Canadian Water and Wastewater Association

Residential Food Waste Grinders

Issues Analysis Paper

This paper is focused on food waste grinder use by the residential sector. Food waste grinders may also be used by the Commercial and Institutional (C&I) sector, particularly food service establishments (e.g. restaurants, cafeterias in hospitals, schools, etc.). As food waste grinders used in the C&I sector are typically larger units, the issues discussed in this paper can be magnified. It is considered best practice for jurisdictions to require, through their Sewer Use Bylaw or other regulatory means, that C&I food waste grinders and similar equipment used in the preparation of food be connected to a solids interceptor (prior to connecting to a grease interceptor). Jurisdictions can also consider a prohibition on commercial food waste grinders. The Canadian Council of Ministers of the Environment (CCME) Model Sewer Use Bylaw (2009) contains an optional additional requirement for prohibition of food waste grinders and other pretreatment requirements in the Advanced Clauses, Section 7.

Table of Contents

Introduction

Residential food waste grinders are defined as a device, usually electrically powered, installed under a kitchen sink between the sink's drain and the p-trap. The grinder shreds food waste into pieces small enough—generally less than 2 mm (0.079 in)—to pass through internal household plumbing. These small pieces are then combined with enough water to make a slurry, sending the debris from the kitchen sink into the municipal wastewater system, thereby converting a solid organic waste into a liquid/solid waste transferring the food waste from one waste stream to another.

Food waste grinders, also commonly known as 'garburators ™', food waste disposers, or simply food grinders, use both water and energy to convert food waste into a slurry that is disposed of via the building's sewer piping, through the municipality's sewer network and pumping stations and ultimately to the wastewater treatment plant. In evaluating the costs and benefits of food waste grinders in the residential setting, it is important to consider the capacity use costs (ie. capital investment needed to replace system capacity for other development projects), operations and maintenance impact of the additional slurry through the conveyance and treatment process and whether the principle of highest and best use of a resource is being or can be met. The evaluation should also consider the potential cost offsetting provided by energy generation or recovery.

Regulation of residential food waste grinders varies amongst different municipalities due to factors such as awareness, differences in the wastewater system design and capacity, technology employed by the wastewater treatment facilities and existence of food scraps/waste recycling programs. Some jurisdictions (e.g. Squamish, BC; Ottawa, ON; Cobourg, ON) have an outright ban on food grinders; others have limited bans, for example in areas with combined sewers (e.g. Victoria, BC and Toronto, ON).

This issues analysis paper is built upon a review of key considerations and their regional context in order to provide guidance to municipalities considering development of food waste grinder policy. A summation of the key considerations is presented in a 'decision tree' tool, found in appendix A.

Guiding Principles

Consistent with CWWA's existing policy statements, the principles of sustainability, highest and best use of resources, pollution prevention, and reduced carbon footprint have been used to guide this issues analysis.

Key Issues

Sustainable systems consider ultimate or lifecycle costs of the total system. The highlighted issues of this analysis are those seen as having impact to the system from source to final treatment and disposal.

The slurry resulting from food waste grinders poses concerns due to the potential for solids settling within conveyance systems leading to potential clogged pipes, pumps and increased odours. To address these potential concerns within the sewers, increased flushing is potentially required which leads to more energy use and greenhouse gas production. Food waste grinders increase the liquid BOD loading at wastewater treatment plants which is only removed in the aeration section and requires energy.

The capacity and level of treatment of wastewater prior to discharge varies widely across Canada, ranging from no treatment to sophisticated systems (Environment Canada, 2017). Treatment includes separating settled food waste solids from the liquid waste stream, and dewatering (and possibly drying) and disposing of the biosolids--all of which takes energy. Keeping food waste grindings out of wastewater treatment plants helps to reduce nutrient loading to receiving water bodies, reduce pump blockages, reduce energy use, reduce odours and reduces the potential for blocked sewers. It is also consistent with the goal of keeping solid waste out of wastewater infrastructure. Wastewater treatment infrastructure has high capital costs and depreciation costs to maintain a sustainable system. Asset management costs and operational costs make the use of food waste grinders more expensive for the wastewater utility than other options (London, ON review).

Some wastewater utility operations are increasing removal of solid wastes prior to aeration to decrease costs, increase existing capacity and lower GHG emissions. Adding a ground food waste would increase costs (eg. pumping)due to increased organic loading from fine particulate in the aeration section (GHG emissions), increased particulate that may settle and end up in the sludge GHG emissions and use up capacity in aeration section

Quantifying the Issues

In order to determine if food waste grinders are, or could be, an issue in your region, it may be helpful to try to quantify their use. A study completed by Metro Vancouver (Love Food Hate Waste, 2014) found that 45% of dwellings in the region have food waste grinders, with the following penetration rate:

- 38% houses
- 61% Townhouses and Duplex
- 43% Apartments

This study also found that 44% of dwellings with food waste grinders use it on a daily basis.

The US EPA study, "Onsite Wastewater Treatment Systems, Special Issues Fact Sheet 2, High-Organic-Strength Wastewaters (Including Garbage Grinders)" states "Table 1 contains reported information that illustrates that in-sink garbage disposal units increase septic tank loadings of

BOD by 20 to 65 percent, suspended solids by 40 to 90 percent, and fats, oils, and grease by 70 to 150 percent." This suggests that the widespread use of food waste grinders would impose significant loads on the treatment process and use a significant portion of wastewater treatment capacity, perhaps requiring major capital investment to upgrade the plant.

Wastewater Conveyance

All municipal wastewater systems have limitations, differing designs, environmental and economic factors to consider including:

- Combined sewers vs separated sewers
- Age
- Pipe material
- Slope
- Flow rate through the pipes
- Design of the collection system (siphons, low spots/dips, elbows, etc)
- Design of lift/pump stations
- Types of pumps
- Pump maintenance accessibility
- Maintenance resources

Combined vs Separated

Combined sewer and separated sewers are both challenges to consider as they both potentially have low lying areas and pipes. Combined sewers are generally sized larger allowing for more debris to settle as self-scouring velocities are harder to achieve. As a storm event occurs this could potentially dislodge debris and clog the pump, move the clog or simply enter the plant without issue. Also in a combined system, there may also be an issue with untreated sewage with now higher BOD due to food waste being released into the environment.

Age

A factor or value used to indicate the smoothness of the interior of a pipe is called the C factor. The higher the C Factor, the **smoother** the pipe, the greater the carrying capacity, and the smaller the friction or energy losses from water flowing in the pipe. New pipes start off very smooth but as it ages it becomes rougher catching debris.

Pipe Material

Different pipes materials have different C factors. This compounds with the age of the pipes and the slope. Pipe material with a higher C factor (rougher) or older pipes can form a slurry or clump. When a slurry/clump becomes lodged and accumulates more organic matter, the organics will ferment and can potentially lead to odour issues as well as to pipe corrosion.

Slope

Flat or low lying pipes don't promote the self-scouring velocities required to move liquid and solids. This can potentially lead to odour issues as well as to pipe corrosion as the organics will ferment and form acids and gasses. Hydraulic profiles and construction practices play an extremely important role.

Flow rate

Flow rates are likely reducing nationally as water conservation through lower water use fixtures is becoming standard (eg. toilets, faucets, washing machines, dishwashers, etc). As flow rates reduce, the carrying water for solids reduce. Self-scouring velocities are critical for odour and corrosion control. Water conservation savings could be lost due to additional water needed for sewer main flushing, plus costs associated with odour and corrosion control. Oversizing of pipes for future growth and generally reduced flows is already leading to challenges with solids settling out. Compounding this with ground food waste could form a paste and possibly a pipe blockage. This will ultimately lead to basement back-ups and possibly environmental spills.

Collection system design (siphons, elbows, dips, etc)

Hydraulics generally dictate the collection design. Any deflection from a straight pipe can lead to an accumulation of debris. Siphons, elbows, dips, and low-lying pipes are examples of deflections that are required but will need special attention. Accumulation leads to odours, corrosion and blockages. The less debris the better, especially fine compactable material.

Design of the lift/pump stations

Lift/pump stations designs are an important part of the collection systems, and gravity mains have to flow freely.. The design has to consider the hydraulics of the whole system not just the station. Pipe material, slopes, flow rates, nature of the sewage (combined or separated sewers), potential odour characterization studies are all factor that are required to be considered during design. Some stations are designed with bar screens for large debris removal. Paste like food waste slurry can potentially adhere to the screen causing a blockage and a bypass.

Pipe capacity

Solids settling out of this slurry can lead to clogged pipes if the flow and velocity is not sufficient to carry the slurry down the pipes. Any low lying or slower velocity areas will become challenging to maintain. As this slurry sits in one spot and collects more and more organic matter, the organics will ferment and can potentially lead to odour issues and pipe corrosion. Debris may, over time, solidify, making removal difficult and consuming unknown capacity, thereby increasing the risk of a sewer overflow.

Pump types
Pump design and maintenance (frequency and ability) are additional factors to consider in dealing with a slurry with increased solids to liquid ratios. As the slurry reaches the pumps, some of the organic matter goes through whereas some will stick and may eventually jam the pump itself. This potentially leads to increased maintenance activities and human intervention is required. Some pumps are designed with easy clean-outs whereas other are not. Increased maintenance generally results in increased costs.

Pump maintenance and accessibility
Debris clogs pumps causing reduced flows and vibration issues. Pumps need to be designed with easy access for cleaning and minor/major maintenance tasks. Clogging of the pump is directly related to the amount and type of debris it is pumping.

Wastewater Treatment
WWTP across Canada must meet federal requirements of the Wastewater Systems Effluent Regulations. Additional requirements of wastewater treatment vary from location to location depending on provincial legislation, and may include plant-specific Operational Certificates with limitations to be considered in local policies on food waste grinders.

For instance, a community which operates under 'no treatment' will not be limited by the capacity of a treatment plant or the volume of wastewater collected. On the other hand, a community operating under tertiary treatment could be significantly impacted by increased solid to liquid ratios and increased total wastewater volumes.

In addition, some wastewater treatment plants that employ anaerobic digesters may benefit from increased organic content in received wastewater as more organic matter received at the digester may increase methane production and the ability for electricity generation. However, most digesters are the last process of a treatment train so the entire train must be designed or capable of handling excess loading from food waste grinders in order to realize the benefit at the digester.

Maintenance Resources
Permitting organic content to increase in sewage flows will in most cases increase maintenance requirements of the conveyance and treatment systems. Budgets, human resources and equipment costs must be evaluated.

FOG (Fats, Oils and Grease)

These organic materials may combine with other solids in the wastewater conveyance system and create blockages which are very difficult to remove (i.e., fatbergs), requiring significant resources (eg. equipment, personnel, water and energy).

Odour
If the slurry sits in one spot and collects more and more organic matter, the organics will ferment and can potentially lead to odour issues. Again, managing these odours requires regular maintenance of the collection system and significant allocation of resources.

Nutrient Loadings
As food is ground down, the organics attach themselves to the smaller pieces of debris, and are carried to the wastewater plant ultimately. Increased nutrient loading can affect the ability of the plant to

properly treat the influent. Studies on the effluent from grinders have shown the parameters to be above typical sewer-use- bylaw limits. *(*USEPA archived document*).* To overcome this, a municipality might have to re-design the plant incurring additional capital and operating costs. Without a redesign or optimization, increased organic matter could cause nutrient exceedances in the plant effluent with resulting environmental, legal and financial implications.

Increased nutrient loading directly leads to increased treatment requirements. The question becomes what is the current plant able to treat? If it's within the parameters then no capital improvements or optimizations are required, if it's not, then investments will be required. More treatment may be required based on the following:

- increased TSS loadings in the wastewater influent stream
- increased BOD loadings in the wastewater influent stream
- increased nutrient loadings in the wastewater influent stream may cause higher loadings of nutrient in the effluent which create higher eutrophication potential
- higher influent TSS loadings would result in an increased biosolid production rate driving the need to address residual management issues
- increased plant influent rate due to the higher rate of water consumption per household during food waste grinder operation
- increased loading of FOG in the wastewater streams

Parry (2013), Wainberg et al. (2000) and Lacovidou et al (2012) reported the following major effects of food grinder usage on wastewater quality and treatment processes:

- increased TSS loadings in the wastewater influent stream (more treatment required)
- increased BOD loadings in the wastewater influent stream (more treatment required)
- increased nutrient loadings in the wastewater influent stream may cause higher loadings of nutrient in the effluent which create higher eutrophication potential (more treatment required)
- higher influent TSS loadings would result in an increased biosolid production rate driving the need to address residual management issues
- increased plant influent rate due to the higher rate of water consumption per household during FG operation
- increased loading of FOG in the wastewater streams (more treatment required)

The impact of food waste grinders on wastewater quality is demonstrated in the following table, taken from (Metcalf and Eddy, 2004).

Table 1: Impact of Food Waste Grinders on Wastewater Quality

constituent	increased value in kitchen waste after food grinder addition (kg/capita.d)	without food grinder	with food grinder	Percent increase
BOD5	**0.0182**	**0.082**	**0.100**	22
COD	0.02724	0.1907	0.218	14
TSS	**0.0227**	**0.0908**	**0.114**	26
NH3 as N	0.0009	0.008	0.009	13
ORGANIC N as N	0.0005	0.005	0.006	20
TKN as N	0.0014	0.013	0.015	15
ORGANIC P	0.0001	0.001	0.001	0
INORGANIC P	0.0002	0.002	0.002	0
TOTAL P	0.0003	0.003	0.003	0
FOG	0.0040	0.030	0.034	13

Water Use

The operation of food waste grinders require water to convert food to a slurry and then to transport it through the sewer system. Manufacturers recommend running cold water through the unit before, during and after grinding (Insinkerator, 2017). Using cold water helps solidify organics for more effective disposal. Manufacturer and self-help websites also state that fat, oils, grease, vegetable peels, bones and other uneaten foods should not be put in the grinder (Today's Homeowner, 2017).

Maintenance and cleaning of food waste grinders should not require significant water use. Manufacturer guides recommend using ice cubes to sharpen grinder blades and baking soda with the sink filled halfway with warm water for cleaning and deodorizing (Insinkerator, 2017).

The per capita water use associated with food waste grinders will vary depending on number of people in the household, food preparation habits, and the make, model and age of the grinder. As detailed in Table 1 below, reported per capita water usage with food grinders will range from 2.5 to 15 litres per day.

Table 2 – Reported Food Grinder Water Use

Gallons/Capita/Day	Litres/Capita/Day	Source
1	3.78	http://blog.insinkerator.com/cold-water-when-running-a-garbage-disposal/
1	3.78	New York City Study, 1997
	3 – 4.5 (median 3.75)	City of Ottawa, 2005
	4 – 8 (median 6)	Metcalf & Eddy 4th Edition
0.8 – 4.0	3 – 15 (median 9)	EPA Resource Use and Residuals Generation in Houeholds, EE-0449, March 1979
	2.5	CH2M Hill Canada Limited (2013). Assessment of the Impacts of Food Waste Grinders on York Region's Sewage Infrastructure.
Average LCD (using medians)	4.8	
Average Household Usage	12	
Percentage of HH Usage	2%	

For the purposes of this report, an average of 4.8 litres per capita per day (LCD) has been used to estimate household food grinder water usage. Using an average 2.5 persons per household (2011 Canadian census), an average household would use 12 litres of water per day to run a food waste grinder. This represents nearly 2% of the average Canadian household daily water use (Environment Canada reported 251 LCD residential water use for 2011, X 2.5 = 627.5).

Energy Use

Regarding energy use associated with the food waste disposal, wastewater treatment is a preferred approach to divert the food waste from landfill and treat it locally. Wastewater treatment facilities are often located in urban areas closer to the sources of food waste, and thus it requires less energy to transport food waste to a nearby treatment facility such as an anaerobic digester than to a landfill. The anaerobic digesters convert the food waste into biogas, which is either flared or used on-site as an energy source, and residual, which is much reduced in volume and can then be trucked to compost facilities or landfill.

There are two means for food waste to reach the wastewater treatment facility: transport by a special food waste collection truck or grinded down by garburator and washed into a sewer system. The major benefit of transporting by truck is that tipping fee can be collected to fund the collection. For this type of transportation, diesel fuel consumption is the main energy cost. The consumption amount per unit food waste depends on the collection route and varies with local situations.

The second type of transportation is associated with the wastewater collection system. When food waste is grinded down in household and washed into a sewer system, it transforms into an organic waste liquid slurry. This type of organic waste liquid is typically characterized as turbid with high levels of BOD (bio-chemical oxygen demand), FOG (Fats, Oils, and Grease), SS (suspended solids), nitrogen, and phosphorus. A sample organic loading strength of food waste from Metro Vancouver was reported (shown in the table below) by Nkansah-Boadu in a joint study conducted by Metro Vancouver and the University of British Columbia (Nkansah-Boadu, 2017). The preliminary results provide region-specific figures, that were found to be generally in line with those available in the literature. Once inside the sewer collection system, the food waste liquid is transported by means of gravity flow and lift station pumping. The primary energy use associated with the transportation is the pumping energy. Some other secondary energy use are associated with steaming flushing the clogged sewer line by fat and grease, etc. The liquid eventually reaches the wastewater treatment facilities for final biological or chemical clean-up.

Table 3: Organic Loading Strength of Food Waste Study Results

	sCOD, mg/l	tCOD, mg/l	sBOD, mg/l	tBOD, mg/l	TSS, mg/l
Mean	7497	26875	3685	9943	10192
Standard Deviation	1168	7263	933	2321	2294
Minimum	5769	17675	2353	6319	6044
Maximum	9817	43568	5495	15450	14257
Median	7335	25977	3714	2321	10427

In the wastewater treatment facilities, there are many ways to treat the organic waste slurry, which consist of different processes with different associated energy consumption amounts. The organic waste liquid may be treated under a conventional approach in a wastewater treatment plant (with details in the next paragraph), or in a specialized treatment facility, such as the one in the East Bay Municipal Utility District shown in the Figure below (USEPA archived document).

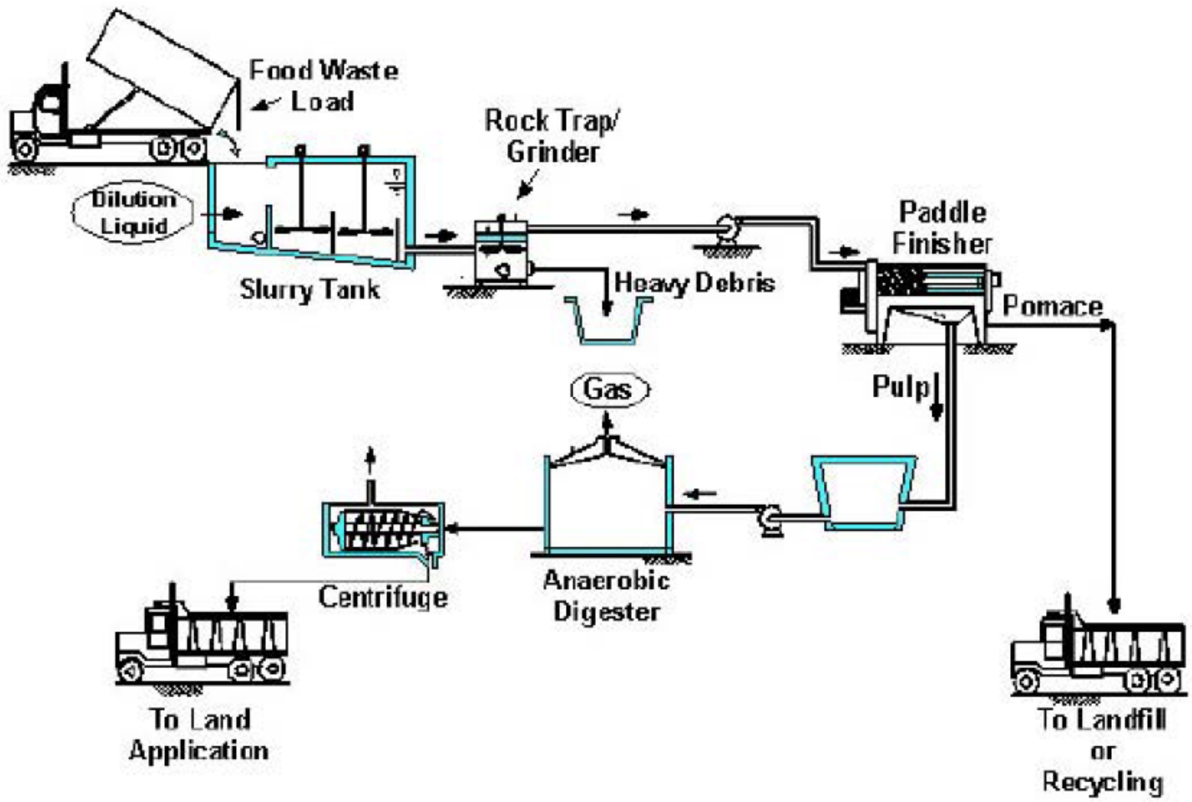

Figure 1: East Bay Municipal Utility District Food Waste Treatment Process

In the conventional wastewater treatment process, the wastewater may be subjected to pH adjustment and chemical/physical processes that cause the wastewater to form flocs to remove organic loading. Treatment systems such as coagulation and filtration, or other innovated technologies such as ozone addition are also used to enhance the removal of nitrogen and phosphorus. Sequencing batch reactors are often employed in small food processing factories and have been observed to improve the removal efficiency of nitrogen and phosphorus. The conversion of aeration tanks to include anoxic mixing capability increases the removal efficiency of phosphorus and is also effective in preventing bulking. Membrane separation method of activated sludge, micro-filtration/ultra-filtration bioreactors, moving-bed or fluidized-bed bioreactors, and entrapped media bioreactors are used to improve the nitrification or removal efficiency of refractory organic. These are more energy intensive process. Anaerobic treatment systems such as anaerobic digester is recommended by USEPA to treat food waste (USEPA archived document). Other less energy intensive processes include stabilization pond and lagoons.

Solid Waste Management

In recent years, reaching zero waste has become a popular goal amongst many municipalities in the world. As one example the City of Vancouver is currently working on a Zero Waste 2040 plan to embark on creating a zero waste community. A main principle of zero waste is that “waste” should be seen as a valuable resource that could be conserved, reused, recycled, or composted. In the case of organic waste, it should be seen as a valuable commodity that can create beneficial end products such as compost or renewable energy source (biogas). Using food grinders to dispose organic waste down the drain does not align with this principle embraced by the zero waste communities.

Generally, in areas where there is an established organic waste collection system and processing capability, a comprehensive set of organic waste can be captured and diverted without the use of food grinders. A study done in 2012 through the City of Vancouver Greenest City Scholars program found that centralized composting systems can potentially achieve higher diversion rates than the use of food waste grinders . While food waste grinders might be convenient and easy to use, they are not capable of handling all organic waste as compared to a centralized composting program, or even a backyard composter or a worm composting bin. For example, items such as bones, shellfish, napkins, paper plates, wooden utensils, solid fats (small amount), yard trimmings, etc. can all be captured by the organic waste collection program but a food grinder would not be able to handle these items. Because food grinders cannot replace curbside collection, the use of food grinders for single-family homes is redundant and reduces the efficiency of curbside organics collection programs. Also, many food items can clog pipes as they dry, potentially increasing maintenance costs of the sewer system.

Some may argue using food grinder is a more convenient option for residents to dispose of their organic waste. However, convenience in itself does not determine what is best environmentally. And while biosolids are recovered from sewage, they are of lower quality and less value than compost produced from source-separated organics. More importantly, residents need to be continually educated and made aware of their actions in order to make sustainable changes to their disposal habits and the way they think about waste.

This phrase sums up best on how solid waste and waterways interrelate with each other: Food is not garbage, sinks are not garbage cans, and natural waterways are not landfills.

Conclusion

There is no one-size-fits-all recommendation given the diversity of wastewater systems and regional objectives across Canada. Each of the related considerations has advantages and disadvantages that should be assessed by policy makers at the regional or municipal level to help decide whether food waste grinders are appropriate for that region or system. As outlined in the decision tree, key considerations include impacts of food waste on wastewater conveyance and treatment processes, impacts on biosolids processing and disposal, greenhouse gas impacts, water and energy use to operate food waste grinders, and the cost of a food waste collection and composting system.

References

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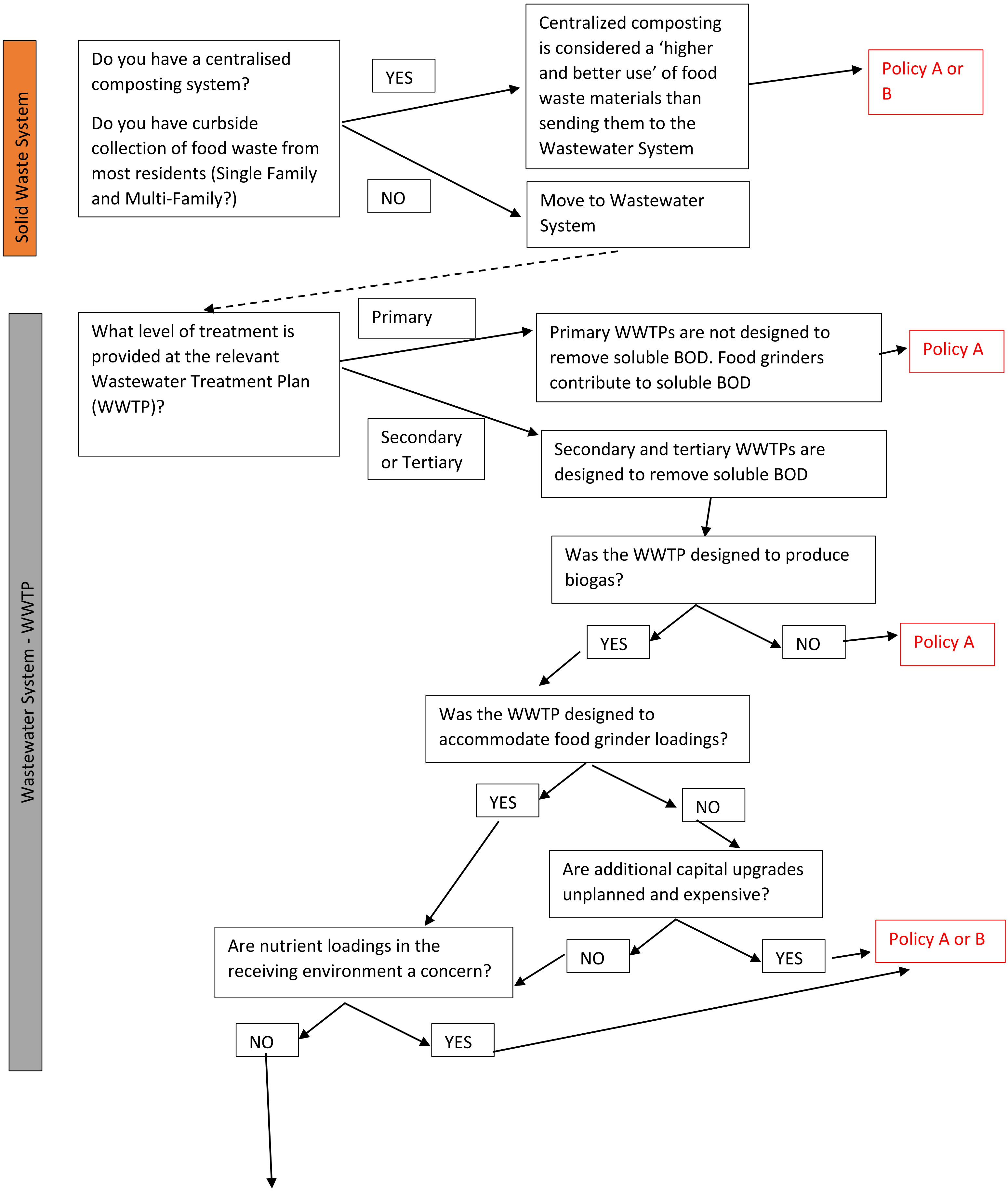
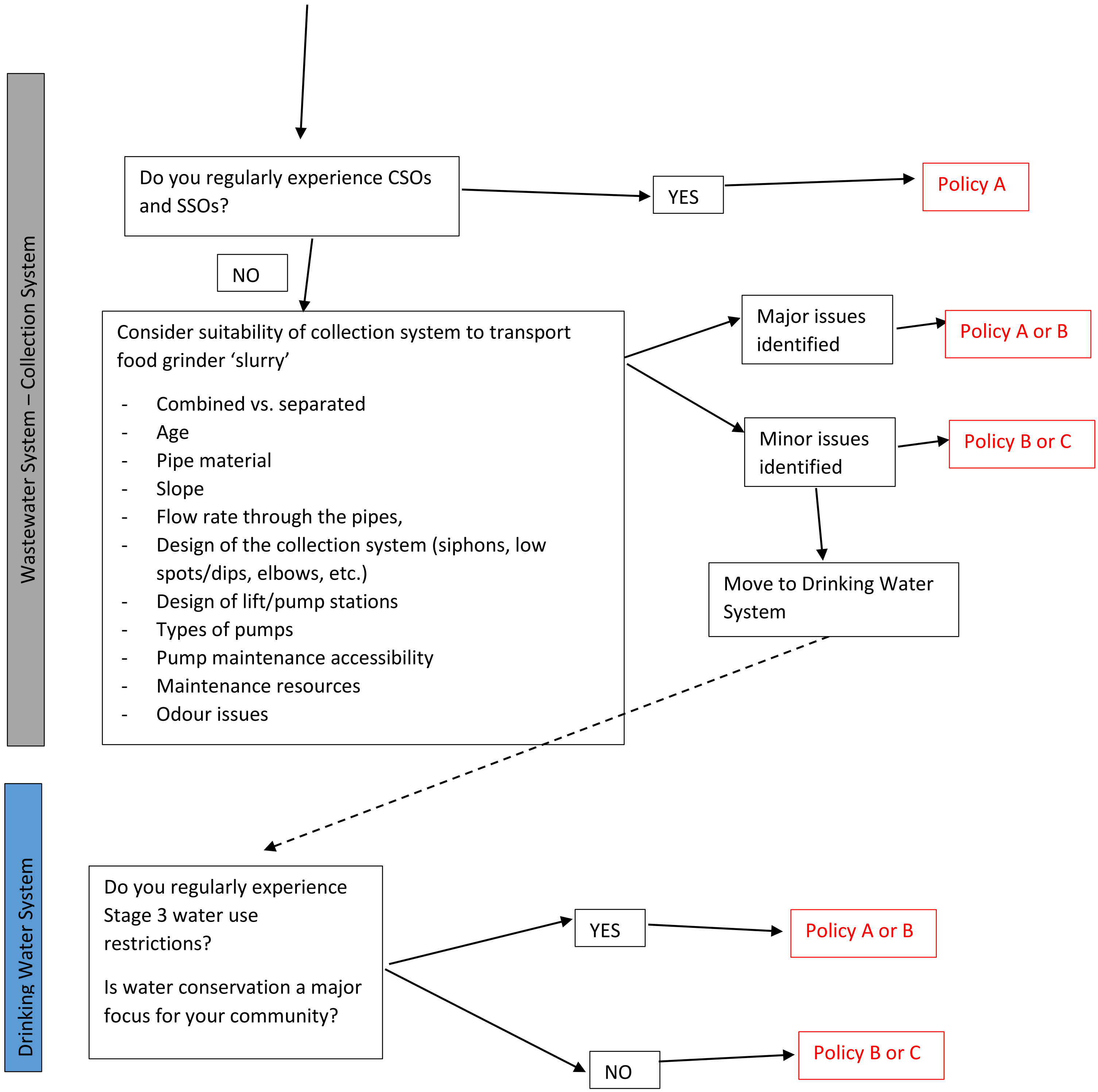
7. Nkansah-Boadu, F., “Organic Loadings and Impacts for Wastewater Treatment Plants from Food Grinder Waste”. Article prepared for the Source Control Group, Liquid Waste Services, Metro Vancouver.
8. “The Benefits of Anaerobic Digestion of Food Waste at the Wastewater Treatment Facilities”. USEPA archived document.

Appendix A: Decision Tree

Decision Tree: Residential Food Waste Grinder Policy





Policy A: May wish to consider a policy prohibiting or discouraging the use of food grinders

Policy B: May wish to adopt 'do nothing' or 'wait and see' approach.

Further study/analysis needed. Continue to monitor impacts.

Policy C: May wish to promote or encourage the use of food grinders