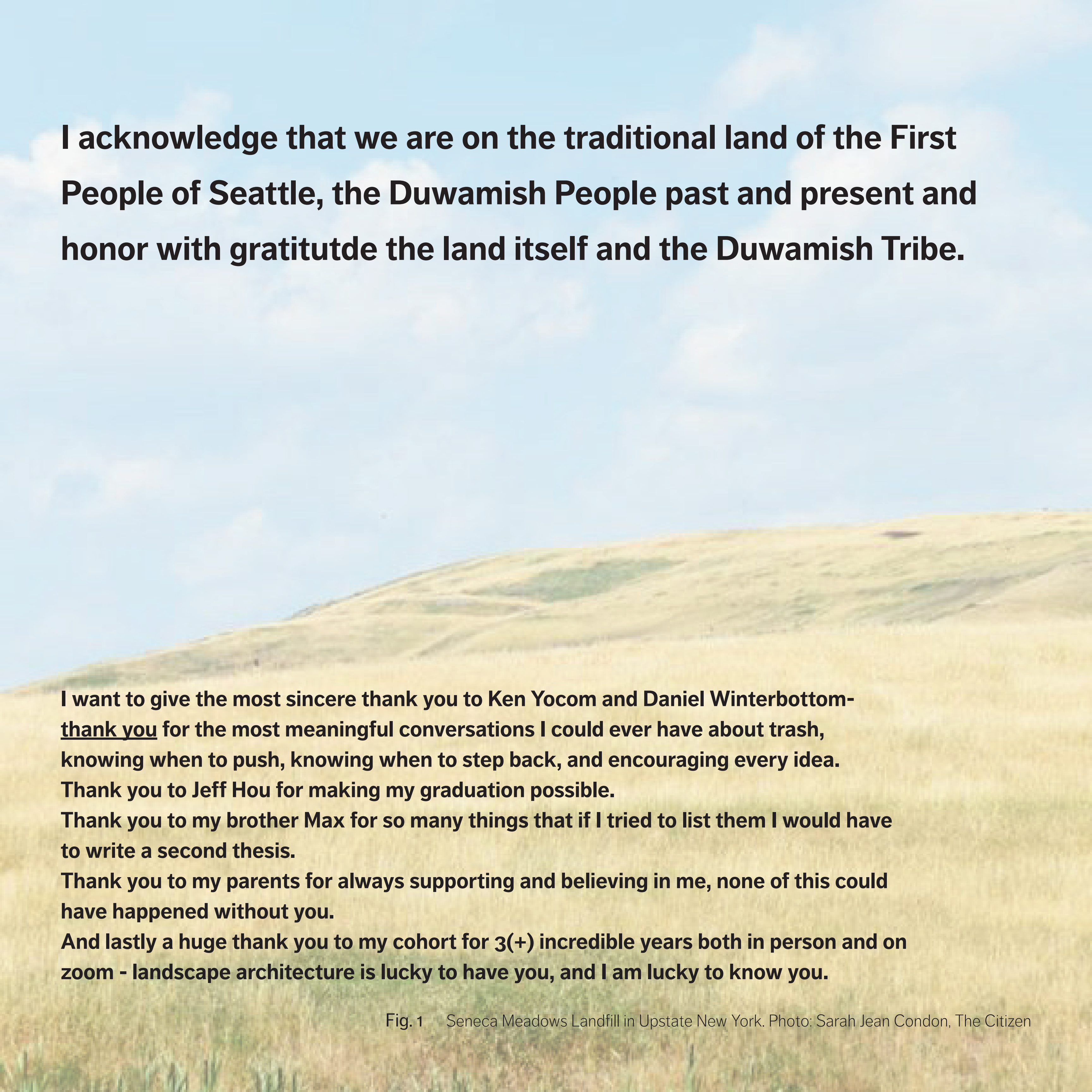


Fig. 1 Seneca Meadows Landfill in Upstate New York. Photo: Sarah Jean Condon, The Citizen

Table of Contents

List of Figures

List of Terms

CHRLF – Cedar Hills Regional Landfill

EIS – Environmental Impact Statement

ELFM - Enhanced Landfill Mining

EPA - Environmental Protection Agency

KCSWD – King County Solid Waste Division

LFG - Landfill Gas

LFM - Landfill Mining

LMOP - Landfill Methane Outreach Program

MSW - Municipal Solid Waste

MSWF – Municipal Solid Waste Facility

TAP – Toxic Air Pollutants

WTM - Waste-to-Material

WTE - Waste-to-Energy

garbage has to be the poem of our time because
garbage is spirtual, believable enough

to get our attention, getting in the way, piling
up, stinking, turning brooks brownish and

creamy white: what else deflects us from the
errors of our illusionary ways, not a temptation

to trashlessness, that is too far off, and,
anyway, unimaginable, unrealistic: I'm a

hole puncher or hole plugger: stick a finger
in the dame (dam, damn, dike), hold back the issue

of creativity's flood, the fothcoming, futuristic,
the origins feeding trash: down by 1-95 in

Florida where flatland's ocean- and gul-flat,
mounds of disposal rise (for if you dug

something up to make room for something to put
in, what about the something dug up, as with graves:)

the garbage trucks crawl as if in obeisance,
as if up ziggurats toward the high places gulls

and garbage keep alive, offerings to the gods
of garbage, of retribution, of realistic

expectation, the deities of unpleasant
necessities: refined, young earthworms,

drowned up in macadam pools by spring rains, moisten
out white in a day or so and, round spots,

look like sputum or cream-rich, broken-up cold
clams: if this is not the best poem of the

century, can it be about the worst poem of the
century: it comes, at least, toward the end,

so a long tracing of bad stuff can swell
under its measure: but there on the heights

a small smoke wafts the sacrificial bounty
day and night to layer the sky brown, shut us

in as into a lidded kettle, the everlasting
flame these acres-deep of tendance keep: a

free offering of a crippled plastic chair:
a played-out sports outfit: a hill-myna

print stained with jelly: how to write this
poem, should it be short, a small popping of

duplexes, or long, hunting wide, coming home
late, losing the reail and recovering it:

should it act itself out, illustrations,
examples, colors, clothes or intensify

reductively into statement, bones and corpus
would do to surround, or should it be nothing

at all unless it finds itself: the poem,
which is about the pre-socratic idea of the

dispositional axis from stone to wind, wind
to stone (with my elaborations, if any)

is complete before it begins, so I needn't
myself hurry into brevity, though a weary reader

might briefly be done: the axis will be clear
enough daubed here and there with a little ink

or fined out into every shade and form of its
revelation: this is a scientific poem,

asserting that nature models values, that we
have invented little (copied), reflections of

possibilities already here, this is where we came
to and how we came: a priestly director behind the

black-chuffing dozer leans the gleanings and
reads the birds, millions of loners circling

Fig. 2 Image: author

a common height, alighting to the meaty streaks
and puffy muffins (puffins?): there is a mound,

too, in the poet's mind dead language is hauled
off to and burned down on, the same energy held and

shaped into new turns and clusters, the mind
strengthened by what it strengthens: for

where but in the very asshole of comedown is
redemption: as where but brought low, where

but in the grief of failure, loss, error do we
discern the savage afflictions that turn us around:

where but in the arrangements love crawls us
through, not a thing left in our self-display

unhumiliated, do we find the sweet seed of
new routes: but we are natural: nature, not

we, gave rise to us: we are not, though, though
natural, divorced from higher, finer configurations:

tissues and holograms of energy circulate in
us and seek and find representations of themselves

outside us, so that we can participate in
celebrations high and know reaches of feeling

and sight and thought that penetrate (really
penetrate) far, far beyond these our wet cells,

right on up past our stories, the planets, moons,
and other bodies locally to the other end of

the pole where matter's forms diffuse and
energy loses all means to express itself except

as spirit, there, oh, yes, in the abiding where
mind but nothing else abides, the eternal,

until it turns into another pear or sunfish,
that momentary glint in the fisheye having

been there so long, coming and going, it's
eternity's glint: it all wraps back round,

into and out of form, palpable and impalpable,
and in one phase, the one of grief and love,

we know the other, where everlastingness comes to
sway, okay and smooth: the heaven we mostly

want, though, is this jet-hoveled hell back,
heaven's daunting asshole: one mus write and

rewrite till one writes it right: if I'm in
touch, she said, then I've got an edge: what

the hell kind of talk is that: I can't believe
'm merely an old person: whose mother is dead,

whose father is gone and many of whose
friends and associates have wended away to the

ground, which is only heavy wind, or to ashes,
a lighter breeze: but it was all quite frankly

to be expected and not looked forward to: even
old trees, I remember some of them, where they

used to stand: pictures taken by some of them:
and old dogs, specially one imperial black one,

quad dogs with thier hierarchies (another archie)
one succeeding another, the barking and romping

sliding away like slides from a projector: what
were they then that are what they are now

GARBAGE

a.r. ammons

(1993)

01 | INTRODUCTION

TERRA INCOGNITA means unknown land. The term was coined by Professor William Rathje to describe landfills – a landscape created by the accumulation of once known objects, becomes unknown.[1] Perception around these objects change from having value, to having no value. The build-up of valueless objects takes on a new form, literal land forming, as well as new meaning. The meaning of waste has been the debate of scholars for decades, especially since landfilling became a primary strategy for modern waste management.[2] It is a direct reflection of our lives and our cultures, both a concept and a physical thing.

ISSUE

The amount of Municipal Solid Waste (MSW) the world produces far exceeds current infrastructural capacity. The things we throw away, while arguably benign individually, are dangerous once accumulated in large quantities. The mix of organic and inorganic content begins to break down in a process called "biodegradation" producing significant amounts of methane and leachate as byproduct. Methane, a harmful gas, is one of the main drivers of climate change and leachate, a liquid full of toxins, has the potential to pollute water sources affecting humans and environment on a broad scale should it leak into the water table. Today, of the roughly 2 billion tons of waste produced by the world annually, 19% goes through a material recovery process like recycling or composting, nearly 11% is treated by modern incineration technology, 37% is disposed of in sanitary landfills, and 33% is disposed of without any management or regulation, referred to as open dumping.[3] The degree to which a country uses any of these four waste management practices varies all over the world, especially between high-income and low-income countries. The primary waste management practice in the United States, a high-income country, is sanitary landfilling - 50% of our solid waste goes to landfills.

The first sanitary landfill in the United States was built in Fresno, California in 1937. As opposed to open dumping, sanitary landfills are specifically engineered with bottom liners and a covering process which prevent toxic methane and leachate to harm nearby residents and the environment. These technological advances may prevent harmful toxins from leaking into the surrounding area, but they do not decrease the toxicity of the landfill itself. Working conditions within the landfill need to be heavily regulated to ensure the safety of its workers. Encountering mixtures of harmful chemicals and substances albeit accidental can have lasting health implications for an unlucky worker. Methane build-up within landfills can cause explosions if not monitored correctly and toxins from the landfill can have severe impacts on the local flora and fauna should liners be compromised. Since 1937, sanitary landfilling has been the US's main waste management strategy. The sanitary landfill is, in theory, the best solution for solid waste management – waste is taken from the household to a place out of sight and out of mind, to slowly decompose over time.[4] Despite the ease and convenience sanitary landfills provide, no one really wants to live close by. People are uncomfortable with the idea of living next to and confronting their waste and generally do not support the building of new landfills.[5] These feelings are not unfounded, landfills have a history of being placed in ecologically and/or socio-economically sensitive areas and have often caused harm to their surrounding neighbors due to policies exploiting those who do not necessarily have the resources to advocate for themselves.[6] The geographies of land are highly contested and without support or viable land to build new landfills, this contested legacy will continue.

There is a need to reimagine status quo waste management strategies in order to address concerns surrounding the placement and operations of landfills in the United States. Viable space to place landfills might exist, but the lack of support for landfilling by surrounding neighbors, those advocating for more sustainable practices, and those advocating for environmental justice means that viable space for new and expanding landfills is a finite resource. Many existing landfills are nearing capacity, and few new landfills are being constructed. As national and global populations are projected to drastically increase in the future, so will the amount of solid waste produced. All these pressures have caused many municipalities to begin rethinking their waste management systems.

CRITICAL STANCE

Instead of fearing this increase of waste and lack of solutions, we have the opportunity to use it as a catalyst to promote new policies and strategies to change waste management systems. Waste is inevitable, we cannot deny its existence and its relevance in our life cycles. What we can do is redefine the way we perceive and therefore engage with waste at all stages of material lifecycles including production and consumption. Rather than designing waste management systems that factor in the reuse and regeneration of a material, we have designed linear systems in which products, when deemed 'valueless' go to a final resting place and are forgotten. Yet, their material existence does not end here, despite our intentions. These linear systems of waste management neglect to recognize and appreciate the full life cycle of materials creating a system that is imbalanced and inherently dangerous*. Shifting our perceptions of solid waste in the United States offers the greatest opportunity to reconceive our waste streams and waste management systems*. Materials considered 'dirty' and 'unwanted' have value. By hiding away our waste management systems, society has lost touch with the impacts their actions and habits have on the local and global environments.

In a future where the very definitions of waste has changed, the need for and purpose of landfills should reflect that change. Closing and aging landfills can be used for resource extraction, energy production, and superfund restoration research. Historically, waste management paradigms have favored privatization and monetization of waste processing. This has had negative impacts on waste workers and laborers. Not only is there an opportunity to change the physical landscape of landfills, but a unique opportunity to create a system in which landfills can act as a publicly owned and operated utility, benefitting the surrounding community.

Speculating on the future of landfills presents a unique opportunity to turn something commonly believed as a negative or community blight into a positive community asset. Speculation as a framework for design has gained popularity in landscape architecture as an approach to generate new thinking on assumed and staid practices, especially in these times at the front edge of an impending shadow of extreme climate change.

FRAMEWORKS

Anthony Dunne and Fiona Raby, authors of Speculative Everything: Design Fiction, and Social Dreaming, introduced the *Probable / Plausible / Possible / Preferable* (2013) framework that has become popular in design. Essentially, when trying to predict the future, it is necessary to imagine many different scenarios, because trying to predict *the* future is an impossible and unproductive endeavor. The probable describes what is likely to happen, the plausible what could happen, the possible should be compromised of a believable series of events even if fictional, and the preferable is different depending on who or what it defines. Probable and plausible thinking entrenches us in the status quo. When we fail to think outside the parameters of assumptions and common practices we have constructed ourselves, we fail to make a future in which radical change is achievable.

Landscape Architect Rob Holmes (2020) adds to this thinking by engaging with solutionist vs. non-solutionist thinking. He argues that the solutionist framework is inherently limiting because it tries to fix dynamic problems with static solutions in search of some kind of quantifiable outcome. He offers the non-solutionist framework in which problems are not defined as "problems or issues" but rather different conditions that can be explored and manipulated in a variety of ways to reach other types of conditions. He offers several different methodologies within this framework, including the exploratory scenario under which my thesis operates. Exploratory scenarios, much like Dunne and Raby's 'possible' scenario, frame problems as different narratives to explore different futures. Narratives are not defined as solutions, but rather states of being to work towards.

A key mechanism for such a process, storytelling, has a role in landscape architecture that is not necessarily used in practice. Stories have had a powerful effect on policy and peoples' perceptions of the world. For example, Upton Sinclair's The Jungle changed working conditions for immigrants in Chicago in the early 20th Century and Rachel Carson's Silent Springs arguably sparked the environmental revolution of the 1970s. The power of storytelling has the capacity to inspire sweeping societal change. Similarly, design inspired by storytelling also has the power to spark visions for the future of our built and managed landscapes that extend well beyond incremental and linear prospects of change.

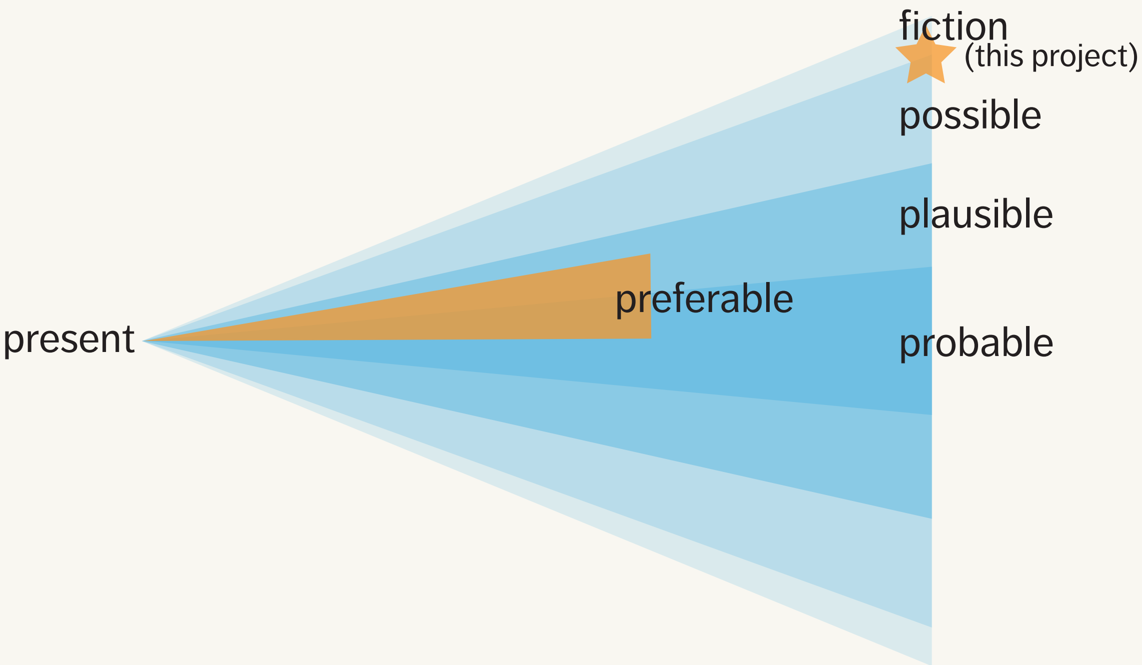


Fig. 3 Framework diagram adapted from Dunne and Raby's Speculative Everything.

Dunne and Raby (2003, 3) write,

"To find inspiration for speculating through design we need to look beyond design to the methodological playgrounds of cinema, literature, science, ethics, politics, and art; to explore, hybridize, borrow, and embrace the many tools available for crafting not only things but also ideas-fictional worlds, cautionary tales, what-if scenarios, thought experiments, counterfactuals, rectio ad absurdum experiments, prefigurative futures, and so on."[7]

METHODOLOGY

In order to speculate upon newdesign thinking for the future of material lifecycles and sanitary landfills, I conducted a literary review and theoretical analysis, researched case studies of landfills in several different stages of operation, conducted a site analysis of a nearby landfill, and applied regenerative and remediation strategies to the site. A summary of these steps is provided in the following sections.

LITERARY REVIEW + ANALYSIS

All research, fiction and non-fiction, was used to inform my current waste thinking ideas and design decisions for this thesis. The literary review and analysis is integrated within chapters 2, 3, and 6 of the document. Reference material includes fictional stories, theoretical thinkings, data-heavy analyses and scientific papers.

CASE STUDIES

An examination of three landfills, all capped and redesigned post-closure offers insight into how surrounding environmental, economic, societal, and cultural factors effect both the narrative of a waste landscape and its operations. I sought to compare the differences between landfills to learn what practices we believe should be carried forth into future waste management practices and what should be left behind.

SITE ANALYSIS

Due to the Covid-19 pandemic, visiting an operating landfill, specifically the landfill I have chosen to focus my speculative design on, was not possible. Site analysis was limited to what I could learn about the Cedar Hills Regional Landfill online, and through my helpful contact at the landfill. I was supplied with the most up to date AutoCAD drawings of the landfill and used those as a spatial and measured base to reimagine the site. I was also able to explore the edges of the site and get a better understanding of the surrounding environmental conditions and community.

APPLICATIONS / DESIGN

I conducted extensive research into new, or more accurately, emerging, waste management techniques like landfill mining and excavation, waste-to-energy production, compositing, and phytoremediation. With consideration to waste perception and theory, I apply these concepts to the Cedar Hills Regional Landfill to come up with a long-term plan before, during, and after closure of the landfill. This design assumes and tells the story of a nation that has significantly redefined its policies and politics around waste to promote more sustainable and recyclable materials. By combining tangible, albeit not widely-used programs with fiction, the resulting design is regenerative and speculative but arguably possible.

FICTIONAL INSPIRATION

On a personal level, this thesis was largely inspired by a deep appreciation with the fantastic. Growing up, my local landfill was a place of mystery, intrigue, and lore – a mountain fenced off from the surrounding community. I am joined in this interest by many notable authors and creatives. In 1993, A.R. Ammons wrote a 2,217 line poem titled "Garbage" detailing the wonder of the unknown and the world within a world that the accumulation of garbage creates. "The Dump Ground", an essay by Wallace Stegner describes the dump from his childhood. He uses rich imagery to tell the collective history of his town through what was discarded. He writes,

"The dump was our poetry and our history. We took it home with us by the wagonload, bringing back into town the things the town had used and thrown away. Some little part of what we gathered, mainly bottles, we managed to bring back to usefulness, but most of our gleanings we left lying around barn or attic or cellar until in some renewed fury of spring cleanup our families carted them off to the dump again, to be rescued and briefly treasured by some other boy with schemes for making them useful."[8]

Several feature presentations have also used dumps and landfills as landscapes of danger, productivity, adventure and exaggeration. *Slumdog Millionaire* uses the dump to highlight the very real poverty conditions in India, *Thor: Ragnarok*, a modern superhero movie, uses the dump as a scene to meet scavenger and pirate-like characters while noting the differences between social classes. *WALL-E*, a children's film, creates a world where a lone robot is left to clean up after humans have left the planet uninhabitable. Despite the dire situation, the robot finds beauty and life in the wasteland.

If one stops to analyze it, they can probably find the commonplace facts behind the fictional trope of the landfill or dump, and I believe landscape architecture can learn a lot from this fiction. Authors and writers are arguably landscape architects of the settings of their stories and dumps are oftentimes used in fiction to depict places of magic, mystery, intrigue, and adventure, rather than simple dirt and grime.

INTENTIONS

While much of this thesis focuses on research of solid waste, it does not intend to redesign the waste management system as we know it today. Rather, it focuses on a scenario in which we have decentralized our waste management system and the materiality of products are more sustainable and biodegradeable than current day. In this scenario, there will no longer be a need for sanitary landfills. The question I am choosing to focus is –

what kind of design opportunities will post-closure landfills offer in a speculative future?

A WASTE CACOTOPIA

kevin lynch

excerpt from Wasting Away (1990)

“ The inhabited buildings slowly extrude their continuous ribbons of compressed garbage and trash. The ribbons fall onto the cargo belts that move steadily toward the high ridges at the city boundary. In these populous continents, each city presses against the next, and so the waste ridges form a network, though which tunnel the intercity roads. Each city posts frontier guards, to prevent a neighbor from tipping its trash over the crest.

The waste ribbons are unloaded high up, and are shaped to settle compactly, at a high angle of repose. As the base of the waste-belt expands, it presses the settlement into a narrower territory. Few extensive uses remain, since food and water are shipped in from a distance, with consequent leakage and spoiling. Yet the ground is encumbered with abandoned buildings and weedy lots of uncertain ownership, so that it is difficult for a city to contract efficiently into a denser formation. Men wearing respirators and mounting big machines are at work daily in this no man's land, demolishing buildings, slashing weeds, and spraying dangerous insects and vermin. Truant children play in these jungles, too, and deplorable accidents are common.

At greater expense, a city may have its trash carried to some distant uninhabited sink. The Grand Canyon is partly full, a permanent conduit having been reserved for the Colorado underneath. The Mindinao Deep is shallow now, and Holland is well above sea level. However, as wastes have been piled over the Arctic snowfields, the surface darkening, along with the greenhouse effect of the polluted atmosphere, has caused melting of the ice and a rising sea level.

The inhabited settlements jut out over the seas, or are built over the larger rivers, which have been straightened and lined with a glassy coat in smooth cross section, to carry the flow more rapidly to the ocean. Thus, the settlements can evacuate directly into the liquid medium below. Filters remove the coarser ejecta, however, so that stream or tidal flow will not become viscous. Imported water is added to the channel, to keep the whole in motion. Since buildings are sealed, the resulting odors are not so noticeable. The ocean itself, too corrosive for the hulls of ordinary ships, and so littered with floating debris as to make navigation hazardous, is traversed by long submarine tunnels.

Ordinary fumes are vented to high altitudes; toxic dusts and gases are sealed in thin bags and ejected into space. These bags are strong enough to confine their contents until well away from the earth, and are highly reflective, so that passing craft can easily avoid them. Aerial sweepers keep the approach lanes open through the air around major landing sites. These sites are also favored locations for vacation hotels, since the sun or moon can frequently be glimpsed through the aerial openings.

To replace the materials so rapidly consumed, the earth, the moon, two planets, and several asteroids are mined for minerals, oxygen, water, and hydrocarbons. As the earth is hollowed out underneath and the wastes pile up on its surface, there is concern that its rock beds may collapse downwards, vulcanism in reverse. To prevent this, wastes are injected into the empty mining

Fig. 4 Image: author

galleries. Later, however, they are drilled out again, as the productive appetite swells for new minerals or for lower grades of previously mined material.

The massive transport and transformation of matter requires a corresponding expenditure of energy. Once expended, it is vented as pervasive noise, or as waste heat. Since the earth's radiation into space cannot match the flow, this venting energy has resulted in a persistent warming of the climate. Recently then, radiators have been transported to the troposphere, to step up this outward flow.

Fossil hydrocarbons are almost depleted, and the forests are stunted or cut over. Nuclear and solar power are now the prime sources of energy. The former is constrained to the rate at which its by-products can safely be spewed forth into space, since far too much of the earth's surface is already contaminated by radioactivity. Solar power, on the other hand, is inhibited by the increasing opacity of the atmosphere. For the most part, solar energy is nor collected by orbiting panels flying above the smog. In order to increase this source of energy, and since the earth is now more securely shielded from solar radiation, new destabilizing compounds are being shot into the atomic furnace of the sun to speed up the rate of nuclear fusion, accelerating the sun's stellar evolution. This shortening of the active life of the sun is not considered likely to affect the life span of the human species.

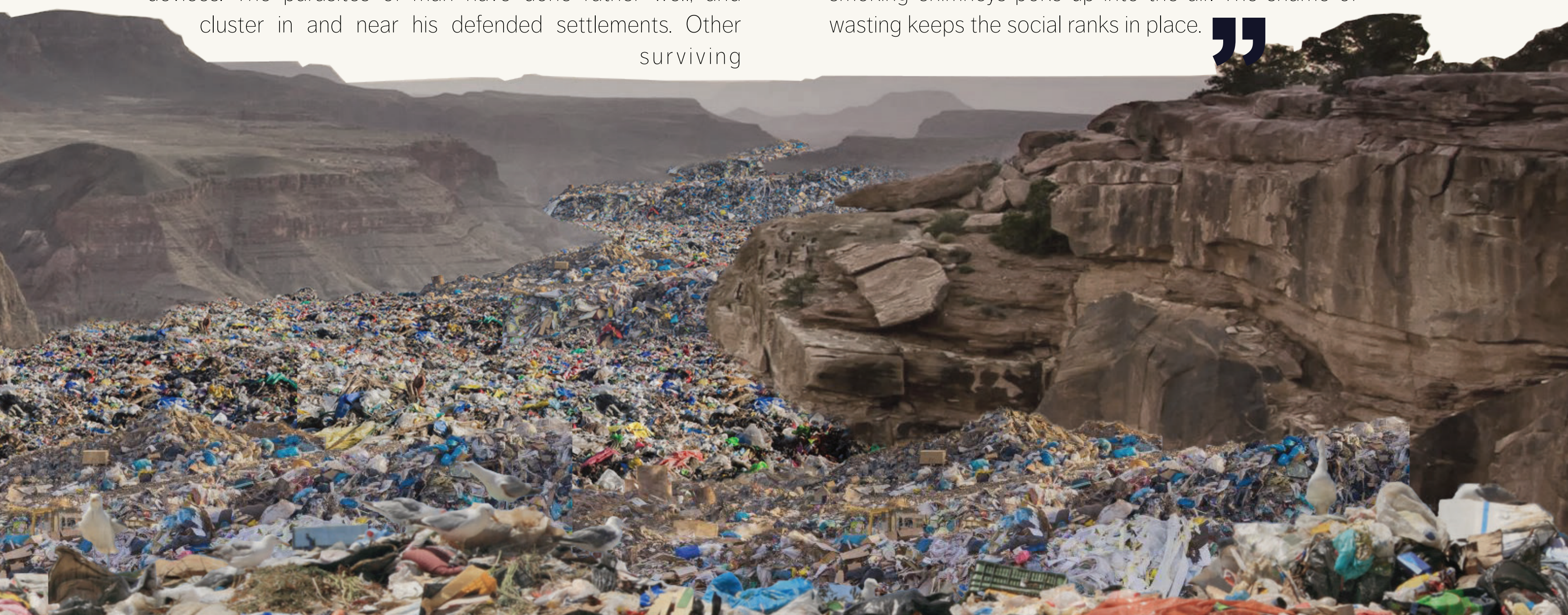
More than half of the more recent living species are now extinct, due to complete disruption of their habitats. Some few, most dear or useful to man, have been brought inside, or live in protected areas, or have been fitted with respirators and other prosthetic devices. The parasites of man have done rather well, and cluster in and near his defended settlements. Other surviving creatures, especially those of the more primitive orders, have evolved rapidly under the stress, taking advantage of the rich flow of toxins, wastes, and heat. These new organisms, which bloom and subside, periodically invade the human territories.

Human beings themselves must be more active and aggressive. Women bear 10 to 20 children, so that the strongest may be selected and the weak put away. Life is short and full of incident. Riots and demonstrations are frequent; cities contend against each other, their armies trampling back and forth.

Celebrations, displays, and the trading of possessions sustain the passage of goods, so necessary to the system of production. Splendid feasts are prolonged by vomiting. The casual destruction of valuables before the envious eye of many spectators is the best evidence of wealth and power.

The houses of the rich are spotless, kept clean by sophisticated machines in the hands of the low-class sweepers. Surroundings grow somewhat dirtier as one descends the income scale. Multiplying the rate of consumption by the degree of cleanliness gives the measure of social rank. A sophisticate eats rapidly, washes often, and dons fresh clothes after every meal.

Waste and death are not mentioned in polite society. Unwanted infants are exposed at night in remote places. Adults die in special hospitals, to which they have been sent, nameless, to be purified. Children are taught to excrete unnoticed, in the secret places hanging over the sewer streams. They learn not to speak of rivers. Among themselves, they may snigger over the fat tubes of waste squeezed out beneath the buildings, or the teasing way in which the smoking chimneys poke up into the air. The shame of wasting keeps the social ranks in place. ”



02 | DIALECTICS

WASTE (n.)

1. *Material that is not wanted; the unusable remains or byproducts of something*
2. *An act or instance of using or expending something carelessly, extravagantly, or to no purpose*

The word "waste" can be used in a multitude of ways, sometimes inherently contradictory and confusing. For example, when used as a noun, 'waste' can refer to something, say a banana, that has passed its expiration date and is no longer useful to consume for nutrition (see definition 1, above). In the same sense, 'waste' can refer to a perfectly ripe banana that is just out of reach and therefore cannot be consumed (see definition 2). Whether or not these bananas are considered a 'waste' depends on the purpose assigned to them ***and*** if they are able to fulfill that purpose. In this case, both bananas, ripe and rotten, could not fulfill the purpose assigned. 'Waste' therefore follows a liner path. Bananas, when they cannot be consumed, are no longer necessary and should be disposed of. What these definitions fail to consider is that bananas may have other purposes besides consumption.

The lifecycle of the banana begins as a seed. Most found in tropical climates, banana plants grow, flower, and produce fruit. To humans, apes, monkeys, insects, and many other organisms, the banana's purpose is for consumption of nutrients. To the banana plant, the banana's purpose is for reproduction – the plant is dependent on the banana fruit to by some means, leave the plant, and spread its seed. Should the banana drop to the ground directly beneath the plant, the soil can absorb essential nutrients from the decaying fruit that will in turn aid the growth of the plant and the improve the health of the environment around it. The entire lifecycle of the banana, ***including death***, has purpose – it is cyclical. Perception defines value. One man's trash is another man's treasure.

This basic life cycle science lesson should be familiar to most but is often forgotten when it comes to municipal solid waste, the things we throw away everyday like water bottles, used up chapsticks, old notebooks, take-out containers, etc.

The ease and convenience afforded to us by regular trash collection means that it is easier for us to throw things away than reimagine a use beyond the original purpose. When it comes to waste management our perceptions are limited to an anthropogenic lens, which neglects to consider the wholistic purpose of something. Again, take the rotten banana – by deeming it valueless in terms of nutrition or taste, we ignore its value in decomposition. To us, the end of its lifecycle is when we throw it away in the trash, effectively removing its ecological value. The key to understanding what is and is not waste, is to understand our perceptions surrounding waste.

PERCEPTION (n.)

1. *A way of regarding, understanding, or interpreting something; a mental impression*

Perception is powerful. Perceptions dictate the way we live and how we interact with each other and the environment. Despite an assumed collective familiarity with waste, perceptions are not so universal. The way we perceive waste is extremely complex and constantly evolving. Our human-centered perception of waste is generally a negative one. Waste is commonly associated with decay, loss, harm, and uselessness amongst many other descriptors. We assign these adjectives for good reason – we fear waste because it is a direct representation of death. Death is the end of our conscious selves and the end of our perception of the world around us. When we die, we no longer serve a purpose to ourselves and cannot comprehend that we may serve a purpose after death. Therefore, “to waste” or “wasting” used as a verb is an uncomfortable process for us because it is a reminder of our own mortality.

WASTE (v.)

1. *Use or expend carelessly, extravagantly, or to no purpose*
2. *(of a person or a part of the body) become progressively weaker and more emaciated*
3. *Devastate or ruin a place*
4. *(of time) pass away; be spent*

Wasting, used as a verb, is almost exclusively used in a negative light to describe a process of decay or death. A banana is wasting on the countertop (1.), his kidneys are wasting away from the cancer (2.), the dump has wasted the surrounding environment (3.), or she wasted time playing instead of studying (4.). Again, a change in perception could change the negative connotations of these statements.

The wasting(v.) of municipal solid waste is physically manifested by our various waste management practices and because we perceive the wasting process as a linear one, our waste management systems are also linear. For most people, the life of waste ends at the street curb on trash day. But the life and meaning of waste does not end there. William Rathje, a professor of anthropology at the University of Arizona pioneered the field of ***garbology*** – a field determined to literally unearth our past to better understand the world we live in through what we throw away. He saw the magic of garbage as true knowledge with the power to correct history as we know it – "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."[9] Rathje started The Garbage Project in 1973 and for three decades, he worked with students to discover trash trends and what that says about spending habits, consumption habits, societal and cultural norms, world events, and who we are as people in the United States. Ultimately, he found that our aversion to waste and our negative perceptions of it have influenced the way we manage waste and that the linear way we manage waste is unsustainable. Waste itself is not the issue – we have no reason to be ashamed of wasting as it is part of life. If we can separate waste from what the myth of waste has become, then we can effectively implement strategies to process and manage waste in sustainable ways.

While dumps and landfills are the most convenient places for archaeologists to learn about past and present society, they have not always been the most widely used or the most popular waste management practices. The use and popularity of certain waste management practices over time have been dictated by public perception and societal values of a given time period.

"Waste is what is worthless or unused for human purpose. It is a lessening of something without an apparently useful result; it is loss and abandonment, decline, separation, and death. It is the spent and valueless material left after some act of production or consumption, but can also refer to any used thing: garbage, trash, litter, junk, impurity and dirt. As we have seen, there are waste things, waste lands, waste time, and wasted lives."

Kevin Lynch, Wasting Away

THE EVOLUTION OF WASTE MANAGEMENT

The history of waste management is defined by the rise and fall and rise again of the four different types of waste management – dumping, burning, material reclamation, and source reduction.[10] In his book, ***Garbage Wars*** (2002), David Naguib Pellow details the complex history of waste management in Chicago and the United States by explaining the intrinsic link between policy, technology, and environmental justice. He outlines the following pattern, "(1) A waste management or other pollution technology is introduced, (2) Strong vocal opposition by community activists follows. (3) the city and/or the industry introduces stricter regulations and/or new, purportedly "cleaner" technologies." He calls this the *movement-policy cycle.*[11]

The Movement-Policy Cycle

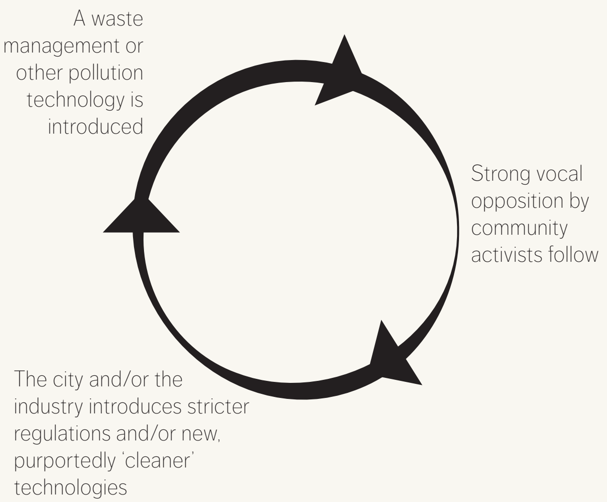


Fig. 5 Pellow's "Movement-Policy Cycle"

As density in urban areas increased, there was a clear need in developing American cities in the late 1800s for central waste management systems. Because of the stigma around trash collection as "dirty work" for people at the bottom of the social ladder and the minimal need for verbal communication required to do the job, new immigrant families were the first to jump on this opportunity and create their own waste collection businesses with their family members, horses and carts.[12]

Immigrant families found early success in the waste hauling business during this time. Every week, they made rounds to individual households to pick up waste via horse and cart and haul it off to a dump, located somewhere on the edge of town, often in minority neighborhoods. Scavenging went hand in hand with hauling at the time. It was part of the job to sort through the trash and reclaim items and materials that could be resold and reused. However, as waste management policy and technology developed and with the advent of plastics, it became harder to resurrect reusable material.

Recycling as a waste management tactic hit its peak popularity during World War I, World War II, the environmental movement of the 70s and arguably again today. An increased sense of nationalism brought about by extreme propaganda efforts from the US government during WWII encouraged people to recycle their materials, especially metal scraps and aluminum, to "send back" to their enemies, namely the Japanese.[13]

Despite increased recycling efforts during war time, these efforts were abandoned as soon as the war was over. The 1950s and early 1960s marked the beginning of disposables – a burgeoning industry selling the idea that single use was the epitome of a modern lifestyle.

Fig. 6 Man standing on mountain of trash at Freshkills Sanitary Landfill around 1950. photo: National Geographic

The 1960s also saw the decline in the popularity of incinerators, after public eco-consciousness was ignited by the release of Rachel Carson's ***Silent Spring.*** Solid waste was named the "third pollution", after air and water pollution, and talk of "the garbage crisis" was common in newspapers. Sanitary Landfills regained popularity amongst those advocating for more sustainable waste management practices during this time. Technology advances like the garbage compactor, black plastic bags, and automatic billing systems made waste management easier and more efficient, but they also decreased the amount of salvageable material for recycling and decreased the amount of required labor. This reduction in labor resulted in the loss of jobs and a minimization of face-to-face time between garbage workers and households leading to negative perceptions of laborers.[14] Waste management slowly became more centralized and controlled by fewer stakeholders. Previously successful, immigrant-run family businesses could not compete with the economies of scale that larger corporations could attain, leading to the rise of the first multinational corporation controlling the waste industry.[15]

The 1972 OPEC Embargo resulted in a need for new sources of energy, which led to the return of incinerators as a viable waste management solution. They became "resource recovery" facilities, now known officially as Materials Recovery Facilities (MRFs), including the sorting and "scavenging" of reusable materials. Although incineration and Waste to Energy plants provided energy, they did nothing for source reduction, cost taxpayers more than landfills, and were extremely toxic to surrounding communities and environments.[16]

Cries and protests against incinerators began again in the 90s, this time focusing on recycling as the preferred type of waste management. Popularity of incinerators decreased and once again, sanitary landfills rose to the top of US waste management practices, where they remain today. Recycling rates rose but had little to no impact on the amount of waste the population was sending to landfills. In fact, recycling rates in the US have plateaued over the past few years –around 40%.[17] Although sanitary landfills have become the best practice for an "out of sight, out of mind" mentality, recycling has recently emerged as one of our best solutions to lower the amount of solid waste sent to landfills. Germany, for example, has an extremely robust sorting infrastructure that starts with the individual. Each household has several different color bins relating to a different type of recyclables. This makes the sorting process more efficient. Companies even pay extra fees depending on how much packaging their product uses. Recycling has become a part of German pride – with rates hovering around 70% for the past few years.[18]

For the most part, the US has not needed to invest heavily in MRFs because China would buy a substantial amount of recycling from the US. In 2017, China implemented ***Operation National Sword***, essentially a ban on intaking any foreign recyclables. While this ban seemingly came out of the blue, some point to the recently released ***Plastic*** China documentary showing the story of two families – one who owns a recycling facility and the other who works there. The documentary highlights the dangerous and inhumane working conditions at the MRF and how that impacts the entire surrounding environment. ***Operation National Sword*** was implemented to decrease the amount of recyclables accepted from other countries and incentivize the government to reform MRFs to build safer systems. This had a major impact on North America and parts of Europe that relied heavily on sending their recyclables to China for processing. Some countries have responded well to the policy, using the ban as an initiative to improve their own recycling infrastructure.[19] Currently, the US operates around 300 MRFs and is still realizing how to improve national recycling. The US is not held back by a lack of funding, but by our economic model, policies to ensure a desired level of consumption, and lack of support by private corporations to improve upon national sustainability.

ECONOMIC MODELS

The term "take-make-waste" refers to a linear economic model in which raw materials are extracted from the earth, used to make products, and then discarded in a pile at the end of their productivity.[20] This economic model has been and continues to be the norm for much of the world, especially the US. There are several drivers of the "take-make-waste" model that have become ingrained in US economic policy, directly influencing the astounding amount of waste the US creates.

THE PRIVITIZATION OF WASTE

The US's waste management system is considered a public utility, meaning that taxpayers fund the disposal of municipal solid waste and help subsidize the private companies that provide waste management infrastructure. Because our current waste management model is based on the transportation of waste from Point A (the trash bin) to Point B (the landfill), taxpayers are dependent on the operations of private companies to take their waste away. Rob Gonan, co-founder of Recyclebank and past Deputy Commissioner for Sanitation, Recycling and Sustainability for New York City says "For the past few decades, US cities have spent billions on exporting waste that could have been used instead to improve infrastructure and social services."[21]

Loose laws surrounding industrial waste disposal by private companies means that taxpayers are paying for companies to dispose of their, often times hazardous, waste. Companies pay less to throw away more. Because of this, companies are also incentivized to ***make*** more. Overhead to dispose of their products is nearly non-existent so companies do whatever they can to sell more and make more.

ENGINEERING CONSUMERS

"Consumer engineering" is a term created by Earnest Elmo Calkins, an innovator of modern advertising. He famously said, "Wearing things out does not produce prosperity. Buying things does."[22] He and several other marketing contemporaries of the 1920s concocted the notion that ***all*** products, not just food products, had a shelf life. There are things we use, and things we use up. The economic boom of the 1920s and expansion of credit meant people had money to spend. Advertisements influenced the public to buy and re-buy all kinds of products. Manufacturing had also boomed after World War I and mass production was efficient and lucrative. More people were making more money producing more products to sell to more people to throw away.

Not only were people buying and throwing away more products, but these products also contained packaging which was immediately thrown away upon purchase. This has set a precedent for how we sell products presently. Today, a third of all MSW is packaging and containers.[23]

PLANNED OBSOLESCENCE

While consumers were being convinced that their products had a shelf life, engineers were working on designing products to actually have a shelf life. One of the first incandescent lightbulbs manufactured in 1901 is still burning at a fire station in Livermore, California. There is a live stream of the bulb, still going strong, at www.centennialbulb.org. Obviously, if all lightbulbs were created to last like this, lightbulb sales would plummet. In 1924, General Electric and Philips poured money into developing a standardized bulb that would not burn for more than a thousand hours. They were successful.[24]

More companies followed suit and implemented "degradation guidelines" or fines to product designers if they found their products lasted too long. This sparked an ethical debate amongst product design professionals. An article titled "Product Death Dates – A Desirable Concept?" published in the leading product engineering journal, ***Design News,*** in 1958 argued that designing for product failure was indeed desirable. The author argued that it was unethical to design a product in which some parts fail before others. The whole product should fail at the same time. It is clear to see that this argument cannot apply to all products – like cars.[25]

A contemporary example of this is the iPhone. Apple releases a new and improved iPhone every year. They have advertised their products in such a way that they have an almost cult-like following amongst consumers who are willing to pay a lot of money for a new phone every year. Those who do not want, or cannot afford, to buy a new iPhone every year are familiar with their phone slowing down or glitching more often after a few years of use. It is difficult to bring an Apple product in to fix one part. It is easier to just buy a new iPhone.

Another, somewhat frightening example is PPE or personal protection equipment. We have all become familiar with PPE, like masks, in the wake of the Covid-19 pandemic. Whereas PPE was never really mass consumed before the pandemic, once stay at home orders were implemented, the public began purchasing large amounts of PPE supply that was previously only used by health professionals, creating a shortage at hospitals that were filled with Covid-19 patients. "PPE was designed to be thrown away, there are no systems in place for reuse of sterilization, making it dangerous to ***not*** throw away..."[26] These linear systems of waste management neglect to recognize and appreciate the full life cycle of materials creating a system that is imbalanced and inherently dangerous.

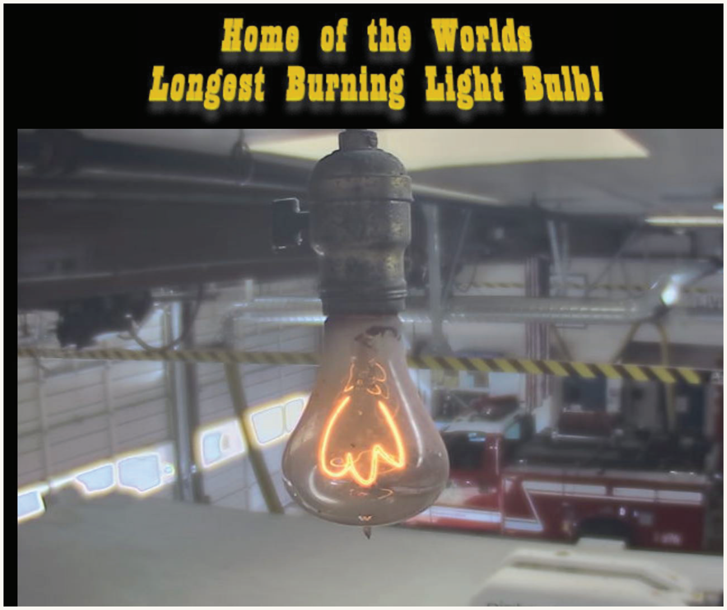


Fig. 7 Screengrab taken of Centenniel Bulb from centennielbulb.org on December 14, 2021

WASTE PROJECTIONS AND TRENDS

GLOBAL

The world generates 2.01 billion tons of MSW annually, a third of which is not managed in an environmentally safe manner, i.e., open dumping. This amount of waste is expected to grow to 3.4 billion tons by 2050, which drastically outpaces projected population growth. Furthermore, 1.6 billion tons of carbon dioxide equivalent greenhouse gas emissions were generated from solid waste management in 2016. This comprises about 5% of all global emissions. This percentage is projected to increase to 2.6 billion tons of carbon dioxide equivalent by 2050.

Roughly 40% of waste is disposed of in landfills, 19% undergoes material recovery through recycling and composting, 11% is incinerated, and 33% is openly dumped. Overall, high-income countries generate more solid waste per capita with more advances waste management systems and in contrast, low-income countries have less advanced waste management systems and lower rates of waste per capita. Despite the fact that low-income countries produce less waste, they are more susceptible to the health and environmental consequences of open dumping.

NORTH AMERICA

North America, comprised of the United States, Canada, and Bermuda in the ***What a Waste*** World Bank report, generates the highest amount of waste at 4.9 pounds per capita per day compared to other regions in the world.[27] A report by the United States Environmental Protection Agency (EPA) confirms this amount of solid waste generation in the US alone. The EPA estimates that 292.4 million tons of MSW was generated in 2018, which is around 23.7 million tons more than in 2017, and about 82 million tons more than in 1990. In 2018. approximately 23.6% of waste was recycled, 14.6% was composted, 11.8% was incinerated, and 50% was landfilled.[28]

KING COUNTY

King County, which includes 41 cities, makes up about 20% of Washington's annual waste. All MSW produced in King County, excluding the cities of Seattle and Milton, is sent to one landfill – the Cedar Hills Regional Landfill. That is 931,000 tons of waste created by 1.5 million people in 2,050 square miles.[29]

WASTE CHARACTERIZATION IN WASHINGTON STATE

The Washington State Department of Ecology completed a Waste Characterization Study detailing what and how much is sent to landfills. Despite the number of campaigns launched against plastics, they are not the most prevalent material found in landfills – organic materials, like food waste, are at 28.5%. Paper products and packaging are at almost 15% with plastic products and plastic packaging make up almost 10% of material in Washington landfills. Although recycling and composting are very popular in Washington State, both categories outweigh plastics.[30]

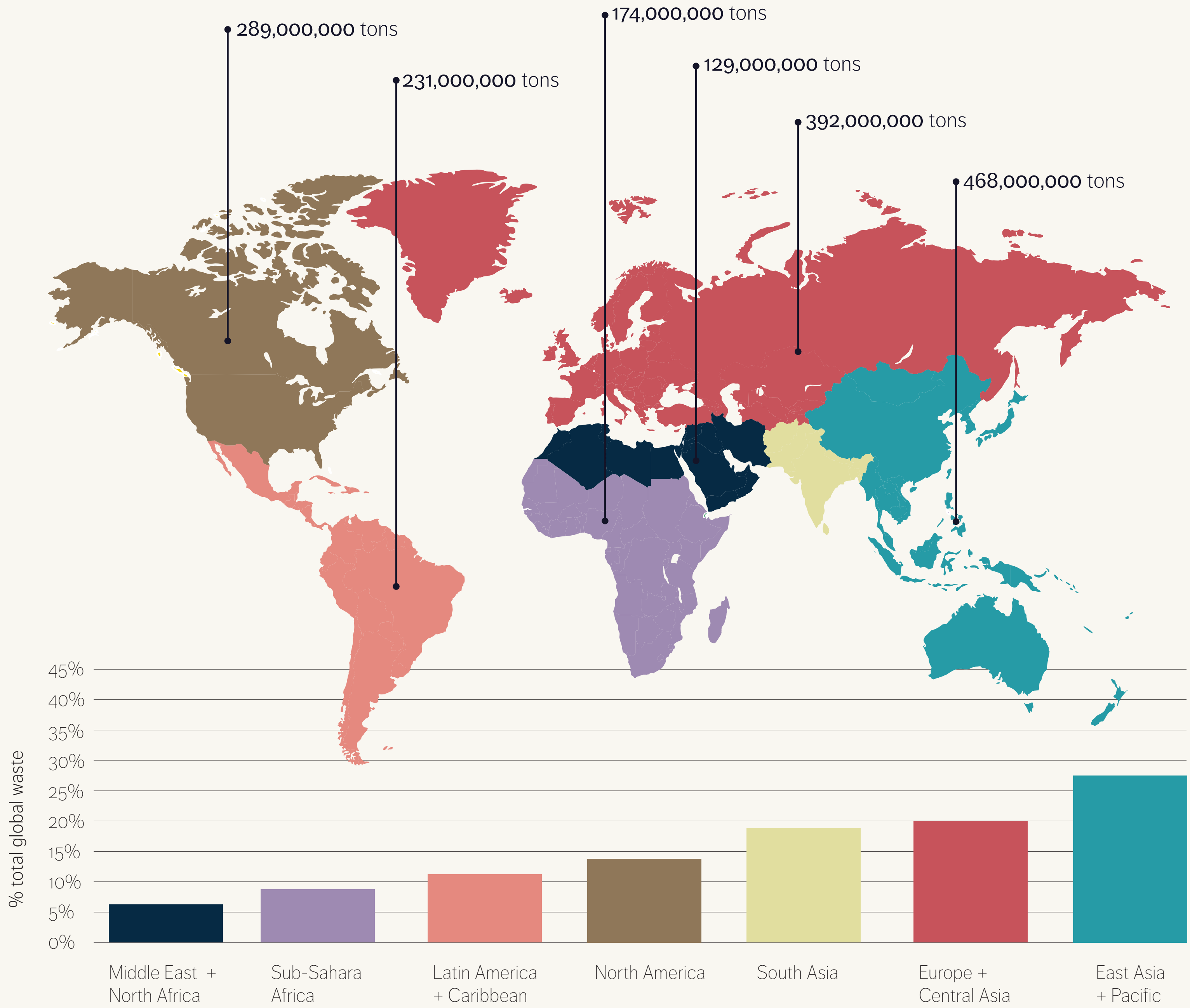


Fig. 8 Waste production per area of the world based on data from What a Waste: A Global Snapshot of Global Waste Management 2050 created by the World Bank Group.

Whatever our perceptions of waste may be, we are producing a lot of it and we are only projected to produce more. In the US, unless we actively and individually disrupt the linear waste management system, most of our MSW ends up in sanitary landfills. Although different types of waste management, especially material recovery and material reduction, are gaining momentum in the US, there is still a lack of infrastructure and policy to push these types as our main strategy for waste management. We are and will remain dependent on sanitary landfills as our main strategy for waste management unless we can radically reimagine the way we think, feel, and act towards our waste. The declining public perception of sanitary landfills and time limit before open landfills are full requires us to figure out not only new waste management systems but innovate on the purpose and operations of landfills themselves.

We Are What We Throw Away

RUBBISH!
The Archaeology of Garbage.
By William Rathje and Cullen Murphy.
Illustrated. 250 pp. New York:
HarperCollins Publishers. $23.

By Witold Rybczynski

SINCE 1973, a group of anthropologists at the University of Arizona has been conducting a series of systematic archeological digs, minutely sifting, classifying and recording the contents of more than 14 tons of excavated material. The site of their investigation, however, has not been ancient burial grounds or prehistoric settlements, but urban landfills — in other words, garbage dumps.

The result of their work is documented in "Rubbish!" which, despite its sensational exclamation point, is neither a harangue on the environmental perils of a throwaway society nor a tongue-in-cheek history of trash. William Rathje, a professor of anthropology at the University of Arizona and director of the university's garbage project, and Cullen Murphy, the managing editor of The Atlantic, have written a lucid and provocative book that steers well clear of self-righteousness — and bad jokes — and takes aim at several sacred cows along the way.

The garbage project is based on an arresting premise: "That what people have owned — and thrown away — can speak more eloquently, informatively, and truthfully about the lives they lead than they themselves ever may." The idea that garbage is a useful source of cultural information about the past is hardly novel; after all, middens, the sites of many archeological digs, are rubbish heaps under another name, and the pottery shards and flint scraps that we look at in museums are really just very old garbage. But can we actually learn something useful about the modern world by scrutinizing its rubbish?

Garbage doesn't lie. The evidence of junk-food wrappers, liquor bottles and girlie magazines often flies in the face of what we tell ourselves — and what we tell others — about what we do. By comparing the results of surveys of food consumption with the contents of the respondents' trash containers, the garbage project discovered a phenomenon they called the Lean Cuisine syndrome — people consistently underreport the quantity of junk food they eat, and overreport the amount of fruit and diet soda they consume. Most people also underreport their consumption of alcohol by 40 to 60 percent; on the other hand, heads of households regularly exaggerate the amount of food their families consume — the Good Provider syndrome. "What people claim in interviews to have bought and consumed, to have eaten and drunk, to have recycled and thrown away," the authors write, "almost never corresponds directly or even very closely to the actual remnants of material culture in their Glad or Hefty bags."

If we are deluded about our own patterns of consumption, it follows that we might also hold mistaken notions about garbage in general. Most people believe, for example, that expanded polystyrene foam — which is used in fast-food packaging, coffee cups, packing "peanuts" and the molded forms that come around stereo equipment — constitutes a major proportion of our garbage and represents a serious strain on the capacity of landfills. But the garbage project found that expanded polystyrene foam accounted for less than one percent of the volume of garbage dumped in landfills between 1980 and 1989. And what about the 16 billion

Continued on next page

Witold Rybczynski is the author of "Waiting for the Weekend" and the forthcoming book "Looking Around: A Journey Through Architecture." He lives in a house with a wall made out of recycled bottles.

What We Throw Away

Continued from preceding page

disposable diapers that Americans use every year? They constituted an average of no more than 1.4 percent, by volume, of the average landfill's total solid-waste contents during 1980-89.

What, then, makes up the biggest portion of garbage? Not surprisingly — in an information age — it is paper, which takes up over 40 percent of the contents of landfills by volume. (The two runners-up are construction debris and yard waste, which consists of grass clippings and leaves.) Newspapers alone constitute about a third of the volume of discarded paper: a year's worth of The New York Times takes up about 1.5 cubic yards, as much space as 18,660 crushed aluminum cans or 14,969 crushed Big Mac clamshells would require.

But, surely, paper is biodegradable? Well, yes and no. The garbage project regularly uses newspapers to date garbage layers precisely because, even after several decades, they remain intact and perfectly legible. The problem, the authors say, is that, landfills "are not vast composters; rather, they are vast mummifiers." There is biodegradation, but its pace is measured in centuries, not decades. Even organic materials, such as food scraps, remain unchanged after 30 or 40 years. Mr. Rathje and Mr. Murphy cite an account of an excavation of an ancient Roman garbage dump in which the smell of putrefaction remained unbearable even after 2,000 years.

CHRISTOPH ABBREDERIS

As the authors point out, there has always been garbage, and almost always a lot of it. They quote an estimate that the street level of the ancient city of Troy rose almost five feet per century as a result of debris accumulation. Present-day street levels on the island of Manhattan are typically 6 to 15 feet higher than they were in the 17th century; it wasn't until 1895 that the city undertook systematic garbage removal.

The focus of the final chapters of "Rubbish!" is the so-called garbage crisis. "So-called" because, as the authors document, Americans' per capita production of garbage has been remarkably stable over the last century (there is now more paper and plastic, but considerably less coal ash and horse manure). Likewise contrary to popular wisdom, Americans do not produce more garbage than everyone else. A comparative study of several United States cities and Mexico City found that although American households generated more packaging waste, on average they produced one third less garbage than their Mexican counterparts, whose fresh (unpackaged) food resulted in much more food waste.

There is no cause for alarm, but neither is there reason for complacency. (Indeed, the authors suggest several policies that could effectively reduce the amount of waste generated, including charging families for garbage removal by volume, as has been successfully done in the city of Seattle.) We should all learn to reduce our production of waste and encourage efforts at recycling, but the chief lesson of this far-ranging and provocative book may be the discovery that what we think we know about garbage is often based on half-truths, misperceptions and incomplete knowledge. □

Fig. 9 Article about Rathje's Garbage Project by Witold Rybczynski in the New York Times, July 5, 1992.

"One aspect of Whitemud's history, and only one, and a fragmentary one, we knew: the town dump. It lay in a draw at the southeast comer of town, just where the river left the Hills and where the old Mounted Police patrol trail (I did not know that that was what it was) made a long, easy, willow-fringed traverse across the bottoms. That stretch of the river was a favorite campsite for passing teamsters, gypsies, sometimes Indians. The very straw scattered around those camps, the ashes of those strangers' campfires, the manure of their teams and saddle horses, were hot with adventurous possibilities. The camps made an extension, a living suburb, of the dump ground itself, and it was for this that we valued them. We scoured them for artifacts of their migrant tenants as if they had been archaeological sites potent with the secrets of ancient civilizations. I remember toting around for weeks a broken harness strap a few inches long. Somehow or other its buckle looked as if it had been fashioned in a far place, a place where they were accustomed to flatten the tongues of buckles for reasons that could only be exciting, and where they had a habit of plating the metal with some valuable alloy, probably silver. In places where the silver was worn away, the buckle underneath shone dull yellow: probably gold.

Excitement liked that end of town better than our end. Old Mrs. Gustafson, deeply religious and a little raddled in the head, went over there once with a buckboard full of trash, and as she was driving home along the river she saw a spent catfish, washed in from the Swift Current or some other part of the watershed in the spring flood. He was two feet long, his whiskers hung down, his fins and tail were limp—a kind of fish no one had seen in the Whitemud in the three or four years of the town's life, and a kind that none of us children had ever seen anywhere. Mrs. Gustafson had never seen one like him, either. She perceived at once that he was the devil, and she whipped up the team and reported him, pretty loudly, at Hoffman's elevator.

We could still hear her screeching as we legged it for the river to see for ourselves. Sure enough, there he was, drifting slowly on the surface. He looked very tired, and he made no great effort to get away when we rushed to get an old rowboat, and rowed it frantically down to where our scouts eased along shore beckoning and ducking willows, and sank the boat under him and brought him ashore in it. When he died we fed him experimentally to two half-wild cats, who seemed to suffer no ill effects.

Upstream from the draw that held the dump, the irrigation flume crossed the river. It always seemed to me giddily high when I hung my chin over its plank edge and looked down, but it probably walked no more than twenty feet above the water on its spidery legs. Ordinarily in summer it carried six or eight inches of smooth water, and under the glassy surface of the little boxed stream the planks were coated with deep sun-warmed moss as slick as frogs' eggs. A boy

THE DUMP GROUND

wallace stegner

(1960)

could-sit in the flume with the water walling up against his back, and grab a cross-brace above him, and pull, shooting himself sledlike ahead until he could reach the next cross-brace for another pull, and so on across the river in four scoots.

After ten minutes in the flume he would come out wearing a dozen or more limber black leeches, and could sit in the green shade where darning needles flashed blue, and dragonflies hummed and stopped in the air, and skaters dimpled slack and eddy with their delicate transitory footprints, and there pull the leeches off one by one, while their sucking ends clung and clung, until at last, stretched far out, they let go with a tiny wet puk and snapped together like rubber bands. The smell of the flume and the low bars of that part of the river was the smell of wolf willow.

But nothing else in the east end of town was as good as the dump ground. Through a historical process that went back to the roots of community sanitation, and that in law dated from the Unincorporated Towns Ordinance of the territorial govern- ment, passed in 1888, the dump was the very first community enterprise, the town's first institution. More than that, it contained relics of every individual who had ever lived there. The bedsprings on which Whitemud's first child was begotten might be out there; the skeleton of a boy's pet colt; books soaked with water and chemicals in a house fire, and thrown out to flap their stained eloquence in the prairie wind. Broken dishes, rusty tinware, spoons that had been used to mix paint; once a box of percussion caps, sign and symbol of the carelessness that most of us had in matters of personal or public safety. My brother and I put some of them on the railroad tracks and were anonymously denounced in the Leader for nearly derailing the speeder of a section crew. There were also old iron, old brass, for which we hunted assiduously, by night con ning junkmen's catalogs to find out how much wartime value there might be in the geared insides of clocks or in a pound of tea lead carefully wrapped in a ball whose weight astonished and delighted us.

Sometimes the unimaginable world reached out and laid a finger on us because of our activities on the dump. I recall that, aged about seven, I wrote a Toronto junk house asking if they preferred their tea lead and tinfoil wrapped in balls, or whether they would rather have it pressed flat in sheets, and I got back a typewritten letter in a window envelope advising me that they would be happy to have it in any way that was convenient to me. They added that they valued my business and were mine very truly. Dazed, I carried that windowed grandeur around in my pocket until I wore it out. ”

Fig. 10 Image: movie still from Thor: Ragnarok, Disney/Marvel 2017

03 | MANIFESTATIONS

Much like waste, the terms we use to describe the accumulation of waste – dumps and landfills – can be misleading. "Dump" and "Landfill" are often used interchangeably, although their definitions and narratives are distinct. In order to understand these distinctions in dump and landfill narratives, it is important to understand the evolution of the word and the form.

Dumping as waste management does not always manifest in the same form of waste accumulation. There is an important distinction to draw between open dumps, landfilling, and sanitary landfills. Open dumps, or open-air dumps, describes the accumulation of sold waste in an area without any kind of regulations or environmental precautions. Dumps do not undergo an intensive planning and designing process, they are simply created. Dumps are the most toxic of the three manifestations.

Landfilling describes places that have used dumps as fill to create new land. The important difference to note here is that landfills are dumps that have a cap. They are created without liners, but do have a cap.

Sanitary landfills, the form of waste accumulation that comes first to mind today, described a place that is carefully planned, lined with several layers of materials, filled with waste in specific cells, and covered daily until they are closed. Sanitary landfills are heavily regulated and monitored.

These three terms – dumps, landfills, and sanitary landfills – are often used interchangeably, much like the word "waste." While functionally they all serve the same purpose to harbor solid waste in one place, their narratives, or lack thereof are fundamentally different.

DUMPS VS. LANDFILLS

To understand the narratives told by landfills, we must first understand the narratives, or stories, told by dumps – the very first form of leaving waste in place.

A dump is an open area filled with refuse with no liners, covers, methane/leachate collection system, or policy regulations. The waste that accumulates there is not touched, besides by scavengers and seagulls. A landfill, more specifically a sanitary landfill is a much more technologically advanced waste management system. Preventative measures are taken to stop leachate or methane from seeping into the environment around it, although this does not necessarily eliminate the pollution within the confines of the landfill. While the two forms of waste accumulation are the result of the same waste management practice, "dumping," their meaning and narratives are different. Mira Engler, associate professor at Iowa State University, author of ***Designing America's Waste Landscapes***, says this - "The open dump is an ecological habitat and a site of accelerated entropy and decomposition. The tamed modern landfill, however, is less a habitat than an artifact, the largest built monument of contemporary society."[31] Dumps are dynamic and alive ecosystems and landfills are artifacts – fossils frozen in time.

While Rathje focused on the archaeological importance of waste and what the contents of our trash bins say about us as a society, Engler draws a greater meaning from the accumulation of that waste, specifically in the context of dumps – the aesthetics, social aspects, and symbolic power– what they mean to us and how that meaning has changed over time.[32]She says, "Dumps are fraught with ample, conflicting imaginings and facts; they yield scientific data and are laden with myths; they are built as monuments to last and host processes of entropy; they symbolize death while standing for progress. Their power lies in their contradictions and ambiguity. Probes of the dumps reveal treasures, fears, losses, abnormalities, absences, and enigmas. Their inherent dialectics makes them a rich subject for intellectual and aesthetic investigation of our everyday lives and places."[33]

LANDFILLING AS LANDFORMING

Making "mountains" from trash is not a new phenomenon. Accumulated solid waste as form building has been present in society throughout history. The Maya would dump their waste at the edges of their villages, which exploded from methane build-up from time to time, creating more room for waste.[34] In the Old Testament, the people of Jerusalem would dump their refuse in a valley outside of the city with natural gas vents so that their waste would be incinerated. This Valley of Gehenna or Gei-Ben-Hinom literally translates to "hell" creating a setting for many myths and allegories in the bible.[35] In the United States, much of what is known about ancient Native American Civilizations comes from shell middens – or dumps formed from the discarded remains of shellfish. Other artifacts can be found in these middens such as tools and ceramics which have given insight into their lives.[36] Shell middens can be found throughout the coastal United States even today.

Waste accumulation at home took on a different form than the classic "mound" of waste often associated with dumps. In ancient Rome, people would just leave their waste on the floor until it became unbearable. Once this occurred, they would cover the waste with a layer of clay (akin to what we do today to cap landfills) and go on with this method until a room was unlivable.[37] The Romans would just keep developing vertically as necessary. Today, where the remains of Troy are sited in Turkey, archaeologists found that the city is built upon nearly 15 feet of waste. In fact, many ancient cities were built and rebuilt upon their own dumps.

As civilizations discovered the public health risks associated with open dumps, it became more common and encouraged to dump waste in areas that are not easily developed – for example geographical depressions like swamps, gullies,

Fig. 11 The contents of a shell midden found in North America

lakes, rivers, oceans, quarries, etc. Although it was not immediately clear that accumulating waste could have polluting effects on the surrounding people and environment, especially in or near bodies of water, it was evident that after a certain accumulation of waste, some of this previously unusable land could become usable. Since this discovery, dumps were often sited in places that were deemed valueless in terms of developable real estate. The Tuileries Gardens and Parc de Butte Chaumont in Paris as well as Central Park in New York City were some of the first public parks built upon open dumps. Landscape Architect, Frederick Law Olmsted served as the Executive Secretary of the United States Sanitary Commission, advocating for the redevelopment of dumps as a public health necessity.[38]

This set a precedent in the United States to use dumping as a means of urban development. Not only could municipalities make money from trash collection as a public service, but they could then cap these dumps and sell the real-estate. This revelation brought about regulations to locate dumps in opportune areas to be redeveloped, changing them from dumps to landfills. Places like Central Park in New York City, Pioneer Square in Seattle, and Foster City in the Bay Area are three of many examples of dumps to landfill redesigned as real-estate. Changing the land-use of the dump changed both its perceptions and narratives. Dumps are rich in the stories and narratives that landfills lack, or rather hide away. The accumulation of items, all with individual lives and stories, take on new life and meaning in dumps – available for anyone to see if they would just look.

Fig. 12 A hill created from a large shell midden found in South America.

DUMP NARRATIVES

Engler identifies two specific and somewhat at odds narratives for dumps – the **fantastic** and the **abject**. **Fantastic** meaning 'extraordinarily good or attractive' and 'imaginative or fanciful; remote from reality.' And **Abject** meaning '(of something bad) experienced or present to the maximum degree' and '(of a person or their behavior) completely without pride or dignity; self-abasing.' These narratives pervade all types of story-telling from poetry to non-fiction, film to performance art. The themes present in each narrative remain the same over time, but our current waste management policies fail to reflect them.

THE FANTASTIC DUMP

A.R. Ammons very long poem "Garbage" (1993) is a wonderful example of the **fantastic dump**.

> *dew shatters into rivulets on crunched cellophane*
> *as the newly-started bulldozer jars a furrow*
>
> *off the mesa, smoothing and packing down:*
> *flattening, the way combers break flat into*
>
> *speed up the strand: unpleasant food strings down*
> *the slopes and rats' hard tails whirl whacking*
>
> *trash: I don't know anything much about garbage*
> *dumps: I mean, I've never climber one: I*
>
> *don't know about the smells: do masks mask*
> *scent: or is there a deodorizing mask:*

Written as a long stream of consciousness, Ammons is able to describe the wonder in every detail of a dump – he finds intrigue and meaning in everything gross and disgusting. Engler describes the poem as "a cultural mirror for self-introspection."[39] Wallace Stegner takes on the fantastic narrative in his story "The Dump Ground" in which he tells the story of a town and its inhabitants through the activities and items at the local dump. Despite the repulsive exterior of dumps, both authors recognize that the wealth of knowledge and literal treasure that can be found in dumps.

The Pixar film *WALL-E*, imagines a fantastic future in which production and consumption outpace and overwhelm the earth, forcing humans to take refuge on a spaceship while programmed robots clean up the mess. After hundreds of

Fig. 13 WALL-E finds life in the wasteland.

Fig. 14 Denes stands in her wheatfield, planted atop a landfill in Manhattan.

years, only one robot remains, fulfilling his duties day to day, while discovering objects that he takes home to assign a new value. He eventually stumbles upon life in the wasteland, setting off a chain of events to bring the human race back to earth. Although it is clear that humans had to leave because of their degraded environment, that the overall build-up of waste is negative, the film shows that value is dependent on perception.

Agnes Denes, a concept-based artist in the 1960s and 1970s created ***Wheatfield – A Confrontation*** (May 1982), in which she planted a wheat field on two acres of a landfill in lower Manhattan, very close to the former World Trade Centers. Two hundred truckloads of dirt were brought in, seeds planted, and maintained for four months. The crop was harvested on August 16 and yielded over 1,000 pounds of healthy, golden wheat. The purpose of this land art was to expose the mismanagement and mis-valuation of land. Although the project was placed on a landfill, not a dump, her piece exposes a new perspective on the value of land, calling out that covering up dumps for profit by private entities is not the only perception of these wastescapes. By reimagining one such perception, she brings attention to the idea that there is much more meaning hidden beneath the surface than we realize.

THE ABJECT DUMP

The **abject dump** recalls an extreme accumulation of waste. Being at a dump is to experience the maximum degree of waste, which is not pleasant. Waste smells bad, can be slimy to the touch, and depending on what it is, poisonous. This narrative of the abject dump describes the most negative aspects of a dump. "They are places of abuse and oppression, hosting both victims and perpetrators."[40] They are scary and imposing places with social uses to match. Robert Sullivan portrays the meadowlands with the abject dump narrative in his book, ***The Meadowlands: Adventures at the Edge of the City*** (1998). Latife Terkin's ***Berji Kristin: Tales from the Garbage Hills*** tells the story of a place in which cast-offs, unemployed, homeless, old people, are sent to live on the margins of the city in the "garbage hills." Their way of life is formed by the garbage around them and while the story is fiction, it is also a depiction of how many people live in slums.

The Great Gatsby by F. Scott Fitzgerald, uses the industrial dump as a symbolic setting of the novel. The ashes from industry dumped here are a symbol for the extreme pursuit of wealth regardless of the social and environmental impacts it may have. The "...valley of ashes – a fantastic farm, where ashes grow into ridges and hills and grotesque gardens, where ashes take the forms of houses and chimneys and rising smoke, and finally, with transcendent effort, of ash-gray men, who move dimly and already crumbling through the powdery air." Sets a scene in which the ash, or waste, takes on a life of its own. The valley of ashes, however, is overwhelmingly abject, describing the moral-less people who created it and the hazardous effect it has on its surroundings.

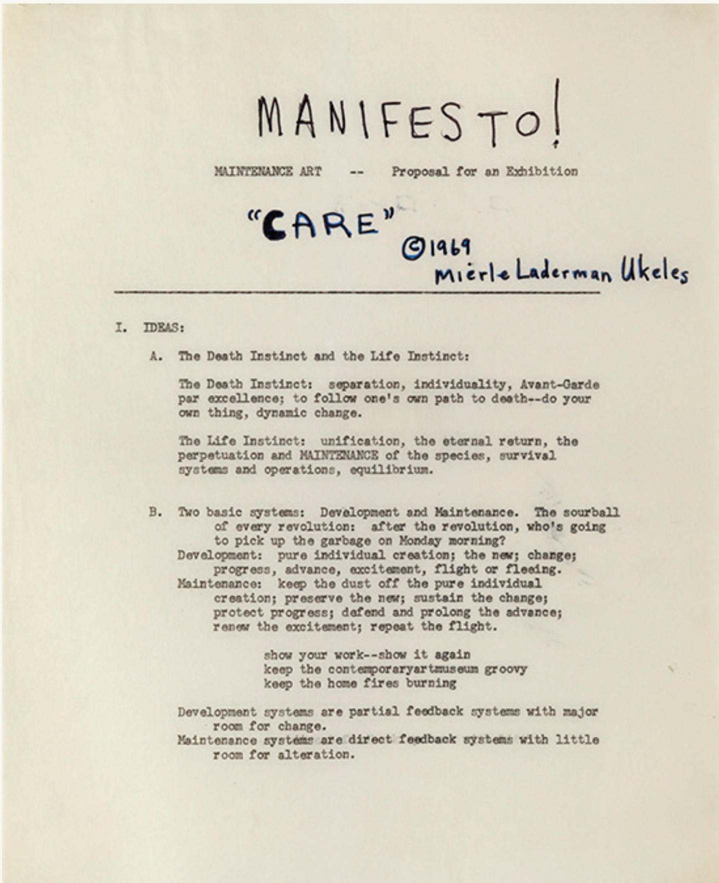
Kevin Lynch, prolific city planner and theorist, went so far as to imagine two worlds both at maximum – and another where nothing is. Where everything is wasted, the whole world is a dump. People leave their trash wherever they choose, and they produce a lot of it. Materials are consumed rapidly, and byproducts expelled without thought of environmental safety. Smog fills the air and waste fills the sea, creating an almost uninhabitable world. Where nothing is wasted, not even fire is used for fear of the waste it produces. Not a single weed would be found, and genetics manipulated so that all humans are a standard size, ensuring no clothing would be wasted. Every birth must replace a death. Everything is controlled. Both worlds, without any semblance of balance, are dangerous and

Fig. 15 The Valley of Ashes from The Great Gatsby featured film (1974) directed by Jack Clayton.

repressive in their own ways. The parables are meant to reveal that we cannot survive without waste. Waste, if improperly managed, is dangerous, but if it is embraced, we thrive.[41]

Mierle Ukeles is another concept-based artist who used trash as a medium. She served as the artist in residence at New York City's Department of Sanitation for 39 years starting in 1978. Themes of "Development and Maintenance" pervade throughout her art and directly addresses waste management. Her manifesto "Care" describes development and maintenance. Whereas development is associated with 'creating' and includes production and consumption, maintenance is associated with 'keeping up' and includes waste management. She notes that our culture values development and not maintenance, despite the fact that maintenance requires much more time and energy.[42] Ukeles work highlights the intense amount of physical strain sanitation workers undergo to be avoided and ignored by the rest of society. Her pieces were filled with symbolism inspired by solid waste management, yet critics argue she did little to actually have an impact on working conditions.

Both the fantastic and the abject dump provide grounds for stories, myths, and lessons that are relevant to the human condition and should be learned from. These lessons, however, are not present in most landfills and sanitary landfills. In addition to literally covering up the garbage in dumps, we cover up and ignore the stories and narratives held inside when we create landfills. This is apparent in the out of sight, out of mind policy adopted to control our waste management systems.



MANIFESTO!

MAINTENANCE ART -- Proposal for an Exhibition

"CARE"

©1969
Mierle Laderman Ukeles

I. IDEAS:

A. The Death Instinct and the Life Instinct:

The Death Instinct: separation, individuality, Avant-Garde par excellence; to follow one's own path to death--do your own thing, dynamic change.

The Life Instinct: unification, the eternal return, the perpetuation and MAINTENANCE of the species, survival systems and operations, equilibrium.

B. Two basic systems: Development and Maintenance. The sourball of every revolution: after the revolution, who's going to pick up the garbage on Monday morning?
Development: pure individual creation; the new; change; progress, advance, excitement, flight or fleeing.
Maintenance: keep the dust off the pure individual creation; preserve the new; sustain the change; protect progress; defend and prolong the advance; renew the excitement; repeat the flight.

show your work--show it again
keep the contemporaryartmuseum groovy
keep the home fires burning

Development systems are partial feedback systems with major room for change.
Maintenance systems are direct feedback systems with little room for alteration.

Fig. 16 Ukeles' manifesto 'Care' (1969)

SANITARY LANDFILLS AS PUBLIC AMENITY

Dumps, however mysterious and intriguing, are very dangerous health hazards. Rainwater, mixed with degrading organic materials and other toxins in a dump creates "garbage juice" or harmful leachate that can seep into the earth and pollute groundwater. Biodegradation of organic materials through anaerobic processes produced methane, a gas that under too much pressure will cause an explosion. Un monitored, open dumps are extremely dangerous and as populations grew and became denser, the US revised criteria in Title 40 of the Code of Federal Regulations part 258 in Subtitle D of the Resource Conservation and Recovery Act. This revised policy introduced location restrictions, composite liners requirements, leachate collection and removal system requirements, standardized operating practices, groundwater monitoring requirements, closure and post-closure care requirements, corrective action provisions, and financial assurance.[43] Thus began the reign of the "sanitary municipal waste facility."

To protect the surrounding environment, landfills were lined and capped for closure, creating neat pockets of solid waste within the earth, covered with soil, grass, and other plants with shallow roots systems. In doing so, we hide away or waste and all the mystery and intrigue, fantasy and abjection that goes with it. Our waste management system has truly placed waste ***out of sight, out of mind*** which has had negative impacts on our perceptions of waste and therefore our consumption habits. We have limited interaction with our solid waste and since sanitary landfills work well, there is limited innovation in waste management. Engler argues that maybe we do not wish to interact with our waste, and have built systems so that interaction is minimal, because sending away no longer useful materials reminds us of our own mortality. She also notes the similarities between cemeteries and dumps – both began as small operations in the backyard and then eventually moved to a towns periphery. Cemeteries were considered the first urban parks in the US and now, post-closure landfills are turning into parks.[44]

This mentality blinds us to see what landfills ***could*** become –

LAND RICH WITH RESOURCES**.**

Fig. 17 Seneca Meadows Landfill daily operations. Photo: Sarah Jean Condon, The Citizen

ANATOMY OF A MODERN LANDFILL

According to ***Geotechnical Aspects of Landfill Design and Construction*** (2002), "A modern, well-constructed landfill can be characterized as an engineered structure that consists primarily of a composite liner, leachate collection and removal system, gas collection and control system, and final cover."[45]

Landfills are now designed to perform 3 main functions[46]:

1. Contain waste and separate it from its environment
2. Capture contaminated water that contacts the waste (leachate)
3. Control gas migration

Responsible modern municipal sanitary landfill design starts with locating the landfill in an appropriate location. Whereas dumps and landfills had historically been located on land deemed "valueless" land like marshes and wetlands to try and create valuable real-estate, sanitary landfills today need to be located in areas that are structurally stable and maintain a relatively low environmental impact.

Once a landfill has been sited, preparation of the site begins. As before, the beginning step of landfill construction begins with a big hole in the ground. This, however, is where design and engineering of open dumps stops and the modern landfill begins. Sanitary Landfills consist of the following parts:

(a) Bottom and lateral side liners system
(b) Leachate collection and removal system
(c) Gas collection and control system
(d) Final cover system
(e) Stormwater management system
(f) Groundwater monitoring system
(g) Gas monitoring system

The pit is covered in about 2 feet of clay soil, to create a very impervious natural soil surface. Next a geomembrane liner, less than a tenth of an inch thick, made from impermeable polyethylene is placed on top of the clay soil. This protective layer is extremely important as the defense against leachate leak. Above the geomembrane is a 1 to 2 foot-thick drainage layer, constructed of very highly permeable materials such as sand or gravel to promote leachate collection. This layer includes a complex series of perforated pipes to collect and move leachate throughout the site. Should leachate sit at the bottom of the landfill and gather, there is a risk of explosion due to methane build up. Above the drainage layer, a protective barrier is put in place to protect the leachate collection system from compaction from equipment, consisting of a maze of pipes laid through the landfill, designed to move all percolating leachate into adjacent lagoons.

Finally comes the waste layer. Waste is strategically placed within specific areas of the landfill depending on site planning. At the end of each day, open waste is covered with a 6-inch layer of soil to prevent refuse from blowing away, odors, and attraction of disease vectors.[47] The contents of a single day's worth of dumping and covering is referred to as a cell. Landfills are formed by the creation of these daily cells, or pockets filled with waste. Therefore, creating earth with waste does not subscribe to the normal stratifications and geological processes, but rather strictly anthropogenic ones.

Once an area, or zone, reaches its height capacity, the waste is then covered in about a foot of soil, 2-3 feet of clay, another geomembrane liner, a 1-foot drainage layer, and depending on planting plans, .5 feet of topsoil that will support vegetation growth. Often, landfills do not encourage vegetation growth within this topsoil layer for fear of roots compromising the cap, and therefore this layer is designed to be very thin. Some studies suggest however, that roots tend to grow only where there is water availability. Most roots would tend to stray away from the drainage layer because of the lack of water and have a low likelihood of puncturing the protective cap.[48] Landfills agree that some vegetation is needed for the sake of soil stability and evapotranspiration but post closure design should refrain from using trees and shrubs.

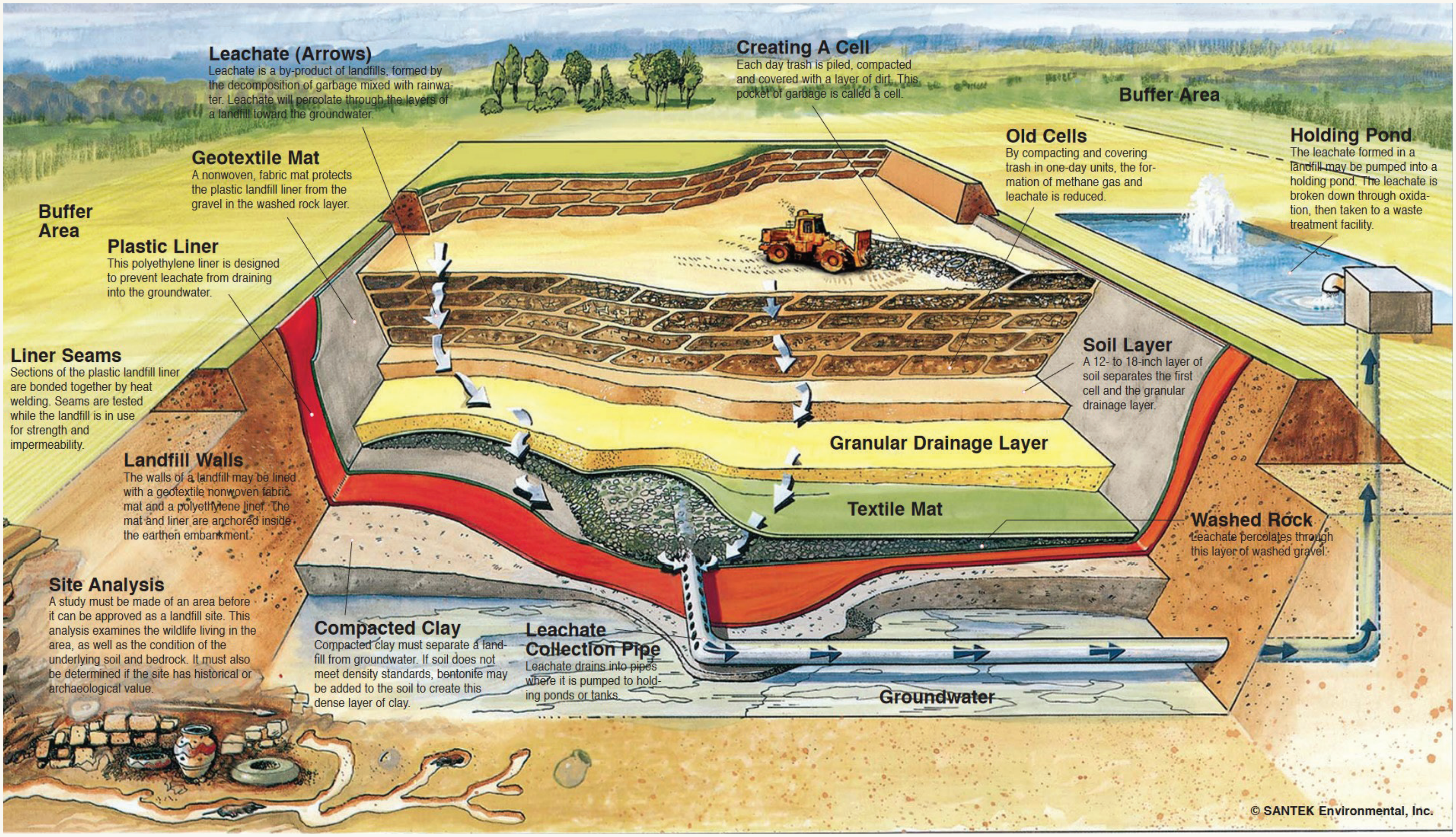


Fig. 18 Landfill diagram showing how a landfill is constructed, created by Santek Environmental, Inc.

MSW LANDFILL CURRENT OPERATIONAL STATUS

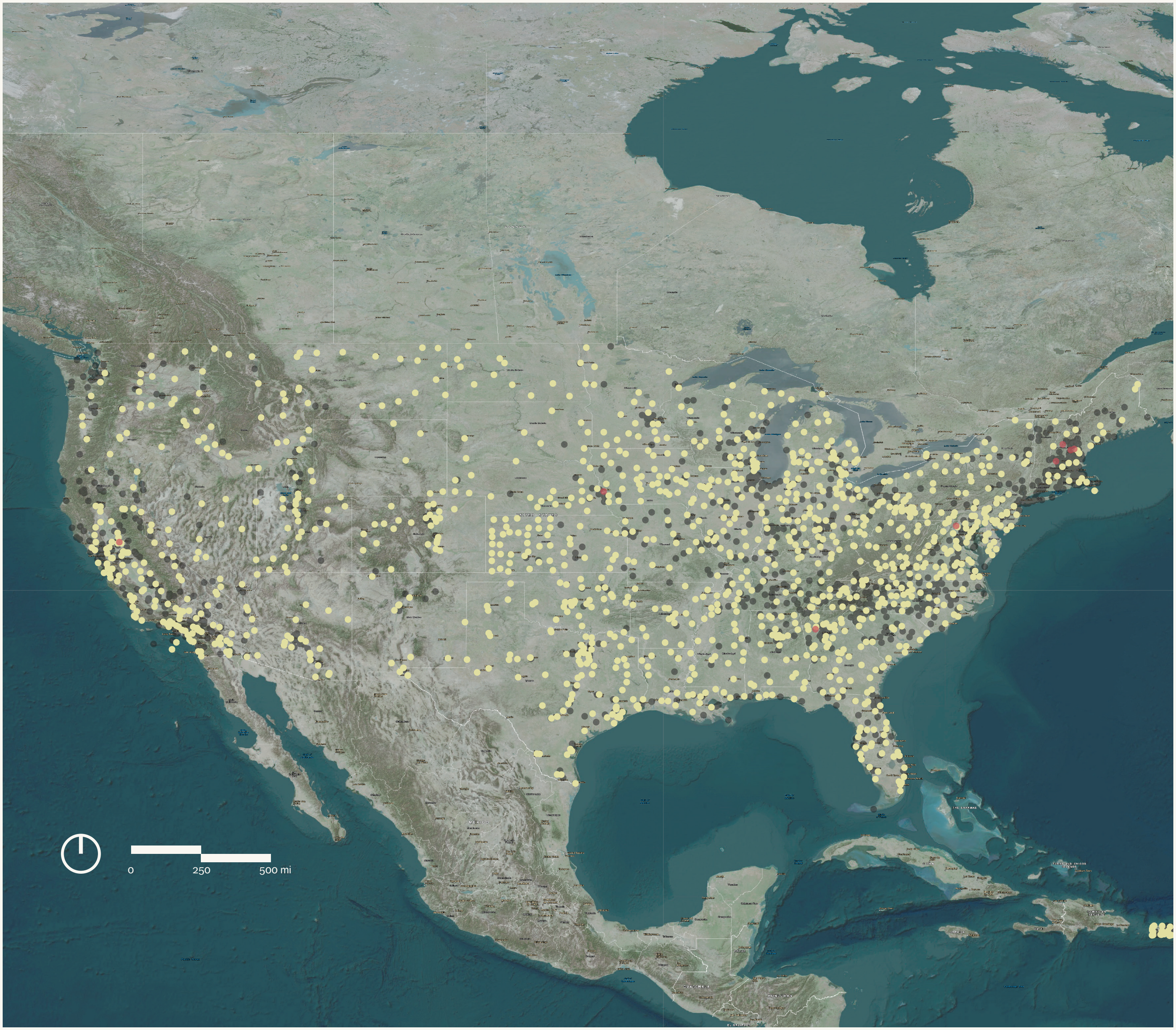


Fig. 19 Map showing the current operational status of landfills in the US.
Image created by author in QGIS using included base map images and EPA LMOP dataset (2016)

LANDFILLS IN THE UNITED STATES

The Environmental Protection Agency's Landfills Methane Outreach Program (LMOP) has completed a database in 2016 with the most up to date information about MSW landfills in the United States. While the dataset is not perfect, it includes pertinent information regarding the locations, operational status, and size of most MSWF in the US including Alaska, Hawaii, and Puerto Rico. The original intention of the dataset was to find and site landfills in the US that might be eligible for a landfill gas (LFG) program. Data is updated about 2 to 3 times per year. Using this dataset, and QGIS, I created a series of maps that tell a story of the rise and fall of sanitary landfilling in the US, as well as discerned information on how much land landfills take up and where they are.[49]

OPERATIONAL STATUS OF US LANDFILLS

According to the LMOP dataset, there are 1,279 open sanitary landfills, 1,324 closed sanitary landfills and 27 operational status unknown sanitary landfills in the US. This figure does not include dumps. There are some odd 2,631 landfills currently holding almost 27 billion tons of waste. (EPA 2016) This is the equivalent of 73,972.6 Empire State Buildings ***and*** only accounts for a portion of all MSW created because as of recent years, only about half of MSW created annually is sent to landfills. The rest is either processed via recycling, composting and combustion, or it ends up somewhere unintended like the ocean.[50]

The map shows that most MSW landfills have accumulated on either cost of the US and close to heavily populated areas. There are less MSW landfills in western/central US.

CURRENT OPERATIONAL STATUS

OPEN

CLOSED

UNKNOWN

OPERATIONAL STATUS PER DECADE

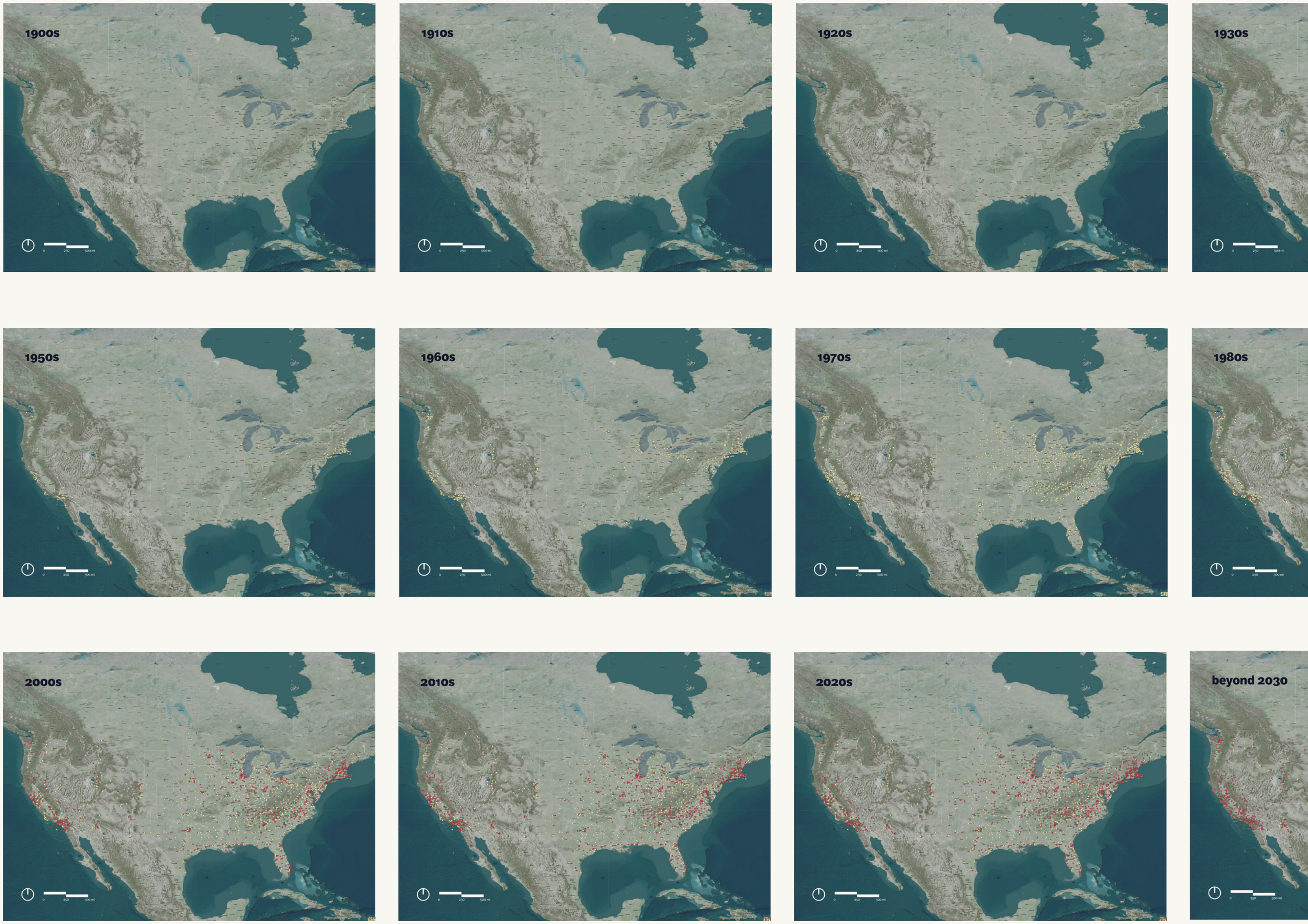
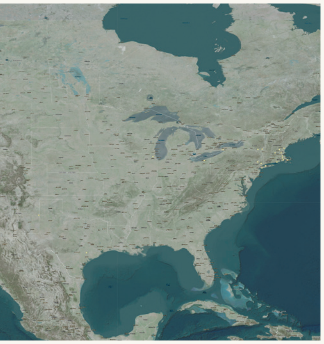
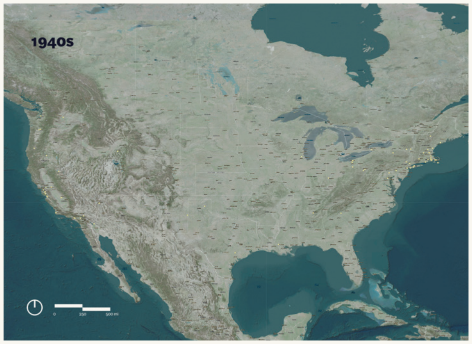
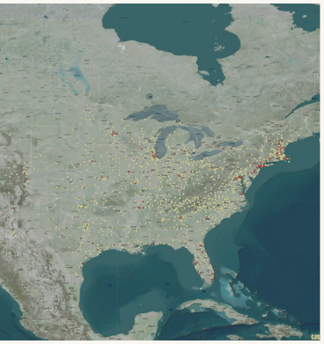
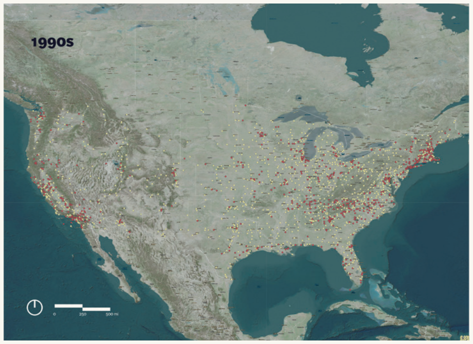


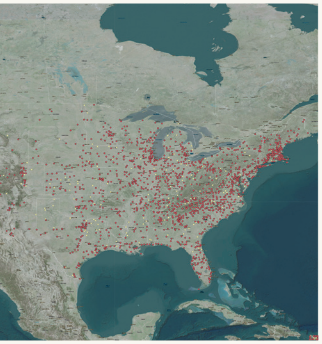
Fig. 20 Sequence of maps showing the operational status of landfills in the US per decade.
Image created by author in QGIS using included base map and EPA LMOP dataset (2016)











OPERATING LANDFILLS PER DECADE

This series of maps shows the number of landfills opened and closed per decade, starting in 1900. There is a huge boom in the opening of landfills around the 1970s and 1980s, that correlates with the rise in popularity of MSW landfills as the US's main waste management strategy. Within the last few decades, however, there has been a sharp decline in the number of landfills opening and a sharp incline in the amount of MSW landfills closing. Clearly there are more landfills closing currently, than are being created even though we are wasting more than ever. (EPA 2016)

This dataset shows the continued closure of all landfills in the US, according to the LMOP dataset, however, the dataset does not include any information for future MSW landfills planned for construction. Keeping in mind that some MSW landfills will probably be constructed in the future, the trends shown here support the fact that MSW landfills have fallen in popularity and will continue to decline. (EPA 2016)

OPERATIONAL STATUS PER DECADE

OPEN

CLOSED

LANDFILLS BY SIZE

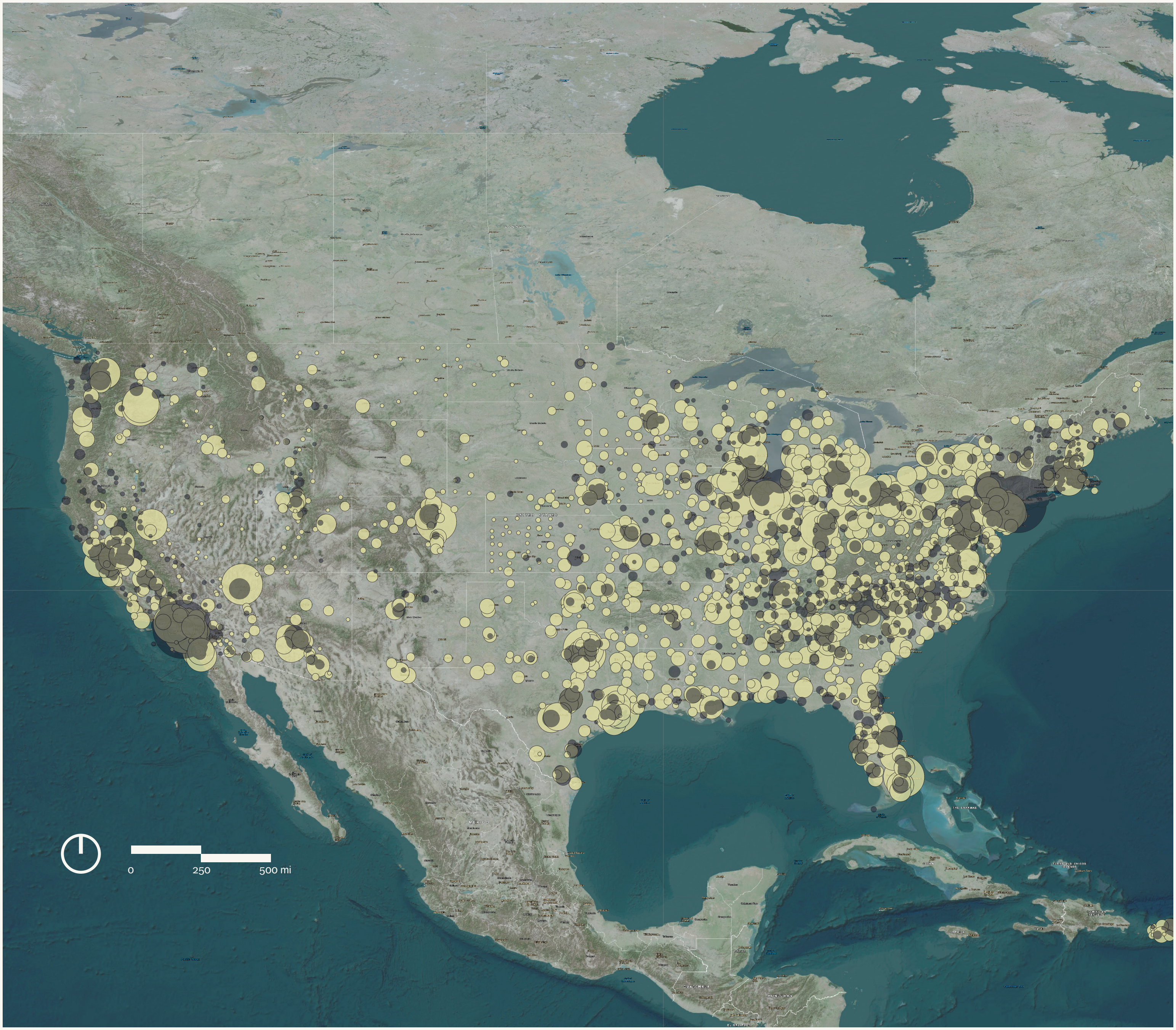


Fig. 21 Map showing the relative sizes of open and closed landfills in the US.
Image created by author in QGIS using included base map and EPA LMOP dataset (2016)

LANDFILLS BY SIZE

This map shows the relative size of MSW landfills, both opened and closed, in the US based on their volumes of waste in place. The largest landfill with the most waste in place is Puente Hills Landfill in Los Angeles County, California and is currently closed. Puente Hills operated for 56 years, closed in 2013, rises 500 feet high, covers over 700 acres, and contains 142,250,454 tons of waste. (EPA 2016)

The second largest landfill is the Freshkills Sanitary Landfill in Staten Island, New York at 135,450,945 tons of waste in place. Freshkills was opened in 1948 and closed in 2002. Both Puente Hills and Freshkills are slated to be turned into public parks after initial subsidence and the redesigns are being led largely by landscape architects. (EPA 2016)

The largest operational landfill is the McCarty Road Landfill in Houston, Texas with 97,983,501 tons of waste in place. This landfill was opened in 1972 and will close in 2031. (EPA 2016)

CURRENT OPERATIONAL STATUS

OPEN

CLOSED

“Garbage dumps contain an indistinguishable ensemble of discards that are stripped of their individual identities, cut off from their trajectory of usefulness, and forced together into the mess.”

Mira Engler,
Designing America’s Waste Landscapes

Fig. 22 Bird's eye view of Ariel Sharon Park. photo: Latz+Partner

Fig. 23 View of Ariel Sharon park from wildflower fields. photo: Latz+Partner

LANDFILL PROFILES

HIRYA – TEL AVIV, ISRAEL

The Hirya Landfill, just outside of Tel Aviv, Israel was decommissioned in 1998 after accumulating some 25 million tons of waste. This landfill is unique in that its infrastructure and design included, not only burying waste, but a sorting facility, composting facility, and recycling facility, and methane to gas facility, at the base of the landfill. The redesign was led by German landscape architect Peter Latz. The main goal of the redesign was to turn the landfill into a beautiful public park. In order to protect the health of any future plantings, a thin layer of 'bioplastic' was used to separate the landfill from new soil and planting, creating a solid barrier between landfill and park. The various facilities around the park will remain active although no more waste will be buried there. Although the park will not be fully operational until 2023, and development has taken decades, Hirya has turned into a shining example of landfill remediation. In order for safe landfill settlement and compaction to occur it was necessary for development to take around 20 – 30 years which has become the standard for newer landfill reclamation projects. The new Ariel Sharon park is designed to connect the surrounding neighborhoods together, creating a new community while material recovery facilities will remain operational, keeping the memory of the Hirya Landfill alive.[51]

Fig. 24 Freshkills redesign by James Corner Field Operations. photo: James Corner Field Operations

Fig. 25 Freshkills Dump, photo: Mike Segar/Reuters.

Fig. 26 Field growing on the former Freshkills Dump, photo: Timothy Claren

FRESHKILLS – STATEN ISLAND, NEW YORK

Probably the poster child for landfill redesign, in 1955 Freshkills was the largest landfill in the world. Only health concerns from neighboring communities initiated its closing, but the landfill opened up in 2011 to take debris from 9/11. Though difficult to find any specific design information about the park, James Corner of James Corner Field Operations went on record saying that the ecology of the landfill mattered first, and the health of the overall ecosystem is what is driving the design. The park itself is huge – 2,200 acres. Currently, only a portion of the park is open for public use, while the birds and other wildlife establish themselves. Because the building of this park is projected to take such a long time, as funding becomes available, conservation efforts have been successful so far. This case study is relevant to look at because it is so recent. Instead of focusing on turning this landfill into a revenue-producing park right away, the Field Operations team took a master plan approach that is expected to change over time. It will be interesting to see what happens to this park in the future, how much of it will remain a conservation area, how much access humans will have, and how the designers and NYC Parks Department handle subsidence.

Fig. 29 Bird's eye view of Byxbee Park. photo: Hargreaves Jones

Fig. 27 Old lightposts used as landscape structures. photo: Hargreaves Jones

Fig. 28 Mounds shaped like Native American middens. photo: Hargreaves Jones

BYXBEE – PALO ALTO, CALIFORNIA

Byxbee Park used to be one of several landfills surrounding San Francisco. It was decommissioned and capped in the 1990s with the intention of creating a municipal park. Hargreaves Jones landscape architects worked with the artists to form interesting and culturally important earthworks across the site. They incorporated a few of the pre-existing interesting features – such as the 75 telephone poles placed in a grid. The design is both respectful to indigenous and the landfill history while creating a place where people in the city can get out and exercise. There was special care to exclude impermeable surfaces and trees that could potentially harm the cap. Overall, the design worked with the landfill, not against it. However, there has been considerable subsidence since the park was built leading to the destruction of some of the beloved earthworks and other features of the park. This case study is relevant because it will show how clay caps can change over time and how municipalities will respond to that change – in this case, they decided to take away aspects of the design without consulting the original landscape architects.

"King County, Washington, is running out of local options to manage its waste.

The most populous county in the state recently bought itself some time by convincing partner cities to expand its Cedar Hills Regional Landfill again, but that will only solve the area's waste problem for another two decades. After that, the landfill is out of space, unless the county can somehow convince rancorous neighboring residents to remove height restrictions or allow expansion into buffer zones. For the time being, local officials are exploring other alternatives, with landfill critics arguing that waste-to-energy is the best option.

A report released last month by consulting firm Arcadis lends further evidence to the case supporters are mounting for WTE, finding the county could save up to $7.2 billion over the long-term by incinerating waste versus exporting it to other landfills after Cedar Hills closes. If a handful of politicians and local WTE advocates had their way, the county would let go of landfilling sooner rather than later, potentially making King County home to one of the first new incinerators the United States has seen in years.

'There are many things King County does that are the largest, the biggest, the first,' County Councilmember Kathy Lambert, who has advocated for WTE since 2006, told Waste Dive. 'Do we want to be forward-thinking, practical and make sure that we are setting ourselves up to be self-sufficient?'

The Cedar Hills landfill serves all but two cities in King County – Seattle and Milton – and could reach capacity as soon as 2025. The county council approved a solid waste plan that included the expansion in April on a 5-2 vote. Lambert, one of the dissenting voters, called the plan 'disappointing and short-sighted."'

Waste Dive contacted all five council members who voted in support of the plan. As of publication, the members either hadn't responded or declined to comment.

Most of the county's 37 partner cities approved expansion this fall, and the landfill cleared another hurdle this month when the Washington Department of Ecology gave the green light to the county's new solid waste plan. But critics continue to argue a WTE plant would be a more forward-thinking and environmentally friendly solution.

'The rest of the world is going to be so far ahead of us in using technology to deal with this problem,' said Lambert."

Fig. 30 Article by Leia Larsen on wastedive.com November 26, 2019

Fig. 31 Ae

erial image of Washington State with Cedar Hills Regional Landfill circled in red

04 | THE CEDAR HILLS R

The Cedar Hills Regional Landfill (CHRLF) is the last operational landfill left of 9 in King County, Washington. Located just north of Renton and south of the Issaquah, the CHRLF is located in Maple Valley, Washington, formed by the recession of the Vashon Glacier and previously home the Duwe'kwulsh village of the Indigenous Duwamish people. Small residential neighborhoods have been constructed directly east and west of the site along with scattered single-family housing. The Cedar Grove Composting Facility and Quality Aggregates quarry are located just south of the CHRLF. Both sites are accessible by Cedar Grove Road. The Cedar River runs east to west south of the landfill and is an ecologically important habitat for salmon.

Opened in 1965, the CHRLF serves all of King County excluding the cities of Seattle and Milton. As of 2020, that accounts for more than 2.2 million people. Over time the site has grown to a total of 920 acres including the wooded buffer and in most recent years, receives almost 1 million tons of waste annually. This figure is expected to increase in the future, alongside increased rates of recycling. You can even (kind of) see it from space.

With only one active area left, and capacity until 2028, the Cedar Hills Regional Landfill (CHRLF) needs to make a decision – permanent closure or attempt to increase capacity. An increase in capacity is possible by a few means – reopen previously lined areas (keeping in mind that the maximum height the landfill cannot exceed is 800 ft above sea level), move all the structures in the Southeast portion of the site to create a new are to fill, or build a Waste to Energy Plant where incoming waste would be incinerated and the fly ash buried in the landfill. Of these options, the last two have undergone feasibility studies.

Maple Valley is geographically located in the middle portion of the Puget Lowland, an elongated topographic and geological depression lying between the Olympic and Cascade Mountains. The CHRLF sits within rolling hills near the location of a former coal mining town. Before the CHRLF started accepting waste, elevations of the site sat at about 650 feet above sea level along the western border and 359 feet above sea level at the northwestern corner. Landfilling activates have increased that elevation by 100 to 150 feet and the CHRLF now has a good faith agreement with King County to keep elevations under 788 to 800 feet above sea level.[52]

EGIONAL LANDFILL

Cedar Hills: one of few landfills remaining

by Wendy Lippmann

The Cedar Hills landfill, seven miles south of Issaquah near the Cedar Grove Road, is being established as King County's and Seattle's sole garbage dump, and neighbors think the plan stinks.

King County's plans call for the establishment in the next few years of six new garbage transfer stations, the closure of its rural landfills including the Hobart dump and the expansion of Cedar Hills to handle more than double the amount of refuse it currently accepts.

Transfer stations will serve local garbage haulers. The refuse deposited at the transfer stations will then be hauled to Cedar Hills, which, as a regional landfill, becomes the garbage's final resting place.

A $14.5 million capital improvement project bond is being considered by the county to finance the solid waste management plan. A few million will be spent at Cedar Hills to construct berms surrounding the garbage mounds and depressions, "primarily to make it more visibly pleasant," said Solid Waste Management Director Linda Zarek.

But the neighbors of the landfill who organized the "Cedar Hills Action Brigade" last week aren't upset about the aesthetics of Cedar Hills. They say they are concerned about increased semi-truck traffic to the dump, the smell that sometimes permeates their neighborhoods, the concentration of crows and seagulls that scavenge the area and the run-off of contaminated water they fear comes from Cedar Hills and flows toward Issaquah Creek.

The City of Issaquah sued King County six years ago to prevent leachate from contaminating waters generated through the Cedar Hills landfill.

Leachate, a highly toxic and often foul smelling bacteria, was responsible for the death of nearly half a million fingerling and salmon fry in the Issaquah fish hatchery, according to the lawsuit.

Since then, the county has spent millions of dollars and plans to spend millions more for an extensive leachate collection system at Cedar Hills. Zarek claims the system will prevent any pol-

ford.

DOES engineer John Conroy said the county has done "a serious and extensive effort to try to solve the leachate problem." But, when he inspected the site and sampled run-off one year ago, "it was not looking as if they were succeeding in large part," he said. "At that time the landfill was impacting Mason Creek which flows directly into Issaquah Creek," he said.

Based on more recent sampling in the area, Environmental Protection Agency engineer Neal Thompson said the collection system was not capturing all the run-off from the site. But, Conroy said improvements to the system should minimize the impact on Issaquah Creek.

Cedar Hills operates a "compact and cover" system. The dumped garbage is compacted and then covered with dirt excavated from spots on the 920-acre property.

Solid Waste Engineer Clyde Moore estimated Cedar Hills takes in about 800,000 tons of garbage per year, an average of more than 3,000 tons each day. Huge scrapers carry 30 tons of dirt per load to cover the growing mound of garbage and Zarek said all the garbage dumped in a day is usually covered that day.

But Cedar Hills neighbor Linn Emrich claims an area of one to two acres is usually uncovered when he has flown over the site. Zarek responded, "We do everything we can to meet the requirements (of cover)."

A portion of Cedar Hills is currently the dump site for the Ideal Paper Company, which hauls about 800 tons of refuse to the landfill daily, Walter Kinney, Cedar Hills landfill supervisor, said. Kinney said the company uses a separate site because its trailers are not compatible with the county's unloading equipment. The Ideal Paper Company site will not be covered until the hole it dumps in is full, said Kinney. That should take about three months.

Ideal Paper is owned in part by Warren Razore who also owns a 212-acre site adjacent to Cedar Hills. The property is

The King County Cedar Hills landfill, seven miles south of Issaquah, will be the final resting place of all of King County's and Seattle's solid waste within the next few years. Photo courtesy of Linn Emrich.

Pollution from waste oil suspected

Fig. 32 Newspaper article found in the Issaquah Press Newspaper. Written by Wendy Lippman January 21, 1981.

KING COUNTY WASTE MANAGEMENT TIMELINE

prior to 1958 Seattle-King County Department of Public Health manages the solid waste disposal system, dumping wastes in 15 open, unlined rural landfills across the County

early 1960s The proposed construction routes for Interstates 5 and 405 force the closure of several landfills

early 1960s The King County Sanitary Operations Department is organized to eztablish a solid waste transfer system to handle wastes that can no longer be accomodated at the rural landfills

mid 1960s Puyallup and Kit Corner Landfills closed

1965 The federal Solid Waste Management Act is passed in 1965

1965 The Cedar Hills Regional Landfill site is leased from the state and begins operation

1965 Houghton Landfill closed

1969 The King Country Sanitary Operations Department is renamed the King County Solid Waste Division and made a part of the Department of Public Works

1974 The River Basion Coordinating Committee prepares the first solid waste management plan for Seattle and King County which recommends:

- regional management of solid waste
- consolidation of functions into a single agency
- a fesibility study of an energy resource and recovery system, and construction of that system by 1981

1976 Resource Conservation and Recovery Act is passed, amending and replacing the federal Solid Waste Management Act of 1965; RCRA sets more stringent standards for lining landfills, providing daily cover, and putting higher priority on recycling

1981 RCRA and the newly adopted MFS require remediation and conformance measures at the Cedar Hills Regional Landfill

1981 Duvall La

Fig. 33 Timeline of CHRLF history

andfill closed

1985 Cedar Falls Landfill closed

1988 King County considers solid waste incineration, but decides not to pursue it in the 1989solid waste plan because of opposition from the public

1988 King County Council establishes an aggressive waste reduction and recycling goal of 50 percent in 1995 and 65 percent by the year 2000

1991 The National Association of Counties recognizes the Cedar Hills Regional Landfill for its best management practices

1993 Enumclaw Landfill closed

1994 Hobart Landfill closed

1995 The King County Council passes Ordinance 11949, which establishes the following policies:

- Once the Cedar Hills Regional Landfill closes, it will not be replaced with another landfill in King County, and the County will pursue waste export as its long-term disposal option
- The County will optimize capital investment and promote recycling and the marketing of recyclable materials
- The new waste reduction and recycling goal will be to "divert as much material as possible from disposal in a manner which reduces the overall costs of solid waste management to county residents and businesses, conserves resources, protects the environment and strengthens the county's economy"

1996 The King County Council passes Ordinance 12378, which establishes a policy that waste export should begin once the Cedar Hills Regional Landfill reaches capacity

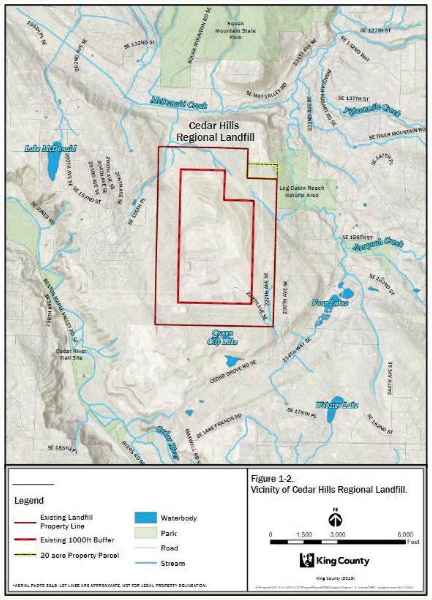
2002 Vashon Landfill closed


MACDONALD CREEK
SEATTLE
NEIGHBORHOOD
CHRLF
CEDAR RIVER
CEDAR GROVE COMPOSTING
RENTON

CONTEXT ANALYSIS

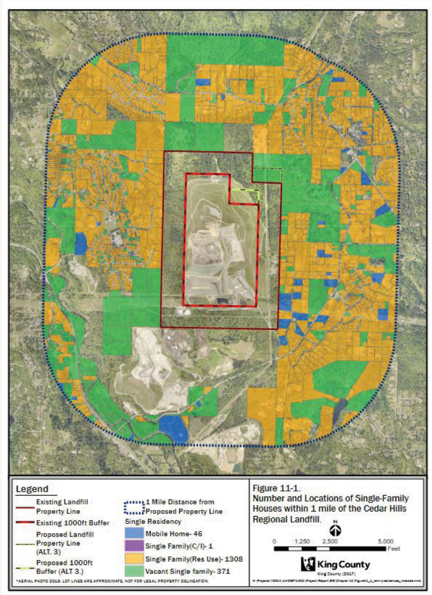
Fig. 34 Context map

ENVIRONMENTAL IMPACT STATEMENT ANALYSIS



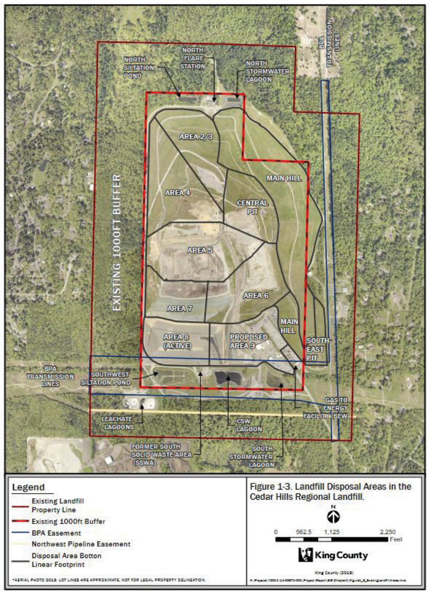
LOCATION

The Cedar Hills Regional Landfill property line shows the footprint of the landfill and the 1000 ft buffer surrounding th landfill. All of this land is owned by King County.



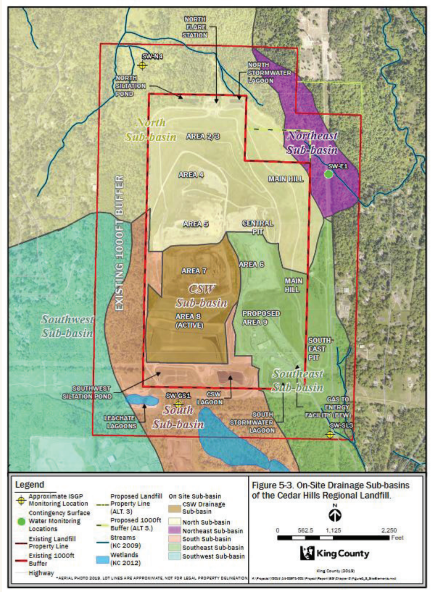
RESIDENTIAL AREAS

Zoning adjacent to the landfill includes mostly single family residential and vacant lots.



LANDFILL AREAS

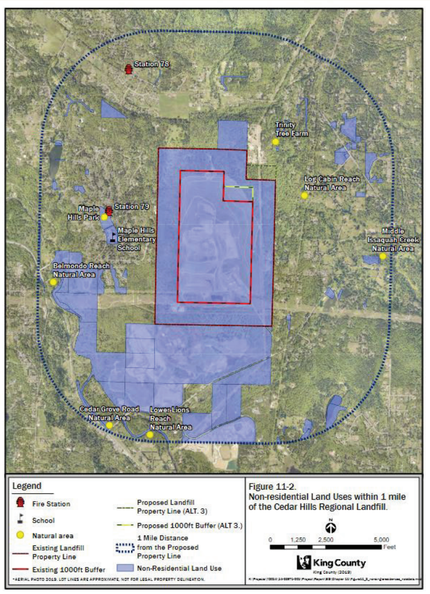
This map shows the different areas waste was dumped in the CHRLF. A more detailed analysis of these areas can be found on the next page.



SUB-BASINS

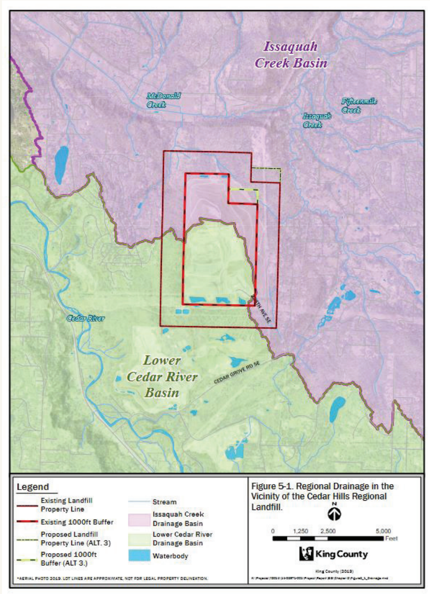
The dynamic topography created by the volume of waste has created several sub-basins shown here. Currently all stormwater is captured and held in retention ponds before being sent to the wastewater treatment plant.

Fig. 35 Images taken from the Cedar HIlls Regional Landfill EIS, prepared by Herrera Environmental Consultants, Inc. (2020)



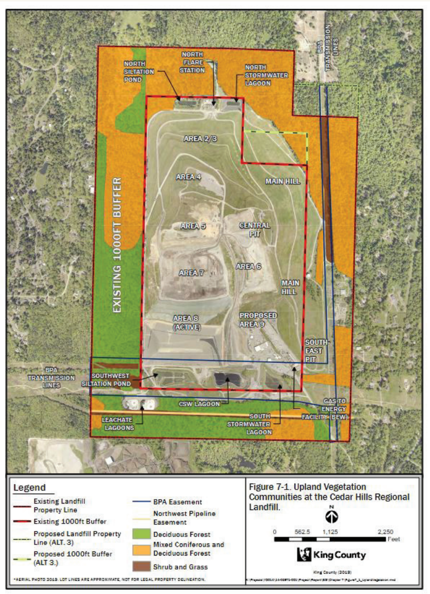
NON-RESIDENTIAL USES

Non-residential uses around the CHRLFinclude fire stations, a school, natural areas, and an industrial composting facility - Cedar Grove, which takes organic waste from King County.



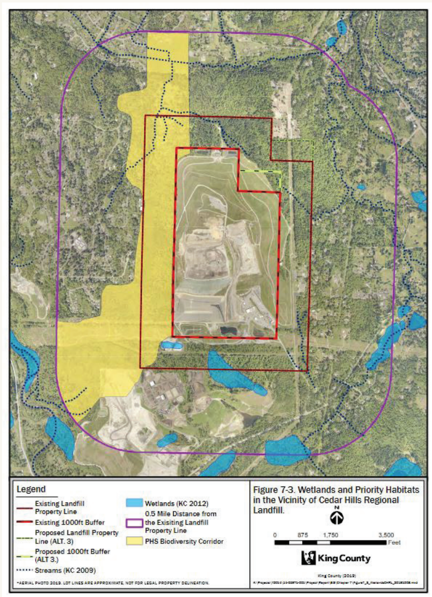
WATER BASINS

The CHRLF lies between two major river basins in King County - the Issaquah Creek Basin and the Lower Cedar River Basin. Stormwater from the site will affect two wate basins.



WOODLAND BUFFER

The 1000 ft woodland buffer consists of deciduous and coniferous trees, as well as some walking paths used by the surrounding communities.



HABITAT CORRIDOR + WATER

While the entire site is bordered by a decidous and coniferous woodland, there is a selinieated biodiversity corridor directly west of the landfill footprint. This map also shows wetland areas and streams.

Fig. 36 Site analysis map

WASTE AREA ANALYSIS

Over the past 50 years, the CHRLF has taken in an enormous volume of waste in both lined and unlined areas. Fig. 34 to the left shows the various waste areas of the CHRLF and their location. These designated areas designate where waste was placed during a specific time period.

Fig 35. Shows the specific waste area, when it was filled, how long it was filled, how much waste is currently in place, whether or not that area is lined, the settlement status of the area, and the operational status of the area. Currently, Area 8 is the ony operational area at the CHRLF and is slated to close in 2028. The Former South Solid Waste Area, Main Hill, and Southeast Pit are all unlined which poses a mjor environmental risk to the surrounding area. Areas 5, 6, and 7 are still in a settlement phase.

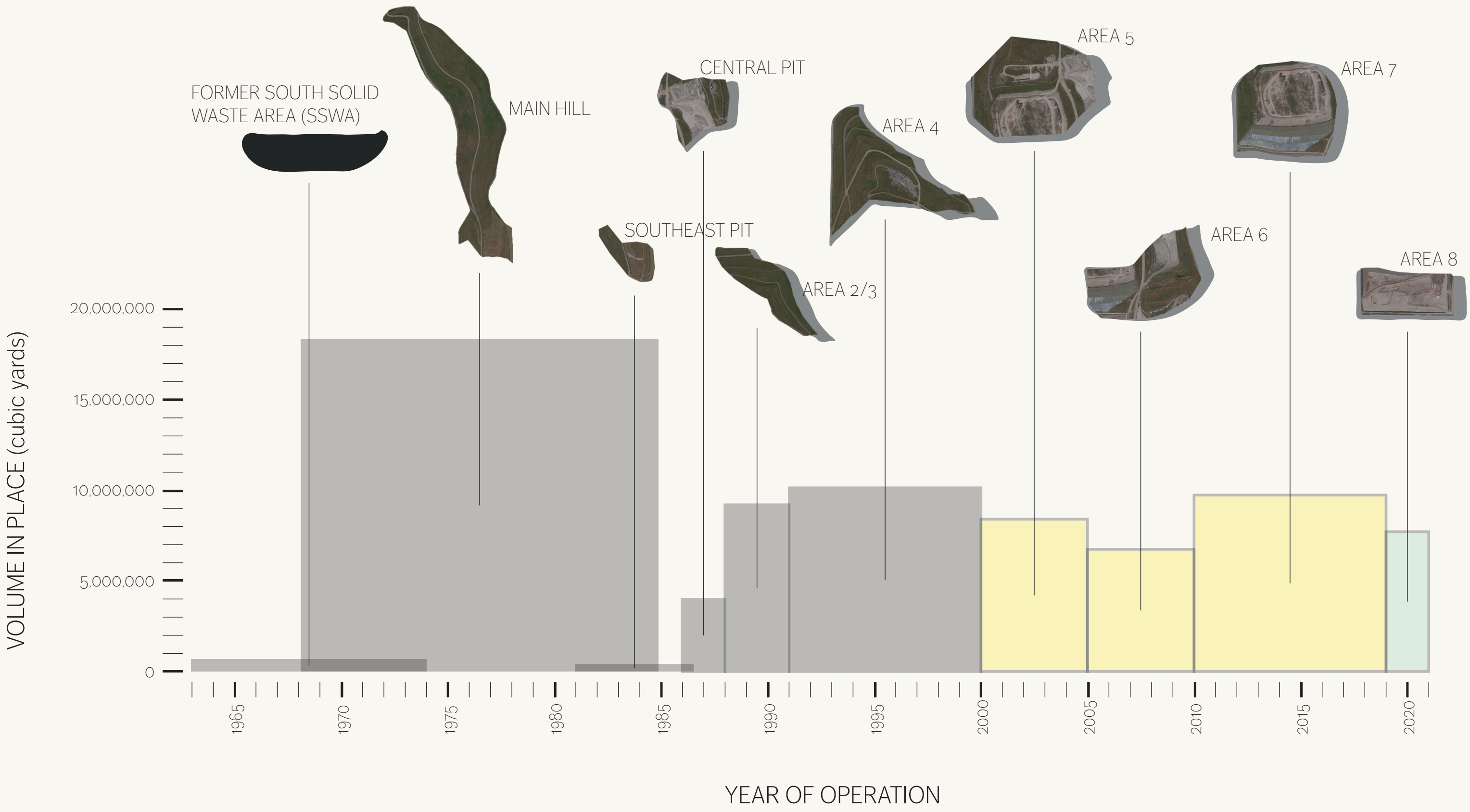


Fig. 37 Graph of CHRLF zones, volume in place, lined v. unlined, years of operations, and settlement status

CHRLF SITE PHOTOS

Fig. 38 Aerial view of the CHRLF with Seattle in the distance. Photo: King County.

Fig. 40 Bald eagles are common visitors, and nusiances, at the CHRLF. Photo:

Fig. 39 Daily opertaions with vies of Mt. Rainier. Photo: King County.

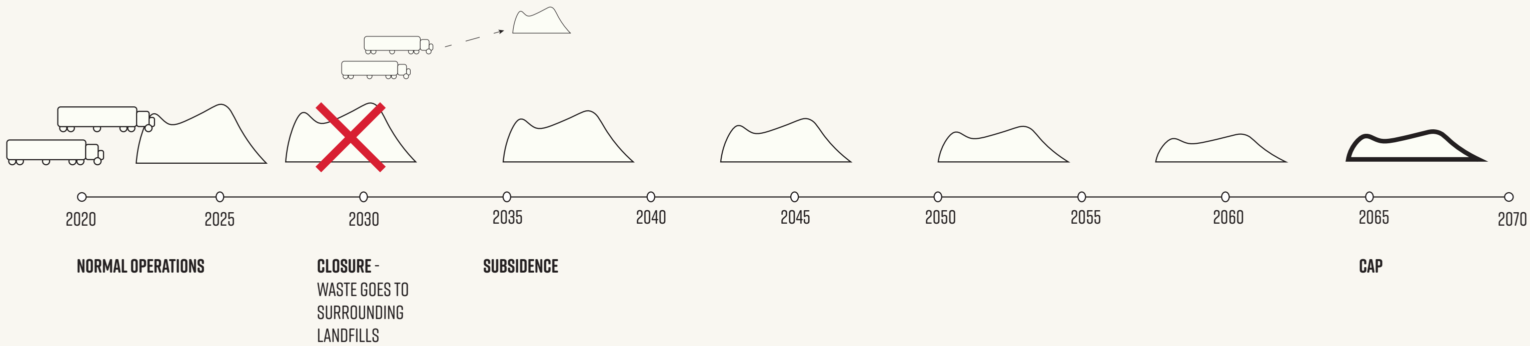
Fig. 41 A ‘tipper’ at the CHRLF empties waste into an open cell. Photo: King County

Fig. 42 Waste at the CHRLF is pushed into cells. Photo: King County. Photo: King County

Fig. 43 A bulldozer at the CHRLF with Mt. Rainier in the background. Photo: King County

PROBABLE

The most probable future, or the one most likely to happen, is that operations will continue as normal until 2028, when the landfill reaches capacity, and the permanent closure process will begin. MSW from King County will then be sent to other regional landfills by rail.[53] After the landfill is capped, the subsidence process takes about 30 years for the land to be safe and useable. The CHRLF can then be developed as open space or real estate. While this is the easiest and most economically feasible option, it fails to consider the capacity timeline for surrounding landfills, the low number of new landfills being built, and the future of waste management.



PLAUSIBLE

A plausible future is the construction of a Waste-to-Energy (WTE) facility – a technologically advanced and environmentally safe incineration plant that has the capability of extending the life of the CHRLF at least 50 years beyond 2028. Depending on the capacity of the WTE facility built, the CHRLF could begin processing its own waste and take in waste from other places. However, burning MSW still produces toxic fly ash that will eventually end up in the landfill. Incineration, while effective at reducing mass, does not halt the landfilling process altogether. Should the WTE facility be built at the CHRLF, it can only operate until the landfill reaches capacity – meaning that eventually, King County will need to either build a new landfill or start sending its MSW elsewhere. This scenario does not stop the possible future, but represents a delaying tactic.

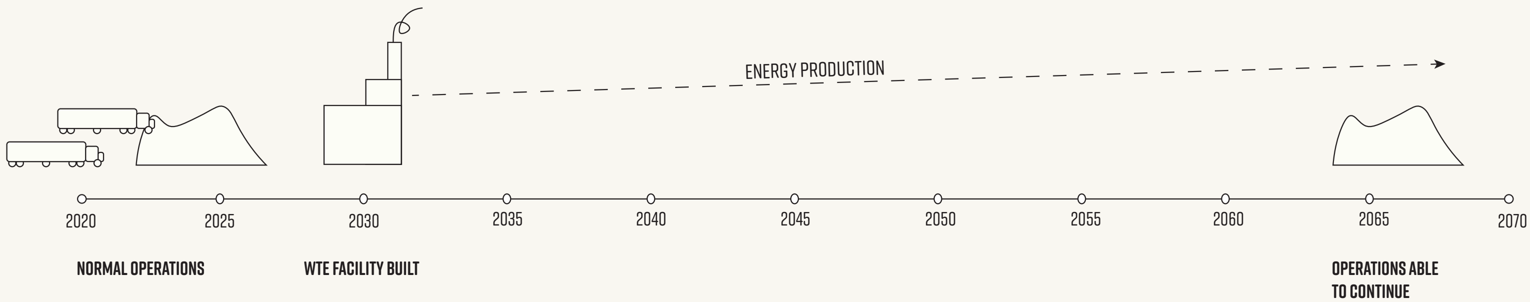


Fig. 44 Timeline diagrams of Irobable and plausible fututes.

LANDFILLS IN THE PACIFIC NORTHWEST

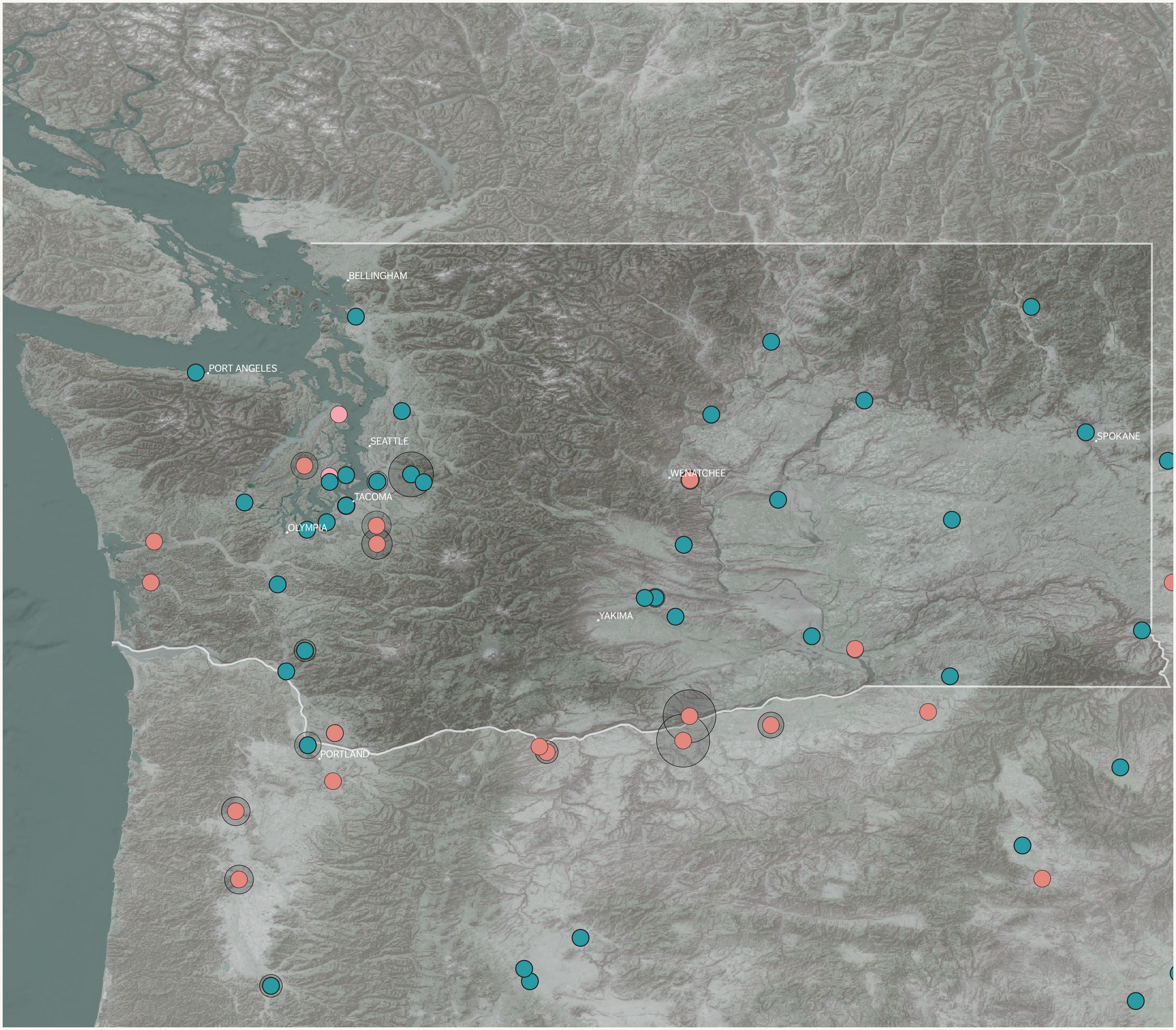
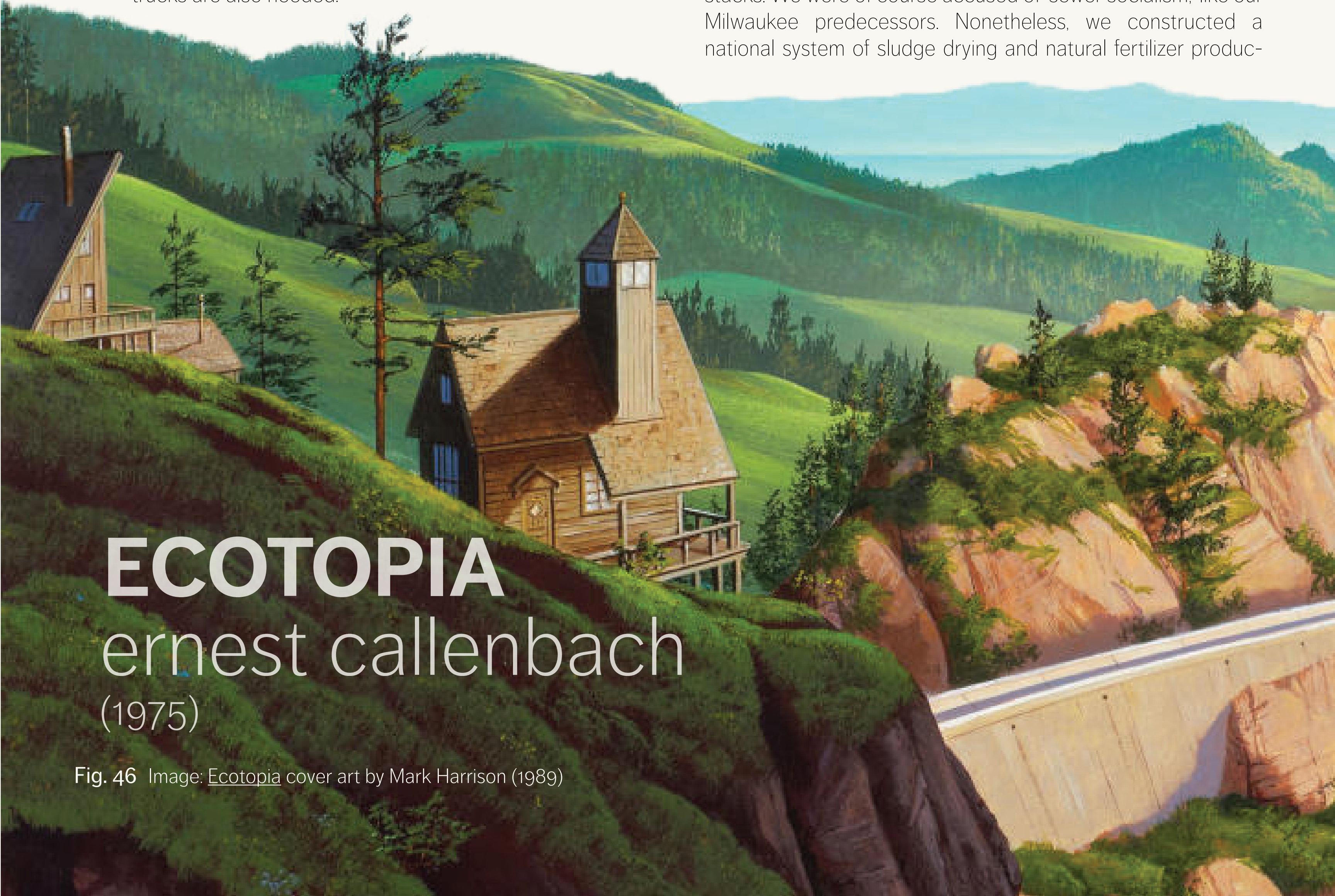


Fig. 45 Map of landfills in the Pacific Northwest showing operational status, size, and ownership type.

“…I squatted awkwardly, and began by asking my carefully prepared questions about Ecotopian agricultural output. These were ignored. Instead the Assistant Minister insisted on giving me “a little background.” He then began to discuss, not agriculture at all, but sewage. The first major project of his ministry after Independence, he said, had been to put the country's food cycle on a stable-state basis: all food wastes, sewage and garbage were to be turned into organic fertilizer and applied to the land, where it would again enter the food production cycle. Every Ecotopian household, thus, is required to compulsively sort all its garbage into compostable and recyclable categories, at what must be an enormous expenditure of personal effort; and expanded fleets of garbage trucks are also needed.

The Sewage system inherited from the past, according to the Assistant Minister, could only be called a “disposal” system. In it sewage and industrial wastes had not been productively recycled but merely dumped, in a more or less toxic condition, into rivers, bays and oceans. This, he maintained, was not only dangerous to the public health and the life of water creatures, but its very objective was wasteful and unnatural. With a smile, he added that some of the sewage practices of earlier days would even be considered criminal if carried out today.

“In my papers over there,” he said, “you can find historical reports of great sums being spent on incinerators to burn up sewage sludge. Their designers boasted of relatively smog-free stacks. We were of course accused of ‘sewer socialism,’ like our Milwaukee predecessors. Nonetheless, we constructed a national system of sludge drying and natural fertilizer produc-



ECOTOPIA

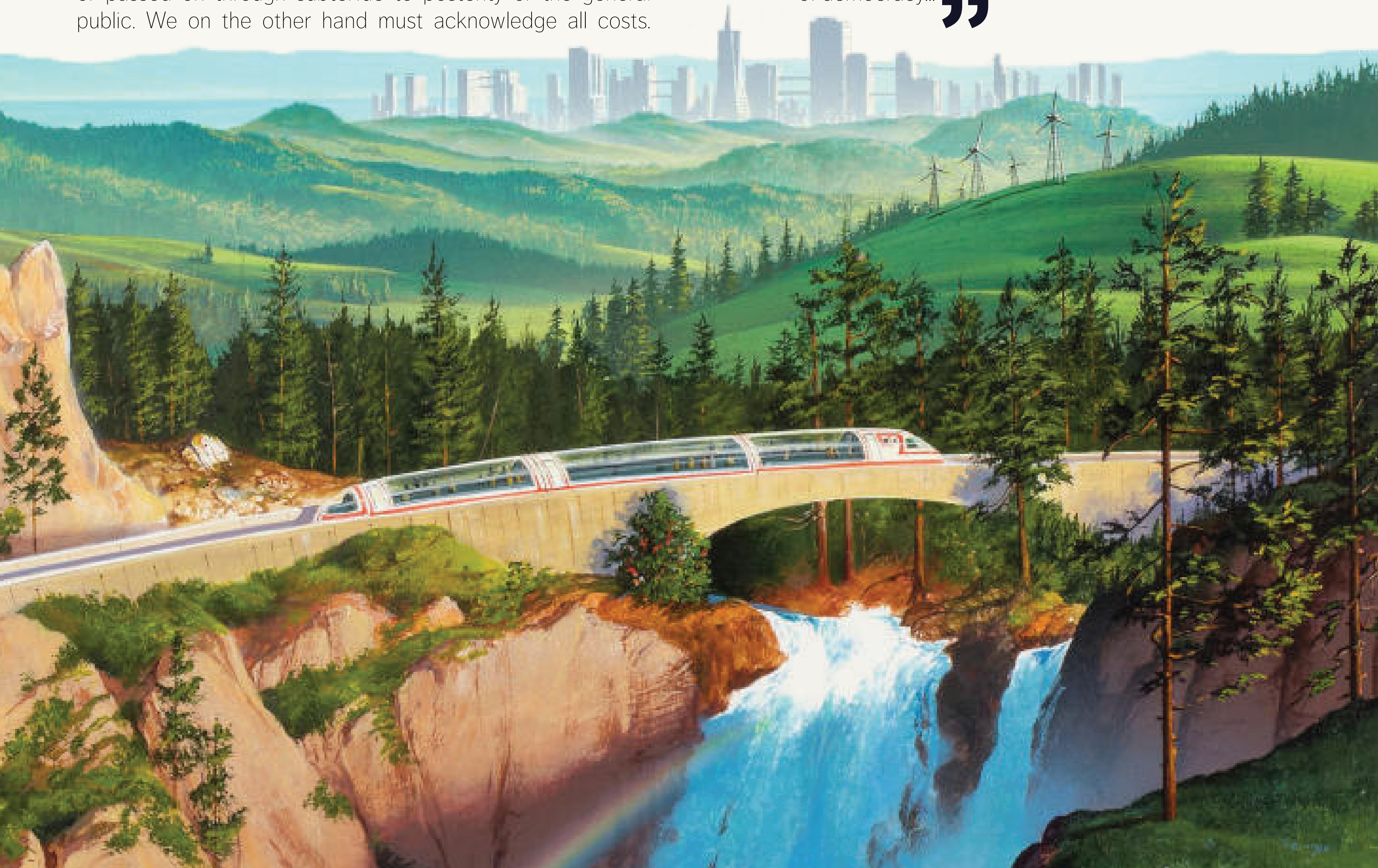
ernest callenbach

(1975)

Fig. 46 Image: Ecotopia cover art by Mark Harrison (1989) tion. After seven years we were able to dispense with chemical fertilizers entirely. This was partly through sewage recycling, partly through garbage composting, partly through reliance on some novel nitrogen-fixing crops and crop rotation, and partyl through methods of utilizing animal manure. You may have seen from the train that our farm animals are not kept in close confinement like yours. We like them to live in conditions approaching the natural. But not only for sentimental reasons. It also avoids the gigantic accumulation of manure which is such a problem in your feedlots and poultry factories."

Naturally, this smug account roused all my skepticism, and I questioned him about the economic drawbacks of such a system. My questions, however, met a flat denial. "On the contrary," he replied, "our system is considerably cheaper than yours, if we ass up all the costs. Many of your costs are ignored, or passed on through subterfue to posterity or the general public. We on the other hand must acknowledge all costs. Otherwise we could not hope to achieve the stable-state life systems which are out fundamental ecological and political goal. If, for instance, we had continued your practice of 'free' disposal of wastes in tercourses, sooner or later somebody else would have had to calculate (and bear) the costs of the resulting dead rivers and lakes. We prefer to do it ourselves. It is obviously not easy to quantify certain of these costs. But we have been able to approximate them in workable political terms- epecially since our country is relatively sensible in scale."

I obtained the detailed analyses on which his assertions are based, and have studied them at leisure. Extensive research would be necessary to confirm or disprove them. They do appear to be suprisingly hard-nosed. Of course the Ecotopian situation has allowed their government to take actions that would be impossible under the checks and balances of our kind of democracy... ”



05 | A POSSIBLE FUTURE

The possible future in which this thesis explores combines elements of the probable and plausible but radically reimagines the perceptions, policies, and economics surrounding our current waste management systems – creating the possible. Taking inspiration from ***Ecotopia,*** the setting for the Cedar Hills Regional Landfill re-design imagines a world in which people value waste as a resource and public utility, believe in circularity, and feel a responsibility to heal that which we have polluted. Keeping waste local and processing it in a sustainable way is a priority.

The CHRLF of the future combines **enhanced landfill mining** with **waste to energy** and **waste to material** technology to create a circular system in which both incoming waste and buried waste are a resource. People feel a responsibility to remove the harmful toxins they have buried in the earth and try to restore the superfund site. **Sorting and composting** waste before the incineration process, gives waste a chance at a second life. Much of waste sent to landfills is biodegradable food material that was never sorted in the first place. With an industrial composting facility directly to the south of the CHRLF, the nutrients in this material can be used again. **Combining this compost with fly ash from incineration**, will create a soil mixture that will then be placed back inside the landfill. The whole site can then be used as a research facility, a giant experiment, to conduct **phytoremediation trials** to begin the healing process. The CHRLF can then become a model for what landfills of the future can become.

The re-design has four main goals –

decentralize power

The feasibility of upkeeping a centralized infrastructure in the United States has greatly diminished. The increased likelihood of extreme weather events has turned the centralized infrastructure into a liability. Thus, the US will begin a process assessing the potential to decentralize this infrastructure wherever possible. The benefits of smaller scale infrastructure include an increased reliability on energy resources and responsibility of separate municipalities over their own resources.

diversify resources

Along with decentralization, a diversification of the US energy portfolio will be necessary to increase the reliability of various energy sources. Reliance on fossil fuels has proven dangerous to both the environment and the economy. The US, therefore, will begin to assess different renewable energy sources all over the country including but not limited to; wind, solar, hydro-thermal, and waste.

decrease waste

A social effort to decrease the number of single-use products will be necessary to decrease the amount of municipal waste generated. At this moment, waste projections far exceed the amount of landfill space left in the US. A severe limit on the creation of new plastics will incentivize new biodegradable technologies and reuse of existing materials before they find a final resting place in landfills.

degrade toxins

The existing number of plastics in the world have proven to be extremely dangerous to the health of our people and our planet. Therefore, resources will be dedicated to the assisted degradation science of plastics in order to help clean our planet and oceans.

strategy:

ENHANCED LANDFILL MINING

There are several different concepts and management techniques surrounding resource recovery in landfills that are currently under development and should be applied depending on community context; enhanced landfill mining, enhanced biodegradation, sustainable landfill, natural cap/catch, and temporary storage place. All these concepts fall under either ***in situ*** or ***ex situ*** resource recovery. Temporary storage place falls under both. ***In situ*** means that resources are recovered from the landfill without extraction whereas ***ex situ*** means resources are recovered with full or partial extraction of waste.[54]

Landfill mining (LFM) is the extraction of MSW from landfills for the purposes of removal, recycling, remediation of the landscape, or refilling. Landfill mining (LFM) is a relatively young technology that has recently regarded as a viable solution to decreasing land area for landfills and a way to reclaim materials without mining new land. Enhanced Landfill mining or ELFM is, "the safe conditioning, excavation and integrated valorization of landfill waste streams as both materials and energy, using innovative transformation technology and respecting stringent social and ecological criteria."[55] ELFM takes LFM one step further, and tries to use the extracted waste to create a closed loop material and energy system as well as contribute positive impacts to communities and ecologies.

Landfill mining roots can be traced back to scavenging and today can be considered a tool for ecosystem revitalization.

Fig. 47 Aerial photograph of landfill being mined. Photo: Eric Lawson, waste360.com

The first documented case of landfill mining was in 1953 in Israel as a means to reuse organic waste as fertilizer.[56] The European Commission's ***Roadmap to a Resource Efficient Europe*** states that waste should be managed as a resource rather than see as a material to be disposed of, recycling and reuse should become economically attractive, energy recovery should be limited to non-recyclable materials, and landfilling as we know it should be eliminated.[57]

LFM has been adopted as a feasible technology for the ecological remediation of old landfills.[58] The CHRLF is a site with ***in situ*** management practices. For example, there is an existing methane capture system on site, in which methane is converted to usable gas, available for resale. Harmful leachate on site is also treated before it is sent to a wastewater treatment plant. The CHRLF has the potential to combine existing ***in situ*** practices with ***ex situ*** Enhanced Landfill mining to excavate waste in place and reuse it for energy, or re-enter it within materials cycles.

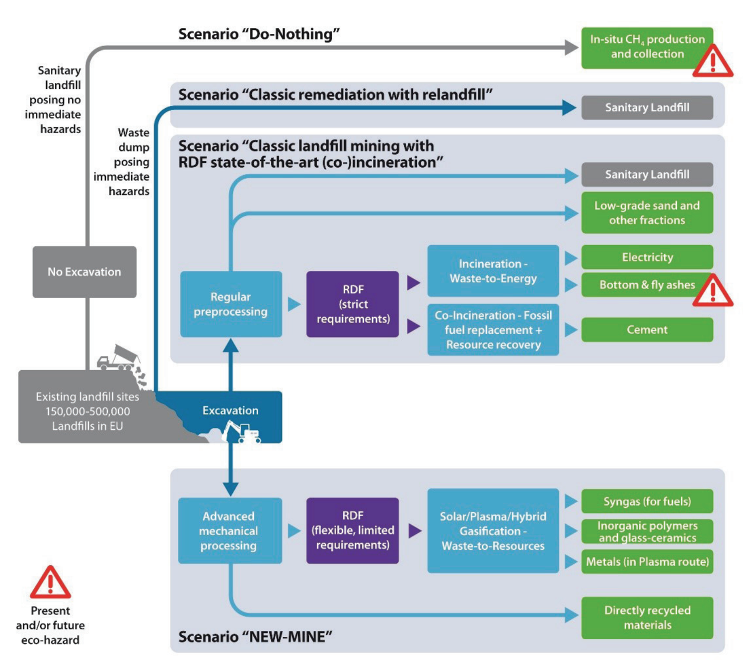


Fig. 48 Enhanced landfill mining scenario diagram from eurelco.org

strategy:

WASTE TO MATERIAL

In 1997, the town of Hague, New York underwent a research study to determine the benefits of combining composting with landfill reclamation techniques. The town wanted to find out if it would be economically feasible to mine their entire landfill, effectively eliminating it. It also aimed to assess whether or not extensive sorting and composting of the waste would improve heating value at a Waste-to-Energy Plant. Overall, the report concluded that, "...reclamation would be a technically and economically feasible alternative to conventional closure."

The study found that mining the landfill, sorting through materials, and setting out the waste in "windrows" to compost led to an average net decrease in weight of about 31% and a decrease in material that would need to be sent elsewhere for processing of 17%. The recovered compost soil met policy standards for Class I compost in New York State, however, cannot be used as food-grade compost because of the presence of small pieces of plastic, glass, and metal that are difficult to remove. Still, the compost can be used as backfill and as landfill cover.[59]

Initial testing of the heat value of the sorted waste showed that it had a higher heat value than unsorted waste. However, the second test, after two more months had passed, did not show any significant differences between the heat value of sorted vs. unsorted waste. If anything, the sorted waste was more difficult to burn. The report says that this low heating value could be due to how much moisture the waste had accumulated from sitting in the windrows, being rained on for months. So, conclusions about the difference in heat value is still not known.

Overall costs of sorting and composting the waste material was compared to costs of normal operations. Because the primary cost in operating a landfill is associated with the transportation of materials, significantly reducing the weight of these waste materials will decrease the overall cost of disposal. The report found that a full-scale composting operation at the Town of Hague landfill would see a net decrease in disposal fees of about 11%.

The reports general findings also concluded that there was no significant odor impact from the windrows or loose trash blown around because the windrows were packed tightly. Leachate was also found not to be a concern, as long as the windrows were sited on the landfills existing footprint. The Town of Hague is still operating it's landfill and despite the success of the findings, these practices have yet to be applied to landfills around the nation.

Fig. 49 Composting windrows. Photo credit: Allison Fortner, soil3.com

strategy:

WASTE TO ENERGY

Waste to Energy (WTE) or incineration technology has had a contentious history in the US and abroad. It essentially involves burning MSW to create heat as an energy source which can then be used by surrounding municipalities. While it may seem like a great solution, burning MSW means burning materials that are not safe to inhale. Old incineration plants would burn MSW in mass, leaching toxins into the air and severely impacting the health of the people and environment around it. Because of this, popularity of WTE has risen and declined over time. Technological advances however have created a WTE technology that can clean the toxins before exhausting them into the atmosphere. This technology has been successfully implemented and operated in places like Denmark and Germany. Normandeau Associates, Inc., an environmental consulting agency, states, "Modern WTE facilities continue to advance toward the goals of sustainability, which include significant reductions in emissions (air, water, and solids), reduced use of water, chemicals and reagents, improved recovery of energy, metals and minerals from bottom ash enabling the utilization of the bottom ash as an aggregate, and improved benefits to the local and regional communities that use the facilities."[60] Although these technologies do exist in some places in the US, past perceptions of WTE have inhibited their successful come back.

The ***Waste-to-Energy (WTE) Options and Solid Waste Export Considerations*** report completed for King County by Normandeau and Associates, Inc. indicated that the "best fit" technology to process the County's waste "is a thermal process that uses grate combustion with a waterwall boiler" or simply put – massburn which entails burning MSW in mass without sorting.[61]

The advantages of building a WTE facility at the CHRLF include reduction of landfill volume, reduced need for landfilling, improvement in air quality, reduced risk to surface and groundwater, increased economic performance, WTE-derived energy to benefit the surrounding community, improved societal impacts through cheaper energy and environmental improvements, and integration with other waste management options to understand the full advantages offered by WTE.

Disadvantages of building a WTE facility at the CHRLF include high capital cost, need for backup/supplemental landfill capacity, limitations on steam and electricity markets, publicly available information on modern WTE capabilities, variability in methods for accounting of GHG emissions, need for consistent, long-term flow as input to WTE facilities, and impact on community recycling goals/performance.

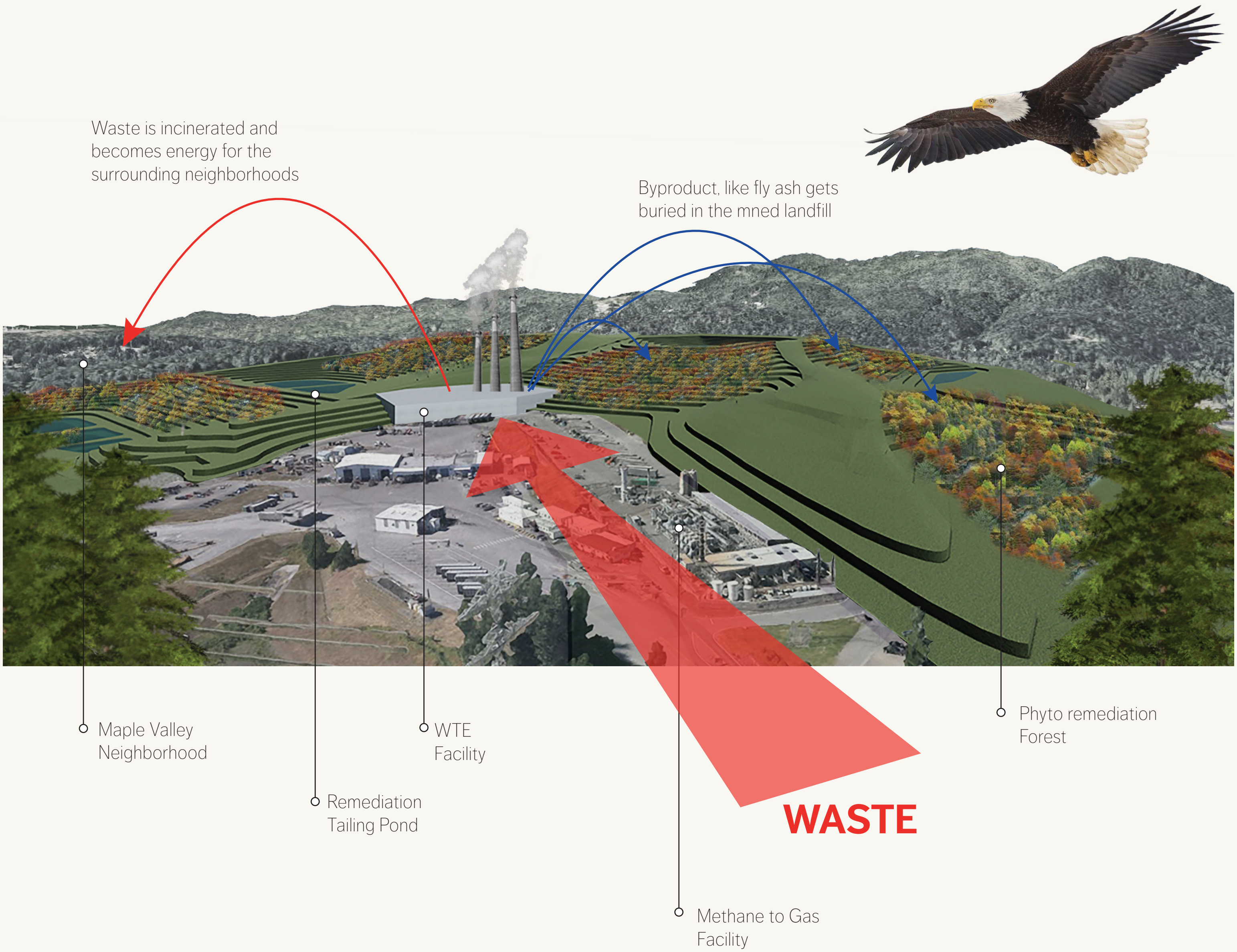


Fig. 50 Perspective diagram showing location of Waste to Energy Plant and waste to energy flow.

strategy:

[RE] LANDFILL

Although WTE and WTM will result in a significant loss in total landfill volume, the process results in a large amount of fly ash – the toxic byproduct of incinerated waste. Of the total volume of waste incinerated, there will only be about a third reduction in total volume, meaning there will be a significant amount of hazardous and toxic material to place back into the landfill.

The design proposes mixing fly ash with compost and placing it back into the landfill in a way that will create several "mini" watersheds. This design pattern mimics that of a traditional mining pit, with tailing ponds at the bottom meant to capture water from each watershed for remediation. This terraced aesthetic recalls that this is a disturbed but productive site. This space has gone through phases of storage to reclamation to regeneration.

The refilling of the landfill will occur in tandem with landfill extraction. The site will be constantly undergoing change. While the terraced watersheds are built up, the actual landfill will be dismantled. Even the terraces themselves may not be permanent. Depending on revitalization of the soil and phytoremediation techniques. The overall look of the site might change from a harsh edged, terraced landscape to a more smoothed out depression over a long period of time. This change can only take place with generations of careful land management and planning.

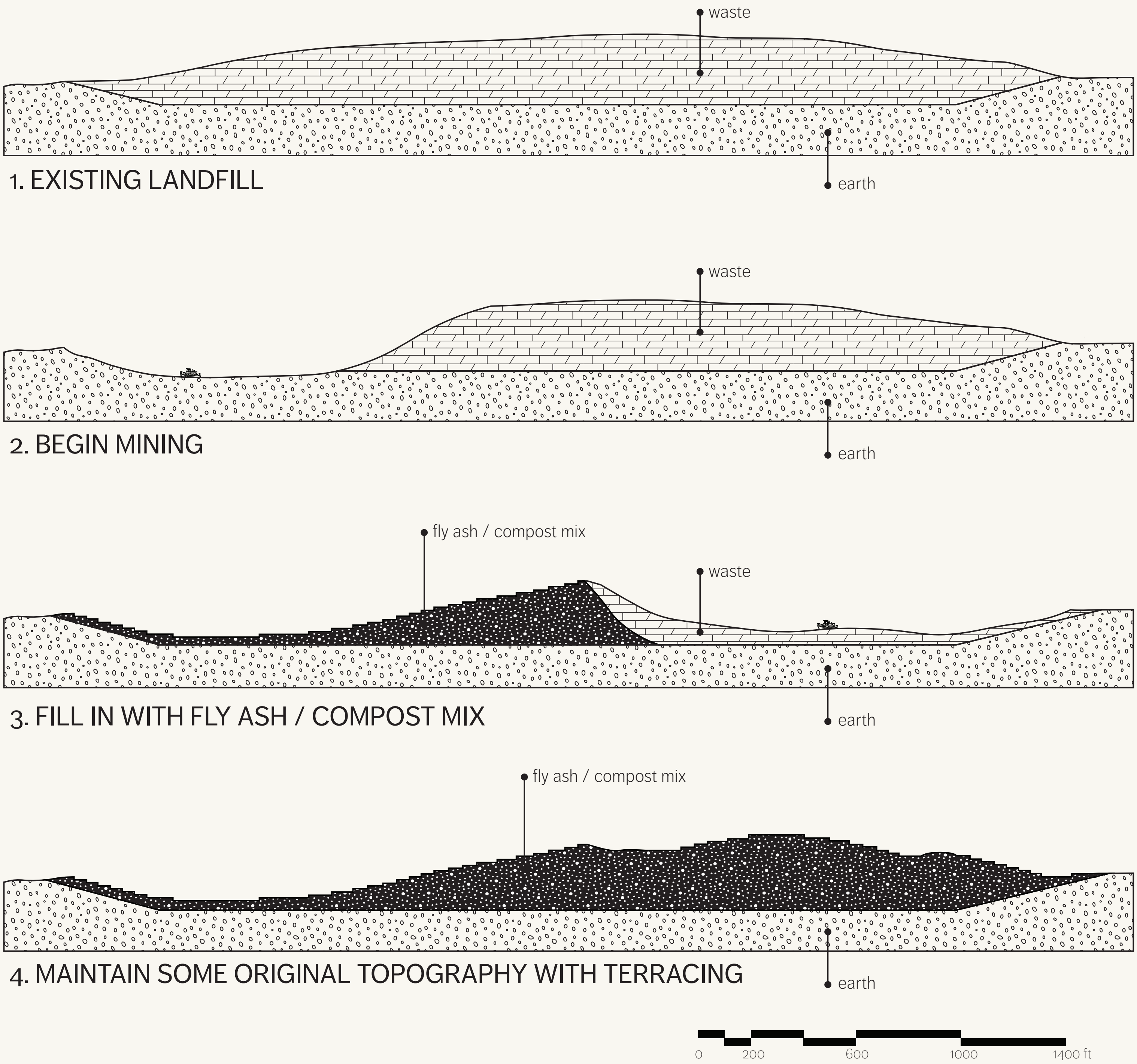


Fig. 51 Section-Diagram showing landfill mining scheme

strategy:
PHYTOREMEDIATION

While an ideal design goal for the site would be to plan a natural remediation process that would require little human intervention, the site is so heavily disturbed and polluted that it will require management for many years to come. This however, does not mean we should not strive to take care of the site until it can potentially become naturally stable. To do this, the CHRLF will be considered an experimental site or a 'living laboratory' to conduct and research various phyto-rehabilitation methods in order to deplete the amount of toxic chemicals and heavy metals in the soil.

There is limited research on the potential to remediate soil with fly ash. Fly ash, the byproduct of incineration of waste and other materials, is extremely toxic. It contains high concentrations of metals and organic pollutants that will leach into the soil, air, water, and impact human health if left untended.

Fly ash can also be used as a construction material, backfills for road constructions and pavement base, for cement and brick manufacturing, filler in asphalt mixture, soil stabilization as cover suitable for soil reclamation, material recovery, manufacturing mineral wool, and zeolite synthesis.[62]

Fig. 52 before and after photos of terraced quarry restoration in Italy

“Generally, there is a gap between researchers in laboratories under controlled conditions and a ‘real field scenario’ where plant species grow and survive in a polluted environment. The future prospects in phytomanagement of fly ash deposits and mine waste sites require better knowledge of native species that are the best adapted to local region which is important for maintaining ecosystem services and quality of human life. Studies about plant community structure, functional characteristics of ecosystems, biogeochemical cycles, and natural selection are considered significant for ecosystem integrity and resilience.”

Authors of Ecological Potential of Plants for Phytoremediation and Ecorestoration of Fly Ash Deposits and Mine Wastes (2018)

A New Story for the Cedar Hills Regional Landfill

In a phased approach, waste will be extracted, sorted, composted and either sent away for further processing to re-enter the raw materials stream, or incinerated to create energy. The CHRLF has enough lined areas to be able to safely sort though and compost extracted waste on site, without risk of toxins leaking into the surrounding environment.

The redesign for the CHRLF, as an experimental and regenerative site, will include all of these practices. After waste is mined from the landfill, it will go through an initial sorting process (some type of machine) where as much larger inorganic material will be removed from organic material as possible. This organic material mostly comprised of soil, food waste, and yard waste will be sorted into windrows on the landfill footprint, right at the edge of the mine site. They will be left alone, but monitored, for two months before going through a final sorting process. All solid waste will be sent to the WTE facility for energy extraction and the rest of the compost will be mixed with fly ash from the WTE facility and "dumped" back into the landfill.

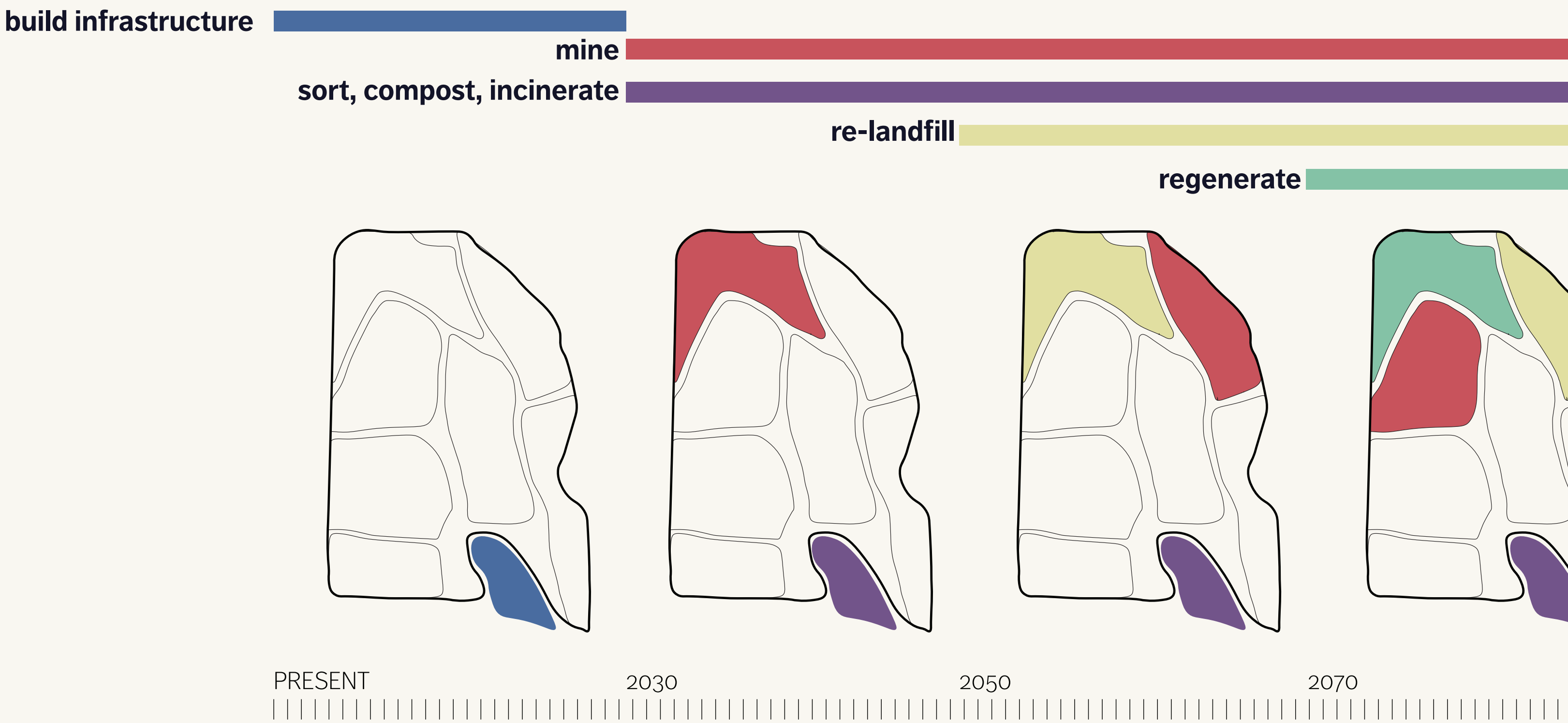
The new WTE facility will be sited in the southeastern portion of the site where the existing structures are currently sited. The plant is nestled into the hillside, making it a seamless part of the landscape. The green roof looks like an extension of the landscape above it, with the exception of several smoke stacks, which release exhaust. Several other buildings sit next to the WTE plant, containing sorting and material recovery facilities, a space for a flea market, and research offices. This space makes up the "hub" of the site – a space for both daily operations of the landfill and people to reclaim materials from the landfill.

Although WTE and WTM will result in a significant loss in total landfill volume, the process results in a large amount of fly ash – the toxic byproduct of incinerated waste. Of the total volume of waste incinerated, there will only be about a third reduction in total volume, meaning there will be a significant amount of hazardous and toxic material to place back into the landfill.

The design proposes mixing fly ash with compost and placing it back into the landfill in a way that will create several “mini” watersheds. This design pattern mimics that of a traditional mining pit, with tailing ponds at the bottom meant to capture water from each watershed for remediation. This terraced aesthetic recalls that this is a disturbed but productive site. This space has gone through phases of storage to reclamation to regeneration.

The refilling of the landfill will occur in tandem with landfill extraction. The site will be constantly undergoing change. While the terraced watersheds are built up, the actual landfill will be dismantled. Even the terraces themselves may not be permanent. Depending on revitalization of the soil and phytoremediation techniques. The overall look of the site might change from a harsh edged, terraced landscape to a more smoothed out depression over a long period of time. This change can only take place with generations of careful land management and planning.

The landfill “watersheds” will be comprised of a landscape entirely built from a fly ash / compost soil combination. Each watershed will host a different combination of plants known to have phyto-rehabilitating properties, providing a unique opportunity for researchers to conduct phytoremediation trials in a somewhat controlled environment. Tailing ponds at the bottom of each watershed provide opportunities for water sampling and hydro-restoration.



phase 1.

BUILD INFRASTRUCTURE

All material recovery facilities will be built in the first phase of the project. This includes all sorting infrastructure and the Waste to Energy plant. All infrastructure will be located in the Southeastern corner of the CHRLF, where all buildings and landfill infrastructure are currently located. All existing buildings will be repurposed and retrofitted to fit the needs of a landfill turned mining site.

phase 2.

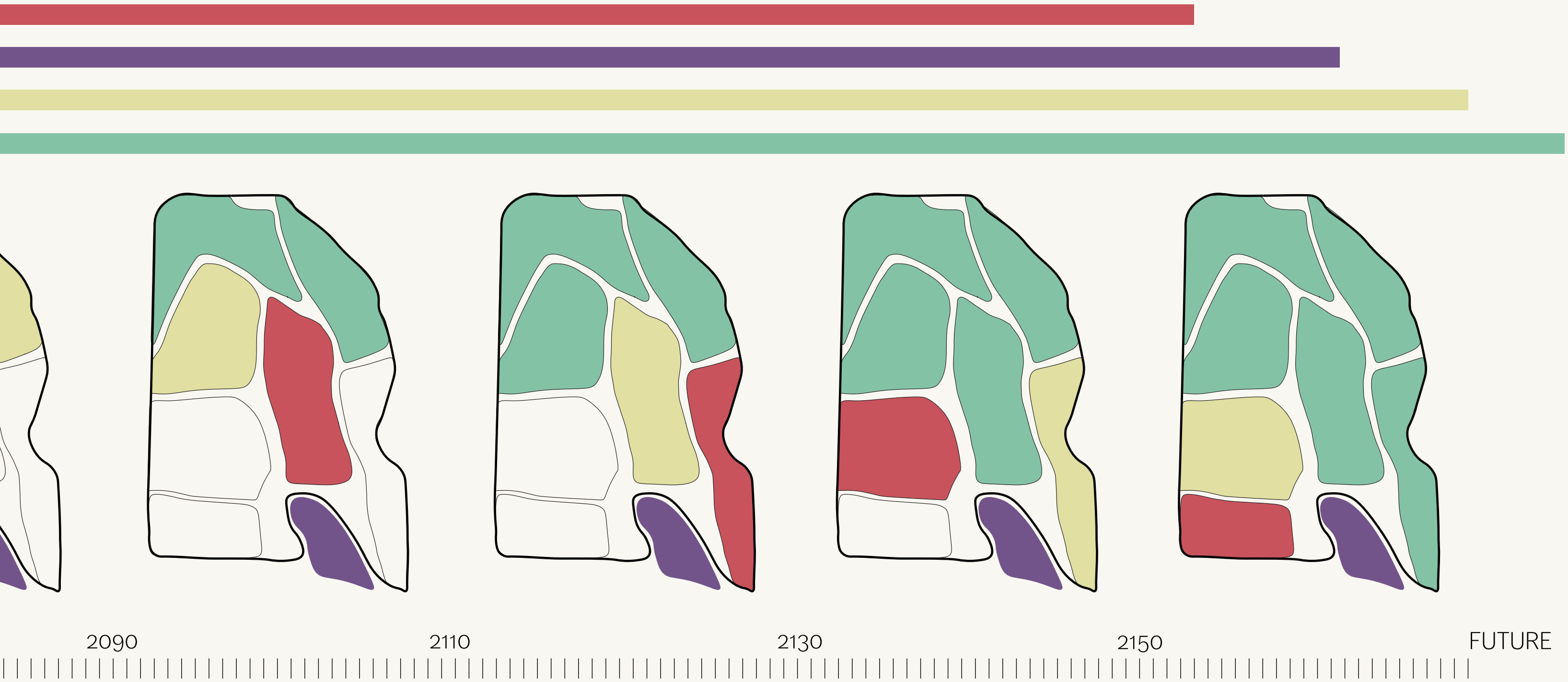
MINE

Landfill mining will begin after the completion of Phase 1 and continue over many years, until the entire CHRLF is mined. Mining will begin in the Northwestern corner of the site and continue mining the site in sections that are based on the CHRLF waste areas.

phase 3.

SORT, COMPOST,

Phase 3 begins in tan
waste is mined, it is tran
built in Phase 1. Waste
and non-organics. Orga
windrows and left to co
of the site. Non-organic
recyclables and combu
sent to a recycling fa
are incinerated at the V
into energy that will b
facilities and supplemen
surrounding communitie



, INCINERATE

dem with Phase 2. As
nsported to the facilities
is sorted into organics
nics are organized into
mpost on a lined portion
s are further sorted into
stibles. Recyclables are
cility and combustibles
WTE plant to be turned
be used to power the
nt energy needed by the
es.

phase 4.

RE-LANDFILL

Phase 4 begins after Phase 2 and 3 begin, but will eventually operate concurrently with them. After waste is incinerated, fly ash byproduct and compost will be mixed together to create a structural and toxic soil that will then be returned to the landfill. This land will then be formed to create several watersheds with stepped topography, reminiscent of mined quarries.

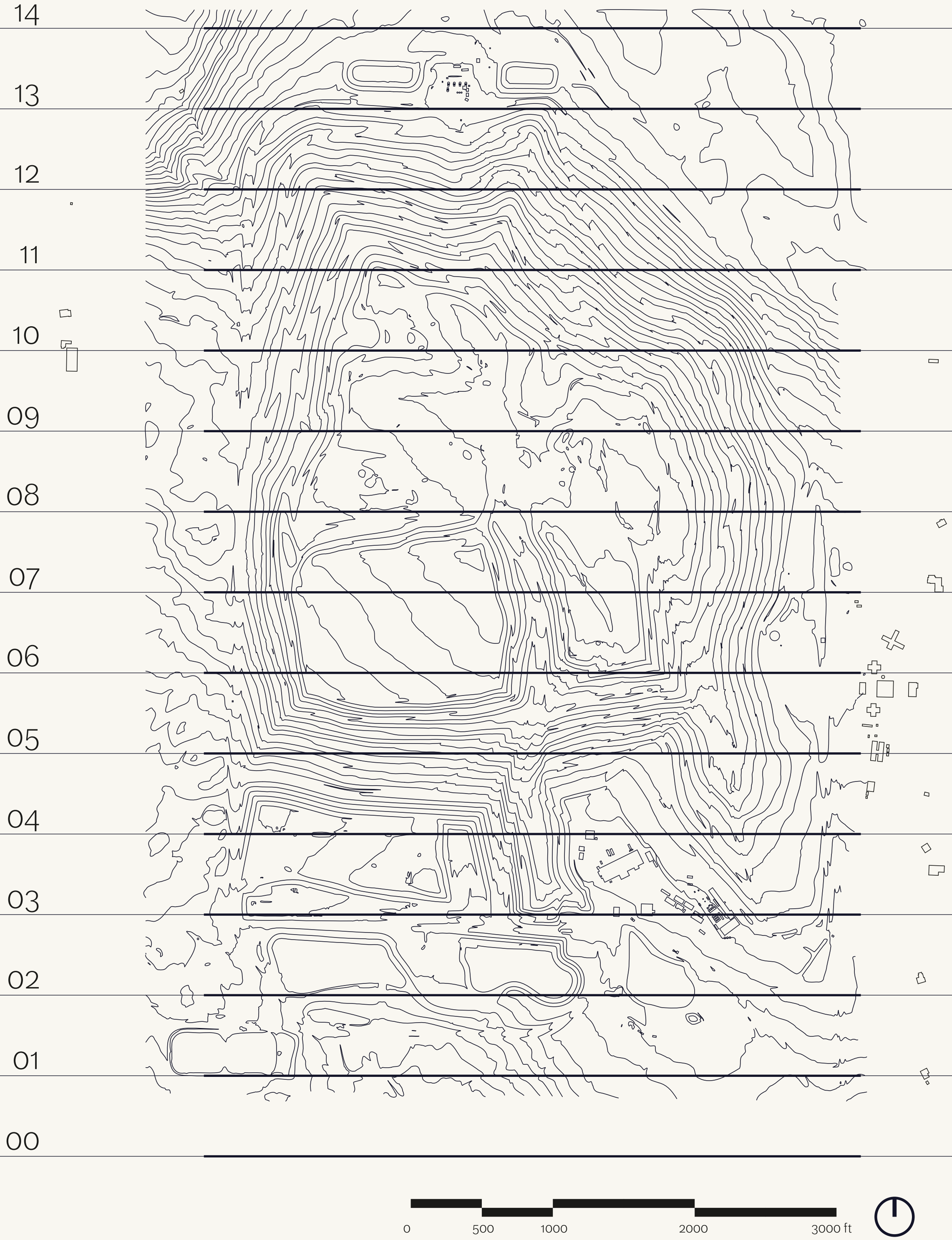
phase 5.

REGENERATE

The watersheds constructed in Phase 4 can then be used as a somewhat controlled environment to conduct essential research on fly ash phytoremediation technologies. This step is meant to attract prominent scientists and create jobs for the local community.

Fig. 53 Phasing diagram of landfill management over time

CHRLF topography before Strategy Implementation



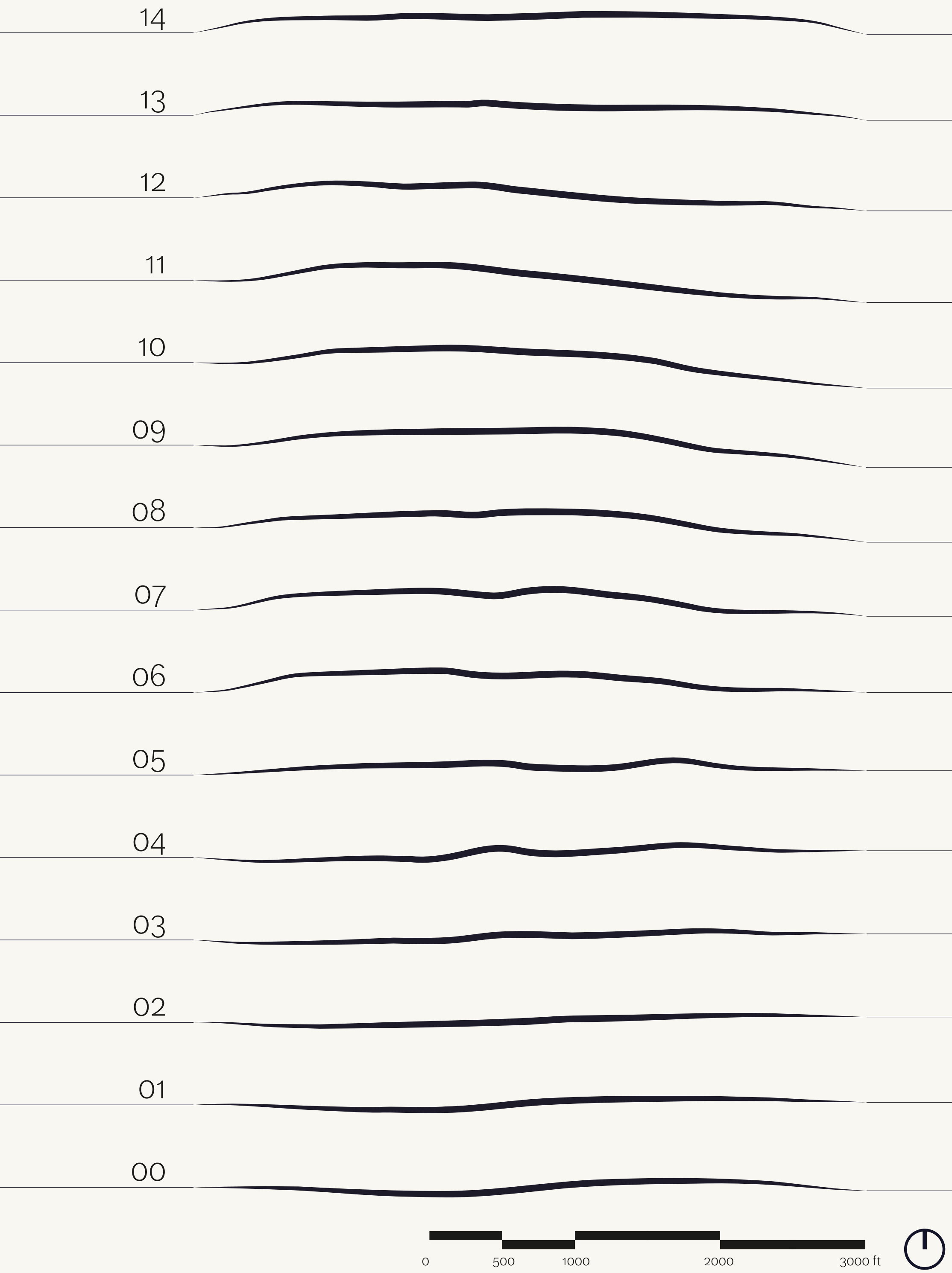
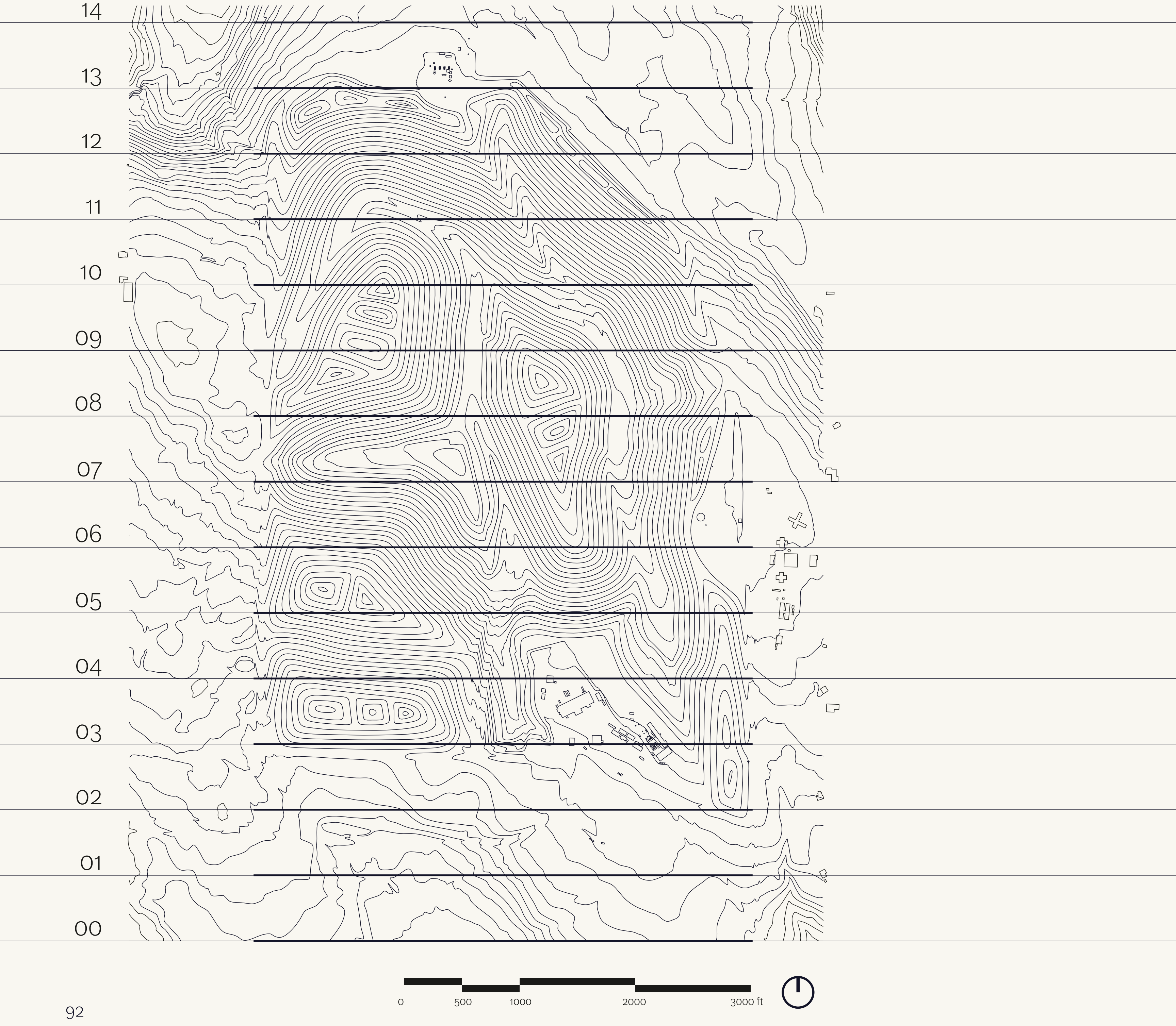


Fig. 54 Shows the exisitng topography of the site in plan and in 14 sections across the site.

CHRLF topography after Strategy Implementation



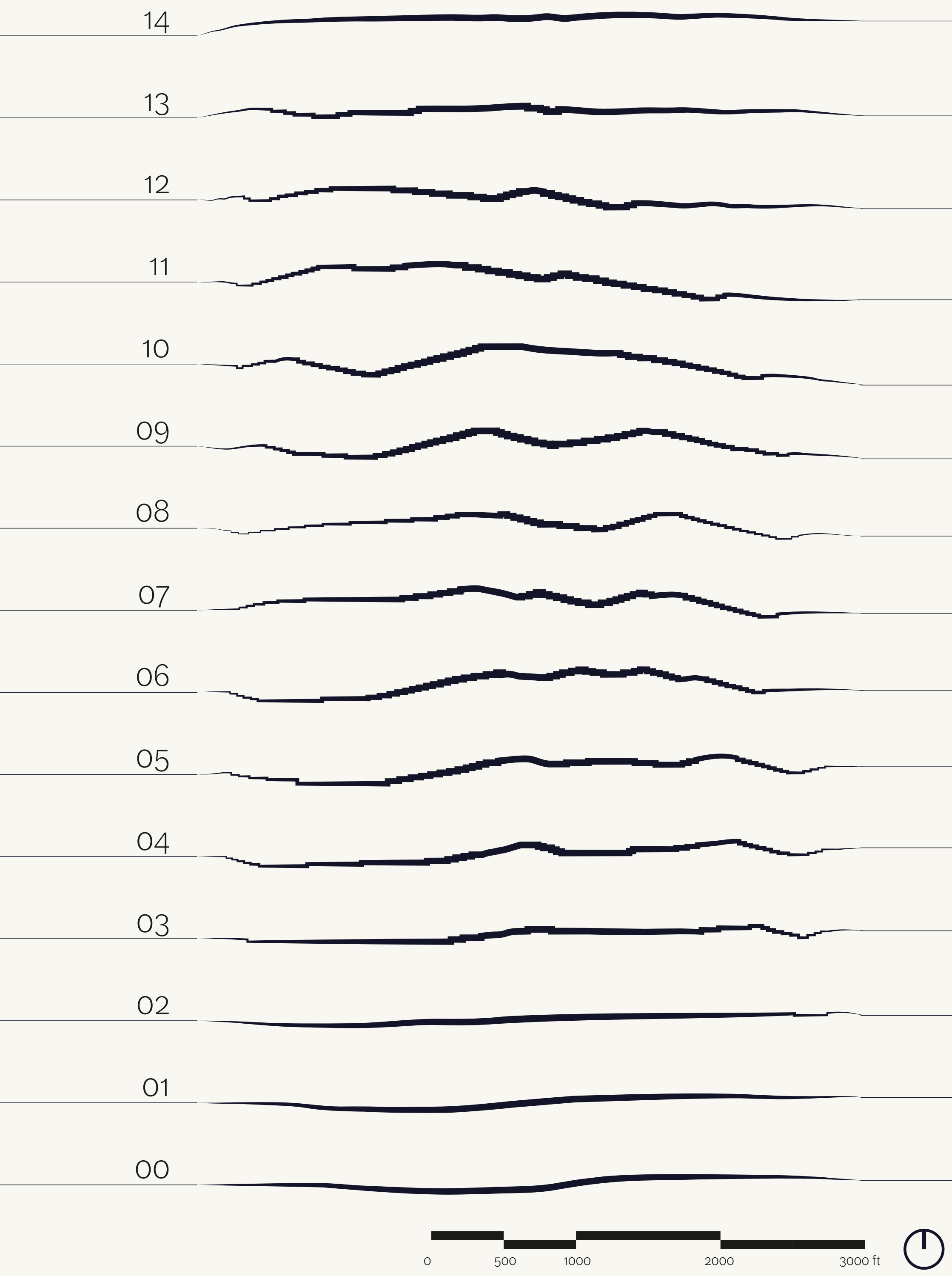


Fig. 55 Shows the proposed topography of the site in plan and the same 14 sections of the previous diagram. Depressions are formed in the land from mining, but the topography is built up with the fly ash/compost byproduct from WTM and WTM operations. The proposed topography maintains some of the high points and some of the original topography for the circulation routes.


REMEDIATION WETLANDS
PHTYO-REMEDIATION PLANT COMMUNITIES
RESEARCH WATERSHED
CIRCULATION ROUTE
TAILING PONDS
TERRACED SLOPE
WTE PLANT
RESOURCE RECOVERY FACILITIES
REMEDIATION WETLANDS
0
500
1000
2000
3000 ft

Plan of Completely Mined and [Re] Landfilled CHRLF

RESEARCH WATERSHED

The mined and [re] landfilled site will be shaped into several different depression zones, resulitng in 8 distinct RESEARCH WATERSHEDS. The purpose of these watersheds is to study the phyto-remediating capacity of diffrent plant communities.

TAILING PONDS

Each RESEARCH WATERSHED will have several TAILING PONDS a the bottom to collect all of the stormwater from the watershed. Water will move through different ponds in steps to be remediated. Researchers will be able to test water quality within the different ponds to monitor the effectiveness of the treatment.

PHYTO-REMEDIATION PLANT COMMUNITIES

Various plant communities will be grown with the purpose to research their impact on soil contamination. Each RESEARCH WATERSHED can contain multiple different plant communities that will be concentrated in different areas, creating an environment in which researchers will be able to control some of the conditions.

REMEDIATION WETLANDS

A series of constructed wetlands at the north and south of the site capture stormwater from the site. As water is cleaned by the various TAILING PONDS, it is piped into either the Northern or the Southern wetlands for further remediation before entering the local water sources

Fig. 56 Plan view of fully mined and restored landfill site

CIRCULATION ROUTE

Trucks, construction equipment, and other vehicles required to move people and waste across the site will be able to use the circulation route shown in brown on the plan. This route connects all of the watersheds and the edges of the site. The topography of the route is the same as the original landfill, helping to create a shape of what once was.

TERRACED SLOPE

As the site is [re] landfilled, the fly ash/compost soil mix will be formed into terraces that will create the RESEARCH WATERSHEDS and house the PHYTO-REMEDIATION PLANT COMMUNITIES. The terraced form is reminiscent of a mined landscape, reminding visitors that this is a heavily managed and manipulated, productive landscape.

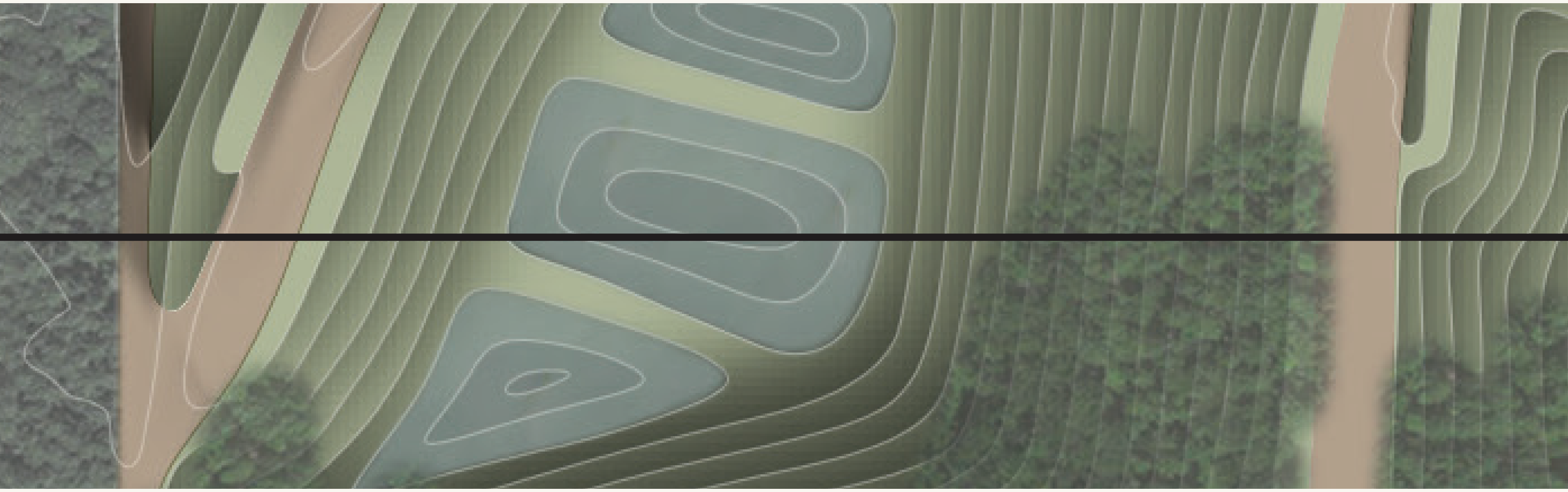
WTE PLANT

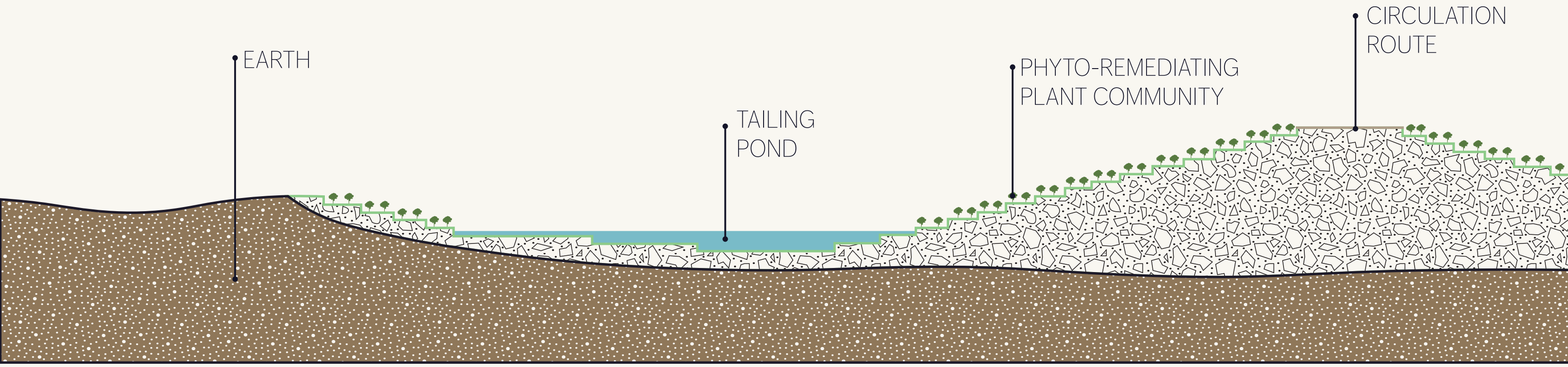
The WTE plant will be built on the part of the site that already houses many of the landfill facilities and has not been filled with waste. The close proximity of the plant to Zone 8 (the last active zone of the CHRLF) means that incoming waste will not have to travel far before being incinerated.

RESOURCE RECOVERY FACILLITIES/WTM

Additional buildings and facilities will be repurposed from exisitng buildings on the site for all resource recovery activities including sorting and composting.

Section Cut 09





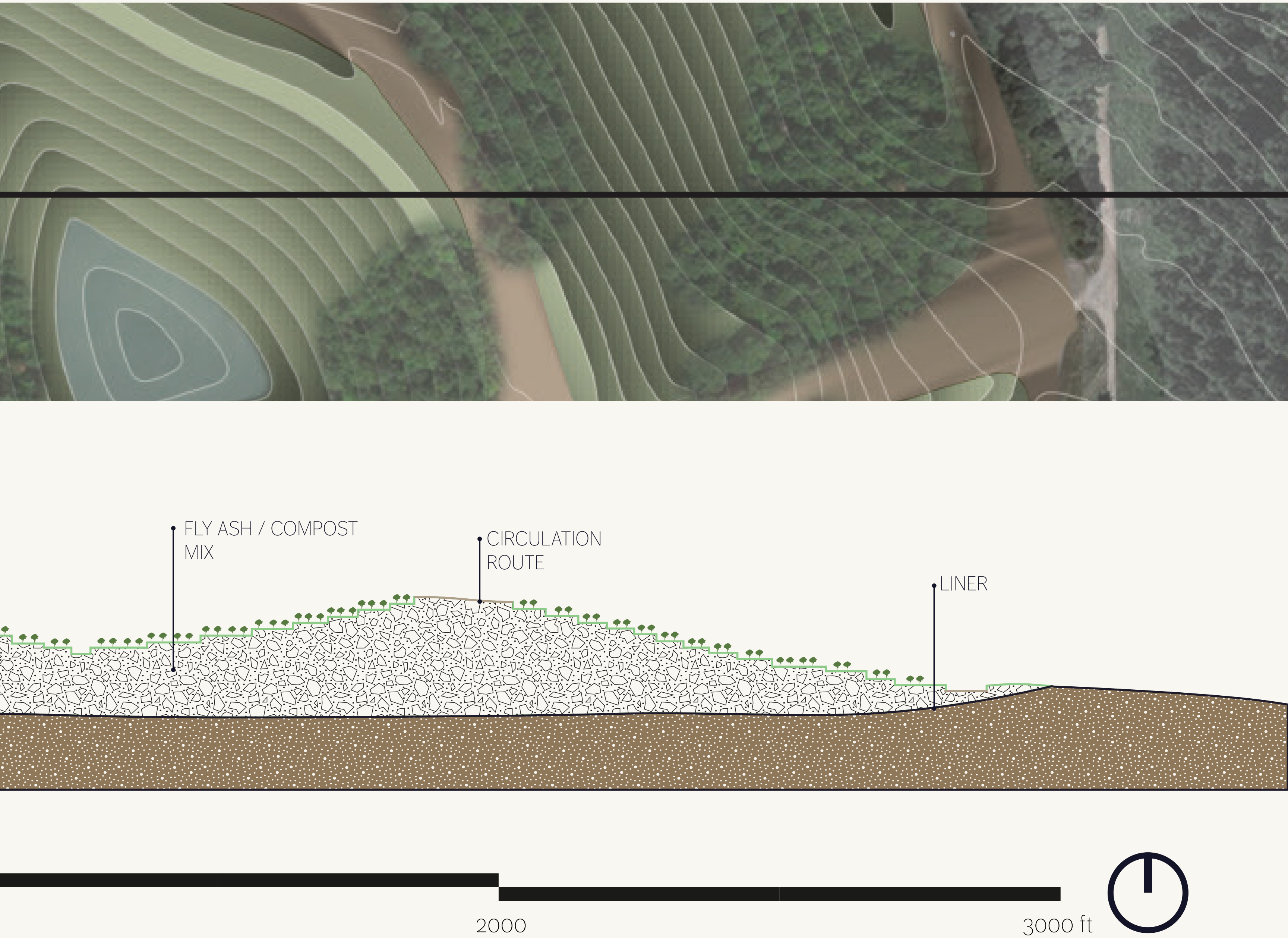
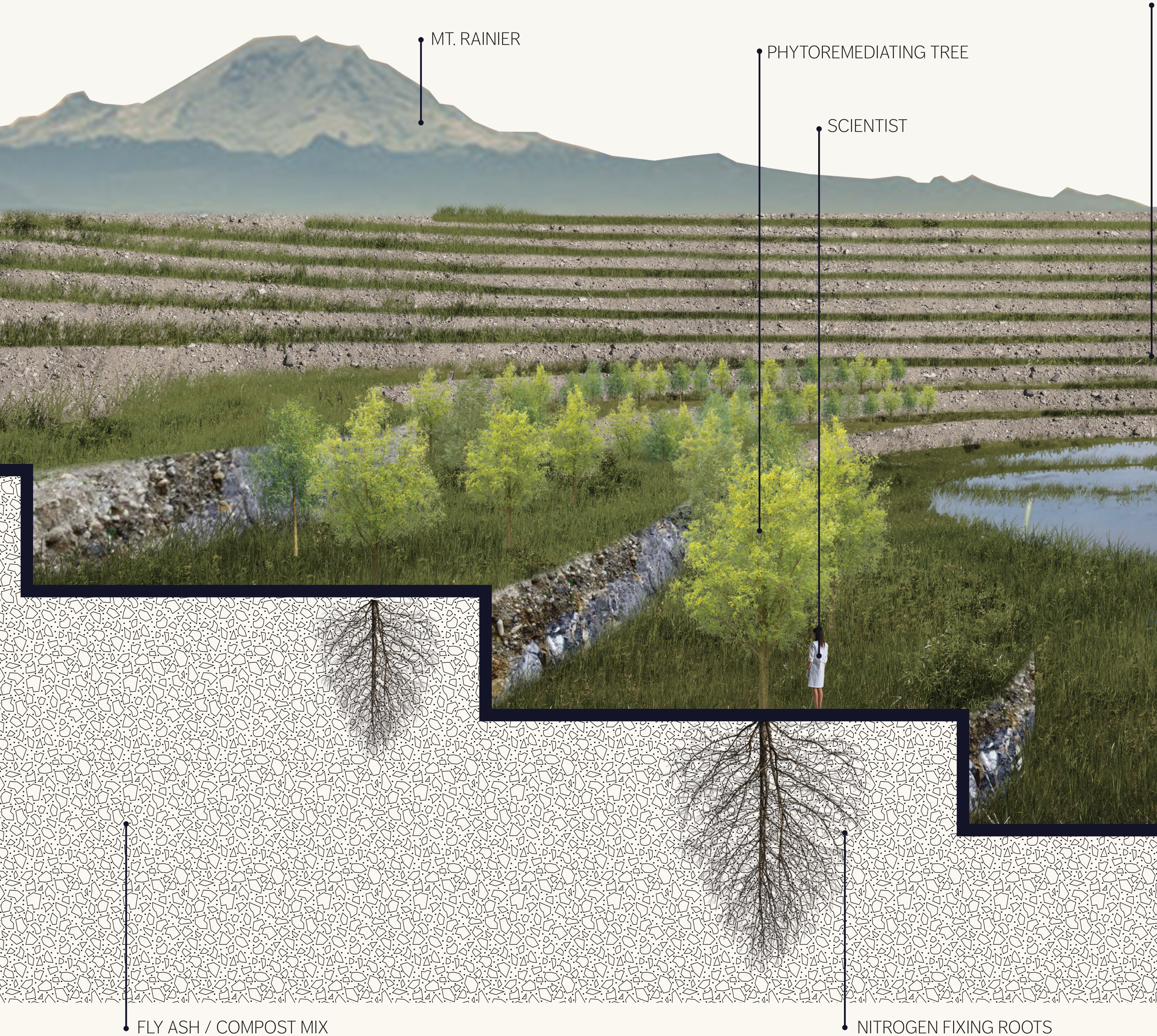


Fig. 57 Plan and Section showing terraced watersheds within the mined landfill constructed of fly ash/compost mix


MT. RAINIER
PHYTOREMEDIATING TREE
SCIENTIST
FLY ASH / COMPOST MIX
NITROGEN FIXING ROOTS

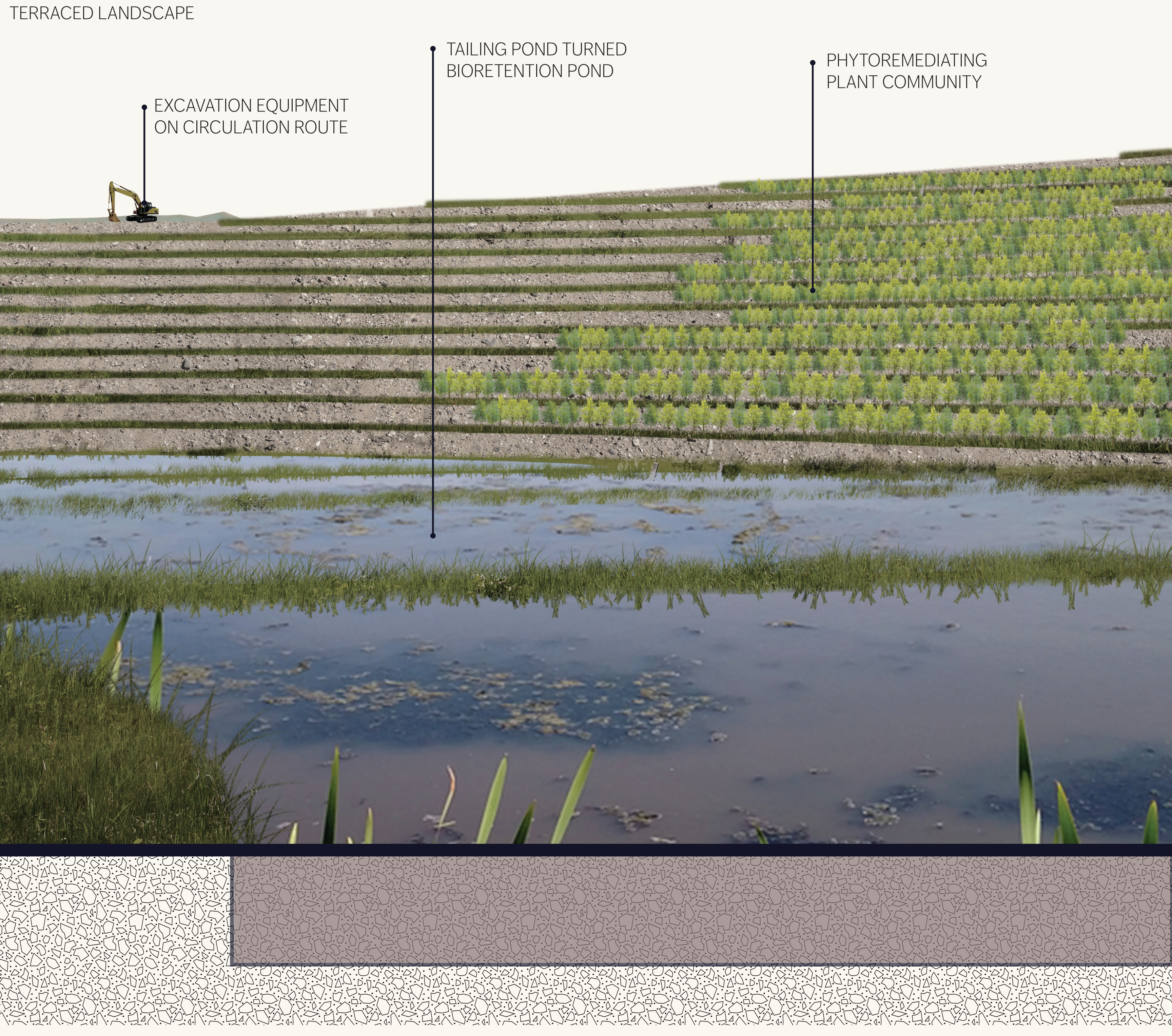


Fig. 58 Section-Perspective showing watershed function during Phase 5 - regenerate

BACK IN THE CAPTAIN'S QUARTERS...

The Captain at his wet bar.
Waters the plant in the sink.

CAPTAIN
There you go little guy. You came a long way for a drink of water... Just needed someone to look after you, that's all --

He is struck with a notion.
Stares out the window at space for a beat.
Sees HIS REFLECTION holding the plant.
Glances at his EARTH GLOBE.

CAPTAIN
(to himself)
We have to go back.

Activates his chair's call button.

CAPTAIN
Auto, come down here!

AUTOPILOT (ON SPEAKER)
Aye-aye, sir.

Eve is still watching Wall-E's vigil on the screen:
...playing Pong...
...Wall-E etches their names in a heart...
Eve is lost in the moments.
So touched.

EVE
(smitten)
Wall-E...
(remembers)
Wall-E!

He's still waiting for her.
She turns to leave and finds
AUTO
lowering in front of her.
Auto spots the plant in the Captain's hand.
"A113" flashes on Auto's lens.

CAPTAIN
Auto, Eve found the plant. Fire up the Holo-detector.

AUTOPILOT
Not necessary, Captain. You may give it to me.

CAPTAIN
(not listening)
You know what? I should do it myself.

Heads for the elevator.

AUTOPILOT
Captain!

Auto shoots back upstairs.
Pops out another APERTURE in front of the elevator.
Blocks the Captain.

AUTOPILOT
Sir, I insist you give me the plant.

CAPTAIN
Auto, get out of my way.

AUTOPILOT
Sir, we cannot go home.

CAPTAIN
What are you talking about? Why not?

AUTOPILOT
That is classified. Captain, give me the plant.

CAPTAIN
(holds plant out of reach)
What do you mean, “classified”? You don’t keep secrets from the Captain!

AUTOPILOT
Give me the plant.

CAPTAIN
Tell me what’s classified!

AUTOPILOT
The plant.

CAPTAIN
Tell me, Auto! That’s an order!

It’s a stare down.
Beat.

AUTOPILOT
Aye-aye, sir.

Auto rises back into the ceiling.
Lowers down over the vanity console.
High speed button pushing.
A NEW BNL VIDEO MESSAGE appears.
Labeled: “TOP SECRET: FOR AUTOPILOT EYE ONLY”.
The BNL FANFARE plays.
Cut to the BNL CEO at the podium.
Haggard. Nervous.
Wears an emergency oxygen vest.
The fanfare plays too long.

BUY N LARGE CEO
(to O.S.)
Just cut it off, will ya?!
(music stops; forced chuckle)
Hey there, Autopilots! Uh, got some bad news. Operation Cleanup has, uh, well... failed! Wouldn’t you know, rising toxicity levels have made life unsustainable on Earth.

CAPTAIN
Unsustainable? What?

BUY N LARGE CEO
Darn it all, we’re going to have to cancel Operation Recolonize.
(dons his life vest)
So just, uh...just stay the course. Rather than try to fix this problem, it’ll just be easier if everyone remains in space.

CAPTAIN
(offended)
Easier?

CEO ADVISOR (O.S.)
Mr. President, sir, it’s time to go.

BUY N LARGE CEO
Alright, uh...uh...I’m giving override directive: “A113”. Go to full autopilot. Take control of everything! And do not return to Earth!
(ready to run)
Repeat! Do not return to Earth!
(throws on his gas mask; to camera crew)
Now let’s get the heck out of here. ”

WALL-E
disney pixar
(2008)

Fig. 59 Image: Movie still from WALL-E, Disney Pixar (2008)

06 | REFLECTIONS

In his book Rubbish! Prof. Rathje makes an important distinction between mental and material realities. **Material reality** is exactly what waste is – inevitable and necessary. **Mental reality** is the way we feel about waste – it is gross, harmful, toxic, a reminder of death. Rathje says this, "The study of garbage reminds us that it is a rare person in whom mental and material realities completely coincide. Indeed, for the most part, the pair exist in a state of tension, if not open conflict."[63] In order to change our perception of waste we must try to combine our ideas of material and mental realities surrounding waste. To do this, I propose three things

1. There is ground for a new lexicon surrounding waste.

It is difficult to comprehend the differences we create between material and mental realities surrounding waste because we simply do not have the descriptors to do so. Creating a larger vocabulary for the subject might begin to help us understand the complexity of waste – both good and bad. Terminology is powerful.

2. We must meet ourselves with more grace and compassion.

Media surrounding climate change and environmental degradation often employ scare tactics. This is not to downplay the severity of climate change, but the fact is that we cannot change the past, we can only change the future, and the more time we spend trying to scare each other into extreme guilt, is less time actually doing something about it.

3. We must be open to change, both big and small.

Waste management is a part of our everyday routine. If we change the very infrastructure we use to waste, we should expect changes on the smallest scale – and we should embrace them.

The future design scenario presented in this thesis is of course, dependent on many different factors outside the realm of landscape architecture. In order to reach a possible scenario like the one described in this thesis, the United State would need to undergo a massive policy and mindset transformation surrounding waste and waste management. A more sustainable waste future would include a reduced dependency on landfilling, a decentralized waste infrastructure, including an increase in our recycling capabilities, and overall decrease in the amount of solid waste we produce, and a massive change in our perception of waste – how we value it and the people who work with it.

While some of the ideas and scenarios presented in this thesis may seem 'far-fetched' they are all ultimately rooted in reality, making this future entirely **possible, not fictional**.

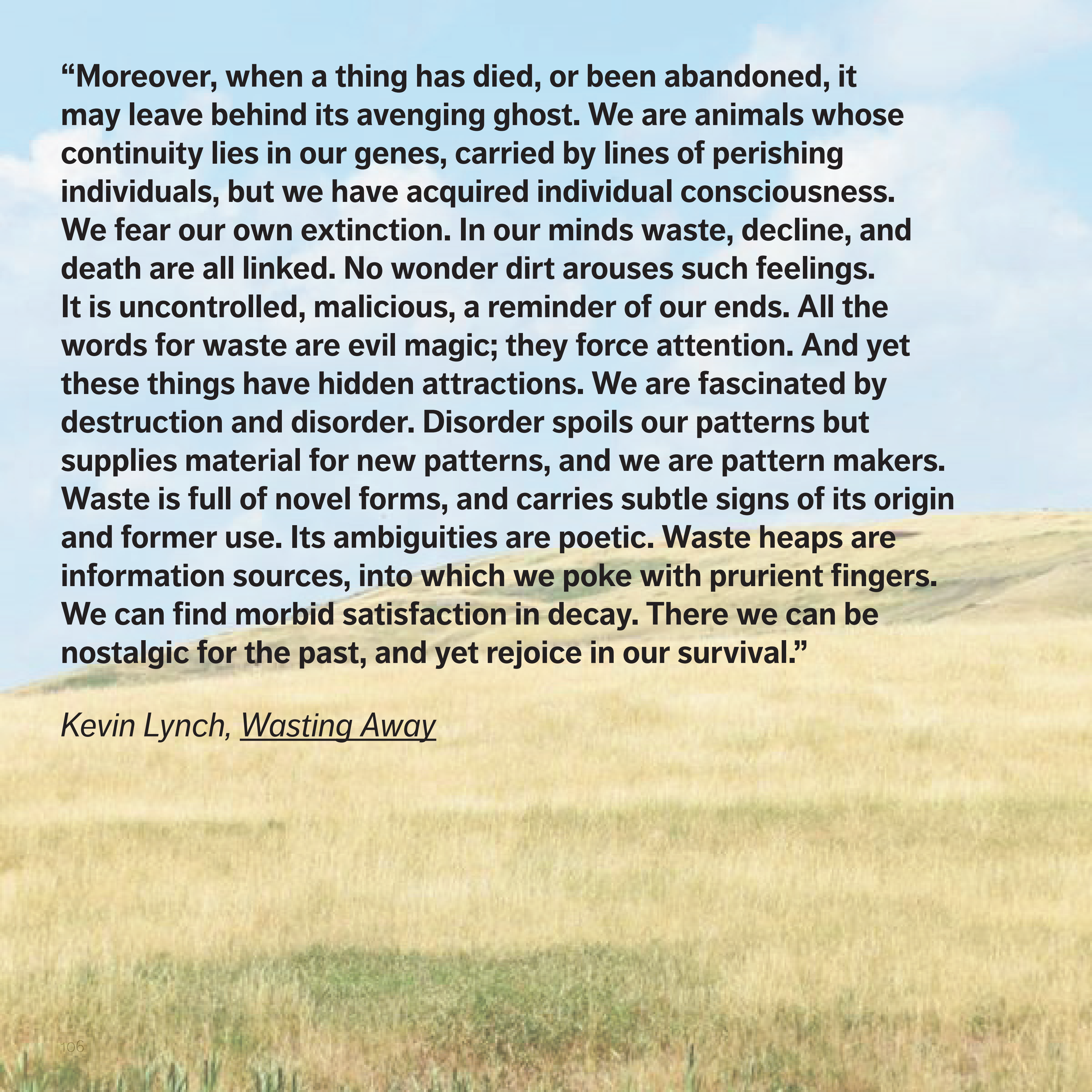
The Green New Deal proposed by Representative Alexandria Ocasio-Cortez and Senator Edward J. Markey called for the government to immediately address and improve upon current policy surrounding climate change and income inequality. The bill did not make it to the senate, however, it did start a conversation about how we are and how we are not using government funds to invest in our own people and infrastructure. The Green New Deal has now inspired the idea of the "superstudio" in landscape architecture – firms and schools alike tackle the same issue with the goal of creating as many ideas and iterations of solutions as possible. The superstudio has solidified the Green New Deal in landscape architecture.

The Build Back Better Framework announced by the Biden Administration in 2021 aims to invest in people and infrastructure in ways that will boost the economy, One of the main goals is to combat climate change which is followed by some of the following goals – "Advances environmental justice through a new Clean Energy and Sustainability Accelerator that **will invest in projects around the country**, while delivering 40% of the benefits of investment to disadvantaged communities, as part of the President's Justice40 initiative" and " Bolsters resilience and natural solutions to climate change through a historic investment in coastal restoration, forest management, and **soil conservation**." Both of these goals are applicable to a redesign and restructuring of waste management practices.

The Build Back Better plan is just the first step in diverting funds to invest in new infrastructure around the nation. While conservatives argue that the bill is too costly and politicians struggle to find a common ground, it is a step, just as the Green New Deal was. The policy change suggested by this speculative future could be made possible by plans like these.

The only way bills like the Green New Deal and the Build Back Better Framework find success, and therefore speculative futures can become reality, is to change perceptions. Our perceptions of value dictate our opinions and our votes. Finding value in what was originally thought valueless could radically change perceptions of people all over the nation and hopefully, be the catalyst for positive change everywhere.

Fig. 60 Photo credit: author



"Moreover, when a thing has died, or been abandoned, it may leave behind its avenging ghost. We are animals whose continuity lies in our genes, carried by lines of perishing individuals, but we have acquired individual consciousness. We fear our own extinction. In our minds waste, decline, and death are all linked. No wonder dirt arouses such feelings. It is uncontrolled, malicious, a reminder of our ends. All the words for waste are evil magic; they force attention. And yet these things have hidden attractions. We are fascinated by destruction and disorder. Disorder spoils our patterns but supplies material for new patterns, and we are pattern makers. Waste is full of novel forms, and carries subtle signs of its origin and former use. Its ambiguities are poetic. Waste heaps are information sources, into which we poke with prurient fingers. We can find morbid satisfaction in decay. There we can be nostalgic for the past, and yet rejoice in our survival."

Kevin Lynch, Wasting Away

Fig. 61 Photo: Sarah Jean Condon, The Citizen

BIBLIOGRAPHY

1 William Rathje and Cullen Murphy, Rubbish! The Archaeology of Garbage (Tucson: The University of Arizona Press, 2001).

2 Mira Engler, Designing America's Waste Landscapes (Baltimore and London: The Johns Hopkins University Press, 2004).

3 Silpa Kaza et al., "What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050," Urban Development Series (Washington DC: World Bank: International Bank for Reconstruction and Development / The World Bank, 2018). 34.

4 William Rathje and Cullen Murphy, Rubbish! The Archaeology of Garbage.

5 William Rathje and Cullen Murphy.

6 David Naguib Pellow, Garbage Wars: The Struggle for Environmental Justice in Chicago (The MIT Press, 2002).

7 Anthony Dunne and Fiona Raby, Speculative Everything: Design, Fiction, and Social Dreaming (Cambridge, Massachusetts: The MIT Press, 2013). 3.

8 "Wallace Stegner," accessed December 27, 2021, https://web.stanford.edu/~jonahw/ATE-F05/Stegner.

9 William Rathje and Cullen Murphy, Rubbish! The Archaeology of Garbage (Tucson: The University of Arizona Press, 2001). 12.

10 William Rathje and Cullen Murphy, Rubbish! The Archaeology of Garbage. 33.

11 David Naguib Pellow, Garbage Wars: The Struggle for Environmental Justice in Chicago (The MIT Press, 2002). 29.

12 David Naguib Pellow. 35.

13 David Naguib Pellow. 42.

14 David Naguib Pellow. 44.

15 David Naguib Pellow, Garbage Wars: The Struggle for Environmental Justice in Chicago (The MIT Press, 2002). 46

16 David Naguib Pellow. 47.

17 Environmental Protection Agency, "Advancing Sustainable Materials Management: 2018 Fact Sheet," December 2020. 3.

18 Brian Brassaw, "Germany: A Recycling Program That Actually Works," Earth911 (blog), July 11, 2017, https://earth911.com/business-policy/recycling-in-germany/.

19 Roman Mars, "National Sword," 99% Invisible, n.d., https://99percentinvisible.org/episode/national-sword/.

20 Ron Gonan, The Waste-Free World: How the Circular Economy Will Take Less, Make More, and Save the Planet (New York: Portfolio / Penguin, 2021). xvii.

21 Ron Gonan. xi.

22 Ron Gonan. 8.

23 Ron Gonan. 9.

24 Ron Gonan.

25 Ron Gonan. 12.

26 Ron Gonan. 5.

27 Silpa Kaza et al. 66.

28 Environmental Protection Agency, "Advancing Sustainable Materials Management: 2018 Fact Sheet," December 2020.

29 King County Department of Natural Resources and Parks, Solid Waste Division, "2019 Comprehensive Solid Waste Management Plan," November 2019.

30 Cascadia Consulting and State of Washington Department of Ecology, "2015-2016 Washington Statewide Waste Characterization Study," January 2018.

31 Mira Engler, Designing America's Waste Landscapes (Baltimore and London: The Johns Hopkins University Press, 2004). 80.

32 Mira Engler. 79.

33 Mira Engler. 82.

34 William Rathje and Cullen Murphy, Rubbish! The Archaeology of Garbage (Tucson: The University of Arizona Press, 2001).

35 Mira Engler, Designing America's Waste Landscapes.

36 Murray Carpenter, "Native American Secrets Lie Buried in Huge Shell Mounds," The New York Times, October 19, 2017, sec. Science, https://www.nytimes.com/2017/10/19/science/native-americans-shell-middens-maine.html.

37 William Rathje and Cullen Murphy, Rubbish! The Archaeology of Garbage.

38 Mira Engler, Designing America's Waste Landscapes.

39 Mira Engler. 75.

40 Mira Engler. 77.

41 Kevin Lynch, Wasting Away (San Francisco: Sierra Club Books, 1990). 5.

42 Jillian Steinhauer, "How Mierle Laderman Ukeles Turned Maintenance Work into Art," Hyperallergic (blog), February 10, 2017, https://hyperallergic.com/355255/how-mierle-laderman-ukeles-turned-maintenance-work-into-art/.

43 Environmental Protection Agency, "Municipal Solid Waste Landfills," n.d., https://www.epa.gov/landfills/municipal-solid-waste-landfills.

44 Mira Engler, Designing America's Waste Landscapes. 83.

45 Xuede Qian, Robert M. Koerner, and Donald H. Gray, Geotechnnical Aspects of Landfill Design and Construction (New Jersey: Prentice Hall, 2002). Xvii.

46 Sampurna Datta and Lauren Eastes, "Biodegradation in Municipal Solid Waste Landfills," accessed May 17, 2021, https://www.geoengineer.org/education/web-class-projects/cee-549-geoenvironmental-engineering-fall-2015/assignments/biodegradation-in-municipal-solid-waste-landfills.

47 Sampurna Datta and Lauren Eastes.

48 Deborah Marton, "Hidden Opportunities: Landfill Restoration Offers Fertile Ground for Landscape Architects. But First Practicioners Must Understand the Landfill's Underlying Technology.," n.d.

49 OAR US EPA, "LMOP Landfill and Project Database," Overviews and Factsheets, April 20, 2016, https://www.epa.gov/lmop/lmop-landfill-and-project-database.

50 OAR US EPA, "Landfill Technical Data," Overviews and Factsheets, January 4, 2017, https://www.epa.gov/lmop/landfill-technical-data.

51 "Ariel Sharon Environmental Park – A Case Study for Transforming Landfills into Public Resources," Milken Innovation Center (blog), June 23, 2021, https://milkeninnovationcenter.org/ariel-sharon-environmental-park-a-case-study-for-transforming-landfills-into-public-resources/.

52 Herrera Environmental Consultants, Inc., "Cedar Hills Regional Landfill 2020 Site Development Plan and Facility Relocation Draft Environmental Impact Statement" (Seattle, WA, September 16, 2020).

53 Normandeau Associates, Inc., "Waste-to-Energy (WTE) Options and Solid Waste Export Considerations," September 28, 2017. viii.

54 Peter Tom Jones et al., "Enhanced Landfill Mining in the View of Multiple Resource Recovery: A Critical Review," Journal of Cleaner Production 55 (May 26, 2012): 45–55.

55 Peter Tom Jones et al.

56 Joakim Krook, Niclas Svensson, and Mats Eklund, "Landfill Mining: A Critical Review of Two Decades of Research," Waste Management, no. 32 (November 13, 2011): 513–20.

57 Juris Burlakovs et al., "Paradigms on Landfill Mining: From Dump Site Scavenging to Ecosystm Services Revitilization," Resources, Conservation and Recycling 123 (July 18, 2016): 73–84.

58 Juris Burlakovs et al.

59 SSB Environmental, Inc., "Town of Hague Landfill Reclamation Study: Researching Ways to Increase Waste Heating Value and Reduce Waste Volume" (Albany, NY, January 1997).

60 Normandeau Associates, Inc., "Waste-to-Energy (WTE) Options and Solid Waste Export Considerations." ix.

61 Normandeau Associates, Inc. ix.

62 Gordana Gajic et al., "Ecological Potential of Plants for Phytoremediation and Ecorestoration of Fly Ash Deposits and Mine Wastes," Frontiers in Environmental Science Environmental Toxicology, no. 13 (November 2018), https://doi.org/10.3389/fenvs.2018.00124.

63 William Rathje and Cullen Murphy, Rubbish! The Archaeology of Garbage (Tucson: The University of Arizona Press, 2001).

Fig. 62 Photo: Sarah Jean Condon, The Citizen