

a landfill reclamation project: an observatory that observes the self  
*a landfill reclamation project: an observatory that observes the self*



# abstract

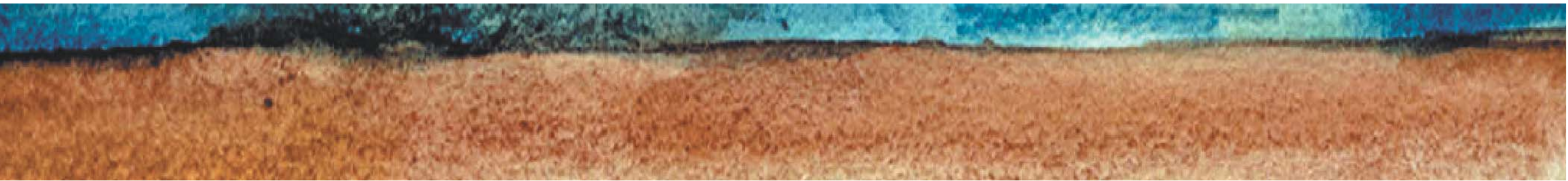
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*a landfill reclamation project: an observatory that observes the self*  
*-amy margaret knotts*

"Transparency- the ability to see into and understand the inner workings of a landscape- is an absolutely essential ingredient to sustainability"

-Robert Thayer from "Green World, Green Heart"

Current land filling practices that bury waste and debris below layers of earth and synthetic caps do not take into account the potential of reclamation of the site after the landfill debris has become stable. As development and consumerism increases, the need for land reclamation grows stronger, as earth will succumb to overabundance of human excessiveness. Can a space be created that not only reclaims land, but also exposes what is hidden- in order to educate the public on the importance of recycling and sustainability? Is it possible to design a space that addresses the issues and culture of the past, present and future, particular to a geographic site? Can landscape architects use landscape as an educational medium for self-discovery?



# a landfill reclamation project: an observatory of the self

amy margaret knotts

submitted to the faculty  
of the  
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in partial fulfillment of the requirements

*Master of Landscape Architecture*

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Paul Emmons *Associate Professor, Committee Chair*

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Brian Katen, ASLA *Associate Professor, Committee Member*

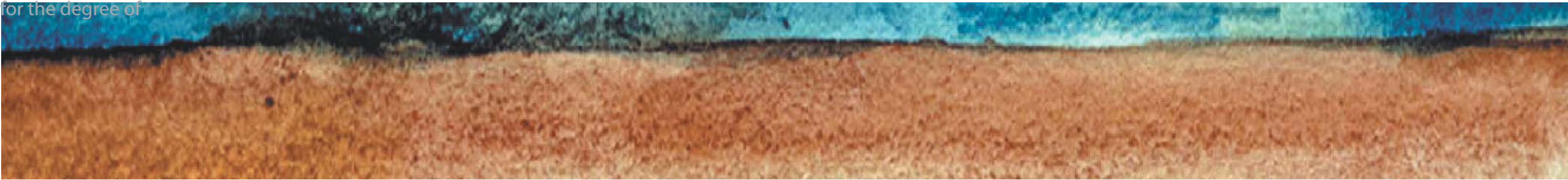
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*November 4, 2005 Alexandria, Virginia*

*Landfill Reclamation, Phytoremediation, Self-discovery in the Landscape, Methane Production, Waste Management, Fauquier County*

for the degree of



# acknowledgements

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to my parents, who taught me the wisdom found in nature  
and the strength of perseverance

to Corbin, for his unquestioning delight as I trotted through  
endless muddy landfills in search of the truth

to the faculty, thank you for:

Paul Emmons: helping me to believe in myself and not always giving me the answers.  
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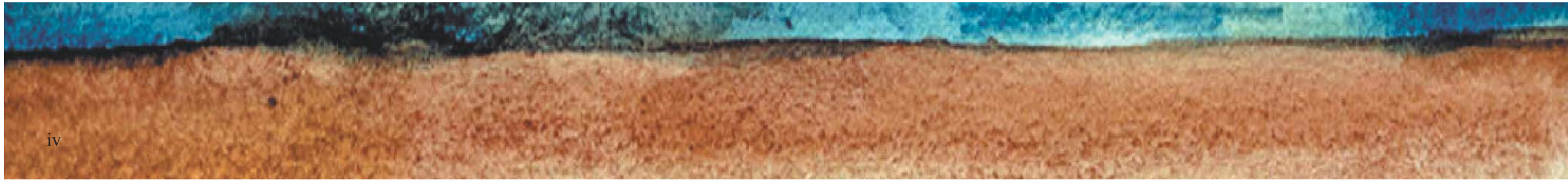
this book is dedicated to the good in the human spirit and that it shall continue to prevail  
and to the belief that we can bring about a change.



*In the attitude of silence the soul finds the path in a clearer light,  
and what is elusive and deceptive resolves itself into crystal clearness.*

*Our life is a long and arduous quest after Truth.*

*Mahatma Gandhi*



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# layer 1

## 1976 ↓

### i n t r o d u c t i o n

In 1999, in the United States alone, residents, businesses, and institutions, daily created more than 230 million tons of Municipal Solid Waste (MSW), which breaks down to 4.6 lbs of waste per person per day. Construction debris makes up the majority of waste found in landfills, and as the need for development continues, so does the need for landfills. Recycling, including composting, diverted 64 million tons of material away from landfills and incinerators in 1999, up from 34 million in 1990. Although the number of landfills in the United States has steadily decreased from 8,000 in 1988 to 2300 in 1999, the capacity that present day landfills can hold has increased, and so has the amount of land needed to create landfills.

Human beings have a right to see how they are harming the environment. Our growing economy is based on consumerism that through advertisement, suggests that we are what we possess, wear, drive and eat. We as a society find solace and happiness in shopping malls; we feel empowered when we are driving a brand new shiny car. But we don't see how these attitudes affect the earth and we don't see how this belief structure creates waste. Some landfills are sited in low income areas, sometimes rural, far from contact with the city. They are usually invisible to the average person; all that is visible is the soft mounding of the earth. Once capped they become "liabilities" to a particular community, and are left fenced in and covered with grass. The smell from the noxious gas that is emitted from landfills is less apparent to nearby inhabitants due to today's technology, which has created systems that inhibit the foul smell of gases created during the decomposition process. Robert Thayer discusses in "Green World, Green Heart"; that 'Landscapes that create an illusion of a better world while depriving us of the actual means of achieving it are not sustainable.' (Thayer 1994, 189-190) It is only through making the waste visible that our society will be made aware of the importance of reusing and recycling. Humans can only understand the strain we have imposed on the earth by seeing the extremes of consumerism.

Through this thesis I intend to investigate two major factors of landfills. First, the potential of self-discovery that is possible in a landfill landscape through revealing the unknown of the natural functions of a landfill. By revealing the basic layers of the landfill, it is my intent to awaken the minds of the viewer to the negativity of over consumption. It is also my intent to urge visitors to be environmentally cognizant of how they dispose of waste in their daily lives. In order to investigate this topic further, I have looked at works created by land artists and how they have revealed the landscape.

Secondly, the potential for land preservation at a landfill site is a major element of my thesis research. For this I have looked at several case studies of concept and built landfill reclamation projects where land was reclaimed for public use. In these case studies I was investigating the basic issues that were of concern when initiating and constructing these landscapes such as: public support before and after, general landfill deficiencies, methane and leachate capturing systems and the potential for using natural toxin cleaners like phytoremediation.

The intent of the design aspect of the thesis was to develop a public park on the site of a closed landfill to investigate the potential "recycling" opportunities that former landfill sites offer. The main attraction of the public park would be an observatory placed atop the landfill that would allow the visitors to have an ideal view of the solar system. As a designer I used as my tools: materials, circulation and the earth's natural processes to help educate the public of what the deeper meaning of the site was. The message is subtle, but very prominent, in every aspect of the design. Not only were case studies, and phytoremediating systems investigated in this thesis, but also the unknown, the solar system. The solar system brought an element of etherealness to an otherwise highly engineered site. It became the "truth" in my thesis and was the guiding principle in many of my design decisions. The thesis was better understood by myself, by investigating the unknown.

layer 2  
ΙΓΛΕΙΣ  
c a s e s t u d i e s



# mount trashmore, virginia beach



By 1966, officials in Virginia Beach, Virginia, were moving ahead with plans to convert an existing acre dumpsite into a viable recreational area. Prior to 1966, the landfill utilized a semi-open trench and cover operation which was costing the city \$75,000 annually and was expected to have a short life span. Roland E. Dorer, Director of the State Department of Health, Insect and Vector Control, initiated the plan to have the once open trench converted into a mountain of trash. This was the best alternative due to the shallow 6-8 foot deep water table that is found in coastal Virginia, which makes burying the trash impossible. Part of Dorer's plan was to purchase the area surrounding the landfill to allow for a recreational facility. The plan, which included a 5,000-seat amphitheater, freshwater lake, jogging and walking path, and parking, was approved by the Department of Health, Education and Welfare for an initial grant of \$192,674. The landfill, which once served the entire Virginia Beach municipality, was capped and converted in 1972 into a successful recreational park, Mount Trashmore Park (MT). (City of Virginia Beach Memo)

Problems such as odors and gas formation were an issue when converting the once open-pit dumpsite into a 68-foot high mound of trash. The odors were a result of Landfill Gas (LFG), which is created during the decomposition process. LFG's are composed of 50-55% methane, 45-50% carbon dioxide and trace amounts of oxygen, nitrogen, and hydrogen sulfide. In addition, the methane component of LFG is highly flammable and if trapped, will explode. Methane in a cubic foot of LFG contributes 20 to 30 times more to global warming, as an equivalent amount of carbon dioxide. Seven places were provided on the landfill as seepage points for methane gases which can be seen with the unaided eye after a rainfall. Roland Dorer explains, "There isn't any danger as the gases are now finding their own natural route to the surface reducing the possibility of the mountain blowing up." MT experienced only one fire in 1972 due to methane accumulation, but none since then. Unlike other landfills, MT does not collect methane gas for use as renewable energy largely because methane production is minimal, due to the landfill's age. (Blakley 2004)

Odor was minimized during park construction, by transferring the waste through conveyer belts from the former open pit to the working site during long periods of rain. By placing waste in cells with soil and water, the issue with odor had been eliminated for the life of the landfill. Recently, work has been underway for repair of the original clay cap due to sagging and seeping of water into the landfill. This resulted in water accumulation in low lying areas on the landfill. This was because the original cap consisting of clay, sand and topsoil, started to degrade. Research has shown that the original method of capping landfills with clay results in fracturing and cracking through diffusion. Another issue with clay liners is that certain chemicals have the potential to degrade clay liners. As a result, MT has recently undergone construction to recap the landfill using a more resilient capping material, a composite, made largely of a plastic liner and compacted soil. (Blakely 2004)

Today, the landfill has been converted into a successful 165-acre recreational park used by over 1 million people annually. Through the help of local volunteers, one of Virginia Beach's largest playgrounds, Kids Cove, was installed atop the landfill. Using spread footings that avoid penetrating the cap, construction of a low impact pedestrian walkway and skate ramps were possible. Adjacent to the playground, within the year, a 30,000 sq ft concrete skate park was installed. Ample parking is provided to the north and south of the park. The annual 4<sup>th</sup> of July festivities are held at the park where the 5000 seated amphitheater does not provide enough seating for the annual turnout. The 30-45 degree slopes of the landfill make slope-flying possible. Average 35 mph winds make conditions optimal for kite flying. (City of Virginia Beach Memo)

# mount trashmore, virginia beach

The existing 52-acre lake, known as Lake Trashmore, is located at the base of the landfill, and feeds into the Chesapeake Bay. It is presently being used as a storm water retention system for the surrounding community, as well as for recreational purposes. It is open all year round for fishing, but is not deep enough for boating. The monitoring of the lake is done often to ensure that leachates are not present. Most landfills produce a minimal amount of leachates after 30 years. Since MT is over 30 years old the French drains that feed leachates from the landfill into the lake are not an issue. Monitoring results show that most of the problems are due to coliform from feces from seagulls that reside at the landfill. Erosion of the lakes edge, due to high velocity winds is also an issue. (Blakley 2004)

Due to the success of the MT, a second landfill located not far from the original is being planned. Found between Centerville Turnpike and Indian River Road, the park, "City View Park" has already been established in proximity to the landfill with the intent that upon the landfill's 2015 closure, it will then become a portion of the park. Unlike MT, the City View project's strength is in establishing the park first prior to siting the landfill. Perhaps with the possible success of City View Park, other Virginia counties will rethink the potential future use of closed landfills, as a place reclaimed for the community.



view of skate park and kid's cove on top of landfill



view from parking lot up to landfill



view from atop landfill looking towards pond and amphitheater

## meadowlands, new jersey



Like Mount Trashmore in Virginia Beach, the Meadowlands in New Jersey has been designed to accommodate the reuse of an existing landfill but on a larger scale. The Meadowlands, located 6 miles west of Manhattan, 4 miles from Newark, 80 miles from Philadelphia and just south of the Giant Stadium, was once a estuarine and freshwater marsh and cedar swamp that covered 20,000 acres of the land. The area was transformed in the 19<sup>th</sup> century by settlers who filled in marshes and creeks to provide land suitable for development and farming. As a result of population growth and the negative stigma that was associated with Meadowlands, the site continued to be an unregulated dumping site into the mid 1900's. It was not until 1969 that the New Jersey Meadowlands Commission (NJMC) was created to regulate and mitigate the degraded condition of the Meadowlands. Since then NJMC's main priorities have been marsh enhancement, site clean-up, proper closure of existing landfills, and educational programs that promote environmental awareness. (The New Jersey Meadowlands Commission)



In 1999, EnCap Golf Holding signed an agreement to oversee the capping of the existing landfills and the future development of the site. The plan is to develop the area into a 72-hole championship golf course, and mixed use resort village, habitat for local wildlife, and an open space recreational facility for the surrounding community. Transportation access was also taken into account during planning of the site redevelopment. The site is close to three international airports: Newark International Airport, La Guardia Airport and Kennedy International Airport, by car from Route 3/17 and by train from a proposed train stop which will provide access to the northeastern boundary of the site via New Jersey Transit Bergen Line railroad. In addition, the redevelopment plan includes proposed recreational trails and on-road bike routes, which will connect to the train stop. (The New Jersey Meadowlands Commission)



Due to the lack of proper capping and maintenance of the existing landfills, the adjacent marsh is polluted with millions of gallons of leachates. The existing landfills will have to be appropriately closed, leachate collection system installed as necessary, and the adjacent marshes and wetlands will have to be restored. Through phytoremediation, heavy metal and other pollution in adjacent waterways and groundwater will be mitigated. Plants used for phytoremediation will also be used for aesthetics to improve the viewsheds of the resort community and to provide shade to lessen the heat island effect. Groves of trees are planned, extending several hundred feet with shrubs, in clusters, spaced 40-60' apart between the groves. This phytoremediation system with the diversity of trees, shrubs and grasses will provide a vegetated buffer between the capped landfills and adjacent waterways. (The New Jersey Meadowlands Commission)

The project will be completed in 9 phases. Four landfills are slated for redevelopment into golf courses: Avon Landfill, Kingsland Park Sanitary Landfill, Lyndhurst Landfill, and Rutherford Landfill. Prior to development the capping process will include: "a cap with a multi-layer, engineered cover system comprised of grading and shaping fill (processed dredge material or recyclables), a barrier layer of processed dredge material (PDM) or geosynthetic material, a layer of vegetative material and a layer of growing medium." In order to control the methane issue in the landfill, a passive LFG venting system will be installed. Each following phase includes the development of the village. (The New Jersey Meadowlands Commission)

Using smart growth principles the architecture of the Meadowlands town will include pedestrian-friendly and comfortably scaled buildings. Mixed-use development along the main street will allow for retail, residential and office uses. Housing options will be diverse with options ranging from high-rise living to mixed-income apartments, condominiums and town homes. Open space will be provided in and around the downtown and in the resort area and will allow for the integration of nature. In the center of the village is the Village Green, which is the center point for passive and active recreation and within one block of all residential neighborhoods. Tree lined main street will encourage community through outside cafes with pedestrian friendly circulation, also enhancing street level views.



Meadowlands is an example of landfill reclamation on a scale much larger than that of Mount Trashmore. Through the development of Meadowlands, which was once considered a "mosquito breeding ground with no foreseeable value", into a thriving community rich with ecosystem diversity, and smart growth principles, land that would have otherwise been lost has now been recycled into a thriving community.

meadowlands, new jersey



# hilltop golf course alexandria, virginia



A local area in Northern Virginia, Hilltop golf course, in Alexandria, Virginia transformed a landfill into a golf course. The 9-hole public golf course that was designed by Lindsay Bruce Ervin, Inc. was formerly a sand and gravel mining operation in 1950. In 1979 the site was converted into a Municipal Solid Waste (MSW) and Construction Debris (CD) landfill that serviced the surrounding community. The original site grew in size to 200 acres after the surrounding parcels were purchased to allow for a 9-hole golf course. The project is being done in phases. Phase 1 included building a driving range, putting green, and chipping green that was located adjacent to the landfill. The second phase consisted of the present golf course and was completed in October 2003. The final phase will consist of capping the existing operating landfill in 7 years and the construction of a two new golf holes and transforming the existing 9-hole executive golf course to a regulation 9-hole golf course. (Hilltop Golf Club, 2002)

The decision to make the landfill a golf course was mostly due to a requirement based on an earlier comprehensive plan that required the plan for Hilltop to consider the post closure of the landfill. The city stipulated that the land would have to be reclaimed for residential and public use. The idea to convert the landfill into a golf course was largely due to cost incentives. In order to build a golf course, large amounts of fill and dirt have to be installed in order to sculpt the contours that are necessary for a golf course. Since the landfill already had extensive fill and the contours to work with, building the golf course was less expensive. The more important issue when building the golf course was in properly capping the landfill, using HTPPE textured cover, and a geo-grid on the slopes. Erosion was controlled by using lespedeza and other grasses that have erosion capabilities. Pipes were installed to direct leachate water into a nearby collection pond that through batched metering was able to monitor toxicity of the water prior to entering the water treatment plant. Methane production is controlled by passive venting which allows methane to escape the landfill as needed. Presently, methane production is minimal with only 6 of the 34 vents generating about 30-40% of the methane. The actual vents are disguised as flagpoles and are distributed throughout the top of the landfill. Settling at the golf course is minimal due to the initial concentration of dozers and compactors that compact the material before it enters the landfill. This technique results in higher operational costs initially but in the future reduces the danger of settling which is detrimental to a golf course. Due to pre-break down of the waste, the outcome is a greater amount of surface area that is useful in golf course design. In cases where settling is inevitable, the design of the golf course accommodates the settling. (Hilltop Golf Club, 2002)

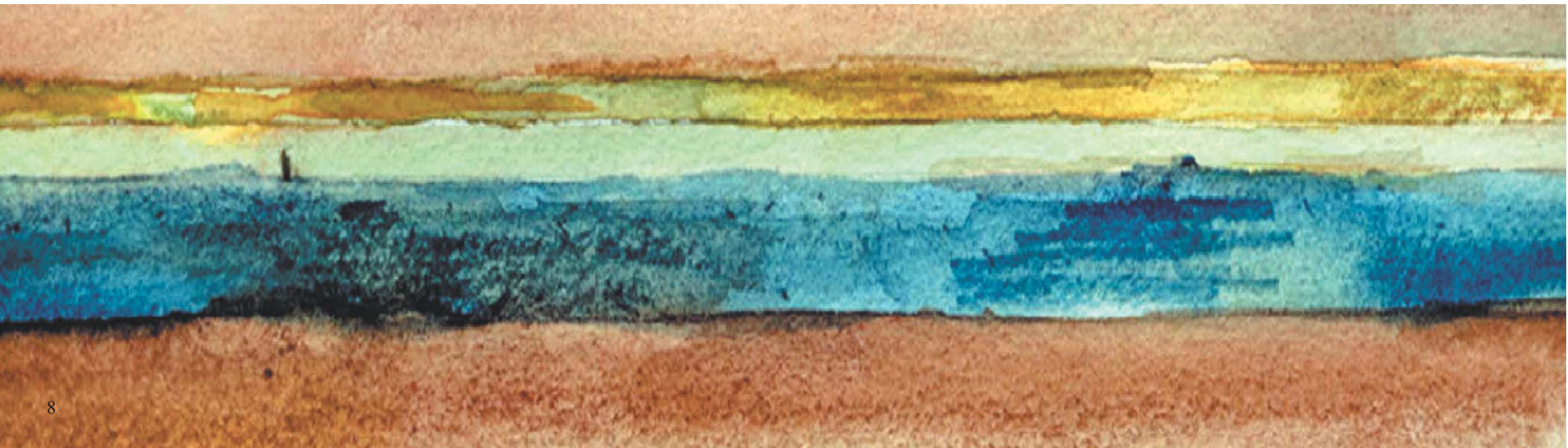


Capped landfill along east portion of site

layer 3

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r e m e d i a t i o n



# phytoremediation

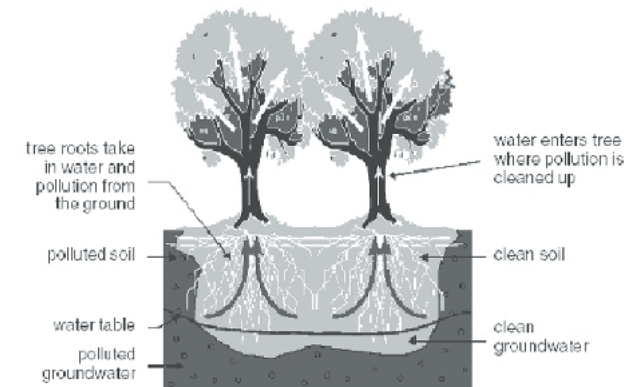


Phytoremediation is a technology that utilizes plants to remove and degrade contaminants found in soil, groundwater, surface water and the atmosphere. Plants have the potential to be useful in wastewater and soil cleanup, due to their ability to evapotranspire groundwater, and produce enzymes that help in the degradation of contaminants found in soil and water. Due to the high toxicity of leachate, phytoremediating plants would have to be used as a subsequent process in the treatment of toxins.

The use of phytoremediating plants is being used extensively at the Meadowlands site. Trees, shrubs, and perennials are being used to prevent further migration of contaminants from the existing landfills into surrounding natural wetlands. Tests done on the site show that most of the soils and water are contaminated with heavy metals that occur in soil levels at 4'-0" and below. Plants proved to be effective in cleaning shallow water contamination due to their root systems. Four main species of plants for phytostabilization and hydrologic control were proposed: *Populus* sp, *Sambucus* sp., *Viburnum* sp. and *Panicum* sp. The plants were chosen since they are native to New Jersey area and due to their phytoremediating abilities. (EDAW 2002)

Plants used:

- Populus balsamifera
- Populus deltoids
- Populus grandidentata
- Sambucus canadensis
- Viburnum dentatum
- Viburnum dilatatum
- Viburnum trilobum
- Panicum virgatum



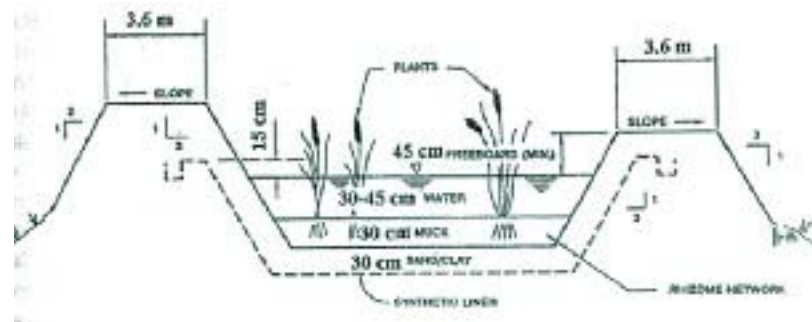
Plant material containing phytoremediating qualities were sited in the lower area of all planted slopes in order to collect the highest concentration of leachates. Plants with more aesthetic value were placed on higher elevation slopes. For 3:1 slopes, a soil retention blanket material was installed to mitigate erosion. Irrigational water was monitored by the landfill report that tested groundwater levels in which the plants were able to extract the most amounts of toxins from nearby soil and groundwater. All herbicides, insecticides, and disease control was monitored to ensure they were applied according to state and federal law to eliminate the chance of migration to nearby wetlands. Plants will be tested prior to disposal from site to ensure that toxins left over in plant material does not exceed regulatory levels. All plants that do display high levels of toxins will be disposed of at appropriate disposal facilities. (EDAW 2002)

Plants can be used as a natural rhizomatic cap for a landfill. Through dense production of rhizomatic and capillary roots, hybrid poplar trees have the ability to provide a dense matting that prevents water from penetrating into the core of the landfill. Natural caps have the potential to replace synthetic caps. By creating a "sponge and pump" system water is discouraged from penetrating the caps. These so-called "Tree Caps" rely on rootable soil and other vegetated cover on top of the landfill. Other trees can be utilized such as fast growing Cottonwoods and Aspens. A study done on the Ecolotree Buffer, showed that the natural barrier reduced groundwater nitrates concentrations from 50-100 mg to less than 5 mg. Poplars are the ideal tree in this system since they are fast growers, after 7 years of growth they grow to a height of 7'-0". (Poplar Technology)

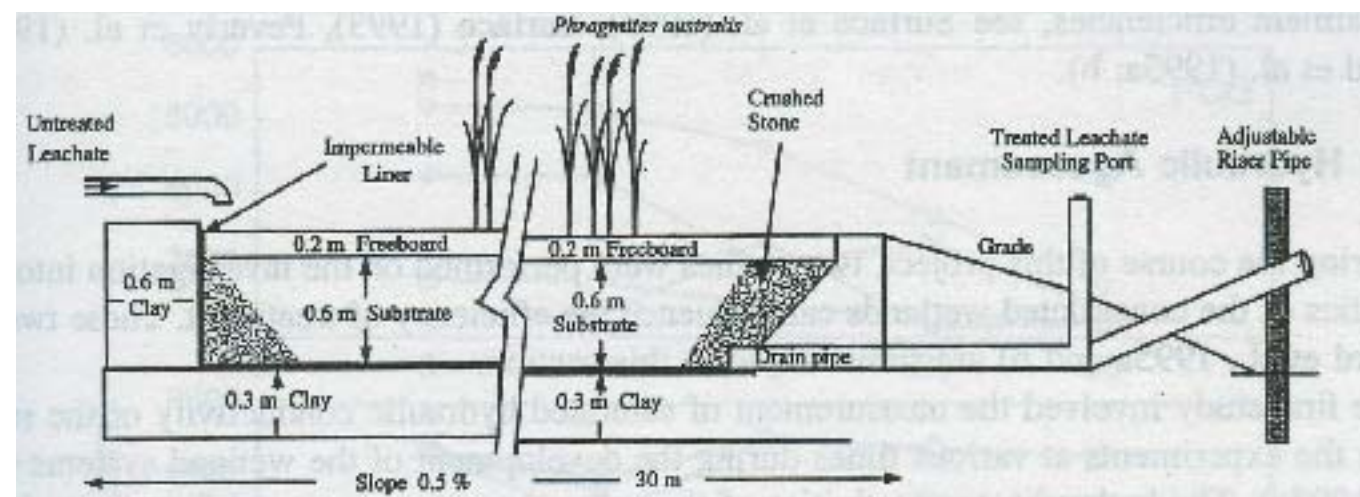
# constructed wetlands

Constructed wetlands offer an opportunity to cleanse leachates through a natural process. The man-made wetlands work by replicating the natural process of a wetland. By replacing the presently used leachate collection system with that of the constructed wetland, it can reduce costs, minimize operational costs, and provide habitat for wildlife. The constructed wetland is able to cleanse the water due to the matrixes of cells containing gravel and wetlands plants. By keeping the leachate water at a level within the root zone, the rhizosphere of plants such as reeds and cattails are able to chemically react to degrade toxins within the leachate water. The flow between the cells is controlled by hydraulic pressure that moderates water flow from cell to cell and controls the amount of flow during rain periods. In some cases, the newly cleansed leachate water is re-circulated back onto the capped landfill to increase the decomposition process. (Mulamootil 1999)

In most cases the use of constructed wetlands results in a one-fourth less cost over conventional leachate treatment systems. New Hanover County in North Carolina utilized the construction of wetlands to treat landfill waste. The five acre site project was made possible by a \$785,000 grant from the North Carolina Clean Water Trust Fund. Not only has the system provided a natural environment for the cleansing of leachates but has also provided habitat for local wildlife, improved the aesthetics of the site, and reduced operational and maintenance costs. By creating a closed loop system that collects the treated leachate water that is then re-applied to the capped landfill, any potential of leachates being deposited into the Cape Fear River, is prevented. (Mulamootil 1999)



cross-sectional detail of a typical constructed wetland



schematic cross-section of a constructed wetland