

CANNABIS WASTE MANAGEMENT IN METRO VANCOUVER



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EXECUTIVE SUMMARY

Since the federal legalization of recreational cannabis in October 2018, there has been a growing number of cannabis producers in the Metro Vancouver region. More than a dozen indoor or greenhouse licensed facilities have begun operations in the regional district over the past couple of years. It is estimated that currently about **14,600 tonnes of plant and growing media waste** are disposed of every year from cannabis production and processing facilities in Metro Vancouver. As more facilities become federally licensed and approved to operate in the region, and as existing facilities expand their production capacity, it is expected that almost **60,000 tonnes of plant and growing media** could be produced in the near future. The majority of this waste consists of growing media, typically used and disposed multiple times in a year by indoor and greenhouse facilities.

Disposing of cannabis waste is a complex regulatory problem due to the plant's unique qualities and strict government controls over waste handling. Over the years, cannabis waste has been managed in three main ways: disposal via a permitted landfill or waste-to-energy facility, composting, or in-vessel digestion. Specific guidance on how facilities should dispose of their organic and packaging waste has been limited throughout North America, with many jurisdictions requiring cannabis waste to be rendered "unusable and unrecognizable" through practices such as mixing it with non-cannabis waste. However, there has not been any specific guidance for what "unusable and unrecognizable" means, creating potential health, safety and contamination issues for haulers, producers and processors. In this report, waste management options for organic and packaging waste are discussed and options considered. These options include practices that reduce waste production and reuse waste products, diverting waste from the landfill and decreasing greenhouse gas (GHG) production.

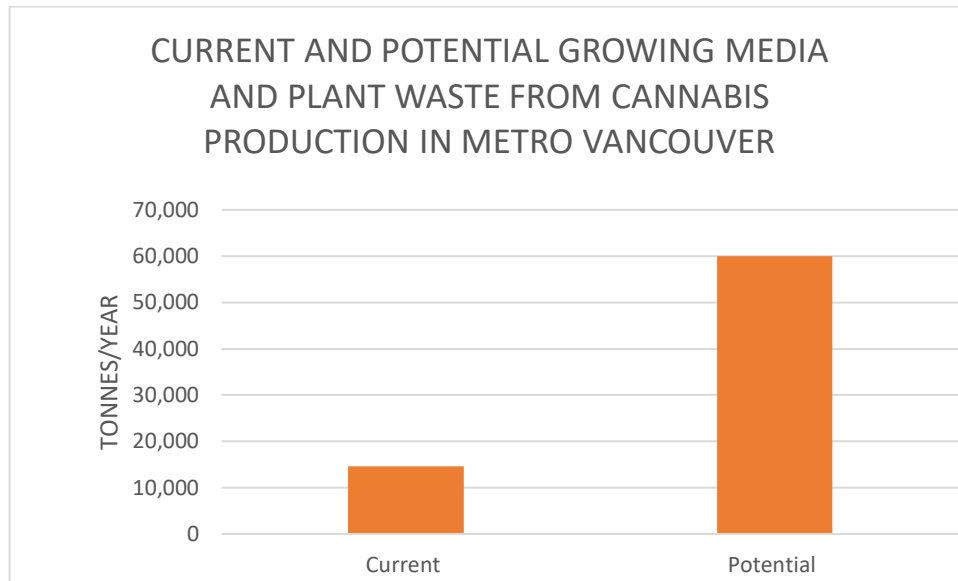


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INTRODUCTION

Commercial cannabis production for the recreational market is an emerging and dynamic industry within British Columbia. Since the federal legalization of non-medical cannabis use in Canada on October 17, 2018, there has been a growing number of commercial cannabis producers in the Metro Vancouver region. As a result, Metro Vancouver expects additional waste production from these facilities. In order to fulfill the region's goal of minimizing waste generation, it is vital that Metro Vancouver understand the quantity and types of solid waste generated from commercial cannabis producers in the region. Therefore, the goal of this research project is to estimate the quantity and types of solid waste produced by commercial cannabis production and processing facilities in the Metro Vancouver region.

METHODOLOGY

This research project implemented four methods:

1. A review of the literature on commercial cannabis growth practices and waste management practices was conducted across a variety of jurisdictions, especially in jurisdictions where cannabis has been legal for several years. Types of practices that minimize and re-use cannabis production waste were identified and researched in more depth.
2. A dozen semi-formal interviews were conducted with key stakeholders in the North American cannabis industry, including cannabis organizations, policy analysts, engineers, agronomists, technicians, waste management service providers, dispensaries, supply chain specialists and more. Although this research planned on interviewing cannabis producers as well, COVID-19 impacted the ability for many facilities to allocate time towards non-essential work. Additionally, larger licensed facilities that were contacted were hard to connect with and/or were hesitant about sharing waste data and information.
3. Research data on the types and quantities of waste were compiled and analyzed through a literature review, generating tables and graphs to show the estimated annual quantities and different constituents of solid waste produced from commercial cannabis production and processing facilities in Metro Vancouver.
4. Associated best management practices to minimize waste generation and maximize reuse, recycling and recovery are discussed through an evaluation of disposal options for commercial cannabis waste based on operational, environmental, economic and regulatory criteria, with suggestions on options that could be considered in Metro Vancouver.

BACKGROUND

On October 17, 2018, the Canadian government passed Bill C-46 and with it, cannabis for recreational use became legal in the country. With legalization came many regulations pertaining to who can grow, process and consume cannabis under the *Cannabis Act*. However, regulations in the *Cannabis Act* regarding waste do not specify how production and processing facilities are meant to dispose of cannabis byproducts.

The two key provincial legislative pieces that relate to non-medical cannabis use are the *Cannabis Control and Licensing Act* which protects children and youth, promotes health and safety and aims to keep the criminal element out, and the *Cannabis Distribution Act* which establishes a public wholesale distribution monopoly. The BC Liquor Distribution Branch was appointed the wholesale distributor and regulator, with private and public retail outlets allowed to open legally and online sales operated by the province through *BC Cannabis Stores*.

In the first year of legalization, it was predicted that about 725,000 recreational cannabis users existed in the province and it was anticipated to increase to approximately 816,000 consumers by 2021. To meet this demand, it was estimated that about 103,000 kg of cannabis would have to be produced by 2021. Compared to other provinces, BC has a lower number of licensed producers, only having 23 of Canada's 109 licensed producers. This is largely attributable to a pre-existing "grey" market including hundreds of dispensaries, and high number of people licensed to cultivate their own medical marijuana. The provincial government has monopolized online sales and banned home delivery by private retailers, however this approach is under review as of the publishing of this report.

Plant Life Cycle

The cannabis plant life cycle in indoor/greenhouse facilities can vary anywhere from 3-5 months depending on the cultivation techniques. The cannabis plant life cycle begins with growing mother plants or stock plants. Cuttings are taken from these plants and kept in humidity domes. They are then planted into peat-based or rockwool plugs for about a week to allow them to root. When the cannabis plant has rooted, they are then transplanted into pots for another week. At this stage, male and female plants are separated before pollination to prevent female plants from producing seeds instead of trichomes.

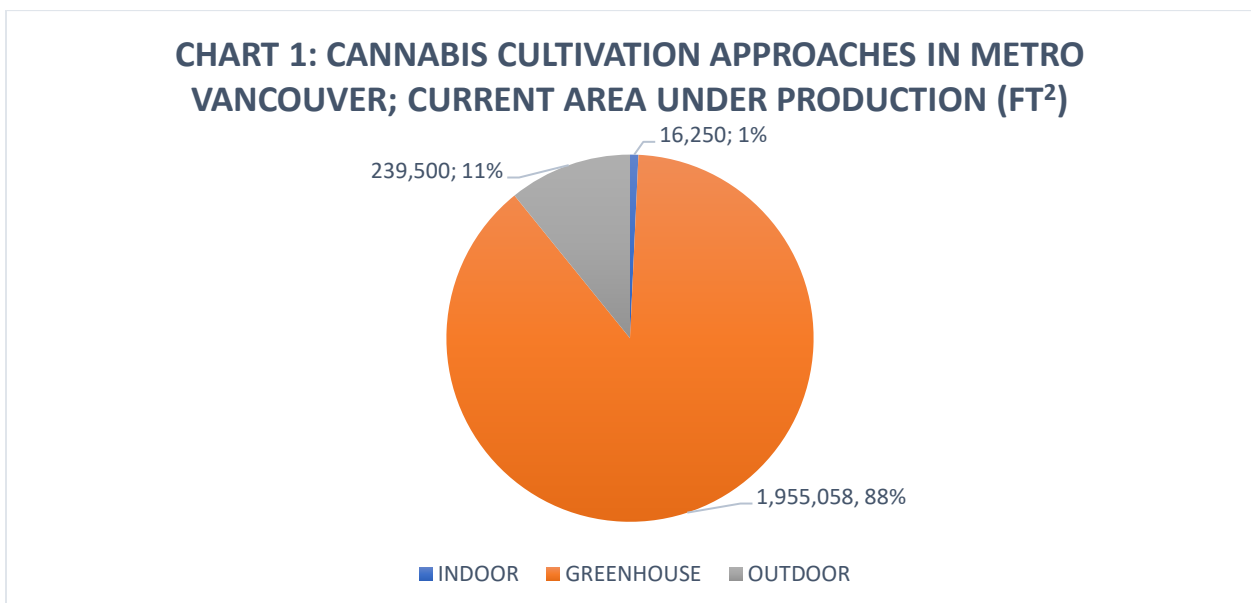
Trichomes are glandular structures on cannabis flower buds that produce cannabinoids, such as tetrahydrocannabinol (THC) and cannabidiol (CBD). While CBD has been shown to help reduce anxiety, insomnia and chronic pain, THC is what produces the "high" sensation among cannabis users. When female flowers are kept away from the pollen produced by their male counterparts, they produce far more valuable resin in a desperate attempt to capture pollen and become fertilized. If no pollen is to be found,

the end result will be flowers covered in a dense layer of trichomes and therefore, higher levels of THC and CBD. Contrarily, if female plants become fertilized by male plants, they go to seed, producing significantly less THC and CBD.

For about two more weeks, the cannabis plant is in its vegetative growth stage and would likely receive about 18 hours of light/day in an indoor setting under a controlled temperature between 21-26 C. Over the course of two months, flowers will begin to grow and over time, light is reduced to about 12 hours/day. After approximately 3 months, the trichomes (resins) become clear to amber in colour and can be harvested. The entire plant is removed from the growing area and individual plant branches are removed from the stalk. Flowers are cut from the branches and are hung or laid on drying racks for about 1-2 weeks. The flowers can then be cut, and bud trimmed by removing all leaves and other plant material. The flower plant material is usually sent to an extraction facility at this stage. The buds are left to cure for about 2 weeks and are then sent for packaging and labelling, storage and eventually distribution to different retail outlets across the country.

Types of Facilities

In Metro Vancouver, cannabis is most commonly grown in greenhouses, followed by outdoor cultivation. Greenhouse production is by far the most common type of cannabis approach used in Metro Vancouver, accounting for about 88% of the total estimated area currently under cannabis cultivation. This is likely because there were already many established greenhouses in the Metro Vancouver region prior to the legalization of cannabis in Canada that have since converted to cannabis licensed facilities. Greenhouses and outdoor production facilities comprised a combined total of almost 99% of the total area under cannabis production in Metro Vancouver, while indoor production consisted of only 1% of the total area.



Greenhouse cannabis facilities are usually in production for 10-12 months of the year, harvesting 4-6 times every year. These facilities do not only produce plant waste, but they also use growing media that requires disposal after each harvest. Additionally, greenhouse production occurs primarily on farmland but can also be constructed on industrial and commercial land. Cannabis plants grown in greenhouses often use a mix of synthetic nutrients and are typically grown in pots of soil or in soilless media, using a combination of natural and artificial light. Proper ventilation and air exchange are key, as these may limit yields with excess humidity, heat or oxygen. Greenhouse-specific HVAC systems exist for closed greenhouse facilities and help cannabis growers accurately control climate systems to ensure the facility maintains ideal growth conditions for cannabis plants. Each individual plant is typically transplanted into a 5-gallon pot to allow for the roots to expand quickly and with enough room. Grow bags are also widely used in cannabis production, placing them on a permeable table with trays or tarps to collect water runoff.

More often than not, cannabis plants are grown in a peat-based growing media, which is discarded after every harvest (multiple times in a year). However, cannabis plants can also be grown in soilless media using hydroponic systems. These operations are quite common and typically use rockwool as the growing media. Rockwool cannot be composted in Metro Vancouver and has to be discarded into the landfill after every use. Additionally, some peat-based growing mediums may not be compostable as they contain vermiculite and other materials that do not break down in a typical composting process.

Indoor cannabis facilities are enclosed and secured with production usually occurring over 10-12 months of the year, with 4-6 harvests every year. They usually take place in buildings located in industrial, commercial and/or agricultural areas and require the use of artificial lighting. Difficult-to-process waste like LED lights, High Intensity Discharge (HID) Grow Lights and Compact Fluorescent Lights (CFLs) are typically used in indoor cultivation sites. Additionally, cannabis indoor facilities operate on a similar waste cycle where spent growing media needs to be disposed of after every harvest.

Seasonal field-based cannabis crops grown outdoors are typically harvested 1-3 times a year. The greenhouse gas (GHG) emissions and overhead costs are predicted to be lower when compared to greenhouse and indoor production systems as they do not require heating and lighting to operate and overall dispose less solid waste. Outdoor production systems are popular in warm, dry climates (such as the Okanagan in British Columbia) as there is less of a threat of diseases due to high humidity levels. In outdoor production systems there is also no waste associated with growing media, instead, outdoor cannabis production systems build the soil with organic matter and compost, helping sequester carbon from the atmosphere and storing it in the soil. Overall, outdoor cultivation tends to have a smaller waste footprint when compared to indoor and greenhouse cultivation approaches and more opportunities to re-use cannabis plant waste within their production systems.

Cannabis Processing

Edible cannabis products became legalized in Canada as of October 2019. No existing environmental regulations are strictly related to extraction and processing facilities in Canada. Cannabis processing facilities are the middleman between growers and retailers. They take the raw plant material and turn it into oils, topicals, edibles, drinks and other products. These are generally produced by extracting cannabis using a solvent such as butane, heptane, propane and/or ethanol to remove active ingredients from the plant. Although most solvent can be recovered using evaporators and condensers, the remaining solvent may be considered hazardous and must be disposed of according to the *Environmental Management Act* and the *BC Hazardous Waste Regulation*. Additionally, the federal *Cannabis Act* and *Cannabis Regulations* set limits for residual solvents in cannabis oils of up to 5,000 ppm.

Cannabis can also be processed using supercritical carbon dioxide, high pressure, and heat to extract oils from the cannabis plant. Carbon dioxide residuals are less toxic than other solvent residuals and usually result in higher yields, reducing the amount of THC and CBD materials that are lost in the process, and overall reducing the amount of potentially hazardous waste that needs to be disposed of. However, the cost required to purchase the equipment needed to use this method is higher than that required for the solvent-based method and can present a cost barrier, especially for smaller facilities.

CURRENT WASTE MANAGEMENT PRACTICES

Regulatory Requirements

The legalization of recreational cannabis use in Canada has had an impact on the waste management industry due to an increase of waste produced from cannabis cultivation facilities. Both the *Cannabis Act (Police Enforcement) Regulations (SOR/2018-151)* and the *Cannabis Regulations (SOR/2018-144)* under the *Cannabis Act* are relevant to waste management practices. Prior to the legalization of cannabis, cannabis was regulated under the *Controlled Drugs and Substances Act (S.C. 1996, c.19)* under the *Access to Cannabis for Medical Purposes Regulations (ACMPR)* and the *Industrial Hemp Regulations*. These were repealed when the *Cannabis Act* and its regulations came into force. Under the *ACMPR*, cannabis was required to be destroyed prior to disposal and was “considered to be destroyed when it is altered or denatured to such an extent that its consumption and propagation is rendered impossible or improbable” (Government of Canada, 2018). However, this has changed. Now, under the *Cannabis Act, Part 9, Division 2, Section 108*, “if cannabis or chemical property has been seized... [it] may be disposed of or otherwise dealt with in accordance with the regulations or, if there are no application regulations, in the manner that the Minister determines”. As a result, there is no clear indication on how cannabis waste should be disposed of as there is no mention of disposing cannabis that has not been seized by an authority. By not directly addressing

disposal of cannabis waste, there is no prescribed methods of disposal and as a result, the onus is put on the cannabis industry.

In addition to the federal regulations surrounding cannabis waste, the province of British Columbia also passed *Bill 30- Cannabis Control and Licensing Act (CCLA)*. However, this act also makes no mention of cannabis waste destruction or disposal methods and makes no amendments to the *Environmental Management Act (EMA)*, which governs the management of waste in the province.

Since cannabis naturally contains THC and CBD, it has been categorized and managed for the last several decades as a controlled substance among jurisdictions worldwide. Restrictions around cultivating cannabis led to a void in scientific research. Particularly in North America, there is a lack of understanding regarding managing cannabis waste. As a result, much of what we know about growing cannabis is based on anecdotal information.

Waste Facilities in Metro Vancouver

Cannabis differs from other crops grown in British Columbia because of the presence of THC and CBD residues in the crop material and its ability to produce several rotations per year and therefore a higher volume of waste per year. In and around Metro Vancouver in particular, there are only a handful of active organic waste management facilities that currently accept cannabis plant waste as a feedstock. There were six commercial cannabis facilities in Metro Vancouver identified in this research. In total, it is estimated that over 2.2 million ft² is currently dedicated to growing cannabis in facilities across Metro Vancouver, with new facilities on the rise and established facilities looking to grow their cultivation areas (to almost 8.3 million ft²).

Greenhouse cultivation seems to be the preferred approach in the region, representing about 88% of the total cannabis growing area. In the province of British Columbia, most vegetables and nursery greenhouse operations are located in the Fraser Valley and Lower Mainland regions. In 2019, the BC Greenhouse Growers Associations saw a 30% membership loss as a substantial number of producers in the Lower Mainland converted to cannabis. The average cannabis greenhouse covers an area of 5-10 acres (217,800-435,600ft²), with larger operations reaching sizes greater than 50 acres (2,170,000ft²).

It is important to note that some large, licensed facilities in Metro Vancouver have recently closed and therefore the waste they would have been producing was not accounted for under current estimates. It is estimated that close to 2 million ft² of cannabis production has ceased in 2020, having a significant effect on the quantities of waste produced.

The data used to estimate the total area under production is based on what conditions the facilities were found to be federally licensed to operate under. However,

the facility itself may not necessarily be operating at its licensed allowable capacity dictated by Health Canada so there may be some overestimations as realistically, they may be operating at a smaller capacity. Moreover, interviewees reiterated that the total area that facilities are licensed to produce for is never the full amount of area that is actually under production. For this reason, the following percentages were used to make more realistic assumptions:

- Indoors - 65%
- Greenhouse - 85%
- Outdoor - 50%

The table below, reflects these realistic percentages for current and potential production for each cultivation approach:

TABLE 1: REALISTIC AREA UNDER COMMERCIAL CANNABIS PRODUCTION		
Cultivation Approach	Current area (ft²)	Potential area (ft²)
Indoors	16,250	16,250
Greenhouse	1,955,058	8,051,404
Outdoors	239,500	239,500
Total	2,210,808	8,307,154

Jurisdictional Scan of Waste Management Practices

Ontario represents the headquarters for several cannabis production and manufacturing operations in the country. The Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) treats cannabis like any other agricultural crop, and farm uses are protected through the Farming and Food Production Protection Act. Currently, standard operating procedures (SOPs) are being developed in partnership with OMAFRA and the Ministry of Environment, Conservation and Parks, however, it is primarily focused on odour controls and will not be specifically addressing waste management concerns.

Alberta has created a comprehensive framework that addresses the legalization of recreational cannabis in Canada and provides best management practices associated with its provincial Environmental Farm Plan (EFP). In Alberta, there are currently no provincial policies or regulations that set cannabis apart from other agricultural crops. Alberta's approach to cannabis legalization has been coordinated by a cross-government team called the Alberta Cannabis Secretariat. In 2018, the government of Alberta released a cannabis waste management fact sheet, outlining proper management and disposal procedures for cannabis waste at cannabis cultivation facilities, testing facilities, product manufacturing facilities and retail stores. Cannabis solid waste in Alberta is currently being regulated as either hazardous or non-hazardous. In their guidelines, non-hazardous waste must be made unusable and unrecognizable by grinding the cannabis solid waste and mixing it with at least an equal amount of other non-cannabis material prior to disposal. They recommend mixing with compostable materials such as food waste, leaf and yard waste or animal manure and disposing at a compost facility or anaerobic digester, and/or mixing with non-compostable materials such as cat litter, sand, plastic

waste or sawdust to dispose at landfill. This second option is problematic. When plant waste is mixed with non-compostable materials, it doubles the amount of waste destined to the landfill and prevents the waste from being composted.

In the United States, 33 states have legalized medical marijuana and 11 states legalized recreational marijuana. **Colorado** has the longest history of cannabis legalization in North America and as a result, the most in-depth information available. The City of Denver is a leader in exploring best practices for growing cannabis sustainably indoors. In the state of Colorado, cannabis cultivation and processing facilities must render their solid waste unusable and unrecognizable through grinding and/or mixing with other waste materials. **Washington** state has the second longest history with cannabis regulation and sales in the United States. Similar to Colorado, cannabis waste must be rendered unrecognizable and unusable prior to disposal. This can be done also through grinding, shredding and/or chipping and incorporating it with other waste materials. **Oregon** has environmental regulations in place to address solid and hazardous waste from commercial operations. It is home to the Task Force for Cannabis Environmental Best Practices. Solid waste in Oregon must be composted, processed or disposed of at permitted solid waste facilities. Cannabis growers must maintain accurate and comprehensive records regarding waste material, keeping it inside a secure storage area with access limited to authorized personnel. **California** requires a waste management plan from cannabis cultivation and processing facilities that identifies composting, land application, commercial waste collection or self-hauling options.

TYPES OF WASTE

The majority of the solid waste that commercial cannabis producers and processors generate falls primarily within two waste streams: plant byproduct and consumer packaging. Plant byproduct refers to the organic waste produced at the production stage, including plant waste and exhausted growing media. Plant waste consists of the stalks, stems, leaves that get discarded after every harvest and can readily decompose in a typical compost pile, becoming a nutrient-rich soil amendment. The content of marijuana plant parts (dry weight) are:

- 10-24% in flowers
- 1-2% in leaves
- 0.1-0.3% in stalks
- <0.03% in roots

A typical commercial cannabis production facility in Metro Vancouver is located in a greenhouse and tends to use peat-based or rockwool growing mediums after cloning to allow the roots to develop. These growing mediums are often discarded after every use due to concerns over disease transmission. Some of these discarded growing mediums are difficult to compost or may not be accepted by organic waste management facilities located nearby. Often times, they end up in the landfill. Rockwool, a combination of chalk

and rock, is widely used as a growing medium despite the fact that it is non-reusable and non-compostable in Metro Vancouver.

Cannabis consumer packaging includes materials such as plastic, glass, vapes, batteries, cardboard and more. While some of these materials can be recycled, most end up in the landfill. The mass production of single-use disposable packaging such as those used by the cannabis industry has become a high-profile issue in waste management all over the world. Furthermore, vape pen batteries are considered hazardous largely due to the presence of heavy metals and their use of lithium-ion batteries. Therefore, they are required to be processed differently and often cannot be recycled.

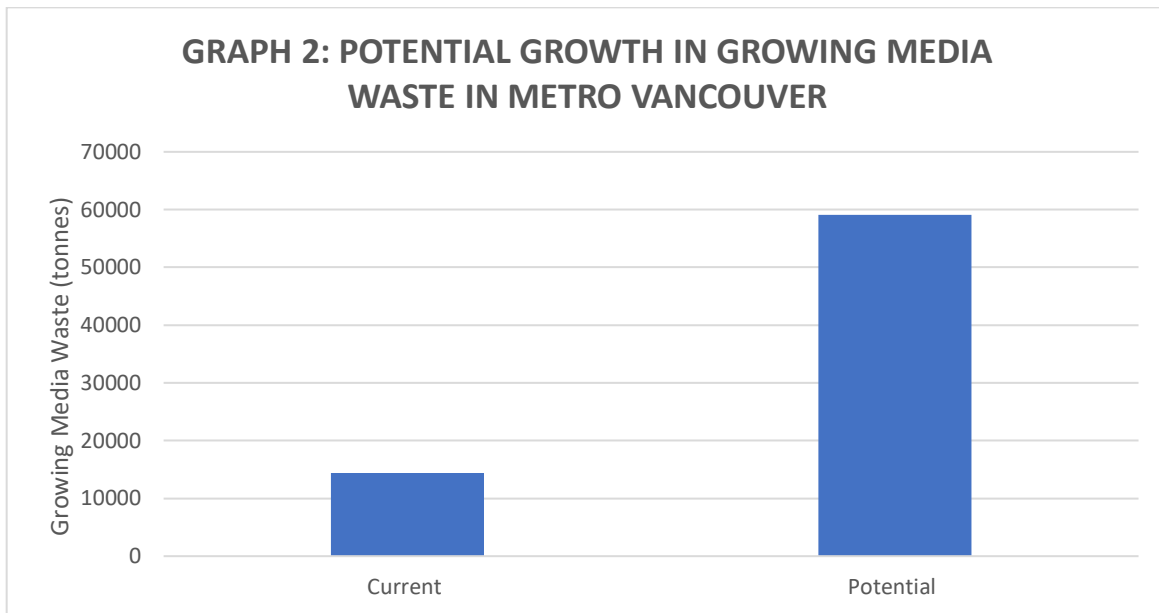
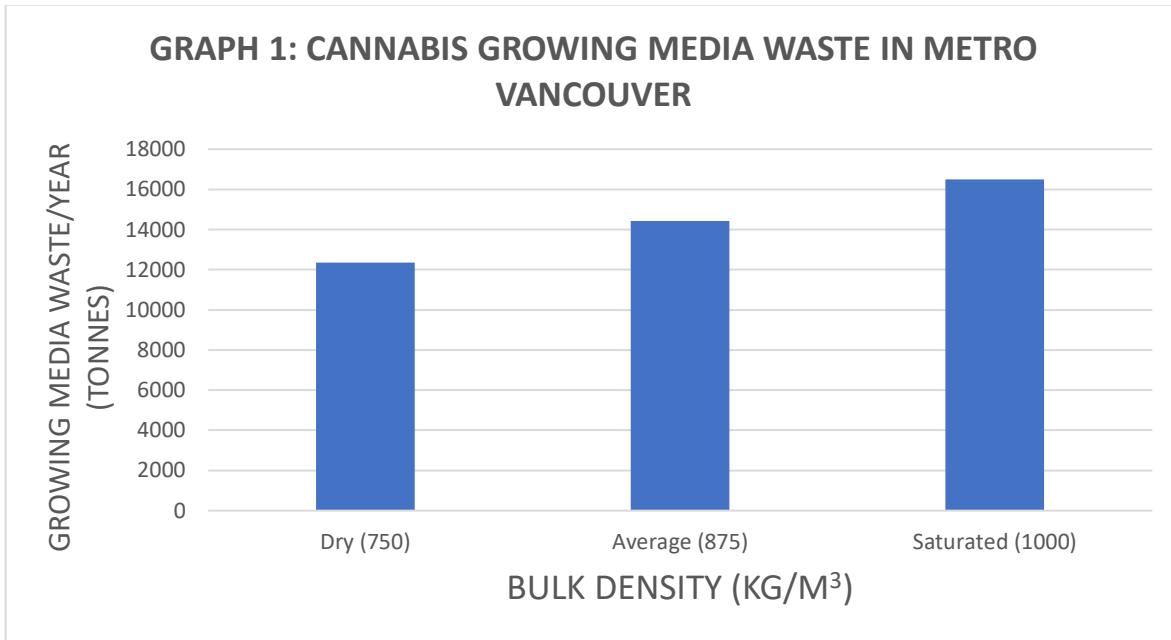
QUANTITIES OF WASTE

The Senate Standing Committee on Agriculture and Forestry estimated that by 2020, about 6,000 metric tonnes of cannabis waste would be produced in Canada. However, this research suggests that, if growing media is included, Metro Vancouver alone surpasses this estimate. In 2019, a report to Metro Vancouver estimated that about 9,098 tonnes of total solid waste is produced every year from cannabis cultivation in the region. In comparison, in the United States, cannabis waste output (organic fraction only) is roughly estimated at several thousand tonnes annually across the country, which is quite small compared to the food industry, agriculture and other sources. Additionally, California estimates that about 25% of the state's disposal stream from cannabis industries consist of packaging waste.

As of August 2019, there were 47 licensed cannabis cultivation facilities in the province, 12 in Metro Vancouver. Cannabis production and processing facilities are responsible for reporting the types and quantities of waste they produce to Health Canada. However, accessing this information, especially during the COVID-19 pandemic which fell in the timeline of this research, was not possible during the timeframe of this study. For this reason, estimates were calculated at the production level by estimating the amount of growing media and plant waste currently and potentially produced in Metro Vancouver.

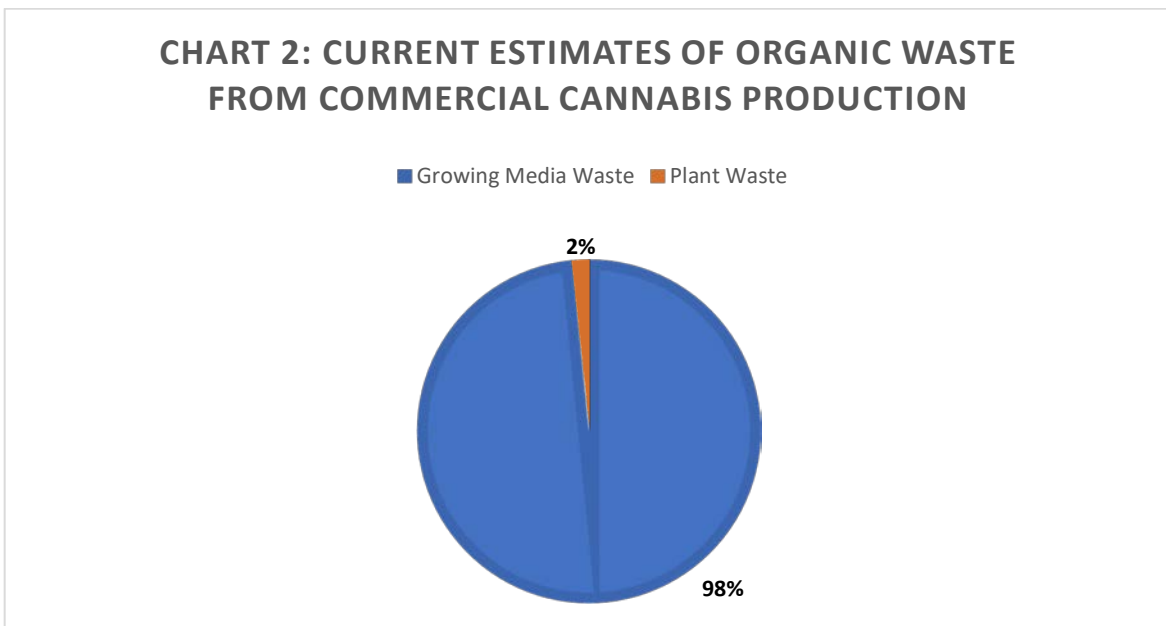
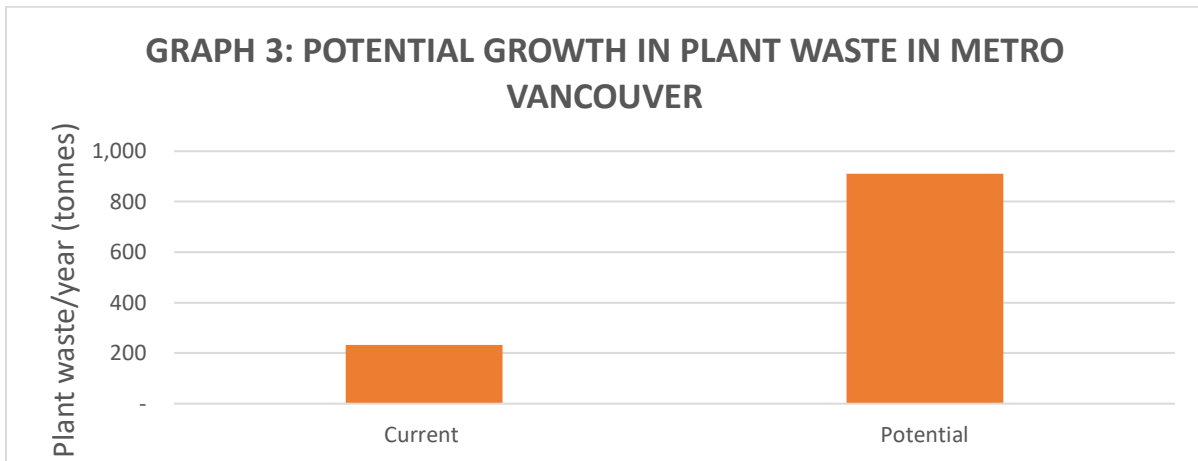
According to a report by Upland Agricultural Consulting, about 15L of growing media are used per cannabis plant per cycle. With an average of 4 cycles per year in an indoor/greenhouse facility and an average density of 1.5 plants/m² (based on Upland Agricultural Consulting's team experience) and an estimated current square footage under indoor/greenhouse cannabis production of over 2.2 million ft², the quantity of growing media waste was estimated. Typical growing media mixes have a dry bulk density of 750 kg/m³. However, saturated media is quite common at the end of a growth cycle and can reach up to 1,000kg/m³. Therefore, a range of estimates were determined based on ranging bulk densities for growing mediums used in cannabis production. Based on these assumptions, it is estimated that between **12,366— 16,489 tonnes of growing media waste** is disposed every year from cannabis production and processing

facilities in Metro Vancouver, with an average of **14,430 tonnes/year**. In addition to solid waste facilities, growing media can also be disposed of in specialized soil facilities. It is estimated that this waste could increase to an average of about **59,045 tonnes/year** as cannabis production and processing facilities become approved and licensed to operate by Health Canada.



Moreover, plant or green waste includes stalks, stems and trimmed leaves. According to Upland Agricultural Consulting, plant residues yield an average of 1.75L of waste per plant. For this calculation, the same plant density (1.5plants/m²) was used and all cultivation approaches were included (indoor, greenhouse and outdoor) in the total

square footage under cannabis production. However, because the number of cycles per year is lower (typically between 1-3 harvests/year) for outdoor production, the number of plants were calculated separately to account for this difference. For outdoor production, 2 harvests were assumed to take place in a year, whereas for greenhouses and indoor production systems, 4 harvests a year were assumed. The average bulk density of green cannabis waste was estimated to be around 114kg/m³. Following these assumptions, approximately **233 tonnes of plant waste** is currently estimated to be produced from indoor, greenhouse and outdoor cannabis production facilities in Metro Vancouver. As more cannabis facilities become licensed federally or existing facilities are approved for expansion, the amount of plant waste disposed is expected to rise. It is expected that approximately **911 tonnes of plant waste** may potentially be produced as license applications get approved, almost a tripling in the amount of waste being produced in the region from cannabis production and processing facilities.



The pie chart above illustrates the estimated quantities of waste from indoor/greenhouse production facilities in Metro Vancouver. As shown, the vast majority of waste (98%) consists of growing media waste, whereas only 2% of the total waste at the production level consists of plant waste.

EVALUATION OF WASTE MANAGEMENT OPTIONS

Organic Waste

The following subsections describe methods that are used by cannabis production and processing facilities to manage plant waste and growing mediums.

1. COMPOSTING

Composting organic materials reduces the volume of crop waste and transforms it into a soil amendment and/or nutrient resource for other crops, preventing greenhouse gas emissions from being released into the atmosphere. On-farm composting is possible in outdoor cannabis production systems where there is space to do so. If on-farm composting takes place, the compost can be applied or tilled into the soil, providing nutrients and biomass for a healthier and more productive soil.

Both the Compost Council of Canada and the Cannabis Conservancy believe composting should be the preferred method to process cannabis plant residuals. Under proper Carbon to Nitrogen ratios, cannabis plant waste, including stalks, stems and root balls can be composted and produce a compost similar to any other green waste. Organic processing should be done in facilities that follow the *Agricultural Environmental Management Code of Practice (AEM-CoP)* and *Organic Matter Recycling Regulations (OMRR)*. This means the collection, storage and use of cannabis plant by-products must be stored in a permanent storage structure or as temporary field storage, protected from the rain in order to avoid leachate, run-off, air contamination and must deter attraction of animals and vectors.

Composting on-site can also be accomplished using in-vessel technologies. Specialized processing units that have already been developed by companies such as Micron Technologies and Brome Composting in Canada are self-contained and can transform cannabis plant waste into compost. They are designed for on-site installation and allow for cannabis waste to be kept in a secured waste receptacle. These in-vessel composting technologies produces minimal odours and act as a closed loop system. This type of composting could be utilized by indoor and greenhouse cannabis producers where outdoor space is limited or does not allow for other forms of composting. Most cultivation facilities in Metro Vancouver grow indoors or in greenhouses which may lack the space to compost the amounts of waste they produce.

Composting cannabis waste can also be accomplished through transportation to off-site composting facilities. Off-site composting can sometimes be problematic due to

limited availability and accessibility of organic waste facilities in the region, requiring hauling of heavy materials over several kilometers, something which may not be financially viable for all cannabis producers. Additionally, each organic waste facility has certain rules cannabis producers need to abide by when they drop off their waste, further complicated the process. Leftover plant materials from cannabis production has the potential to generate marketable products such as construction materials from fibers and stalks. However, because cannabis waste has distinct rules for plant disposal it is challenging to monetize biomass waste.

2. LANDFILLING

Landfilling has been the primary method of disposal of cannabis plant waste in North America. It is perceived as being the simplest, most convenient way of disposing of waste as there are no extra steps required. However, this disposal method is not considered best practice, as it releases greenhouse gases when organic materials decompose in an anaerobic environment. Metro Vancouver has already recognized the importance of diverting organic waste from landfills, implementing an organics disposal ban in 2015. However, despite the costs associated with hauling and disposing of cannabis plant waste, the landfill continues to be the most common disposal method in other jurisdictions studied.

3. OTHER WASTE MANAGEMENT METHODS

Anaerobic digestion is a fermentation process that takes between 6-8 months as microorganisms break down the plant biomass and convert it into biogas and digestate (wet residue). Waste gets heated in an airtight box to a stable 37°C in an oxygen-free environment. This process requires more than 20% of the waste to be dry matter. Anaerobic digestors are typically expensive which can be a barrier for many cannabis facilities.

The Bokashi method is an example of anaerobic digestion which could be appropriate for small-scale producers. Waste is shredded and dropped into an on-site drum that is made airtight and the waste is mixed with at least equal amount of compostable materials, water and an activator for 2 weeks. Through this biologically active anaerobic environment, a liquid is produced (digestate) which is suitable as a fertilizer and the solid portion can be applied as a soil amendment.

Packaging Waste

The following methods are used by cannabis production and processing facilities to manage consumer packaging waste and related cannabis products. This includes non-organic waste such as plastics, glass, and vapes (made of both materials) which are more difficult to recycle and can be hazardous.

1. RECYCLING

Cannabis consumer packaging seems to have been one of the biggest concerns among the public since it became legalized. Federal regulations surrounding packaging has set limitations on what materials can be used, making it difficult to adopt environmentally friendly options. For example, whereas a clear packaging material is more desirable for recycling, they are prohibited under federal regulations surrounding cannabis packaging. Additionally, strong sticky adhesives used in labels are difficult to remove and less desirable for recyclers, however they are mandated in cannabis packaging as these are difficult to remove and mislabel. Although many of the current cannabis packaging and vape products can be recycled, often the onus has been on the consumer to properly dispose of them. However, some people may be unaware that batteries, for example, should be disposed of in a certain way.

Although the BC Tweed cultivation facilities in Metro Vancouver are now closed, they were an excellent example of partnerships that can be established with recycling companies, offering the first national recycling program in the Canadian cannabis industry. Launched in October 2018, Terra Cycle was working in partnership with BC Tweed and collected more than 24 tonnes of cannabis packaging among 435 participating retailers across North America. Terra Cycle specializes in recycling hard-to-recycle waste. Instead of landfilling, it moves waste away from a linear system into a circular one where cannabis waste keeps cycling through the economy. They have two waste streams that they manage: the packaging recycling program and the vape recycling program. Cannabis packaging is collected at retail outlets, cleaned, melted into plastic pellets and transformed into new products that can be recycled again (i.e. watering cans and park benches). The vape program collects vape batteries and cartridges from Canopy Growth brands and the plastic follows a similar process as the packaging program and anything electronic is shredded and sorted into precious metals which then get melted and used for new products.

2. HAZARDOUS WASTE

Waste from the processing of cannabis oils, such as spent solvents, may be subject to the *Hazardous Waste Regulation*. It is the responsibility of the cannabis facility to characterize the waste to determine whether it meets the definition of hazardous waste. A facility may also require a waste discharge permit for air emissions or solid and liquid waste discharged into the environment.

BEST MANAGEMENT PRACTICES

Primary disposal methods for cannabis plant waste are linear and transportation centric, with disposal methods like landfilling and off-site composting. According to the National Cannabis Industry Association (NCIA), most of the cannabis waste in the United

States goes directly into landfills. As there is no clear federal direction as to how to dispose of cannabis waste in Canada, there is an opportunity to provide some clearer guidance on how plant and packaging waste can be disposed of and managed by cannabis production and processing facilities. The following best management practices are focused on minimizing and re-using waste as much as possible, proposing a cannabis industry that is closed loop with waste repurposed in the growing process or elsewhere in the supply chain.

1. **Compost organic waste on-site and re-use in production system.** Compost on-site and apply to an outdoor cultivation facility, if possible. If growing indoors or in a greenhouse, partner with nearby agricultural operations who are able to take the compost produced on-site and/or partner with organic waste facility nearby to haul cannabis plant waste and compostable organic mediums to municipal or private composting facilities nearby. On-site organic waste processing can include anaerobic waste-to-energy, bokashi, aerobic digestion, aerobic windrow piles, etc. Anaerobic waste-to-energy may involve a small scale on site anaerobic digestion system that can process up to 1000-10,000 pounds of cannabis plant waste/day, generating and capturing methane, carbon dioxide and nutrient rich fertilizer and creating a beneficial closed-loop system.
2. **Choose less wasteful cultivation approaches.** If growing inside, grow in greenhouses, with appropriate emissions control technology, to allow passive solar energy as sunlight to supplement artificial light use. Use recyclable lights when possible. Use growing media that can be composted and managed on-site or hauled to a licensed organic waste facility nearby. Avoid using rockwool plugs and vermiculite as these are non-compostable and non-recyclable.
3. **Exclude 'rendering unusable and unrecognizable' from the definition of 'cannabis waste'** (see Appendix 1: Cannabis Waste Definition) as this limits the opportunity for waste to be reused and recycled and often requires additional material purchasing, contributing to more waste being sent to the landfill. Some cannabis facilities may not have sufficient volumes of non-cannabis waste on-site to reach the necessary 50% ratio without having to haul in an additional waste feedstock to comply with the regulation. This leads to an even more wasteful system. Using inorganic materials such as cat litter to meet these regulations forces material to be landfilled whereby half of the material that is organic waste decomposes under anaerobic conditions and contributes to the emissions of greenhouse gases.

4. **Impose a threshold for composting.** Setting a total waste threshold so when facilities are producing more than the allowed amount, they need provide a waste management plan outlining how they are managing the waste. For example, in California if a facility generates more than 4yd³ of solid waste per week, they must show how they recycle their organic waste by either composting on-site, self-hauling to a facility or arranging to have it picked up by a hauler that recycles organic waste.
5. **Recover stalks and stems for industrial fiber applications.** Promote regenerative models and repurposing cannabis waste that move beyond the landfill diversion paradigm and composting as the default solutions. Explore innovations and opportunities in re-using fibers from stems to make a wide variety of products, including t-shirts, animal bedding, house siding, insulation, etc.
6. **Clarify best disposal methods for cannabis production and processing facilities** and provide resources, connections and information on implementing best practices for waste management. Encourage cross-collaboration, further conversations and partnerships among the cannabis industry from retailers, producers, processors, government, researchers and more. Encourage recycling (take-back) programs and/or establish zero-waste manufacturing facilities. Promote the use of these programs particularly for plastic and electronic waste (e.g. by partnering with businesses like Terra Cycle) to help reduce. These recycling programs can be supported using a deposit system where consumers get a discount at the dispensary for bringing in their used device for recycling. Additionally, cannabis product manufacturers can consider designing the primary body of their devices using stronger materials, ideally medically grade, so that they can be reused and recycled more readily, such as creating cartridges and pods that accommodates opening and cleaning.
7. **Mitigate waste through integrating federal standardization and specification for reusable and refillable packaging design.** Use multi-use packaging that follows federal packaging standards. Invest in innovative reusable and refillable packaging systems. Foster a new discourse around the current linear waste model and lead a transition towards improved waste mitigation through more responsible packaging designs and away from single-use packaging. Redefine what sustainable packaging is, disposable is not sustainable. Potentially have tax incentives for those who integrate a system for reusable packaging, waste-to-energy, solar, take-back programs, waste mitigation strategies.

8. **Incentivize extraction processes that use careful material management**, including solvent management plants. Operators could be encouraged to develop and use solvent-less techniques or processes that pose less risks to the environment. For example, supercritical carbon dioxide fugitive emissions may contribute to GHG emissions but may be less toxic than solvents such as ethanol and hydrocarbon byproducts used in solvent-based methods.

OPTIONS FOR CONSIDERATION

The cannabis industry in Metro Vancouver has the opportunity to carve a new path when it comes to reducing the impacts of waste. Integrating models for bulk sales, implementing take-back programs for packaging, providing clear guidance on how waste must be disposed of and managed are some of the ways that the industry can do so. Regulations could be designed to incentivize waste reduction while also enforcing non-compliance. An Extended Producer Responsibility (EPR) approach could hold manufacturers accountable and assigns responsibility to provide incentives to prevent waste at the source while also promoting innovation and supporting the achievement of Metro Vancouver's solid waste management plan

Moreover, providing prescribed methods for the disposal of cannabis waste would be helpful as it is currently unclear how cannabis waste should be destroyed. Best management practices could be determined and communicated with the cannabis industry, ensuring they are all aligned with federal and provincial regulations. Tracking and tracing waste in the cannabis industry is not currently accessible to Metro Vancouver staff, making it difficult to plan for current and potential quantities when they are unknown. Greater transparency and understanding of cannabis waste streams, including the volumes and types waste produced from production facilities to retail outlets would facilitate better understanding of the waste stream. Establishing a self-reporting portal for cannabis producers to report environmental metrics could also be adopted. For example, Big Data from Colorado is a national platform for cannabis industry self-reporting to allow for better understanding of the volume and variety of waste from cannabis facilities. Further development of environmentally effective management and diversion solutions to keep pace with cannabis industry growth would help ensure environmental compliance in sustainable practices moving forward. Establishing connections and improving partnerships with cannabis licensed producers can help share information and data and promote regulations that take into consideration all stakeholders in the industry.

REFERENCES

- Ascent Industries Corp. (2018). Agrima Botanicals Facility – Maple Ridge. BC. Canada. Vimeo. Retrieved from <https://vimeo.com/277163861>
- Backer, R. et. al. (2019). Closing the Yield Gap for Cannabis: A Meta-Analysis of Factors Determining Cannabis Yield. Plant Science. <https://doi.org/10.3389/fpls.2019.00495>
Retrieved from <https://www.frontiersin.org/articles/10.3389/fpls.2019.00495/full>
- Benchmark Botanics Inc. (2020). Operations. Retrieved from <http://benchmarkbotanics.com/pitt-meadows-greenhouse-operations/>
- British Columbia Liquor Distribution Branch (2020). Cannabis. Retrieved from <http://www.bcldb.com/cannabis>
- Brown, S. (2020). Connections: Compost + Cannabis. BioCycle. Retrieved from <https://www.biocycle.net/2020/01/07/connections-compost-cannabis/>
- Butler, R. & Jackiw, R. (2019). Canada: Cannabis Solid Waste- A Problem That's Growing Like A Weed. Recycling Product News. Retrieved from <https://www.recyclingproductnews.com/article/32589/the-highs-and-lows-of-cannabis-waste-management-regulations>
- Commendatore, C. (2019). The Complicated World of Cannabis Waste Generation (Part One). Waste 360. Retrieved from <https://www.waste360.com/legislation-regulation/complicated-world-cannabis-waste-generation-part-one>
- Commendatore, C. (2019). The Complicated World of Cannabis Waste Generation (Part Two). Waste 360. Retrieved from <https://www.waste360.com/legislation-regulation/complicated-world-cannabis-waste-generation-part-two>
- Corbett, N. (2019). Tantalus says city holding up expansion. Maple Ridge-Pitt Meadows News. Retrieved from <https://www.mapleridgenews.com/news/tantalus-says-city-holding-up-expansion/>
- Emerald Health Therapeutics. (2020). How It's Made. Retrieved from <https://emeraldhealth.ca/en/our-difference/how-its-made>
- Globe Newswire (2019). Emerald Health Therapeutics' Metro Vancouver Organic Cannabis Operation Received Cultivation Expansion License for Total Growing Area in First Greenhouse. Retrieved from <https://www.globenewswire.com/news-release/2019/10/15/1929574/0/en/Emerald-Health-Therapeutics-Metro->

[Vancouver-Organic-Cannabis-Operation-Receives-Cultivation-Expansion-License-for-Total-Growing-Area-in-First-Greenhouse.html](https://www.globenewswire.com/news-release/2020/02/28/1992973/0/en/AgraFlora-Organics-to-Acquire-Curated-Portfolio-of-Elite-Live-Plant-Cannabis-Genetics.html)

Globe Newswire (2020). AgraFlora Organics to Acquire Curated Portfolio of Elite Live-Plant Cannabis Genetics. Retrieved from <https://www.globenewswire.com/news-release/2020/02/28/1992973/0/en/AgraFlora-Organics-to-Acquire-Curated-Portfolio-of-Elite-Live-Plant-Cannabis-Genetics.html>

Gorrie, P. (2018). Recycling Cannabis Organics. BioCycle. Vol. 59, No. 6, p. 17. Retrieved from <https://www.biocycle.net/2018/07/06/recycling-cannabis-organics/>

Government of Alberta (2018). Fact Sheet: Cannabis Waste Management. Retrieved from <https://open.alberta.ca/dataset/765cd310-e7f4-45b5-999f-54c737a94145/resource/c40fc259-26ff-4d97-9993-5cb33eefdd17/download/cannabis-waste-management-oct2018.pdf>

Government of British Columbia (2020). Cannabis. Retrieved from <https://www2.gov.bc.ca/gov/content/safety/public-safety/cannabis>

Gyarmati, S. (2019). Zenabis aims to be major player in Canada's pot industry. Delta Optimist. Retrieved from <https://www.delta-optimist.com/news/zenabis-aims-to-be-major-player-in-canada-s-pot-industry-1.23602262>

Hardwood, S. (2018). Health Canada requires that marijuana waste be destroyed -- but is it a missed opportunity? Global News. Retrieved from <https://globalnews.ca/news/4203184/health-canada-destruction-marijuana-waste/>

Health Canada (2019). Guidance Document: Destruction of Narcotics, Controlled and Restricted Drugs and Targeted Substances by Licensed Dealers. Retrieved from: <https://www.canada.ca/content/dam/hc-sc/documents/services/health-concerns/controlled-substances-precursor-chemicals/controlled-substances/compliance-monitoring/destruction-eng.pdf>

Kwan, B. (2019). BC Bud Producers Say New Regulations Will Weed Out Small Growers. The Thye. Retrieved from <https://thetyee.ca/News/2019/06/05/BC-Bud-New-Regulations/>

Lefferts, R. (2019). The Cannabis Waste Problem: How Innovation Leads to Opportunity. CFN Media Group. Retrieved from <https://www.cannabisfn.com/the-cannabis-waste-problem-how-innovation-leads-to-opportunity/>

- Madhok, R. (2019). The Multi-Media Impacts of Cannabis Production in Metro Vancouver. UBC Sustainability Scholar Program. Retrieved from https://sustain.ubc.ca/sites/default/files/2019-35_The%20Multi-Media%20Impacts%20of%20Cannabis_Madhok.pdf
- Marijuana Business Daily (2020). Zenabis to sell cannabis facility, lays off quarter of workforce. Retrieved from <https://mjbizdaily.com/zenabis-to-sell-cannabis-facility-lays-off-quarter-of-workforce/>
- Marijuana News (2018). Agrima Botanicals in Pitt Meadows signs medical marijuana agreement with Aurora Cannabis. 420 Intel. Retrieved from <https://420intel.ca/articles/2018/06/13/agrima-botanicals-pitt-meadows-signs-medical-marijuana-agreement-aurora-cannabis>
- Miller, P. (2019). Solving the Cannabis Waste Problem. Cannabis & Tech Today. Retrieved from <https://cannatechtoday.com/solving-the-cannabis-waste-problem/>
- Neufeld, A. (2019). Canada needs better cannabis waste guidelines to prevent Greenhouse Gas emissions (Opinion). Victoria Buzz. Retrieved from <https://www.victoriabuzz.com/2019/05/canada-needs-better-cannabis-waste-guidelines-to-prevent-greenhouse-gas-emissions-opinion/>
- Nichols, K. (2019). Garbage Game. Marijuana Business Magazine. p. 81-84 <https://mjbizmagazine.com/digital-issues/2019-05-MayJun/80/>
- Peterson, E. (2019). Industry Report: The State of Hemp and Cannabis Waste. Company Week. Retrieved from <https://companyweek.com/company-profile/industry-report-the-state-of-hemp-and-cannabis-waste>
- Slaughter, G. (2020). More uncertainty for Canadian cannabis as class-action suits filed in U.S. CTV News. Retrieved from <https://www.ctvnews.ca/business/more-uncertainty-for-canadian-cannabis-as-class-action-suits-filed-in-u-s-1.4805042>
- Upland Agricultural Consulting (2019). Commercial Cannabis Production in British Columbia: Best Available Control Technologies and Regulatory Oversight of Environmental Considerations. Retrieved from https://www2.gov.bc.ca/assets/gov/environment/waste-management/industrial-waste/industrial-waste/cannabis-production/cannabis_bacts_report.pdf

APPENDIX

Appendix 1: Cannabis Waste Definition

Health Canada used to require plant waste material from cannabis production be rendered unrecognizable prior to disposal, many mixing 50/50 by volume with other materials such as sand or soil, doubling the amount of organic waste going to the landfill. Additionally, where compost facilities may accept plant waste from cannabis production, many don't accept spent growing medias that are commonly used in indoor/greenhouse production systems. When these are disposed of together, it makes it difficult to compost. Cannabis is not an approved feedstock currently under OMRR but is considered an agricultural by-product (vegetative debris) thereby making it suitable under the AEMCoP.

According to the Government of Alberta's Cannabis Waste Management Fact Sheet, non-hazardous solid cannabis waste must be made "unusable and unrecognizable" by grinding the cannabis solid waste and mixing it with at least an equal amount of other non-cannabis material prior to disposal. By rendering cannabis waste as such, materials used to mix with cannabis waste can be compostable or non-compostable, doubling the amount of solid waste that shall be disposed.

Appendix 2: Calculation and Assumptions

PRODUCTION SYSTEM	AREA UNDER PRODUCTION			
	CURRENT (ft ²)	REALISTIC % (ft ²)	POTENTIAL (ft ²)	REALISTIC % (ft ²)
INDOOR	25,000	16,250	25,000	16,250
GREENHOUSE	2,300,068	1,955,058	9,472,240	8,051,404
OUTDOOR	479,000	239,500	479,000	239,500
TOTAL	2,804,068	2,210,808	9,976,240	8,307,154