Composting in the Urban Environment Utilizing Yard Waste and Food Waste in Fairfax County, Virginia

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Thesis submitted to the faculty of the Virginia Polytechnic Institute and State University in fulfillment of the requirements for the degree of Master of Science In Landscape Architecture

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August 16th, 2019

Alexandria, Virginia

Keywords: Composting, urban landscapes, urban food waste, urban yard waste

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ABSTRACT

Urbanization alters the natural soil structure of landscapes. This has a negative impact on the environment. This degradation of the soil in the urban environment needs management practices that protect and restore the nutrient value in the soil. Soil is one of the most essential elements of landscapes. High quality soils make a major contribution to cleaning water, acting as a filtration system that purifies the water it absorbs. Soil also sustains microorganisms that promote vegetation growth and consequently food production, one of the most important human activities that allows us to thrive as a society. The poor soil conditions in the urban environment make it very difficult to sustain healthy trees and vegetation. Urban soil is “modified through the regrading, compaction, cutting and filling, and, sometimes, contamination that comes with creating buildings, roads and associated land uses”, changing the physical, chemical and biological structure of soil. (Trowbridge and Bassuk 3) In general, urban areas require better waste management methods that could use an abundant resource of food and yard waste to make compost. This thesis focuses on composting organic waste in the McNair neighborhood of Fairfax County in order to produce a resource to improve the soil conditions. This improvement would support the vegetation in this urban environment, and, in addition, sequester carbon and divert materials that otherwise would go to landfills. This thesis demonstrates a sustainable method for composting food and yard waste in a mixed-use community in northern Virginia turning waste material into a resource.

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GENERAL AUDIENCE ABSTRACT

The growth of cities has a negative impact on the native soil and vegetation. The expansion of urban areas weakens the microorganisms that live in the soils through soil compaction for the construction of roads and buildings, runoff pollution and the use of chemicals in lawns and gardens. These urban conditions challenge the growth of trees and vegetation in general. Using sustainable waste management practices in cities we can turn organic waste material and turn it into an organic fertilizer to sustain the microorganisms in the soil and promote the growth of vegetation in urban areas. This thesis focuses in composting food waste and yard waste in the McNair neighborhood in Fairfax in order to turn a waste material into a local resource that benefits the community by sustaining green areas and diverting organic waste from going to landfills.

ACKNOWLEDGMENTS

I would like to thank my graduate advisor Nathan Heavers and my committee members Paul Kelsch, Douglas Hays and Susan Piedmont-Palladino for their guidance and support throughout the MLA program.

I would also like to thank my wife Stephanie, my two sons (Walter and Ricardo) and my parents for their encouragement and unconditional support.

Many thanks to all my classmates for allowing me to learn from them in each of their expertise and for contributing directly and indirectly with their comments and feedback.

Special thanks to:

Bernard C. Osilka - Department of Public Works, Prince William County

David Phillips – Director Project Planning and Cost Engineering, AECOM

Jake Klitenic - JK Enterprises / Madera Farms

Josh Etim - Compost Alex

Justen Garrity - Veteran Compost

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CHAPTER 1 - INTRODUCTION

There is much emphasis on the importance of green spaces in densely populated areas. They have an important role in cities offering outdoor space for recreational activities allowing people in the community to interact with each other, enhancing the environment aesthetics of the neighborhood, and increasing the property value in surrounded areas. Unfortunately, these green areas often come as an afterthought on a site where the soils have already been altered to their detriment. “Most places in which we live, whether rural, suburban, or urban, have been significantly impacted by human activities-building houses or businesses, creating roads, or laying pavement for sidewalks or parking lots.” (Trowbridge and Bassuk 2).

Vegetation growing in the urban environment has more challenges for surviving under urban environment due to the soil conditions such as topsoil removal, runoff pollution, air pollution, lack of drainage due to soil compaction, soil erosion, salinization, increased heat loads, among others. “Plantings are made with little appreciation or attention to the character and quality to the material that lies beneath the surface. Or, as an alternative, the material is removed and hauled away, making room for a specified amended backfill material, which may only compound the problem because of the lack of drainage or the presence of contaminants in the surrounded urban material.” (Craul 1).

The rapid population growth in urban areas demands more resources to be available for the ever-growing number of people living and working in cities. Covering 2.7% of the world’s land (excluding Antarctica) (Administration), cities concentrate an important amount of resources that once consumed turns into waste material. As a result, this produces challenges and the need for a sustainable waste management system. Commonly, all municipal solid waste (also known as trash, consisting of everyday household items) from urban areas is collected and delivered to landfills located in the periphery of cities and urban areas. The waste material is then buried or incinerated. These landfills have a lifespan according to their size and type of operation and with time become part of the urban environment with the growth of urban areas.

If people in urban areas would start separating all compostable organic waste such as food waste and yard waste from regular household waste, the same way we separate all recyclable items from solid waste materials, people could turn a waste product into a resource through composting methods; in addition, if this is type of operation would happen in an area where the soil profile has urban characteristics then this material could be used to amend and improve the soils. In addition to sequestering carbon in the soil, composting diverts material from landfills, producing methane gases and running the risks of leachate filtration into wetlands.

CHAPTER 2 –URBAN SOILS IN FAIRFAX COUNTY

2.1 Urban Areas

According to the Census Bureau, urban areas represent “densely developed territory, and encompass residential, commercial, and other non- residential urban land uses.” The Census Bureau identifies two types of urban areas: Urbanized areas, which consist of 50,000 people or more and Urban clusters of at least 2,500 and less than 50,000 people. (U. S. Bureau). In order to have a better understanding of the sizes of urban areas in the United States the largest one is New York-Newark, NY-NJ-CT with a population of 18,351,295 people in 2010 and an area of 3,450.2 square miles. In contrast, Lake Rancho Viejo, CA urban cluster is the least populous urban area and urban cluster with the minimum population of 2,500 people. (U. S. Bureau).

Undoubtedly, with a constant population growth in urban areas, it is clear that people are choosing to move to densely populated places, according to the Department of Economic and Social Affairs of the United Nations, the World Urbanization Prospect of 2018 revealed that more than half of the world’s people live in urban areas (55% more from 30% in 1950) and projected that by mid-century roughly two thirds of the world’s population (68%) will be living in urban areas. (Affairs 1). Although urbanization has a positive role in the social development, economic and technological growth of an area one of the main challenges in urban areas is managing the waste production of the increasing number of people, which involves collecting and transporting the material to be processed in a safe manner.

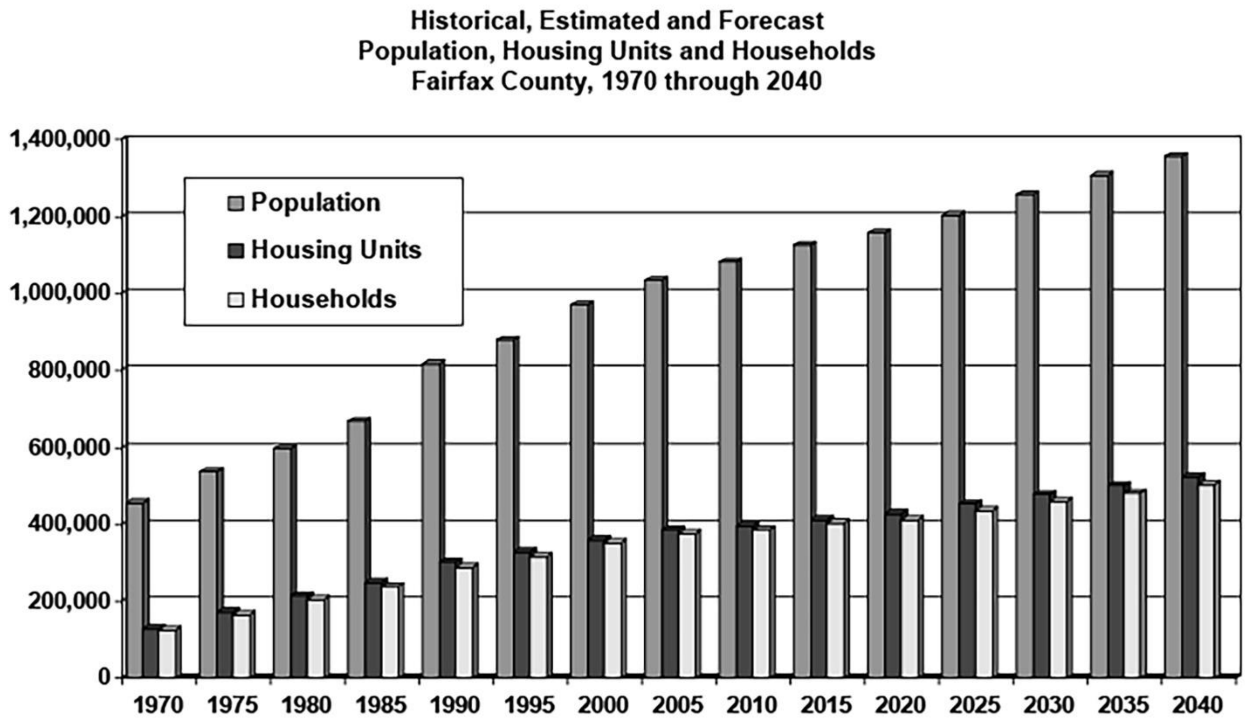


Figure 1: U.S. Bureau of the Census, U.S. Censuses of Population and Housing, population, 1970 - 2001 housing units and households 1970 and 1980.Fairfax County Department of Neighborhood and Community Services, 2016 Integrated Parcel Lifecycle System (IPLS)

2.2 Urban soil characteristics

The soil characteristics in the urban environment have major consequences on the health of trees and vegetation overall. The soil profiles in cities are primarily designed for roads, people, buildings and utilities and everything else that makes it possible to live in cities. One of the most common urban structures are parking lots. “It is estimated that 500 million surface parking spaces exist in the United States alone-a number that increases every day. In some U.S. cities, parking lots cover more than a third of the land area, becoming the single most salient landscape feature of our built environment.” (Ben-Joseph xi). Sealing the pavement with impervious surfaces prevents water filtration into the ground and increases the amount of water runoff into rivers and streams, the excessive amount of water reaching existing streams often alters the natural shape of the stream, deteriorating and losing their ragged vegetated edges. “As runoff flows across paved parking lots, water temperature rises and pollutants such as oil, metals and soils are carried into streams and waterways. Consequently, decreases in oxygen levels and increases in nitrogen threaten the thresholds needed to keep the healthy habitat.” (Ben-Joseph 32). In addition, paved surfaces also produce something known as “soil sealing” killing the microorganism that live in the soil. The life underneath our feet is what promotes vegetation growth sustaining people and animals that depend on it for survival.

The area of paved surfaces is expected to grow in urbanized areas. The United States alone is estimated to have sixty-one thousand square miles of paved ground while in Europe the paved surface area has grown 78% since 1950 (Bogard 5). The increasing number of paved grounds in urban areas need a design system that allows water to access the ground as it happens in nature, allowing green spaces to have the right soils that can hold nutrients and sustain healthy and abundant vegetation.

2.3 Fairfax's soil and history

For the location of this thesis project I have decided to focus on Fairfax County in Virginia. Fairfax is the jurisdiction with the highest population in the region which made it a good candidate for the study of composting in urban areas using food waste.

In order to understand the native soil in Fairfax it is important to make clear what is referred to "Urban soils." Urban soils are areas that have been disturbed, also called "made land". "This includes areas that have been compacted, cut and filled, graded or altered in order to cover them with an impervious surface as buildings, roads, parking lots, etc. On the other hand, native soils consist of soils developed by natural processes from a parent material sharing similar characteristics.

The native soil in Fairfax County can be defined into three major regions. The eastern part of the county is underlain by sediments of the Coastal Plain Province. The Central Part is underlain by crystalline metamorphic and igneous rocks of the Piedmont Province. The western part is underlain by sedimentary and crystalline rocks of the Triassic Basin Province. (Services 5).

Coastal Plain:

This physiographic Province occupies approximately 26 percent of Fairfax County predominantly the area east of Shirley Memorial Highway (I-95). The Coastal Plain consist of unconsolidated sand, silt, clay and gravel strata deposited by ancient oceans and freshwater rivers. This physiographic province can be divided into the High Coastal Plain and Low Coastal Plain. The High Coastal Plain can be found in elevations above 150 feet from sea level. The Low Coastal Plain is between 150 feet and sea level. The soils of the High Coastal Plain tend to be better drained and gravellier than those of the Low Coastal Plain. (Services 5)

Piedmont Upland:

The Piedmont Upland Physiographic Province cover approximately 56 percent of Fairfax County. Located in the central part of the county, west of the Coastal Plain and east of the Triassic Basin. The province is underlain by metamorphic rocks, predominantly micaceous schist, granite, gneiss and greenstone. Areas with greenstone bedrocks can feature soils with thick plastic clays and naturally occurring asbestos fibers. Hilltops are typically wide and rolling, except in places along the lower tributaries of large streams. Here, V-shaped valleys with steep slopes and narrow ridges occur. (Services 5)

Triassic (Culpeper) Basin:

The Triassic Basin, or Culpeper Basin is a sub-province of the Piedmont Upland. It occurs in the west along the border with Loudoun and Prince William Counties occupying approximately eighteen percent of the county. The geology consists largely of red sedimentary (sandstone, siltstone, shale and conglomerate) rocks. Two horseshoe-shaped intrusions of igneous diabase, diorite and syenite, and metamorphic hornfels occur in the vicinity of Herndon and Centreville. The drainage is somewhat dendritic, but not as well developed as the Piedmont Upland. The hilltops are wide and gently rolling, with long gently sloping side slopes and nearly level areas. (Services 6)

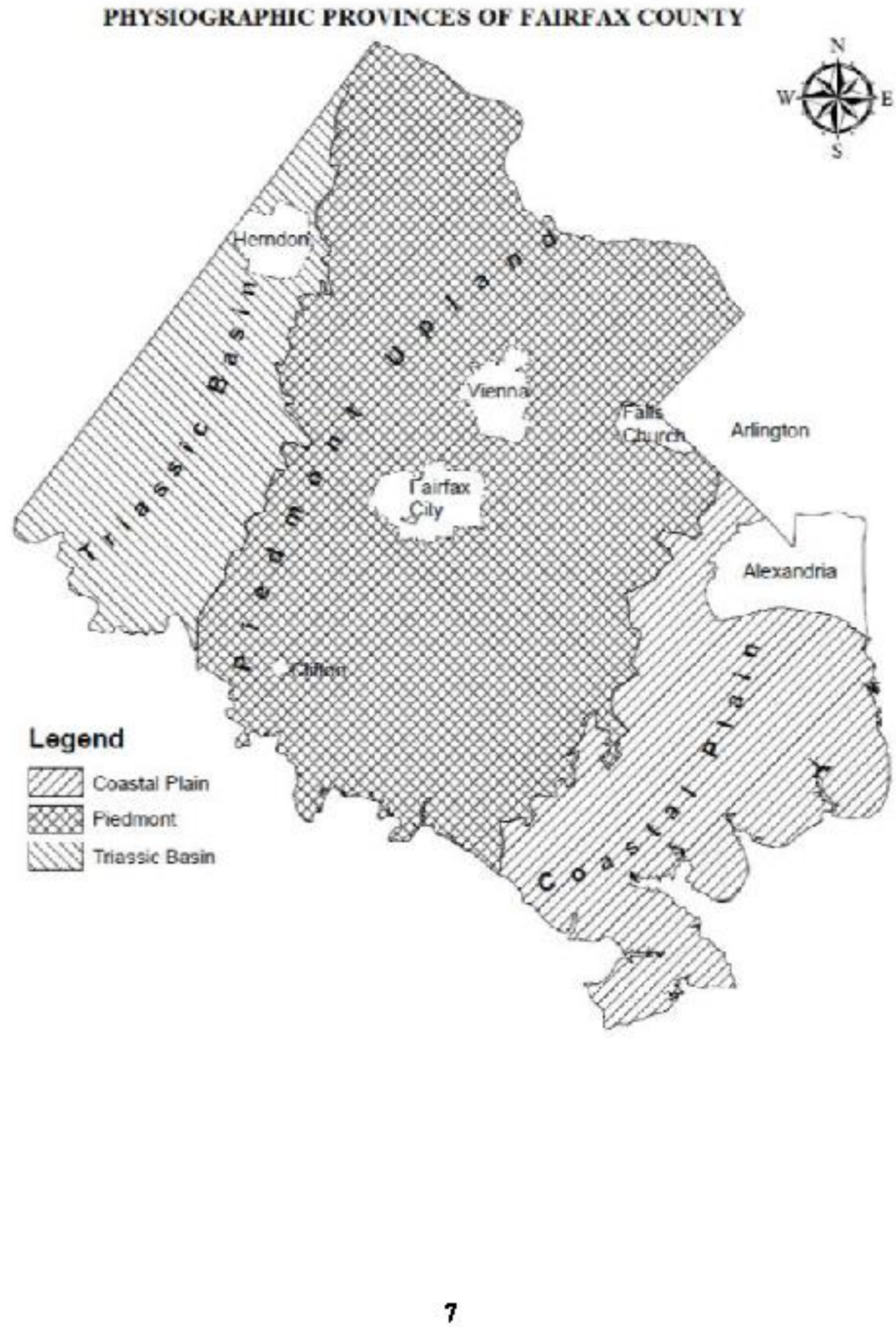


Figure 2: Description & Interpretive Guide to Soils in Fairfax County, page 7. 2013.

The ground in Fairfax County was originally covered by hardwood trees mixed with scattered Virginia pine and red cedar. According to the Soils Survey of 1963, there were small numbers of hemlocks along Occoquan Creek and Occoquan Bay in the southern part of the county. The Lower Coastal Plain and cool sites of the Piedmont Upland had a presence of Yellow-poplar and other hardwood trees. The drier sites of the Coastal Plain and Piedmont Upland were covered by Oaks and Virginia Pine trees, while the Piedmont Lowland had an abundance of Oak scattered pine and redcedar trees. (Agriculture 7)

In 1608 while Captain John Smith was exploring the area bordering the Potomac River, the local Indians had been working the land for about two thousand years growing corn, beans tobacco and squash. The native people that lived in what now we call Fairfax County were adapted to the climate and geography that the Ice Age had left behind (11,000-5,000 B.C.). Their main village located near the Occoquan was called Tauxenent. By the eighteen-century Fairfax County included Loudoun and Arlington counties, including the cities of Alexandria, Falls Church and Fairfax. The county was an agricultural society based on raising tobacco with black slave labor. After 1800, with the river town of Alexandria no longer the county seat, and the national economy changing, Fairfax County went into a long economic decline. (Donald M. Sweig)

“The soil in the county was exhausted from the overplanting of tobacco, many farmers left the county with their families and slaves in search or fertile land. By the 1840’s farmers from the north, many of them from New York, began to immigrate to Fairfax buying the abandoned farms and bringing with them new agricultural practices to the worn-out soils of Fairfax County, working the land with paid labor. Northern Quakers purchased over two thousand acres near Mount Vernon and cut the white oak forest for lumber to sell to northern shipbuilders. Fairfax underwent an agricultural revival increasing its population from 9,370 in 1840 to 11,838 in 1860. This included its migrant population; by 1847, some two hundred northern families had moved to Fairfax County and by 1850, one in three adult white males had migrated from the northern states or a foreign country. This blooming in the county came to a stop with the Civil War." (Donald M. Sweig 1).

Following the Civil War, Fairfax County continued its agricultural production with many Union soldiers and free slaves establishing in the county. The latest most significant population and economic growth began after the Great Depression, continuing until the Second World War to this day. According to Fairfax County data, the increase in new housing units from 1970 to 190 was 131% but only 31% from 1990 to 2010. (County, Housing and Population through the Decades in Fairfax County) The development of urban areas, government facilities and transportation changed the county from a rural agricultural area to a predominantly commercial and residential community. (Donald M. Sweig)

CHAPTER 3 – COMPOSTING METHODS

3.1 Composting history

The Oxford dictionary defines the word compost as "decayed organic material used as a fertilizer for growing plants." (Oxford) which is the simplest way to summarize the natural process in which all organic matter is decomposed by microorganisms under the right conditions, becoming a humus nutrient rich soil amendment which is called compost. This is the process in which all biodegradable material returns into the earth to support new life closing the natural cycle before it starts all over again.

The word "Compost" comes from the Latin "Componere" meaning "put together" often used in the arts, for example writing music is also called a composition; however, it was in France where the word "Composte" took the meaning of mixing organic materials in order to turn organic waste into a soil amendment. Although this practice is becoming more popular again, the origins of this activity could have started intentionally or as an unintended consequence of field preparation or waste disposal in the form of animal manure at some point in history.

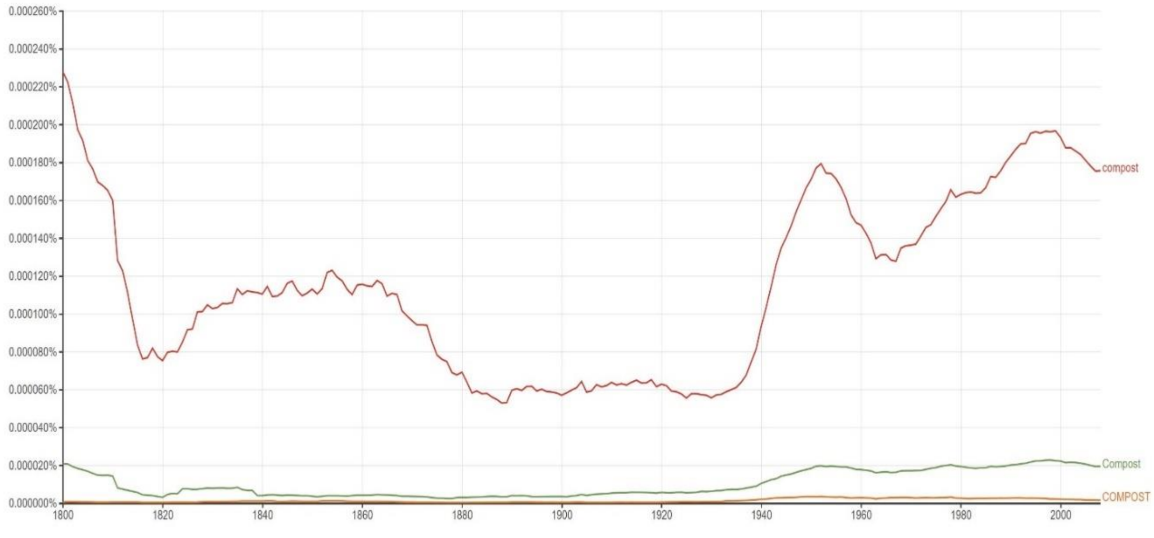


Figure 3: Use of the word Compost over time between 1800 and 2008. https://books.google.com/ngrams/graph?content=compost&case_insensitive=on&year_start=1800&year_end=2019&corpus=15&smoothing=7&share=&direct_url=t4%3B%2Ccompost%3B%2Cc0%3B%2Cs0%3B%3Bcompost%3B%2Cc

We can look at some of the earliest references available for using organic waste as a soil amendment, some of them dating back thousands of years. “The Clay tablets from the Akkadian Dynasty (2320 BCE – 2120 BCE) of Mesopotamia (now Iraq), contain mention of the use of manure as fertilizers- at least 1000 years before Moses.” (Peza 2) Similarly, the bible also mentions the use of manure and rotted straw in addition to the same mixture soak in water, or what we call today “compost tea”, for the use of fertilizing the fields. “The Talmud, a collection of laws and doctrines written by ancient Jewish teachers between 200 and 500 CE, talks about straw, ash, grass and chaff being used in the soil (along with blood from animal sacrifices) as fertilizer. (Peza 2)

The Greeks and Romans were also familiar with the practice of composting, and beyond Europe, indigenous people in every continent were composting at some point. “The practice of burying fish in corn planting hills was taught to early European settlers in New England, along with the collection of seaweed from coastal areas. The ancient Mayans and other Mesoamerican peoples used sophisticated systems that integrated fish culture and plants to fertilize crops from the rich sediment from their fishponds.” (Gershuny) In South America, the Incas believed in feeding back the land, or Pachamama as they referred to Mother Earth. This pre-Columbian practice would ensure the next harvest, often burying a fish in the ground where the planting would happen.

All this knowledge survived through the years and became essential for European settlers as they improved their methods by practice. “Public accounts of the use of stable manure in composting date to the 18th century. Early colonial farmers abandoned the fish-to-each-hill-of-corn system-of fertilizer when they discovered that by properly composting two loads of muck and one load of barnyard manure, they obtained a product equivalent to three loads of manure in fertilizing value.” (Gershuny 3) Farmers had to adapt to what was locally available, some of the most famous American promoters of composting were George Washington, Thomas Jefferson, James Madison and George Washington Carver. “According to Paul L. Haworth, author of the 1915 biography: George Washington: Farmer, Washington “saved manure as if it were already so much gold and hoped with its use and with judicious rotation of crops to accomplish” good tilth”. (Gershuny 4)

By the mid 1800’s new methods of composting were being developed. In 1840 German scientist Justin von Liebig found that plants’ health could benefit from some chemical solutions developing artificial chemical fertilization. In 1905 British agronomist Sir Albert Howard, father of the organic method developed a concept that consisted of three times as much plant matter as manure calling it the Indore method. Where the layers of material would be turned regularly to speed the decomposition process.

Other proponents of organic compost in Europe included Rudolf Steiner, who took organic farming through a holistic understanding, Anne France-Harrar was the creator of the scientific basis for compost and Lady Eve Balfour was an organic farmer and proponent of composting in England. (Peza 4) In the United States, in 1942 J.I. Rodale introduced the practices of Sir Albert Howard’s work to American gardeners and farmers. He created the Organic Gardening magazine (discontinued in 2015). New development in the process of composting includes adding rock dust, biochar, shredding material and moisture control in order to accelerate the decomposition process.

3.2 Process and materials

In order to break down organic matter in the process we call compost a mixture of carbon and nitrogen (C:N) material need to be mixed at a proper ratio under the right conditions in addition to water and oxygen that support aerobic microorganisms that break down the organic matter. A carbon source that is abundant in the urban environment are trees and leaf mulch in combination with a nitrogen source which comes from food waste. The process is the following: bacteria, fungi and other microbes obtain the nutrients they need from a carbon source; it also needs nitrogen to produce enzymes used in the decay process. (Lewis 120)

The moisture content in the pile is necessary to provide an optimum environment for the microorganisms and to prevent them from going into dormancy. “Air is needed because the beneficial soil organisms that break down carboniferous and nitrogenous materials are aerobic”. (Lewis) It is possible to obtain similar results under anaerobic conditions; indeed, anaerobic conditions could happen under static piles or windrow composting if the material is not turned periodically. In that case the oxidation of the material would form a crust in the pile trapping gases generated by the anaerobic process such as methane, organic acids, hydrogen sulfide, and other substances. (Rynk 8) In this anaerobic process the heat decreases, and the decomposition process slows down.

There are many aerobic ways of composting organic matter. In nature, the natural process of breaking down leaves, trees and any other organic material takes more time to turn into compost, what farmers do is mimic what happens in nature and alter the conditions that accelerate the process of composting in order to produce compost faster. There are many ways of decomposing materials aerobically or anaerobically, farmers generally use one of four composting methods: passive composting, windrow composting, aerated piles, and in-vessel composting.

Passive composting involves stacking organic material in piles to decompose over a period determined by the moisture content and weather conditions. Mixing or layering the carbon and nitrogen material is required in order to break down the organic matter. This method is very popular for people in residential areas with gardens, it requires a minimum pile of three cubic feet in order to maintain the heat that activates the microorganism in the pile and start the decomposition process. The bins used for this range from wood, cinderblocks, bricks or plastics containers, anything that will keep the pile firm. "This passive method of composting is essentially windrow composting but with a much less frequent turning schedule. It is a common method used for composting leaves. It demands minimal labor and equipment. Passive composting is slow because of its low aeration rate, and the potential for odor problem is greater". (Rynk 24)

Using the windrow composting method, the organic waste is mixed with a carbon source such as woodchips (mulch). The mixed material is then formed into long narrow windrows. Windrows require periodic turning either by hand or with a shovel, a bucket loader or special turning machine in order to rebuild the porosity of the material after being compacted in the mixing process. It also releases heat and gases as well as feeding the microorganisms with oxygen. This method requires enough space to move the material through the different stages of decomposition.

The aerated pile method is similar the windrow method where carbon and nitrogen materials need to be mixed and piled in windrows; however, aerated piles uses forced air through pipes underneath the windrow that feed the windrow with oxygen accelerating the decomposition process and eliminating the need for turning the windrow. "Because the raw materials are not turned after the windrows are formed, they must be thoroughly mixed before they are place in the windrow." (Rynk 29) Avoid any compaction as it is important for air to be able to go through the window, a base material of peat and compost is needed to support the pipes. Other methods have channels imbedded in the concrete floor where air goes through. In that case a bedding of mulch is needed to maintain the porosity of the bed. Once the composting process is completed the pipes are simply pulled out of the windrows and the bedding material is mixed with the compost. (Rynk 29)

In-vessel composting is a combination of all the other methods but instead of mixing materials in piles it uses a building, large container or vessel. This in-door operation mixes and shreds the materials in a mechanical process in order to speed the composting process, combining the aeration method of periodically turning the material and the forced aeration of static pies. Using rectangular agitated beds is an example of in-vessel composting. The composting process takes place between long narrow channels called beds. Raw material is placed on one side of the bed, typically using a front loader. A mechanical turner mixes the material pushing it toward the other side of the bed. Air is forced from the bottom of the beds into the channels. Each bed has sensors that monitor the temperature activating the turning and aerating mechanism. (Rynk 24)

COMPOSTING OPERATION

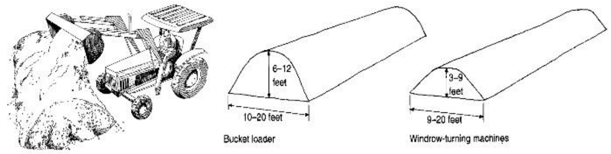
PASSIVE PILE

HANDLING COST: MINIMAL EQUIPMENT

EQUIPMENT: BUCKLOADER NEEDED TO BUILD WINDROWS

DIMENSION: WINDORWS ARE 10' - 20' WIDE UP TO 12' TALL

TIMING: FROM 9 MONTHS TO A YEAR



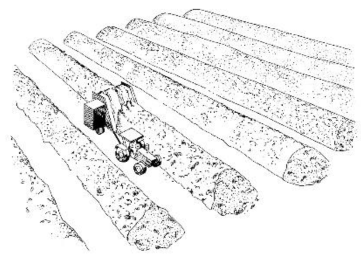
WINDROW COMPOSTING USING LOADER FOR TURNING

HANDLING COST: MINIMAL EQUIPMENT

EQUIPMENT: BACKLOADER AND ROTARY DRUM

DIMENSION: WINDORWS ARE 10' - 20' WIDE UP TO 12' TALL

TIMING: UP TO 9 MONTHS



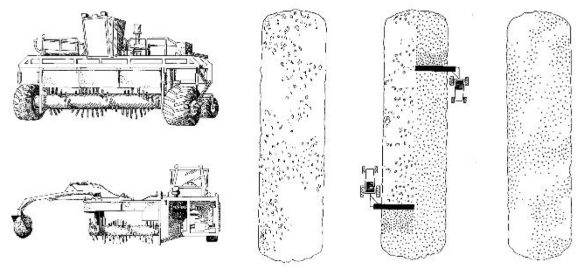
WINDROW COMPOSTING USING SPECIALIZED WINDROW TURNERS

HANDLING COST: MECHANICAL EQUIP AND MAINTENANCE

EQUIPMENT: BACKLOADER AND TURNING E QUIP

DIMENSION: WINDORWS ARE 9' - 20' WIDE UP TO 9' TALL

TIMING: UP TO 9 WEEKS



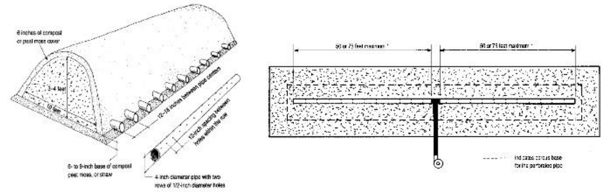
AERATED STATIC PILE SYSTEMS

HANDLING COST: MECHANICAL EQUIP AND MAINTENANCE

EQUIPMENT: BACKLOADER AND AIR CIRCULATION SYSTEM

DIMENSION: WINDORWS ARE 10' WIDE UP TO 4' TALL AND UP TO 75' LONG

TIMING: UP TO 5 WEEKS



IN-VESSEL SYSTEMS

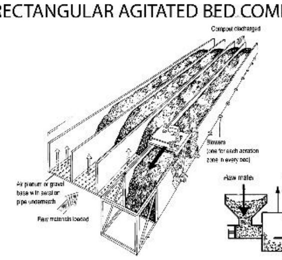
HANDLING COST: MECHANICAL EQUIP AND MAINTENANCE

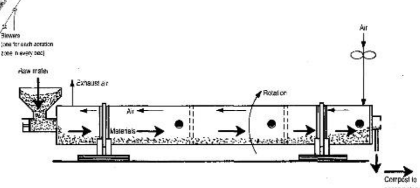
EQUIPMENT: BACKLOADER AND TURNING E QUIP

DIMENSION: VARIES

TIMING: UP TO 5 WEEKS

RECTANGULAR AGITATED BED COMPOSTING SYSTEM - 6' - 20' WIDE FROM 3' TO 10' TALL OVER 100' LONG





ROTATING DRUMS - 11' DIAMETER UP TO 120' LONG

Figure 4: Types of composting operations, On-Farm Composting Handbook by Robert Rynk, chapter 4 page 24

3.3 Windrow Composting: Drawbacks and benefits

Windrow composting is the recommended method for the purpose of this thesis project. The simplicity of its process and the flexibility of sizing the piles according to the amount of material available makes it an ideal method for an operation that needs to be close to high populated areas with high value real estate. Windrow composting has the advantage of being a temporary operation that could move to different locations without the need of a facility or aerated equipment, although it requires enough space for storing, mixing and curing material.

As mentioned, windrow composting consists of piling long narrow windrows of mixed nitrogen and carbon materials that need to be turned periodically controlling the moisture levels. The size of the windrow typically starts at three feet high for heavy materials like manures and goes up to twelve feet high for lighter material such as leaves. The width of the window varies between ten to twelve feet. The size of the windrows depends on the size of the equipment being used to turn the material and the ratio of materials. The recommended ration for composting food waste is 3:1 carbon to nitrogen. After mixing carbon and nitrogen materials a reduction of 20% in volume happens added to a 025% due to compaction after a month of periodically mixing the windrow.

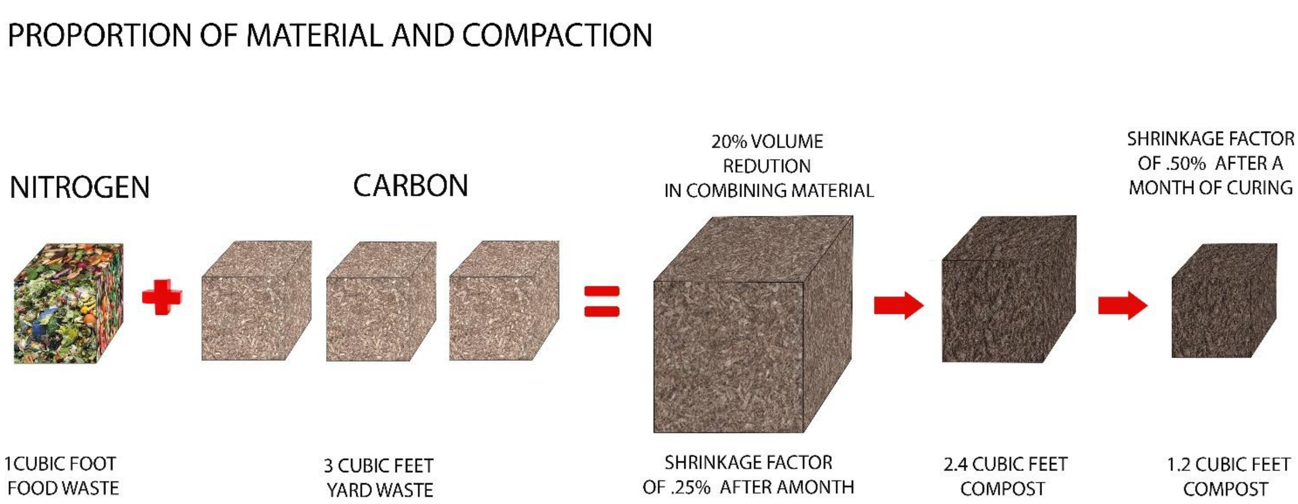


Figure 5: Carbon and nitrogen material and compaction ratio

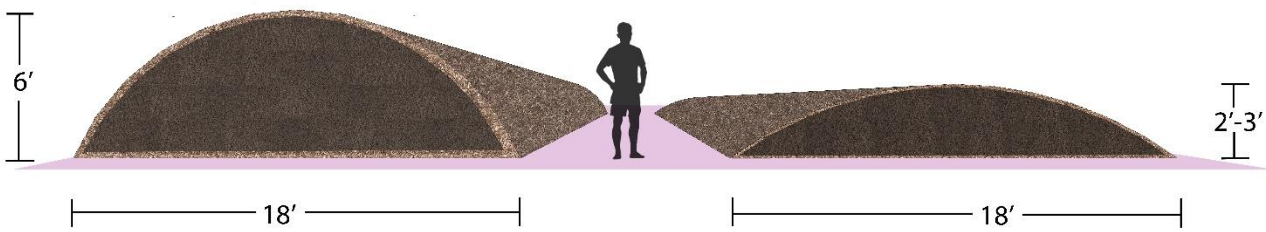


Figure 6: Windrow compaction comparison between a recent mixed windrow and a cured windrow

One of the drawbacks of a windrow composting operation is the space needed for the different stages of composting. The site should have enough space for vehicles to be able to come into the site delivering materials. There should also be enough space for storing the carbon material in order to have enough during the time that it is less available.

The mixing area is determined by the amount of material handled and the type of equipment being used to turn the windrows, a bucket loader would typically build windrows twelve feet tall and twenty feet long. (Rynk 71) The space needed in between windrows could be from ten to fifteen feet in order for machinery to be able to go through turning the windrows. After the material is mixed and rested it is moved to a curing area. In this stage the material is left untouched for at least a month, depending on the volume. This process ensures that the compost is mature enough to use. “An immature compost continues to consume oxygen and thereby reduces the availability of oxygen to the plant roots. Immature compost can also contain high levels of organic acids, a high C:N ratio, and other characteristics that can be damaging when the compost is used for certain horticultural applications.” (Rynk 13). The volume of material that comes from the mixing stage has reduced in size by a shrinkage factor, so the space for curing process is less than the mixing area. In addition, windrows in the curing process can line up next to each other, also referred as toe to toe windrows. Since it no longer needs to be turned there is no need for space in between windrows for machinery to go through.

Odor control is an important aspect of windrow composting, although aerobic conditions should not generate any odorous compound. It is possible that certain raw material may generate odors. In farms, the best solution to deal with this issue is a large distance between the windrows and people; however, aerobic composting methods can manage odorous conditions with proper management. “Occasionally, equipment problems or unusually wet weather creates problems. In these instances, pungent ammonia odors can be controlled by providing extra carbon in the mix and maintaining the PH level below 8.5.” (Rynk 58). The key for minimizing odors is keeping the material aerated and controlling the raw materials that go into the mix. Setting a bedding layer of carbon material and a combination of mature compost and mulch on the outside layer of the windrow would help control the odors and at the same time would prevent the windrow from losing moisture. In addition, for a composting operation that is set in proximity of a populated area, a place with the least amount of traffic flow would be the most adequate location for the site.

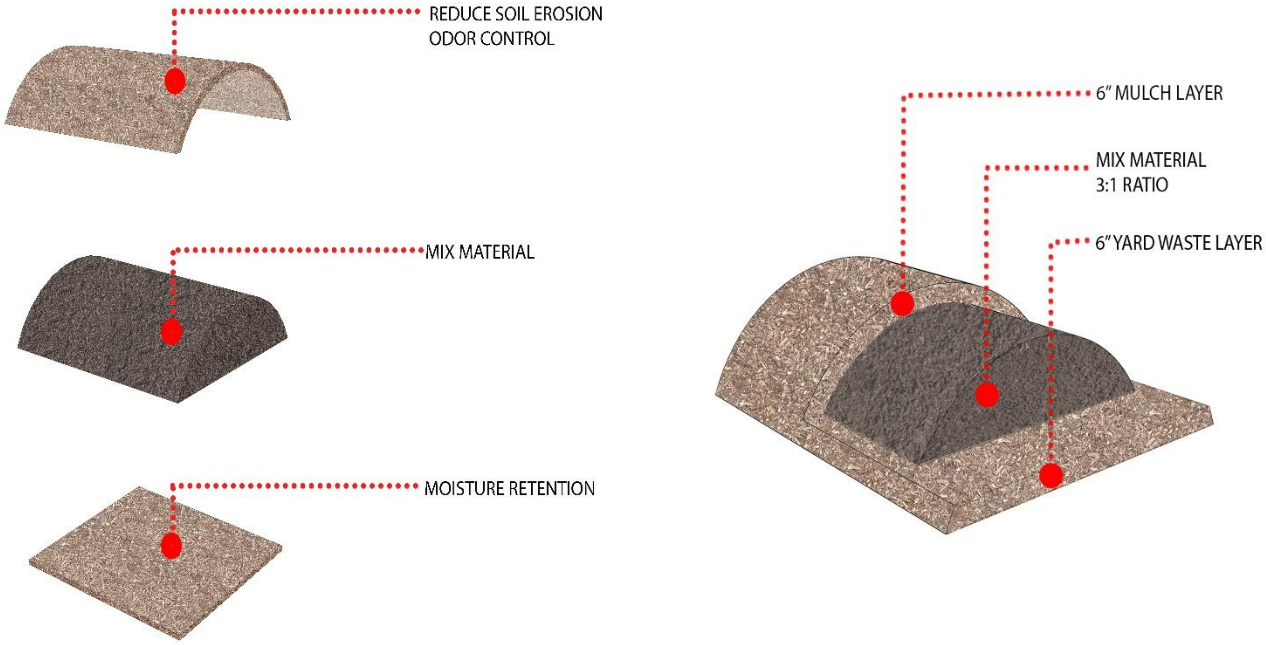


Figure 7: Windrow structure

Another challenge with windrow composting is the drainage requirement. Poorly drained grounds can lead to ponding water generating runoff and muddy conditions. An asphalt or concrete surface is recommended for this type of operation that needs clean accessibility of vehicles dropping, turning and loading the material. The ground slope at the site should be 1% at the minimum and an ideal of 2-4% (Rynk 64). Any runoff should be diverted away from the windrows and into an infiltration area or holding pond before going into any wetlands. All these environmental considerations require space that could be hard to find in urban areas and that would be considered the biggest drawback for composting in urban areas. The proximity to high valued properties makes it difficult to set up an operation that would fit all of these conditions;

however, the benefits of being able to process and turn waste materials into a valuable product within a community could surpass all the drawbacks.

The benefits of having a compost operation in the urban environment include:

- creates a source of soil amendment which is needed on disturbed grounds
- improves the soil structure and increases nutrient content in the soil
- improves moisture retention reducing water runoff and soil erosion
- reduces the amount of waste from going into landfills and incinerators.

In addition to all the environmental aspects previously described, composting in the urban environment could create a valuable commodity for the community in terms of saving resources in soil amendments in order to provide a healthy environment for vegetation. The average price of cubic yard of compost in Fairfax County is $35 which is roughly the equivalent for amending ninety square feet of grass area at a depth of 3" of compost. Other potential users for compost in urban areas are people with gardens, farmers, commercial landscape care companies, golf course operators, etc. Furthermore, composting organic waste in the urban environment, through the windrow method, could become part of the solution for the solid waste crisis affecting urban areas by the increasing number of people living in cities, at the same time closing natural cycle which produces a nutrient rich resource capable of sustaining life.

3.4 Examples of Compost operations in Fairfax County

Fairfax county's Solid Waste Management (SWM) has taken actions to anticipate and better manage municipal solid waste generated in the county. This includes yard waste and household items. Some of the programs include a backyard composting program in order to reduce the source of organic waste and promote the reuse of this material. In the 1990's, the county initiated a composting and grass cycling program to encourage people composting food waste and yard waste in their backyards using passive pile composting method. The program was called "YIMBY" (Yes in My Back Yard) which intended to reduce the amount of organic waste from going into the solid waste management system. This was a great initiative by the county, and it has been copied to other counties such as Prince William County which gives its residents a discount when buying composting beans from the county; unfortunately, this initiative had limited success due to the small number of people willing to continue the program. However, Fairfax county has internally continued the practice to ensure that all facilities incorporate environmentally sound ground maintenance, grass cycling and composting to the maximum extent possible. (FairfaxCounty 8-3)

Fairfax County Code, section 109-5-2 requires the recycling of yard waste, including yard debris, leaves and grass clippings. This collection program is available to all residents in single family homes and most townhouses in the county. As of 2004, "the county provided leaf collection services to 20,198 household units in 30 approved leaf districts from the end of October through the end of the calendar year". (FairfaxCounty 8-4) The yard waste collection program relies primarily on out of the county composting facilities in order to process the amount of yard waste generated in the Fairfax County. Another method of recycling yard waste within the county is grinding it into mulch available for residents. This mulch material is available for free at the I-95 and I-66 Recycling and Disposal Center located at 9850 Furnace Rd., Lorton, VA 22079 and the

I-66 Recycling and Disposal Center located at 4618 West Ox Rd., Fairfax, VA 22030. Additional locations for collecting free mulch for residents include the following public parks in the county:

- Baron Cameron Park
  11300 Baron Cameron Ave.
  Reston, Virginia 20190
- Bull Run Regional Park
  12619 Old Yates Ford Rd.
  Clifton, Virginia 20124
- E.C. Lawrence Park
  5200 Sully Rd.
  Chantilly, Virginia 20151
- Grist Mill Park
  4320 Mt. Vernon Memorial Hwy.
  Alexandria, Virginia 22309
- Lewinsville Park
  1659 Old Chain Bridge Rd.
  McLean, Virginia 22101
- Pine Ridge Park
  3401 Woodburn Rd.
  Annandale, Virginia 22003

The amount of carbon material produced by the county is more than what it can process on its own. In 2002, Fairfax County sent 54,061 tons of yard debris to out of the county composting facilities. 32,133 tons of yard waste material went to Prince William County Compost Facility at Balls Ford Road, and 21, 928 tons of yard waste material went to Loudoun Composting in Loudoun County. The same year Fairfax County grounded 48,196 tons of brush material and 2,150 tons of vacuumed leaves. (FairfaxCounty)

	2000	2001	2002
Inbound Yard Waste			
I-66 Inbound Brush	28,745	31,100	34,000
I-66 Inbound Leaves and Grass	25,942	27,022	29,380
I-95 Inbound Brush	12,667	15,030	14,085
I-95 Inbound Leaves and Grass	16,508	20,365	18,817
I-66 & I-95 Inbound Vacuumed Leaves	9,000	9,697	8,014
Outbound Yard Waste			
Sent to Out-of-County Composting Facilities	45,060	49,561	54,061
Prince William County Compost Facility	21,414	29,502	32,133
Loudoun Composting	23,646	20,059	21,928
Brush Mulch Distributed	42,450	47,387	48,196
Vacuumed Leaves Mulch Distributed	6,390	7,523	2,150

Figure 8: Fairfax County waste transfer quantities 2000 - 2002 (in tons) Yard Waste - Current Fairfax County Management System 8-10

Prince William County's Balls Ford Road Composting Facility is the only county owned commercial scale composting site in Northern Virginia, this composting facility is in Manassas in an industrial area surrounded by other recycling facilities with a capacity to process up to 50,000 tons of yard debris and food waste per year. Balls Ford Road Composting Facility uses windrow composting method that are turned every few weeks using heavy equipment. The windrows at the site run up to 320' long and about 20' tall sitting on a 30-acre site and taking from seven to twelve months to compost organic waste material. This facility includes a bioretention area, grinding area, mixing area, drop off location of organic waste, screening, curing and storing areas for costumers to pick up materials and sells the cured compost at $25 per cubic yard.

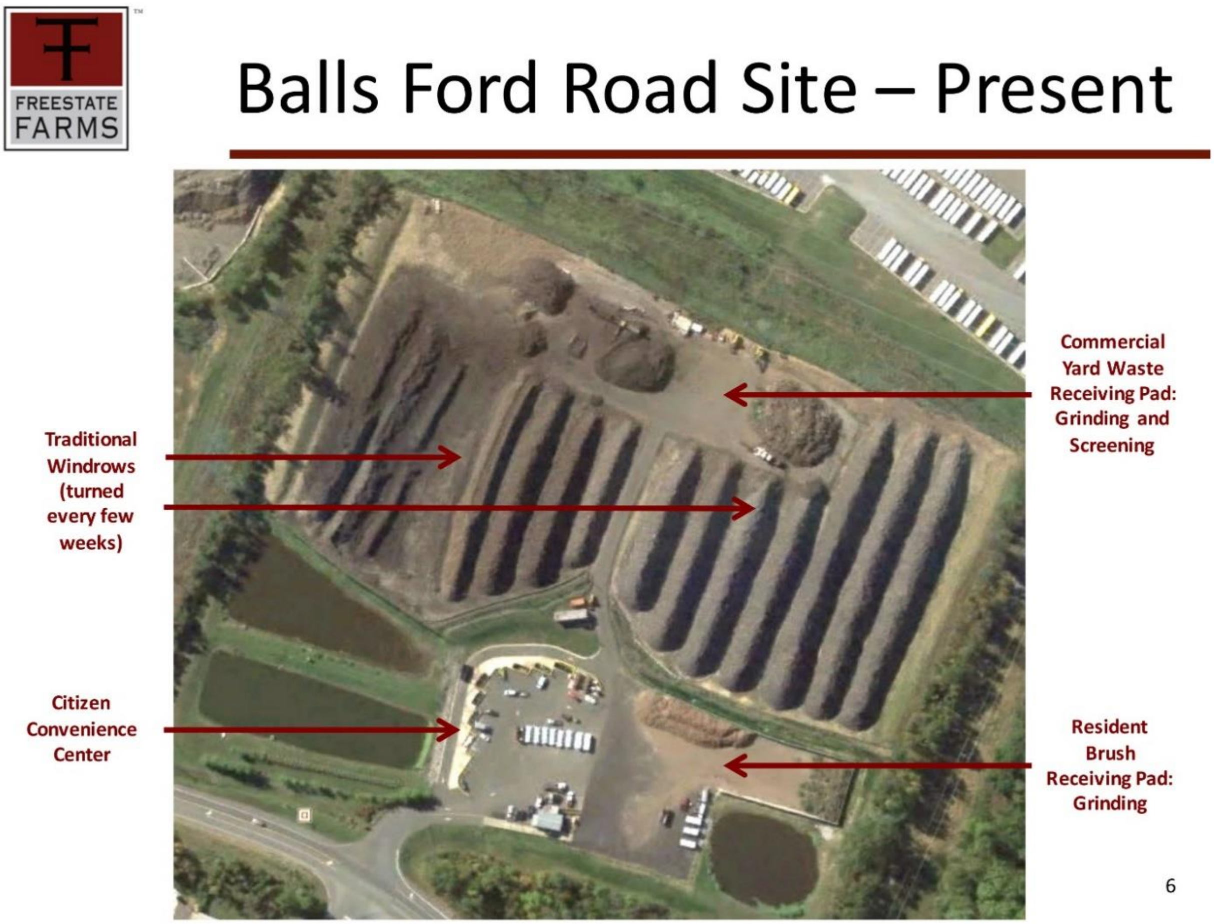


Figure 9:Integrating Anaerobic Digestion into Existing Composting Operation by Freestate Farms *(Farms 6)*

The future of the Balls Ford Road Composting Facility will look completely different with the implementation of anaerobic digestion operation into the site. In 2015 Prince William County and Freestate Farms executed a 20-year contract to redevelop the existing site in order to be able to process the increasing demand for organic waste material. This public-private partnership will allow the Balls Ford Road Composting Facility to process 175,000 tons of yard waste annually that would take about 3 months to have a finish product. Freestate Farms' investment of $10 million in new technology will create a facility that combines different composting methods in order to process organic waste at a faster rate for the increasing demand and future regulations on handling organic waste.

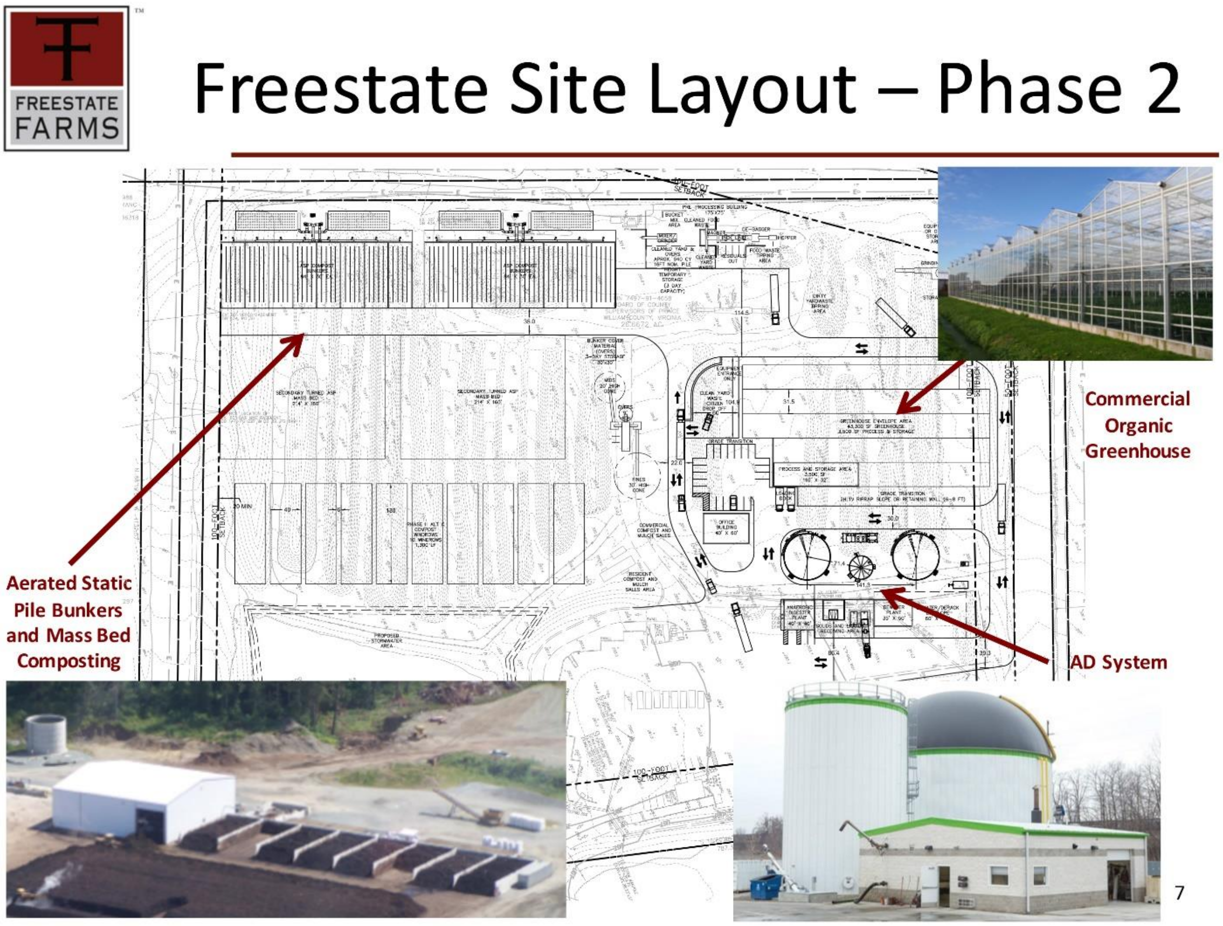


Figure 10: Redevelopment of composting operations at Balls Ford Road Facility by Freestate Farms *(Farms 7)*

CHAPTER 4 – COMPOSTING IN THE URBAN ENVIRONMENT

4.1 Site criteria

The site criteria for a composting operation in the urban environment would require different needs than operations located on farms or landfills in peri-urban areas. This composting facility would need to provide enough spaces for all the different stages of composting and environmental control measures in an area with scarce space available. The advantages of having a composting operation in an urban area are the proximity to the source of organic waste needed for the composting process and the proximity to the end user. Another important element needed is appropriate land conditions. Composting operations need a firm surface to be able to support the constant movement of vehicles and materials. Drainage is another important factor. The nutrient rich runoff from windrows could have a negative impact to wetlands. It is important to be able to provide a bioretention area to allow the treatment of any water runoff coming from the windrows before it reaches bodies of water. Other factors could include pedestrian accessibility, usage of un-used or abandoned sites and proximity to a site with urban soils characteristics in need of soil amendment.

For the purpose of finding a site near a source of organic waste in an urbanized area I have based my research in Fairfax County. Fairfax County is the most populous jurisdiction in the Washington DC area, with a population almost equal to the combined number of people living in Washington DC and Baltimore. Fairfax County has an area of 309.9 square miles containing many urban centers with an increasing number of residents.

Other neighbor counties population are:

- Montgomery County
  1.04 million people
- Prince George County
  909,535 people
- Prince William County
  451,721 people
- Loudoun County
  375,629 people

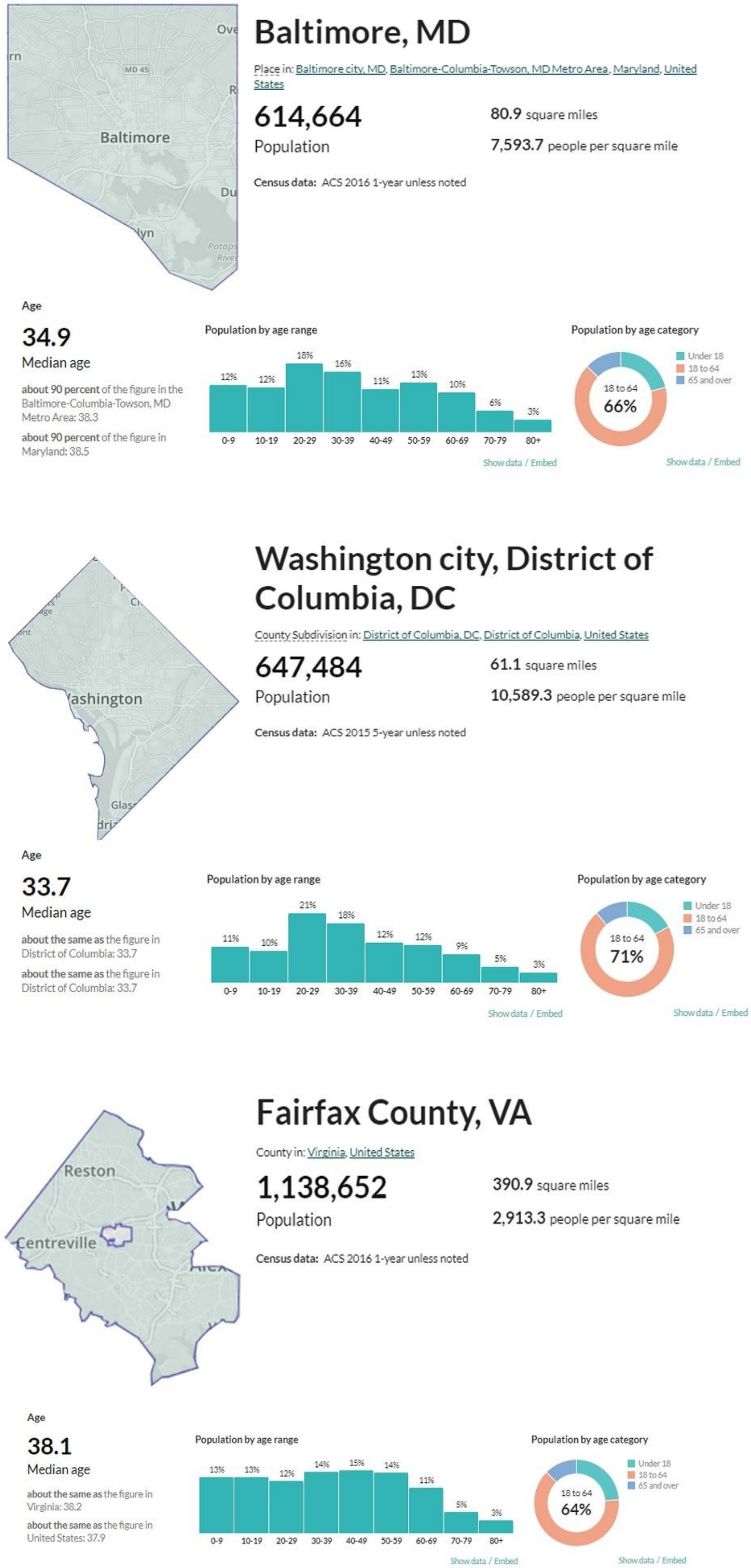


Figure 11: Baltimore, Washington DC and Fairfax Demographic comparison by Fairfax County.

4.2 Site selection

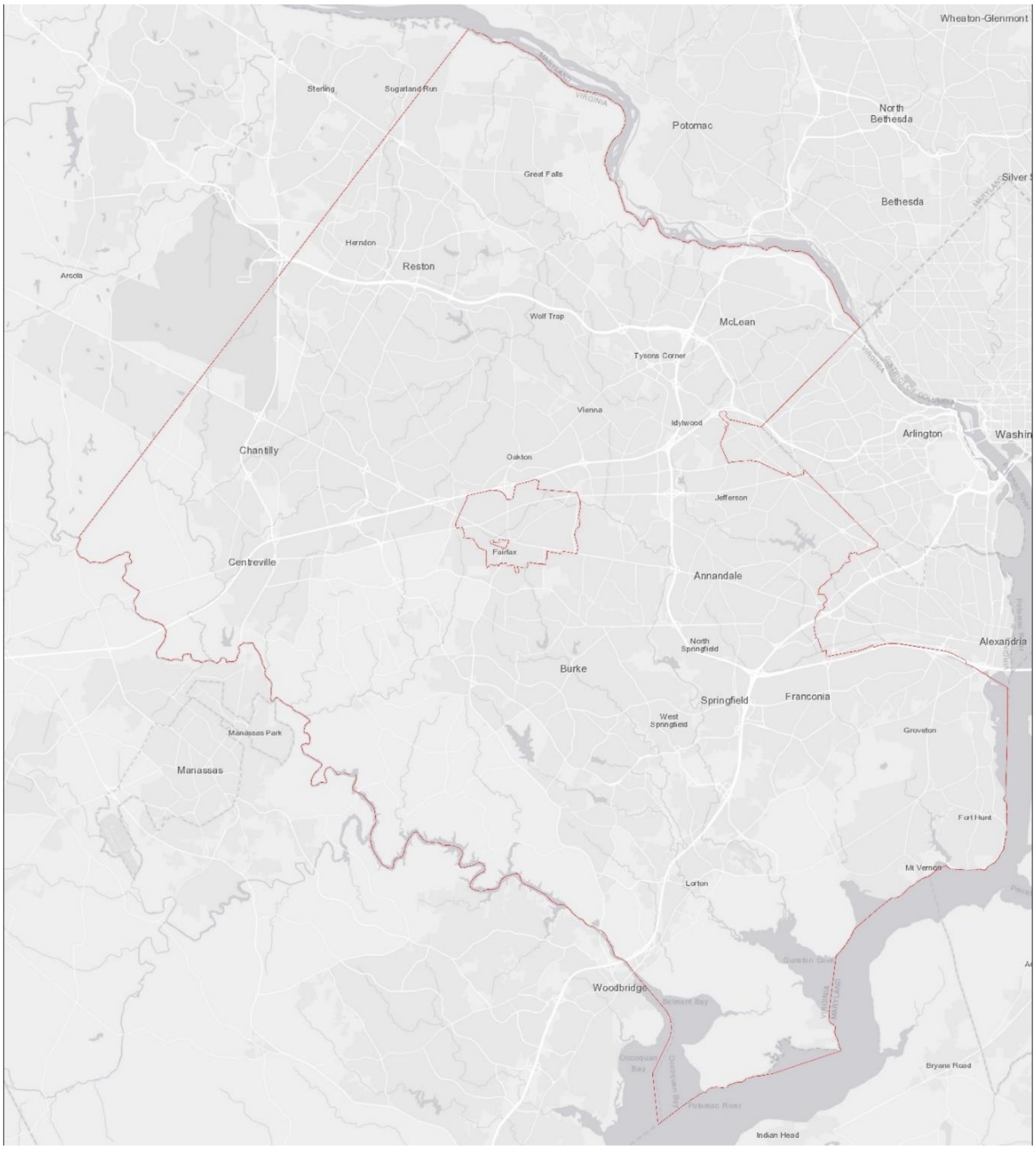


Figure 12: Fairfax County border line

Landfills and farms are places that also serve as composting centers. In the case of landfills, they are designed to process solid waste material that is collected and brought to the landfill. This is material that once it comes into the landfill does not leave, except for recyclable material and yard debris that gets composted. Landfills are subjected to a lifetime of collecting solid waste determined by the type of operation and regulated by the city or county where the landfill is located. Once the working life of the landfill is over, it is sealed with a cover system from all sides to minimize filtration and erosion. (Office)

Farms are places capable of processing their own organic waste by composting it on site. The composted product returns to the land in the form of organic fertilizer. Since its origins Fairfax County has been an agriculture area that has gone through many phases of growth. Today, most of the farms have moved outside of the county as urban areas have expanded. The few farms remaining in the county are horse stables, nurseries, floriculture farms, hay farms, museums and educational centers. Like landfills, the few farms remaining in the county are in peri-urban and rural areas, away from urban centers.

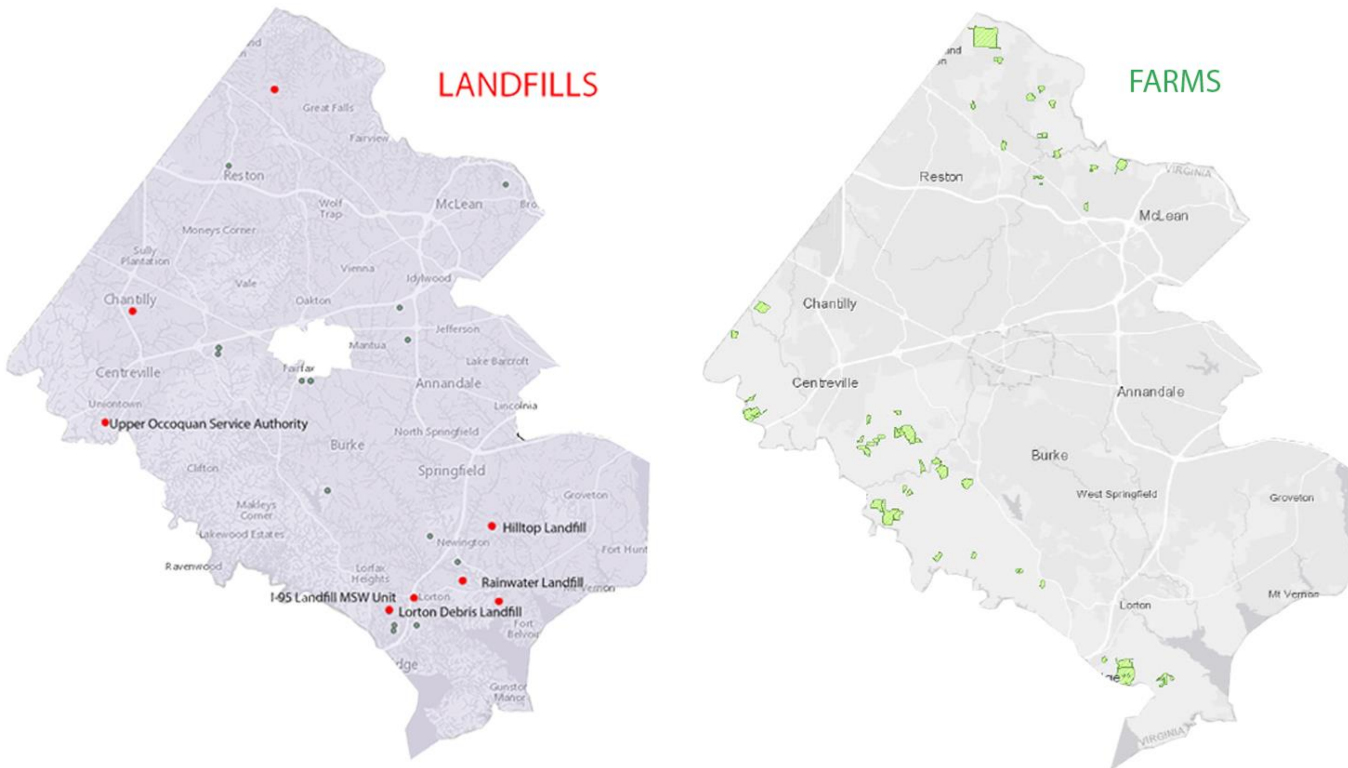


Figure 13: Location of farms and landfills located in Fairfax County

By aligning the location of the existing farms and landfills with current and projected urban centers we can find that in Fairfax County, farms and landfills are in peri-urban areas. Therefore, they would not be considered as ideal locations for composting facilities due to their remoteness. In addition, the usage of composite liners on landfills prevents vegetation with deep root system from being planted.

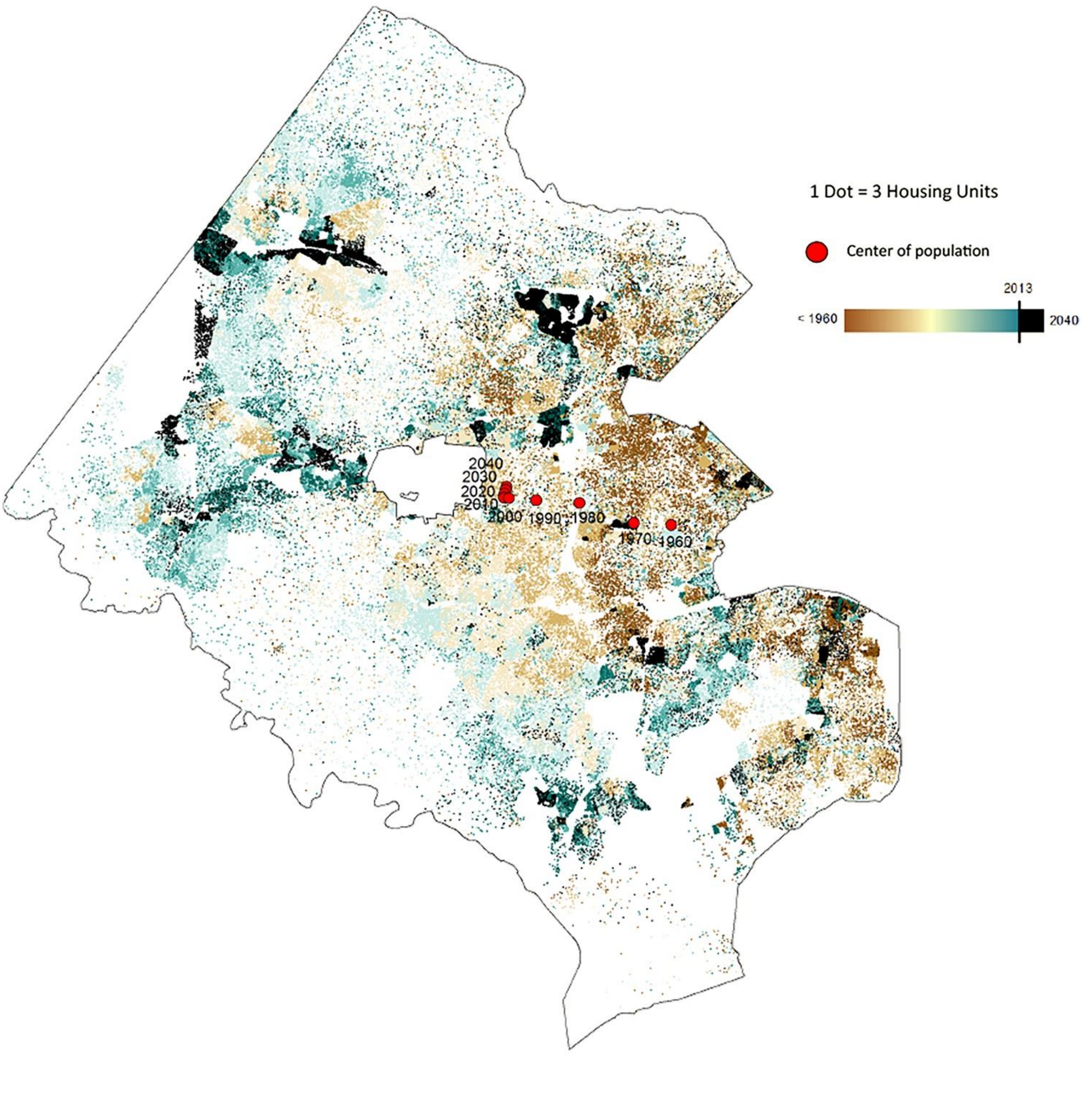


Figure 14: Housing and Population through the Decades by Fairfax County *(County, Housing and Population through the Decades in Fairfax County 1)*

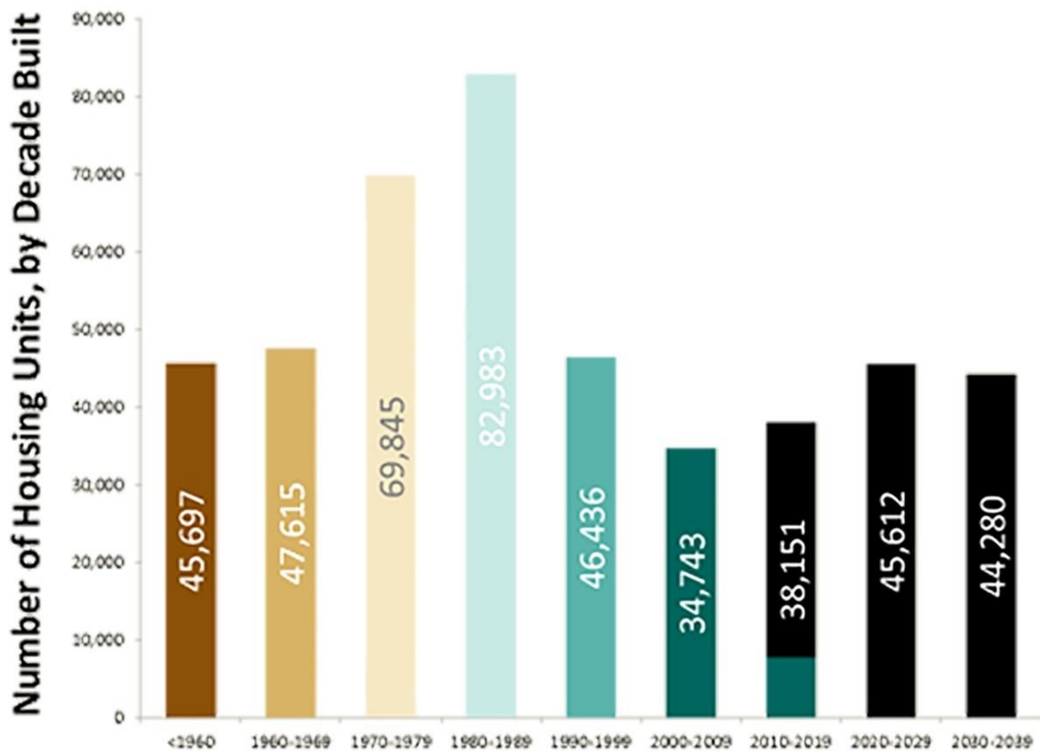


Figure 15: Number of household units built from 1960 to 2039 by Fairfax County

Figures 14 and 15 show a graphic report by Fairfax County of the number of housing units being built by the decade from 1960 projecting to 2039 with a peak of over 80,000 units between 1980 and 1989 spread throughout the county. Another interesting fact is the growth movement throughout the years from east to west with projections of growth concentrating in the northern side of the county with some exceptions of smaller areas on the east and south. Figure 14 shows the center of population slowly moving north west with the development of urban areas such as Tysons Corner and Reston.

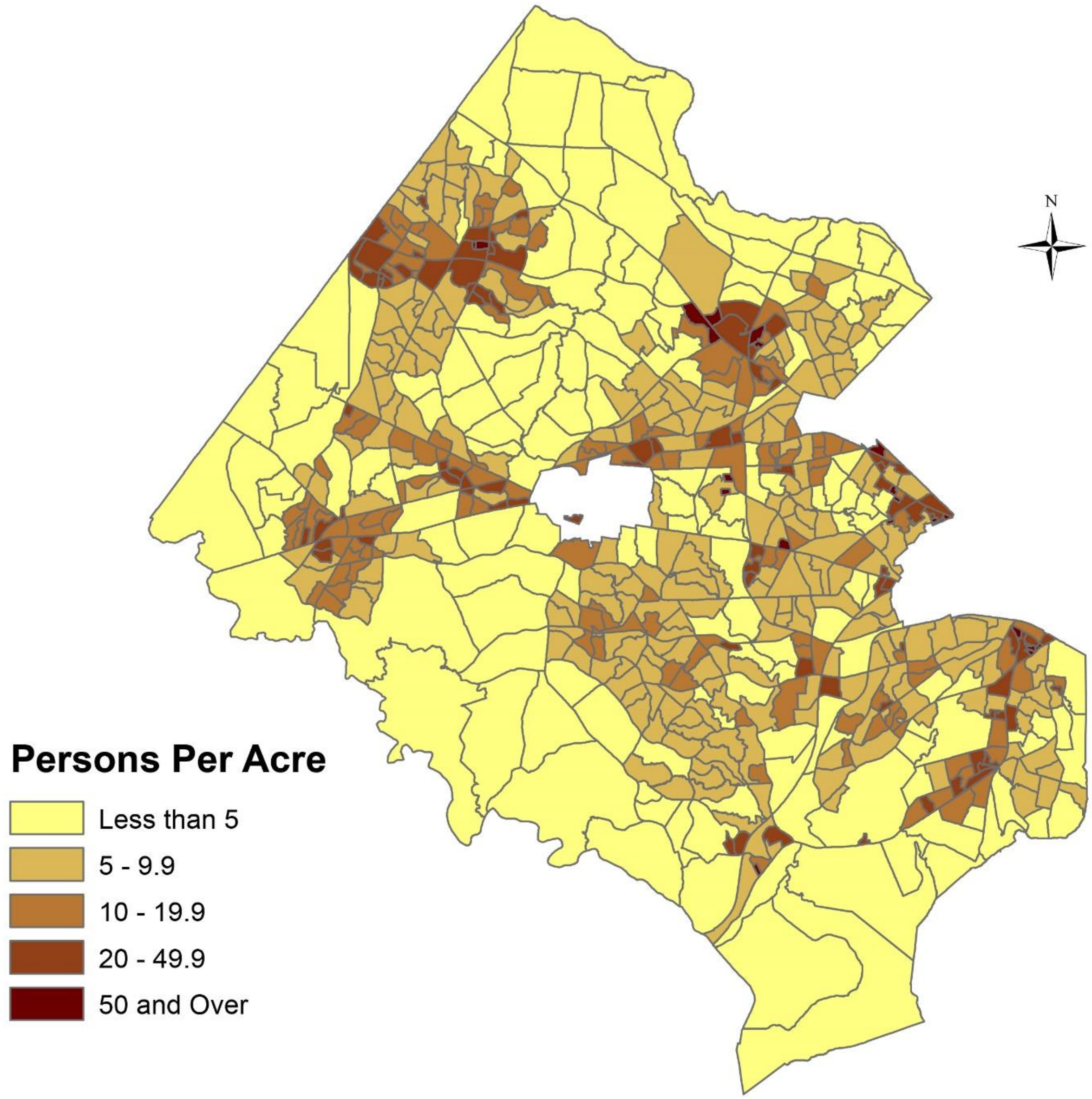


Figure 16: Forecast population density by census block groups by Fairfax County Integrated Parcel Lifecycle System

Following the pattern of urban growth and the projected growth of urban centers we can identify potential sites able to provide a composting operation within these areas. The few available spaces near urban centers need to be able to meet the criteria for composting in the urban environment. These criteria demand enough spaces for the different stages of composting, space that is in high demand in urban areas. Most of the spaces available in urban areas already have a public, commercial or residential use, other spaces include utility and transportation services.

A type of space that can be found through the county is utility corridors. Utility corridors in Fairfax County go through many urban centers, running along roads, public, residential and commercial areas carrying pipelines for gas or sewage, electric and telephone lines. Many times, the land underneath these corridors belongs to the utility company but there are cases where the property owner grants a right of way for the utility company to build and maintain the infrastructure. “Easements are signed by property owners and recorded on the title of the affected real state.” (Energy) These areas allow the utility company to maintain and operate facilities and substations under these corridors. Dominion Energy, the utility company in Fairfax County responsible for most utility corridors, keeps and maintains the entire width of the right of way, limiting the usage of the space, including any construction or vegetation planted. There are exceptions to this. By submitting an encroachment request to Dominion Energy, they will review the request and determine if permission is granted. (Energy)

The following are examples of the types of encroachments that have been denied and permitted in the past:

Denied

- Building and building extensions
- Most watercrafts.
- Stored trailers, RV's or motor homes.
- Playground equipment
- Burial sites.
- Mechanical equipment.
- Any type of fire or burning.

Allowed

- Road, trails and parking lot may be permitted under the right conditions.
- Farming except for any permanent irrigation system and physical structures.
- Community gardens without any permanent storage structure.

Figure 17 shows the location of utility corridors through Fairfax County represented in red, blue and black color lines. The red lines red lines represent the corridors with underground pipelines, the blue lines represent all electric power lines and the black color lines represent all phone lines. Overlaid to this, in purple color, are the current and projected urban areas from figure 14 between 2013 to 2040. In addition, is the information from figure 16. For the purpose of finding a site with the composting criteria needed, I am focusing on the areas where the utility corridors intersect the urban centers.

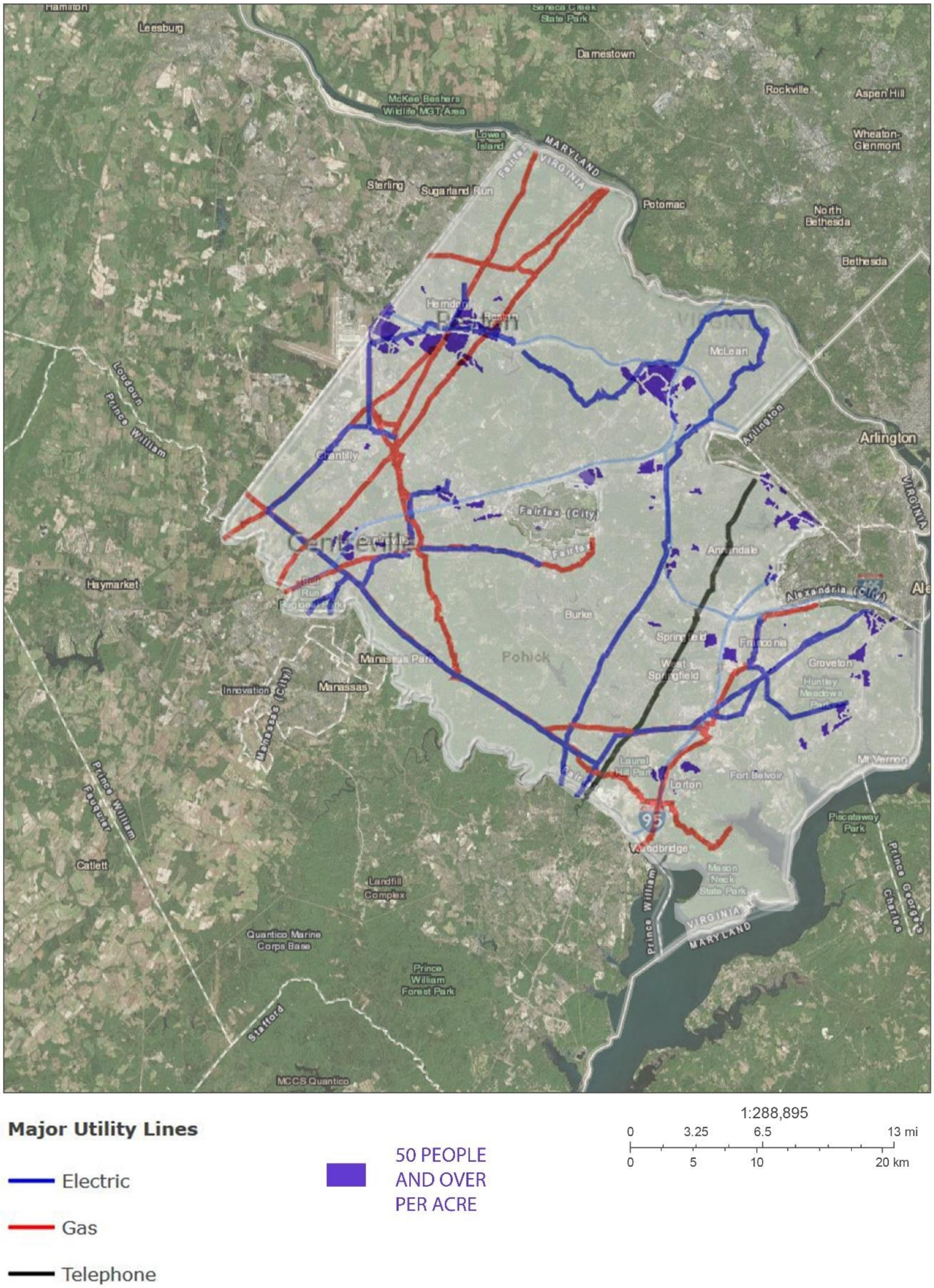


Figure 17: Electric corridor lines in blue and red overlaid with urban centers in purple

Using the map on figure 17 I have selected four urban centers that intersect with electric corridors (blue line) in order to study the ground conditions under the corridors in populated areas and select a site that would allow a composting operation. The selected areas are Merrifield, Tysons Corners, Reston and McNair.

Merrifield

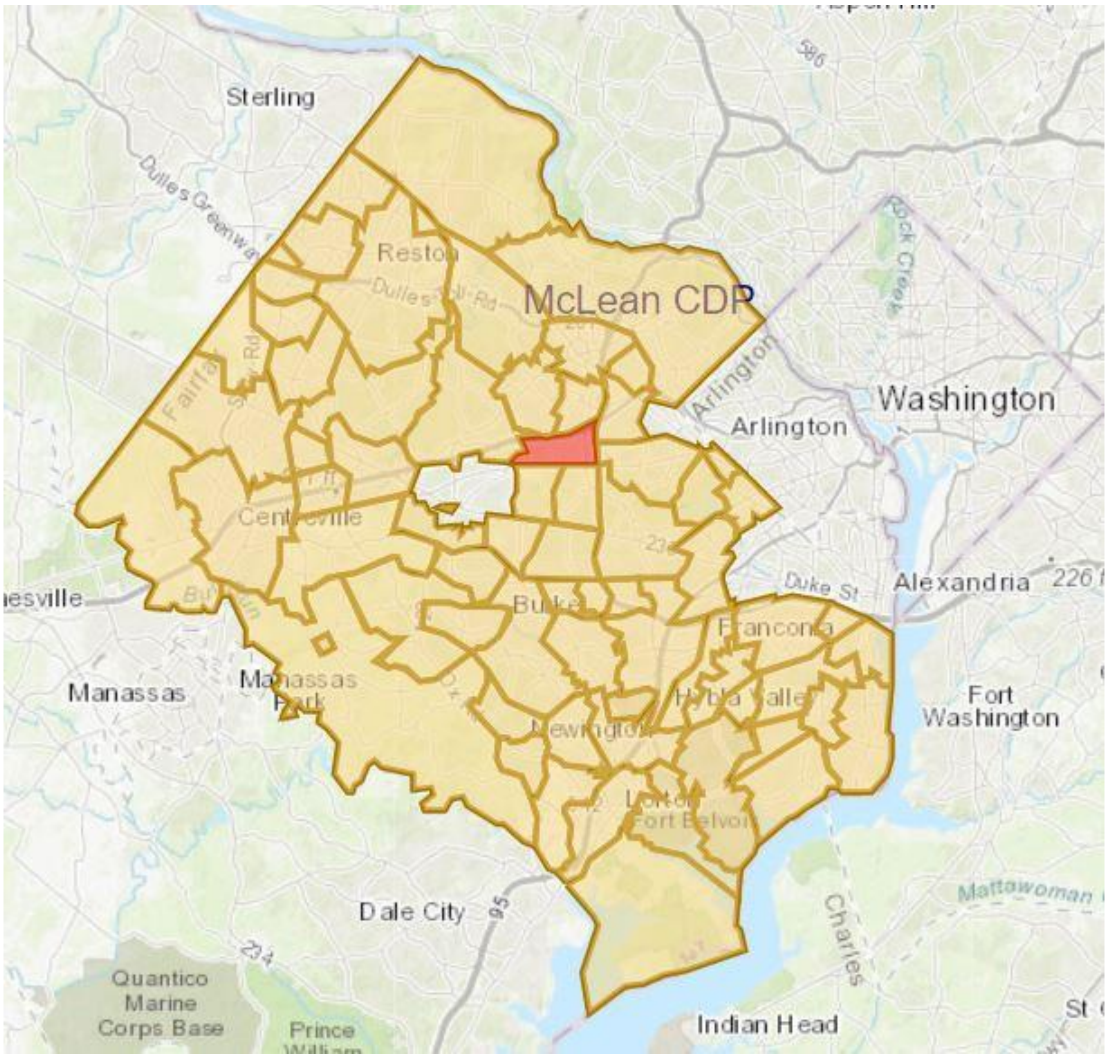


Figure 18: Map of Merrifield CDP by Fairfax County Department of Management and Budget; Economic, Demographic and Statistical Research. *(Budget and Economic)*

Merrifield CDP (Census Designated Place) has 22,799 people as of 2018 on 1,741 acres of land. (Budget and Economic) Located at the heart of Fairfax County it is located south of the intersection of interstate 495 and rout 66. Coming from the east, the utility corridor runs along a medium between Shreve Rd and a bike lane crossing Interstate 495 and route 66 to continue to the Washington and Old Dominion trail heading east. The trail runs behind a single-family home area, which according to the planning and zoning viewer of Fairfax County, has 4 dwellings per acre. The utility corridor also runs south before it crosses interstate 495 heading west. It branches off into a substation where it goes across the entire length of Jefferson District Park's golf field and runs along interstate 495 south.

Figure 19: Utility corridor running across Merrifield. Red circles symbolize selected sites.

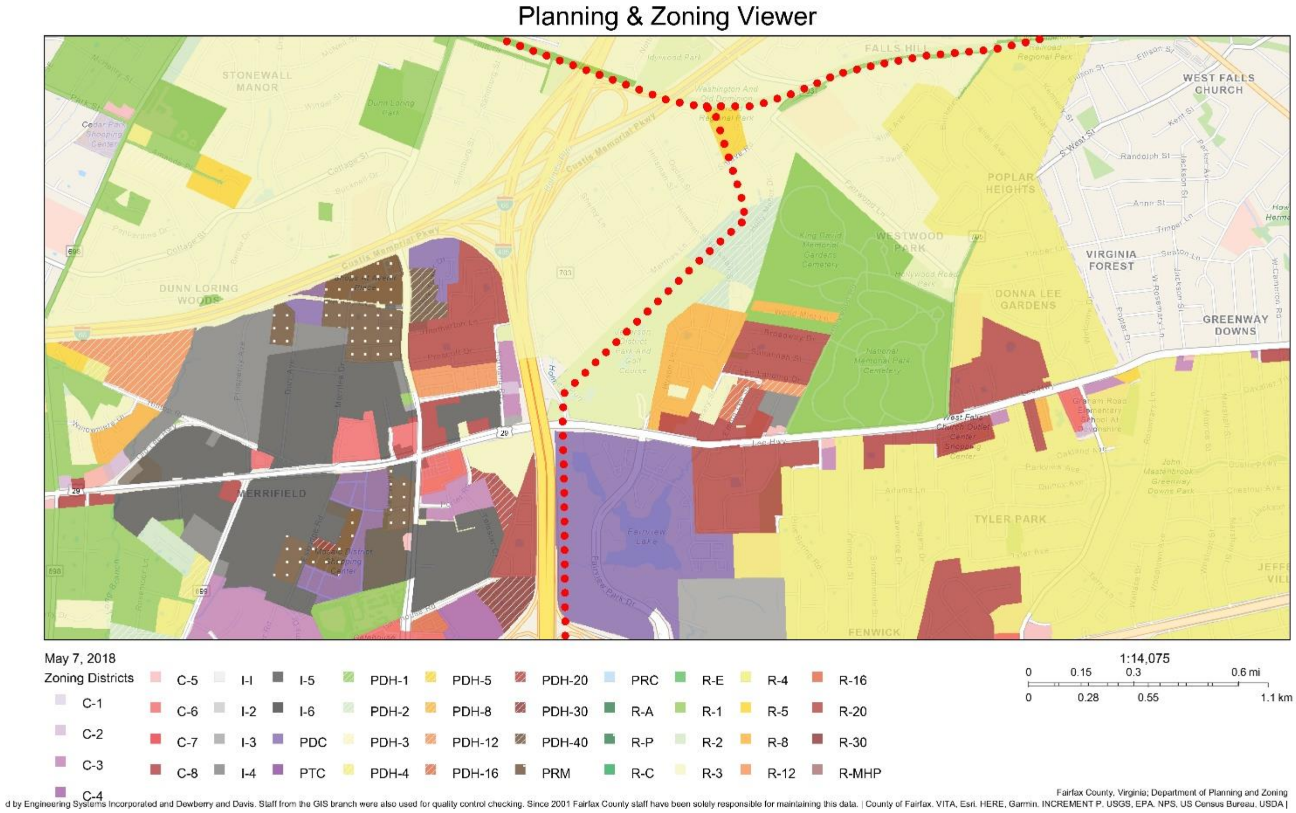


Figure 20: Utility lines running across Merrifield zoning area by Fairfax County *(County, https://www.fairfaxcounty.gov/planning-development/)*

Site A in Merrifield is located between the substation and Jefferson district Park. It sits behind a single-family home area rated as 4 dwelling units per acre. One of the largest neighbors in the area is King David Memorial gardens. This site is divided by a stream reducing the size of the possible composting facility and increasing the risk of having nitrogen rich leachate reach the stream. An advantage of this location is having Jefferson District park and King David Memorial Garden in proximity—possible end users for the compost generated on this site, in addition to the neighborhoods around it. This Site presents several disadvantages. With less than an acre of space, it does not offer enough space for all the composting process; It sits close to a stream and has a low number of people nearby. In addition, the ground on the electric corridor is vegetated and maintained by Dominion Electric.

Figure 21: Site A in Merrifield. Colored area represents electric corridor. Image by Google Earth

Figure 22: Site A, view from Hillsman St. Image by Google Earth

The second site analyzed in Merrifield is located under the electric corridor running along interstate 495 on the east side. It sits south of General Contractor headquarters Hitt Group. Hitt uses the spaces underneath the electric corridor as parking space. The site is about one and a half acres between the parking space and a stream running across the electric corridor into a lake. Unlike site A, this location is on a High Intensity Office area, without any direct access from nearby neighborhoods. In addition, it also sits on a vegetated space.

Figure 23: Site B in Merrifield. Colored area represents electric corridor. Image by Google Earth

Figure 24: Site B. View from Interstate 495. Image by Google Earth

Tysons Corners

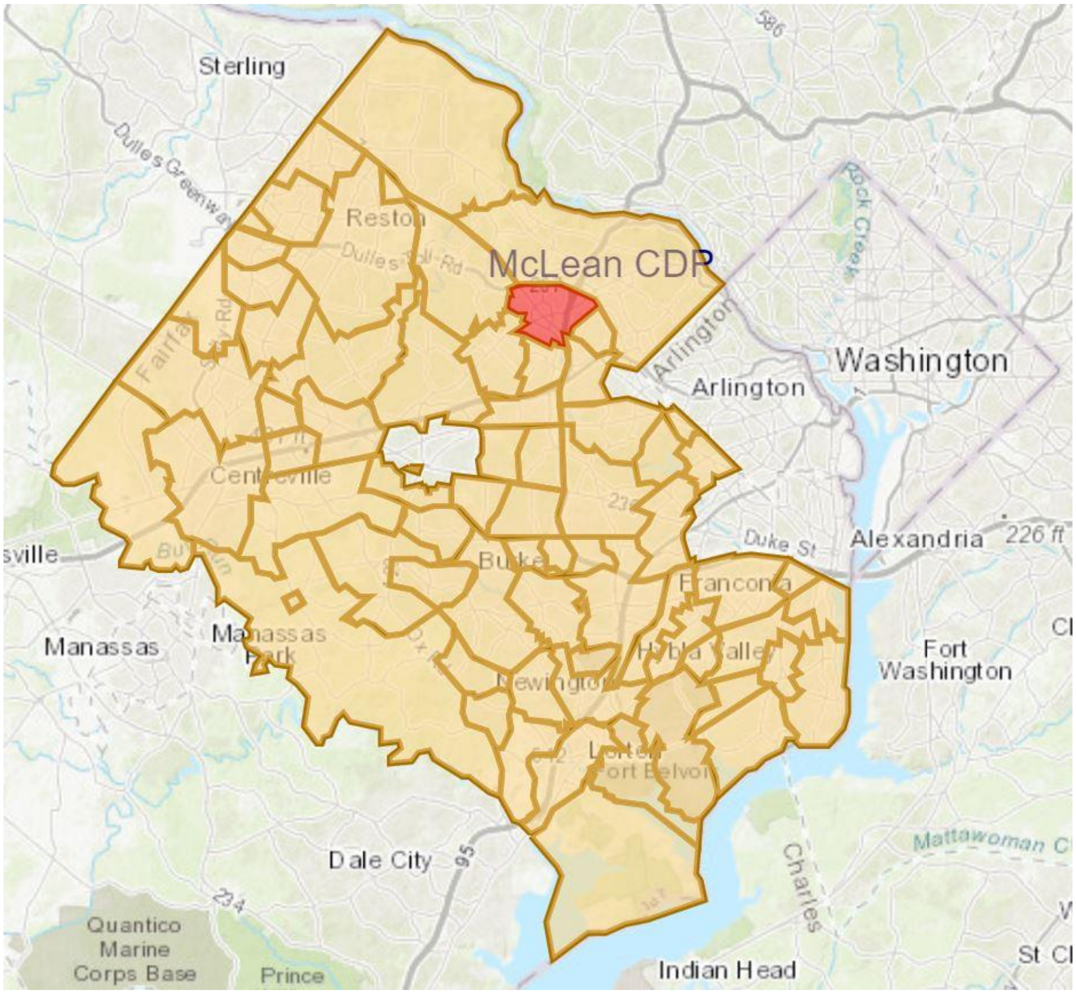


Figure 25: Map of Tysons Corners CDP by Fairfax County Department of Management and Budget; Economic, Demographic and Statistical Research *(Budget and Economic)*

Tysons Corners CDP has 28,160 people as of 2018 and sits on 2,734 acres of land. (Budget and Economic). Located on the northern side of the county it is one of the densest urban centers in Fairfax County. The utility corridors in Tysons Corners run separately on the east side and the west side. On the west side the utility corridor goes across residential and commercial areas, going over neighborhoods, office buildings' parking lots and a metro station parking lot. On the east side it is mainly on residential areas until it connects with the rail lines.

Figure 26: Utility corridor running across Tysons Corner. Red circles symbolizes selected sites.

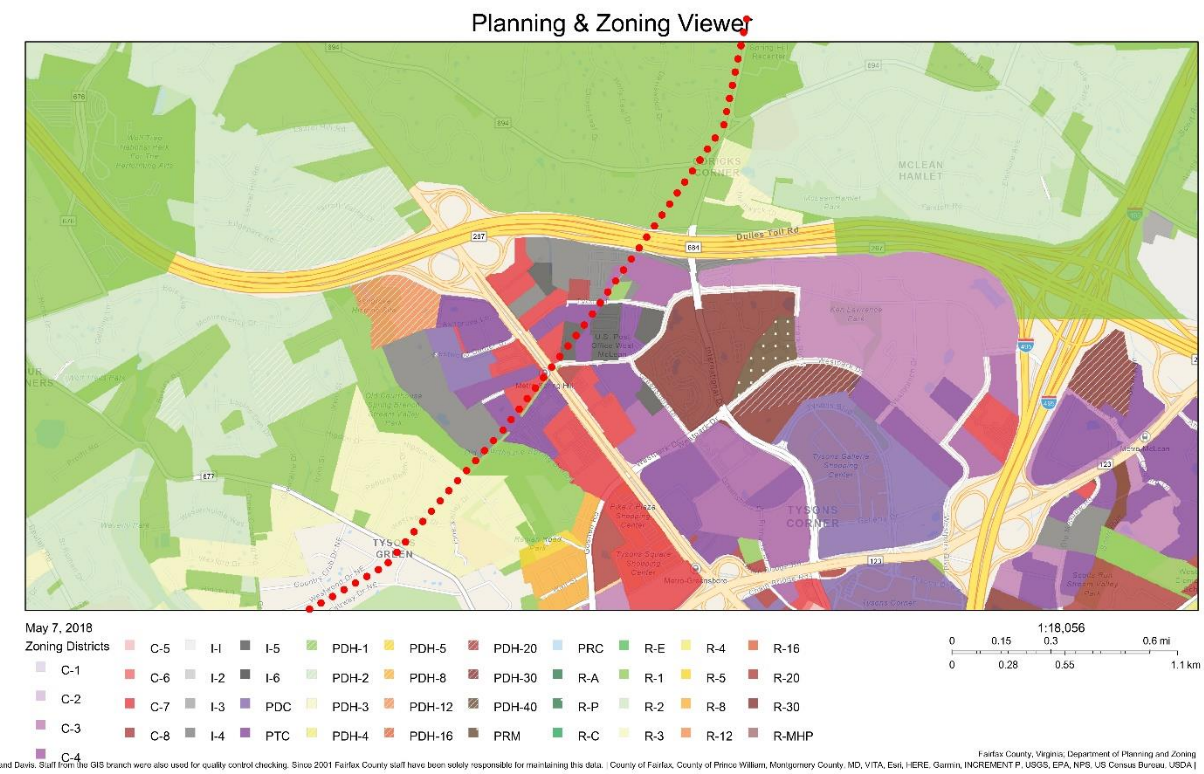


Figure 27: Utility lines running across Tysons Corners zoning area by Fairfax County. *(County, https://www.fairfaxcounty.gov/planning-development/)*

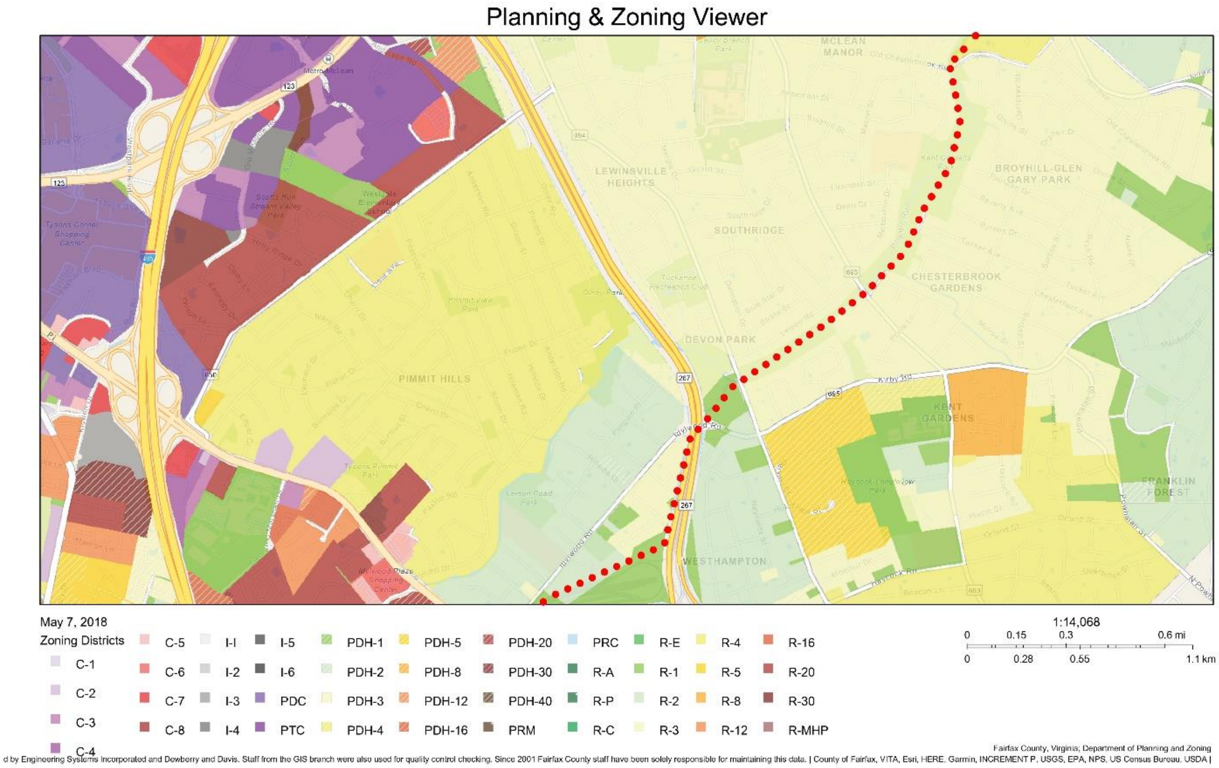


Figure 28: Utility lines running across Tysons Corners zoning area by Fairfax County. *(County, https://www.fairfaxcounty.gov/planning-development/)*

Site A on Tysons Corner is a threshold between office commercial and residential areas. The site is about 10 acres of land and is part of Ragian Rd Park. It is in between a High Intensity Office space and a 4 Dwelling Unit per acre space. Considered a park and recreational area, it has the required space for a composting operation, however it is highly vegetated with trees, a stream runs across the park and there is a low population of residents living close by.

Figure 29: Site A in Tysons Corners. Colored area represents electric corridor. Image by Google Earth.

Site B is located north of site A. This is a busier space under the utility corridor, it is located at the intersection of Leesburg Pike and Spring Hill Rd., across Spring Hill Metro Station. The site is next to an office building parking lot on a vegetated area, with less than an acre of space. It does not have the spaced required to operate a compost facility. In addition, it is in a High Intensity Office Space with no proximity to neighborhoods.

Figure 30: Site B in Tysons Corners. Colored area represents electric corridor. Image by Google Earth.

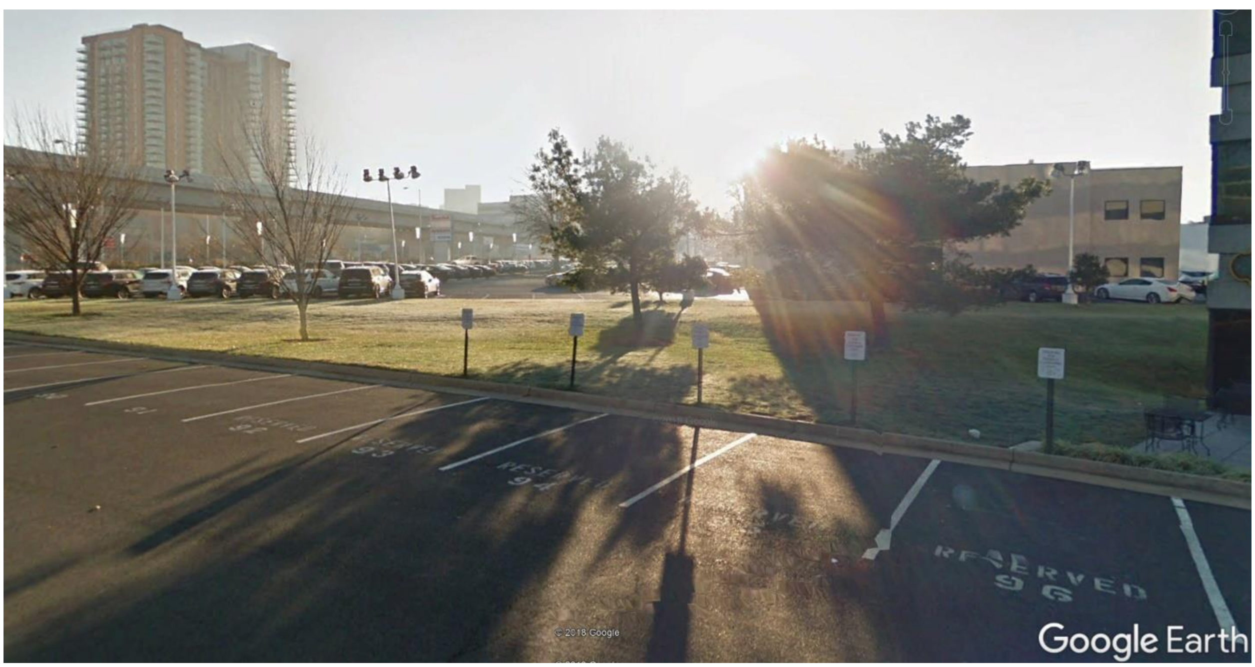


Figure 31: Site B. View from office building parking lot. Image by Google Earth

Site C is on the east side of Tysons Corners. It is the area where the utility corridor runs along Dulles Toll Rd. on the west side and connects into a substation. On the west side of the site is a 4 Dwelling unit per acre area with a railroad line separating the site from the neighborhood. The advantage of the site is that the substation is next to a bioretention area; however, with about an acre of land space it does not offer the required space for a composting facility in addition to the low number of residents living nearby.

Figure 32: Site C in Tysons Corners. Colored area represents electric corridor. Image by Google Earth.

Reston - McNair

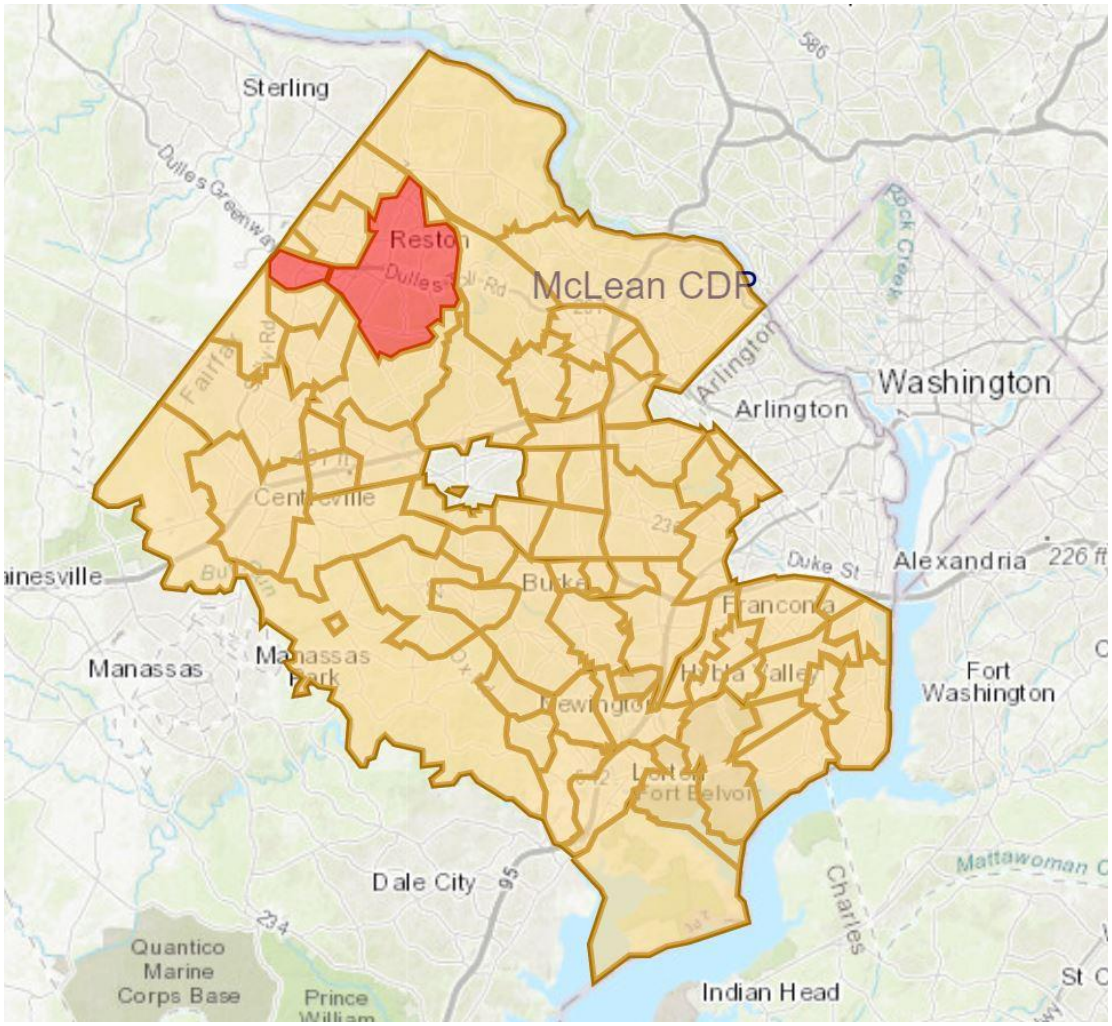


Figure 33: Map of Merrifield CDP by Fairfax County Department of Management and Budget; Economic, Demographic and Statistical Research *(Budget and Economic)*

Reston and McNair CDP are areas that combined have 83,736 people as of 2018 in a combined area of 11,341 acres (Budget and Economic). Located on the north western side of the county it is an area in constant development. The utility corridor runs along Dulles toll Rd. in Reston, then it turns south into McNair crossing Dulles Toll Rd and heading into a substation at Dulles Airport.

Figure 34: Utility corridor running across Reston and McNair. Red circles symbolize selected sites.

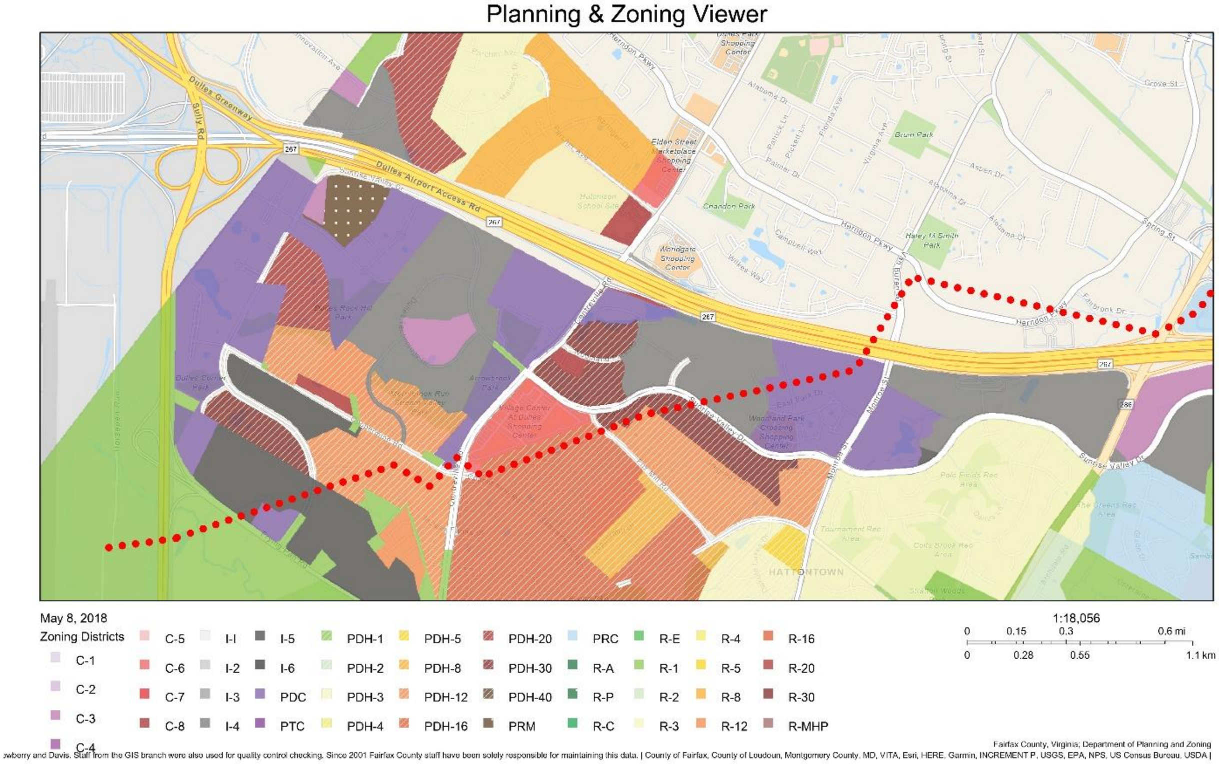


Figure 35: Utility lines running across McNair zoning area by Fairfax County. *(County, https://www.fairfaxcounty.gov/planning-development/)*

Site A is located on the parking lot of a shopping center on a diverse zoning area. Surrounded on the south and east sides are 12, 16 and 30 Dwelling units per acre area and on the north side is a High intensity Office area. The site sits on a Planned Development Housing, adjacent to 25 acres of commercial space with 3 acres of parking spaces underneath the utility corridor. The ground is paved with proximity to a large volume of people living in the surrounding neighborhoods.

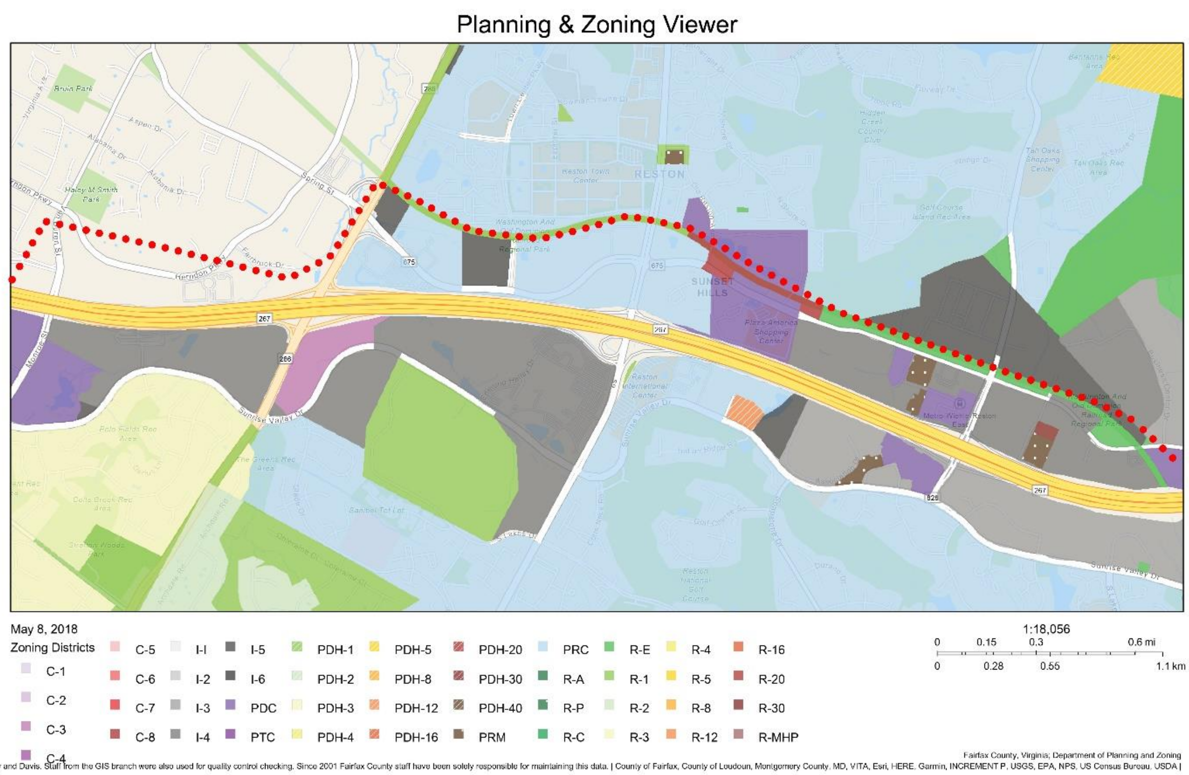
Figure 36: Figure 32: Site A in Tysons Corners. Colored area represents electric corridor. Image by Google Earth.

Figure 37: Site A. View from shopping center parking lot. Image by Google Earth

Site B is located on the parking lot of an office building, next to a wooded area currently being developed. The site is considered a High Intensity Office area on almost an acre of paved ground. This site is connected to drainage that connect to bioretention areas, however, with about an acre of parking space it does not provide the required space for the composting operation.

Figure 38: Figure 32: Site B in Tysons Corners. Colored area represents electric corridor. Image by Google Earth.

Figure 39: Site B. View from office building parking lot. Image by Google Earth



Site C is located on a Planned Residential Community, along Washington and Old Dominion trail. On the south side there are office buildings and on the North side is Reston Town Center with many mixed-use buildings close by. Part of the site serves as parking space for an office building. The site is very accessible to the nearby neighborhoods with two acres space, including paved and vegetated ground.

Figure 40: Utility lines running across Reston zoning area by Fairfax County *(County, https://www.fairfaxcounty.gov/planning-development/)*

Figure 41: Figure 32: Site C in Tysons Corners. Colored area represents electric corridor. Image by Google Earth.

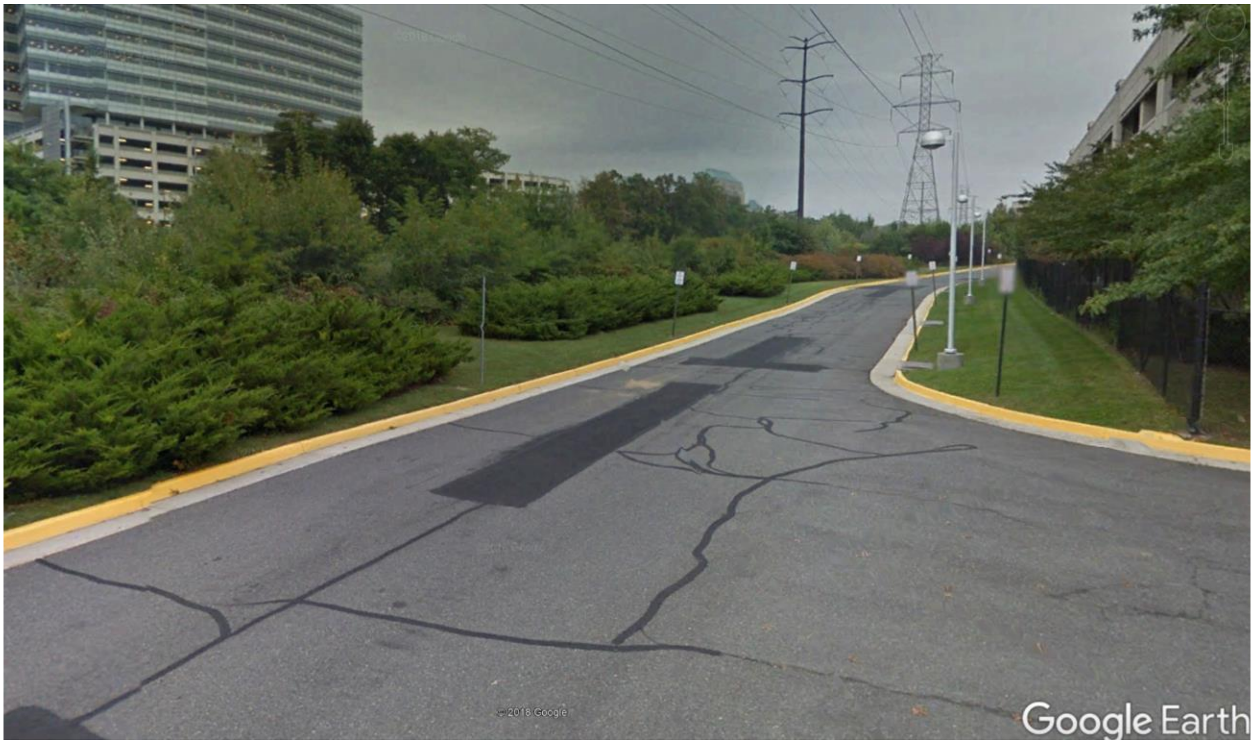


Figure 42: Site C. View from office building parking garage. Image by Google Earth

Site D sits also on a Planned Residential Community, along Washington and Old Dominion trail. On the North side is an extensive golf course surrounded by a single-family home neighborhood. It is partially paved and currently used as parking lot for the office buildings and shares space with Washington and Old Dominion trail. With almost 2 acres of space and not direct access to dense neighborhoods it would not be ideal for a composting operation.

Figure 43: Figure 32: Site D in Tysons Corners. Colored area represents electric corridor. Image by Google Earth.

Figure 44: Site B. View from Metro Center Dr. Image by Google Earth

Urban Areas	Sites Explored	Located in urban centers	High volume population	Paved surface	Required space	Accessibility	Bioretention area	No wetlands nearby
Merrifeild	A	☑	☐	☐	☐	☑	☐	☐
	B	☑	☐	☐	☐	☐	☐	☐
Tysons Corners	A	☑	☐	☐	☑	☑	☑	☐
	B	☑	☐	☑	☐	☑	☐	☑
	C	☑	☐	☐	☐	☐	☑	☐
Reston McNair	A	☑	☑	☑	☑	☑	☑	☑
	B	☑	☐	☑	☐	☐	☑	☐
	C	☑	☑	☑	☑	☑	☐	☑
	D	☑	☐	☑	☐	☐	☐	☑

Figure 45: Site criteria

Comparing each of the sites in three different urban areas of Fairfax County shows their differences and similarities. Although all of them are located within urban centers, not all of them are near high volume populations. Many urban areas in Fairfax County have residential that consists of single-family homes with low populations of people. These areas are usually secluded from commercial and industrial zones. On the other hand, other parts of the county with newer development the zoning areas are more mixed, as in the case of Reston and McNair. For these reasons site A in McNair would be the most ideal location for a compost operation in the urban environment. Its proximity to neighborhoods with high volume of people living in condos, apartments and townhouses makes it possible to collect local organic waste to be processed on site in addition to the space available for the different stages of composting.

4.3 McNair

The utility corridor goes through McNair coming from a substation at Dulles Airport on the west side and going north east into Reston. This corridor splits McNair into two sections, almost determining the boundaries between commercial and residential areas. On the south side there is a diversity of high-volume residential areas among townhouses, condos and apartment units in addition to some shopping centers and educational institutions. The northern side of McNair is a combination of high intensity office area with some high-volume residential areas scattered on the North westside. The space underneath the utility corridor is mostly used as parking space except for the western end of McNair, which is wooded undeveloped land. McNair also has a network of wetlands moving storm runoff from east to west. The closest wetland is in Arrowbrook Park on the northern side of Centreville Rd. It is a bioretention area designed to hold the water coming from the network of streams connecting other bioretention areas and releasing slowly on the southern end and going into a stream that connects another bioretention area.

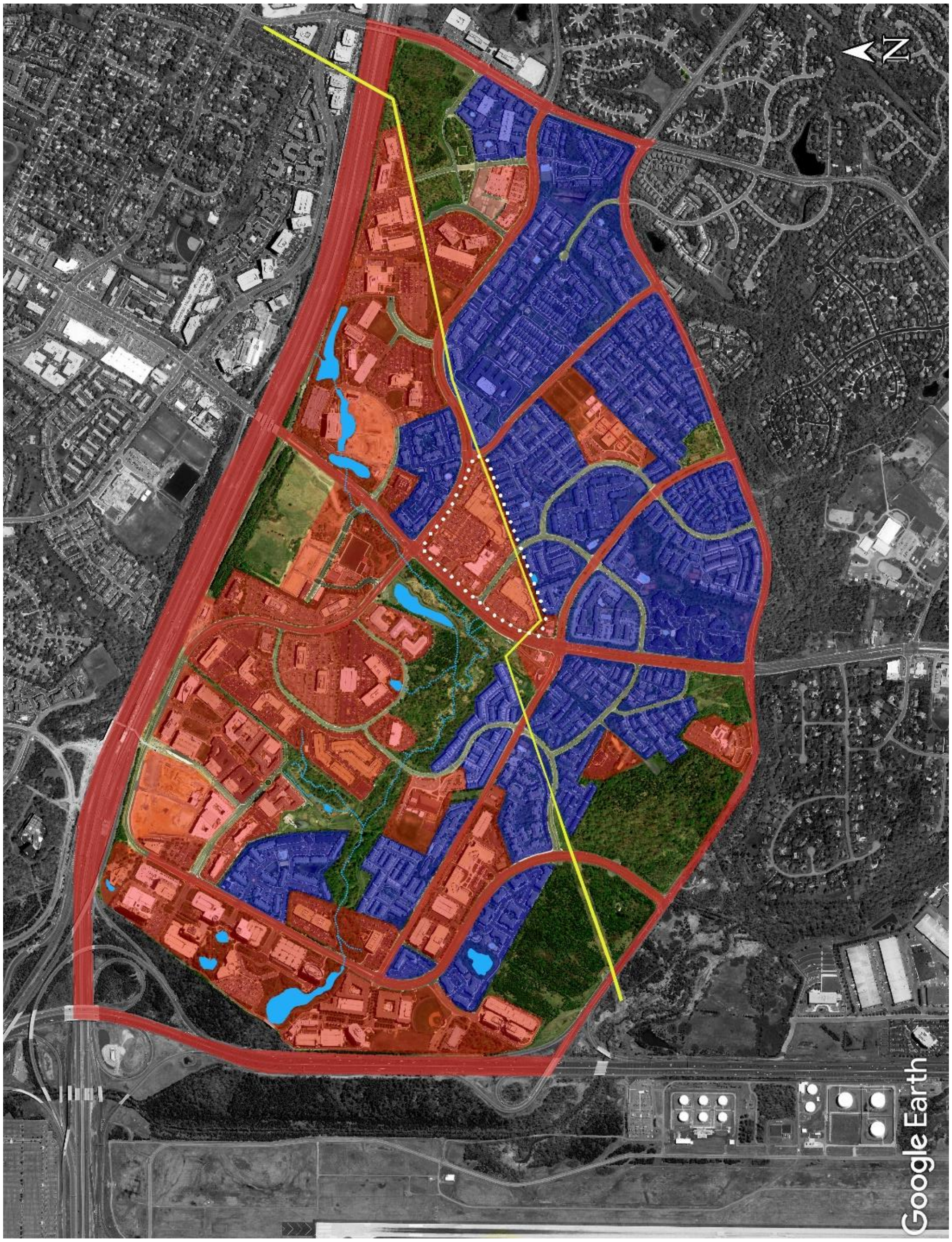


Figure 46: McNair CDP, Residential areas color in blue, commercial areas colored in red, utility corridor represented by the yellow line. Proposed site within white dotted line.

Village Center at Dulles

Developed in the early 1990's, Village Center is commercial area with 300,000 sf of retail space. There are restaurants, a grocery store, a pharmacy, a gym and other chain stores all managed by Regency Centers. According to Regency, the overall population within 3 miles is 104,935 people with a daytime population of 31,509 people. (Centers 2).

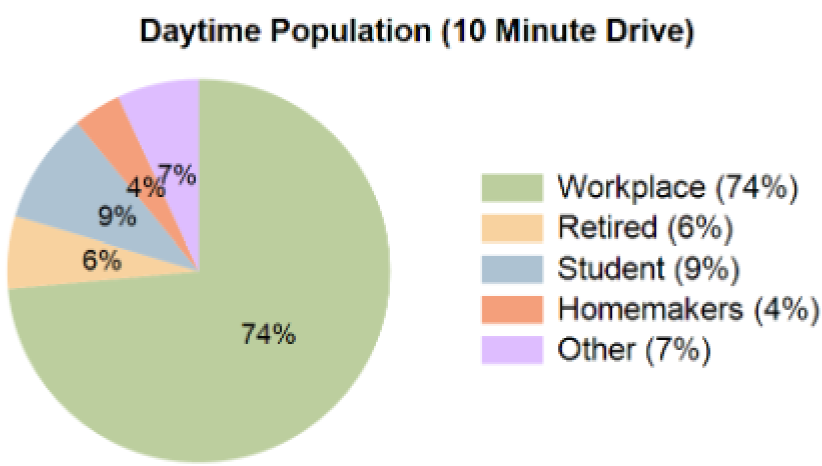


Figure 47: Regency's daytime population within minute drive *(Centers 2)*

Village Center sits on the projected center of population path that the county has been following since the 60's. The re-development of Village Center could take advantage of this location by turning a shopping center into a mixed-use structure with underground parking, freeing the site from paved surfaces and replacing it with green areas using the compost produced on site. This re-development will not only offer more living space for the increasing number of people moving to McNair but it will also offer retail space for the business already there, improving the site with sustainable green areas that will benefit the future residents and attract new customers.

Figure 48: Aerial by of Village at Dulles by Google Earth

Village Center at Dulles
301,048 SF

SPACE	TENANT	SF
0011	AVAILABLE	2,460
0012	AVAILABLE	12,222
0034B	AVAILABLE	5,023
0054	AVAILABLE	3,465
0001	GOODYEAR	6,017
0002	GOODWILL	11,197
0003	HAMA SUSHI	2,656
0004	HYDERABADI BIRYANI CORNER	1,257
0005	PRIYA SPICES	863
0006	CHUTNEY'S	795
0007	CHINA KING	2,910
0008	RUBINO'S	2,849
0009	GIANT	48,424
0010	VA ABC	3,808
0013	DESI POLLO AND PIZZA	690
0014	PHO NEW	3,409
0015	TATVA INDIAN CUISINE	3,598
0016	SORENTO GRILL	1,788
0018	NOODLES & COMPANY	3,167
0019	STARBUCKS	1,800
0020	LYDIA'S TAILORING	658
0022	CLOCK TOWER ANIMAL HOSPITAL	3,561
0023	A-1 CYCLING	2,647
0024	GNC	1,317
0025	GOLD'S GYM	44,460
0026	ASPEN JEWELRY DESIGN	2,437
0027	CHAO PHRA YA	2,499
0028	D4 KARATE	2,539
0029	MATHNASIUM	1,200
0030	MADRAS CHOPSTICKS	1,569
0032	NED DEVINE'S	7,517

SPACE	TENANT	SF
0033	CHUCK E. CHEESE	13,658
0034	A STONE'S COVE KITBAR	3,967
0035	SUNTRUST BANK	3,000
0036	MCDONALDS	3,475
0037	BREAKERS BILLIARDS CAFE	8,260
0038	AT&T	1,492
0040	THE TOOTH DOC FAMILY DENTISTRY	1,388
0041	SUBWAY	1,540
0042	THE UPS STORE	1,540
0043	POULIN CHIROPRACTIC CLINIC	1,540
0044	MCNAIR BARBER	1,400
0045	THE WIRELESS CENTER	1,540
0046	VIRGINIA KITCHEN AND BATH	1,540
0047	BELLA BALLERINA	1,000
0048	TROPICAL SMOOTHIE CAFE	2,132
0050	CLOCKTOWER CAR WASH	3,137
0051	GLAMOUR NAILS	1,068
0052	COUNTRY OVEN	1,260
0053	VILLAGE CLEANERS	2,205
0055	7-ELEVEN	3,675
0056	CVS	12,005
0057	ADVANCE AUTO PARTS	12,755
0058	HOMEGOODS	20,940
0059	FIREHOUSE SUBS	2,160
0060	MATTRESS FIRM	4,224
0061	NORTHWEST FEDERAL CREDIT UNION	2,630
0062	A-1 CYCLING	1,710
0063	BANK OF AMERICA	1
0064	AT&T - TOWER	1

Source:
https://www.regencycenters.com/property/detail/414/VillageCenteratDulles

Figure 49: Village Center at Dulles site plan. *(Centers 1)*

Composting in McNair

According to the United States Environmental Protection Agency, in 2013 the average person in the United States produced 4.40 lbs. of municipal solid waste. (Agency) That number is different for Fairfax residents. Historical Waste Generation Rate (WGRS) shows that in 2015 Solid Waste management Plan update “WRGs have declined over the period 2004-2013, from a peak WGR of 7.80 pounds per capita per day (lbs./cap/day) in 2006 to a low of 5.78 lbs./cap/day in 2013.” (County of Fairfax). The WGRS from 2013 is 24% more than the national average; however, for the purpose of this this study I will be using the average waste per capita per day of 4.4 lbs.

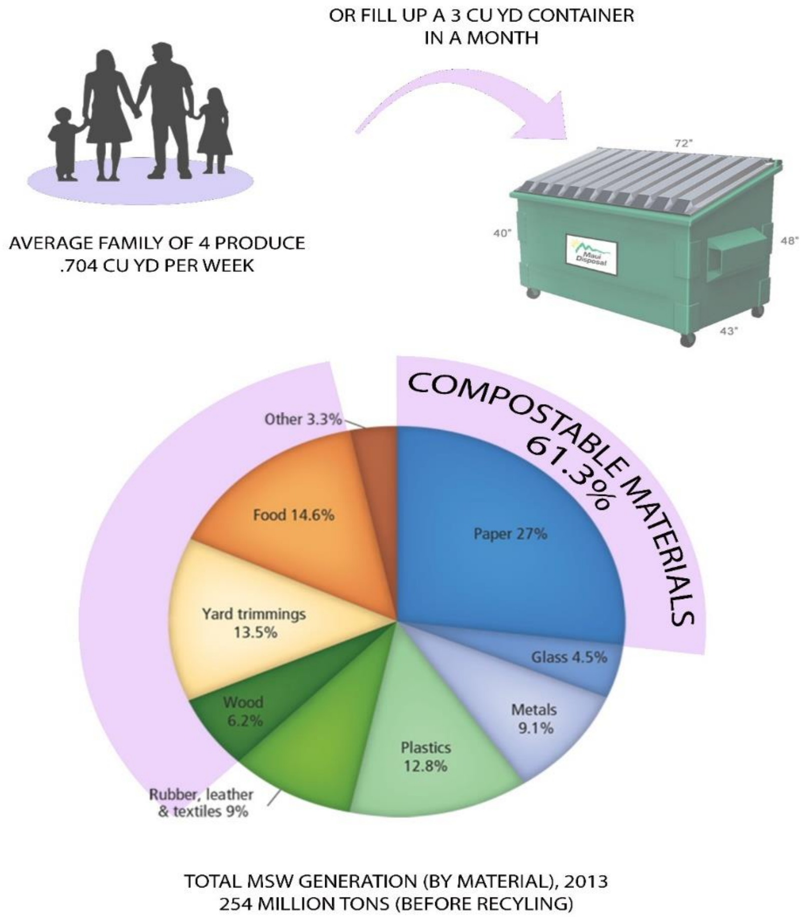


Figure 50: Waste generation rate per capita per day and Municipal Solid Waste breakdown. *(Agency)*

There are 19,962 people living in McNair as of 2018. Rounding the number of people to 20,000, assuming that all of them would start separating food waste from solid waste and following the EPA’s number for or waste produce by the average American we can calculate that each person produces .64 lb. of food waste per day meaning Mc Nair residents produce 740 cu ft of food waste per day.

This food waste would be collected from every residence on a bi-weekly basis and would be brought to the site. Upon arrival it will be mixed with yard waste material already stored in site. The yard waste will come to the site whenever it is available. Because it is mostly carbon material, it does not rot nor emits pestilential gases. Carbon material could safely be store in piles like windrows. The windrow building process would begin with the mixture of food waste and yard waste at a ratio of 3:1 carbon to nitrogen forming windrows of 6’ by 18’ wide. knowing these numbers, we can calculate that there will be 25’ of windrows built per day or 175’ per week.

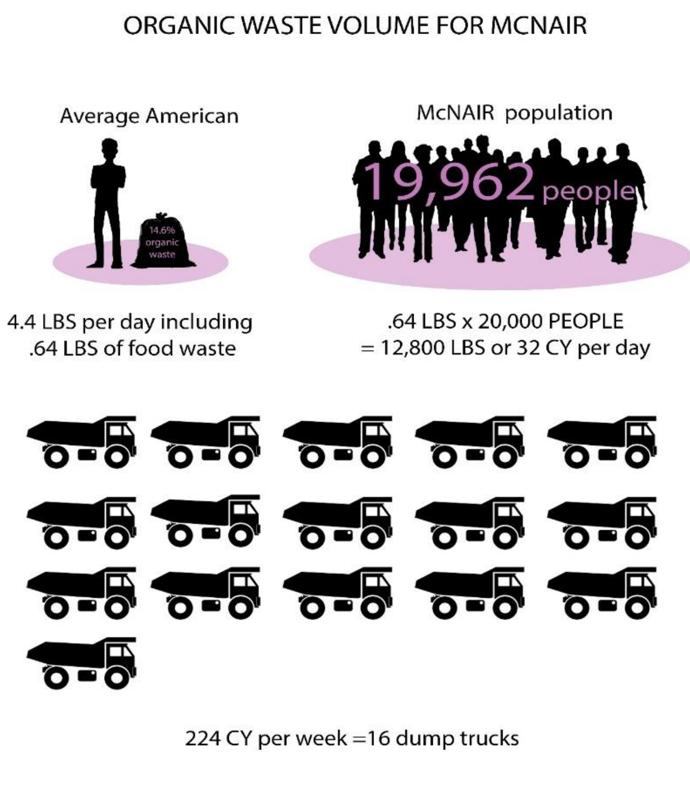


Figure 51: Calculation of total food waste generated in McNair

The amount of yard debris and food waste will vary at different times. During the fall, a large percentage of carbon is gathered from leaf mulch and during the winter it could be a combination of leaf mulch and Christmas trees. The same would be for food waste. One of the many advantages of composting food waste is being able to see what is being discarded, like seasonal produce such as pumpkins, oranges, watermelons, etc. Figure 52 is a projection of food waste and yard waste that one would be able to identify before they are mixed into a windrow.

Figures 53 and 54 show the phasing process for the redevelopment of Village Center at Dulles:

- Phase 1: The process would begin in January 2020 by working on the lowest elevation on the site. This would allow the preparation of a bioretention area that will collect any water runoff coming from the site. This first phase will cover the west half for the site estimating that he demolition of current structures, regrading and excavating to build a bioretention area would take 1 year. During this period the site will be collecting carbon material and storing it for future use.
- Phase 2: By July 2020 the mixing area, where food waste and yard debris are combined and piled into windrows, starts collecting food waste. The curing area starts collecting material as well and starts feeding the bioretention area with finished compost. At this time vegetation is being planted on the west side of the site and new demolition starts in the middle area of the site. This process takes 8 months.
- Phase 3: By March 2021, the demolition process continues to the next area, this is the site for future mixed-use buildings. The regrading work begins on the new green space which will start to receive cured compost.
- Phase 4: November 2021, the curing area starts to transfer finished compost to new park space. In this phase the last retail space will start the demolition process. On this retail space is where the grocery store is. The advantage of doing this process in phases is that

some retail space will still be available to the public while other parts of the project are being worked.

- Phase 5: July 2022, In this phase the curing area transfers finished compost to new park space and new construction breaks ground. The mixing, curing and storing spaces move underneath the electric corridor.
- Phase 6: Curing area transfers finished compost to new park space. New and final mixed-use development is built, and finished compost is delivered and pickup for the use of the community and areas that need to be amended.

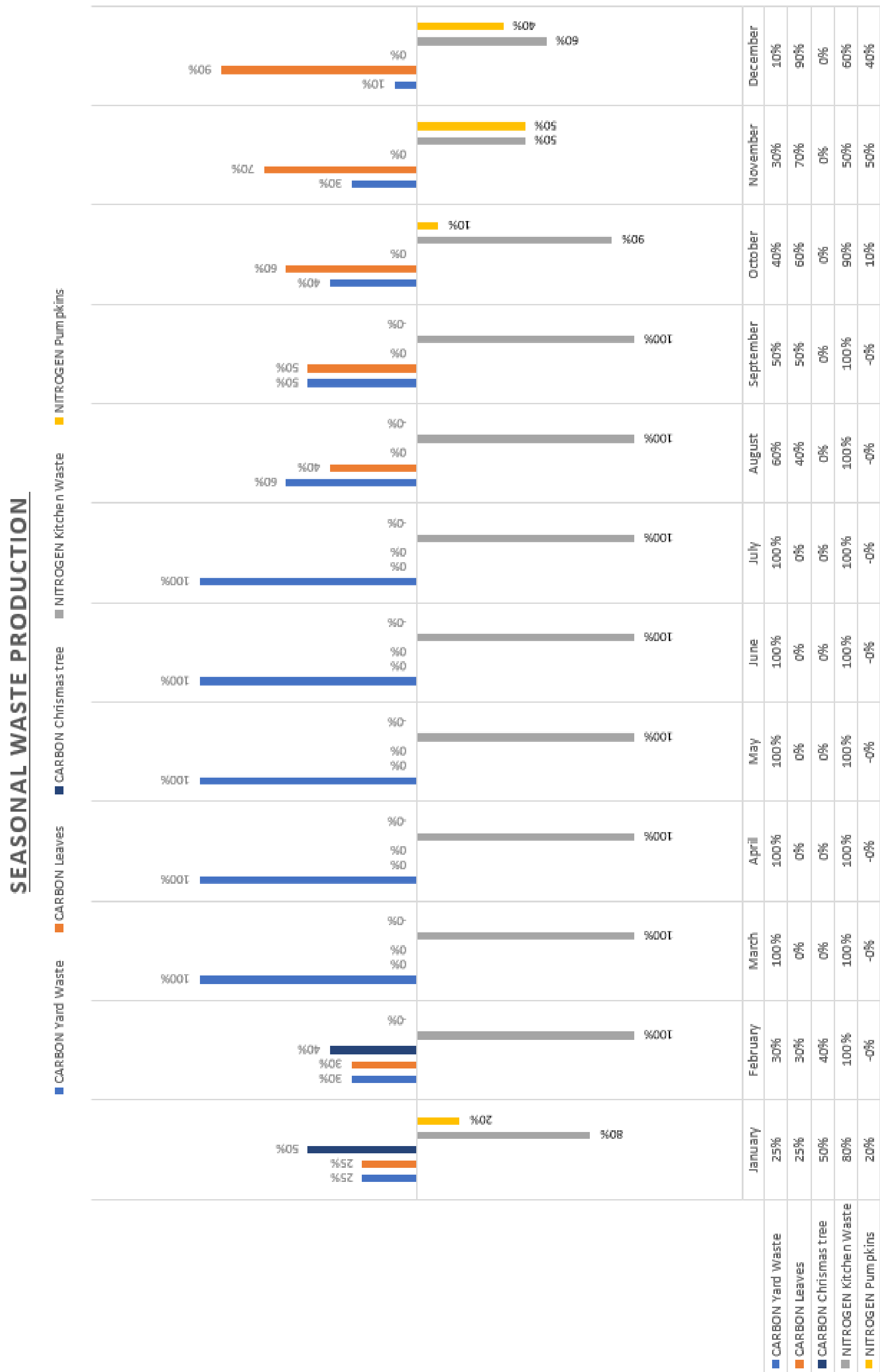


Figure 52: Projection of seasonal organic waste

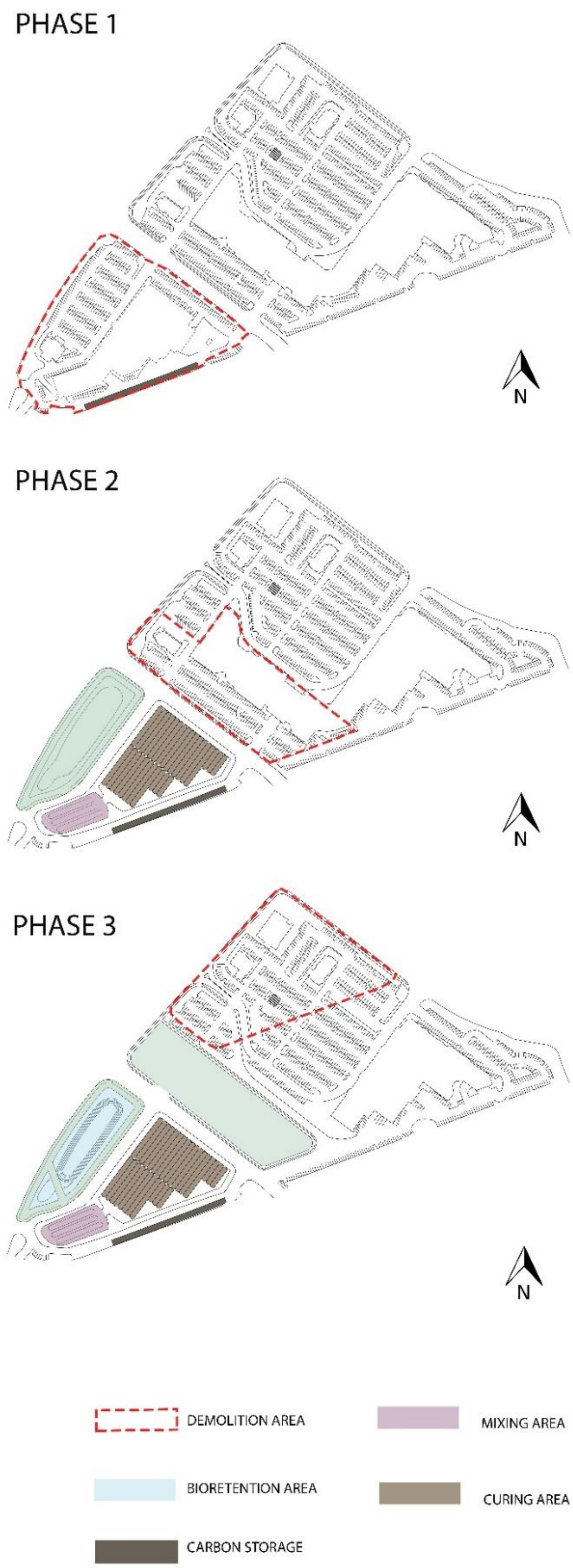


Figure 53: Proposed phasing plan part 1

- JANUARY 2020 - JULY 2020

  - DEMOLITION AND DRAINAGE PREPARATION BEGINS ON WEST SIDE OF THE SITE.
  - MULCH COLLECTION BEINGS ON SOUTHERN SIDE OF THE SITE.

- JULY 2020 - MARCH 2021

  - MIXING AREA BEGINS COLLECTING FOOD WASTE AND MULCH MATERIAL.
  - CURING AREA FEEDS COMPOST MATERIAL TO BIORETENTION AREA
  - NEW DEMOLITON AREA BEGINS

- MARCH 2021 - NOVEMBER 2021

  - CURING AREA AMMENDS THE SOIL FOR NEW PARK SPACE
  - NEW DEMOLITION AREA BEGINS

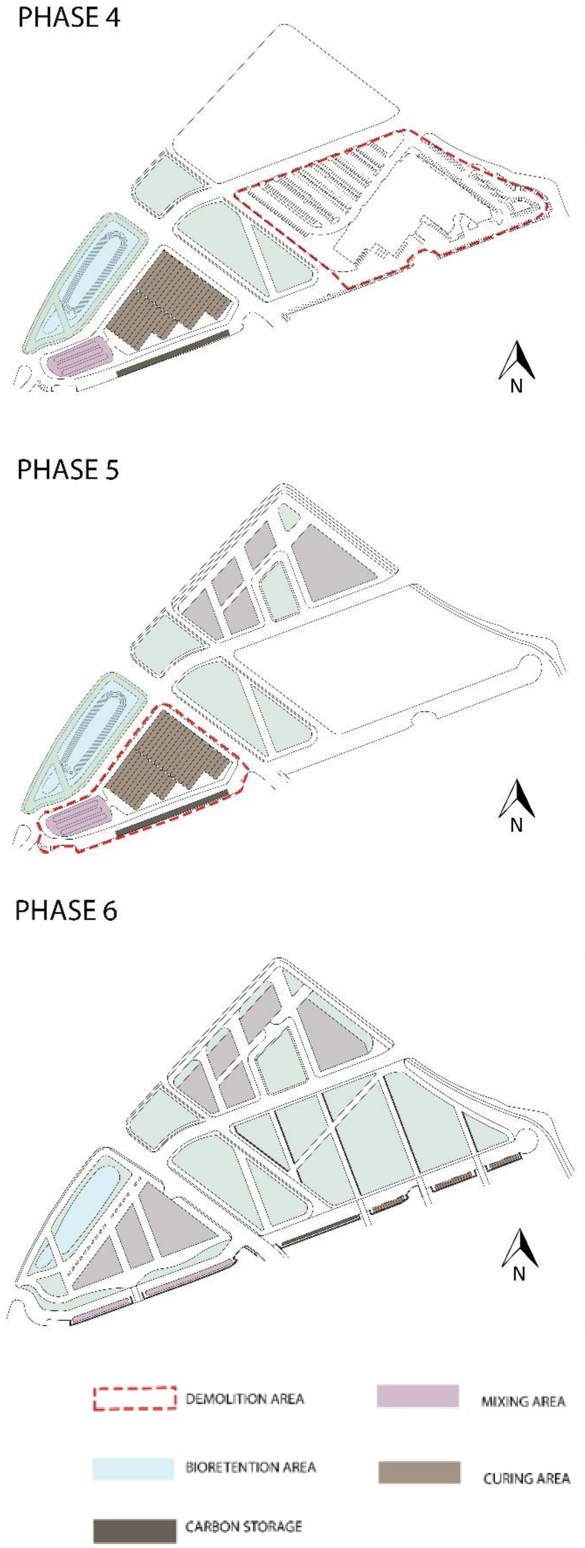


Figure 54: Proposed phasing plan part 2

- NOVEMBER 2021 - JUNE 2022

  - CURING AREA TRANSFERS COMSPOST TO NEW PARK SPACE.
  - NEW BUILDINGS START CONSTRUCTION.
  - NEW DEMOLITION AREA BEGINS ON EXISTING RETAIL AREA

- JULY 2022 - MARCH 2023

  - CURING AREA TRANSFERS COMPOST TO NEW PARK SPACE.
  - NEW CONSTRUCTION BEGINS
  - MIXING, STORING AND CURING AREAS MOVE UNDERNEATH THE ELECTRIC CORRIDORS

- MARCH 2023 - MARCH 2026

  - CURING AREA TRANSFERS COMPOST TO NEW PARK SPACE.
  - NEW MIX USE DEVEPOMENT FINISH CONSTRUCTION
  - FINISHED COMPOST IS DELIVERED OR PICK UP TO AMMEND OTHER AREAS IN MCNAIR.

Figure 55: Proposed grading plan, lowest point on the site on bioretention area on the west side.

The new Village Center at Dulles would now be able to welcome more people offering more activities other than shopping. It will offer housing to the projected number of people expected to move into the area and it will offer green areas for different activities while locally turning organic waste into compost.

On the lowest point of the site, the bioretention areas will collect any water runoff coming from the site and it will slowly release it the network of bioretention areas in McNair. The west part of the site will offer 3 mixed-use buildings and green buffer between the buildings and the mixing area underneath the utility corridor (sections A and D, see figures 59 and 62).

The center area of the site will offer a long park space surrounded by trees enclosing the green spaces. This area is a dynamic space for open concerts, farmers markets and any other events that need the space for a large number of people. On this section underneath the utility lines will be the carbon storing area. This is where all mulched yard debris will be stored for later use in the mixing stage.

The third and largest section of the site is split into two areas, the farthest north will have 5 mixed-use buildings and a plaza area for open coffee shops. This space will be the face of the site on the northern side. This is the intersection of Sunrise Valley Dr. and Centreville Rd. both streets are double 3-way lanes. The southern side of the site is park space. It has four long sidewalks crossing the park connecting the neighborhood on the south to the mixed-use buildings on the north. These sidewalks have retaining walls on the eastern side to contain the added amended soil giving trees more space in which they can extend their roots. The area closest to the buildings offers an orchard with a variety of trees adapted to our climate, such as pear, apple or fig. This is a symbolic area where people visiting are not only able to drop off organic waste but also see what the process of composting can produce. The other half of the park space offers sport fields such as baseball, football and soccer fields. These fields would be used by the local neighbors, specially the McNair community that live in apartments and townhouses that do not have backyard space for such activities (see section C figure 61). The space underneath the utility corridor will be the curing space. At this stage of composting the compost is left untouched for about a month before it is ready to be used.

The proposed design offers a mixed-use structure that will offer commercial/retail space on the first levels and apartment units above, like the kind of development already happening in Reston Town Center; however, this would be a more sustainable development which would be able to process the food waste generated in McNair and the yard waste generated by the county, turning organic waste into a valuable resource to amend urban soils and maintain the vegetated areas at their best.

Figure 56: Proposed site plan

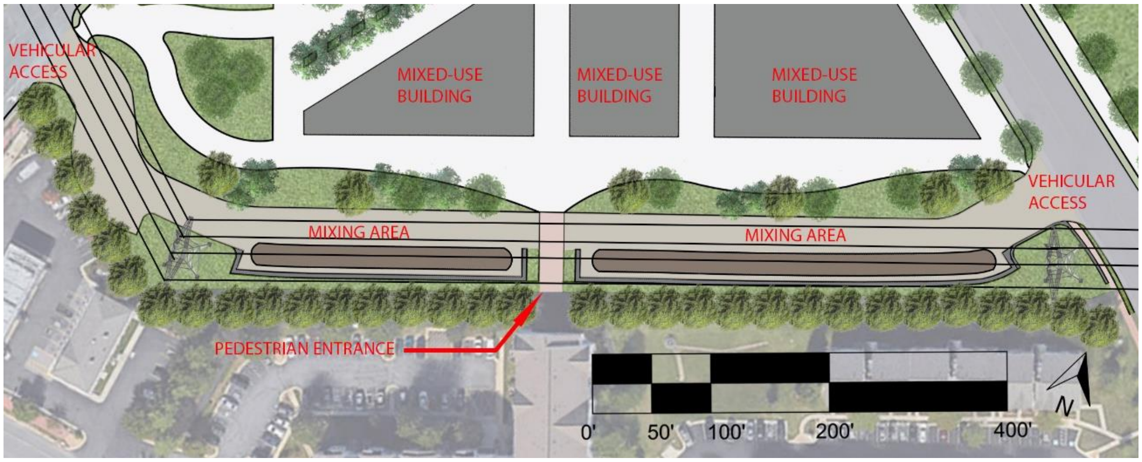


Figure 57: Mixing area under utility corridor on west side of the site.

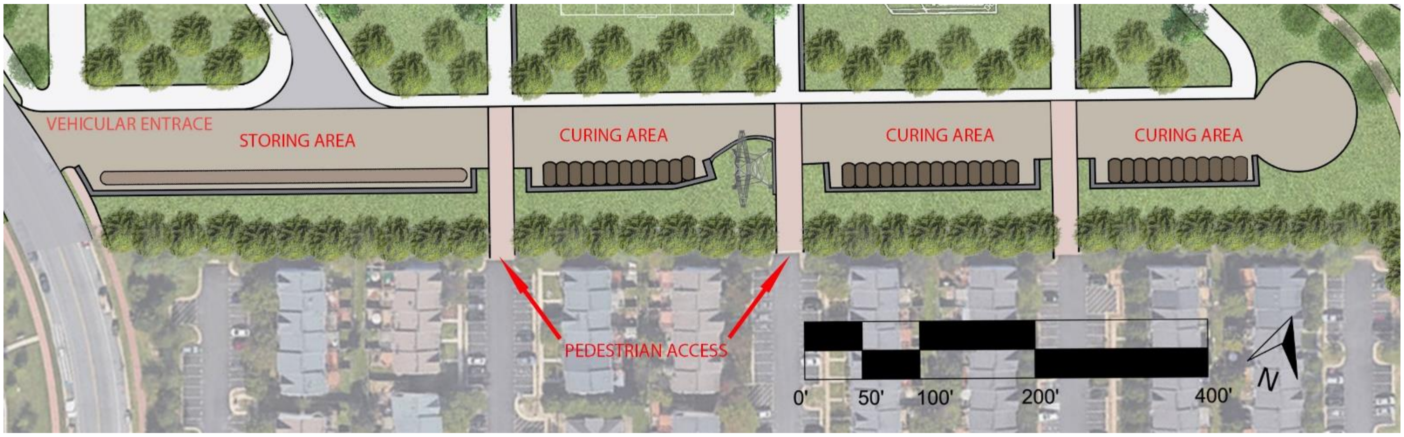


Figure 58: Storing and curing area under utility corridor on the east side of the site.

Figure 59: Water runoff diagram

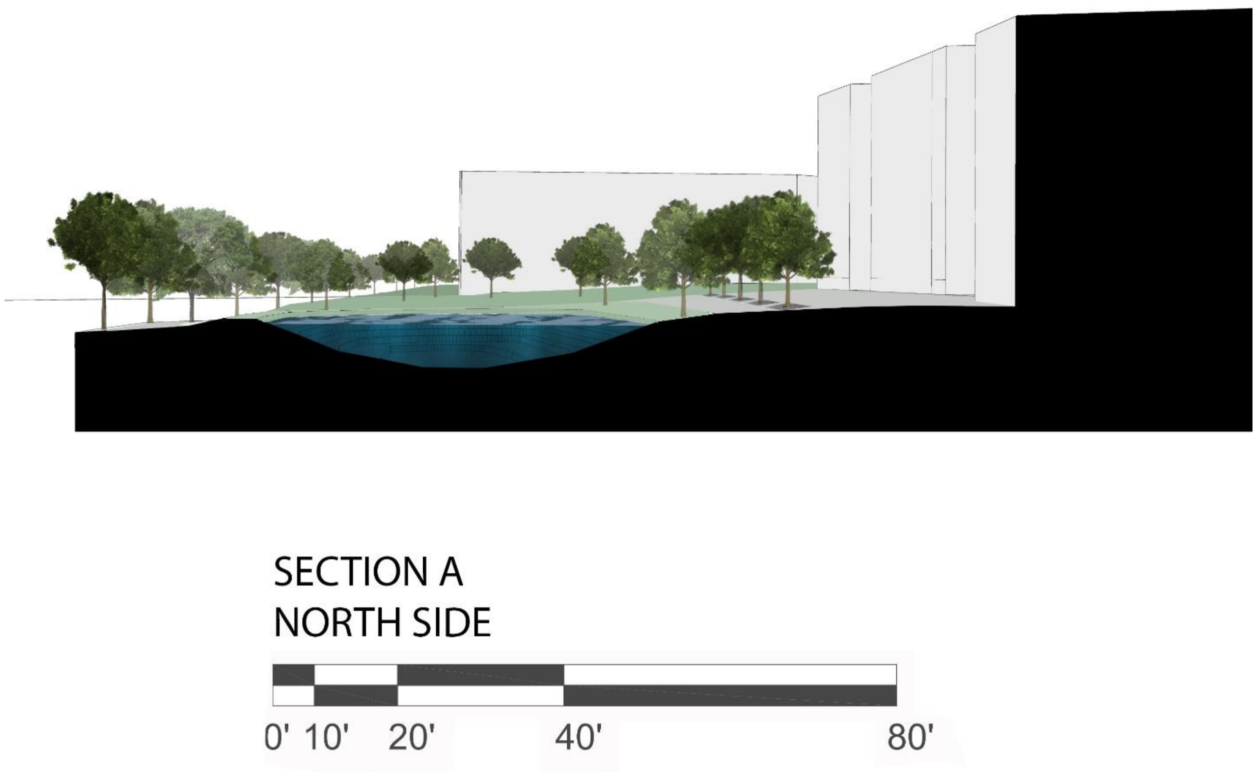


Figure 60: Section A North side at bioretention area, lowest point of the site.

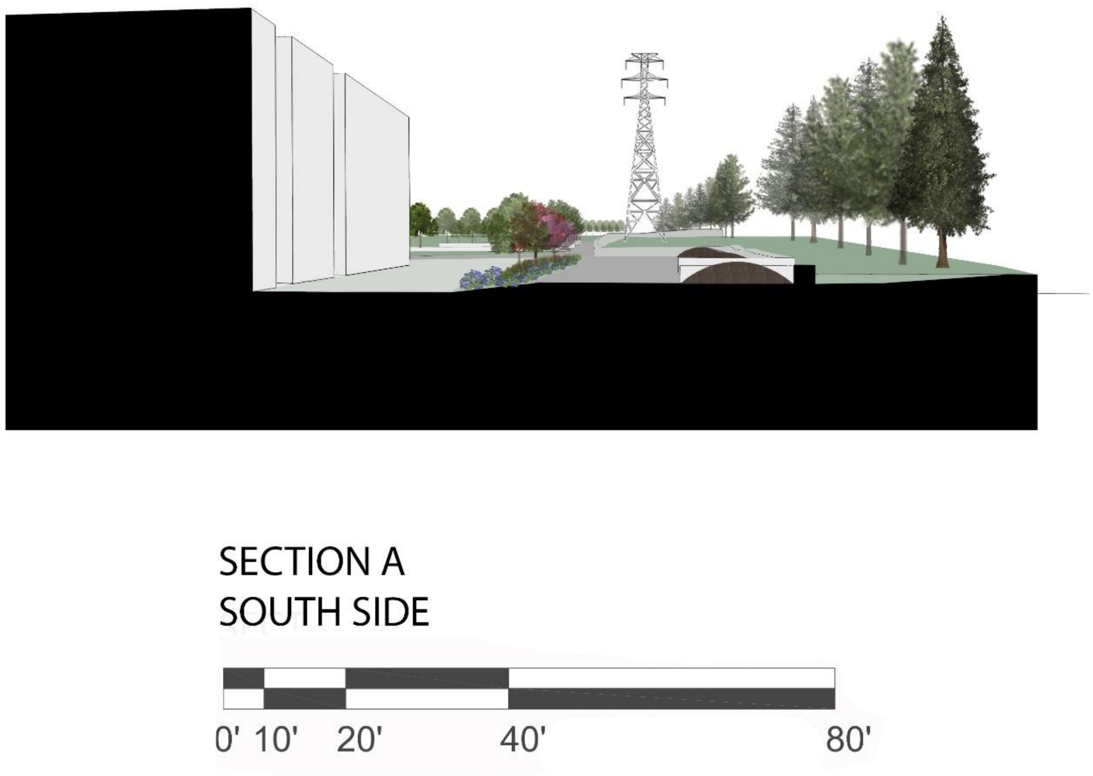


Figure 61: Section A South side, at mixing area under utility corridor.

Figure 62: Section B North side, along multi use lawn space.

Figure 63: Section B South side, long multi use lawn space and storing area under utility corridor.

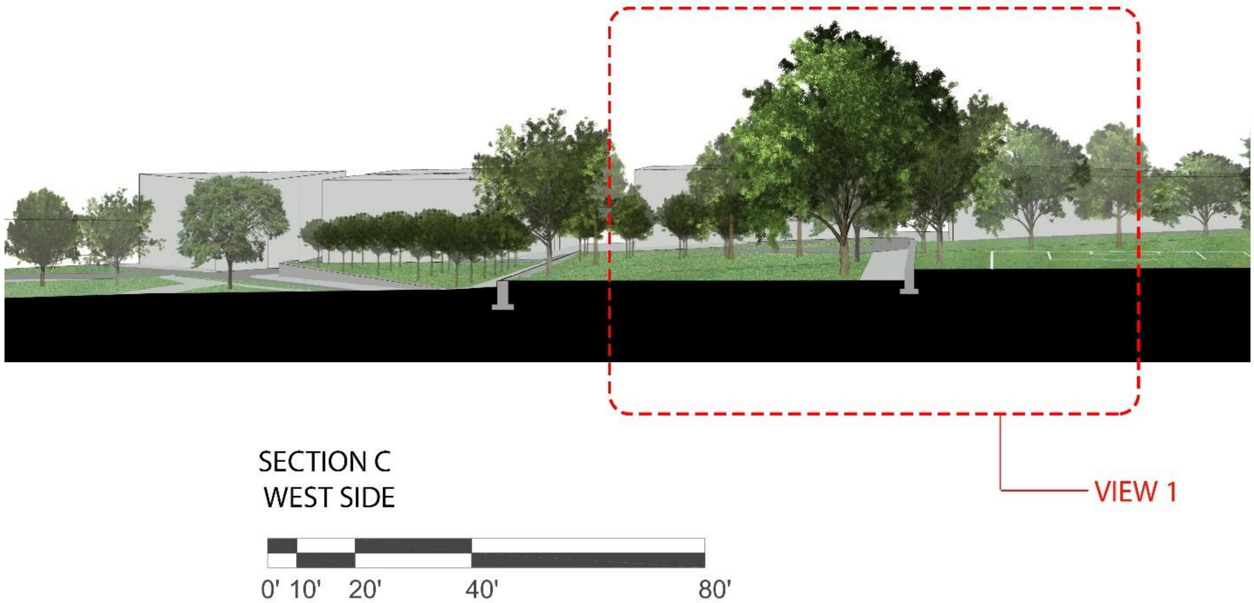


Figure 64: Section C West side, across sport fields and retaining walls.

Figure 65: Section C East side, across sport fields and retaining walls.

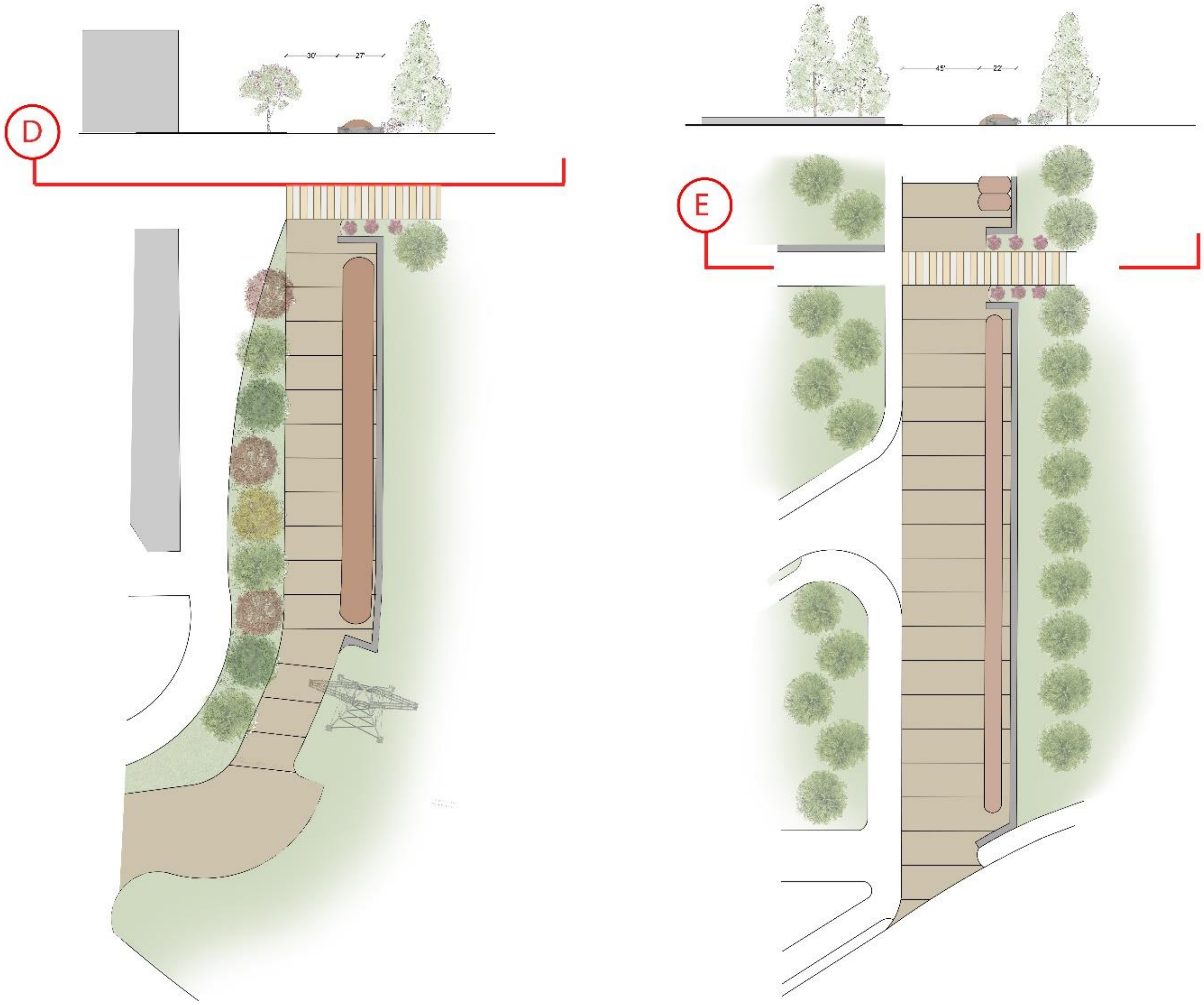


Figure 66: Sections D and F. Entrances to the site connecting townhouse neighborhood with site.

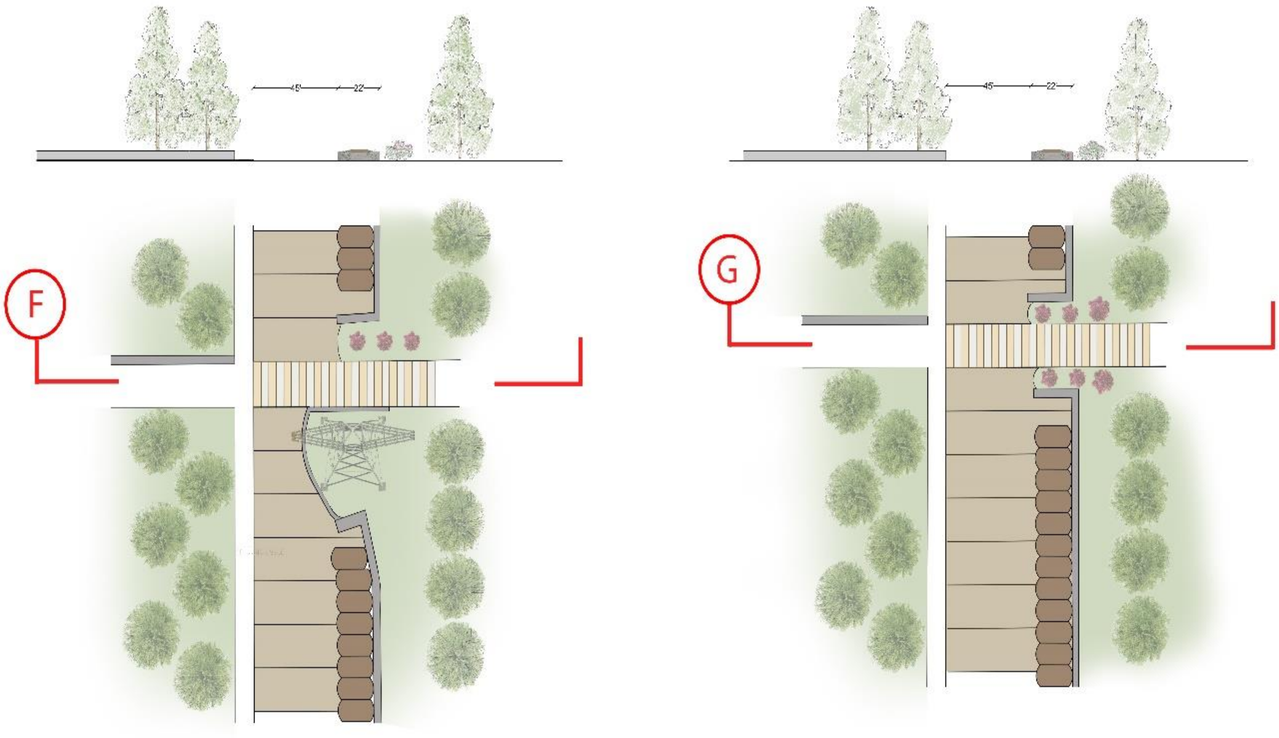


Figure 67: Sections F and G. Entrances to the site connecting townhouse neighborhood with site.

Figure 68: View 1

Figure 69: View 2

CHAPTER *5 – CONCLUSION*

The expansion of urban areas along with rapid population growth has a toll on the living organism underneath us: soil. The soil structure in the urban environment has been impacted by the negative effects of urbanization such as runoff pollution, impermeable surfaces, soil erosion, soil compaction, etc. These soil characteristics challenge the survival and growth of vegetation in the urban environment by disturbing the native soil and changing its biological characteristics. “In urban environments, because of human debris incorporated into the soil, especially related to construction or industry, PH can vary significantly…Low PH levels can produce an aluminum toxicity problem that limits most plants growth…leachate from limestone contained in concrete and other building materials can raise the PH levels causing problems to some plants with reduce uptake of iron or manganese.” (Trowbridge and Bassuk 4-5).

As more people move into cities, the demand of resources increases in order to sustain the increasing number of people. It is estimated that the population in Fairfax County will increase to 1.35 million people before 2040. (County of Fairfax) This number is overpassing the number projected by the Solid Waste Management Plan back in 2004 as shown on figure 66.

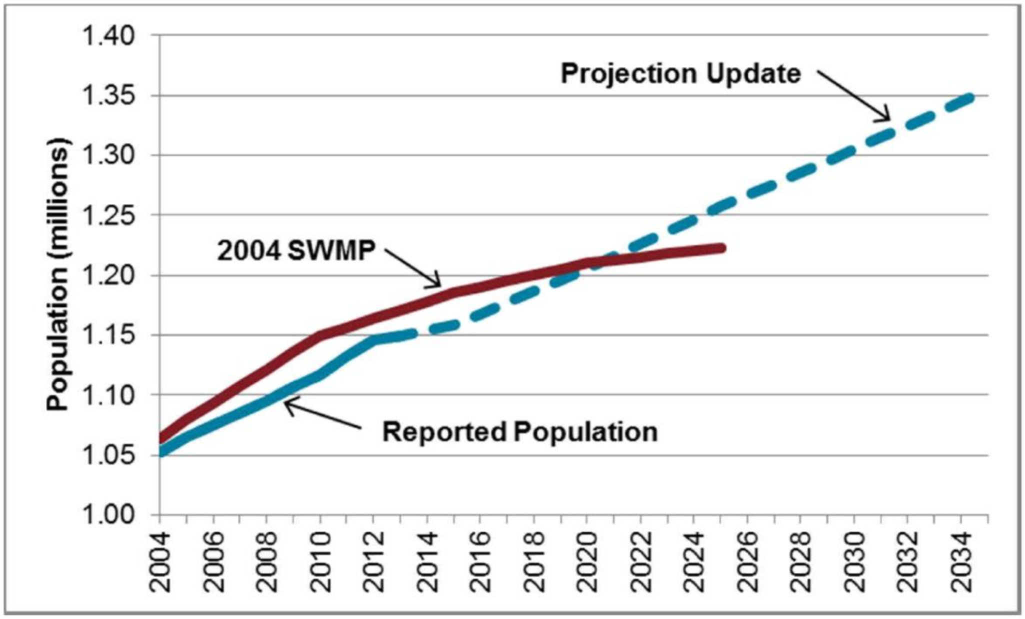


Figure 70: Population forecast in Fairfax County. *(County of Fairfax 4)*

Municipal solid waste is currently buried in landfills or burned in incinerators in or near the county. These facilities have a lifetime determined by their size and type of operations.

MSW Facilities used by or potentially available to Fairfax County				
Facility	**Location**	**Use**	**Remaining Capacity(1)**	**Remaining Useful Life(1)**
I-66 Transfer Station*	Fairfax, VA	MSW Transfer	3,000 TPD	>20 years
Covanta E/RRF*	Lorton, VA	MSW Disposal	3,000 TPD (~1.2 million TPY)	>20 years
I-95 Landfill (Area III)*	Lorton, VA	Ash Residue Disposal	4,209,861	32
Prince William County Landfill*	Manassas, VA	MSW Disposal	2,814,870	12
King George Landfill*,(2)	King George, VA	MSW Disposal	9,519,264	14.6
King and Queen Landfill	Little Plymouth, VA	MSW Disposal	9,441,589	29.8
Atlantic Waste Disposal	Waverly, VA	MSW Disposal	40,808,523	71.6
Old Dominion Landfill	Richmond, VA	MSW Disposal	2,546,103	6.2
Shoosmith Sanitary Landfill	Chester, VA	MSW Disposal	7,500,000	12

Figure 71: Municipal Solid Waste capacity in nearby Landfills. *(County of Fairfax 10)*

Most of the waste currently going into landfills is organic material containing nutrients that can be recycle through a composting process. Chapter 109.1 Solid Waste Management states that all waste material must be "sourced-separated for recycling at both residences and non-residential properties." (County, Solid Waste Management Program Chapter 109.1 recycling Program Requirements 10) If the residents in Fairfax County would also separate all organic waste from solid waste material as it is done with recyclable materials, we could take advantage of this organic nutrient rich resource and use it to amend the soil with urban characteristics. Diverting organic waste from going into landfills and incinerators will also prolong the lifetime of these facilities allowing them to process more inorganic waste.

Improving the waste management operations in urban areas is essential in order to amend urban soils. Exporting yard debris and leaf mulch to out of county composting facilities is not a sustainable solution for dealing with organic waste. The process of transporting organic waste itself can be considered a misuse of resources. If instead of transporting the material it could be processed within the area that generates it, the natural nutrient cycle could be closed.

The benefits of composting in the urban environment would not only benefit the living organisms in the soil but also the vegetation growing in it. It will improve the air quality allowing healthy trees to absorb air pollutants. Green areas will be able to absorb water runoff filtrating stormwater and storing it in the ground. This will reduce the need for chemical fertilizers which may have a negative effect on the native wildlife and will educate the community, engaging them into the composting process. The utility corridors that transfer electrical energy through the county will now also produce energy on the ground level recycling the nutrients in organic waste and turning it into a resource for the use of the community.

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