Fall 2017

Optimized Organic Waste Treatment System An assessment of composting and biogas potential at Santos Organics

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Submitted in partial fulfillment of the requirements for Australia: Sustainability and Environmental Action, SIT Study Abroad, Fall 2017 Contents

ISP Ethics Review

(Note: Each AD must complete, sign, and submit this form for every student's ISP.)

The ISP paper by Abbie Winter (student) does conform to the Human Subjects Review approval from the Local Review Board, the ethical standards of the local community, and the ethical and academic standards outlined in the SIT student and faculty handbooks.

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Program: Australia: Sustainability and Environmental Action

Date: 17/12/2017

Acknowledgements

I would like to present my kindest regards to everyone who has assisted me in the production of this study, and a special appreciation towards my project advisor Katrina Shields, who provided support, expert advice, and assistance whenever I was in need.

I cannot appreciate the people enough who presented me with their time, focus, and knowledge via interviews and lecture presentations**:** Evan Anderson, farmer at "The Farm"; Andrew de Vries, Compost Designer for Compost Central; Peter Wadewitz, Peats Soils & BiobiN Technologies Managing Director; Dave Forrest, Commercial Organic Farmer; Ron Lakin, BioBowser Managing Director; and Jeanette Martin, Harvest Community Kitchen Project Champion for Mullum S.E.E.D.

To Monica DiLeo and Paul Crebar– this project would not have been possible had it not been for your considerate outreach, dedication, and willingness to assist me through this research. I cannot grant enough gratitude to you both and to Santos Organics for this amazing opportunity.

Abstract

Food waste holds incredible environmental degradation implications due to its ability to produce and emit potent greenhouse gases, as well as allow for the resources initially used to produce it to go to waste. When in a gloabal crisis of environmental degradation as well as food security, it is a shame to see food be wasted when other more optimal outlets are available.

This study utilizes the Triple Bottom Line to assess the ideal systems with which the three branches of Santos Organics should manage their food waste to optimize its lifecycle in order to further promote the business' status of sustainability within their Byron Bay, Byron Arts and Industries District, and Mullumbimby locations. The analysis of data through the lens of Structured Decision Making Models, Triple Bottom Line oriented cost-benefit analyses, and Food Waste Hierarchies allowed for the conclusions to be reached for optimized systems of food waste management for each branch.

The incorporation of the Bin Trim food waste reduction education program offered by the New South Wales Environmental Protection Authority is highly suggested to the business as it teaches the branches to manage their food with strategies in mind to avoid the fundamental unnecessary wasting of it. In addition to this, food waste recycling systems have been specially tailored to each branch to assure all three sectors of the Triple Bottom Line are satisfied across the branches' unique conditions and environments. Systems of anerobic digestion, aerobic digestion, dehydration, large scale compost facilities, vermicomposting, and animal feed biotechnology are analyzed and assessed to fulfill this function.

The Byron Bay branch can benefit from the incorporation of biotechnology for animal feeds, specifically the utilization of Black Soldier Flies, within their current offsite composting with Evan Anderson at "The Farm" in Byron Bay. Mullumbimby will be able to utilize an anerobic system to fully harness food waste's the energy potential as well as degradation into liquid fertilizer to benefit themselves and the community across the Triple Bottom Line. The Warehouse branch

Definition of Terms

Triple Bottom Line (TBL) is a sustainable framework for decision making as it places equal value within the decisions economical, environmental, and social impacts

Black Soldier Flies (BSL) are insects that have long larvae lifecycles in which they consume large quantities of food waste or manure, processing it into fertile castings to be used as soil amendments. They are also high in protein in this larvae stage and can function as livestock feed.

Compost is the resulting fertile product of the decomposition of organic matter via biological processes

Anaerobic digestion is the process of the decomposition of organic matter within oxygen deficient systems, causing the microbial bodies responsible for the decomposition to release methane gas and carbon dioxide.

Aerobic digestion is the process of the decomposition of organic matter within an oxygen sufficient systems, so the micbobial bodies that decompose the organic matter release carbon dioxide and water vapor

Biogas is the harnessed methane gas produced by anaerobic digestion that has the potential to be processed and utilized as an alternative energy source

Food Waste Hierarchy is a model that identifies the most preferred methods of managing food waste in consideration of its environmental impacts

1. Introduction

1.1 Review of Current Knowledge

1.1.1 Food Waste Lifecycle

With 7.5 billion humans on this planet, food is in incredibly high demand as food insecurity is a prevalent and urgent crisis– in 2016, 815 million were reported chronically undernourished by the Food and Agriculture Organization of the United Nations (FAO, IFAD, UNICEF, WFP & WHO, 2017, p. 6). The globe wide pressure for food promotes the intensification of agriculture and unsustainable extractive farming practices, “such as heavy tilling, multiple harvests and abundant use of agrochemicals” (Watts, 2017, pp. 6). The consequences of these practices manifest themselves in the form of water and land degradation via desertification, soil erosion, water pollution, and salinization, all of which are components that will affect the future production of food. It is a self-perpetuating system as the more degraded the land and water conditions become, the more people will go without food– it is a social and environmental crisis.

The intrinsic value of food should be regarded with the upmost importance due to its implications with human health and environmental degradation, so its status as waste should not be taken lightly. The United Nation’s Global Land Outlook highlights food waste as an additional driver of land degradation, and notes that in wealthier countries “food waste is a result of profligacy and inefficiencies towards the end of the food supply chain” (UNCCD, 2017, p. 8). Australia is and has been experiencing the consequences of food scarcity as there currently 3.6 million Australians who “have experienced food insecurity at least once in the last 12 months” (Foodbank, 2017, p. 6). In response to this crisis, Australia’s Department of Environment and Energy published the National Food Waste Strategy to “contribute towards global action on reducing food waste” (Department of Environment and Energy, 2017, p. 3).

The document outlines a Waste Hierarchy, which identifies the most preferred methods of managing waste in consideration of their environmental impacts. The highest ranked waste management practice placed on the hierarchy is Avoidance– the preliminary reduction of waste is the most sustainable route due to the conservation of natural resources and elimination of end-of-life responsibilities. Following this is Reuse in the form of donation and repurposing. Mindful consumption, use, and reuse are preventative steps and should be opted for over waste-oriented ones that suspend the foods’ intended function to feed the hungry. That being said, the unavoidable food waste has options much more viable than landfills and incineration. After the Avoidance and Reuse methods come the categories of Recycling, Reprocessing, Energy Recovery, and finally, Disposal (Department of Environment and Energy, 2017, p.

16). These practices do require the foods' loss of nutritional value, however more sustainable methods of food waste processing fall within the Recycling, Reprocessing, and Energy Recovery categories. Disposal is the absolute last resort in regard to processing food waste, and should be avoided with every opportunity to do so.

Organic waste that is sent to the landfill decomposes under anaerobic conditions, resulting in the release of methane gas instead of carbon dioxide. Methane is a very potent greenhouse gas as it is more effective at trapping heat than carbon; carbon dioxide has the Global Warming Potential of 1 while methane's is 25 within a 100-year time horizon (IPCC, 2007, p. 213). In 2005, 25 millions of tons of food waste was sent to landfills in the United States, and if this was composted then the greenhouse gas impact "would be the equivalent of removing 7.8 million passenger cars from the road" (USCC, 2008, p. 2). Therefore, any opportunity to divert organic waste from landfills is an opportunity to avert greenhouse gas emissions. The Recycling, Reprocessing, and Energy Recovery categories do exactly this, as they provide methods of waste management beneficial at least in their ability to divert organic waste from landfills.

1.1.2 Sustainability and Triple Bottom Line

In consideration of these topics regarding social and environmental well-being comes the subject of sustainability. Sustainability is the ability for a behavior to be continued without diminishing the quality of social systems, the environment, or the economy for both present and future generations within the current restraints of the finite Earth. As mentioned by Robert Costanza in his piece *Building a Sustainable and Desirable Economy-in-a-Society-in-Nature*, the world we live in has "biophysical constraints" which must be taken into account via sustainable action (Costanza, 2013, pg. 2). To support a healthy future for both the environment and the people in it, sustainability must be incorporated within food waste considerations and management. The land degradation, greenhouse gas emissions, and food scarcity implications of the current conventional food waste system are characteristic of a system that is overshooting its biophysical constraints.

Fortunately, unsustainable conventional practices are beginning to be scrutinized as sustainable systems and alternatives are becoming more endorsed and therefore prevalent. The development of the Triple Bottom Line (TBL) framework has allowed for institutions "to take responsibility for their non-financial impacts, including impacts on community and the environment" (Environment Australia, 2003, p. 3). Utilized in businesses, project planning, investment decisions, academics, and governments, this framework has the opportunity to evaluate what Slaper and Hall call "comprehensive investment results", evaluating performance regarding profits, people, and the planet (Slaper, Hall, 2011, p. 1). Andrew Saviz correlates positive TBL fulfillment with an increase in a business' value, as represented by a rise in "profitability and shareholder value and its economic, environmental, and social capital" (Savitz, 2013, p. 5). The TBL's evaluation of economic, environmental, and social equity maintenance makes it a useful tool for measuring a business's sustainability status.

1.1.3 Santos Organics: Sustainable Business

Santos Organics is a praiseworthy example of a sustainable business, discernable through a TBL assessment of their mindful practices. Their mission is to "empower people and communities to live in a healthy and sustainable way, by providing them the knowledge, food, and goods they need to do so", which they fulfill as a wholefood retailer and community-centered environmental nonprofit (Santos Organics, 2017, para. 1). Their strict sustainability and ethics product policy alongside their ability to stand as an economically viable business promotes their title as a sustainable business in conjunction with the TBL as all three dimensions are met.

As a keystone wholefoods retailer in the Byron Shire, Santos Organics has the opportunity to reshape what the food system looks like there. According to Parfitt, Rose, Green, Alden, and Beilby in the Australian Food Sovereignty Alliance, a sustainable food system is one that is able to "continue to reproduce itself over the long-term, fulfilling its basic objectives of feeding us well, providing dignified livelihoods for farmers and food system workers, and caring for the soil and living ecosystems" (Parfitt et al., 2013, p. 81). Santos Organics already promotes proper feeding through their sustainability and ethics food policy, and the livelihood of food system workers is respected through their exclusive sale of ethically sourced fair-trade food. However, improvements to further their already conscious care for the ecosystems are possible.

Within the juice bars, commercial kitchens, and retail stores that Santos Organics runs over its three locations throughout the Byron Shire, food waste in the form of scraps and expired produce is unavoidable. Current systems are in place to manage some of the waste via composting, however Communications and Culture Manager Paul Crebar acknowledges that more efficient and beneficial schemes could be implemented to reap benefits from the "optimal life cycle of [their] compost" (Crebar, 2017). With the implementation of the appropriate system as outlined by the National Food Waste Strategy's Waste Hierarchy, each branch of Santos Organics has the opportunity to further their status as a sustainable business in all three facets of the TBL.

1.1.4 Justification and Aim of Study

A growing technological foundation of food waste management alternatives supports the potential of a more efficient system to optimize the life cycle of the food waste produced by Santos Organics. The aim of this research is to identify the optimal system to manage and process Santos Organics' food waste in order to satisfy all dimensions of the TBL– people, planet, and profit. The community will profit from the rich-compost outputs as well as the educational opportunity of understanding what happens to the food waste produced by their grocer. The environment will benefit from the avoidance of greenhouse gas production associated with the presence of organics in the landfill waste stream, as well as increased soil health and resource conservation. Santos' economic framework has the potential to benefit from the sale of the viable outputs of the food waste management system as well as a potential decreased reliance on subscription waste services.

On an even larger scale, the installation of an optimally efficient and effective organic waste treatment system can act as a case study to inspire and direct other businesses towards the implementation of this alternative solution. Santos Organics is already a radical business in their deliberate strategies towards achieving sustainability across the three elements of the triple bottom line, so this project will help them to further raise the expectations of customers seeking sustainable businesses. The application of an efficient organic waste treatment system will only advance Santos Organics as a business while simultaneously heightening the bar for others in the field.

2. Methods

2.1. Location of Study

This study was conducted from October 28th to November 23rd,2017 in the Byron Shire due to my intention of researching for the three branches of Santos Organics in Byron Bay, the Byron Arts and Industries Estate, and Mullumbimby. Santos Organics is the main focus of this research due to their status as a sustainable non-for-profit wholefoods distributor and their pursuit of more environmentally conscious practices through research.

2.2 Units of Study and Shortcomings

This study is highly based in background research through available data, accessible through the internet, expert advice, site assessments for potential organic waste treatment system installations, and interviewing of the right people to get necessary data points. Therefore, interviews, lectures, site assessments and background research form the entirety of this research. However, due to the nature of an interview-intensive research process, the gathering of the data is at the mercy of the interviewees responses or lack therefore of. Therefore, many data points were unobtainable or required circumventive strategies to acquire them. Also, the utilization of phone interviews was helpful to reach experts from areas all over the region and even country, however this required extensive procedures of email outreach to get initial contact, and in some cases, follow up contact when necessary. Ideally, methods of direct approach would have resulted in much more time efficient gathering of data. During all interviews, whether in person or over the phone, I took guided copious notes highlighting the relevant and crucial points necessary for my research. Similarly for conducting site assessments and attending workshops, I made sure to take detailed notes of all applicable information.

In regard to the framework of this research, it is highly oriented around the concept of food waste hierarchies, especially the ones outline by the Australian and United Kingdom's governments. These hierarchies provide a structure for the study as they function as a baseline to define the ranking of preferences in regard to what food waste processing systems are most sustainable. That being said, the Triple Bottom Line is also a central influence on the analytical scope in which food waste is viewed throughout this research. The results of my research were organized using models either inspired by or derived from the Triple Bottom Line– whenever I analyzed my notes I formatted the data into these models, such as the Structured Decision Making Model, to allow for organized reasoning and eventual interpretation.

2.3 Interviews

I conducted interviews either over the phone or face to face with the following people:

Monica DiLeo– Santos Organics Assistant to General Manager

Paul Crebar– Santos Organics Communications and Culture Manager

Evan Anderson– Farmer at Byron Bay "The Farm"

Andrew de Vries– Compost Designer for Compost Central

Peter Wadewitz– Peats Soils & BiobiN Technologies Managing Director

Dave Forrest– Commercial Organic Farmer

Ron Lakin– BioBowser Managing Director

Jeanette Martin– Harvest Community Kitchen Project Champion for Mullum S.E.E.D

2.4 Ethical Issues

Before the conduction of this research, I received ethics approval from the LRB with the conditions that I receive informed consent from any and all interviewees while explicitly informing them of their ability to remain anonymous in my study or go by a preferred alias. While conducting my research, I did come across the ethical issue of one interviewee who opted to remain anonymous within my paper. Therefore, I respected their request and referred to them as an anonymous source when referencing the interview.

3. Results

3.1 Identification of Options– Avoidance

Each branch of Santos Organics is already practicing some form of composting, a practice that falls under the Recycling category of Australia's Food Waste Hierarchy (Figure 1). Therefore, methods of Reprocessing, Energy Recovery, and Disposal would be adverse and impractical in regard to food waste management, and should not be considered. In considering how to improve the food waste systems at each of these branches, systematic changes must be made to improve their method of food waste Recycling, or to advance them into one of the more highly preferred categories of Reuse or Avoidance.

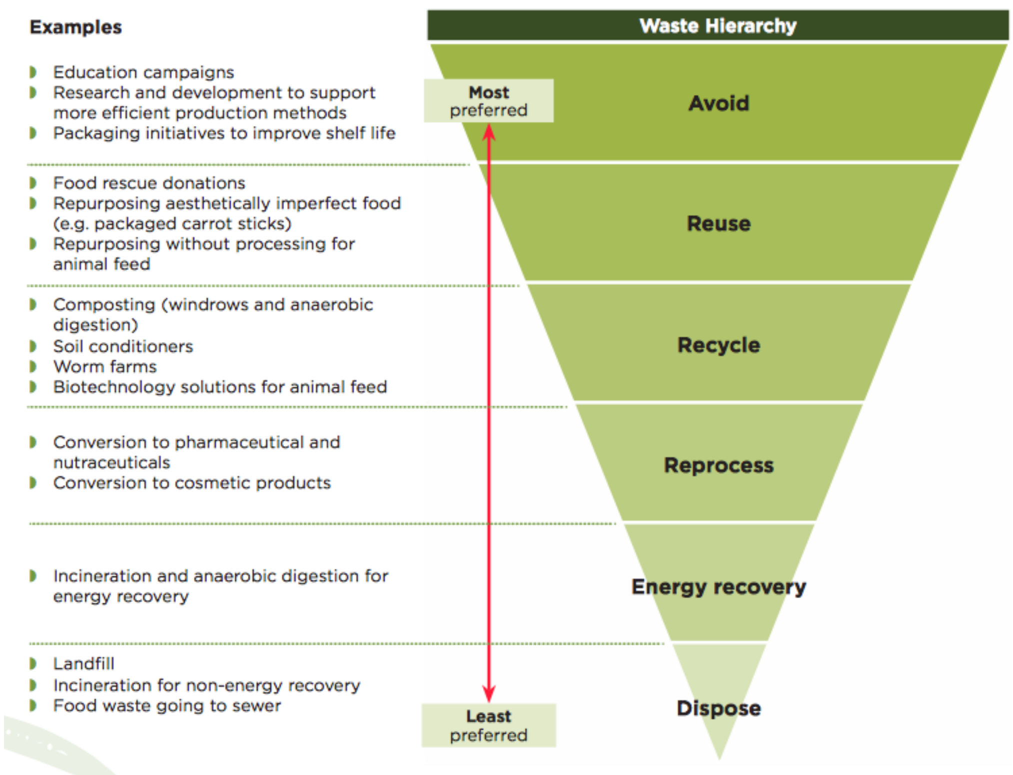

Figure 1 Australia's Waste Hierarchy (Department of the Environment and Energy 2017)

Avoidance strategies are already implemented by Santos on a small scale as the stores only terminate the foods' life cycle as waste when necessary due to passed expiration dates and quality control. Their mindfulness about food waste is an environmentally conscientious choice as well as an economical one too– wasting product is not a financially wise business decision. Each branch utilizes sales and clearances to entice customers to purchase food that is nearing its best by and expiration dates; items are marked down, occasionally repackaged, and displayed prominently to avoid wasted products where and when possible.

Business education systems are also available through environmental consulting organizations and governmental programs, like the New South Wales Environmental Protection Agency's Bin Trim Program. This program provides businesses with "free waste and recycling assessment and produces a tailored action plan", as well as grants eligibility for rebates to help cover the cost of recycling equipment (EPA, 2017).

3.2 Identification of Options– Reuse

Some systems of Reuse are utilized already at Santos Organics' warehouse and Byron Bay branches. At the warehouse, employees benefit from the food waste as they either take it home to be composted or repurpose the waste as animal feed, most prominently for chickens. This strategy of food waste repurposing harnesses the food's caloric benefits, and also offsets the employees' need to purchase animal feed. The production of conventional animal feed is an energetically and resourcefully expensive process. In the US, 56 percent of their water use is directed towards irrigating feed crops, and major feed crops like corn, wheat, and soybeans "are the first- second-, and fourth-leading consumers of fertilizer, respectively" (Jacobson, 2006, pp. 89-96). The ability to reuse food waste as an animal feed replacement is a wise diversion of organics from landfills as well as a digression from unsustainable feed conventionalities.

The Reuse method of donation can and should be utilized by each branch where possible as it directly addresses the issue of food insecurity while maximizing the life cycle of Santos' food products. In accordance with condition the *Civil Liability Amendment (Food Donations) Act 2005 (*NSW), Santos would "not incur any civil liability" in the case of incident that could result from the consumption of their donated food, as long as it is donated while in a safe to consume condition and with good faith. For example, Santos may not shelf their products that have surpassed their "best before" dates, but these products are suitable for donation, whereas food past its "use by" date needs to be managed as waste (Do Something and NSW EPA, 2012, p. 17). The Byron Bay branch does donate food to the local food bank, "The Liberation Larder". By enforcing that the branch utilizes this avenue of food reuse in consideration of best by dates, they can maximize the potential of all their food for the benefit of the society and the environment. The Santos Organics warehouse would also be able to utilize this food bank as an outlet for viable food that has passed its best by date. Food banks in the Mullumbimby area are available to the Mullumbimby branch, such as the Food Recovery initiative at the Mullumbimby & District Neighbourhood Centre. This organization is willing to accept food donations as long as the food is unopened within its original packaging and is in viable condition. The food can be used in cooking for meals or can be packaged as food parcels for community members in need.

3.3 Identification of Options– Recycling

Within the Recycling segment, the Waste Hierarchy designates anaerobic digestion, composting, soil conditioners, worm farms, and biotechnology solutions for animal feed as methods of food waste processing. These are categories of systems that should be taken into consideration when assessing the best method of recycling the unavoidable food waste produced by Santos Organics.

3.3.1– Anaerobic Digestion

Within the Recycling division, discrepancies lie among the ranking of anaerobic digestion. The United Kingdom' Waste and Resources Action Programme has also developed their own Food and Drink Material Hierarchy, which nearly overlaps with that of Australia except for the ranking of anaerobic digestion (Figure 2). The United Kingdoms' model specifically ranks anaerobic digestion as more preferable than composting within the Recycling realm. The Australian framework places it as equal to composting as a Recycling method, and mentions it again lower down in the hierarchy as an Energy Recovery strategy.

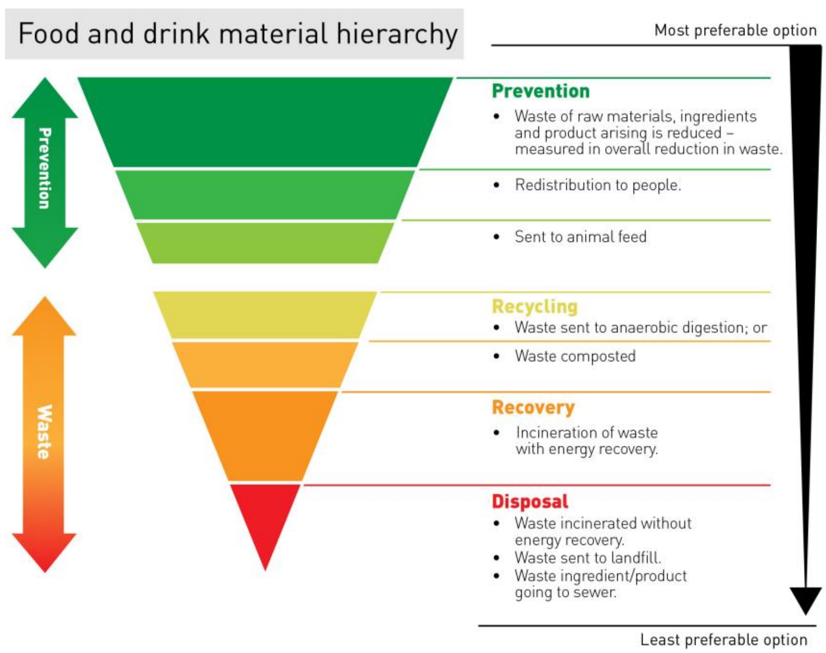

Figure 2 United Kingdom's Food and Drink Material Hierarchy (Waste and Resources Action Programme 2017)

An expert in the field comments on this difference, explaining that Australia has anaerobic digestion classified lower due to its ranking system based on waste, not food waste. They also note that the United Kingdom "separates organics from inorganics in the system" in its waste hierarchy, so therefore it is able to recognize all the benefits that anaerobic digestion poses. According to the expert, "anaerobic digestion is the best technology suitable for food waste– it recovers energy and bio fertilizer".

Anaerobic digestion provides not only the decomposition of organic material into a liquid fertilizer, but also the ability to produce renewable energy. In-vessel anaerobic systems simulate oxygen deficient conditions in which the microorganisms responsible for degrading the organic material emit a combination of carbon dioxide and methane gas, instead of the usual carbon dioxide and water vapor emitted within aerobic conditions. In this system, the usually highly potent greenhouse gas methane is captured and harnessed as a biogas to be used as a fuel source. The implementation of an anaerobic digester involves the opportunity to utilize a renewable energy source to offset the use of fossil fuels, as well as benefit from a consistent source of liquid fertilizer. Paul Crebar at Santos Organics advocates for the BioBowser digester to be considered for the Santos Organics' branches (Crebar, 2017). Ron Lakin from BioBowser highlights that the liquid fertilizer produced by the system has the potential to benefit the community in the form of fertilizer donations or be sold to offset the costs of the system (Lakin, 2017). These benefits can be seen in Appendix A in the TBL assessment of the anaerobic digester system. The major concerns outlaid by the TBL assessment are the outright costs of the system, the additional responsibility that would be placed on the staff, and the system's energy requirements. The major benefits are the biogas production and ability to use and sell the liquid fertilizer (Appendix A).

3.3.2– Composting

Beyond anaerobic digestion, the term "composting" can indicate a myriad of different options for food waste processing. Large scale compost facilities offer both residents and institutions the ability to compost food waste with curbside organics waste pickup systems. Food waste is processed in high volumes under controlled conditions to produce mulch or compost, which is usually sold back to the regional farmers to benefit their soil health and crop yield. As outlined in Appendix B, the compost pickup system has major benefits including the financial support of a local sustainable business, no high upfront costs, and minimal responsibilities placed on staff. The major costs include Santos' inability to donate the food scrap compost to institutions and individuals of choice, the transportation of the food scraps, and the loss of educational and promotional opportunities that would be available with an on-site system (Appendix B).

In-vessel aerobic digesters are another form of composting that would benefit Santos Organics, as seen in Appendix C. These systems mimic traditional aerobic decomposition processes but the in-vessel technology allows for odor-free onsite waste management without the same intense management requirements as a compost pile. Other major benefits include the ability to donate or sell the compost product, educational and promotional opportunities with the onsite system, and elimination of food scrap transportation. Downsides include the high energy use, the additional responsibilities placed on the staff, and the initial cost of the system (Appendix C).

3.3.3– Soil Conditioners

Although not producers of compost, dehydrating systems function as soil conditioners as they produce fertile biomass as well as water, both which are sterilized by the non-biological aeration. This biomass soil amendment contains all the nitrogen, carbon, and trace elements as the pretreatment food waste. By removing all water content from the food waste, the biomass produced is usually 10 to 20 present of the initial food waste's volume, according to a dehydrator system provider from Eco Guardians. As seen in Appendix D, the major benefits from this system lie with its ability to produce grey water as well as nutritionally rich soil amendments, can manage decomposable utensils, and does not require transportation of the food scraps. However, its major downsides are the energy use, initial cost of the system, and the increased responsibilities placed on the staff (Appendix D).

3.3.4- Worm Farms

Worm farms are highly efficient food waste decomposition systems that are able to rebuild barren soils into fertile ones without the need of any additional technology. At his Public Composting Talk held at Santos Organics warehouse, Andrew de Vries emphasizes the noteworthy ability of worms to completely decompose fruit, vegetable, and even meat scraps into highly fertile soil via aeration of the soil and excretion of vital deposits into the soil. There are many technologies available to foster worm farms, like the Subpods that are currently utilized at the Santos warehouse, which are all relatively low cost. This low economic system is a major benefit as outlined in Appendix E, along with the educational opportunities available with this system. The one major weakness of this system is its incredibly labor-intensive nature and large responsibility to place upon someone to manage Santos' food waste (Appendix E).

3.3.5- Biotechnology for Animal Feeds

At the Byron Shire Council's Compost for Healthy Soils Workshop, organic farmer Dave Forrest proposed the hybrid vermiculture and animal feed production system of Black Soldier Flies (BSL). He mentions that this system, although not vermicomposting due to use of BSL instead of worms, is valuable in its ability to process food waste efficiently through the larvae's digestion as well as function as a food source favorable than direct food scraps due to incredibly high protein content. The BSL larvae are a self-harvesting food source, as the larvae crawl up and out of the system towards light when they are pupating, so it is at this stage that they may be easily collected to be used as feed (Forrest 2017). Due to its self-harvesting nature as a protein source as well as an efficient method of food waste decomposition, this system of macro organismal composting is preferable to the traditional worm farm. As seen in Appendix

F, this system has minimal costs across the TBL spectrum with only the one major shortcoming of its nature as a labor- and responsibility-intensive system. The system's major benefits lie with its ability to produce protein-heavy macro organism feed sources, provide an educational opportunity, and low economic requirements in both the short and long term (Appendix F).

3.4 Feasibilities of Recycling Systems

3.4.1 Anaerobic Digestion– BioBowser

This 5-cubic meter anaerobic digester has the upfront cost of $4,000, plus DST. However with the pairing of the EPA's Bin Trim program a rebate to assist with the cost for this system would be available. Like all other onsite systems, the BioBowser requires a checklist of conditions obtainable through a site assessment to ensure its ability to be properly installed and utilized.

At the Mullumbimby branch, there is an open space in the back for the 5-cubic meter machine adjacent to a shed with water access and the ability to hook up to the main building's single-phase electricity. The system is able to manage the site's 600 liters of weekly food waste, and there are storage containers and space available to house the liquid fertilizer, which is produced at a rate nearly identical to the rate that food waste is put in. Ron Lakin from BioBowser puts it simply as "100 kg of food waste a day goes in, 100 kilograms of liquid fertilizer a day comes out" (Lakin, 2017). This fertilizer has the potential to be sold or donated to the community members and institutions like the local school systems' gardens and the community gardens. A BioBowser composter in the Sunshine Coast has utilized the system's fertilizer for profit as it is being successfully sold at a rate of $200 per cubic meter, mentions Lakin (Lakin, 2017). Paul Crebar from Santos Organics also mentions the possibility of instituting a fertilizer distribution service, in which a paid position created by Santos would have the responsibility of fertilizing the gardens of subscribers to the service (Crebar, 2017).

The staff at the branch are willing to accept the responsibilities that come with the management of the system. The Biobowser is user friendly as all the food scraps produced by Santos Organics will be able to be digested, including the decomposable cutlery if it is pretreated by soaking it in the system's liquid fertilizer before adding. As food scraps are added, water will need to be added as well, which can be in the form of grey water if there is any on site.

The biogas produced by the system can be used for cooking gas within the main building, which would be possible with the addition of a pump and pipeline leading from the system to the main building's kitchen. Currently, the store utilizes one 45-kilogram bottle of liquefied petroleum gas every three weeks, bought at a rate of $124 per bottle. In terms of legal clearances for the use of the biogas and distribution of the liquid fertilizer, Ron Lakin from BioBowser assures that all legalities and clearances required by the Environmental Protection Authority are taken into account, so with the introduction of the system BioBowser will provide any sample testing and paperwork that may be required (Lakin, 2017).

The Mullumbimby branch also has the possibly of pairing this system with the Mullumbimby Community Garden and their development of their new Harvest Community Kitchen. This would benefit Santos Organics as it would leave the property space open onsite for expansion possibilities. The community garden would benefit by having a constant source of liquid fertilizer available at all times, as the Santos store would still load the machine regularly with food scraps. Additionally, the Mullumbimby S.E.E.D's Feasibility Study for the kitchen outlines that the gas used to power the stoves from Brunswick Valley Gas would cost around $600 a year, which is a cost that could be offset by the use of the anaerobic digester's biogas (Martin, 2017, p. 57). Unfortunately, if the biogas is not used on a regular basis then the pressure release valve will have to be used, releasing the unused biogas into the atmosphere. This raises huge environmental concerns considering the pungent Global Warming Potential of the 70 percent methane and 30 percent carbon dioxide gaseous mixture produced in the system.

Unfortunately, the Byron Bay branch and Warehouse do not have the same available space that the Mullumbimby one does. The Byron Bay branch is located on a small plot with no feasible space to store any sort of onsite system. The Warehouse's location in the Arts and Industry Estate does have a small plot of land, however it is already being used for a composting initiative, so no available space is readily available. Also, the store's status as a leased property may stand in the way of introducing a long term technological food processing system.

3.4.2 Aerobic Digestion– Closed Loop Organics Unit

Due to the Byron Bay branch's and Warehouse's inability to house onsite systems, they are both ineligible for the aerobic systems as well. However, the Mullumbimby branch is able to house Closed Loop Organic's CLO50 system that is just under 2 cubic meters. The only difference is that this system requires a shelter from rain and direct sunlight, so a roofed structure would have to be built off of the storage shed to cover the area housing the composter. The system requires 3-phase energy with an electricity maximum usage of 1700kWh a month, which can be hooked up to the main building's electricity. The digester has an outright cost of $54,000, which is eligible for the EPA's rebate through the Bin Trim Program. The machine can also be rented for a 48-month period for $954, however this plan is not eligible for the rebate.

The system is able to reduce the food waste volume by 90 percent, so 10 percent of the input's volume is harvested as compost on a weekly basis (Closed Loop, 2017, para. 1). Therefore, in regard to employee management, the system needs to be emptied once every seven days, which is a half hour non-labor-intensive task. The loading process is also minimally demanding, as the system does not require carbon additives to accompany the food waste, and all food waste is accepted with the exception of bones, decomposable utensils, and mass quantities of cooking oil. Due to limited space the compost by-product will need to be distributed, either through sales or donations to institutions such as the community garden, local school gardens, or interested community members for the benefits of their personal gardens. This system's outputs are also subject to the same legalities outlaid by the EPA that affect the anaerobic digester, but the system provider is aware of these technicalities and requirements and will provide all information, paperwork, and testing logistics necessary for the use and dispersion of the compost.

3.4.3 Soil Conditioner– Gaia Recycle

Both the Warehouse and the Byron branch must be disregarded when considering the Eco Guardian Gaia Recycle system as the space restrictions of the stores would be an issue in regard to storing the system and especially the biomass byproduct. The Mullumbimby branch's space allowance and food waste production makes it a proper candidate for the GC 100 Gaia Recycling model, as assessed by an Eco Guardian representative. This the 95 x 140 x 129.1 cm system would need a roof-structure built over it if stored outside to shelter it from precipitation and direct sunlight. However, this reasonably small, odorless and, besides the sound of the fan, noiseless system has the potential to be stored inside, space permitting.

The Eco Guardian representative highlights that this system is "as straightforward as it gets" when it comes to onsite food waste management technology, as it doesn't require specific nutrient and water additive ratios like other food waste management systems. Therefore, the management of the system is fairly straightforward– all food scraps, including animal bones and decomposable cutlery, are able to be dehydrated. The only responsibility the system requires besides the regular loading of food waste is to be unloaded at the end of the cycle. One cycle of 50 kilograms is 10 hours, and once this is processed the resulting biomass is 15 to 20 percent of the input's volume. The Mullumbimby store would need to store this biomass in airtight containers when storing it, as exposure to moisture initiates decomposition of the biomass.

The system utilizes 3 phase power, and more information needs to be provided to the Eco Guardians to receive an energy use estimate and tailored financial model to cover the cost of the system. However, like the other systems, this one would be subject to receiving the EPA's Bin Trim rebate with program participation.

3.4.4 Large Scale Compost– Richmond Waste Curbside Pickup

The Richmond Waste's Curbside Pickup subscription is an option available to all three branches of Santos Organics. A representative from the Richmond Waste Service affirms that it is a $9 weekly fee and pickup service, in which organics in the form of fruits, vegetables, meat, bones, and decomposable cutlery are able to be managed. The compost end-product is made available for sale to community members and especially farmers. The bins that are collected on a weekly basis are only 240 liters however, so this system will have to be used in conjunction with another to process the weekly 600 liters of food waste or additional service costs may need to be incurred.

3.4.5 Worm Farm– Compost Central

Andrew de Vries' Compost Central vermicomposting systems are cost, space, and resource efficient means of processing food waste into fertile soils. However, the only branch suitable for applying these vermicomposting systems is the warehouse, in which these systems are already in place. Both the Byron Bay and Mullumbimby branches have no available garden space for an on-site worm farm to process the amount of food waste produced at each.

3.4.6 Animal Feeds Biotechnology– Black Soldier Fly Feeding Operation

The BSL food waste consumption system is too complex and labor-intensive to ask of the Santos employees, so this system is limited to being utilized offsite. Therefore the only branch able to adopt this strategy of composting is the Byron Bay retail store; their current food waste processor Evan Anderson at The Farm in Ewingsdale has the potential to install and manage this feeding operation at this site, especially as the farm has plans to incorporate a thirty-chicken caravan. The self-harvested pupa would be able to be utilized as a protein rich food source for them, as well as make the decomposition of Santos' food waste much for efficient.

BSL compost systems are not commercially available and need to be built by hand, so further research on the exact structural specifications is necessary. However, The Farm is a highly educational based institution with the motto "Grow, Feed, Educate", and would show interest in the preposition of this radical yet forward system of food waste processing and simultaneous food production (The Farm, 2017, para. 2). This production of a protein feed source could also lead to further innovations on the farm, like the introduction of aquaculture systems.

3.5 Structured Decision Making Model

In assessing all of the waste management options for all the branches, a methodical system like the Structured Decision Making Model proposed by BC Hydro is required (Figure 3). This model is used by "describing the Problem, stating the Objectives and how they are measured, creating Alternatives, their Consequences and analyzing the Tradeoffs"(BC Hydro, n.d., p. 4). In the decision making process of assessing the optimal food waste management option for each branch of Santos Organics, a variation of this model will be utilized with the incorporation of the three dimensions of the TBL.

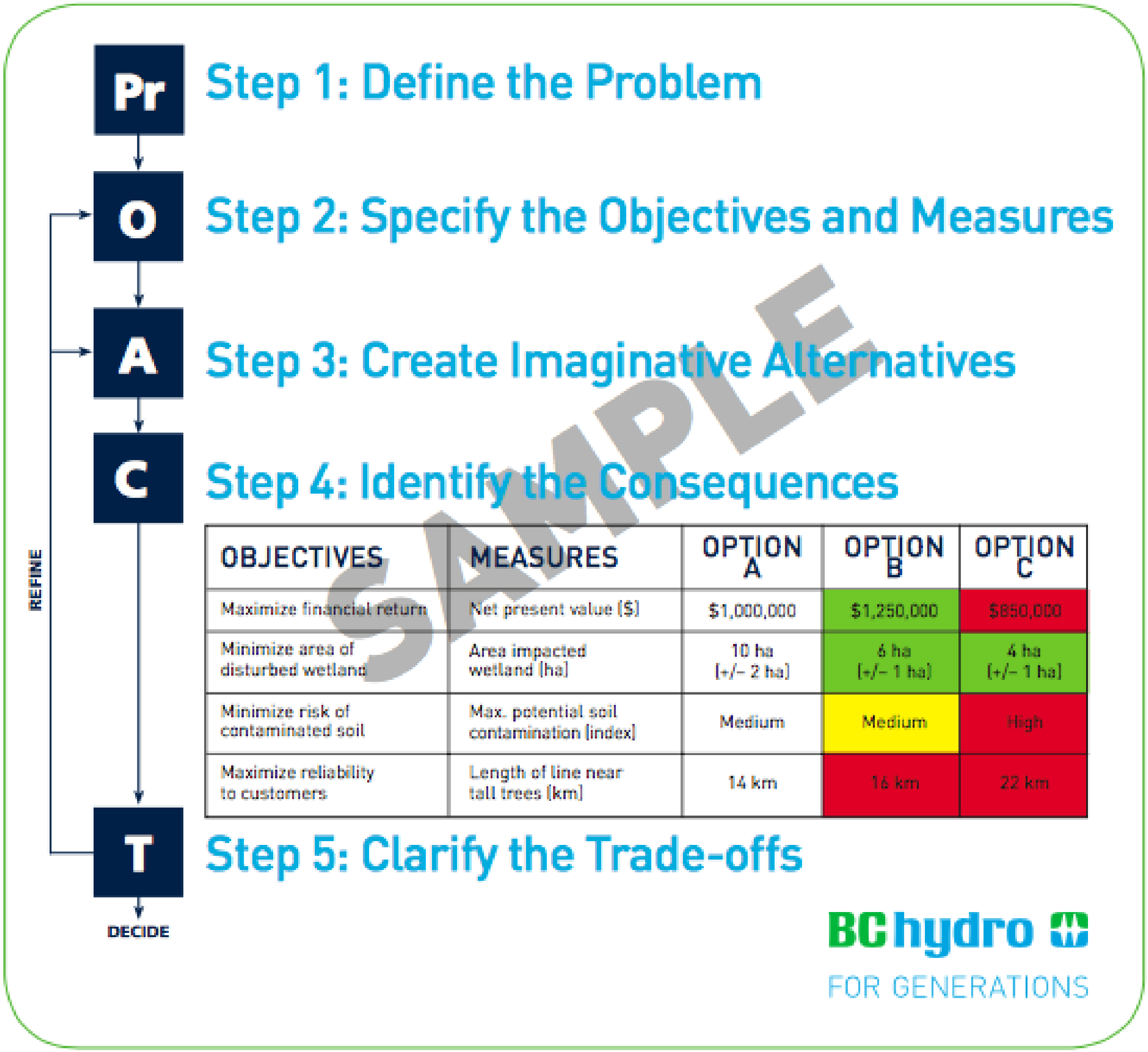

Figure 3 BC Hydro's Structured Decision Making Model

The only other system able to be implemented at the Warehouse besides its current one is the Richmond Waste curbside pickup service, as seen in Appendix G. Similarly as evident in Appendix H outlining the Byron Bay branch, only two options besides its business as usual system were viable– Richmond Waste curbside pickup service and the offsite Black Soldier Fly feeding operation system (Appendix H). Each of these systems have been analyzed in accordance to the objectives outlined in the Structured Decision Making Model.

For the Mullumbimby branch, the potential options identified after the site and feasibility assessments are the BioBowser both on and offsite at the Mullumbimby Community Garden, the CLO50, the GC100, and Richmond Waste curbside pickup. Some additional calculations are included to supplement the available data. Unfortunately, the electricity costs for some of the systems are unavailable, so this data is missing from the analysis. Further research on this would result in a more concise decision making process.

In assessing the maximum distance travelled to deliver the food waste processing byproducts, the farthest point in Mullumbimby from the Santos Organics store was measured in the assumption that the byproducts would be donated within the community.

The profit made from the BioBowser's liquid fertilizer is calculated assuming the weekly 600 liters is able to sell at the $200 per cubic meter rate as suggested by Lakin.

Calculation of BioBowser Liquid Fertilizer Income

$$600\ L\ liquid\ fertilizer * \frac{\$200}{1000\ L\ soil\ conditioner} * 3\ weeks = \$360\ every\ 3\ weeks$$

This profit of $360 every three weeks simulates the scenario of the system being placed on the Mullumbimby Community Garden, in which the biogas production would pose no economical benefits to the Santos Organics store. If the sytem were to be placed onsite however, the profits would be calculated by adding the store's triweekly gas cost of $124, as this cost would be offset by the alternative use of biogas.

Calculation of BioBowser Liquid Fertilizer and Biogas Income

$$\$360 + \$124 = \$484\ every\ 3\ weeks$$

The calculation of the CLO50's income via its compost is based on the Norther Rivers Waste Biocycle Compost at $35 per cubic metre (Northern Rivers Waste, 2017, para. 6) . This is calculated also assumes that the machine is reducing the weekly food waste's volume of 600 L by 20 percent, producing 120 L of compost a week.

Calculation of CLO50 Maximum Income

$$120\ L\ compost * \frac{\$35}{1000\ L\ compost} * 3\ weeks = \$12.6\ every\ 3\ weeks$$

The calculation of the Gaia Rccycler's income via its soil conditioner is based on the average price of ANL Landscapes' soil conditioners at $52 per cubic meter (ANL, 2017). This is calculated assuming that the machine is reducing the weekly food waste's volume of 600 L by 20 percent, producing 120 L of compost a week.

Calculation of GC100 Income

$$120\ L\ soil\ conditioner * \frac{\$52}{1000\ L\ soil\ conditioner} * 3\ weeks = \$6.24\ every\ 3\ weeks$$

4. Discussion

4.1 Identification of Optimal Systems

The Structured Decision Making Models provide visual frameworks of the empirical data from which optimal systems of unavoidable food waste processing for each branch can be extracted.

4.1.1 Warehouse Branch Optimal System

The warehouse proposes limited options for systems, however the Structured Decision Making Model of Appendix G shows clear favor towards the business as usual system. The branch already utilizes food waste as animal feed as the employees are able to take it home to their livestock, touching upon the Reuse section of the Food Waste Hierarchies while simultaneously benefitting the employees. The onsite composting methods are not only efficient vermicomposting systems but are also cost free to the branch, making it an incredibly economically viable system as compared to the subscription based pickup system. The community benefits as well as the onsite composting operation doubles as a classroom, via the posted literature about the composters and through the regularly scheduled Compost Talks held by Andrew de Vries. All three fields of the Triple Bottom Line are Satisfied, and the order of the Hierarchy of Food Waste is respected.

4.1.2 Byron Bay Branch Optimal System

Limited options remain for the Byron Bay branch due to their space confinement, but also due to the preexisting efficiency of their current system as seen in Appendix H. The waste pickup system by Richmond Waste offers few additional benefits that are not already supplied by the current system. The offsite decomposition of the branch's food waste is a fairly efficient system in all fields of the Triple Bottom Line, however the ability to utilize the food waste to produce a protein high food source via the Black Soldier Fly feeding operation would allow for another dimension of food waste revaluing to be added to the branch's practice. This system, although labor and technicality intensive, provides additional benefits to the already fairly efficient system mainly in the form of protein animal feed sources and in educational opportunities, as this radical system provides unique educational opportunities for the public that come to visit the farm for reasons such as these– to see and understand the growing field of agriculture.

4.1.3 Mullumbimby Branch Optimal System

There are a plethora of options available to the Mullumbimby branch, however the Structured Decision Making Model as well as consideration of the Triple Bottom Line cost-benefit analysis steers the decision towards the favor of the BioBowser's installation onsite. The largest weaknesses within the onsite BioBowser system lie within its labor requirements of the staff as well as its upfront cost of $2,500. However, Paul Crebar the Communications & Culture Manager from the Mullumbimby store has expressed the interest and possibility of creating a job specifically for the management and dispersal of the system and its byproducts. This would address the issue of over loading the employees with compost responsibilities, while also creating job opportunities in the community. The cost of the system is also a lessened concern, as the store's participation in the Environmental Protection Authority's Bin Trim program could grant the store a rebate ranging from one to fifty thousand dollars.

The ability to sell the liquid fertilizer at a $200 per cubic meter rate as well as circumvent gas costs through the utilization of the systems biogas places the anaerobic digester far beyond the others in terms of economics. The large volume of fertilizer produced also allows for town wide donation initiates–bringing rise to potential community-engagements such as fertilizing all of the district's school gardens. This is where the CLO50 and GC100 fell short, as lowered byproduct volumes entail lowered opportunities for sale and donation. Placing the BioBowser at the community garden would benefit them greatly with the ability to use the renewable biogas energy in the new kitchen, however the gas build-up due to its irregular use would cause the release of methane and carbon dioxide in the atmosphere, offsetting any greenhouse gas emission aversion the system intended to do.

5. Conclusion

In accordance to the Food Waste Hierarchies, all three branches must make it their main priority to avoid food waste, then consider its reuse, before even planning on how to recycle it. Therefore, the education systems in place by the New South Wales Environment Protection Authority' Bin Trim program are key in optimizing the food that is processed through each of the Santos Organic branches. The free of charge program will only help to benefit the branches' considerations of how to manage food and its avoidance as waste. Next, the ability to reuse food must be utilized via donation to food banks when possible or to utilize it as animal feed; hunger should be a high priority in the list of considerations when discussing food waste.

When it comes to the recycling of food waste, the three systems proposed by this research can and should be implemented as soon as possible. The Mullumbimby branch will be able to incorporate the BioBowser anaerobic system on site to benefit from its production of liquid fertilizer as well as biogas. This system carries numerous possibilities for community benefits due to the valuable byproducts. They are economically beneficial too, as the sale of the liquid fertilizer can help offset the cost of the system, provide additional grant money that Santos can use towards funding community projects, and the cost of triweekly stove fuel can be avoided as it will be replaced by the system's biofuel. The Byron Bay branch will benefit the community through the installation of a Black Soldier Fly larvae feeding operation, as it can be used as an educational tool on the offsite farm as well as feed provider for the farm's livestock. The Warehouse currently has an optimal food waste treatment plan installed and in action at their site, however the immediate application of the Bin Trim programs' food waste reduction strategies will benefit the environment, the branch's economic status, and the community through methods of revitalizing food that may have been wrongly labeled as waste.

Future research on the topic should never cease, as new technologies to better the food life cycle are always subject to arise. This proposed plan could be void in years' time with the development of more advanced systems, so this proposition is by no means final or static. Further research can also be applied to the systems explored in this paper, such as the GC100, CLO50, and the Biobowser as some gaps exist within the information gathered, specifically in regards to system costs and electric requirements.

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7. Appendices

7.1 Appendix A: Anaerobic Digester TBL Analysis

ENVIRONMENTAL	
PROS	**CONS**
No transportation of food scraps	Energy requirements for system
Renewable energy source– off puts energy demand of store	Water requirements for system
Composts pretreated decomposable utensils	
Produces rich liquid fertilizer	

ECONOMIC	
PROS	**CONS**
Potential to sell liquid fertilizer byproduct	Upfront cost of system
Save gas costs	Energy Costs
Unsubscribe from pickup service	Water Costs
Ability to receive rebate from Bin Trim Program	Transportation/storage of liquid fertilizer post-processing

COMMUNITY	
PROS	**CONS**
Potential to disperse liquid fertilizer byproduct to group of choice– community garden, school gardens, residential gardens, etc	Diverting food scraps from current receiver for their composting use
Potential for creating compost service job	Asking for more responsibilities from staff
Educational opportunity on site	

7.2 Appendix B: Local Industrial Composting Facility TBL Analysis

ENVIRONMENTAL	
PROS	**CONS**
Efficient high capacity facility will thoroughly compost food scraps	Not utilizing food scraps' ability to generate renewable energy
Can manage decomposable utensils	Transportation of food scraps
Produces rich solid compost	

ECONOMIC	
PROS	**CONS**
No high upfront cost	Cost of weekly service
	No profit from compost/fertilizer production

COMMUNITY	
PROS	**CONS**
Financially supporting Richmond composting as a sustainable business in NSW	Diverting food scraps from current receiver for their composting use
Minimal additional responsibilities placed on staff	Inability to donate the food scrap compost to parties of choice
	Denies educational and promotional opportunity made available by onsite systems

7.3 Appendix C: Aerobic Digestion TBL Analysis

ENVIRONMENTAL	
PROS	**CONS**
No transportation of food scraps	Not utilizing food scraps' ability to generate renewable energy
Produces rich solid compost	Energy use
	Cannot manage decomposable utensils

ECONOMIC	
PROS	**CONS**
Potential to sell viable byproduct	Initial cost of system
Unsubscribe from pickup service	Transportation/storage of solid compost post-processing
Ability to receive rebate from Bin Trim Program	Energy cost

COMMUNITY	
PROS	**CONS**
Potential to provide community with compost output– community garden, school gardens, residential gardens, etc	Diverting food scraps from current receiver for their composting use
Educational and promotional; opportunities on site	Asking for more responsibilities from staff

7.4 Appendix D: Soil Conditioner TBL Analysis

ENVIRONMENTAL	
PROS	**CONS**
Produces nutritionally rich soil amendments	Not utilizing food scraps' ability to generate renewable energy
Can manage decomposable utensils	Energy use
No transportation of food scraps	
Does not require water and instead produces it	

ECONOMIC	
PROS	**CONS**
Potential to sell viable byproduct	Initial cost of system
Unsubscribe from pickup service	Transportation/storage of biomass post-processing
Ability to receive rebate from Bin Trim Program	Energy cost

COMMUNITY	
PROS	**CONS**
Potential to provide community with compost output– community garden, school gardens, residential gardens, etc	Diverting food scraps from current receiver for their composting use
Educational and promotional; opportunities on site	Asking for more responsibilities from staff

7.5 Appendix E: Worm Farms TBL Analysis

ENVIRONMENTAL	
PROS	**CONS**
Produces rich solid compost	Not utilizing food scraps' ability to generate renewable energy
	Cannot manage decomposable utensils

ECONOMIC	
PROS	**CONS**
Space efficient traditional compost system	
No large upfront costs	
Minimal long-term maintenance costs	
Unsubscribe from pickup service	

COMMUNITY	
PROS	**CONS**
Potential to provide community with compost output– community garden, school gardens, residential gardens, etc	Large responsibility and labor-intense system for system manager
Educational opportunity	

7.6 Appendix F: Biotechnology for Animal Feeds Analysis

ENVIRONMENTAL	
PROS	**CONS**
Potential to use macro organisms as protein feed source instead of proceed feed	Not utilizing food scraps' ability to generate renewable energy
Produces rich solid compost	Cannot manage decomposable utensils

ECONOMIC	
PROS	**CONS**
Space efficient traditional compost system	
No large upfront costs	
Minimal long-term maintenance costs	
Potential to use macro organisms as protein feed source instead of purchased feed	
Unsubscribe from pickup service	

COMMUNITY	
PROS	**CONS**
Potential to provide community with compost output– community garden, school gardens, residential gardens, etc	Large responsibility and labor-intense system for system manager
Educational opportunity	

7.7 Appendix G: Structured Decision Making Model of Warehouse Branch's Potential Systems

	Objectives	Measures	Business as Usual	Richmond Waste
Economic	Minimal upfront costs	Cost of system ($)	0	0
	Receive NSW Bin Trim rebate for system	Money saved from rebate recieval ($)	0	0
	Minimal system upkeep costs	Monthly subscription or electricity costs ($)	$0	$36
	Financial profit from system	Income resulting from system ($/3 weeks)	$0	0
Social	System's exposure to community as educational opprotunity	Who is exposed to system	Customers, people attending scheduled Compost Talks, passing pedestrians	Plant visitors
	Donate food waste byproduct to community	Potential for donation	Staff	None
	Level of difficultly for system caretaker	Minimal, Moderate, High	Moderate (vermicomposting)	Minimal (Bin to Curb)
Environment	Diminish transportation of food scraps/compost product	Max distance traveled for food waste or product (km)	0	51.4
	Process all of branch's food waste	Fruits/vegetables, citrus, and decomposable utinsels	Fruits/vegetables	Fruits/vegetables, citrus, and decomposable utinsels
	Maximize nutritional content of food scraps	End products	Compost	Compost

7.8 Appendix H: Structured Decision Making Model of Byron Bay Branch's Potential Systems

	Objectives	Measures	Business as Usual	Richmond Waste	Offsite BSL System
Economic	Minimal upfront costs	Cost of system ($)	0	0	Minimal
	Receive NSW Bin Trim rebate for system	Money saved from rebate recieval ($)	0	0	$1,000-$50,000
	Minimal system upkeep costs	Monthly subscription or electricity costs ($)	0	$36	0
	Financial profit from system	Income resulting from system ($/3 weeks)	0	0	Offset price of chicken feed
Social	System's exposure to community as educational opprotunity	Who is exposed to system	Farm visitors	Plant visitors	Innovative sytstem viewable by Farm Visitors
	Donate food waste byproduct to community	Potential for donation	Compost	None	Compost
	Level of difficultly for system caretaker	Minimal, Moderate, High	Moderate (Transport of food scraps, aerobic composting)	Minimal (Bin to Curb)	High (self designing and building of system, maintanence of BSF, coordination with chicken feed)
Environment	Diminish transportation of food scraps/compost product	Max distance traveled for food waste or product (km)	7.3 km	68.8 km	7.3 km
	Process all of branch's food waste	Fruits/vegetables, citrus, and decomposable utinsels	Fruits/vegetables, citrus	Fruits/vegetables, citrus, and decomposable utinsels	Fruits/vegetables, citrus
	Maximize nutritional content of food scraps	End products	Compost	Compost	Compost, animal feed protein

7.9 Appendix I: Structured Decision Making Model of Mullumbimby Branch's Potential Systems

	Objectives	Measures	Business as Usual	Onsite BioBowser	Community Garden BioBowser	CLO50	GC100	Richmond Waste
Economic	Minimal upfront costs	Cost of system ($)	$0	$2,500	$2,500	$54,000	–	$0
	Receive NSW Bin Trim rebate for system	Money saved from rebate recieval ($)	$0	$1,000-$50,000	$1,000-$50,000	$1,000-$50,000	$1,000-$50,000	$0
	Minimal system upkeep costs	Monthly subscription or electricity costs ($)	$36	Electricity costs	Electricity costs	Electricity costs	Electricity costs	$36
	Financial profit from system	Income resulting from system ($/3 weeks)	$0	$484	$360	$12.60	$6.24	$0
Social	System's exposure to community as educational opprotunity	Who is exposed to system	Public Comm. Garden visitors	Customers and fertilizer beneficiaries	Comm. Garden visitors and fertilizer beneficiaries	Customers and compost beneficiaries	Customers and biomass beneficiaries	Plant visitors
	Donate food waste byproduct to community	Potential for donation	Compost	Liquid fertilizer	Liquid fertilizer	Compost	Soil Amendment	None
	Level of difficultly for system caretaker	Minimal, Moderate, High	Moderate (Transport of food scraps, aerobic composting)	High (Loading, draining liquid fert, transport of product)	High (Loading, draining liquid fert, transport of product)	High (Loading, unloading compost, transport of product)	High (Loading, unloading biomass, transport of product)	Minimal (Bin to Curb)
Environment	Diminish transportation of food scraps/compost product	Max distance traveled for food waste or product (km)	200 m	5 km	5 km	5 km	5 km	68.8 km
	Process all of branch's food waste	Fruits/vegetables, citrus, and decomposable utinsels	Fruits/vegetables, citrus, and decomposable utinsels	Fruits/vegetables, citrus, and decomposable utinsels	Fruits/vegetables, citrus, and decomposable utinsels	Fruits/vegetables and citrus	Fruits/vegetables, citrus, and decomposable utinsels	Fruits/vegetables, citrus, and decomposable utinsels
	Maximize nutritional content of food scraps	End products	Compost	Liquid fertilizer (600 L) and biogas	Liquid fertilizer (600 L) and biogas	Compost (60-120 kg)	Grey water and soil amendment (60-120 kg)	Compost

7. 10 Appendix J: Interview Questions for Site Assessments

1. What current composting system do you have in place?
2. How much waste / day at each site?
3. Type of waste / day at each site?
4. Is there a space available to house system?
    a. At least 5 cubic meters, access to 3 phase electricity, potential cover?
5. Are there uses for the biogas?
6. Are there uses for the liquid fertilizer?
7. Potential to waste from other local people/institutions– cafes, restaurants and fruit and vegie shops.
8. Do you have any suggestions for improving your system here?

7.11 Appendix L: Interview Informed Consent Form

Consent for participation in a research interview

Composting of Organic Waste for Santos Organics– A Feasibility Study and Triple Bottom Line Analysis of Options

Conducted by Abbie Winter

INTRODUCTION & BACKGROUND/PURPOSE

I am an American student currently studying environmental action and sustainability here in Australia, and I am undertaking a research project through this course specifically pairing with Santos Organics to propose an optimal composting system for them.

Before you agree to participate in this study, you should know enough about it to make an informed decision. If you have any questions, please ask me.

INFORMATION

I'll ask a few questions regarding your role in Santos Organics' compost process, which will probably take around 10 minutes depending on how much you expand on each question. The information you provide will help me to identify strengths and areas of improvement within the current system.

My research will be proposing a way to make the current composting system more efficient and beneficial for everyone involved, ideally including yourself.

CONFIDENTIALITY & PARTICIPATION

You also have the opportunity to remain anonymous or choose the way in which I will acknowledge you within my research. If you choose to be anonymous, I will hold this information as confidential and it will not be used in any written or oral form.

Your participation in this study is voluntary; you may decline to participate. If you decide to participate, you may withdraw from the study at any time. You may also decline to answer any specific question. If you withdraw from the study at any time the information already obtained from you will be destroyed.

Subject's signature __________________________________ Date: ____________________

Researcher's signature ________________________________ Date: ____________________