The Number One Way to Go Number Two: Proposing the Best Composting Toilet Model for Allegheny College's Campus

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April, 2023

Submitted in fulfillment of the senior thesis requirements of the Department of Environmental Science at Allegheny College and approved by the senior thesis committee.

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Pledge

Acknowledgements

It is incredibly hard to put into words how very grateful I am for the support I have received throughout my undergraduate experience. I have been fortunate enough to have a glittering network of friends, peers, mentors, professors and family members who have all enriched my life in one way or another.

To Eric Pallant, thank you for always pushing me not to take myself so seriously all of the time. Although it was challenging for me, I know I am better for it. I will always be grateful for the times you have helped me to understand when to relax and when to work hard.

To Kelly Boulton and Kurt Hatcher, thank you for always being eager to sit with me while I unloaded all of my ideas. I always walked away from our conversations feeling renewed and inspired. I appreciate both of your willingness to always squeeze me into your hectic schedules.

To my comp group, you all are capable of so many incredible things and I am so excited to see where life takes you. Each and every one of your topics was interesting and fun to learn about and I couldn't have asked for a better group to spend my Tuesdays with.

To my family, I wouldn't be where I am today without your unconditional love and support. Knowing that you are all behind me in everything I do has given me the strength I have needed to grow and believe in myself. Dad, thank you for proofreading my research for spelling errors and always pushing me to elevate my writing. To Rachel and Wesley, for making me so proud to be your big sister and strive to be half as smart and talented as you both are. And to my mom, thank you for all of the late night phone calls, and emotional support. I love you so much.

To my wonderful roommates, I couldn't have completed my comp and still been a functioning human being without you. I can't thank you all enough for filling this year with such lovely moments and memories and especially movie nights.

Finally, to my incredible friends and the people on campus who have made my college experience so rewarding. I will never be able to thank you enough for touching my life in the many ways you all have. Each and every one of you has taught me a great deal about love and the importance of being able to be authentic and candid with the people around you. From the bottom of my heart, you are the best people I know. Thank you for the endless support in good times and bad. I am so very fortunate to know you all.

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Abstract

As climate change and human impact continue to strain our planet's natural habitats and resources, water scarcity is becoming a pressing concern and is projected to have devastating implications for areas already suffering from lack of water availability as well as areas that are not currently water scarce, but will be in the future. In an effort to find and promote alternative solutions to wasteful water usages in everyday life, I propose that Allegheny College should implement a composting toilet facility on their campus. I researched existing toilet brands as well as local legal guidelines and narrowed my focus to three potential toilet models that are best suited for Allegheny College and then compared them in capacity, cost, and maintenance. The results of the analysis showed that the Clivus Multrum M54 Trailhead composting toilet is the best suited model for Allegheny College, on the grounds of convenience and legality and would work well in any location on campus or campus owned.

Abbreviations and Definitions

Bio-drum™ = patented design for the Sun-Mar rotating compost basin

Carrden = The garden outside of Carr Hall at Allegheny College

Centrex 3000 = Sun-Mar Centrex 3000 NE/AF

Clivus = Clivus Multrum

Compost Quick = Sun-Mar brand specific cleaning solution for composting toilet units

M10 = Clivus Multrum M10

M54 = Clivus Multrum M54 Trailhead

Pink House = The specialized greenhouse located in the Carrden

Introduction

Today, over one fourth of the global population live in water stressed countries (United Nations, 2021). That number is projected to double by the year 2050 (Chertock, 2021; unicef, 2020). Water is a finite resource with freshwater making up only 3% of global water supply and potable water representing a fraction of that (WWF, 2022). According to the World Economic Forum, the gap between global water supply and demand is projected to reach 40% by 2030, and in many places demand is already exceeding available water (World Economic Forum, 2022). Climate change is also exacerbating water scarcity, making water access more unpredictable. Increased frequency in droughts deplete freshwater resources and floods contaminate already limited reservoirs of potable water (Tsegai, 2022; Barbetta, 2022). As average global temperature continues to rise, terrestrial water storages held in soil, snow, and ice are diminishing (United Nations, n.d.). Water scarcity occurs for many reasons, but as the global population continues to increase and climate change continues to skew the available supply of freshwater, many countries' water resources and their subsequent allocation are failing to meet accelerating demand.

Demand for water resources is competitive across all sectors, but agriculture is by far the biggest user of water accounting for 72% of withdrawal (United Nations 2021). Eventually demand and scarcity issues will require water to be reallocated more fairly between economic sectors, but the growing population and a 50% projected increase in irrigated food production by 2050 make it challenging to redistribute water from agriculture at this time (Chertock, 2021; The World Bank, 2022). Although, agricultural irrigation is in need of some major improvements to avoid runoff and exterior water wastage, as well as an eventual reassessment of water resources in the near future.

While it's a big step down from Agriculture, about 16% of all water withdrawals go to municipalities for households and services (United Nations, 2021). In the home, people can waste approximately 900 billion gallons of water nationwide, which is the equivalent water use of nearly 11 million homes (EPA, 2022). The average family wastes about 180 gallons a week and toilets are by far a main source of water use in

the home, accounting for nearly 30% of an average home's indoor water consumption (EPA, 2022; EPA, 2022). Since the current water infrastructure in developed countries produces one quality of potable water for all uses such as drinking, irrigation and toilets, switching out flush toilet models for water saving alternatives can allow for a large quantity of usable water to be reallocated for more useful purposes within the home (Anand, 2014).

In the United States, approximately 2.2 million miles of underground pipes are responsible for delivering safe and reliable drinking water to millions of people (RAI, 2021). This infrastructure is aging and severely underfunded making the pipes susceptible to breaks, which occur every 2 minutes in the US, with an estimated loss of 6 billion gallons of treated water each day (RAI, 2021). Members of the American Society of Civil Engineers (ASCE), which releases an annual report card for American infrastructure systems, estimates that approximately 240,000 water main breaks occur every year, with an annual loss of more than 2 trillion gallons of drinkable water (Nabers, 2021). The system for waste water removal from the home is a very similar series of outdated pipes. On average, the age of most sewer systems in Pennsylvania is approaching 75 years with many exceeding 100 years old (RIA, 2022). The funding gap between repairing and upgrading existing systems, meeting regulatory requirements, controlling overflows and constructing new or expanding existing systems to meet demand, is estimated to reach $8 billion in the next 10 years (RIA, 2022). Only $900million is expected to be available over that time, which is only 1/10 of the yearly investment required to maintain wastewater infrastructure in Pennsylvania alone (RIA, 2022).

Some alternatives to the standard flush toilet are low flow and gray water toilets. While these options are good in theory, they also come with setbacks. Many countries that don't have adequate access to potable water also lack sewage systems and water treatment facilities. Since the water resources in these areas are most frequently used for drinking when available and not for the purposes of waste sanitation, water saving options are unnecessary and unhelpful. For the countries that do have sewage systems and water infrastructure in place, water saving alternatives to traditional toilets are only

addressing half of the problem. Both low flow and greywater options mitigate potable water in toilets, however, they still cause considerable strain on water infrastructure systems.

While repair and rehabilitation are necessary and unavoidable, other solutions should also be explored to reduce the burden on the current infrastructure and develop more sustainable options (Anand, 2014). Composting toilets, also known as waterless toilets or green toilets, are a technology that is not frequently considered but has many benefits when being used to combat water scarcity. Not only do composting toilets require little to no water to function, they are often cut off from both the potable water supply and waste water infrastructure (Anand, 2014). This allows composting toilets to be used not only in areas with aging infrastructure, but also in areas without access to safe, if any, infrastructure at all. For many countries that lack access to clean water and safe sanitation, implementation of waterless toilets has the potential to service one in four people worldwide (Sierra, 2022). Lack of access to basic sanitation and hygiene acutely impacts children under 5, and as a result, about 450,000 children die from diarrhea every year (CDC, 2022; Troeger et al, 2018). Composting toilets offer a safe and hygienic waste management system to places that lack such resources, so there is potential to not only save water, but also save lives.

Additionally these green toilets also create a valuable product from the fecal as well as liquid matter that is inputted into them. The compost that results from the system provides the added benefit of nutrient cycling. As previously stated, the global population continues to grow, which results in an increased need for agriculture and food production, as well as feed crops for animals (Roell, 2020). The global population continues to demand higher and higher yields of food supplies which has lead to a rapid depletion of nutrients within the soil, specifically nitrogen, phosphorus and potassium (N,P, K) (Hidalgo et al, 2020) The invention and implementation of synthetic fertilizers have increased crop production, allowing more food to be grown on less land, but has also taken a large tole on environments impacted by agriculture (Manthiram, 2021). The manufacturing of synthetic fertilizers is extremely energy intensive and requires transportation of finished products on an international scale, and the application of

synthetic fertilizers, if not properly utilized, can runoff into water bodies and be lost into the atmosphere as ammonia making agriculture the second largest source of climate change pollutants (Manthiram, 2021; Pan, 2016). Human waste, also known as biosolids, contain organic matter and nutrients when composted and can help to reduce the amount of synthetic fertilizers needed. There is still controversy over whether or not biosolids are safe to use in agriculture, however, studies have shown that fertilizers derived from human waste can be just as, if not more productive than synthetic alternatives, with little to no risk of pharmaceutical or pathogen transmission. (Spicer, 2002; MDEQ, 2014; Chow, 2020; Weston, 2023). Composting toilets can further improve the quality of the fertilizer and can help to replenish necessary nutrients to the soil through general use, even if the product is not applied directly to food crops (Weston, 2023).

Even with all of these benefits, composting toilets remain an underutilized resource as a result of lack of knowledge and acceptance of their functionality. Interest in these systems are growing, but not enough to have an impact on water systems, nutrient cycling, or improved sanitation and hygiene. At Allegheny, we have a commitment to sustainability that transcends verbal and hypothetical implications. We have made it our mission to contribute less to the worsening climate and use our influence in favor of sustainable solutions and alternatives. Composting toilets are not the only option to target water scarcity and they may not be the most impactful especially in areas like northwestern Pennsylvania, however, if more schools and institutions such as Allegheny start to utilize composting toilets, it might help shed light on the growing concerns of global water scarcity, creating avenues for research and exploration into new alternatives and new technologies. It is our responsibility as an institution of higher education to trailblaze methods for sustainable living and provide a template for individuals to implement new technologies into their lives, or spread their knowledge to places in need.

In 2015, the United Nations adopted a comprehensive plan of action known as the 17 Sustainable Development Goals (UNSDG, n.d.). They represent an urgent call for all countries to form a global partnership in order to protect the planet and the

individuals who call it home. The goals are meant to make people realize that tackling climate change is a larger problem that must encompass ending poverty, reducing inequality, improving education and health all while preserving our natural resources and habitats (See Figure 1).

The goal of this paper is to propose the best model of composting toilet specific to Allegheny College campus based on factors such as cost, capacity, and maintenance. I am aiming to address the 4th UN SDG in hopes that adding a composting toilet to Allegheny college will provide an educational opportunity to the students to utilize in other aspects of their lives and to gain an awareness of sustainable alternatives to the parts of our lives we don't often consider changing. I am also considering the 6th UN SDG by proposing the more frequent usage of a utility alternative to ensure availability and sustainable management of water and sanitation for all (UNSDG, n.d.). Since this is still a topic that is being developed and built upon, information was pulled from peer reviewed literature as well as some gray literature. I will be discussing and comparing composting toilet models for the purposes of recreational use at Allegheny college, and will also be specifying why many models are not suitable for a campus, but could be very beneficial in other applications. The potential placement of the proposed composting toilet will also be presented.

Figure 1. Sustainable Development Goals[1]

[1] *The 17 Goals.* (n.d.). United Nations. Retrieved February 10, 2023, from https://sdgs.un.org/goals

Methodology/ Process and Approach

I started my research process by first navigating google and google scholar for key words such as “compost”, “toilet” (not an all inclusive list) and looked specifically for articles that were published within the past 4 years and websites that corresponded with those articles. If I found contradicting statements, I made sure to dig deeper and often accepted the fact with the largest number of reputable supporting articles as the most correct statement. If I was unsure if an article or source were peer reviewed or reputable, I googled the journal or the website title to check for bias. One of the articles I found on Science Direct offered a list of composting toilet brands. I searched each company by name on google to make sure they still existed and formed a chart of the remaining brands along with the models they offer that could handle the usage at a college, the maintenance involved, the cost, and any other details offered on their respective websites that I couldn’t yet determine the importance of and added them to a “notes” column.

I gained an understanding of how different composting toilets functioned by reading each brand's website's description of their products and used that knowledge to make informed decisions about what make and model might best suit Allegheny college. Once I had a better understanding of exactly how a composting toilet should function based on the findings of my online navigation, I started looking for my background and why my project is important and meets the SDGs. I looked at the UN SDG website and concluded that my two most important goals were 6: clean water and sanitation, and 4: quality education. I used these goals to establish the importance and possible impact of implementing a composting toilet on campus.

I also made sure to search for up to date PA legislature on waste management, by searching the phrases “PA law on composting toilets”, “is it legal to use human waste as compost”, “alternative sewage in PA”, “sewage treatment laws”, among others (not an all inclusive list). I visited Shadybrook Park in Meadville to confirm that composting toilet technology already exists in town and would be acceptable to implement on campus. Through my search for the PA legislature I found that there was a certification

that sewage alternatives had to meet in order to be considered legal as well as odorless. From this point on, I only considered toilets from the list of certified brands and models. There were only two, Clivus Multrum (Clivus) and Sun-Mar. I realized at this point that my original chart didn't accurately portray the information that initially influenced my consideration for possible toilet options, so I reorganized the chart for my final paper. I included a column for whether or not the model was still in existence, as the source I originally found was from 2014. I also included columns for where the brand is manufactured/where it ships to, if they need to be retrofitted or can be self-contained in an outdoor unit, whether or not they are well suited for small groups or commercial usage and if they possess the required legal certification.

I corresponded with Kelly Boulton, Allegheny College's Director of Sustainability, to figure out some details of the application of the toilet on campus. I asked her questions about our campus's current composting facilities and if there was a possibility of using the waste in the Carrden, and ultimately decided that might be for another research paper. We also discussed who might be responsible for maintaining the toilet unit and did not come to a conclusion.

I called the number on the Clivus Multrum composting toilet website and was met with a representative named Brian Barry. We maintained email and phone correspondence for many questions I had regarding models that accommodate institutions such as Allegheny College. During a phone conversation with Mr. Barry, I asked questions such as " how should I go about finding a projected usage", "how does seasonality affect usage and maintenance", and "how does this system generally create soil from waste". During this correspondence, Mr. Barry also told me that they had installed M54 Trailheads at a number of locations such as, but not limited to, the University of Washington, Lewis and Clark College, Bucknell, and Cornell.

Over the last few months, of the fall semester, Mr. Barry and I corresponded through email and I asked clarifying questions about the M10 and M54 models such as "what are the dimensions of these models" to which he responded with a specification sheet for each unit, and "what is the cost of the units" to which he responded with a cost

estimate in his own words for one model and a cost sheet for another. The one that he responded with an estimate, has some customer customization options that may effect the overall price but I opted for the least expensive option. I continued correspondence with Mr. Barry up until the week my first draft was due when I became aware from the Clivus website that there might be an option for a Clivus representative to clean and maintain the unit instead of having someone do that on campus. I emailed about the cost and was met with a direct answer.

I also contacted a representative from Sun-Mar about some clarifying questions regarding the toilet I considered from their brand to use on campus. The representative who I spoke to, his name was Joe, but he did not give me a last name. The question I asked Joe during this call was “can this model of Sun-Mar be used outdoors or does it need to be retrofitted into a house or existing structure?” He answered that the unit is meant for a house basement and is traditionally used underground, however, as long as it is out of the elements and off of the ground, it can be contained in a foundation above ground. I used this information in the cost consideration in my results section.

After collecting all of the data from both Clivus and Sun-Mar, I then curated a series of charts aimed at comparing the three models best suited for Allegheny based on capacity, cost, maintenance requirements and toilets that were legally certified for use in PA. I separated my charts into cost, maintenance, and capacity of the three toilet models.

Discussion of Results

What is a Composting Toilet

In order to accurately write and make decisions about which composting toilet is best for Allegheny College campus, it was crucial to first gain an understanding of what a composting toilet is and how it functions. Composting toilets have two main components, the toilet itself and the composting tank that acts as a waste receptacle.

There is also a vent pipe and/or a fan that acts as the ventilation system preventing odor from entering the toilet room. It is common to also find drainage or either an initial urine separating system, which helps dry the waste out faster, further mitigating odor and limiting harmful pathogens from growing in the tank (Separett, 2020; Urine Diversion, n.d.). The composting in these toilet systems is done largely through an aerobic digestion process, or in some cases, through the use of worms known as vermicomposting. The aerobic process undergone in the composting toilet unit is specific to each model. Some models need manual mixing and others have rotating basins that allow for hands free aeration. A combination of bulking and manual mixing of some degree are necessary for all models. After the composting process has taken place, there is both a solid and a liquid byproduct of the waste. The solid byproduct is a rich hummus like material that is far developed from the original input, and the other is a nitrogen rich, urine based liquid that has drained from the solid matter.

Although the primary components of the composting unit are generally the same, each system can be designed to function differently. A composting toilet can be either self-contained or central meaning that the composter and toilet are directly connected in a single unit or the toilet is a separate fixture that often transports waste into a separate compost area. Figure 2 illustrates the visual difference between these two systems.

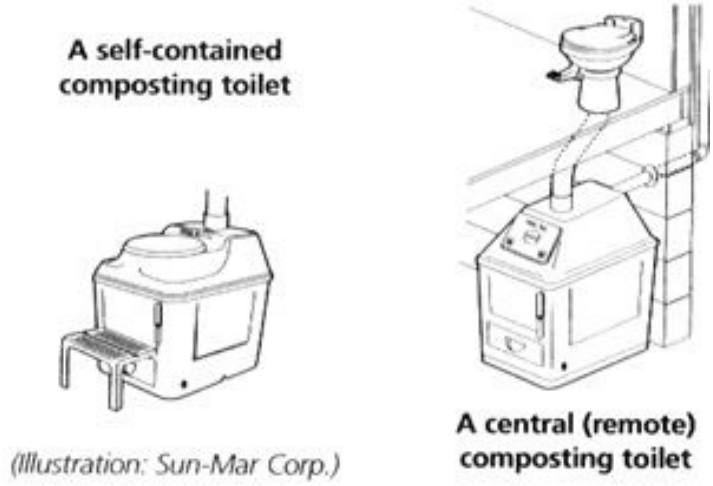

Figure 2. Self-contained vs Central composting toilet[2]

[2] Public Utilities Commission. (2021). Composting Toilets. Retrieved March 22, 2023, from https://sfpuc.org/accounts-services/service-installations/composting-toilets

Different composting toilet brands also have different styles of chamber tank. Some units have a single tank.(see figure 3).

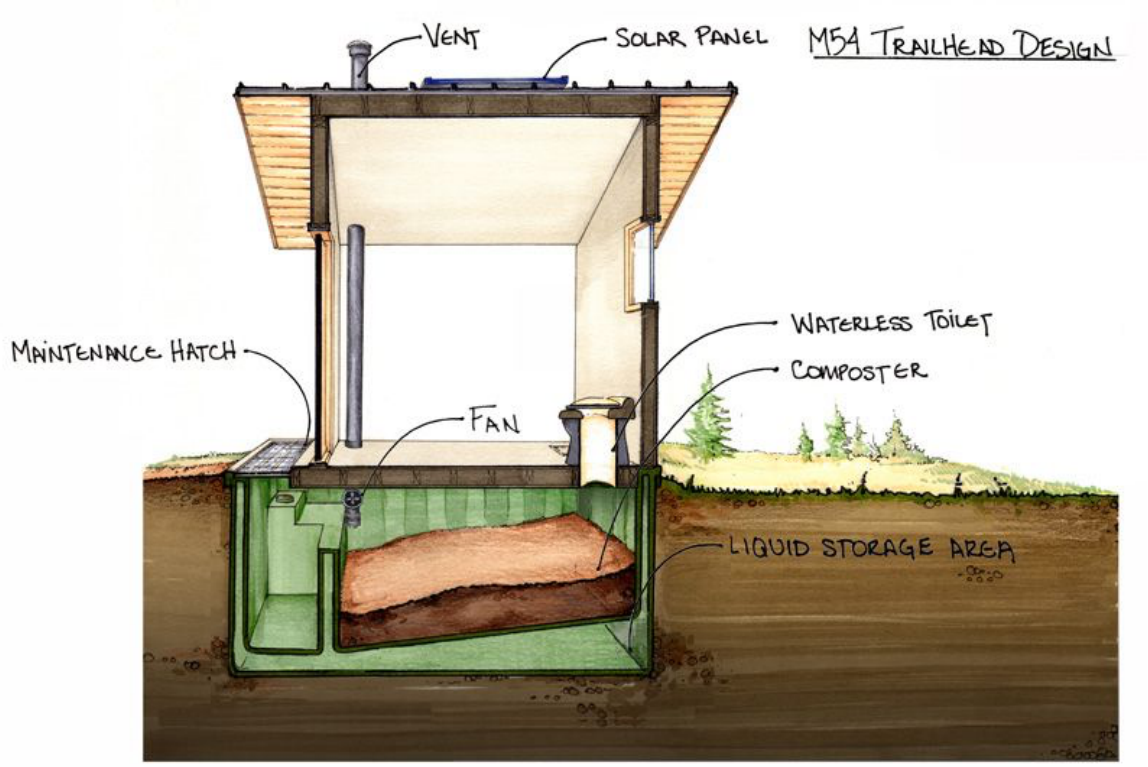

Figure 3. Single Tank Composting Toilet Model[3]

In a single tank unit, waste needs to be periodically mixed and moved so old waste that has started to decompose does not get lumped in with fresh waste, otherwise the process will need to be extended to account for the most recent fecal matter. Other units may have multi chamber tanks, often referred to as barrel tanks and are mixed or rotated to allow for composted waste to be totally separate from newer waste (see figures 4 and 5).

Units can also either be electric or solar in order to power the fan that is a necessary part of the ventilation system that allows for aerobic decomposition. Toilets also have the option to be fully waterless or water saving, and even foam flush. (Anand, 2014). Current composting toilets on the market can utilize any combination of these design features.

[3] *Products and Services.* (n.d.). Clivusmultrum Incorporated. Retrieved October 12, 2022, from https://clivusmultrum.com/products-services.php

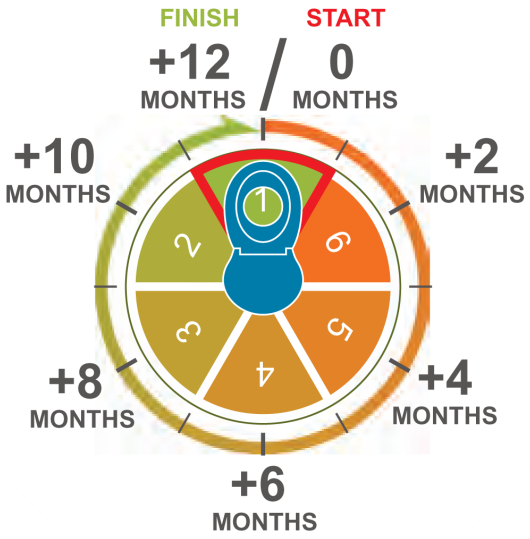

Figure 4. Rotating Toilet Timeline[4]

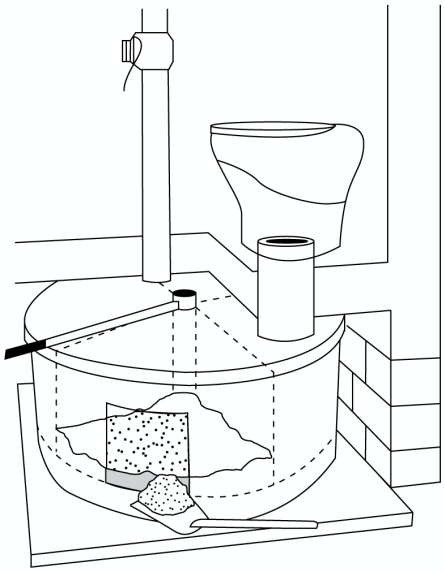

Figure 5. Carousel Toilet Schematic[5]

NSF Certification

According to the PA legislature within the Commonwealth of Pennsylvania code, it is mandatory for composting toilets to be certified by NSF in order to be installed. The National Sanitation Foundation (now just NSF) was founded in 1944 to help standardize food and sanitation standards in the US in a time where there were none. NSF has since expanded into a global organization, operating in over 170 countries. The services performed by NSF are a series of strict procedures such as extensive product testing, material analyses and even unannounced inspections. All products that bear the seal of NSF are thoroughly evaluated. The certification also extends past the initial clearances and involves regular inspections of manufacturing facilities and regular re-testing of products. Composting toilets, along with kitchen appliances, home water treatment systems, dietary supplements, personal care products and more all fall within the kinds of products that can receive NSF certification.

[4] *Rota-Loo.* (2020). PFG Group. Retrieved March 19, 2022, from https://pfg-group.com.au/rota-loo/
[5] *Waterless Toilets,* (2013). Australia's Guide to Environmentally Sustainable Homes. Retrieved March 19, 2022, from https://www.yourhome.gov.au/water/waterless-toilets

Based on the NSF website, the only two brands of composting toilets that are certified are Clivus Multrum and Sun-Mar. Because NSF standard certification is a legal requirement for composting toilet installations in the state of Pennsylvania, these were the only brands that I considered when deciding which composting toilet model would be the best for Allegheny College's campus.

Existing Legislation in Pennsylvania

There are some inconsistencies in the PA legislation for composting toilets. This could be a result of varying levels of knowledge and motivation to include supportive legal outlines for composting toilet units. The responsibility of regulating composting toilets can also be misunderstood on multiple levels of legislation. These kinds of toilets are regulated by the Department of Health, local watershed authorities, and Departments of Environmental Conservation or Protection. Although these groups often have the same goals, their processes and approach to those goals can vary, creating conflicting policy ideas and incongruent regulations. There is also limited incentive to standardize building codes. "In the U.S., the regulations were developed by counties, municipalities and state departments of environmental quality and show some variation as well as a general lack of detailed guidelines (Anand, 2014; Jenkins, 2005, Branstor, 2014, p. 94)." Further, the codes have not been adapted in recent years to better accommodate or promote waterless waste management projects.

When researching the legality and feasibility of implementing a composting toilet on Allegheny College's campus, the Pennsylvania Code from the Commonwealth of Pennsylvania ended up being the most helpful source (Pennsylvania Code, 2022) . Even though it was the basis for understanding which toilets are allowed to be installed in PA, the entire code for recycling toilets, incinerating toilets and composting toilets was summed up within five short subcategories. One of those specifications is essentially a restatement of the manufacturer installation and utilization guidelines, which only serves to say that the unit needs to be operated however the manufacturer says to. The current

PA code also specifies that for any new building, a sewage system still needs to be implemented on site to dispose of waste liquids. If the existing residence already includes sewage, it can not be altered for the composting toilet. This outdated legislation currently prohibits waste systems from truly ever being waterless and makes it challenging to move away from outdated sewage treatment infrastructure in a way that would allow these systems to access their full sustainable potential.

There is no specification for how to utilize, or if it is even legal to utilize, the compost end-product and there is variation among sources. The Pennsylvania Department of Environmental Protection discusses ways in which to utilize compost, but there is no section or inclusion of compost from human waste. When it comes to composted manure, literature and legislation are difficult to find. There is also no specification for composting at institutions, residences, or buildings. Composting regulations listed are reserved for on-farm practices exclusively and are only considered if the materials are generated from “normal farming operations” such as food processing, waste or sludge that are not considered hazardous. What is considered hazardous then? That is not elaborated in any of the documents. There are also no established requirements for the processing and use of treated domestic sewage except for on agricultural land. There is also no mention of composted waste either as the document only discusses raw sewage usage on agriculture which wouldn’t be the toilet end product.

The only thing that is very clear in the Commonwealth of Pennsylvania Code, is that any liquid waste is NOT to be utilized and must be disposed of in on lot sewage systems. Since there is little to no clarification on what is able to be composted, how it is composted, or where to use it, for now it is assumed that implementing a composting toilet unit on campus would be best suited to educate people on sustainable alternatives to traditional waste methods, or to serve as a toilet option for locations that lacks plumbing infrastructure.

Composting Toilets on the Market

I put together a chart of all of the toilet brand names I came into contact with throughout my research. One source I have utilized frequently by Chirjiv Anand, on “Composting Toilets as a Sustainable Alternative to Urban Sanitation", had an extensive list of brand names of composting toilets, but was published in 2014. In order to prove whether or not these toilet brands were relevant to my study, I searched each one up individually to make sure they were all still viable options. Many of the toilets still existed but there were some like the Eco Toilet and Envirolet brands that were no longer relevant or very challenging to find updated information on. There were other toilets that were included in the list that were not composting toilets at all, such as the Eco John, which is an incinerating toilet and Lzour, which is a portable camping toilet unit that does not compost. Once I knew the toilet existed and performed the composting function that I was looking for, I scoured each toilet's website as well as any supplementary materials such as specification sheets and distributor websites for the details on each brand. I recorded which units were solar, electric or both, whether or not they are self-contained or central, how they need to be stored and where they can be installed, and the price range. This was helpful, but the most important sections of the chart for my analysis were the “Personal or Commercial”, “Ships to the US”, and “NSF Certified” sections (See Table 1).

Toilet Companies	Still Exist	Ship to the US	Electric or Solar	Price Range	Personal or Commercial	Notes	Function	NSF Certified
BioLan[6]	Yes	No (Finland and Sweden only)	Solar	£1,042.44	Personal	Can be placed directly in the house or installed outdoors	All models are self contained single tank Also urine diverting models	No
Biolet[7]	Yes	Yes (based in	Electric	$1,470-$	Personal	Can be placed	Self contained single tank	No

[6] *Biolan Products,* (n.d.). BIOLAN. Retrieved January 20, 2023, from https://www.biolan.com/products/toilets.html
[7] *Biolet - The world's best composting toilets,* (2023). BIOLET. Retrieved Jan 20, 2023, from https://www.biolet.com

		Sweden but some models are manufactured in the US)		2,970		directly in the house	unit	
Clivus Multrum[8]	Yes	Yes	Both	$4,000-$27,000	Commercial	Can be retrofitted or installed in an outdoor structure	Both self contained and central models with single chamber tank	Yes
Ecolet[9]	Yes	No (15 year old Australian company)	Both	$1,700-$3,690 australian dollars	Personal	Needs to be retrofitted	All models are self contained single tank	No
Eco John[10]	Yes (Except its an Incinerating toilet)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Eco Tech[11]	No? (comes up on a site from 2023, but the pictures are underdeveloped and the other models are from Sun-Mar)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Eco Toilets	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ekolet[12]	Yes	No (Sweden, Finland, Jermany, UK,	Electric	649,00€-3.799,00€	Doesn't specify	Can be retrofitted or installed in an outdoor	Both self contained and central models with multi	No

[8] See (*Products and Services,* (n.d.).)
[9] *Composting Toilets,* (2021). ecoLet. Retrieved, January 20, 2023, from https://www.ecolet.com.au
[10] *The EcoJohn Family,* (2023). EcoJohn. Retrieved January 20, 2023, from https://shop.ecojohn.com
[11] *EcoTech Carousel Composting Toilet System,* (n.d.). Ecotech. January 20, 2023, from https://ecotechproducts.net/product/ecotech-carousel-composting-toilet-system/
[12] *Outhouse UR for Ekolet UV composting toilet,* (2018). Ekolet. Retrieved, January 20, 2023, from https://ekolet.com/product/outhouse-ur-for-vu-composting-toilet/

		Japan)				structure	chamber tank	
Envirolet (AKA Santerra Green & Natureshead)[13]	No? (most recent source is 2016 and has been discontinued from Lowes website)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EnviroLoo (Green Loo Australian website)**[14] [15]	Yes	No (South Africa)	Solar	$3,850-$4,450	Commercial	Can be retrofitted or installed in an outdoor structure (serious competition for Clivus if it were NSF certified)	Central unit with single tank	No
Green Toilet[16]	Yes	Yes (but is a Finnish company and the website is partially in another language)	Neither	$1,090	Personal	Needs to be retrofitted or installed in an outdoor structure	Self contained single tank unit	No
Lzour[17]	Yes (Except it is a portable compact camping toilet on Amazon)	N/A	N/A	N/A	N/A	N/A	N/A	N/A

[13] *Envirolet Composting Toilets,* (2016). Green Home Product Source. Retrieved January, 2023, from https://green-home-product-source.com/envirolet-composting-toilets.html
[14] EnviroLoo, (2022). Retrieved January 20, 2023, from https://enviro-loo.com
[15] *The Enviro Loo,* (n.d.). EnviroLoo. Retrieved January 20, 2023 from https://www.greenloo.org/enviro-loo.php
[16] *Green Toilet 330 composting toilet,* (n.d.). Pikkuvihrea. Retrieved January 20, 2023, from https://pikkuvihrea.fi/en/product/green-toilet-330-composting-toilet/
[17] *Lzour Portable Toilet-Compact Indoor & Outdoor Commode for Camping, RV, Boat and More-Easy Cleaning,* (n.d.). Amazon, Retrieved February 14, 2023, from https://www.amazon.com/Lzour-Portable-Toilet-Compact-Cleaning/dp/B08CKX6BWT

Phoenix[18]	Yes	Yes (but just Montanna and Canada)	Solar	$4,700-$6,100	Personal	Needs to be retrofitted	Doesn't specify	No
Rota Loo (Green Loo Australian website)[19]	Yes	No (Australia, UK, Tasmania)	Both	$3,995-$9,119 australian dollars	Personal	Needs to be retrofitted	Both self contained and central models with multi chamber tank	No
Separett[20]	Yes	No (almost anywhere else)	Electric	95.20€-1399.60€	Personal	Can be placed directly in the house, very small, online only	Self contained single tank	No
Sun-Mar[21]	Yes	Yes	Both	$629-$2,465	Personal and Commercial	Should be retrofitted inside, but can be installed in an outdoor structure	Self contained and central models with multi chamber tank and urine diversion	Yes
Terra Nova[22]	Maybe? (only record is a paper from 2006)	No (Germany)	Electric	Unknown	Both	Can be retrofitted or installed in an outdoor structure	Central, single tank model	No
Toilet Tech Solutions***[23]	Yes	Yes (west coast)	Neither	$7,260-$14,100 + urine diverting + building cost	Commercial	Installed in an outdoor structure	Central single "tank" (more like an outdoor pit) Urine diverting	No

Table 1. Existing Composting Toilet Brands

[18] *Using the Phoenix Composting Toilet System in Public Facilities,* (2007). Advanced Composting Systems, LLC. Retrieved January 20, 2023, from https://www.compostingtoilet.com/LITRACK/ap_guide.pdf
[19] *Rota-Loo.* (2020). PFG Group. Retrieved March 19, 2022, from https://pfg-group.com.au/rota-loo/
[20] *Toilets,* (Feb, 2021). Separett. Retrieved March 15, 2022, from https://separett.com/en/en/toilets
[21] *Central Composting Toilets,* (n.d.). Sun-Mar. Retrieved November 17, 2022, from https://usa.sun-mar.com/central-toilets-centrex-composting-toilets/
[22] *Terra Nova Composting Toilet System,* (2006). Retrieved November 14, 2022, from https://www.yumpu.com/en/document/view/7142715/terranova-composting-toilet-system-berger-biotechnik
[23] *Superior Human Waste Management,* (2022). Toilet Tech Solutions. Retrieved November 15, 2022, from https://www.toilettech.com

For personal or commercial use, this allowed me to know if any or all of the composting models of each brand might be big enough to accommodate an institution such as Allegheny that houses more than 5 people, which is about the average number of adults that a personal toilet can handle. This was not an in-depth description, but more of an indication for me to eventually go back and research the brand deeper if they had models that could potentially accommodate a large number of uses. A majority of the brands I came across only manufactured self contained personal waste treatment units and did not have the capacity to handle being located on a college campus where a varied number of students would be using it every day. I also made sure to include whether or not the remaining brands could ship the product to the United States, which a slight majority of the existing toilets do not, and the ones that were left are largely only available on the west coast. At this stage my search was already narrowed to a couple of toilet model options, being Clivus Multrum, Sun-Mar, Toilet Tech Solutions, Pheonix and even the Enviro Loo. Although Enviro Loo is a South African company, I was very impressed with how in-depth their website was and the functionality of their systems. I wanted to eventually go back and see if they may ship to the US on special occasions. At this point I began sifting through whatever legal documents I could find that explained the laws and regulations surrounding implementing composting toilets in Pennsylvania which narrowed my search yet again.

Model Comparison

Capacity

I decided to compare the Clivus Multrum M10, Clivus Multrum M54 Trailhead, and Sun-Mar Centrex 3000 NE/AF for implementation on Allegheny's campus. The Clivus Multrum and Sun-Mar are the only brands certified by NSF, meaning all of the other brands I was originally considering are no longer viable. According to PA law as well as NSF certification, composting toilets systems can only be verified if the toilet can handle the stated capacity for an extended period of time plus occasional overload. Allegheny College is an institution of higher education with an approximate population of

1300 students, and the capacity for many of these toilets is far less than that, however, it is safe to assume that not every student will be comfortable enough to or consider using these options. That being said, capacity was definitely a factor in my consideration of composting toilet models and Table 2 compares the capacity between the Clivus Multrum M10, Clivus Multrum M54 Trailhead, and Sun-Mar Centrex 3000 NE/AF.

CAPACITY	**Clivus Multrum M 10**	**Clivus Multrum M54 Trailhead**	**Sun-Mar Centrex 3000 NE/AF**
Annual / Daily Usage & Recommendations	20,000 visits annually (60 uses per day) *recommended for full time residential and small commercial sites	20,000 visits annually (60 uses per day) *recommended for remote areas	11,000-18,000[24] visits annually (30-50 uses per day[25]) *varies based on seasonal and continuous use

Table 2. Capacity

Instead of exclusively picking between the largest models, I chose to consider models that came highly recommended by representatives from both Sun-Mar and Clivus for institutions similar to Allegheny. The highest recommendation between Clivus brands was for the M54 Trailhead which is the brand's fifth largest unit. The recommendation came from Brian Barry who works for the company. The capacity for that model is an estimated 60 uses per day (See Table 2). I also chose to include the M10 model by Clivus Multrum in this comparison because it accommodates the same capacity but has a different installation system. Even though these models are not the largest manufactured by Clivus Multrum, they are heavily utilized in other environments that resemble Allegheny College. Through personal communication with Mr. Barry as well as through informational videos from the Clivus Multrum website, it appears that the M54 Trailhead model has even been utilized on other campuses such as the University of Washington, Lewis and Clark College, Bucknell, and Cornell, as well as golf courses

[24] I arrived at these numbers by multiplying the average uses per day by 365 days in a year and rounding them off to the nearest thousand (see footnote 7)

[25] See (MediLexicon International, 2022). This number was calculated from the recommended capacity of 5 adults for continuous use and 8 adults for seasonal use. I found the numbers 30 and 50 from multiplying the number of people by the number of times the average person uses the restroom (approximately 7)

and more remote locations with large pedestrian populations (Barry, Personal Communication).

I also was recommended the Sun-Mar Centrex 3000 by Joe, my contact through Sun-Mar. This model is the biggest that Sun-Mar has to offer and I opted to consider the waterless version and the non-electric version in order for the unit to be applicable in any location, inducing places that lack plumbing infrastructure and electricity. Although it is the largest option from Sun-Mar, the Centrex 3000 has a smaller capacity than the Clivus Multrum M54 Trailhead and the M10 by about 20 uses per day (See Table 2). Since I am unsure how many people would utilize a composting toilet, should it be installed on campus, I believe that including a toilet of this capacity is an acceptable option to consider. However, depending on the location, that could potentially influence my final recommendation.

Maintenance

The maintenance involved in each unit is a factor that I considered heavily when comparing toilet models. Each model has a slightly different list of requirements for how to maintain the toilet and composting unit. I gathered all of the data I could find from each company's website as well as any specification sheets that were sent to me by either of my company contacts. I displayed all of the data I could find based on how often certain jobs need to be performed for the toilet to remain operational. I separated the tasks into daily/weekly, monthly, annual, as needed, and seasonal (See Table 3). Since both companies had very different and very specific requirements for maintenance of their own respective models, I did my best to create common categories to better compare the workload between tasks.

MAINTENANCE	Clivus Multrum M 10	Clivus Multrum M54[26] Trailhead	Sun-Mar Centrex 3000 NE/AF[27] [28]
Daily/Weekly	**Clean Fixtures** - Multrum cleaner or a mild soap diluted with water - Clean inside bowl - DO NOT pour excess solution into toilet **Bulking** - About a cup after every use (1 gal per roll of toilet paper) - Softwood planer shavings (no treated lumber, aromatic woods, sawdust, corn, newspaper, or wood chips)	**Clean Fixtures** - Multrum cleaner or a mild soap diluted with water - Clean inside bowl - DO NOT pour excess solution into toilet **Bulking** - About a cup after every use (1 gal per roll of toilet paper) - Softwood planer shavings (no treated lumber, aromatic woods, sawdust, corn, newspaper, or wood chips)	**Start Up** - Remove finishing drawer and spray that and Bio-drum™ with Compost Quick - 1 bag of bulking and 2 quarts of warm water and ½ of the microbe mix (2 tbsp) added to the rotating drum before initial use **Clean Fixtures** - Spray 3-4 pumps of Compost Quick on surface of compost every other day **Bulking** - Add one cup of bulking per person per day through access door - Then turn the drum handle clockwise to aerate compost (6 complete revolutions, 42 turns of the handle - Add 1 tbsp microbe mix to Bio-drum™
Monthly	**Unit Upkeep** - Remove any non biodegradable material - Waste will build in a mound under toilet chute and should be leveled monthly - Catch up on any missed bulking - Mix one scoop of bacteria with a gallon of water and sprinkle it evenly over the pile **Rotating** 1. After 6 months the pile is too big to mix and must be	**Unit Upkeep** - Remove any non biodegradable material - Waste will build in a mound under toilet chute and should be leveled monthly - Catch up on any missed bulking - Mix one scoop of bacteria with a gallon of water and sprinkle it evenly over the pile **Rotating** 1. After 6 months the pile is too big to mix and must be	**Unit Upkeep** - Remove the finishing drawer and rake solid debris from under the drawer. + Pay extra attention to the back corners - Remove and dispose of solid debris (non biodegradables) **Rotating** - Rotating for this unit happens after every use

[26] *M54 Trailhead Maintenance Manual,* (n.d.). Clivusmultrum Incorporated. Retrieved February 4, 2023, from https://www.portlandoregon.gov/bds/appeals/index.cfm?action=getfile&appeal_id=11895&file_id=10013
[27] *Initial Start-Up for a Central Toilet.* (n.d.). Sun-Mar, Retrieved February 4, 2023, from https://usa.sun-mar.com/wp-content/uploads/2021/04/initial-startup-centrex.png
[28] *Ongoing Centrex Toilet Maintenance,* (n.d.). Sun-Mar, Retrieved February 4, 2023, from https://usa.sun-mar.com/wp-content/uploads/2022/03/CENTREX-Daily-Use-and-Maintenance-infographic.png

	moved from under the toilet chute in the back right corner to the back left corner + Add 4-5 gal of water for right consistency 2. After another 6 months move material from back left to front left 3. After another 6 months, move the compost for a final time to the front right corner. 4. After 8 months, finished compost can be removed from front right (frequency in rotation is dependent on frequency in use) 5. Remove liquid from reservoir when full	moved from under the toilet chute in the back right corner to the back left corner + Add 4-5 gal of water for right consistency 2. After another 6 months move material from back left to front left 3. After another 6 months, move the compost for a final time to the front right corner. 4. After 8 months, finished compost can be removed from front right (frequency in rotation is dependent on frequency in use) 5. Remove liquid from reservoir when depth is 14 inches	
Annual	- Clean and inspect vent system (keeps toilet odorless) - Wait at least one year after initial usage before removing any compost	- Clean and inspect vent system (keeps toilet odorless) - Wait at least one year after initial usage before removing any compost	- Twice a year, spray Bio-drum™ screen with compost quick and scrub with a wire brush - After at least a year when the unit is half full, remove compost from Bio-drum™
As Needed	Clivus offers maintenance services to all customers, ranging from complete system maintenance to periodic inspection and reporting. In locations beyond our immediate service area, Clivus provides maintenance through local subcontractors	Clivus offers maintenance services to all customers, ranging from complete system maintenance to periodic inspection and reporting. In locations beyond our immediate service area, Clivus provides maintenance through local subcontractors	For advice on cleaning the outside shells of self-contained or Central units, please call Sun-Mar's customer service department at 1-888-341-0782, option 4.
Seasonal Care	*this unit is designed for indoor use but seasonal care is similar to M54 Trailhead unit*	**Shut Down** - Drain liquid from storage tank - if using solar, remove the battery and put on a trickle charter. - if mature waste is expected to freeze solid, dig out a space under the	Winterization - Temp has to be 55℉ for the microbes to be active, anything below will slow down decomposition - Do not rotate or mix compost that is frozen or inactive

		chute for new accumulations of waste and add bulking as usual. **Start Up** - Re-install battery - Check system for proper functioning - add bacteria to the product - moisten and mix the pile	

Table 3. Maintenance

The Clivus Multrum brand toilet models had less maintenance to prepare the toilet for its first usage as well as less labor intensive tasks on daily and weekly basises. They do however, have a lot more upkeep from month to month. The Clivus Multrum brand monthly maintenance plan is also a lot more thorough than Sun-Mar, explaining more about what happens every 4,6,8 and 12 months in addition to the maintenance required for one month periods (See Table 3). The amount and difficulty of annual maintenance for both brands is very similar, but the seasonal care is where the toilet models truly begin to differ. When it comes to winterizing the unit, the Clivus Multrum M54 Trailhead is designed to be used exclusively outdoors and has specifications for when, and how to transition to winter maintenance. Both of the other units are meant to be indoors and don't come equipped with a list of steps to take to work through the winter, however, after personal communications with both Joe and Mr. Barry, I learned that the Clivus Multrum M10 and the Sun-Mar Centrex 3000 NE/AF can still be used in the winter.

For winterization of traditionally indoor models, precautions need to be taken in order to ensure that the compost byproduct is safe (even if its legal application after the compost journey is impossible to find legislation on). For one thing, the units need to be used sparingly as the temperatures start to drop. For all three possible units, the bacteria in the composter that turns raw waste into the composted soil must be alive in order to work. These bacteria are only active at temperatures higher than 55 degrees.

This means that waste added to the unit during periods of time when the temperature is lower than that threshold will not be able to be broken down until the temperature rises back up to above 55. Since these units would be located outside and since PA temperatures are certainly capable of going below 55 for many months out of the year, it is important to understand that the total composting time will also increase by as many months that the toilet accumulated waste but was unable to process it. Because of the way in which Pennsylvania weather conditions impact the composting process of the toilets, this is also why I chose to opt out of vermicomposting options. The Clivus Multrum M10 and M54 come with an initial shipment of worms to aid in the composting process, but like the bacteria in the system, the worms would likely die when the weather changes and would need to be replaced yearly which could become expensive.

Another consideration for maintenance is the amount of aid provided by both companies in maintaining the units as needed (See Table 3). For Sun-Mar, a lot of the maintenance is largely individual. The majority of the weekly, monthly and yearly upkeep is fully the responsibility of the toilet owner. There is a customer service department phone number for advice on cleaning but aside from that much of the work is done on site. For the Clivus Multrum units, maintenance services are offered to all customers, ranging from complete system maintenance to periodic inspection and reporting. In locations that are remote or beyond their immediate service area, Clivus provides maintenance through local subcontractors. The only caveat is that Clivus' website is unclear about which areas are considered within their service area and where the nearest subcontractor is located.

Cost

The monetary value of each toilet also played a large role in the comparison between models. There are many factors involved in how much a unit might cost (See Table 4). First I compared the prices of the actual composter. For both models of Clivus the toilet fixture and compost tank were part of a package, but for the Sun-Mar model they were separate. Any additional materials that were not included in the initial

package but were still required to run a non-electric and waterless unit were also included and added to the total price (See Table 4). The Sun-Mar model had a lot of parts that were sold separately but still required, and yet it still ended up being the least expensive model that I considered in terms of total cost. The M10 unit was the second cheapest option and like the Sun-Mar required a little bit more overhead in terms of purchasing solar packages that would ensure neither units need to be hooked up to electricity. I opted out of any units that required electrical hookups because they added to the overall cost of the toilet. The only real reason for any electricity is to light the space and to run the vent fan which keeps the toilet odorless and both can be powered by a solar panel for a smaller additional charge than purchasing an electric model. Non electric models are more versatile, meaning they can operate at any location, making it more worthwhile to pay the extra money to have one on campus.

The most expensive unit by far is the Clivus Multrum M54 Trailhead. It is twice as expensive as the M10 and over 5 times as expensive as the Sun-Mar Centrex 3000 NE/AF models. While this is a shocking sticker price upon first glance, it is not that much of a surprise. This is the only unit that comes equipped with a composting tank, a toilet head, and a prefabricated building to house both components. Clivus also ships the unit directly to our desired location and assists in its installation process. Unlike the other two units, with the M54 there is no need to construct a foundation and building from scratch, as most of these units need to be completely out of the elements, and there is no additional cost for labor. For both Clivus models, there is also a service fee for Clivus workers or subcontractors to come and maintain the unit for $350 a visit. While this is also an additional fee to the two more expensive models, it also alleviates the responsibility of anyone from the College such as the cleaning services or maintenance to come and clean and mix the contents of the unit themselves.

Building Certification Process and Cost

A potential roadblock to the installation of any of these units are the local zoning regulations and building codes that regulate the kind of construction that can legally

occur in Meadville. As I was researching the legislature for composting, I came across the permits and information page on planning, zoning and building regulations on the City of Meadville website as well as the fees involved in acquiring them. In order to propose a new construction project, applications and additional materials are required for clearance of typical circumstances. This will be a consideration later if the College ever decides to move forward with this proposal as all of the composting toilet units require new construction for their housing facilities.

I did not follow the entire process of applying for construction permits and following zoning regulations. Since my proposal and goal was just to identify which toilet is best suited for Allegheny and each model under consideration would require building code approval, I figured that this requirement did not impact my decision between the models. I did, however, consider some of the more general fees towards each of the three toilet unit's overall cost break-down in Table 4. Since all three units must be housed in a constructed facility, I made sure to include the cost of a zoning permit, the building permit fee and the building permit cost of buildings with total construction costs >$6,000 or <$6,000. There are potentially more fees and legislative requirements that would need to be included in the final cost analysis but this is just a cost estimate to recognize that seeking local building zoning permits and building codes is another factor in the feasibility and affordability of implementing composting toilets on campus.

COSTS	**Clivus Multrum M 10**	**Clivus Multrum M54 Trailhead**	**Sun-Mar Centrex 3000 NE/AF**
Upfront / Installation	$6,845 M10 package	$27,000 Trailhead package	$2,265 Unit $365 Waterless Toilet
Maintenance	$350 per visit[29]	$350 per visit[11]	*call Sun-Mar customer service, otherwise maintenance is done independently
Structure	- $946.4 concrete slab	*included in installation	- $405.6 concrete slab

[29] Barry, B. personal communication, January 24, 2023

	foundation[30] - $490 for three cinder block walls[31] - $29.38 waterproof mortar mix (50 lbs per pack)[32] - $2071 upper structure[33] - $84, 71 inch 6 step treads[34] - $119.88 stair treads[35] - $14.28 100 connector screw (100pk)[36] - $30.96 L gauge strong ties (x2 per step, 12 total)[37] + Unknown door cost + Unknown labor cost		foundation[12] - $118.8 for 3 cinder block walls[13] - $29.38 waterproof mortar mix (50 lbs per pack)[14] - $1,149 upper structure - $41.94, 35 inch 3 step treads - $59.94 stair treads[17] - $14.28 100 connector screw (100pk)[18] - $15.48 L gauge strong ties (x2 per step, 6 total)[19] + Unknown door cost + Unknown labor cost
Additional Materials	- $550 40 watt solar package - $35.70 per additional cleaning and microbe pack	$35.70 per additional cleaning and microbe pack	- $168 AF Waterless Kit - $50 Vent fan - $150, 10 watt solar package - $16.95 Cleaner - $18.75 Microbe mix - $30.90 Magic compost cube
Zone and Permit Cost	$571.86[38]	$639.4[20]	$564.5[20]
TOTAL:	$11,972	$28,025	$5,463.52

[30] (See 2023 foundation Cost) calculated the price of projects by multiplying the total square footage of the base under the composting tank by the projected cost of cement per square foot

[31] *Concrete Block,* (n.d.). Home Depot. Retrieved February 23, 2023 from https://www.homedepot.com/p/8-in-x-8-in-x-16-in-Concrete-Block-1001924/202323962

[32] *50 lbs. Waterproofing Mortar,* (n.d.). Home Depot. Retrieved February 23, 2023 from https://www.homedepot.com/p/Rapid-Set-50-lbs-Waterproofing-Mortar-44010050/304671674

[33] *Lifetime Storage Shed,* (n.d.). Home Depot. Retrieved February 23, 2023 from https://www.homedepot.com/p/Lifetime-8-ft-x-15-ft-Storage-Shed-60075/202956726

[34] *6-Step Ground Contact Pressure Treated Pine Stair Stringer,* (n.d.). Home Depot. Retrieved Feb 23, 2023 from https://www.homedepot.com/p/6-Step-Ground-Contact-Pressure-Treated-Pine-Stair-Stringer-368913/308736509

[35] *Pressure Treated Wood Step-Tread,* (n.d.). Home Depot. Retrieved Feb 23, 2023 from https://www.homedepot.com/p/ProWood-2-in-x-12-in-x-4-ft-Pressure-Treated-Wood-Step-Tread-105655/202297454

[36] *Simpson Strong-Tie #9,* (n.d.). Home Depot. Retrieved Feb 23, 2023 from https://www.homedepot.com/p/Simpson-Strong-Tie-9-x-1-1-2-in-1-4-Hex-Drive-Strong-Drive-SD-Connector-Screw-100-Pack-SD9112R100/202071152

[37] *Simpson Strong-Tie ML Gauge.* (n.d.). Home Depot. Retrieved Feb 23, 2023 from https://www.homedepot.com/p/Simpson-Strong-Tie-ML-2-in-x-4-in-12-Gauge-ZMAX-Galvanized-Medium-L-Angle-ML24Z/202071147

[38] Zone and permit cost for clivus and sunmar contain $30 zoning permit, $30 building permit for <$6,000 total and $500 annual building permit fee. The clivus trailhead is the $30 zoning permit, $0.004 x the construction cost for buildings >$6,000 and $500 annual building permit fee (see *Zoning Permits & Fees*, (n.d.).)

	+ Monthly microbes +Labor costs	+ Monthly microbes	+ Monthly microbes + Labor costs

Table 4. Cost

Luckily, there are already composting toilets that exist in Meadville which is incredibly promising for the prospect of implementing one on campus considering it has been successfully done in the past. The units are located at Shadybrook Park, a local recreational site in the downtown area and are beautifully decorated with murals for the enjoyment of users and park goers. If the College was to apply for a toilet unit, there is no foreseeable reason that the request would be denied, at least from a municipal perspective, since the toilets have obviously been well received by the local population and have been maintained well enough that when I visited there was no notable odor or filth.

My Recommendation

My informed recommendation for the best composting toilet unit for Allegheny College would be the Clivus Multrum M54 Trailhead. While it is the most expensive unit I researched, it makes up for the cost by having a minimal effort maintenance process. The unit is prefabricated which means all of the parts are included in purchase and just need to be assembled on site. This takes away a lot of the stress and time commitment that goes into finding a contractor who is familiar with composting toilet installation, hiring people to lay foundational concrete for the tank, and constructing a facility around the tank to protect it and above the tank for the bathroom itself. The M54 also has maintenance options through Clivus who will come and keep up with the unit so the only necessary on site maintenance will be the addition of bulking material per use. The school already receives wood shavings from a local source for our on site composting facility and the same wood shavings can be used for the toilet. Additionally, the Clivus M54 Trailhead is designed for outdoor use and has step by step directions for how to winterize the unit, which is very important for installation in Pennsylvania with constant weather changes in all seasons. The compost tank is also easily accessible in the M54.

There would need to be a lot of consideration into building structures for the M10 and the Centrex 3000 in order for the compost hatch to be accessible on either of them. Lastly, the Clivus Multrum M54 Trailhead has been successful in environments similar to Allegheny College. Clivus Multrum has been perfecting their composting toilet technology in the US for 50 years and is a highly respected and established brand. Other Colleges and Universities of Allegheny's size have purchased composting toilets for their own campus from Clivus using the M54 model. The composting toilets located in downtown Meadville are also M54's which could make the legal side of things a lot easier since there is already a local rubric for composting toilet additions.

Location

When I started the research process for this project, I thought that the location would be a factor in deciding which composting toilet would be best for the college and ultimately help me narrow my options even further. However, after careful consideration of the options, I realized that for me a clear winner was the Clivus Multrum M45 Trailhead as previously mentioned. This still left the question as to where on campus would this unit live. In order to fulfill my original goals for implementing a composting toilet at Allegheny college, I understood that the best place for the toilet would be where there is the highest demand or where it is most seen. I have not decided on a singular location, but am instead offering some personal insight into why either of the two locations I am proposing could be good options.

The location with the highest demand for a toilet facility is Bousson Research Forest. Students and professors alike often design and perform research projects at this location and there is currently no on site toilet or waste facility. The compost output could potentially be able to be used directly in the woods, or at the very least help the many students who have admitted to putting uncomposted waste into those woods anyways due to the lack of a receptacle. Bousson was also suggested as a potential location by both Kelly Boulton and Beth Choate who are professors at Allegheny College and have vested interest of their own into having a toilet installed there. It is

also guaranteed to get used if it is installed at Bousson, however, there is no telling the frequency of use the unit might accommodate.

The other location was the most seen location. While situating a toilet in the center of campus would certainly be the most seen, it would be a stretch to get that approved by the college in terms of curb appeal so my next best choice was in the center of the Carden on the back side of the Pink House. My reasoning for this location was that it is already centrally located in the ES department where it is passed on tour routes and easily accessible for ES faculty and students who would be most willing to use it as well as educate others about it. The compost wouldn't be used on the plants that are in the garden, however the compost would already be located directly on campus to theoretically be allocated to a variety of landscaping purposes such as bases of trees and bushes if it is legal to do so.

Future Research

There are many areas of my research that I would have loved to dive deeper into had they been more relevant to my question and had there been enough time. The first area of study that would have been interesting focuses on all of the legislature about composting, composting toilets and the use of that compost afterwards. So far I have found a lot of conflicting information about the methods for and restrictions on composting human waste. Much of the legislation doesn't even mention composting and just provides regulations for the direct use of raw domestic sewage which is very different from what the composting toilet would be producing. Ultimately it would be cool to sift through all of the different regulations about composting toilets to see if there is a clear answer that is being overlooked. Maybe eventually there will be amore cohesive and organized management of these documents and even ways in which to amend them as composting toilets continue to become more common in the future.

Another big question mark for me still as well is what can human compost actually be used for. This goes hand in hand with adjusting the legislature around it because based on all of my research, human manure can safely and effectively be used

on food crops to cycle the nutrients lost to a currently linear cycle. In order for this to happen, we have to break down the stigma of composted waste being unclean and unsafe even though it endures a chemical process that changes it completely from the original product. Finding ways to assess and eventually dismantle our current hesitation on this subject would be a very important area for future study.

Appendix

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Seasonal & Residential Packages
Price List

M1W, M2W & M3W - Standard

One-piece, seamless construction. Ship partially assembled. The package includes: compost tank, liquid storage support cradle, automatic moistening system, automatic liquid removal system, interior ventilation fan, waterless toilet and chute, maintenance tool, Multrum Bacteria, Multrum Cleaner, Multrum Composting Worms*, starter bed material and installation hardware.

Model	Uses		Volume		Price
	Daily	Annual	Cu Ft.	Gals.	
M1W	10	3,600	33	248	$4,000.00
M2W	15	5,500	41	309	$4,495.00
M3W	50	18,250	75	560	$6,695.00

M10W & M12W - Standard

Multi-piece construction. Ship disassembled. The package includes: compost tank, support cradle kit, automatic moistening system, automatic liquid removal system, interior ventilation fan, two waterless toilets and chutes, maintenance tool, Multrum Bacteria, Multrum Cleaner, Multrum Composting Worms*, starter bed material and installation hardware.

	Daily	Annual	Cu Ft.	Gals.	
M10W	60	22,500	90	755	$6,845.00
M12W	85	30,000	132	984	$7,195.00

M1W, M2W & M3W - Foam-flush

One-piece, seamless construction. Ship partially assembled. The package includes: compost tank, liquid storage support cradle, automatic moistening system, automatic liquid removal system, interior ventilation fan, (1) Foam-flush toilet, maintenance tool, Multrum Bacteria, Multrum Cleaner, Multrum Composting Worms*, starter bed material and installation hardware.

Model	Uses		Volume		Price
	Daily	Annual	Cu Ft.	Gals.	
M1W	10	3,600	33	248	$6,395.00
M2W	15	5,500	41	309	$6,695.00
M3W	50	18,250	75	560	$8,895.00

M10W & M12W - Foam-flush

Multi-piece construction. Ship disassembled. The package includes: compost tank, support cradle kit, automatic moistening system, automatic liquid removal system, interior ventilation fan, two Foam-flush toilets, maintenance tool, Multrum Bacteria, Multrum Cleaner, Multrum Composting Worms*, starter bed material and installation hardware.

	Daily	Annual	Cu Ft.	Gals.	
M10W	60	22,500	90	755	$11,245.00
M12W	85	30,000	132	984	$11,595.00

*Call Clivus after six months of system use to arrange for shipment.

Prices are in U.S. dollars and do not include freight or sales taxes. Check or money order accepted. Prices are FOB point of manufacture and subject to change without notice. 10% restocking fee for returned product.

U.S. Patent Number 5,228,984

Clivus Multrum, Inc., 15 Union Street, Lawrence, MA 01840 | 800.425.4887 | clivusmultrum.com

Rev. 12/21

clivusmultrum incorporated

Model M10
Specification Sheet

NSF Certification

The Clivus Model M10 is certified by the National Sanitation Foundation under Standard 41 (day-use, park).

Capacity

M10 Volume

Solids storage capacity: 90 cubic feet; 755 US gallons

Daily capacity at average temp. >65°F: 60 visits

Annual capacity at average temp. >65°F: 22,000 visits

Specifications and Materials

Dimensions

Installed: Length: 101"; Width: 44"; Height: 55"

Weight: 300 lbs

Working Area on Top of Composter: 30"x48"

Waste Access Door: 10"x30" (composter front)

Compost Access Lid: 32"x44" (composter front)

Polyethylene Wall Thickness: 0.375" nominal

Materials

The M10 Composter is rotationally molded high-density linear polyethylene resin that conforms with the following specifications:

- Density (ASTM TEST 4883): 0.937 g/cm3
- Tensile Strength at Yield (ASTM D638): 2,550 psi
- Envt. Stress Crack Resistance, 100% Igepal, (D1693A): >1,000 hrs

Ventilation

AC: 120V, 60 Hz, 71w, .67 amp fan with 263 cfm at free air. Fan made of GE Noryl plastic, totally enclosed, ball-bearing motor, in-line, direct drive. UL & CSA approved. Energy Star rated. Diameter: 11.75"; Inlet/Outlet Diameter: 6"; Length: 9.625". The fan is mounted in-line near the composter, with 4" PVC or ABS ducting (not included). 12V DC available.

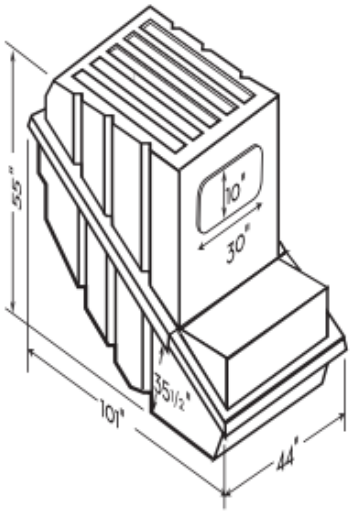

Figure 1. | M10 Composter

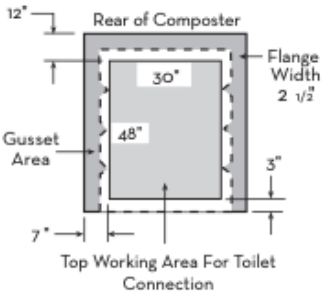

Figure 2. | M10 Composter, Top View

Liquid Removal Pump

AC: Submersible, 115V, 5 amp, with 18', 3-conductor, oil-resistant cord. UL & CSA approved. 1" NPT liquid discharge outlet. Capacity is 20.4 gallons per minute at 1' with a maximum pumping height of 26.3'. 12V DC available.

Tank Alarm

Automatic tank alarm responds to liquid level and air flow sensors.

AC: 120 VAC, 50/60 Hz, 7 watts max. Alarm Horn: 82 decibels at 10 feet; meets Type 3R water-tight standard as installed by factory. Alarm Beacon: meets Type 3R water-tight standard as installed by factory. CSA certified.

Automatic Moistening System

An automatic control device monitors daily compost mass moistening. Timer is housed in water-resistant NEMA box. Spray time is preset at factory.

Components

Solenoid: 120V AC, 50/60 Hz, UL & CSA listed.

Timer: Synchronous motor, 48 max. on-off cycles, 120V AC, 0.1 watts. 12V DC available.

Composter Wood Support Cradle Kit

Supports the M10 Composter. Made from pressure treated lumber.

Toilet Options

Waterless Toilet

Constructed of impact resistant fiberglass with sanitary white finish. Seat and lid are made of plastic; the liner is rotationally molded polyethylene. The toilet must be located directly over the composter, which is situated in a space or room below. The toilet is connected with a 14" diameter straight chute.

Toilet Height: Standard: 14"; ADA Compliant: 18"

Width: 18.5"; Length: 24.25"

Foam-flush Toilet

The Foam-flush toilet is constructed of vitreous ceramic. The seat and lid are made of plastic. The toilet connects to the composting unit with a 4" plastic pipe. The drain may slope up to 45 degrees from vertical. A water connection and a power connection (AC) are required.

Toilet height: Standard: 16"; ADA compliant: 17.5"

Width: 15"; Length: 29"

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