Zero Waste Strategies and Innovation for Sustainability

A 2010 Group Project

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The mission of the Bren School of Environmental Science & Management is to produce professionals with unrivaled training in environmental science and management who will devote their unique skills to the diagnosis, assessment, mitigation, prevention, and remedy of the environmental problems of today and the future. A guiding principle of the School is that the analysis of environmental problems requires quantitative training in more than one discipline and an awareness of the physical, biological, social, political, and economic consequences that arise from scientific or technological decisions.

The Group Project is required of all students in the Master's of Environmental Science and Management (MESM) Program. It is a three-quarter activity in which small groups of students conduct focused, interdisciplinary research on the scientific, management, and policy dimensions of a specific environmental issue. This Final Group Project Report is authored by MESM students and has been reviewed and approved by:

James Frew

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Abstract

"Zero waste" is a strategy to minimize the amount of materials and resources consumed, in order to conserve water and energy and to ultimately mitigate climate change. In 2009, Gills Onions, the largest onion processor in the nation, set a goal of achieving zero waste at its processing facility in Oxnard, California. Gills Onions challenged our group to develop a comprehensive inventory of all its waste streams and to provide recommendations that would move it closer to its zero waste goal.

We identified three critical components to achieving a zero waste goal: establishing a baseline; analyzing the waste streams; and identifying opportunities to reduce, reuse, recycle, all while considering economic and practical limitations. We divided Gills Onions' waste streams into four broad resource categories: Onions, Energy, Water and Materials. Using the Climate Registry protocol, we calculated, verified and publicly reported Gills Onions' complete greenhouse gas inventory.

We made nearly 50 recommendations that will enable Gills Onions to: 1) reduce its total volume of waste, 2) increase diversion from landfill, 3) decrease energy and water consumption, and 4) increase sustainability. The resulting cost savings could exceed $900,000 annually, demonstrating that a zero waste strategy can be good for the environment and for a company's bottom line.

Executive Summary

Cities and businesses are increasingly adopting an anti-garbage strategy known as zero waste[1]. Zero waste is a goal that aims to minimize the amount of materials and resources consumed, in an effort to conserve water and energy and ultimately to mitigate climate change. Many motivations drive zero waste initiatives. For cities, a zero waste goal offers an opportunity to reduce the amount of waste going to landfill and provides a framework for reducing greenhouse gas emissions. By pursuing zero waste, cities may begin to fundamentally shift the way citizens think about waste: from garbage, or something to be discarded, to a potential valuable resource. Businesses also embrace zero waste initiatives for many reasons. Waste disposal costs are becoming increasingly expensive. Moreover, businesses perceive that customers are interested in purchasing products from organizations that exhibit environmental stewardship. Finally, businesses want to get ahead of regulations that ultimately may make them responsible for the waste that they generate

In 2009, Gills Onions, the largest onion processor in the United States, set a goal of achieving zero waste at its processing and office facilities in Oxnard, California. The company took a major first step to achieving zero waste by implementing a strategy to convert its onion waste to energy using a biodigester and fuel cell technology. However, while onion waste was the most visible aspect of the operation, the company realized that onions were not the only waste stream it was generating, and sought out the expertise of the Bren School to take a holistic approach to analyzing all its waste streams.

The role of this group project was therefore to take a comprehensive inventory of all of Gills Onions' waste streams, to analyze waste reduction opportunities, and to provide the company with a set of recommendations that would move it closer to its zero waste goal. By taking a systematic and rigorous approach to evaluating the waste generated from every aspect of the company's onsite operations, we were to provide Gills Onions with the information and strategies needed to achieve zero waste.

We identified that there were three critical components to achieving a zero waste goal: first establish a baseline to identify how much waste was being generated. Second, analyze all the waste streams and lastly, identify opportunities to reduce, reuse, or recycle while also taking into consideration both economic and practical limitations.

Prior to establishing the baseline, it was necessary to define the system boundary to delineate what would be included in our analysis. We set the system boundary to coincide with the facility in Oxnard, California, in order to encompass only those activities over which the company has complete operational control. We then divided Gills Onions' waste streams into the four broad resource categories that are used in the company's everyday operations; Onions, Energy, Water and Materials. For each resource

[1] Some examples include Seattle, San Francisco, Toyota, and Walmart.

category we conducted a comprehensive audit to establish the 2008 baseline. For the energy resource category this baseline analysis included calculating, verifying and publicly reporting Gills Onions' complete greenhouse gas inventory to the Climate Registry. For the other resource categories, we relied on various audit methodologies including waste characterizations, and company record analysis. We used cost-benefit and environmental analyses including resource reduction evaluations, green supply chain management, and previously conducted life cycle analyses to identify where opportunities existed to reduce, reuse or recycle. Ultimately, we provided Gills Onions with an extensive set of recommendations that will not only move the company closer to achieving zero waste, but are also economically beneficial and operationally viable.

Combined with the company's initiative to convert onion waste to energy, the recommendations we identified for Gills Onions have the opportunity to increase material waste diversion from 25% up to 53%. Moreover, the company could further reduce material waste generation by 12%; reduce water consumption by 30%; reduce purchased onsite electricity by 47%; decrease greenhouse gas emissions by 17%; and eliminate 100% of the onion waste by converting it to energy and cattle feed.

The recommendations we made to Gills Onions touched on every aspect of its business, and if implemented would not only reduce the aforementioned environmental impacts but would also allow the company to recognize over $900,000 in savings year over year.

Our group project results have implications that extend beyond Gills Onions to the larger business community, and we have drawn one definitive conclusion about a zero waste initiative: zero waste is not only good for the environment, but is a good business strategy as well.

Acknowledgements

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Introduction

Across the nation an anti-garbage strategy known as zero waste is taking hold. From cities such as Boulder, Seattle, and San Francisco to companies such as Walmart, Pepsi, and Toyota, zero waste initiatives are being embraced. Zero waste is a goal that aims to minimize the amount of resources and materials consumed, in an effort to conserve water and energy and ultimately to mitigate climate change. Zero waste is not simply about reuse, recycling and diversion from landfills, it also represents a fundamental shift in thinking, to preventing waste from being created in the first place.

Communities adopt zero waste initiatives not just because waste management and landfills are becoming increasingly expensive. Landfills also have potentially detrimental public health and environmental impacts, consume valuable amounts of land and promote the permanent burial of natural resources[i]. In addition, states, such as California, Hawaii, Minnesota, and Washington, are mandating greenhouse gas (GHG) emission reductions. These mandates are motivating communities to consider zero waste initiatives because landfills are a significant source of carbon dioxide (CO_2) and methane (CH_4), greenhouse gasses which contribute to global warming[ii]. Moreover, waste that is eliminated at the source minimizes reliance on virgin materials and improves energy efficiency, both of which result in greenhouse gas emission reductions[iii].

Businesses are launching zero waste initiatives because of increasing waste disposal costs and because customers are demanding products from companies that exhibit environmental stewardship. Businesses understand that wasted resources during the production and distribution increase the costs of their products[2]. In addition to reduced costs and increased market opportunities, businesses are looking ahead at proposed regulations that might ultimately make companies responsible for the waste that they generate.

In 2009 our client, Gills Onions, set a goal of achieving zero waste. Gills Onions, located in Oxnard, California, is the largest fresh onion processor in the nation. With 375 employees, the company processes more than 200 million lbs of onions a year. During processing the onions are peeled, sliced and diced, which results in more than 50% of all the onions ending up as waste. As Gills Onions' business has grown over the past 25 years, so has its waste disposal problem, to the point where the traditional land application method of returning the onion waste to the fields was no longer feasible. Achieving zero waste was not simply a "green" initiative for Gills Onions, it was a business imperative. Therefore, in 2009 the company implemented an Advanced Energy Recovery System (AERS) to convert its onion waste into cattle feed and clean renewable energy.

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[2] An example of businesses reducing waste is Walmart which set a goal to reduce waste at its retail stores by 25%. To accomplish this goal, Walmart is pressuring its 60,000 suppliers to reduce their packaging which in turn will keep down the cost of their products.

While onion waste was the most conspicuous aspect of the operation, the company sought out our expertise at the Bren School to take a systematic and rigorous approach to analyzing all of its waste streams. Our role was to create a comprehensive inventory of all of Gills Onions' waste streams and provide the company with a set of recommendations that would move it closer to its zero waste goal.

To embark on a waste reduction strategy, we determined that Gills Onions needed to know its starting point. Given that energy, water and a wide variety of materials are used during the processing of onions, it was logical for us to divide our analysis into four primary resource categories: Onions, Energy, Water and Materials. We defined the system boundary to coincide with the property line surrounding Gills Onions' facility in Oxnard, California, in order to encompass only those activities for which Gills Onions has complete operational control.

We measured and established the 2008 baseline for each category; Onions, Energy, Water and Materials, with the objective of identifying specifically how far the company was from "zero". Our second objective was to identify opportunities to reduce, reuse, or recycle within each of the four resource categories, while considering the very real economic and practical limitations of the business. Our third objective was to examine the broad economic and environmental impacts of a zero waste strategy to assess whether a zero waste goal is practical and makes good business sense for other companies.

To accomplish our three key objectives, we conducted audits of Gills Onions' onion, energy, water, and material resources, applying the mass balance concept of examining inputs and resulting outputs. To create a comprehensive set of waste reduction recommendations, we used various analytical methods including resource reduction evaluations, greenhouse gas emissions accounting, green supply chain management, and previously-conducted life cycle analyses to identify where opportunities existed to reduce, reuse or recycle. In addition, we developed cost-benefit models that incorporated internal expenditures and savings generated, to determine annual net returns and the payback period for significant capital investments.

By providing Gills Onions with a set of recommendations based on robust analyses, and a baseline from which to measure its progress towards achieving zero waste, our group project will have significant impacts beyond the scope of the project itself. Gills Onions has an opportunity to set an example for the entire Californian Food Processing Industry to follow. For example, Gills Onions is already the first in the industry to implement AERS to convert its onion waste into energy. Gills Onions is therefore well positioned to extend its leadership role to encompass zero waste as well. The Gills Onions zero waste case study can be a catalyst for change, providing factual evidence which demonstrates to organizations that eliminating waste not only helps reduce costs and improve process efficiencies but also decreases environmental impacts and improves a company's overall "green" image. Gills Onions is well positioned to lead the food processing industry on a path to sustainable growth.

Barriers to Achieving Zero Waste

While we recognize that achieving zero waste is a long-term goal, there are barriers that can significantly impede success. Some of the barriers that Gills Onions has faced include technical issues, product quality concerns, health and safety requirements and the need for focused leadership and dedicated capital.

Technical Feasibility

While a zero waste goal aims to reuse and recycle to the maximum extent possible, unfortunately not all materials can be reused or recycled, others are very difficult to recycle, and for some materials, markets do not exist or are not accessible[iv]. While the types of materials and quantities that can be recycled are growing, markets for recycled materials are not pervasive and in some areas are still relatively small[v]. Additionally, markets for recycled products are particularly sensitive to economic conditions and can shrink substantially during a recession[vi]. Due to the potential unreliability of recycling markets, a zero waste initiative should strive to reduce waste at the source to minimize the burden of waste diversion or disposal.

Product Quality and Process Constraints

Maintaining product quality can be a significant barrier to achieving zero waste, particularly in the food processing industry where shelf life, tamper resistance, and food safety issues are paramount concerns. For example, to ensure freshness, the onions and the entire processing facility need to be cooled to and maintained at 32-34°F, a process requirement that makes it difficult to reduce the demand for both water and energy. Likewise, material waste reduction opportunities have to be weighed against the assurance that products are contained and protected adequately, prevented from spoiling, branded and marketed to relay enough relevant information, tamper resistant, traceable, and convenient for customers[vii]. Identifying alternative packaging materials is particularly challenging for Gills Onions because onions require packaging which breathes in order to prevent moisture build up, while not allowing odors to escape.

Health and Safety

Another barrier to achieving zero waste in the food processing industry is compliance with national and state health and safety requirements. Materials must be regularly cleaned or changed, and are often prevented from reuse[viii]. For example, gloves are required but have to be discarded immediately upon contact with the face, and materials used for testing are single-use only. As a result, to keep the food safety risk low, food processors often can consume more disposable resources than are desirable, and can be constrained in the types of materials that they are able to use.

Strict health and safety requirements also apply to the production process itself, and require frequent and careful cleaning and sanitizing of all equipment. While necessary to prevent the contamination of food by *Salmonella*, *Listeria monocytogenes*, *E. coli* or other pathogens, the cleaning and sanitizing processes can require additional energy and water resources as well as the use of detergents and chlorine[ix]. These are important considerations when identifying process improvements, water and chemical reduction opportunities, and material substitution alternatives.

Focused Leadership and Capital

A successful zero waste initiative requires dedicated leadership, ongoing employee education, and strong analytical abilities. Leadership for the initiative is essential, as making progress against a zero waste goal is likely to require changes in processes and employees behaviors', both of which may encounter resistance. Gills Onions has begun addressing this barrier by assigning Nikki Rodoni, the company's Sustainability Director, as the leader for the company's zero waste initiative. Businesses which commit to a zero waste goal without dedicating leadership, time and attention are less likely to realize significant benefits.

While pursuing a zero waste goal can save companies money by reducing energy, water, and waste costs, some waste reduction opportunities can require considerable capital outlays. Access to capital, high interest rates and fees can pose significant impediments to implementing projects which would help a company achieve its zero waste goal. For example, the AERS project would have cost Gills Onions $9.5 million, however the company received several million dollars in government grants and tax incentives, which offset the company's initial capital requirements and made the project financially feasible. Without the incentives, the project may not have been implemented.

Despite potential technical, product quality, health and safety, and leadership barriers, a zero waste goal is not impractical, and numerous opportunities do exist to minimize waste by reducing, reusing and recycling energy, water and materials. However, key barriers exist, specifically in the food processing industry, and these need to be considered when working toward a zero waste goal. With Gills Onions' commitment to achieving zero waste, our role was to work within the confines of these restrictions to identify key recommendations that would support its zero waste initiative.

Zero Waste Strategies and Innovation for Sustainability

SPRING 2010

Onions

Objectives:

- Quantify the amount of onion waste generated at Gills Onions' processing facility in 2008.
- Identify the environmental and economic impacts of converting onion waste to energy and cattle feed.

Methodology:

- Used Gills Onions' 2008 production records to calculate theoretical onion waste generated.
- Conducted on-site waste audit to identify actual onion waste diversion practices.
- Characterized environmental impacts associated with land application of onion waste and compared them to using solid onion waste for cattle feed and using onion juice in biodigester and fuel cells for energy.

Baseline:

2008 Onions Baseline
217.8 Million lbs Processed

Findings:

- 54% of all onions theoretically become waste.
- Converting onion waste to energy and cattle feed could potentially reduce total solid waste by 99%.
- Onion waste was contaminating recyclables.
- Onion waste was found in dumpster going to landfill.
- Onion waste was increasing disposal costs due to additional labor, transportation and tipping fees.

Recommendations:

- Separate onion waste from film plastics to prevent contamination of recyclables, reduce disposal costs, and capture 100% of onion waste.
- Provide ongoing education for employees and supervisors to increase waste diversion.

2010 Projection:

- 30% of all onion waste will be sold as cattle feed.
- 70% of all onion waste will be used to produce energy.
- 0% of onion waste will contaminate recyclables.
- 0% of onion waste will be found in dumpster going to landfill.
- Gills Onions will reduce onion waste to zero.

Potential Benefits

Convert 100% of Onion to Cattle Feed and Energy

Waste Reduction

118.2 Million Pounds of Onion Waste Annually

Potential Savings

Resource Category	Annual Savings	Payback Period (Years)
Onions	$507,000	0

Onions

The first waste stream we analyzed was the company's primary product, Onions. Gills Onions is a specialized food processing company which sells whole peeled, sliced and diced red or yellow onions to its customers across North America. Its customers are divided into three categories: industrial customers, which are primarily other food processors using pre-prepared onions to make products such as salsa and spaghetti sauce; commercial customers, which include large food distributors such as Sysco as well as restaurant chains such as A&W and McDonald's; and retail customers, which include stores such as Ralph's, Smart & Final, and Gelson's. Gills Onions' customers can specify which parts of the onion they want and in precisely what dimensions. For example, A&W, the fast food chain, specifies particular yellow onion varietals sliced into half inch thick rings that are three inches in diameter. While Gills Onions offers onions in a wide variety of sizes and shapes, the more specific an order the more waste is produced as quality control rejects those parts of the onion that do not meet the specifications.

One of Gills Onions' key product differentiators is its long shelf life of 16 days. Consequently, onions are processed "on demand" only after an order has been received. To extend the life of the processed onions, Gills Onions cools the onions to 32°F as soon as they are received and keeps them between 32-34°F throughout the entire production process. Moreover, Gills Onions practices state of the art food safety procedures, such as continuously cleaning conveyor belts with ozone. Food safety is paramount for the company, particularly after experiencing a recall due to the detection of *Listeria monocytogenes* in one of its retail products in June 2007. While these practices taken together ensure that Gills Onions' products have the longest shelf life in the industry, they also have implications for the amount of energy and water used throughout the process, and the willingness and flexibility of the company to try new alternatives within the plant.

How it Works

To document Gills Onions' onion waste baseline, it was important for us to understand the company's onion supply chain and process flow. Gills Onions contracts with its sister company, Rio Farms, to grow all of its onions. Rio Farms has three primary growing regions: San Joaquin Valley, Imperial Valley and King City. At these locations, onions are harvested, stalks are removed, and the bulbs are packed directly into large plastic bins which hold 1,000 lbs of onions each. The raw onions are transported by Gills Transport on open bed semi-trailer trucks immediately to the Oxnard processing facility, or to one of two regional cold storage warehouses: King City Cooling or Bakersfield Cold and Dry Storage. The onions are kept in the large plastic bins and cooled during storage at each location until they are needed to fulfill an order. Refer to Figure 1 for a diagram of the onion processing flow.

Tops, Tails, and Peeling

Raw onions are pulled out of storage "on demand" to satisfy only those orders that are needed to be processed within 24 hours. A forklift dumps the entire contents of the 1,000 lb bin into a sluice that feeds the onions to the peeling line, where the tops and tails are mechanically sliced off and the skins are blown off with compressed air. Whole peeled onions are cleaned and transported to the Quality Assurance (QA) line in a trough of treated water. In QA, employees manually inspect the whole peeled onions to ensure that all of the skins have been removed. The whole peeled onions are then either conveyed directly to the dicing line or are bagged in large blue polyethylene bags (blue bags). Bagged whole peeled onions are either shipped directly to industrial customers in large cardboard containers, or moved by forklift in large plastic bins to the slicing line, which is located on the other side of the processing facility.

Dicing Line

The dicing process is an elaborate series of machines that fully automate the process of dicing, rinsing, drying and bagging the onions in one continuous process. Diced onions can also be packed into polylactic acid (PLA) retail cups.

Slicing Line

The slicing process requires employees to manually insert individual whole peeled onions into the slicing machine. After the onion has been sliced, employees visually inspect the onion rings and manually select and bag those onion rings that meet customer specifications.

At each step of onion processing, onion waste is generated, particularly during peeling and slicing.

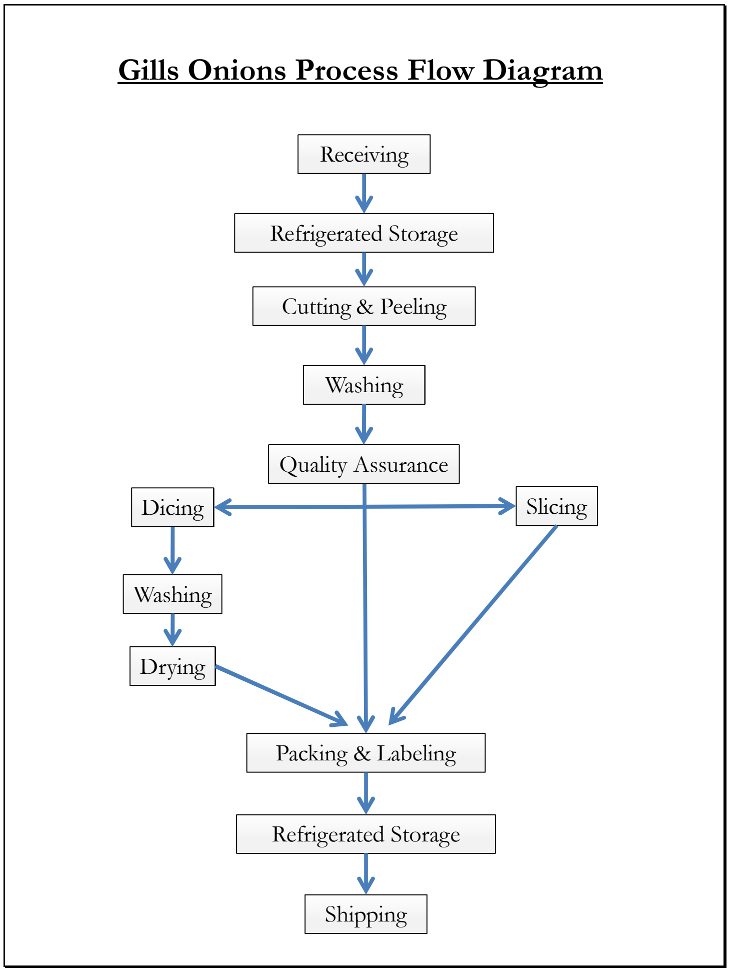

Figure 1 Onion processing flow diagram

Onion Waste Methodology and Baseline

Based on company production reports, in 2008 Gills Onions received 217.8 million lbs of onions from the fields (Table 1). Of these, approximately 1.5% or 3.2 million lbs were rejected before processing due to size, shape or damage. Of the 213.6 million lbs of raw onions remaining, 98.6 million lbs were sold as finished goods. We calculated that the total onion waste from pre-process rejects and all aspects of the production process totaled 118.2 million lbs. Based on our calculations, finished goods represented 46% of raw onions received, whereas the remaining 54% ended up as waste.

Table 1 2008 Onion Baseline and Onion Waste Analysis			
Onions	**Inputs (lbs)**	**Outputs (lbs)**	**Percentage of Onions Received**
Raw Onions Delivered	217,842,000		
Finished Goods		98,642,000	46%
Total Onion Waste *(including pre-process rejects)*		118,190,000	54%

The amount of onion waste Gills Onions generates depends on several factors including the size and quality of the onions received; the amount of time in storage; the accuracy of the mechanical processes; and specificity of customer orders. While Gills Onions does not measure onion waste at each stage of processing, we observed the most onion waste being generated during the peeling (including the removal of tops and tails) and slicing processes.

The Onion Waste Problem

As Gills Onions' business has grown over the years, so has the volume of onion waste. Like most farmers and food processors, prior to 2008 Gills Onions sent all its onion waste to the fields, using the biomass as a natural fertilizer[x]. This method of disposal is traditionally referred to as land application (Figure 2). Specifically, the company contracted Rio Farms to collect the onion waste from the Oxnard processing facility on a daily basis and to land apply the waste to its 30 acres of farmland on the outskirts of Oxnard. However, as volumes increased to more than 300,000 lbs per day, land application became problematic: attracting pests, creating an offensive odor, and impacting the productivity of the soils. The high sulfur content of the onion waste was rendering the Rio Farms acreage unusable and impacting its future revenue generation opportunities. Gills Onions' onion waste was costing the company nearly $500,000 per year in labor and transportation for disposal. Moreover, due to concerns over contamination of the water table, many city and county jurisdictions began banning land application[xi].

Figure 2 Land application

Finding a Productive Use for Onion Waste

In 2008, Gills Onions began a two-pronged strategy to address its onion waste problem. First, the company invented a proprietary method for pressing the onion waste to separate the liquid onion juice from the solid onion "cake". In April 2008, the company began selling the onion cake as high grade cattle feed to several dairies[3]. While the revenue generated from selling the dairies 38 million lbs of onion cake was a breakeven proposition, covering only the cost of labor and transportation, it reduced Gills Onions' land application by 30%. Selling onion cake as cattle feed also reduced disposal costs by $500,000 in 2008[4]. During 2008 and the first half of 2009, Gills Onions continued to land apply the liquid onion waste to the Rio Farms fields.

In July 2009, Gills Onions began converting the liquid onion waste to energy. With the installation of a biodigester (Figure 3), the company converts its onion juice into biogas, which in turn is used in two fuel cells to generate electricity for the processing facility. Starting in August 2009, all of the liquid onion juice squeezed out of the onion waste began to be directed to the 145,000 gallon biodigester, where it is broken down anaerobically by microorganisms for the generation of biogas[5].

Figure 3 Gills Onions' 145,000 gallon anaerobic digester

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[3] Gills Onions actually gives the solid onion waste or cake to its sister company, Gills Transport, to sell and use the revenue to cover cost.

[4] See Appendix A for more details.

[5] Onion juice converts to biogas within two hours, resulting in 75-85% methane, 10 - 20% carbon dioxide, 5% hydrogen sulfide, and 3% water. For more details on the AERS system see Appendix A.

In January 2010 the biodigester went into full production. By using its proprietary screw press and a small amount of lime, Gills Onions captures approximately 70% of its onion waste as onion juice[6]. We estimate that this will produce 10.7 million gallons of onion juice annually for use in the biodigester. Looking forward, approximately 38% of raw onions received will be available for energy production in the form of onion juice[7]. By implementing the cattle feed and onion waste to energy initiatives, Gills Onions has the potential to eliminate its onion waste, which represents 99% of the company's total solid waste.

Continuing Onion Waste Issues

When we conducted waste audits in June and July 2009, we found onion waste everywhere[8]. Onion waste was being mixed in with the recyclables, particularly in the film plastic recyclables, contaminating the waste stream and rendering the whole load not recyclable (Figure 4). We also found onion waste mixed in with the garbage going to the landfill, adding a significant amount of weight to each load and increasing the company's tipping fees. From the waste audits we conducted in July 2009 and annualizing the results, we found that nearly 136,000 lbs of onion waste were going to landfill and contaminating recyclables, collectively adding $7,600 in disposal fees and nearly $5,000 in estimated lost recycling revenue[9].

Figure 4 Onion waste contamination in film plastic recycling

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[6] Onion juice is fed into the biodigester at a rate of 20 gallons per minute and is diluted with water at a rate of 28 gallons per minute. The biodigester is kept at a temperature of 91 to 93°F to maximize productivity. The residence time of the liquid in the biodigester is 4.1 days.

[7] Based on 2008 production numbers, 82.7 million lbs of onion juice divided by 217.8 million lbs of raw onions received equals 38% of all onions received are available as onion juice for the production of energy.

[8] See Materials section for more detailed information.

[9] Onion waste going to landfill was 135,840 lbs (68 tons) which at $48/ton in tipping fees, cost the company $3260/year. Contaminated film plastic rejected from recycling totaled 181,000 lbs which cost an additional $4347 in tipping fees. If the film plastic had not been rejected, at 2009 rates, it would have been worth $4877 in recycling revenue.

Solving the Continuing Onion Waste Issue

We brought the pervasive onion waste issue and its implications to the attention of the Gills Onions management team in a report with photographs illustrating our point. The photographs were revealing and motivating. Within 48 hours, the management team had assigned an employee to sort all film plastic recycling waste (post-production) and to separate out the excess onion waste. While this addressed the immediate issue of recycled material contamination, it did not get to the source of the problem. Consequently, we made specific procedural recommendations for the separation of onion waste from material waste during processing within the facility. Recognizing that the problem was a training issue, we took the company's shift supervisors out to the recycling and garbage dumpsters and showed them the magnitude of the problem. Leveraging group member Laura Hamman's fluency in Spanish, we were able to educate the supervisors about the issue and associated costs. This was instrumental in winning their support for making changes on the processing line.

By the Fall of 2009, Gills Onions had implemented our process change recommendations by separating onion waste from film plastic during the production process. Since then, all loads of recyclable plastics have been "clean" and accepted for recycling, and Gills Onions began to receive revenue from the plastic waste stream. In our January 2010 waste audit we found 75 lbs of onion waste in the garbage, confirming that nearly 100% of all Gills Onions' onion waste is now being successfully diverted from the landfill and into more productive (and profitable) uses, as cattle feed and for the creation of electricity with the biodigester and fuel cells[10].

Environmental Impacts of Land Application

To compare the environmental impacts before and after the implementation of AERS, we attempted to quantify the greenhouse gas (GHG) emissions from Gills Onions' practice of land application of onion waste. Unfortunately, we were unable to identify a standard protocol to accurately calculate CO_2 emissions from land application. Even the Climate Registry, the North American emissions protocol and reporting registry, currently does not have a protocol for calculating emissions from land application[11]. In the conversations we had with experts, we were advised that, to calculate the associated GHG emissions, we needed to find out how much of the land applied onion waste was broken down by aerobic versus anaerobic processes[12].

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10 Annualized, this represents 21,525 lbs of onions, an 84% decrease in onion waste contamination.

11 The Climate Registry is a nonprofit organization that sets consistent and transparent standards to calculate, verify and publicly report greenhouse gas emissions into a single registry. It encourages voluntary early action and helps organizations compile comprehensive and accurate data to reduce GHG emissions. Unlike the global Carbon Disclosure Project, members of the Climate Registry agree to not only calculate and publically report their entity-wide GHG emissions annually, members commit to a third-party verification process with an ANSI accredited verification body to ensure accuracy and credibility. Ryerson, Master and Associates, Inc. of Santa Barbara verified the report we prepared for Gills Onions.

12 Per conversations with Arturo Keller, Professor, Bren School of Environmental Science & Management and Mauricio Mesones, Senior Program Associate, The Climate Registry.

This analysis would require information about soil type, application and tilling methods, average daily temperatures, pH of soil, and precipitation relative to application, among other things. In contrast, several studies that we referred to argued that emissions from land application should not be included in a GHG inventory because the emissions are biogenic[xii] [xiii]. These studies indicate that land application naturally returns the carbon assimilated during photosynthesis back to the atmosphere and for this reason is carbon neutral.

Calculating emissions from land application was outside the scope of our project. However, to get a sense of what the GHG emissions might be we conducted a worst case scenario analysis. In our analysis we assumed that 100% of the onion waste was tilled deep into the soil, degraded anaerobically, and resulted in methane emissions. Our results indicated that 795.5 metric tons of methane (CH_4) would be emitted from land application of onion waste, which is the equivalent of 16,700 metric tons CO_2e[13]. While this scenario may not be realistic, it was surprising to see that the amount of GHG emissions produced from land application could be nearly one and a half times greater than all the GHG emitted by Gills Onions in 2008[14]. While we were unable to calculate the GHG emissions directly associated with land application of onion waste, we determined that the indirect emissions from transporting onion waste to the fields resulted in 401.5 metric tons CO_2e[15].

In summary, as Gills Onions' onion waste exceeded 300,000 lbs a day, its traditional disposal method of land application became extremely problematic. By implementing two innovative programs, solid onion waste to cattle feed and liquid onion waste to electricity, Gills Onions had the potential to eliminate more than 99% of the company's total solid waste, saving $500,000 per year in disposal costs. The AERS electricity generation from onion waste not only reduces the company's onsite demand for purchased electricity from the utility grid, but by replacing land application of onion waste, it reduces GHG emissions from transporting onion waste to the fields and eliminates an unspecified amount of direct GHG emissions associated with onion waste when land applied. In conclusion, the implementation of AERS helps Gills Onions achieve its zero waste initiative and clearly demonstrates a company's opportunity to capitalize on its waste stream to accomplish triple bottom line benefits of people, planet and profits.

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[13] Estimated worst case scenario CO_2e emissions from land application of onion waste = 118.2 million lbs onion waste * 70,000 ppm COD/lb * 5.3 ft^3 CH_4/lb COD * 0.04 lb CH_4/ft^3 * 1 metric ton /2,205 lbs = 795.5 metric tons CH_4 * 21 GWP CH^4 = 16,706 $mtCO_2e$.
[14] In 2008 Gill Onions total greenhouse emissions equaled 11,152 mtCO2e.
[15] See Appendix A for more details.

Energy: At a Glance

Zero Waste Strategies and Innovation for Sustainability

SPRING 2010

Energy

Objectives:

- Identify the amount of energy consumed at Gills Onions' processing facility for 2008.
- Quantify the greenhouse gas emissions associated with Gills Onions' energy consumption
- Identify the environmental and economic impacts of converting onion waste to cattle feed and to energy using a biodigester and fuel cell (Advanced Energy Recovery System— AERS).

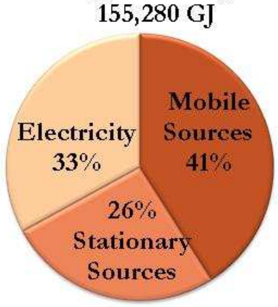
Gills Onions' Fuel Cell

Methodology:

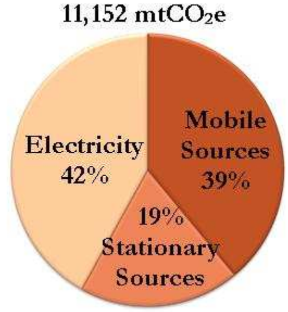
- Used the Climate Registry Protocol to create an inventory of all of Gills Onions' energy sources.
- Calculated greenhouse gas emissions associated with all energy sources and related equipment.
- Expanded system boundary to include transportation associated with delivering raw onions to the facility, disposing of onion waste, and Gills Onions controlled deliveries to customers.

2008 Baseline:

Energy Consumption
155,280 GJ



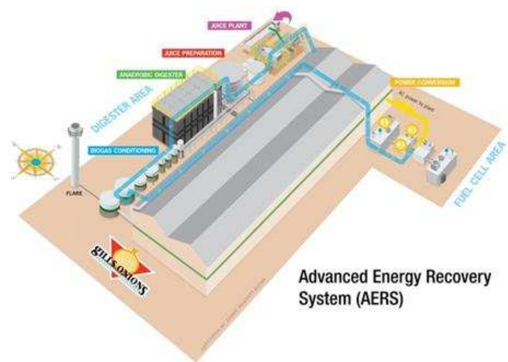
Greenhouse Gas Emissions
11,152 $mtCO_2e$



Findings

- Electricity represented 33% of all energy consumed in 2008.
  - 50-75% of electricity used by refrigeration system.
- 41% of all energy consumption attributable to mobile sources.
  - 99% of mobile sources used diesel.
  - Virtually all diesel consumption was associated with Gills Transportation.
- Stationary sources (non-electric) consumed 26% of all energy used.
  - 98% of stationary sources used natural gas.
  - The air compressor used 99% of the natural gas.
- The emissions intensity (CO_2e/gigajoule) of purchased electricity was much higher than other energy sources.
- Implementing the biodigester and fuel cells (AERS) will reduce purchased electricity demand by 5.26 million kWh and eliminate 1,855 $mtCO_2e$.

Energy (cont'd)



Gills Onions' Waste-to-Energy System

Recommendations:

- Reduce greenhouse gas emissions associated with transportation.
- Reuse waste heat from air compressor and fuel cells onsite.
- Conduct a comprehensive energy audit to identify where energy efficiency improvements can be made.
- Implement key performance indicators (KPI) based on production to quantify, track and reduce energy consumption.
- Ensure Yard Dog truck engines are not running continuously.
- Consider installing time-of-use battery system to store self-generated electricity for use during peak periods.

2010 Projection:

- Gills Onions will generate 600 kW of electricity from onion waste using biodigester and fuel cell (AERS), satisfying 100% of base-load electricity requirements.
- Gills Onions will reduce 47% of purchased onsite electricity demand.
- Greenhouse gas emissions will be reduced by 1,855 metric tons of CO_2e
- Implementation of biodigester and fuel cells (AERS) will result in an annual net savings of more than $500,000.

Potential Benefits

1. Convert Onion Waste to Energy
2. Reduce Greenhouse Gas Emissions

Greenhouse Gas Reduction

1,855 Metric Tons of CO_2e

Potential Savings

Resource Category	Annual Savings	Payback Period (Years)
Energy	$537,000	6 - 7

Energy

With Gills Onions' commitment to converting its onion waste to energy, the first objective for the Energy category was to create a baseline of the company's total energy consumption including electricity, natural gas, diesel, propane and gasoline. We established the baseline year as 2008, before the biodigester and fuel cells (AERS) were fully implemented. Our second objective was to determine the "waste stream" associated with the company's energy use; therefore, we calculated, reported and verified Gills Onions' baseline greenhouse gas emissions (GHG) inventory to the Climate Registry. Using the 2008 baseline data of energy inputs and GHG emission outputs, our third objective was to analyze the economic and environmental impacts of Gills Onions' transition to renewable energy with the implementation of AERS. Our final objective was to develop recommendations to help the company reduce its overall energy usage and associated emissions.

To create the 2008 baseline of Gills Onions' energy consumption and associated GHG emissions, we created an inventory following the Climate Registry General Reporting Protocol[16]. The Climate Registry is a North American, nonprofit organization that sets consistent and transparent standards to calculate, verify and publicly report greenhouse gas emissions into a single registry. Members of the Climate Registry must commit to a third-party verification process with an accredited verification body to ensure accuracy and credibility. Gills Onions is a founding member of the organization and the company needed to prepare its first year of emissions reporting and verification for the Registry. Ryerson, Master and Associates, Inc. (RMA) of Santa Barbara was contracted to conduct an independent verification of the 2008 greenhouse gas inventory that we calculated and prepared for Gills Onions.

Impact of Decision to Follow Climate Registry Protocol

There were two significant boundary implications associated with the decision to use the Climate Registry protocol. Initially we set the system boundary for our project to coincide with the Gills Onions processing facility in Oxnard because the company has complete operational control over everything onsite. However, as we began collecting information, we discovered that Gills Onions has ownership and operational control over a cooling facility in King City which is used as overflow storage for onions after the harvest. Consequently, for the purposes of the energy baseline and GHG reporting in the Climate Registry, we expanded our system boundary and included King City Cooling electricity consumption and emissions in our calculations[17].

[16] The Climate Registry General Reporting Protocol (GRP) version 1.1 published May 2008 with the GRP Updates and Clarifications released April 27, 2009.

[17] Gills Onions also uses a third party cooling facility, Bakersfield Cold and Dry Storage (BCD). Since Gills Onions does not have operational control or ownership of this facility, these emissions were not included in our baseline analysis.

The second boundary issue that emerged during our data collection process was the transportation of onions and onion waste. Gills Onions contracts out to its sister companies, Gills Transport and Rio Farms, for three services: delivering raw onions from the fields to Oxnard; transporting onion waste; and delivering finished goods to customers within 300 miles of Oxnard. Since Gills Onions does not own either company, it is not required to report their associated emissions to the Climate Registry. However, Gills Onions' processing facility depends on the delivery of onions, and Steve Gill, owner of Gills Onions, has operational control over Gills Transport and Rio Farms. Consequently, we expanded the boundary of the Energy section of our group project to include the fuel consumption and associated emissions from transportation services provided by Gills Transport and Rio Farms.

2008 Energy Use and Emissions Baseline

To report the baseline for energy consumption and emissions, the following section is divided into three subsections; electricity, mobile sources, and stationary sources. In each subsection we describe the methods we used to compile the baseline and analyze the findings. Each subsection will describe in detail and refer to the following aggregate profiles of Gills Onions' total energy consumption (Figure 5) and associated greenhouse gas emissions (Figure 6). For the purposes of comparison, all energy usage has been converted to a common energy unit, gigajoules (GJ). Gills Onions' total energy consumption in 2008 was 155,280 GJ, and calculated GHG emissions for 2008 were 11,152 metric tons of CO_2 equivalents ($mtCO_2e$).

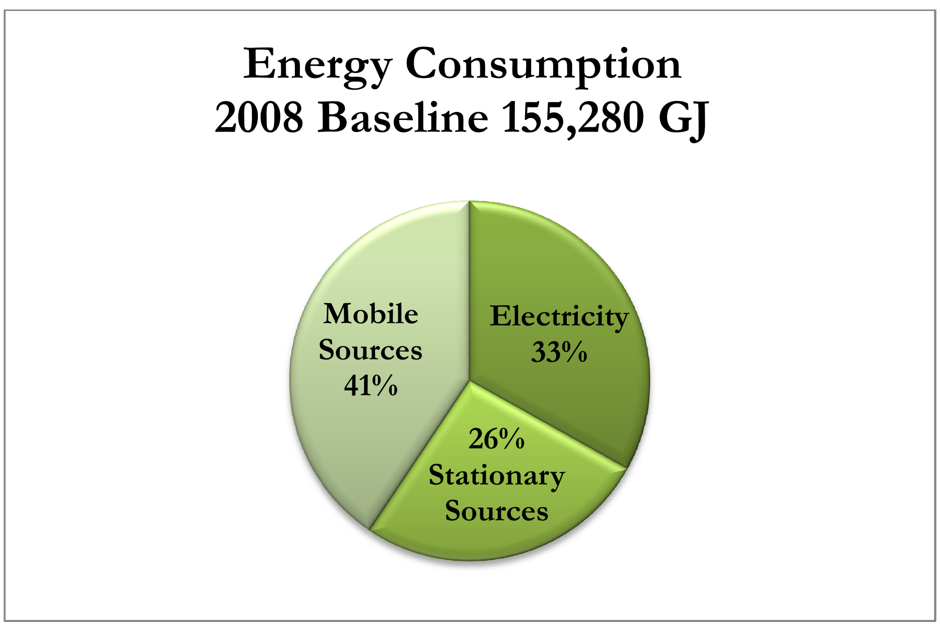


Figure 5 Aggregate profile of Gills Onions' 2008 energy consumption

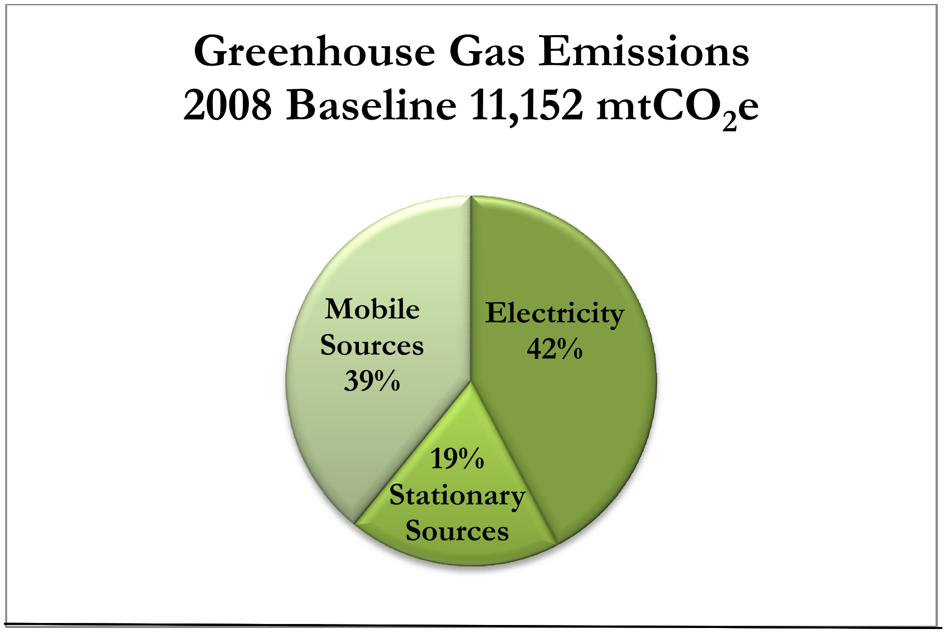


Figure 6 Aggregate profile of Gills Onions' 2008 greenhouse gas emissions

Electricity Baseline

To calculate the baseline electricity consumption, we obtained a detailed breakdown from Gills Onions' utility provider, Southern California Edison (SCE) for 2008.

Total electricity consumption for 2008 was 14.3 million kWh (Table 2). For a full discussion about how the energy consumption and emissions were calculated, see Appendix B. The Oxnard facility used 78% of the total electricity consumption while King City Cooling used the remaining 22%. As portrayed in the aggregate profile of Gills Onions' total energy use, electricity usage represents 33% of the company's total energy consumption (Figure 5).

While we did not calculate the electricity used by each individual process within the Oxnard facility, we identified that Gills Onions' single largest demand for electricity was the ammonia compressor refrigeration system and evaporation towers, which keep the entire 100,000 sq ft processing facility at a constant 32-34°F. The amount of energy this system consumes is dependent on the ambient air temperature, the quantity of onions being stored onsite, and the temperature of the raw onions coming in from the fields. At a minimum, the refrigeration system demand is 50% of the Oxnard facility's electricity consumption and can increase to as much as 75% of the total plant electricity during peak summer production hours[18].

[18] Per Ron Starzl, Engineering Consultant to Gills Onions, electricity demand for refrigeration can vary between 746 kW and 1,164 kW, representing approximately 50% to 75% of Gills Onions' average base load of 1,950 kW during production.

The King City Cooling facility also has a similar ammonia compressor refrigeration system, albeit smaller. However, because there is no production onsite, the cooling system constitutes nearly 100% of the warehouse's energy consumption.

Table 2 2008 Electricity Baseline and Associated Emissions				
Electricity	**Inputs**		**Emissions**	
	kWh	**GJ**	**$mtCO_2e$**	**Percentage**
Gills Onions Oxnard Facility	11,171,162	40,216	3,685.1	78%
King City Cooling	3,120,000	11,232	1,029.1	22%
Total Electricity	**14,291,162**	**51,448**	**4,714.2**	

Emissions

The Climate Registry considers greenhouse gas emissions from electricity to be Scope 2 emissions or indirect emissions. Based on Gills Onions' electricity consumption and where its electricity is supplied from,[19] the company's total 2008 greenhouse gas emissions from electricity were 4,714 metric tons of CO_2e. Emissions from electricity represented the largest proportion (43%) of total GHG emissions (Figure 6)[20].

Analysis

Even with Gills Onions' electricity being provided by relatively clean California sources (primarily natural gas), the difference between energy consumption and emissions underscores the high emissions intensity of electricity as compared to the other energy sources. To compare the emissions intensities of the different energy sources, we calculated the ratio of GHG emissions in CO_2 equivalents to the gigajoules used over the year. The emissions intensity of electricity is more than 80% higher than the emission intensity of natural gas (Table 3).

Table 3 Comparison of 2008 Electricity Vs. Natural Gas Emissions Intensity and Cost Per Gigajoule		
	Emissions Intensity ($mtCO_2e/GJ$)	**Cost per Gigajoule** ($)
Electricity	0.0916	$33.353
Natural Gas	0.0508	$9.024

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[19] The CAMX sub-region called the Western Electricity Coordinating Council –WECC.

[20] Electricity GHG emissions were 4,714 $mtCO_2e$ or 43% of 2008 total GHG emissions of 11,152 $mtCO_2e$.

In 2008, the cost of electricity per gigajoule was more than 3.5 times higher than the cost of natural gas for the same period[21]. While the cost comparison between electricity and natural gas can vary widely from year to year, looking closely at the emissions intensity and costs per gigajoule of electricity reinforces the decision by Gills Onions to reduce its reliance on purchased electricity from the utility grid by producing electricity onsite with AERS.

Gills Onions' AERS project will enable the company to reduce its electricity demand by 5.3 million kWh per year[22]. Based on the 2008 consumption baseline, this will represent a 47% reduction of the company's purchased electricity demand at the Oxnard facility[23].

Stationary Sources Baseline

Gills Onions has a wide variety of stationary equipment which consumes natural gas, diesel, gasoline and propane. To calculate the 2008 baseline for stationary source energy consumption and emissions, we created a detailed inventory of all the stationary equipment onsite and calculated the amount of fuel energy consumed. Unfortunately, Gills Onions had not tracked fuel consumption and usage by equipment type. Therefore we had to extrapolate fuel consumption based on publicly available equipment specifications and anecdotal information from Gills Onions' employees about general usage patterns. The Climate Registry accepts a simplified estimation method for calculating the inventory as long as there is a well documented rationale for the calculation and that the emissions reported using this method constitute less than five percent of total emissions. Table 4 below is the aggregate baseline for stationary source energy usage and associated emissions by fuel type. A detailed description of the stationary source inventory by fuel type follows. A description of the methodology for calculating usage is included in Appendix B.

Table 4 2008 Stationary Sources Aggregate Baseline and Associated Emissions by Fuel Type

Stationary Sources	Inputs		Emissions	
Fuel types	**Therms/ Gallons**	**GJ**	**Metric tons CO_2e**	**Percentage**
Natural Gas (Therms)	373,323	40,588	2,061.26	99.4%
Diesel (Gallons)	762	112	7.76	0.4%
Gasoline (Gallons)	570	75	5.04	0.2%
Propane (Gallons)	30	3	0.17	0.08%
Total Stationary		**40,777**	**2,074.23**	

[21] The average cost per gigajoule of electricity was $33.35 as compared to the average cost of natural gas per gigajoule of $9.02.
[22] Electricity savings from using two 300 kW fuel cells at full capacity = 600 kW*8,760 hours/year = 5,256,000 kWh/yr.
[23] Percentage of electricity saved yearly from fuel cells 5,256,000 kWh/11,171,162 kWh used at the Oxnard facility.

Natural Gas

To understand the total natural gas consumed by Gills Onions, we requested a summary report for 2008 by gas meter, including monthly natural gas consumption. Constellation New Energy is the supplier of the natural gas and Sempra Energy (Southern California Gas) delivers it via pipeline and invoices customers for the gas consumed. We physically located each gas meter, identified the corresponding account number, and determined which piece of equipment ran off of each gas meter.

The total natural gas used by Gills Onions in 2008 was more than 373,000 therms (Table 4), which converts to 40,600 GJ. Of the total stationary source energy consumption, natural gas represented 99.5%, with diesel, propane and gasoline making up the remaining 0.5%. In 2008, natural gas was almost exclusively used for the air compressor which blows the peels off the onions after the tops and tails have been removed. Powered by a Caterpillar Centric 815 horsepower engine, the air compressor used 366,000 therms in 2008, representing 98% of Gills Onions' natural gas consumption. Backup generator maintenance and fuel cell testing constituted the remaining 2% of natural gas consumption[24]. Since the biodigester was not fully implemented until the end of 2009, the company planned to generate electricity from the fuel cells using natural gas instead of biogas in the interim.

Emissions

The Climate Registry required us to identify where the natural gas was generated and the type of equipment using the natural gas, as these factors affect combustion efficiency and the resulting emissions[25]. Total greenhouse gas emissions from natural gas were by far the most significant contributors to Gills Onions' stationary source emissions. Total natural gas GHG emissions were 2,061 metric tons of CO_2 equivalents with emissions from the air compressor (2,023 mtCO2e) constituting 98% of the total.

Analysis

While natural gas represented approximately 26% of Gills Onions' 2008 total energy usage (Figure 5), it represented only 18.5% of the company's GHG emissions (Figure 6). As discussed previously, the emissions intensity of natural gas is substantially lower than the emissions intensity of electricity (Table 3).

In 2009, before the biodigester was fully implemented, Gills Onions powered the two 300 kW fuel cells with natural gas to generate electricity onsite. We estimated that the net savings between purchased electricity and self-generated electricity would be approximately $267,720 if Gills Onions were to run the fuel cells on natural gas for the full year[26].

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[24] In 2008 the back-up generator was tested twice during maintenance and consumed 1,096 therms. In December 2008, the two new 300 kW fuel cells were tested using natural gas and consumed 6,003 therms during the test.

[25] Gills Onions' air compressor was classified as Natural Gas fired, 4 Stroke, Rich Burn, Reciprocating Engine and the backup generator and fuel cell test run was identified as Unknown Electric Power Sector because the majority of the use was for the fuel cell test converting natural gas to electricity.

[26] See Table A1 in Appendix A for a detailed explanation of how costs were derived.

Recommendation: While the largest cost savings for Gills Onions is to use the fuel cells with biogas from the biodigester, there is a potential cost savings associated with using fuel cells with natural gas to generate electricity onsite. We recommend that Gills Onions periodically check the growth of its base load demand for electricity. Should the company's demand increase from 600 kW to the point where it is consistently at 900 kW, Gills Onions should consider adding another fuel cell to meet the need. While the company may not have enough onion waste to fuel another fuel cell, Gills Onions could potentially save in the long term by using another fuel cell powered by natural gas, depending on natural gas prices.

Stationary Sources - Diesel, Gasoline, Propane Baseline

Within the guidelines of the Climate Registry, we calculated an inventory of all the stationary equipment that used diesel, gasoline and propane (Table 5). The data available with regard to total consumption by fuel type for stationary sources was only somewhat accurate and the estimates by type of equipment were even less accurate. For a detailed analysis of our methodology and calculations see Appendix B.

Table 5 2008 Inventory for Stationary Sources by Fuel Type.

Stationary Source Inventory by fuel type	Gallons of Fuel
Diesel	
2 Pressure Washers (5 gal tanks w/ red diesel)	748
2 Pressure Washers (usage per yard record white diesel)	14
Gasoline	
The following equipment are filled from Tony's pump	570
Stand-by waste water pump	
Portable emergency pump	
Portable generator	
2 - Portable Pressure Washers	
Propane	
3 Catalytic Heaters (3 gallons ea.)	9
3 Catalytic Heaters (6 gallons ea.)	18
10 Torches (16 oz ea.)	0.5
30 Bunsen Burners (16.4 oz ea.)	1.5

Recommendation: Based on our experience trying to collect baseline data for stationary sources, we recommended that Gills Onions label each piece of stationary equipment with a number for easy identification. We also suggested that the company create a new record to track fuel usage by type and by piece of equipment. Gills Onions implemented this new procedure in September 2009. The new procedure will provide one quarter of actual recorded data for 2009, which will be helpful in extrapolating and reporting 2009 energy consumption and emissions to the Climate Registry.

Emissions

Using the Climate Registry standard protocols we calculated greenhouse gas emissions from each stationary fuel source (Table 4) which resulted in total combined CO_2e emissions for propane, diesel and gasoline combined of 13.1 metric tons of CO_2e[27]. Collectively this represented 2% of total stationary source emissions and only 0.001% of Gills Onions total greenhouse gas emissions for the year. Our estimates and emissions calculations were verified by RMA and accepted by the Climate Registry.

Mobile Sources Baseline

Gills Onions has a wide variety of mobile sources or vehicles which combust diesel, gasoline and propane. Following the Climate Registry guidelines to generate the 2008 baseline for energy consumption and emissions, we created a detailed inventory of all onsite and on road vehicles. Table 6 below is the aggregate baseline for vehicle fuel usage and associated emissions by fuel type.

Table 6 2008 Mobile Source Aggregate Baseline for Energy Consumption and Emissions

Mobile Sources	**Inputs**		**Emissions**	
Fuel type	**Gallons**	**GJ**	**Metric tons CO_2e**	**Percentage of Total**
Diesel (total)	424,163	62,148	4,309.6	98.7%
Gills Onions	4,916	720	50.27	
Gills Transport	407,329	59,682	4,138.23	94.6%
Rio Farms	11,918	1,746	121.07	
Gasoline	1,696	223	14.95	0.3%
Propane	6,770	682	39.00	0.9%
Total Mobile	**432,629**	**63,053**	**4,363.56**	

Gills Transport and Rio Farms are sister companies of Gills Onions and Steve Gill has operational control over both companies. The services Gills Transport and Rio Farms provide to Gills Onions are essential to its core business – delivering raw onions from the fields, disposing of all the onion waste and delivering approximately 30% of all finished goods to customers within a 300 mile radius of Oxnard. 94.6% of the total mobile source fuel demand (Table 6) and 38.4% of Gills Onions' 2008 total energy consumption are related to Gills Transport activities[28].

Table 7 provides a comprehensive inventory of Gills Onions' vehicles and our estimates for gallons of fuel used by fuel type[29].

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[27] See Appendix B for a detailed description of how the calculations were derived.

[28] Gills Transport diesel fuel consumption of 407,329 gallons is the equivalent of 59,682 GJ, which represents 38.4% of Gills Onions' total energy consumption of 155,280 GJ.

[29] See Appendix B for a detailed description of how the calculations were derived.

Table 7 2008 Baseline Inventory for Mobile Vehicles by Fuel Type	
Mobile Source Inventory	**Gallons**
Diesel – Gills Onions	**4,915.5**
Onsite Vehicles (red diesel/agricultural)	
1 Caterpillar Forklift (20 gal tank)	1,040
3 Yard Dogs* (50 gal tank)	1,350
1 Ford Tractor (20 gal tank)	1,040
On-Road Heavy Duty Vehicles (white diesel)	
1 Ryder Bobtail**	967
1 "Big" Flatbed Truck	261
1 Ryder 24 ft Roll-off special body***	145.5
On Road Light Duty Vehicles (white diesel)	
1 Ford Pickup "Tony's Old Truck" (1995) (January – August, 2008)	112
Diesel – Gills Transport and Rio Farms	**419,247**
Gills Transport	
22 Peterbilt truck engines(1998 – 2008) (435 – 500 horsepower engines)	407,329
Rio Farms	
2 tanker trucks (1,600 and 3,200 gallon capacity)	7,870
2 dump trucks (16,000 and 18,000 lbs capacity)	4,048
Gasoline	**1,696**
On-Road Heavy Duty Vehicles	
1 Ford Flatbed Truck (1990)	67
On-Road Light Duty Vehicle	
Tony's "New" Ford Pickup (2002) (formerly Arturo's Truck)	1,032
Arturo's New Ford Pickup (purchased Aug 2008)	597
Propane	**6,770**
Nissan G24 Forklift	
Nissan 3807 Washing Forklift	
Cat-Bin Dumper Forklift	
Armadillo Power Sweeper****	

*A Yard Dog is an engine with a single person cabin only used onsite to move trailers around the yard.
** A Bobtail is a small refrigeration truck typically used to transport product within a 20-30 mile radius of Oxnard.
***The 24' Roll-off is a specialized truck for hauling the large dumpsters to and from the recycling center and landfill.
****The Armadillo Power Sweeper is similar to a small street sweeper and is used to keep the grounds around the processing facility clean

Diesel – Gills Onions

In 2008, Gills Onions purchased two types of diesel from two different suppliers. Dewitt delivered a total of 3,430 gallons of red diesel which was only used for onsite heavy duty equipment because it is highly polluting. Silvas is the supplier of white diesel which was used for on-road vehicles. In 2008, 1,500 gallons of white diesel was purchased from Silvas by individual employees using a company account.

Diesel – Gills Transport

Gills Transport provided detailed information on 2008 vehicle miles traveled monthly for each of the three delivery activities: raw onions, finished goods, and cattle feed. Total fuel usage by Gills Transport for 2008 was approximately 407,330 gallons to travel a total of more than 2.4 million miles (Table 8). Gills Transport represents 94.6% of the total energy consumption by mobile sources and 38.4% of Gills Onions total energy consumption.

Table 8 Gills Transport Fuel Usage and Miles Traveled by Service Provided (Actual)

Deliveries	Raw Onions	Finished Goods*	Onion Waste as Cattle Feed	Total
Lbs of Onions	217,842,000	30,994,000	38,145,400	
Miles	1,831,122	409,950	165,636	2,406,708
Fuel Usage (diesel)	305,187	74,536	27,606	407,329

*Excludes finished goods transported by other carriers besides Gills Transport

Diesel - Rio Farms

Rio Farms was contracted to dispose of Gills Onions' solid and liquid onion waste in 2008, before the biodigester was implemented. We estimated that Rio Farms' use of white diesel in 2008 was 7,870 gallons for hauling liquid onion waste to the fields, and 4,048 gallons of white diesel for hauling solid onion waste to the fields (Table 9). Gills Onions was generating so much onion waste that the tanker and dump trucks were hauling on a continuous basis, averaging more than 15 trips per day.

Table 9 2008 Rio Farms Estimated Fuel Usage and Vehicle Miles Traveled (estimates)

Deliveries	Liquid Onion Waste	Solid Onion Waste*
Lbs of Waste	56,031,200	24,013,400
Miles	43,275	22,262
Fuel Usage (diesel)	7,870	4,048

*Gills Onions stopped sending solid onion waste to the fields in April 2008 and began selling it as cattle feed.

Gasoline

In 2008, Gills Onions purchased approximately 1,700 gallons of gasoline from Silvas which represented 0.3% of Gills Onions total mobile source energy consumption[30]. For all on-road vehicles, particularly gasoline-based, it was important to collect the model year because this affects average fuel economy due to the environmental regulations at the time of manufacture.

[30] Gasoline consumption in 2008 totaled 1,696 gallons which converts to 223 GJ of energy and represents 0.3% of the total mobile source energy consumption of 63,054 GJ.

Propane
In 2008, onsite vehicles used 6,770 gallons of propane or 1% of the company's total energy consumption by mobile source[31].

Emissions
According to the Climate Registry General Reporting Protocol, CO_2 emissions from mobile sources are directly related to the quantity of fuel combusted, thus are calculated based on fuel consumption. CH_4 and nitrous oxide (N_2O) emissions depend more on the emissions control technologies employed by the vehicle and distance traveled, therefore emissions calculations require vehicle type and year as well as vehicle miles traveled.

In 2008, Gills Onions emissions from mobile sources totaled 4,364 metric tons of CO_2e, representing 39% of the company's total greenhouse gas emissions for the year (Figure 6). The single largest contributor to the mobile source emissions was Gills Transport, representing nearly 95% of the total mobile source emissions (Table 6). Rio Farms was the second largest contributor to mobile source emissions with 3%, and Gills Onions' own mobile source emissions, including diesel, gasoline and propane, represented the remaining 2% of the total GHG emissions for mobile source.

Analysis
For the purposes of the Climate Registry, since Gills Onions does not have ownership of Gills Transport and Rio Farms, the company is not required to report emissions associated with these services. Consequently, Gills Onions' GHG emissions reported to the Climate Registry were 6,894 metric tons of CO_2e. In comparison, we included the collective 4,259.3 metric tons CO_2e of emissions associated with the services provided by both Gills Transport and Rio Farms for a total companywide emissions inventory of 11,152 metric tons of CO_2e. This represents a 38% difference between what was required in the Climate Registry and what we considered to be the results of Gills Onions' core business decisions and practices and underscores the importance of boundary definitions in greenhouse gas inventory and emissions reporting. While Gills Onions' emissions inventory and reporting are purely voluntarily, it is easy to see how large companies who are facing mandatory reporting could find ways to hide emissions and avoid reporting by dividing a company into smaller and smaller businesses, thereby staying under the mandatory reporting threshold of 25,000 metric tons CO_2e[32].

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[31] Propane consumption equaled 6,770 gallons which converts into 682 GJ and represents 1.0% of Gills Onion's total energy consumption for 2008 of 63,054 GJ.
[32] AB 32 mandatory reporting threshold is 25,000 $mtCO_2e$.

Recommendation: We see the value in supply chain greenhouse gas emissions reporting. We believe that looking at GHGs emitted along the supply chain would provide transparency as to where emissions are being generated and impose pressure to reduce emissions at the source. Using such an approach would prevent emissions from simply being exported to another trading partner. Because Gills Onions sees value in this approach, it is planning to do a follow-up group project with the Bren School focusing even further upstream at the ecological footprint of the growing fields.

Analysis - Gills Transport

Recognizing that transportation was such a substantial component of Gills Onions' emissions, we identified three ways the company will be able to reduce these emissions in the future. First, when Gills Onions fully implements its strategy for selling solid onion waste as cattle feed and using the liquid onion waste for energy, the need for Rio Farms to haul solid and liquid onion waste to the fields will be eliminated. Eliminating land application will not only reduce the emissions associated with the transportation by approximately 121 metric tons of CO_2e (Table 6), but will also eliminate the CO_2 and CH_4 emissions associated with land application of onion waste itself.

Second, we identified that Gills Transport has recently improved the fuel economy and reduced the emissions of its fleet. Gills Transport fleet inventory included 22 truck engines which, in our base year of 2008, were all Peterbilt engines. All of these trucks had been previously retrofitted with catalytic converters, ahead of regulatory deadlines, to reduce emission toxicity. However, the catalytic converters reduced the average mpg from 6 to approximately 5.2. To deal with increasing fuel prices, in 2009 Gills Transport began converting its entire fleet over to Freightliner engines which get 20 percent better fuel mileage and lower emissions. According to Ron Perry, Manager of Gills Transport, it was more cost effective to replace its entire fleet than to retrofit the Peterbilt engines. He estimates that the additional fuel cost savings will more than offset the difference between the replacement costs and retrofit option.

Gills Transport has been increasing transportation efficiency by:

- Increasing the load capacity of its refrigeration units from 48 to 53 feet and its open bed trailers by moving from singles to sets of doubles[33];
- Minimizing the number of empty trucks on the road;
- Consolidating loads for better utilization;
- Using ultra-low sulfur diesel (ULSD) fuel in all its engines;
- Installing a new valve stem to improve engine operation and reduce emissions;
- Deploying new technology to automatically control temperatures in the refrigeration units for greater efficiency[34];

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[33] An engine can pull one single trailer or two double trailers. The increased capacity of the double trailers increases fuel efficiency per load of onions.

[34] The controls turn off the cooling system when the trailer is at the desired temperature to save energy.

- Replacing all of its tires with the new low rolling resistance tires which can improve fuel mileage by 15%[35].

While the capital investment costs of these improvements is significant, Gills Transport has implemented systems that both reduce environmental impacts and reduce costs in the long run.

Finally, Gills Onions can affect the emissions associated with the transportation of onions if and when it develops a new onion processing facility currently being planned for King City. Purely from a transportation perspective, building a processing facility in King City would put processing capabilities 230 miles closer (one way) to two of Gills Onions' three growing regions (King City and San Joaquin) as well as closer to many of its customers.

In summary, Gills Onions' has taken significant strides to reduce the fuel consumption and emissions impact from its transportation services by eliminating the need to haul onion waste for land application and increasing the fuel efficiency and optimization of Gills Transport vehicles.

Summary 2008 Baseline of Energy Use and Emissions

The total energy consumption for 2008 was 155,280 gigajoules with a mix of 33% from electricity, 26% from natural gas, 40% from diesel, and the remaining 1% from gasoline and propane consumption (Table 10).

[35] Low rolling resistant tires will become mandatory in 2011 as an AB 32 Scoping Plan Early Action item.

Table 10 Summary 2008 Baseline of Energy Use and Emissions				
	Inputs			Total Emissions
Electricity	**Dollars**	**kWh**	**GJ**	**$mtCO_2e$**
Gills Onions Oxnard	$1,341,558	11,171,162	40,216	3,685.13
King City Cooling	$374,400	3,120,000	11,232	1,029.10
Total Electricity	**$1,715,958**	14,291,162	**51,448**	**4,714.23**
Stationary Source	**Dollars**	**Therm/Gal**	**GJ**	**$mtCO_2e$**
Natural Gas (Therms)	$366,283	373,323	40,588	2,061.26
Diesel (Gallons)	$1,810	762	112	7.76
Gasoline (Gallons)	$2,280	570	75	5.04
Propane (Gallons)	$ 76	30	3	0.17
Total Stationary	**$ 370,449**		**40,777**	**2,074.23**
Mobile Source	**Dollars**	**Gallons**	**GJ**	**$mtCO_2e$**
Diesel -Total	$1,733,208	424,163	62,148	4,309.58
Gills Onions	$14,294	4,916	720	50.27
Gills Transport*	$1,670,051	407,329	59,682	4,138.23
Rio Farms*	$ 48,864	11,918	1,746	121.07
Gasoline	$ 6,785	1,696	223	14.95
Propane	$ 17,260	6,770	682	39.03
Total Mobile	**$1,757,253**	432,629	**63,054**	**4,363.56**
Group Project Total	**$ 3,843,661**		**155,280**	**11,152**
Reported to Climate Registry			**93,852**	**6,894**

* Gills Transport and Rio Farms transportation emissions were excluded from the Climate Registry and included in our calculations

Gills Onions' energy consumption costs a total of $3.8 million or an average of $24.75/GJ. Cost per gigajoule ranged from $9.02 for natural gas to $33.33 for electricity. In 2008, Gills Onions' associated greenhouse gas emissions amounted to 11,152 metric tons of CO_2e (Table 10). The major components of were: electricity consumption at the Oxnard facility (33%); natural gas emissions, primarily due to the Caterpillar engine air compressor (18.5%); and emissions from diesel consumption (38.6%), most of which were attributable to Gills Transport services. The emissions intensity ratio of GHG emissions ranged from 0.05 $mtCO_2e$/GJ for natural gas to 0.09 $mtCO_2e$/GJ for electricity (Table 11).

Table 11 Greenhouse Gas Emissions Intensity by Fuel Source	
Fuel Source	**Emissions Intensity (mtCO_2e/GJ)**
Electricity	0.0916
Natural Gas	0.0508
Diesel	0.0698
Gasoline	0.0669
Propane	0.0570

In 2008, natural gas was consistently the most cost effective fuel and with the lowest associated emissions. In 2010, biogas produced from onion waste will become the fuel alternative with the lowest emissions profile, since it virtually generates no greenhouse gas emissions[36].

The total GHG emissions (11,152 mtCO2e) that we attributed to Gills Onions' operations in 2008 for this group project differs significantly from what we reported to the Climate Registry (6,894 mtCO2e). The difference was primarily due to our inclusion of those transportation elements for which we were confident that Gills Onions had operational control, including the onion and onion waste delivery services provided by Gills Transport and Rio Farms.

Recommendations

1. **Establish KPI's**-We suggest that Gills Onions create key performance indicators (KPIs) to measure and track energy use as a percentage of a unit of production (e.g. per pound of onions sold). Not only will this raise awareness of energy usage, it will provide ongoing information to track results of energy efficiency programs.

2. **Conduct Energy Audit-** We recommend that Gills Onions conduct a comprehensive energy audit of all of its internal processing activities to identify where energy efficiency improvements can be made. Gills Onions' largest energy consumers, the refrigeration system and the air compressor, continue to be the most obvious places to look for large energy efficiency improvements. New ideas and technologies come to market regularly which would make it beneficial to reevaluate the refrigeration system and air compressor on a regular basis. By conducting a comprehensive energy audit, Gills Onions will be able to identify smaller and perhaps easier opportunities for energy efficiency improvements within the processing plant. For example, the lights currently used in the processing facility could be replaced with new fixtures and bulbs that are more efficient.

[36] Ironically, Gills Onions' ability to create biogas and onsite electricity is ultimately limited by the amount of onion waste available, which was the entire problem that prompted the AERS solution in the first place.

3. **Turn Off Idling Equipment** - Another opportunity we identified to conserve energy was to turn the engines of the Yard Dogs[37] off as the trailers are being filled with cattle feed and only turn the engines on again to move the trailer forward.

4. **Reuse Waste Heat** - Another opportunity for Gills Onions is to identify new applications for using the waste heat generated by the Caterpillar air compressor (up to 67.8 therms/hr from exhaust heat) and the fuel cells (650-750°F). The company is already using some waste heat from the air compressor to warm the biodigester. Cogeneration or combined heat and power are the most efficient applications for the waste heat; unfortunately, Gills Onions' processing facility does not require heating equipment such as boilers. One potential application is to use waste heat to generate more electricity onsite using a Stirling engine[xiv].

5. **Time of Use** - Gills Onions should continue to investigate "time of use" options where the company could save money by reducing energy consumption during peak periods. There are several options, including adjusting shift schedules or storing energy during off peak times for use during peak periods. The advantage to Gills Onions is obvious as SCE offers significantly reduced rates during off peak periods. For example, if Gills Onions were to acquire a bank of batteries, it could generate electricity onsite from biogas in the morning and store it for use during peak periods, thus avoiding emissions from lower-quality sources. While utilities such as SCE are aggressively building their portfolio of renewable energy sources, meeting increasing energy demand and peak loads continue to create pressure to build more power plants[xv.]

In conclusion, by implementing these recommendations, Gills Onions will be able reduce energy consumption and the associated emissions, while improving the bottom line.

[37] Yard Dog is a single cab engine used onsite only for moving trailers.

Water: At a Glance

Zero Waste Strategies and Innovation for Sustainability

SPRING 2010

Water

Objectives:

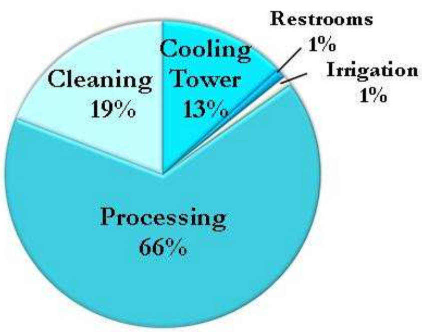
- Identify the amount of water consumed at Gills Onions' processing facility and the associated costs for 2008.
- Quantify the amount of wastewater generated in 2008 and the associated costs.
- Find opportunities to reduce water consumption on-site and provide recommendations that are economically beneficial.

Methodology:

- Used Gills Onions' utility bills and data provided by the city of Oxnard.
- Calculated usage for cooling tower, biodigester and cleaning based on company records.

2008 Baseline:

Water Consumption: 81 Million Gallons
Consumption Cost: $266,000



Wastewater Discharge: 79 Million Gallons
Wastewater Cost: $250,000

Findings:

- The refrigeration system (cooling tower) represented 13% of all water consumption in 2008.
- The implementation of the biodigester in 2010 will increase water consumption by 15 million gallons annually.
- End-of-night cleaning represented 19% of all water consumption in 2008.
- Were unable to estimate water usage by process due to a lack of individual flow meters in the facility.
- Water rates in the city of Oxnard have been and are continuing to increase.
- Wastewater treatment plant on-site could provide source of water.

Recommendations:

- Reuse water from wastewater treatment plant as source of water for biodigetser, cooling tower and irrigation.
- Install flow meters on all water consuming processes to measure water efficiency.
- Implement key performance indicators (KPI) based on production to quantify, track and reduce water consumption.

2010 Projections:

- Water consumption will increase by at least 15 million gallons or 19% due to implementation of the biodigester.
- Water costs will increase.

Potential Benefits

Reduce Water Consumption by 30% Annually

Waste Reduction

25 Million Gallons of Fresh Water

Potential Savings

Resource Category	Annual Savings	Payback Period (Years)
Water	$215,000	3 - 4

Water

Gills Onions uses large amounts of water during virtually every stage of onion processing and in everyday operations. Water is used to rinse, clean and transport onions between processes. It is used to clean equipment and the facility. It is used in bathrooms, the kitchen and for irrigation. Water is added constantly to both the cooling tower and more recently to the biodigester to supplement onion juice and reduce foaming. Gills Onions also has an aerobic wastewater treatment plant onsite which is used to treat its wastewater before it is disposed of into the city of Oxnard's sewer system. This aerobic wastewater treatment plant is a potential source of recycled water for some water consuming processes.

Water Consumption

In terms of water, achieving a zero waste goal includes identifying those areas where water waste is being generated either through inefficiencies or over-use, and identifying where opportunities exist to reduce, reuse or recycle water whenever possible. To identify areas where water waste was being generated, we first needed to understand how much water was consumed on a regular basis. By establishing a baseline we wanted to document current water consumption and practices and to create a measurement system that could be used to set goals for the future and document continual improvement. We analyzed Gills Onions' water usage over a two year period by compiling monthly utility information from the city of Oxnard for January 2008 through the end of December 2009. Gills Onions has two main water meters that are read by the city to calculate water usage[38] [39]. Annual water consumption from 2008 and 2009 is presented in Table 12.

Table 12 2008 and 2009 Baseline Annual Water Consumption

2008 Baseline (Gallons)	2009 (Gallons)	Change in Volume (Gallons)	% Change in Water Consumption
80,874,139	79,247,968	-1,626,171	-2%

In 2008, total water consumption was approximately 81 million gallons with average monthly water consumption equal to 6.7 million gallons. In 2009, total water consumption was 79.2 million gallons with average monthly water consumption equal to 6.6 million gallons. Average monthly water consumption fluctuates between 5.4 and 8.6 million gallons. From 2008 to 2009, total water consumption decreased by 2%.

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[38] Water meter #1366188 (3" meter) and #45073191 (2" meter).
[39] The city reports water usage from each of these meters on two separate bills using Hundred Cubic Feet (HCF) of water consumed. We combined the total HCFs from these two meters and converted to gallons to report the total water consumption on a monthly basis.

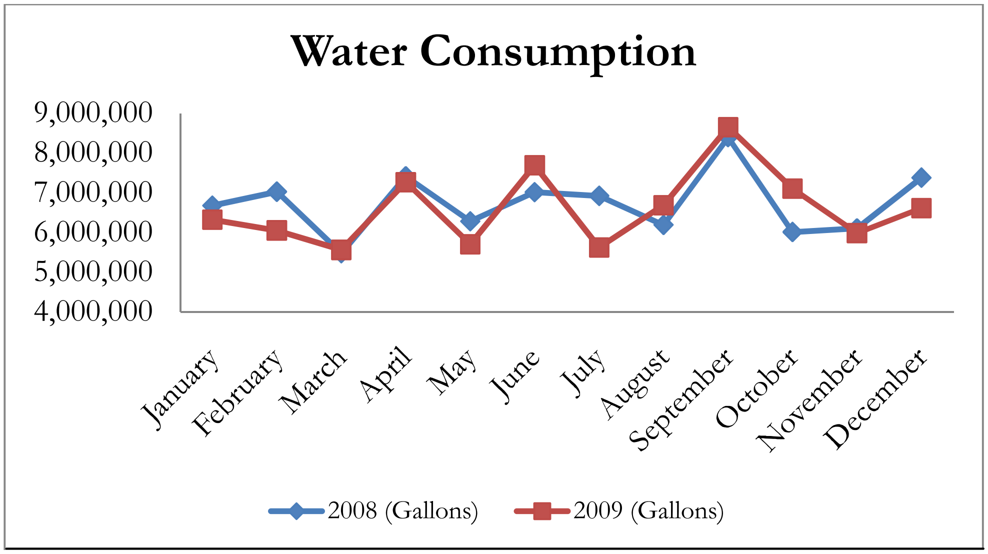

Figure 7 2008 vs. 2009 monthly water consumption comparison

Although there is no clear seasonality trend, September is consistently the highest water consumption month which maybe correlated to weather or conditions of the onions from the field.

Water Consumption vs. Onion Production

Since Gills Onions was not regulating water based on volume, we wanted to provide the company with a baseline metric for water consumption that is based on the primary output of its business. For this reason, we analyzed Gills Onions water consumption as a function of total onions processed.

In 2009, the volume of onions shipped decreased each month (with the exception of November) relative to 2008 (Figure 8).

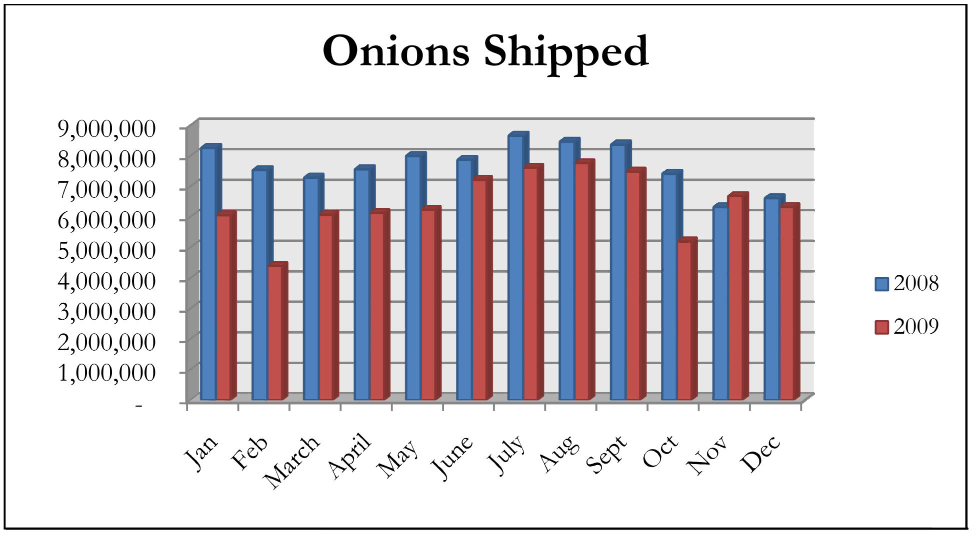

Figure 8 Onions shipped 2008 vs. 2009

We divided the number of onions shipped each month by the amount of water consumed each month (Table 13). We determined that from 2008-2009, even though water consumption decreased overall, the volume of water consumed per pound of onion shipped actually increased in nine out of 12 months, with an average increase for the year equal to approximately 20%.

Table 13 Gallons of Water Used Per Pound of Onions Shipped 2008 vs. 2009 (Gallons)

	2008 Gallons of Water/lb of Onions Shipped	**2009 Gallons of Water/lb of Onions Shipped**	**% Change in Gallons of Water/lb of Onions Shipped**
January	0.808	1.04	29%
February	0.933	1.38	48%
March	0.752	0.92	22%
April	0.980	1.19	21%
May	0.785	.92	17%
June	0.892	1.07	20%
July	0.799	0.74	-8%
August	0.731	0.86	18%
September	1.003	1.16	15%
October	0.811	1.37	69%
November	0.966	0.90	-7%
December	1.116	1.05	-6%
Average	**0.88**	**1.05**	**19%**

Surprisingly, even in some months where the volume of onions shipped declined, water consumption increased. (Figure 9).

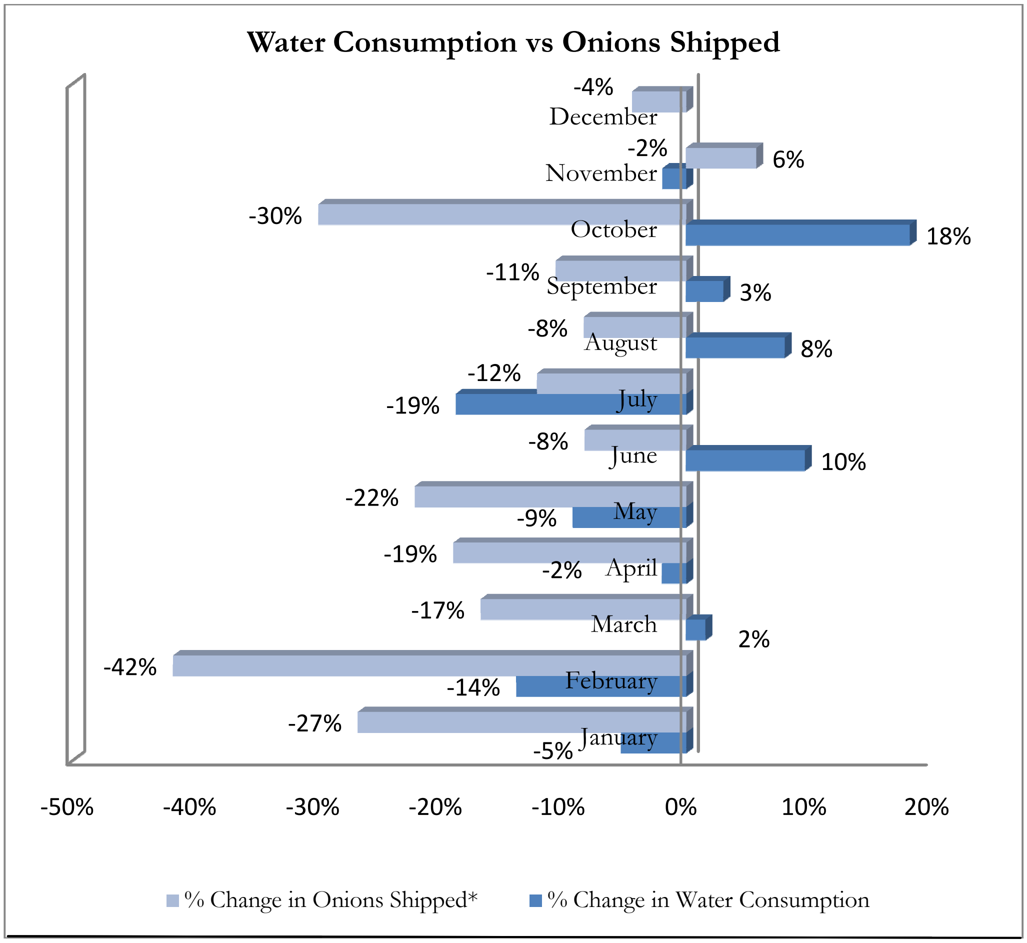

Figure 9 Water consumption vs. onions shipped

Gills Onions currently does not regulate the amount of water consumed as a function of onions shipped or processed. This does not necessarily mean that the company is managing its water use inefficiently. For example, the cooling tower, power washing, restrooms, and irrigation consume water independent of how many onions are processed. However, Gills Onions could regulate the amount of water that is used depending on how many onions are currently being processed. For example, the water that is re-circulated in the flues to rinse and transport onions could potentially be adjusted to correlate more closely with the volume of onions processed. To assess the feasibility and potential benefit of such a change, it is necessary to use flow meters on each of the water consuming processes within the plant.

Water Consumption by Onion Processing Activities

Gills Onions currently does not have individual water flow meters on any of its processing equipment, so we were unable to calculate the total amount of water consumed by individual processes, or associate any volume of water used with volume of onions processed on the 'line' in real-time. Monitoring and controlling the amount of water used based on pounds of onions processed might help reduce water consumption in Gills Onions' everyday processing operations.

Gills Onions does have flow meters that measure the amount of water consumed by both the biodigester and the cooling tower.

Biodigester Water Consumption

Water is added to the biodigester to dilute the onion juice and to reduce foaming. The flow meters on the biodigester control the amount of water that is added to the biodigester on a per minute basis (Table 14). Gills Onions began filling the biodigester in August 2009 and it has been generating biogas since September 2009. Since September 2009 Gills Onions has been adding 28 gallons of fresh water per minute or 14.7 million gallons of water annually to the biodigester[40]. Assuming that 2010 water consumption levels stay constant, we estimate that the biodigester will represent 15% of total annual water consumption.

Table 14 Projected 2010 Biodigester Consumption as Percent of Total Water Consumption

Biodigester Consumption (Gallons Per Minute)	Annualized Biodigester Consumption (Gallons)	Projected Total Water Consumption*	% of Total Water Consumption
28	14,716,800	95,590,939	15%

*Total projected water consumption was calculated by taking 2008 water consumption and adding projected Annual Biodigester Consumption.

At present, Gills Onions purchases potable water from the city of Oxnard for the biodigester. As will be described below, Gills Onions could use recycled water from its wastewater treatment plant for the biodigester.

Cooling Tower Water Consumption

Gills Onions has an evaporative cooling tower onsite that consumes freshwater. The cooling tower is part of the refrigeration system that is used in the onion processing facility. Almost all of the water that enters the cooling tower is eventually evaporated into the atmosphere. What is not evaporated is eventually discharged to the onsite wastewater treatment plant (WWTP).

[40] 1.2 million gallons of water per month.

Gills Onions has a water meter on its cooling tower that is read and recorded daily in hand-written logs. Given that Gills Onions is going through the effort to collect this information, there is an opportunity to report it electronically and use in a more meaningful way.

We relied on the handwritten longs to calculate the total amount of potable water consumed by the cooling tower on a monthly and annual basis. According to our calculations, in 2008 the cooling tower consumed 10.87 million gallons of water, representing 13% of Gills Onions' total annual water consumption (Table 15). In 2009 the cooling tower consumed 8.69 million gallons of water, which represents 11% of total annual water consumption.

Table 15 Cooling Tower Water as Percent of Total Water Consumption (gallons) 2008-2009

2008			2009		
Cooling Tower (Gallons)	**Total Water (Gallons)**	**Cooling Tower as % of Total**	**Cooling Tower (Gallons)**	**Total Water (Gallons)**	**Cooling Tower as % of Total**
10,873,500	80,874,139	13%	8,693,400	79,247,968	11%

As described below, Gills Onions could use recycled water from its wastewater treatment plant for the cooling tower, instead of using fresh potable water. By reusing wastewater in the cooling tower, the company will significantly reduce the amount of water consumed onsite.

Other Water Usages

Other uses of water onsite include water used for cleaning both the facility and the equipment, water used in employee bathrooms and in the kitchens, and water used for irrigation outdoors.

Cleaning

Gills Onions currently relies on a nighttime sanitation crew to power wash the entire facility. Gills Onions keeps handwritten logs that indicate the meter readings before and after the nightly cleaning crew activities. Based on an analysis of these logs, we determined that in 2008 cleaning represented 19% of Gills Onions' total water consumption. Water consumption used for cleaning costs the company $76,000[41] [42]. Because water rates continue to rise, we expect these water costs to approach $86,000 in 2010 (Table 16).

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[41] Based on 2008 water consumption costs at 2008 rates plus .907 for wastewater volume at 2008 wastewater rates, excluding BOD and TSS charges.

[42] Note that the highlighted areas in the table above indicate where we believe that the handwritten logs may have had errors and resulted in inflated numbers for the month.

Table 16 Water Used for Cleaning			
2008 Water Used for Cleaning Equipment			
Gallons	**Consumption Cost***	**Wastewater Cost****	**Total Actual 2008 Costs*****
15,606,492	$49,508	$26,477	$75,985
2010 Projected Water Costs for Cleaning			
Gallons	**Consumption Cost*******	**Wastewater Cost****	**Projected 2010 Costs*********
15,606,492	$59,356	$26,581	$85,937

*2008 Consumption values at 2008 rates
**Based on .907 average wastewater rate
***Based on 2008 rates excluding Biochemical Oxygen Demand (BOD) and Total Suspended Solids (TSS)
****2008 Consumption Values at 2010 rates
*****Based on 2010 rates excluding BOD and TSS

Bathrooms & Kitchen

Gills Onions currently has a total of 25 toilets, 6 urinals and 17 sinks in the employee bathrooms located throughout the processing and office facilities. The toilets are 1.6 gallon (6 liters) per flush, the urinals use no more than 1.0 gallon per flush and the lavatory sink faucets use no more than 2.2 gallons per minute. Gills Onions has sinks that are located in both the kitchens and quality assurance areas which are used infrequently. Based on assumptions about Gills Onions' 375 employees', we calculated that these activities consume approximately 1% of Gills Onions' total water consumption.

Irrigation

Gills Onions uses water to irrigate the landscape surrounding the outside of its processing facility. The islands that divide the parking lot consist mainly of grasses and rose bushes, while the areas surrounding the parking lot consist of bushes, shrubs, trees and grasses. A sprinkler system is used to water the landscape and is managed by a contract gardener. In 2009 the sprinklers were set to water the landscape once daily for 15 minutes. In January 2010, Gills Onions hired a new gardener, who has changed the irrigation schedule, reducing the frequency to three times per week for seven minutes. We estimate that irrigation represents less than 1% of total water consumption.

While Gills Onions currently uses freshwater to irrigate its landscape, the company has in place the appropriate plumbing required to use recycled water for irrigation. However, the company currently does not use recycled water for this purpose because the total suspended solids (TSS) are too high. We believe that Gills Onions could reduce its water consumption by decreasing the TSS loads in its wastewater and reusing the wastewater for irrigation instead of using fresh water from the city.

Summary
Figures 10 and 11 below show the percent of total water consumption by activity for Gills Onions in 2008 and projected water consumption for 2010.

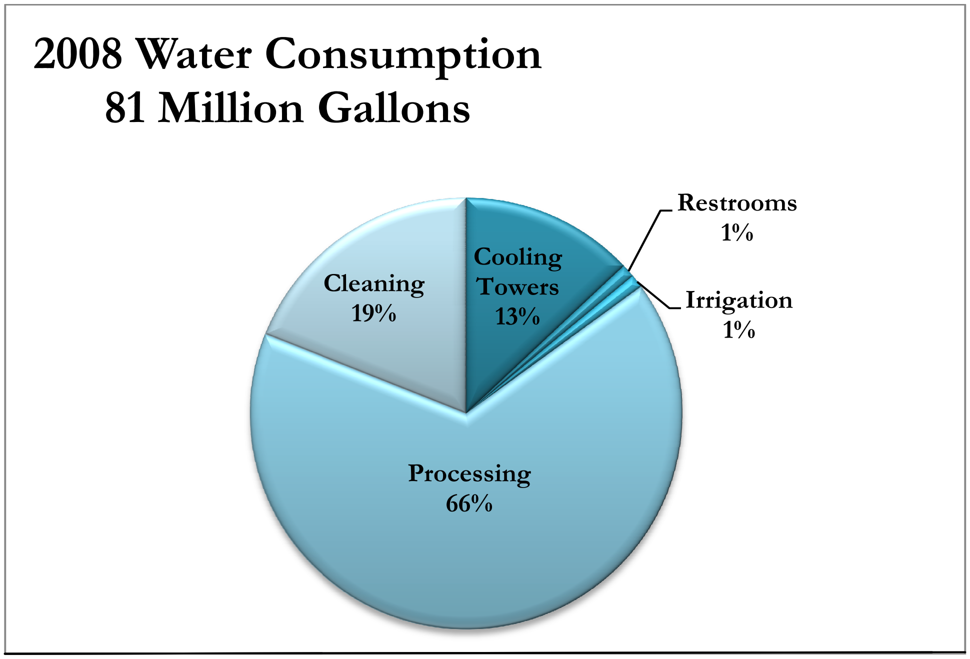

Figure 10 Percent of total water consumption by activity (2008)

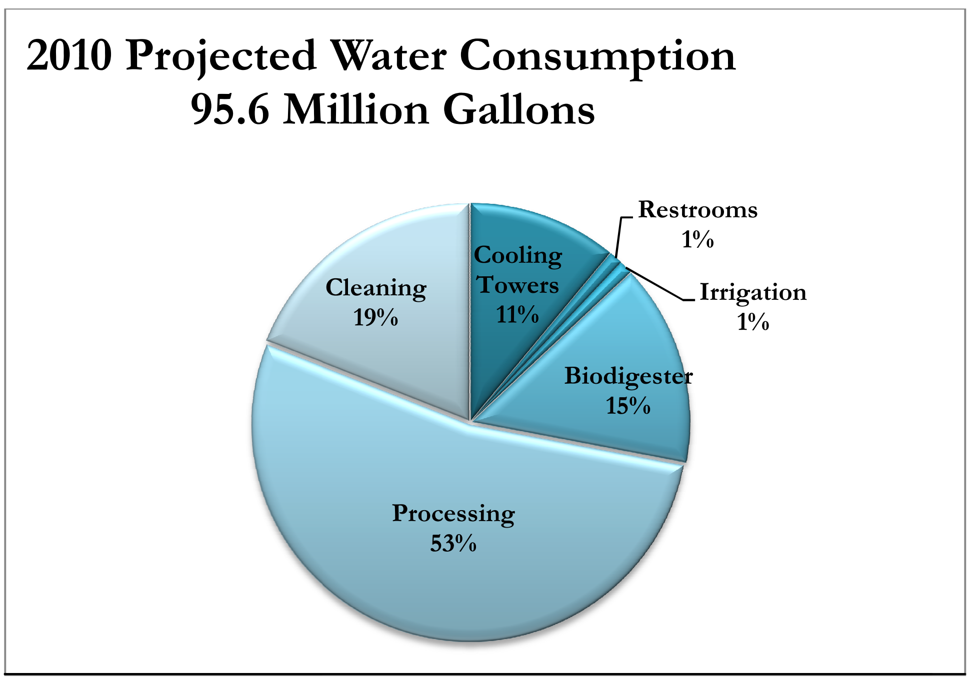

Figure 11 Projected water consumption by activity (2010)

Water Purchase Costs

For Gills Onions, water usage represents a substantial cost of doing business. From 2008 to 2009 water costs increased by 10% even though total water consumption actually decreased by 1.6 million gallons (Table 17).

Table 17 2008 Vs. 2009 Water Consumption and Cost Comparison

	2008	2009	Change	% Change	% Change in Onions Shipped
Consumption (Gallons)	80,874,139	79,247,968	-1,626,171	-2%	-16%
Costs ($)	$266,161	$292,990	$26,829	10.08%	-16%

Increasing Water Costs

A comparison of proposed Oxnard City Industrial Entity water rates, effective July 1, 2010, reveals that rates have increased between 34-37% since August 2006 (Table 18). Given the current water shortages and other water restrictions in California, this trend is not likely to reverse. Water rates can be expected to continue rising.

Table 18 City of Oxnard Industrial Water Rates 2006 - 2010

						Comparison of Change of Rates 8/2006 to 7/2010	
Item Charge	**Rates as of 08/06**	**Rates as of 01/08**	**Rates as of 01/09**	**Rates as of 12/09**	**Rates as of 7/10**	**Actual Change in Rates**	**% Change in Rates**
Meter 3" ($/Month)	$54.73	$65.22	$72.62	$73.71	$75.18	$20.45	37%
Over 23 HCF($/HCF)	$2.14	$ 2.37	$2.77	$2.81	$2.87	$ 0.73	34%

Wastewater Costs

Gills Onions is charged to send its wastewater to the municipal sewer. The company's WWTP treats wastewater from the processing facility to acceptable BOD and TSS levels, in compliance with municipal standards. Wastewater charges include charges for wastewater volume, associated BOD, and TSS levels for each month[43]. Since there is not a working meter on the WWTP measuring how much wastewater is actually being discharged to the city, the volume of wastewater that Gills Onions is charged for is not actually based on a real volume of wastewater. Instead, the company is charged for

[43] The monthly water bills include a single charge for wastewater. The bill does not include the volume of wastewater the company is charged for, or the associated pounds of BOD and TSS. The wastewater charges are based on a formula of total volume, pounds of BOD and pounds of TSS. In addition, the wastewater charges reflected on each monthly bill correspond to the water volume consumed the previous month. We calculated actual monthly wastewater charges, based on reports provided by the city of Oxnard.

wastewater discharges based on 90% of the volume of incoming water purchased from the city of Oxnard[44]. The company is also charged according to the levels of BOD and TSS in the wastewater that exceed the city's acceptable limits[45]. In evaluating all of Gills Onions' water consumption and wastewater volume numbers for 2008 and 2009, it appeared that in 2008, the company was invoiced for wastewater consumption based on using 90.7% of its total water consumption, and in 2009 on 93.8% of total water consumption (Table 19).

Table 19 Volume of Wastewater as Percent of Total Water Purchased 2008 & 2009

Year	Water Purchases (Gallons)	Wastewater (Gallons)	% of Total	Wastewater Costs ($)
2008	80,874,139	73,350,000	90.7%	$248,693
2009	79,247,968	74,371,341	93.8%	$255,531

Purchase volumes derived from Gills Onions Water bills. Wastewater volumes and cost derived from city of Oxnard.

The cost for Gills Onions to discharge its wastewater to the city was $248,693 in 2008, based on delivering 73.4 million gallons of wastewater. In 2009 the cost was $255,531, based on delivering 74.4 million gallons of wastewater, representing a 1.36% increase in price per gallon of wastewater[46].

Increasing Wastewater Costs

A comparison of proposed Oxnard City Industrial Entity water rates effective July 1, 2010 with water rates from January 2009 reveals that rates for BOD are expected to increase 132% during this time period (Table 20). While total volume and TSS rates are not expected to increase as dramatically (1.4% and 7.3% respectively) they are still going up. Unfortunately, because of the increasing expense of treating water and other water quality restrictions in California, wastewater rates can be expected to continue rising.

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[44] Gills Onions is charged based on total water consumed and receives a 10% credit for the wastewater volume.

[45] Gills Onions reports BOD and TSS levels weekly to the City of Oxnard. The city's maximum acceptable level for BOD is 800 ppm and for TSS it is 1,000 ppm. The monthly wastewater charges reflected in water bill for volume, BOD and TSS are two months in arrears. For example, a March 2009 water bill will show water consumption charges for the same month but waste water volume, BOD and TSS charges for January 2009.

[46] Table C1 in the Appendix indicates how water consumption charges and waste water charges have increased from 2008 to 2009.

Table 20 City of Oxnard Industrial Wastewater Rates for Industrial Users 2009 – 2010					
Item Charge	**Rates Effective 1/09**	**Rates Effective 12/09**	**Rates Effective 07/10**	**Comparison of Change of Rates 1/2009 to 7/2010**	
				Actual Change in Rates	**% Change in Rates**
Wastewater Discharge ($/Millions gallons)	$ 1892.47	$ 1819.43	$1919.43	$26.96	1.4%
BOD ($/Thousand lbs)	$264.11	$515.31	$615.31	$351.20	132%
TSS ($/Thousand of lbs)	$364.58	$362.26	$391.24	$26.66	7.3%

Recommendations

The following recommendations offer Gills Onions real opportunities to reduce water consumption and move closer to its zero waste goal and to enable the company to reduce costs and improve profitability.

1. **Install Meters in All Water Using Areas** – Gills Onions should install flow meters on all of its processing lines that involve water so that processes can be analyzed for water efficiency and water flow rates can be optimized for production volumes.

2. **Create a Water-Based Metric for Management Reporting** – Gills Onions should create key performance indicators (KPI) that allows it to easily measure how much water is being consumed each month as a function of the number of onions processed or some other function of onion production. Once flow meters are installed, the company could identify how much water is being consumed per pound of onions processed at various stages of onion processing. By establishing a water-based reporting indicator, Gills Onions would be able to proactively reduce the amount of water required at each stage of processing. The company could encourage staff to implement water efficient practices with charts showing progress and savings, by using incentive programs and rewards, and by using in-language signs and posters.

3. **Use Recycled Water for the Biodigester** – Gills Onions could use recycled wastewater from its aerobic WWTP in its biodigester instead of using fresh potable water purchased from the city. By using recycled water, we estimate that Gills Onions would be able to reduce its fresh water consumption by approximately 14.7 million gallons per year at an annual savings of approximately $88,000.

4. **Use Recycled Water for the Cooling Tower** – Gills Onions could use recycled wastewater in the cooling tower instead of fresh potable water purchased from the city. Recycling would allow the company to reduce its fresh water consumption by approximately 9.8 million gallons at an annual savings of approximately $58,650[47].

5. **Review Current Cleaning Procedures** –Gills Onions should audit its current cleaning processes to identify opportunities where water use might be reduced and/or efficiencies can be improved. The cleaning process should be reviewed to ensure that over-washing is avoided; that the duration of wash and rinse cycles are optimized and; automated clean-in place systems are considered. If possible, water meters in wash-down areas can be installed and water use can be monitored regularly. Washing instructions for operators should be reviewed or prepared and monitored for washing performance so that employees can be provided with consistent instructions for proper cleaning procedures. Finally, employees can be engaged to reduce water consumption through incentive programs.

Figure 12 Water flooded floor

6. **Evaluate Recovering Final Rinse Water for Other Plant Uses**–Gills Onions could reuse the rinse water from the onion bath as a source of water for cleaning. While it would not be possible to use the onion bath water for all of the company's cleaning needs, this water could be used for the 'first equipment rinse down' during cleaning, and to wash off large onion pieces. We estimate that reusing onion bath water could displace up to 10% of the fresh water currently used for cleaning plant equipment. Reusing onion bath water could save up to $9,000 per year, excluding any upfront investment required to implement such a system. Prior to implementing this type of strategy all health and food safety protocols and requirements should be thoroughly reviewed and considered.

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[47] For an in-depth analysis of the feasibility of this recommendation, refer to 'Recycling Wastewater for Use with Biodigester and Cooling Tower" in Appendix C.

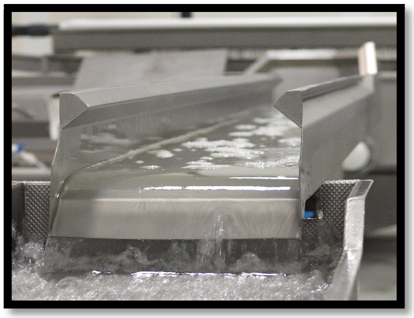


Figure 13 Flue water for cleaning

7. **Use Recycled Water to Irrigate Plants and/or Replace Current Landscape with Xeriscaping** –Gills Onions already has all of the required plumbing in place to use recycled water for landscape irrigation. However, the city would first need to approve such a change and the water would need to be treated to a level sufficient for landscape irrigation.

   Gills Onions could further reduce water consumption by replacing grasses and roses with native plants that require much less water. At the minimum, Gills Onions should ensure that the landscaping is being maintained without excessive amounts of water. Moreover, the company should work with the landscaper to ensure that watering occurs only early in the morning or late in the evening to maximize absorption and minimize evaporation; to only water less than 7 minutes per day, to water only when wind is less than 10 miles per hour; and to alter watering patterns seasonally to meet irrigation requirements.

Materials: At a Glance

Materials

Objectives:

- Establish the amount of material waste generated in 2008 and the amount diverted through recycling.
- Calculate the costs associated with material waste generation.
- Identify opportunities to reduce, reuse, recycle, or substitute materials.
- Provide cost-effective recommendations that reduce material waste generation and increase diversion.

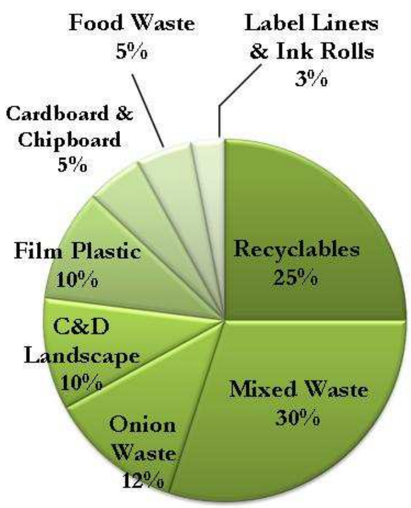
Methodology:

- Conducted waste characterizations of materials going to landfill and diverted through recycling.
- Performed visual assessments to identify where specific materials originated.
- Conducted desktop audits of purchasing records to quantify volume and cost of material waste.

Baseline:

2008 Materials Baseline
566 Tons

25% Recycled
75% Landfill



Findings:

- Classified eight categories of material waste (see pie chart).
- 25% of material waste was being recycled; 75% was going to landfill.
- Light-weight materials were pervasive in the waste stream and represented a high cost for the company (for example; gloves, label backing, tissues, and paper towels).
- Significant contamination issues were impeding recycling opportunities, despite existing diversion programs.
- By addressing onion contamination, diversion rate could increase from 25% to 53%.

Potential Benefits

Reduce Waste Generation Onsite and at Customer Location

Waste Reduction

200 Tons of Material Waste Annually

Potential Savings

Resource Category	Annual Savings	Payback Period (Years)
Material Waste	$211,000	1 - 2

Materials (cont'd)

Recommendations:

- Install disposable glove dispenser system to reduce unnecessary waste.
- Replace single-use blue bags used internally for transporting onions with reusable containers.
- Install energy efficiency electric hand driers in restrooms to eliminate paper towels.
- Install a drinking fountain to eliminate single-use cone cups and encourage employees to use reusable canteens.
- Purchase tissues in bulk to reduce cardboard waste associated with single-use boxes. Implement tissue dispenser system to prevent wasteful practices.
- Reduce paper towel use in the lunchroom by implementing a central dispensing system and remove paper towels rolls from lunch room tables.
- Reduce frequency of lunchroom garbage removal to reduce the amount of plastic can liners used.

- Modify printing practices to reduce paper waste by instituting double-sided printing, using smaller fonts and including more text per page.
- Utilize on-site baler to increase recyclability of rigid plastics and chipboard.
- Require removal and proper disposal of landscape waste.
- Eliminate illegal (non-Gills Onions) waste by enclosing and securing dumpster area.
- Monitor opportunity to implement liner-less label system to reduce label liner waste.
- Monitor opportunity to compost food waste off-site.
- Institute reusable containers and a reverse logistics system for large industrial customers to replace single-use corrugated cardboard.
- Purchase environmentally preferred supplies based on reputable eco-labeling designation (i.e. Green Seal, EcoLogo).
- Include recycling number designation on all clear plastic commercial product bags.
- Establish a comprehensive, ongoing employee training and communication program to inform and reinforce commitment to the company's sustainability goals.

2010 Projection:

- Gills Onions will reduce material generation from 566 tons to 498 tons.
- Gills Onions will increase diversion from 25% to 53%.

Materials

Since this project is primarily concerned with strategies leading toward zero waste, we placed special emphasis on the materials being used and the solid waste generated at the company's site. Our main objectives when analyzing material waste were to establish the 2008 baseline, calculate diversion rates from landfill, and identify any opportunities for reducing, reusing, recycling, and substituting materials.

To make a significant impact on waste reduction, it was critical to know more about the waste that was being generated. To do this we conducted a series of waste assessments following EPA methodology[xvi].

In general terms, a waste audit is a method of estimating the total amount of waste discarded by an entity, the cost to dispose of it, and the fractional amounts of waste that can be recycled, reused, or prevented. There are different kinds of waste audits:

1. **Desktop Audit** – This type of audit estimates waste generation from purchasing data, waste disposal records, and recycling logs. This information is used to calculate how much waste the organization is generating and its associated costs.

2. **Walk-through (or visual waste assessment)** – This involves touring a facility and observing different area's activities. This type of audit is particularly useful in identifying where certain materials come from and in estimating the volume of waste generated in a particular area.

3. **Physical Waste Characterization** - This involves the physical collection, sorting, weighing, and recording a representative sample of a company's waste. This type of assessment is critical for accurately determining waste types and quantities, particularly for a facility without standard waste streams.

We performed all three types of assessments, but placed special emphasis on physical characterizations because they are the best tool to accurately estimate composition and quantities present in the waste stream. We began by sorting the waste streams generated on-site and subsequently mapped them with materials purchasing information, waste disposal records, and walkthroughs. This combination approach was used to determine the composition of waste generated, to measure effectiveness of existing waste management systems, and to detect possible discrepancies between items being purchased and outputs found in the waste stream.

Physical Characterizations

During June and July 2009, we performed four waste characterizations to obtain information on the types and amounts of materials being disposed of at Gills Onions' processing facility and administrative offices. These characterizations included two of materials going to landfill, one specific assessment of food waste, and one of recyclables. These studies involved auditing all materials going to landfill as well as materials diverted, such as plastic bags and cardboard. Our team physically sorted, weighed, and recorded the company's different waste streams present in the dumpster. Following our initial audits we made a series of recommendations to the client. To document progress that the company had made since our initial recommendations we also performed a follow-up audit in January 2010. Ultimately, this analysis forms the 2008 non-onion solid waste baseline for Gills Onions. Using this information the company can measure the effectiveness of future zero waste minimization strategies and increase diversion rates.

First Waste Characterization - June 2009

In the first audit, we analyzed the waste collected in two full days in the company's 1,163 cubic feet dumpster. Due to the large volume of garbage produced in a two-day period, we were able to sort, characterize, and quantify approximately 50% of the waste by weight, while the remainder was estimated. Total weight of the waste generated in two days was 4,181 lbs (2.1 tons). We began by removing and characterizing the heaviest, bulkiest elements and afterward selected the most conspicuous waste streams. We developed a classification based on what we found in the dumpster. The main categories, by weight, were: construction & demolition (C&D) and landscaping; onion waste; film plastic; food waste; cardboard; and non-Gills Onions waste. This latter category included items, such as furniture, that were disposed of in the dumpster but did originate at Gills Onions. For the food waste category, we estimated generation rates by weighing the trash bags from the lunchrooms.

The results of the first waste audit are outlined in Table 21 below. These results were based on the 2,110 lbs (1.1 tons) that we sorted and characterized. While the non-Gills Onions waste amounted to nearly 10% (203 lbs) of the sorted waste, we have excluded it from the findings below to more accurately reflect the characterization of Gills Onions' total material waste (1,907 lbs).

Table 21 Result of First Waste Characterization				
Category	**Description**	**Weight (lbs)**	**Annualized (tons)**	**Percentage**
Construction Demolition (C&D) and Landscaping	Materials from building and demolition, pruning, trimmings and grass	676	97.0	36
Onion waste	Discards from processing plant	353	50.7	19
Film plastic	Clear and colored plastic bags, sleeves, and liners.	292	41.9	15
Food waste	Bags from lunchroom areas containing food material and compostables such as paper towels and paper napkins	196	28.1	10
Cardboard	Corrugated, tissue boxes, corners, end rolls	180	25.8	9
Label liners & ink rolls	Silicon paper that remains after adhesive labels have been removed; rolls with ribbon used for printing labels	66	9.5	3
Gloves	Nitrile and latex gloves used inside the processing plant	59	8.5	3
Paper waste	Hand towels and tissue paper from restrooms	46	6.6	2
PLA cups & lids	Bio-based plastic (polylactic acid) containers	25	3.6	1
Masks, hairnets, cone cups	Breathing masks and respirators, bouffant caps and disposable paper cups	14	2.0	1
Total		**1907**	**273.7**	**100**

The first audit was vital in identifying opportunities for improving waste management systems as well as for measuring the effectiveness of existing waste diversion strategies. After completing the first audit, we prepared a memo and presented preliminary findings with recommendations to the Owner of the company, Steve Gill, and the Sustainability Director, Nikki Rodoni. A copy of the memo can be found in Appendix D1**.** The memo was accompanied by photographs that were taken during the audits to illustrate current waste practices and to help management understand the significance of the problem. Some of the key findings from the initial audit include:

Onion waste was ubiquitous despite existing diversion mechanisms (i.e. energy and cattle feed). Onion waste not only made waste disposal more expensive due to the weight of onions, but it also contaminated recyclables, thus hindering potential recycling opportunities. This particular contamination issue could be avoided by diverting all onion waste to the juicer to produce energy and cattle feed.

Bags and other film plastic, used for packaging and transporting onions, represented 15% of the total waste found in the dumpster. This was surprising since the company had in place a recycling program for film plastic. This type of material is accepted by recycling facilities even if it is wet or contains small amounts of onion waste.

Although not immediately obvious because the audit was based on weight, the presence of small and light items such as gloves, tissues, paper towels, and cone cups was pervasive. Gloves in particular were present in vast quantities, and since nitrile, the material most gloves used onsite are made of, is not recyclable, this waste stream can contaminate other materials, rendering them non-recyclable.

Boxes made of uncoated corrugated cardboard were absent from the regular trash and were being reused or recycled. However, smaller piece of cardboard, tissue boxes, and rolls left over from plastic bags made up 9% of the sorted waste.

Employees were successfully diverting conventional recyclables, such as aluminum, glass, and plastic beverage containers. Additionally, there was virtually no office-type paper – such as bond rag, stationery grade paper - in the general trash, which also showed that this waste stream was successfully being diverted[48].

The initial audit generated high levels of interest among company employees, so it was important to communicate the findings as quickly as they were available in order to capitalize on the momentum. We therefore presented the information to all shift supervisors in addition to upper management. The supervisors, in turn, imparted the information to their subordinates. Companywide dissemination of waste reduction goals is essential because without the participation and commitment of all employees a zero waste objective cannot be achieved.

Second Waste Characterization and Specific Assessments– July 2009

To ensure that the results from the first audit accurately represented current waste practices and composition, we conducted a second physical characterization in July 2009. In addition, we performed a series of specific assessments, including materials diverted through recycling, a food waste sort, a desktop audit, and an office and processing plant walkthrough. Based on the findings of all the audits performed, we calculated total waste generation and composition for the baseline year, 2008.

The one-day general waste characterization was carried out following the same methodology as in the first assessment conducted in June 2009. However, in this instance we added a new category denominated "mixed waste" to encompass materials that were not readily recyclable or reusable (Table 22). We made this modification because during the first characterization, we devoted a lot time to sorting lightweight materials that were not recyclable. As a result, we decided to focus our attention on the materials that could readily be diverted through existing recycling programs.

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[48] Bond rag is a superior grade of strong white paper made wholly or in part from rag pulp.

Table 22 Results of One Day Waste Characterization (July 2009)				
Category	**Description**	**Daily Amount (lbs)**	**Annualized Amount (tons)**	**%**
Mixed waste	Mixed residue, soil, gloves, PLA containers, bathrooms' trash, masks, paper cones, hairnets, label liners, and miscellaneous items	1,218	174.8	44
Onion waste	Discards from processing plant	392	56.3	14
Film plastic	Clear and colored plastic bags, sleeves, and liners.	395	56.7	14
C&D + landscaping	Materials from building and demolition, pruning, trimmings and grass clippings	411	59	14
Food waste	Food material and compostables including paper towels, paper napkins	168	24.1	6
Cardboard	Corrugated, tissue boxes, corners, end rolls	213	30.6	8
Total		**2,832**	**401.5**	**100**

Food Waste Sort

During the first and second waste characterizations we estimated the food waste generated by weighing the bags from the lunchrooms. In July 2009 we conducted a food and beverage audit to corroborate earlier findings and obtain more accurate information on the waste composition generated in the lunchrooms. In addition, we wanted to evaluate whether implementing a composting program would be practicable.

The food and beverage audit consisted of evaluating the food waste produced by employees during a normal operating day that included morning and afternoon shifts, as well as the sanitation crew.

We set up clearly labeled bins for each of the following categories: compostables, recyclables and mixed waste. Labels included descriptions of what went into each bin as well as pictures of the items. Additionally, during the morning and afternoon lunch breaks we were present to help employees sort the discards appropriately. We provided the lunchroom coordinator with detailed instructions so that he could help sort the waste generated during the evening shift. To calculate per capita generation accurately, we requested employee headcount and attendance from human resources. At the end of each lunch break we weighed the contents of all bags. Table 23 presents the percentages by weight of the waste and recycle streams for the food and beverage sort.

Table 23 Results of One Day Food & Beverage Sort by Weight				
Category	**Description**	**Daily Weight (lbs)**	**Annualized Amount (tons)**	**%**
Compostables	Food -all types, milk/juice cartons paper napkins, tissues, paper towels	112	16.1	62
Recyclables	Aluminum cans, plastic & glass bottles, newspapers, cardboard, clean aluminum foil, plastic bags	42	6.0	23
Mixed waste	Plastic wrappers, styrofoam, plastic utensils, gloves, paper cones, contaminated bags, masks, hairnets	29	4.2	15
Total		**183**	**26.3**	**100**

Compostable items represented a significantly larger proportion than the other two categories. This was mainly due to the amount of heavier organic material (food waste) as well as wet paper products present in the waste stream.

Recycled Material Assessments – Film Plastic

To gauge the effectiveness of the recycling programs already in place, we sorted and characterized the materials diverted from landfill through recycling. There are three waste streams being diverted: film plastic, cardboard, and office paper.

Film plastic, which includes plastic bags, sleeves and liners, is placed in a 40 yard roll-off container. Once the container is full, which generally occurs once a week, the film plastic is taken to a local recycler, Del Norte Recycling[49]. At the recycling facility the consignment is inspected for cleanliness. If the level of contamination is unacceptably high, Gills Onions is charged for disposing of recyclable materials at the same rate as for regular trash.

Figure 14 Recycling audit of film plastic

[49] There are three main recyclers that operate in Ventura County: Rincon Recycling, Gold Coast Recycling, and Del Norte Recycling. Gills Onions does not have a contractual agreement with any of them and can choose to deliver its recyclables to any one of them.

We audited the contents of the roll-off container after a week's accumulation. The total weight of the contents amounted to 3,669 lbs (Table 24). As was the case with earlier waste sorts, we documented the findings extensively through photographs.

We sorted the film plastic by color and by type to evaluate whether it made sense to source-separate them prior to recycling, and possibly take advantage of a higher market value offered for clear plastics[50].

Table 24 Results of One Week Film Plastic Audit

Material Type	Description	Daily Amount (lbs)	Annualized Amount (tons)	%
Blue bags and liners	Colored mixture of low density polyethylene (LDPE) and linear low density polyethylene(LLDPE)	2,484	356	68
Clear bags	Clear mixture of LDPE and LLDPE (higher market value)	396	56.8	11
Sleeves	High density polyethylene (HDPE) film	47	6.7	1
Onion waste	Discards from processing plant	439	63	12
Mixed waste	Mixed residue, food waste, soil, gloves, PLA containers and hairnets	303	43.5	8
Total		**3,669**	**526**	**100**

The one week film plastic audit revealed that largest component of this waste stream was blue bags and liners, which amounted to 2,484 lbs. We also found a considerable amount of onion waste as well as mixed waste contamination present in the consignment, which would have likely resulted in a charge to the company at the time of disposal.

Gills Onions had implemented a system to recycle only the largest stream, film plastic, and send most of the rigid plastic to landfill. However, we found that in addition to film plastic, rigid plastics - such as polypropylene (PP) trays and straps used to tie boxes - were present in the recycling bin, but in negligible amounts (<1%). Although rigid plastics are commonly recycled, recyclers generally reject commingled recyclables (in this case film plastic and rigid plastic) and insist on receiving a container with just one type of material in it.

Recycled material assessment - Old Corrugated Cardboard (OCC)

Since its inception, Gills Onions has put in place a system to reuse and recycle cardboard boxes. The boxes come from orders placed with vendors and are generally large and made of uncoated corrugated cardboard. This type of material is widely accepted by recyclers and, historically, its diversion has generated revenue.

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[50] Clear low-density polyethylene (LDPE) has higher purity than colored LDPE which contains pigments. As a result, the recycling market price for clear LDPE can be five times higher than colored LDPE. Rincon Recycling confirmed this information.

At Gills Onions, the handling method for OCC includes opening and flattening the corrugated boxes, removing any contaminants, and manually bundling them using hard plastic bands. The bundles are stored for approximately a week and then some are backhauled to a recycling center, Rincon Recycling. A significant amount of OCC is reused by Gills Onions' sister company, Rio Farms. At present, no logs are kept to calculate how often or how much of the OCC is being removed by Rio Farms.

Our assessment measured the OCC generated during one week. In addition to the bundles made up of large boxes, we accounted for corners and other small pieces. We found that at Gills Onions small, loose pieces of corrugated are currently not reused or recycled, even though they are made of the same material. From conversations with Rincon Recycling and Gold Coast Recycling in Ventura County, we learned that these pieces can easily be recycled if baled.

Recycled Material Assessment - Office Paper

Another recyclable stream that we assessed was office paper. At Gills Onions' administrative offices, all types of office paper are placed in the same recycling container. The main types of paper being disposed of include white ledger paper, glossy coated paper, and other office paper. White ledger paper consists of bleached, uncolored bond, or stationary grade paper without ground wood fibers. Some examples include white paper used in photocopiers and laser printers, as well as letter paper. Magazines and catalogs are usually made from glossy coated paper. This type of paper tends to have lower value than white ledger paper.

Lightweight materials

Our previous assessments had analyzed waste generation strictly in terms of weight. However, during the waste characterizations it became evident that looking at waste generation strictly in terms of weight did not provide the full picture. Many of the items that we found during the assessments were negligible by weight but their presence was pervasive. The major lightweight materials we found include gloves, tissues, paper towels, label liners, and cone cups. To accurately estimate overall consumption of lightweight materials, we relied on annual purchasing data. In addition, we performed visual assessments to estimate general usage per area. A detailed analysis of each of the materials evaluated can be found in the Non-Recyclable Materials section.

2008 Material Waste Baseline

One of our main objectives when analyzing material waste was to establish a baseline from which the company could measure progress toward overall waste reduction and increase diversion. All audit findings were annualized and compared against existing recycling logs and records of tonnage sent to landfill to ensure that the data was within the historical range. Per company's management, we annualized the data based on 5.5 work days per week.

We estimated that in 2008, Gills Onions' total material waste generation amounted to 566 tons. As outlined in Table 25, waste diversion through recycling was 25% (142 tons) and the remaining 75% (424 tons) was sent to landfill at a cost of $20,350 ($48 per ton).

Table 25 2008 Baseline Material Waste			
Category	**Description**	**Annualized Amount (tons)**	**%**
Recyclables*	Film plastic, corrugated cardboard, paper	142	25
Mixed waste	Mixed residue, soil, gloves, PLA containers, bathroom trash, masks, hairnets, paper cones, and items that did not fit into any other category	167	30
Onion waste	Discards from processing plant	68	12
C&D + landscaping	Materials from building and demolition, prunings, trimmings and grass clippings	59	10
Film plastic	Clear and colored plastic bags, sleeves, and liners.	57	10
Cardboard & boxboard	Tissue and glove boxes, corners, end rolls	30	5
Food waste	Food material and compostables including paper towels and paper napkins	26	5
Label liners and ink rolls	Silicon paper that remains after adhesive labels have been removed; rolls with ribbon used for printing labels	17	3
Total		**566**	**100**
*See Table 26 for a breakdown of recycling diversion by category			

After extrapolating the results to get annualized figures, we estimated that mixed waste - comprised mostly of items that cannot be recycled - represented the largest percentage of the waste going to landfill. Onion waste and film plastic combined comprised 29% the total sent to landfill, and could be diverted through correctly sorting and minimizing contamination issues. Furthermore, from the food and beverage sort we conducted we estimated that food waste stream represented 5% of the total waste generated. Table 26 provides a breakdown of the 142 tons being diverted through recycling.

Table 26 2008 Classification of Diverted Waste (annualized)			
Category	**Description**	**Annualized Amount (tons)**	**%**
Film plastic	Clear/colored plastic bags, sleeves, and liners.	77	54
Old Corrugated Cardboard (OCC)	Clean sorted printed or unprinted corrugated cardboard cartons, boxes or sheet.	62	44
Office Paper	White ledger paper, magazines, catalogs, and other office paper.	3	2
Total		**142**	**100**

The amount of film plastic recycled at Gills Onions (77 tons yearly) does not include onion waste and mixed residue that we found and physically removed during the audit. However, when annualized the onion waste found amounted to 11 tons and the mixed waste to 8 tons. This illustrates to what degree contamination can affect recyclables, in many instances rendering them unrecyclable and resulting in a charge as regular refuse.

Initially, we calculated overall generation of OCC based on the quantities audited in a week. However, our estimate was significantly higher (40%) than what the existing recycling logs revealed. This discrepancy was due to the fact that we accounted for small pieces of OCC and because recycling records did not include OCC reused by Gills Onions' sister company, Rio Farms. For the purpose of this analysis, we therefore estimated OCC generation using the records produced by Rincon Recycling, which specified the amount of OCC actually received as well as the rate paid per ton ($30 per ton). According to these calculations, the annual generation for 2008 of OCC was 62 tons, excluding small, loose pieces.

Baseline vs. Potential Diversion

In July 2009 we reported the results of our comprehensive material waste analysis to management. The information presented included the 2008 baseline waste generation, landfill and diversion rates, and various recommendations aimed at reducing waste. A copy of this memo can be found in Appendix D2.

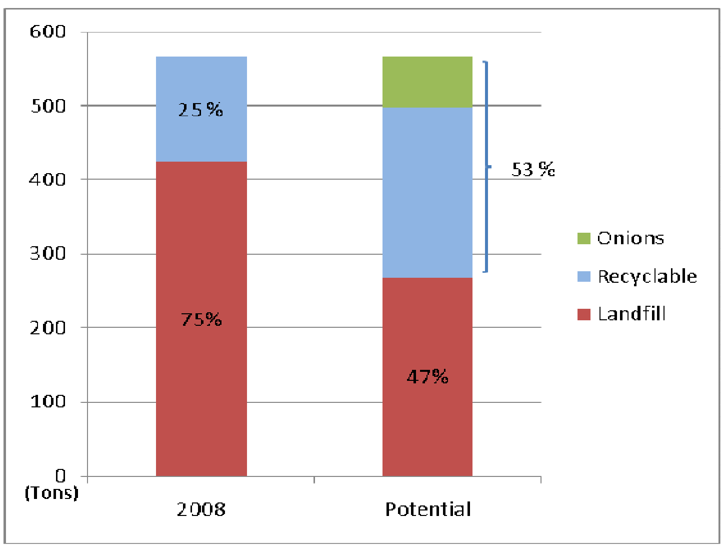

Figure 15 2008 baseline vs. potential diversion

One of the key recommendations that we made was to increase the effectiveness of the existing diversion programs - film plastic recycling and onion waste diversion - through correctly sorting and minimizing contamination issues. We estimated that if this was done, the company could increase its diversion rate from 25% to 53%. As noted in the Onion Section, Gills Onions implemented these recommendations immediately by requiring that employees separate onion waste from the film plastic, first post production and beginning in November 2009, within the processing plant. It is important to note that these improvements did not require the implementation of any new systems. Rather, all that was needed was a closer examination of current practices and a renewed commitment.

Last Waste Characterization – January 2010

In January 2010, we conducted a follow-up audit of material waste to landfill. The results of this characterization are indicated in Table 27 below.

Table 27 Results of January 2010 One Day Audit of Material Waste to Landfill				
Category	**Description**	**Daily Amount (lbs)**	**Annualized Amount (tons)**	**%**
Recyclables	Film plastic, corrugated cardboard, paper	1,373	197	39
Mixed waste	Mixed residue, soil, gloves, PLA containers, bathroom trash, masks, hairnets, paper cones, and items that did not fit into any other category	719	103	21
Onion waste	Discards from processing plant	75	11	2
C&D and landscaping	Materials from building/demolition, prunings, trimmings and grass cuttings	887	127	26
Film plastic	Clear and colored plastic bags, sleeves & liners	7	1	>1
Cardboard & boxboard	Tissue and glove boxes, corners, end rolls	153	22	5
Food waste	Food material and compostables including paper towels, paper napkins	150	22	5
Label liners and ink rolls	Calendered kraft stock that remains after adhesive labels are removed; rolls with ribbon used for printing labels	51	7	1
Rigid Plastics	Polypropylene (PP) trays and straps used to tie boxes, cleaning containers, plugs from plastic bag rolls	57	8	1
Total		**2099**	**498**	**100**

This assessment clearly showed that the strategies implemented for diverting onion waste and film plastic were effective: we found that there were virtually no plastic bags in the dumpster (7 lbs) and that the amount of onion waste had decreased 81% to 75 lbs. Moreover, we estimate that as a result of these improvements, in 2010 overall material waste generation will decline by approximately 12%, from 566 tons to 498 tons per year (Figure 16).

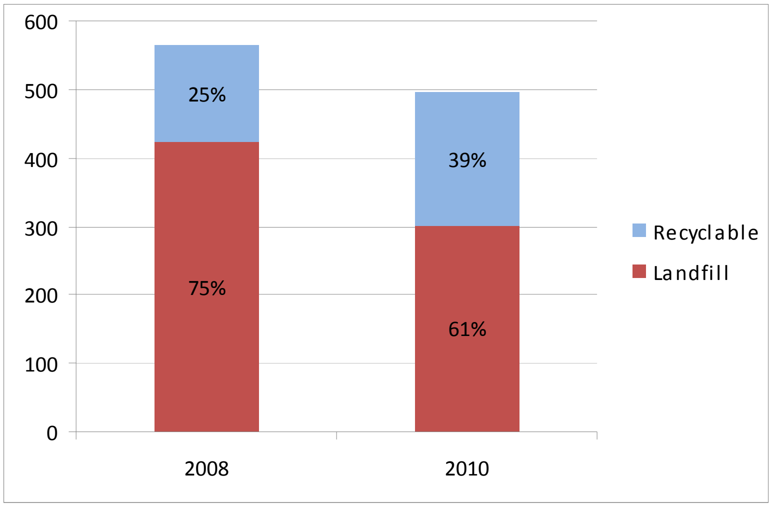

Figure 16 2008 baseline vs. projected waste generation for 2010

We project that the diversion rate through recycling will increase to 39% and that the total tonnage sent to landfill will decrease by over 28%, from 424 tons in 2008 to 303 tons in 2010.

Decision Tree

We determined that there are three key components to achieving a zero waste goal: establishing a baseline; analyzing the different waste streams; and identifying opportunities to reduce, reuse, and recycle. Once we established the baseline, we developed a decision tree to guide the analysis of the different material waste streams. Figure 17 provides a representation of this methodology.

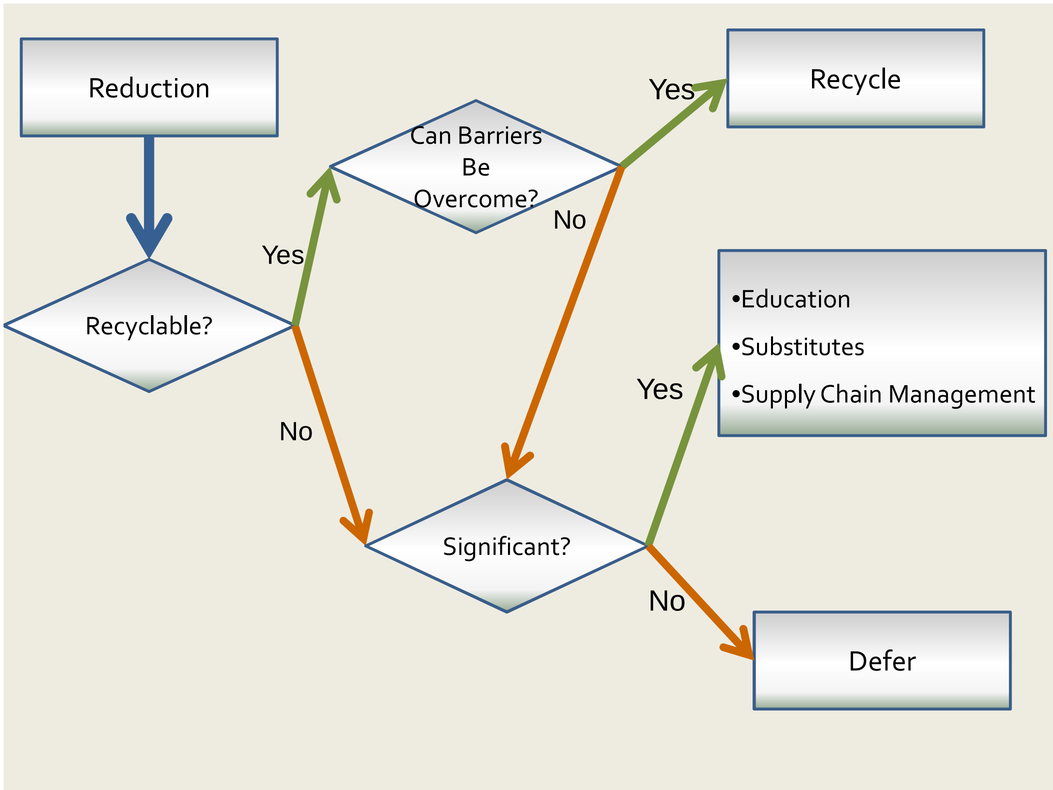

Figure 17 Schematic representation of the methodology used to guide reduction and recycling efforts of a particular waste stream.

Reduction
The first and most important strategy is reduction since it is always preferable to prevent the generation of waste than to have to manage it once it is produced[xvii]. To make a significant impact on waste reduction we needed to know where the particular material originated, the total amount generated, and the purpose it served. Depending on the particular material being evaluated, we used different waste minimization strategies, including source reduction and ongoing education. The particular strategies used are discussed in detail under each material analyzed.

Recyclable? Yes
Once we identified reduction opportunities, we wanted to establish a method for managing the material waste that could not be eliminated. To this end, we asked whether the particular material was recyclable. Recyclable products can be collected, reprocessed, and reused to make new products. Some common recyclable materials are plastic, aluminum, cardboard, glass, and paper. The environmental benefits from recycling material waste include diverting resources from landfill, lowering greenhouse gas emissions, and reducing the amount of virgin materials, water and energy consumed. If the barriers to recycling could be overcome then the material would be recycled.

Barriers

If the particular material was recyclable but was being sent to landfill we analyzed the barriers that were preventing the item from being recycled. Some recycling barriers include contamination, technical issues, food safety requirements, and the need for dedicated personnel.

1. *Contamination* – based on our assessments, we determined that one of the most obvious barriers to recycling was contamination. Recyclers generally reject materials that are contaminated with dirt, onion and other mixed waste. Depending on the severity of the problem and the volume of the particular recyclable, the company needs to evaluate whether it is sensible to implement a diversion program. At Gills Onions, where film plastic represented 13% of the material going to landfill, we determined that higher diversion rates could be attained immediately by improving the existing recycling programs and avoiding onion contamination.

2. *Technical Feasibility* - An important finding of our analysis was that, although technically every type of paper or plastic product is recyclable, identifying an accessible facility capable of reprocessing the material was often difficult. For recycling to be economically feasible and effective an adequate source of recyclable material needs to exist and there needs to be a demand for the recycled material. Additionally, markets for recycled products are particularly sensitive to economic conditions and in the case of plastics, to the price of oil. The size of the recycling market fluctuates with economic cycles and can shrink substantially during a recession.

3. *Food Safety* - Another challenge to recycling is given by the strict food safety requirements set by different entities at the national and State level, such as the Food and Drug Administration and the California Department of Public Health. These regulations mandate that hygiene be maintained and that materials be regularly cleaned or changed frequently, and are often prevented from reuse.[xviii] For example, even if recyclable, materials used for testing are single-use only. As a result, to keep the food safety risk low, food processors often consume more disposable resources than are desirable and can be constrained in the types of materials that they are allowed to use.

4. *Volume* - Lastly, even if the material is recyclable and there is a facility nearby that accepts it, the actual volume generated may not warrant the implementation of a new diversion mechanism. Establishing a recycling program for a specific waste stream requires training employees, making space available and setting up a collection system, and designating personnel responsible for operating the program. If the volume of the particular material is small, it may not be practical to allocate resources to divert it.

Recyclable? No

If the material is not recyclable or if the barriers to recycling cannot be overcome, the significance of the issue needs to be established. Similar to the aforementioned practicalities of implementing a recycling program, if the overall amount generated is low relative to the other waste streams (a threshold 5% or lower), it may be preferable to defer dealing with that particular material and focus on waste prevention and other strategies that can lead to the reduction of waste.

Conversely, if the amount generated of a particular material is significant and recycling is not an option, other alternatives to manage the stream should be evaluated, such as pollution prevention through education, finding substitutes, and managing the supply chain. We employed these strategies when evaluating the different Gills Onions' waste streams. For example, we identified an option to non-recyclable gloves, and contacted different suppliers in search of recyclable alternatives or take back programs.

Analysis of Materials and Recommendations

We applied the decision tree methodology described above consistently when evaluating each waste stream, and grouped the material according to whether or not it was recyclable. Subsequently, we analyzed several strategies for going beyond recycling, including the implementation of a reusable container system to eliminate the internal use of plastic bags and a reverse logistics program.

Recyclable and Compostable Materials

Food Waste

According to our calculations, food waste represents 5% of the total waste generated yearly at Gills Onions. Although this is the threshold of significance that we established in our methodology, we thoroughly investigated the possibility of starting a food waste diversion program.

There are numerous obstacles associated with the implementation of a food composting program either onsite or at a composting facility. Having a composting program onsite requires space for collection bins, designating staff responsible for collecting and composting the food, and training employees to separate acceptable materials. In addition, an onsite program commonly produces odors and attracts vectors.

Since Gills Onions is a food processing facility, and because food safety and cleanliness are paramount concerns, the possibility of attracting pests to the facility ultimately eliminated the onsite composting option.

Taking the food waste to an offsite facility also requires designating staff responsible for running the program and training employees to source separate compostable materials, but could help dispel concerns related to vectors and odors. However, this option is not available at this time. According to the California Department of Resources, currently there are no licensed food waste compost sites in Ventura County that could collect food scraps and compost them[xix].

Recommendation: Since food composting currently is not a viable option, our recommendation to the client was to continue monitoring local offsite alternatives and to focus on employee education to reduce food waste generation. Some of the elements of an education program of this kind would include teaching about portion control, disposal of beverages in the drain and minimizing the use of paper products such as napkins and paper towels which cannot be recycled[51]. We estimate that decreasing the amount of liquids and paper products used in the lunchrooms would reduce waste by 8.8 tons per year, and generate savings of $420 in disposal costs.

Table 28 Food Waste Recommendation

Item	Percent of Material Waste Stream	Recommendation	Waste Reduction Potential (Tons)	Annual Savings Potential ($)
Food Waste	5%	1. Reduce Generation 2. Monitor Local Offsite Composting Options	8.8	$420

Film Plastic

Currently, Gills Onions has a system in place to recycle film plastic which accounts for 24% (134 tons) of the total waste generated (566 tons). However, due to high levels of contamination only 13% (72 tons) were actually recycled, while the remainder was sent to landfill.

One of the "contaminants" present was rigid plastic. During the recycling audit, we found a small amount (<1%) of rigid plastic commingled with film plastic. Although this type of plastic is recyclable, recyclers generally reject consignments with more than one type of material. The assessment revealed that there was considerable misinformation among employees as to what types of materials were recyclable and which ones were actually being recycled at Gills Onions.

Recycling rigid plastic items onsite would involve setting up separate bins for that purpose, training employees to source separate those items, and taking the full bins to a recycling facility. However, establishing a recycling system for this specific waste stream could be deferred since rigid plastics represent only 3% of the total waste generated at Gills Onions.

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51 We observed several employees throwing out beverages that contained a significant amount of remaining liquid. Liquid can simply be emptied into sinks prior to disposal. Moreover, a lot of food waste was generated from leftovers of meals.

Recommendation: Our specific recommendations included minimizing contamination issues -particularly onion waste - to recycle all film plastic; continue evaluating diversion of rigid plastic and; educating employees on how to properly dispose of different plastic materials at the facility. We estimate that if all film plastic is recycled the company could not only save as much as $6,400 yearly in disposal costs, but it could also generate nearly $7,400 (134 tons at $55 per ton) in revenue from recycling (Table 29).

Table 29 Film Plastic Recommendation				
Item	Percent of Material Waste Stream	Recommendation	Waste Reduction Potential (Tons)	Annual Savings Potential ($)
Film Plastic	13%	1. Eliminate Contamination 2. Recycle all Film Plastic 3. Evaluate Recycling Hard Plastics	133	$13,700

Corrugated Cardboard and Chipboard

As noted earlier, boxes made of corrugated cardboard were absent from the regular trash and were being diverted. However, smaller boxes and fiber core rolls left over from plastic bags made up 7% (30 tons) of the total waste. Some of these items, such as glove and tissue boxes, are made of mixed-low grade paper known as chipboard. Chipboard is made mostly of paper and is combined with minor amounts of other materials such as wax or glues. As a result, recyclers may be reluctant to accept this type of material, particularly if it is not separated from OCC. In fact, Rincon Recycling, the recycler that currently accepts Gills Onions corrugated boxes, does not accept unbaled chipboard.

Recommendation: The obvious options available in trying to eliminate this waste stream are to identify a recycler willing to take this type of material, or to bale chipboard prior to disposal. We estimate that as the recycling markets recover, it will be easier to find recyclers who take this material. According to our calculations (Table 30), if small pieces of OCC and chipboard are baled and recycled the company could save over $1,400 yearly in disposal fees, and it could generate $900 (30 tons at $30 per ton) in revenue from recycling

Table 30 Corrugated Cardboard (OCC) Recommendation				
Item	Percent of Total Waste Stream	Recommendation	Waste Reduction Potential (Tons)	Annual Savings Potential ($)
OCC	5%	1. Bale and Recycle Small Pieces of OCC and Chipboard	30	$2,300

Utilization of Baler

As noted earlier, the company has a baler onsite, which is in good condition but requires maintenance prior to running. Using the baler presents a number of benefits including improved ease of handling, increased marketability of recyclables and a decrease in storage requirements. The baler can be used for different waste streams prior to being diverted through recycling, including film plastic and corrugated cardboard. In addition, small chipboard boxes as well as other paper products, such as corners and end rolls, can be baled and diverted from landfill. Baling will also save space, particularly in the case of film plastic which is highly voluminous. Moreover, baling has the potential to eliminate hauling trips for Gills Onions to a recycling facility since recyclers will often pick up baled materials. Baling recyclables will also render the material up to 50% more valuable on the recycling market[52].

Recommendation: We recommended that the company start using the baler and have outlined all steps required to make the baler operational. A copy of this memo can be found in Appendix D3.

According to our calculations (Table 31), if the company baled its largest recyclable waste stream, film plastic, it could increase revenues by approximately $3,600 per year.

Table 31 Baler Recommendation

Item	Percent of Material Waste Stream	Recommendation	Waste Reduction Potential (Tons)	Increased Revenue Potential ($)
Baler	N/A	1. Fix and Make Baler Operational 2. Use Baler to Increase Value of Film Plastic Recyclables	N/A	$3,660

Construction & Demolition (C&D)

In our classification we grouped C&D with landscaping to account for all the waste that could not be mapped to purchasing records. We estimate that C&D, which includes materials such as wood, cement, and pipe, represents 25 tons (5%) of the total waste.

Recommendation: Our recommendation to the company was to separate this type of debris and take it to a Materials Recycling Facility (MRF) in Ventura County. Although the price of disposal per ton is the same as for landfill, this strategy could divert C&D from actually being sent to the landfill.

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52 Per Rincon Recycling.

Table 32 Construction & Demolition Debris (C&D) Recommendation				
Item	Percent of Material Waste Stream	Recommendation	Waste Reduction Potential (Tons)	Annual Savings Potential ($)
C&D	5%	Source Separate C&D and Divert through Recycling	25	$0

Landscaping Waste

Another large component of the waste stream to landfill was landscape waste. At this time, the company contracts with a landscaping service that comes weekly to maintain the grounds. Some of the maintenance services included are pruning plants and trees, mowing the lawn in the parking lot as well as replacing some plants and cleaning up. The islands that divide the parking lot generally have grass, which is mowed weekly. The grass clippings, along with any green waste generated during the weekly maintenance, are disposed of onsite in Gills Onions' dumpster for regular trash, and subsequently sent to the landfill. During the characterizations, we identified that some of the landscaping waste disposed of onsite does not originate at Gills Onions.

Recommendation: Our recommendation to the client was to consider xeriscaping or, alternatively, require that the landscaping service include removal and proper disposal (offsite composting) of green waste as part of its services. This action would not only avoid green waste from Gills Onions going to landfill but it would prevent landscape waste from other facilities being disposed of in the company's dumpster. We estimate that this strategy would decrease the amount of waste sent to landfill by 34 tons per year and reduce the company's tipping fees by approximately $1,600 (Table 33).

Table 33 Landscaping Waste Recommendation				
Item	Percent of Material Waste Stream	Recommendation	Waste Reduction Potential (Tons)	Annual Savings Potential ($)
Landscaping	6%	1. Require Removal and Proper Disposal of Landscape Waste 2.Consider Xeriscaping	34	$1,630

Office Paper

This is the smallest stream relative to the other materials being diverted through recycling, representing only 2% of the recyclables. At present, all types of paper including white ledger, glossy coated paper, and mixed paper, are placed in the same recycling container. Although, ledger paper has higher recycling value than other types of paper, source separating them further would not be practical at this time, given the small volume generated per year (3 tons).

Recommendation: To reduce the volume of office paper generated even further, we identified several strategies, including changing the printers' default setting to print on both sides of the page and modifying existing large reports to maximize printing per page. The company prints daily, weekly and monthly reports that print on only half of the page. These reports could be reformatted to print more information on each page – thus requiring less paper. Based on our previous recommendations to Gills Onions some of these reports have already been modified.

Moreover, the company should purchase paper with post-consumer content. While not necessarily a benefit for Gills Onions, buying post-consumer content paper does have broader implications. Substituting recycled materials for virgin materials saves resources, energy and water, as well as reduces air pollution and greenhouse gas emissions. In order to ensure that the performance of this type of paper is satisfactory, the company could start by purchasing paper that includes 10% post-consumer content and increase the post-consumer content over time.

We estimate that by printing duplex, and adjusting the reports to use the whole page, the company could reduce the amount of office paper it uses by at least 40%[xx]. This will translate into $420 in paper cost savings per year (Table 34).

Table 34 Office Paper Recommendation

Item	Percent of Material Waste Stream	Recommendation	Waste Reduction Potential (Tons)	Annual Savings Potential ($)
Office Paper	<1%	1. Purchase Paper Containing Post-Consumer Recycled Content 2. Alter Reports to Maximize Printing Per Page	<1	$ 420

Non-Recyclable Materials

Onion Waste

As noted in the Onion section, we estimate that onion waste represents 16% of the landfill waste. Given that there are diversion mechanisms already in place (biogas and cattle feed production), we recommended to the company that employees source separate this stream within the processing plant, and send all onion waste to the juicer. This recommendation was implemented in November 2009.

Unauthorized Dumping

We determined that a substantial portion of the waste was not generated at Gills Onions. Although not considered when establishing the material waste baseline, the refuse that did not originate at Gills Onions represented 10% of the sorted waste. During the characterizations we found items such as a fold-out couch, an artificial Christmas tree, and a stroller in the dumpster. According to plant employees this is an ongoing issue. Apparently, due to the open and easy access to the company's large dumpster, it has been used by employees and others as a general dumping site. This practice adds to Gills Onions' tipping fees over time.

Recommendation: We recommend that Gills Onions fence in the area as soon as possible. We believe that this strategy would save the company nearly $1,400 per year in disposal fees.

Table 35 Unauthorized Dumping Recommendation

Item	Percent of Material Waste Stream	Recommendation	Waste Reduction Potential (Tons)	Annual Savings Potential ($)
Unauthorized Dumping	N/A	Fence Off Dumpster	30	$1,440

Mixed Waste

To analyze this category, we broke it down into the individual materials that we evaluated. These materials include gloves, paper towels, tissues, cone cups, can liners, and label backing.

Single-use gloves

Nitrile gloves are used extensively in the food processing industry to avoid contamination and preserve food safety. Nitrile is a synthetic rubber that has a high degree of flexibility and a good resistance to solvents[xxi]. Additionally, because nitrile is a synthetic material, it does not produce the same irritations and allergic reactions as natural latex rubber and is thus favored over latex. However, currently nitrile gloves cannot be recycled, and when disposed of improperly, they contaminate other materials that are recyclable.

Based on company's purchasing records, we calculated that 1.1 million nitrile gloves are used annually at Gills Onions, which translates into approximately 3,900 per day. At $0.11 per pair, the company spends over $61,000 yearly on single-use gloves. We calculated that on average, a plant employee changes gloves nearly 10 times a day, based on 200 employees who wear this type of glove. We brought this information to the attention of managers and employees. When we shared the information on the number of gloves per employee per day, managers as well as employees were surprised because they estimated that employees only needed to change gloves a maximum of five times per day.

During the visual assessments conducted, we noticed that a considerable amount of gloves were discarded without being used. We later concluded that this was occurring because of the way they are dispensed. First, gloves are tightly packed inside each box, making it difficult to take only one pair at a time. Second, the cardboard around the opening of the box tears easily resulting in several gloves being dispensed at a time. Third, there are numerous glove boxes available throughout the plant, which may be conducive to wasteful practices. Lastly, boxes are routinely removed from the dispensers which, in turn, can lead to boxes falling on wet surfaces and being contaminated.

Recommendation: We devised a number of strategies that would help curb the number of unused gloves discarded. These strategies included:

1. Identifying a container that dispensed only one pair of gloves at a time
2. Strategically placing dispensers only in areas where employees prepare prior to entering the plant.
3. Requiring that glove boxes remain inside the dispensers.

We estimate that by implementing these strategies, overall consumption of gloves would decrease by nearly 50%, and the company could save $30,000 per year (Table 36).

Table 36 Single-Use Gloves Recommendation

Item	Percent of Material Waste Stream	Recommendation	Waste Reduction Potential (Gloves)	Annual Savings Potential ($)
Single-use Gloves	N/A	1. Implement Glove Dispenser System 2. Strategically Locate Glove Dispensers 3. Monitor Recycling Alternatives	550,000	$30,000

Recommendation: While we do believe that Gills Onions has the opportunity to reduce glove waste by half, the company will still use and dispose of approximately 500,000 gloves per year. To manage this waste stream we attempted to find a recyclable alternative that would result in diversion from landfill. Vinyl seemed to provide such an option. Vinyl also represents a more cost effective alternative (50% less expensive than nitrile gloves), while still satisfying food safety requirements for avoiding contamination. However, although vinyl gloves are similar to nitrile in terms of resistance and non-allergenic properties, employees resist the change to vinyl because they claim that these gloves do not fit as well and they harden in a cold environment. Moreover, we learned that, although vinyl is a recyclable material, no recycling facility in Ventura County currently accepts vinyl gloves, making it extremely difficult to do anything productive with this waste stream. As a result, we recommended ongoing monitoring of the recycling option and focusing on employee training to reduce unnecessary waste.

Reusable gloves

Latex canner gloves are also used at the facility, although in much smaller quantities. Based on purchasing records, we calculated that 24,000 latex gloves are being used yearly at a cost of approximately $10,000. While Gills Onions' employees were treating these gloves as if they were single-use, they can actually be used several times, as long as they are sanitized after each use.

Recommendation: We recommend that the company implement a multi-use policy for employees that wear this type of glove. We believe that this strategy can easily be implemented since there are already sanitation tubs in the processing plant and a number of employees already reuse latex gloves until they are damaged. We estimate that if gloves were reused at least once, the company could save approximately $5,000 in addition to the associated disposal costs (Table 37).

Table 37 Reusable Gloves Recommendation

Item	Percent of Material Waste Stream	Recommendation	Waste Reduction Potential (Gloves)	Annual Savings Potential ($)
Reusable Gloves	<1%	1. Implement Multi-Use Company Policy 2. Reuse Gloves Until Damaged	12,000	$5,000

Paper towels (rolls)

Paper towels represented another ubiquitous waste stream. Yearly, 8,000 rolls of 11" x 8.78" towels are used at a cost of nearly $7,000. According to our calculations, 160 rolls are consumed each week in the employee lunchrooms. Paper towels are used as napkins as well as for cleaning the tables. A walkthrough of the facility revealed that there was one roll of kitchen towels on each table located in the women's and the men's lunchrooms, totaling 27 rolls of paper at any one time (Figure 18).

Figure 18 Gills Onions' lunchrooms

Recommendation: During the food and beverage audit we conducted in July 2009, we saw that most of the compostable material collected in the main lunchrooms was made out of paper products. In July 2009, we recommended removing the rolls of paper towels from the individual tables and mounting dispensers on the wall. This strategy is commonly used in fast-food restaurants because it is known to lead to lower usage of paper napkins[xxii]. In November, the company acquired a total of six wall mounted dispensers and removed the paper towel rolls from the individual tables.

The removal of the paper towels occurred without previously announcing the change to the employees. As a result, employees initially resisted the new dispensing method and, according to the lunchroom coordinator, were taking excessive amounts of towels and leaving them on the tables. This fact highlighted the importance of communicating and educating employees throughout the process, because without employees' support, waste minimization strategies will likely be ineffective.

Nevertheless, management estimates that paper towel consumption has decreased by nearly 10% as a result of implementing the recommendation. This reduction translates into a yearly savings of $700 in paper towel costs (Table 38).

Table 38 Kitchen Paper Towels Recommendation

Item	Percent of Material Waste Stream	Recommendation	Waste Reduction Potential (Paper Towel Rolls)	Annual Savings Potential ($)
Kitchen Paper Towels	N/A	1. Remove Paper Towel Rolls from Kitchen Tables 2. Mount Paper Towel Dispensers	800	$700

Paper towels (multifold)

The six restrooms located in the processing plant are equipped with dispensers of 9.2" x 9.4" multi-fold paper towels. According to our calculations, employees use approximately 538,000 of these towels yearly at a cost of nearly $3,200, for drying their hands.

To eliminate this particular waste stream, we analyzed the environmental and economic impacts of replacing the multi-fold towels and dispensers with energy efficient hand dryers. The dryer considered was the Dyson Airblade, because it was the only dryer certified as hygienic for use in a food processing facility.

For our environmental analysis we relied on an existing life cycle assessment[xxiii]. Environmental assessments of hand drying methods consistently show that jet hand dryers – such as the Dyson Airblade – have far lower environmental impacts relative to paper towels. For the economic analysis we relied on the information supplied by the manufacturer as well as on Gills Onions' records including energy costs.

Recommendation: According to our calculations if the company retrofitted all six restrooms with energy efficient hand dryers, the payback period for the dryers would be 1-2 years. In year 2 and beyond, the company would recognize savings of nearly $7,000 per annum (Table 39). The complete analysis can be found in Appendix D4.

Table 39 Bathroom Hand Towels Recommendation

Item	Percent of Material Waste Stream	Recommendation	Waste Reduction Potential (Paper Towels)	Annual Savings Potential ($)	Payback Period
Bathroom Hand Towels	N/A	Install High Efficiency Electric Hand Driers in Employee Bathrooms	538,125	$7,000	1-2 Years

Facial Tissues

Based on purchasing records, we calculated that 22,200 boxes of 125 tissues are consumed each year at a cost of about $22,000. This translates into 77 boxes of tissues used each day.

Due to the nature of the product and because employees work in a cold environment, having tissues handy is indispensable. However, during the waste characterizations and walkthroughs we routinely found boxes containing unused tissues. We consulted with employees and they confirmed that, similar to gloves, when a tissue box falls on a wet surface they dispose of it since it is assumed that the tissues are contaminated.

Recommendation: To avoid practices that may lead to unnecessary waste, we recommended that dispensers be mounted on walls or on surfaces close to where they are needed, hence preventing the tissue boxes from falling on the wet floor or in the tubs filled with liquid. Additionally, to reduce the volume of chipboard boxes, we recommended the implementation of refillable dispensers that do not require a box[53].

We estimate that the implementation of the above recommendations will result in a reduction of approximately 25% in the use of tissues, which will amount to $5,500 in yearly savings (Table 40).

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[53] The company started testing two refillable dispensers in January 2010 and is currently evaluating the installation of these dispensers throughout the processing plant.

Table 40 Tissues Recommendation				
Item	Percent of Material Waste Stream	Recommendation	Waste Reduction Potential (Boxes of Tissue)	Annual Savings Potential ($)
Tissues	<1%	1. Mount Refillable Dispensers in Convenient Locations 2. Purchase Tissues in Bulk	5,525	$ 5,500

Paper Cone Cups

Currently, approximately 150,000 water cone cups are consumed per year at a cost of about $2,500.

Because of its shape, cone cups cannot be put down and therefore are disposed of immediately after a single use. According to the manufacturer, the Solo disposable cone cups are neither recyclable nor compostable since they are sealed with a fine polyethylene lining bonded to the paper.

A way to eliminate this waste stream entirely would be to install water fountains in the areas where there are currently water coolers. We estimate that this retrofit would cost about $90 per water cooler ($270 for the three existing coolers) including installation[54]. Additionally, employees can be encouraged to bring their own reusable cup or canteen. Conversely, the company could provide each employee with a reusable container or canteen[55]. Another alternative, although less preferable, would be to identify another disposable container to substitute for the cone cups that is either compostable or recyclable.

Recommendation: Our recommendation to the client was to install water fountains and encourage employees to bring their own reusable container. The implementation of this strategy would result in savings of $2,500 and less waste (Table 41).

Table 41 Cone Cups Recommendation				
Item	Percent of Material Waste Stream	Recommendation	Waste Reduction Potential (Cone Cups)	Annual Savings Potential ($)
Cone Cups	<1%	1. Purchase & Install Drinking Fountain 2. Encourage Use of Reusable Mug	150,000	$ 2,500

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[54] Based on quote provided by PlumbingSupply.com on drinking fountain bubblers and valves and assuming it takes one hour of labor to install at $2.00/hr (including benefits).
[55] We identified a number of alternatives that range in price from $5 - $15.

Can Liners

At Gills Onions approximately 22,000 plastic bags are used yearly to line waste receptacles at a cost of approximately $1,200.

In the employee lunchrooms and adjacent areas plastic liners are used for the ten recycling and garbage bins that range in size from 30 – 45 gallon. During the food waste audit, it became evident that only one set of bins (one for garbage and one for recycling) per lunchroom was sufficient for the relatively small amount of waste generated daily. This was evidenced by the fact that, even after the busiest lunch break of the day (206 employees in the morning shift), each bin was filled to less than a quarter of its capacity.

Having additional bins in each lunchroom, requires the use of more plastic bags and could lead to more opportunities for recyclables to be discarded as trash rather than recycled. Conversely, we observed that with more bins, trash was being placed in the recyclables, resulting in higher contamination of recyclable materials. Additionally, we identified that the liners were being replaced three times per day, yet the amount of garbage generated did not require the bins to be emptied and the liners replaced so frequently.

Recommendation: We recommended that Gills Onions empty the contents of the bins into a receptacle with larger capacity and dispose of that liner only once a day. Gills Onions implemented this recommendation in September 2009. We estimate that the savings associated with this action will amount to $120 per year (Table 42).

Table 42 Trash Can Liners Recommendation

Item	Percent of Material Waste Stream	Recommendation	Waste Reduction Potential (Tons)	Annual Savings Potential ($)
Trash Can Liners	<1%	1. Use Fewer Trash Receptacles 2. Replace Trash Liners Only Once Daily	<1	$120

Label liners

One of Gills Onions most obvious waste streams is label liners, which is the coated paper that is released upon removing an adhesive label. The label liners used at Gills Onions are either made of silicone coated paper or super calendered kraft (SKS) stock, materials that are generally not recyclable. The company uses peel-off labels for branding, tracking and monitoring its products.

At this time, Gills Onions purchases labeling systems from two manufacturers: Data Gear and Bizerba. Both systems rely on labels with liners and include printers, ribbon, and tracking services that allows Gills Onions to identify where individual orders originate and on what date. We estimate that yearly, the company generates 6.2 million feet – nearly 825 miles – of label liner waste. Label liners and ink ribbon represent 4% (17 tons) of the annual waste sent to the landfill.

In an effort to entirely eliminate this waste stream we conducted extensive analysis on a linerless system option. Linerless labels serve the same function but do not have the backing as waste. We identified a linerless system that is provided by a different company, General Data. However, Data Gear and Bizerba do not currently offer a linerless system that would be adequate for Gills Onions' needs. Because traceability and monitoring of finished product orders are at the core of Gills Onions' business, it is highly unlikely that the company would be willing to change to a supplier with whom it has no previous relationship.

Recommendation: Our recommendation to the client is to work with other food processors to put pressure on label manufacturers to develop linerless label systems that satisfy this sector's requirements. In addition, we recommended monitoring the market for recycling opportunities.

Producer Take Back

During the characterizations performed, we found materials in the dumpster that appeared to be recyclable and came from the regular use of packaging items. These materials included polyethylene plugs that serve as end pieces on the fiber core spools of plastic bags, and polypropylene (PP) plates (Figure 19), used to hold the spool of Zipper tape.

Figure 19 Black polypropylene plate

While the manufacturers of these items claim that they are recyclable, recyclers in Ventura County indicate that currently there is no market for this type of rigid plastic and therefore do not accept them.

To avoid landfilling this waste stream, we looked into the possibility of having Gills Onions collect these items for return to the manufacturer for reuse. The mixed items are easily identifiable and are disposed of when the plastic bag rolls or Zipper tape rolls are finished. As a result, we believed that implementing a collection and return system would be straightforward.

Upon contacting the supplier of the plastic bags, Golden Eagle, we learned that they would only be willing to take back the PET plugs if they were sanitized and certified to be FDA compliant. Moreover, Golden Eagle would not pay to take these items back, even if sanitized, because they cost $.02 per unit. Similarly, the Zipper tape manufacturer, Zip-Pak, expressed that due to collection costs and sanitation issues, they would not accept the PP plates.

Because of the effort and expense associated with sanitizing and certifying these items, this is not a viable alternative for Gills Onions to dispose of this small waste stream. However, this could present an opportunity for the company to exert a leadership role and push its suppliers to develop solutions or offer alternatives that will eliminate these waste streams.

Recommendation: We recommend that Gills Onions engage packaging managers in the food processing sector and work with suppliers to implement take back programs or provide recyclable alternatives.

Waste-to-Energy

As exemplified by label liners and nitrile gloves among others, there are materials that cannot viably be reused or recycled. However, an alternative to landfilling these materials is to send them to a thermal recycling facility for energy creation. Waste-to-energy facilities in California are intended to help with the State's diversion goals by taking wastes that cannot be recycled and making productive use of them.

At present, there is one commercial waste-to-energy facility in the Southern California coastal region where Gills Onions could deliver its non-recyclable materials: the Commerce Refuse-to-Energy Facility (CREF). Although this facility would accept most of the Gills Onion's non-recyclable materials, there are two formidable barriers to the implementation of this strategy: CREF is located 70 miles away from Oxnard and there are currently no haulers available to transport the waste. In addition, the cost of waste disposal at CREF would be significantly higher than in the Ventura County landfill. Tipping fees at CREF amount to $61 (compared to $48/ton in Ventura County) and, due to food safety requirements, Gills Onions would have to use a vehicle that does not deliver onion products for transporting non-recyclable materials to the waste-to-energy facility.

Recommendation: Given the challenges associated with delivering materials to a thermal recycling facility, we recommend that Gills Onions continue monitoring hauling alternatives to the nearest waste-to-energy facility.

Beyond Recycling

While recycling is a legitimate alternative to landfill, when analyzing waste, it is not the end goal. Recycling still consumes energy and resources, so it should be considered only after options to reduce and reuse have been exhausted. Recycling should be a last resort because demand for recycled materials fluctuates with economic cycles and export markets. If demand for recycled materials plummets – as it did in 2008 - the result can be an accumulation of waste materials and/or disposal to landfill.

In an effort to go beyond recycling we analyzed the possibility of eliminating the use of blue bags within the processing facility as well as of implementing a reverse logistics system.

Replacing Blue Bags with Reusable Container System

To go beyond recycling, we analyzed one of Gills Onions more conspicuous waste streams and one that is actually recycled: the blue bags.

Gills Onions uses blue bags to transport whole peeled onions internally from one processing station to another within the plant. After being filled, the bags are transported to the slicing line and discarded after the onions are removed. The lifetime of a blue bag inside the processing plant can be as short as ten minutes. According to our calculations, in 2008 the company used nearly 589,000 blue bags to internally transport onions at a cost of approximately $74,000. These bags represent 12% (66 tons) of the total waste generated yearly (566 tons).

Given the strict food safety regulations, the bags cannot be reused. Therefore, we explored the possibility of eliminating the bags entirely by implementing a reusable container system within the processing plant. We identified a system that met the requirements for size, storage, food safety, and portability. The container we identified was a reinforced, stackable, reusable, polyester fiberglass bin with smooth internal surfaces, a lid, and was of the following dimensions: 16½x 11 3/8 x4 5/8 inches. It can hold up to 200 pounds with a capacity of .38 cubic feet, can endure temperature extremes, is easy to clean and can be purchased with a dolly for easy mobility. We calculated that the company would need to acquire 977 containers and 20 dollies at a cost of approximately $16,000.

Because a reusable container system is only viable if there is an adequate washing and sanitation system in place, we researched potential container cleaning systems. We identified the Numafa container cleaning system which meets all Hazard Analysis and Critical Control Point (HACCP) requirements and can sanitize up to 600 bins per hour. In addition, the system is energy and water efficient and costs nearly $92,000, including installation and tax.

Implementing the complete reusable container system and sanitation, including operating expenses will cost $135,000 in the first year, but will have a payback between one and two years. While this system requires upfront capital investment, its short payback period of 1.8 years is based on an annual savings of nearly $60,000. In addition, the company will avoid having to manage 66 tons of waste.

Recommendation: We recommend the implementation of a reusable container and sanitation system and eliminate the use of the blue bag for transportation within the processing plant (Table 43). For the complete analysis see Appendix D5.

Table 43 Replacing Single-Use Blue Bags with Reusable Containers					
Item	Percent of Material Waste Stream	Recommendation	Waste Reduction Potential (Tons)	Annual Savings Potential ($)	Payback Period
Blue Bags	12%	Implement Reusable Container System to Replace Blue Bags	66	$59,520	1-2 Years

Replace Corrugated Cardboard Bins and Implement Reverse Logistics for Industrial Customers

One of the principles of zero waste is to minimize the amount of waste beyond the company's boundary, including what is shipped to customers[xxiv]. The waste that is shipped to customers typically comes in the form of packaging, as it is essential for containing, protecting, and storing products. For food products in particular, the packaging alternatives are limited given the strict food safety requirements. Consequently, we focused on the outermost layer of packaging to identify opportunities to minimize the utilization of natural resources and produce the least amount of waste.

For its largest industrial food service customers, Gills Onions packs up to 40 blue bags of whole peeled onions in a single-use 40x48x40 inch corrugated cardboard bin that can hold up to 2,000 lbs. Based on our calculations, in 2008 Gills Onions used over 14,000 single-use cardboard bins. Given that these cardboard bins are only used for 84 customers, this represents an opportunity to eliminate a significant amount of packaging that ends up as waste at the customers' site.

Figure 20 Single-use, display ready cardboard bin (DRC)

An emerging trend in the food industry is to replace single-use, display ready cardboard bins (DRC) with reusable plastic containers (RPC) and to implement a reverse logistics program to recover the containers from customers. By switching to RPCs, companies can eliminate waste and reduce overall energy consumption and GHG emissions.

Recommendation: Since Gills Onions already uses an RPC for bringing onions from the field to the processing facility, we recommended that the company implement a similar system to replace the corrugated containers shipped to its industrial customers.

We conducted an extensive analysis, taking into consideration environmental and economic impacts associated with this action. For the environmental analysis we relied on existing life cycle inventory (LCI) study by Franklin Associates that compared the environmental impact of RPCs to single use corrugated cardboard containers for delivery of fresh produce to retailers[xxv]. We based our economic analysis on data from manufacturers and used an economic model from the Reusable Packaging Association (RPA).

To minimize the weight and space required for returning the reusable bins, we recommended the use of the collapsible, stackable, reusable PP container from RPP Containers. This system relies on the implementation of a reverse logistics program. We estimate that Gills Onions would require 1,100 containers at a cost of $103 per unit, totaling $113,300. This estimate takes into account number of shipments, dwelling time, and approximate number of return trips per year.

Assuming that each RPC would travel 3,000 miles (worst case scenario), we estimated that the total cost per use for the RPC would amount to $4.76 compared to $10.15 for using cardboard bins. Under this scenario, Gills Onions could save nearly $77,000 annually if they switched to RPCs using a shared pool reverse logistics system. We anticipate that the savings could be significantly higher, given the fact that 40% of Gills Onions' industrial orders are shipped within a 500 mile radius and that most of the company's industrial customers are located in California.

In addition, replacing single-use cardboard containers with an RPC system provides environmental improvements. The benefits stem from being able to reuse individual containers multiple times as opposed to manufacturing and disposing of single-use cardboard containers.

Given the economic and environmental benefits associated with switching to RPCs when a reverse logistics program is used, and the short payback period (2-3 years), we recommended that Gills Onions implement a reusable container system and employ a common pool logistics network for its industrial customers (Table 44). For the complete analysis refer to Appendix D6.

Table 44 Implement Reusable Containers and Reverse Logistics for Large Customers

Item	Percent of Material Waste Stream	Recommendation	Waste Reduction Potential (Tons)	Annual Savings Potential ($)	Payback Period
Corrugated Cardboard Bins	N/A	Implement Reusable Container System for Large Customers and Implement Reverse Logistics System	N/A	$76,660	2-3 Years

Creating a Culture of Sustainability

In the various audits we performed, as well as in informal interviews with employees, it became apparent that often employees were uncertain as to the company's policy regarding disposal of a particular material. Even when uncertainty was not a factor, there was often considerable resistance to change, and the sentiment of "we have always done it this way" often prevailed. These facts highlighted the importance of establishing a consistent set of policies outlining how to dispose of the different types of materials, and ensuring that all employees know and follow these standards.

However, even clearly articulated goals and policies may not be sufficient if they are not coupled with employee buy-in. Employees must be aware of the reasons behind a zero waste initiative and know that they are an integral element of the success of such an initiative. Moreover, employees need to perceive that it is not an arbitrary program but it is an essential part of the Gills Onions' culture.

In order to maximize the impact of Gills Onions' waste reduction program and continue to build on that success, it is essential to create a "Culture of Sustainability" within the company. Implementing a cultural change in any organization is a long-term initiative that requires multiple elements. We recommend the following steps to achieve this cultural change:

1. Designation of an executive "champion" for the program.
2. Leadership-by-example by the executive and management teams, demonstrating their authentic commitment to these Principles.
3. Develop and communicate a Gills Onions' Environmental Statement that clearly and succinctly states company-wide principles of sustainability. Elements may include:

    a. Engaging and training employees to conduct their activities in an environmentally responsible way
    b. Minimizing waste through resource reduction and recycling
    c. Conserving resources through efficient use
    d. Handling and disposing of waste in a safe and environmentally responsible manner
    e. Engaging business partners to strive for high levels of environmental performance

4. Based on these principles, and with employee participation, develop measurable sustainability goals and job-specific operating policies designed to produce the desired behavioral changes. Consider establishing broad-based rewards for achieving measurable goals or other program milestones.
5. Educate all employees in these principles, goals, and policies, the reasons behind them, and the expected benefits to the company, individual employees, and other stakeholders. Incorporate this training into the company's recruiting and new-employee orientation programs.

6. Establish an employee-managed "Sustainability Committee" to engage the workforce in the ongoing development and administration of the program. Committee membership should rotate periodically, and include representatives from throughout the organization and from multiple levels.
7. Have the Sustainability Committee issue regular progress reports and ongoing communication regarding the results and impact of the program, both within the company and beyond. This can be in the form of meetings, newsletters, and posters on company bulletin boards.
8. Solicit employee input and participation at all levels of the organization, via suggestion boxes, departmental or other work-group meetings, questionnaires, and other methods. Encourage participation with periodic public recognition of the best ideas, as well as inexpensive prizes or other incentives given by random drawing from among all ideas submitted.
9. Re-assess program goals periodically and update as necessary.

As noted above, employee buy-in and ownership is essential to achieving success with any broad-based company initiative such as this. Only by creating and reinforcing this "Culture of Sustainability" can Gills Onions maximize the impact of their programs and achieve the best results.

Conclusion

In the previous pages we have provided analyses and recommendations that will provide Gills Onions with a roadmap towards achieving zero waste. We identified that there were three critical components to achieving a zero waste goal: establishing a baseline to identify the amount of waste being generated; analyzing each waste stream, and identifying opportunities to reduce, reuse, or recycle.

We divided the waste streams into the broad resource categories that are used in the company's everyday operations; Onions, Energy, Water and Materials. We established baselines for each one of these categories, which represent the point of departure from where improvements can be measured. Subsequently, we thoroughly examined each waste stream relying on cost-benefit and environmental analyses such as resource reduction evaluations, green supply chain management, and previously conducted life cycle assessments. Ultimately, we provided Gills Onions with nearly 50 recommendations that will not only move the company closer to achieving zero waste, but are also cost-effective and operationally viable. We calculated that our recommendations will result in net savings exceeding $900,000 annually. Combined with the company's own initiative to convert onion waste to energy, the total net savings from Gills Onions' zero waste initiative will exceed $1.4 million annually.

The recommendations we developed will enable Gills Onions to increase material waste diversion from landfill, decrease material waste generation, reduce water and energy consumption, and increase overall sustainability.

Some recommendations will likely not be adopted because they may not align perfectly with the company's short-term objectives. However, various recommendations have already been put into action or are in the process of being implemented. This is the case particularly for those recommendations that focus on preventing or reducing the amount of waste without requiring the implementation of new systems or large capital outlays.

Based on the latest audits we performed, we provided Gills Onions with a scorecard outlining the 2010 forecast for each resource category analyzed. We are pleased to report that in 2010 Gills Onions will: 1) divert 100% of the onion waste; 2) decrease purchased electricity by 47% and its associated emissions by 17%; 3) increase material waste diversion from 25% up to 53%; and 4) reduce material waste generation by 12%.

Our group project results have implications that extend beyond Gills Onions to the larger business community. As is evidenced by the savings that we have identified for Gills Onions, we are confident that other businesses that engage in zero waste initiatives will also uncover value in their waste streams. However, finding such opportunities requires concerted effort including dedicated leadership, an analytical approach and a commitment to change. Sustainability Officers can transform their positions from a cost center to a profit center if they measure and analyze their resource consumption and associated waste streams. By identifying where efficiency and reduction opportunities lie

Sustainability Officers can save their organizations money and increase profitability in the process. In the end, organizations will find that a zero waste goal is good for the environment and good for business.

For a summary of the 2008 baseline and 2010 projections please see Table 45 below. For a complete summary of all of our recommendations please see Table 46 below.

Table 45 Summary 2008 Baseline and 2010 Projection for All Resource Categories

Category	2008 Baseline	Percentage of 2008 Total	2010 Projection
Onions	217.8 million lbs processed 118.2 million lbs waste	46% Finished Goods 54% Onion Waste	100% of onion waste convert to energy & cattle feed
Energy	155,280 GJ Energy Consumption	33% Electricity 26% Stationary Sources 41% Mobile Sources	144,670 GJ
	11,152 $mtCO_2e$ Greenhouse Gas Emissions	42% Electricity 19% Stationary Sources 29% Mobile Sources	9,297 $mtCO_2e$
Water	81 million gallons	66% Processing 19% Cleaning 13% Cooling Towers 1% Restrooms 1% Irrigation	95.6 million gallons
Materials	566 tons	25% Recycled 30% Mixed Waste 12% Onion Waste 10% C&D/Landscape 10% Film Plastic 5% Cardboard/Chipboard 3% Label Liners & Ink Rolls	498 tons

Table 46 Summary Recommendations for All Resource Categories			
Item	**Recommendation**	**Benefits to Environment**	**Economic Benefit *($)**
Onions			
Onion Waste	1. Source Separate and Divert 100% Onion Waste to AERS	Eliminate 118 million lbs onion waste	$507,000
Energy			
Onsite Electricity Production	1. Implement Biodigester and Fuel Cells 2. Reevaluate Opportunity for Additional Fuel Cell if Baseload Electricity Demand Exceeds 900kW	Reduce 5.3 million kWh purchased electricity	$537,000 6-7 Years
GHG Reporting	1. Label and track fuel consumption and miles traveled or miles used for all mobile sources 2. Evaluate Greenhouse Gas Emissions from Supply Chain Activities	Avoid 1,855 $mtCO_2e$	N/A
Transport Energy Use	1. Continue Improving Transportation Fuel Efficiency 2. Consider Fuel Cost Saving and Reduced Emissions When Evaluating New Processing Facility	TBD	TBD
Energy Efficiency	1. Turn Off Idling Equipment 2. Conduct Energy Audit to Identify Efficiency Opportunities 3. Establish Key Performance Indicators for Energy	TBD	TBD
Waste Heat	1. Evaluate Reuse of Waste Heat from Air Compressor and Fuel Cells	TBD	TBD
Energy Use	1. Investigate Time-of-Use Energy Options such as Battery Storage	TBD	TBD
Water			
Water Efficiency	1. Install Water Meters in All Water Using Areas 2. Create a Water-Based Metric for Management Reporting (KPI)	TBD	N/A
Biodigester Water Use	1. Use Recycled Water for the Biodigester	Reduce 14.7 million gal	$116,000 2-3 Years
Cooling Tower Water	1. Use Recycled Water for the Cooling Tower	Reduce 9.8 million gal	$99,000 3-4 Years
Cleaning Water Use	1. Review Current Cleaning Procedures	TBD	TBD
Reuse Rinse Water	1. Evaluate Recovering Final Rinse Water for Other Plant Uses	Reduce 1.5 million gal	$9,000
Landscape Water Use	1. Use Recycled Water to Irrigate Plants or 2. Replace Current Landscape with Xeriscaping 3. Ensure watering <7 minutes per day	800,0000 gallons water	$4,000

Table 46 Summary Recommendations for All Resource Categories - Continued			
Materials			
Food Waste	1. Reduce Generation 2. Monitor Local Offsite Composting Options	8.8 tons	$ 420
Film Plastic	1. Eliminate Contamination 2. Recycle all Film Plastic 3. Evaluate Recycling Hard Plastics	133 tons	$13,700
Corrugated Cardboard	1. Bale and Recycle Small OCC and Chipboard	30 tons	$2,300
Baler	1. Fix and Make Baler Operational 2. Use Baler to Increase Value of Plastic Recyclables	N/A	$3,660
C&D	1. Source Separate C&D, Divert Through Recycling	25 tons	$0
Landscape Waste	1. Require Removal and Proper Disposal	34 tons	$1,630
Office Paper	1. Purchase Paper Containing Post-Consumer Recycled Content 2. Alter Reports to Maximize Printing Per Page	<1 ton	$ 420
Illegal Dumping	1. Enclosing Dumpster Area to Deter Non-Gills Onions Waste Disposal	30 tons	$1,440
Single Use Gloves	1. Implement Glove Dispenser System 2. Strategically Locate Glove Dispensers 3. Monitor Recycling Alternatives	550,000 gloves	$30,000
Reusable Gloves	1. Implement Multi-Use Company Policy 2. Reuse Gloves Until Damaged	12,000 gloves	$5,000
Kitchen Paper Towel	1. Remove Paper Towel Rolls from Kitchen Tables 2. Mount Paper Towel Dispensers	800 towel rolls	$ 700
Bathroom Hand Towel	1. Install High Efficiency Electric Hand Driers in Employee Bathrooms	538,125 paper towels	$7,000 1-2 Years
Facial Tissues	1. Mount Refillable Dispensers in Convenient Locations 2. Purchase Tissues in Bulk	5,525 boxes of tissues	$5,500
Cone Cups	1. Purchase and Install Drinking Fountains 2. Encourage Use of Reusable Mug	150,000 cone cups	$2,500
Trash Can Liners	1. Use Fewer Trash Receptacles 2. Replace Trash Liners Only Once Daily	<1 ton	$120
Label Liners	1. Work With Other Food Processors to Encourage Label Manufacturers to Develop Linerless Label Systems that Satisfy Requirements 2. Monitoring Market for Recycling Opportunities	TBD	TBD
Producer Take Back	1. Engage Food Processing Sector to Encourage Suppliers to Implement Take Back Programs or Provide Recyclable Alternatives	<1 ton	N/A
Waste-to-Energy	1. Continue monitoring hauling alternatives to the nearest waste-to-energy facility	TBD	TBD
Blue Bags	1. Implement Reusable Container System to Replace Blue Bags	66 Tons	$59,520 1-2 Years
Corrugated Cardboard Bins	1. Implement Reusable Container System for Large Customers and Implement Reverse Logistics System	N/A	$76,660 2-3 Years
* Payback period is less than 1 year if not indicated			

Appendix A Onion Waste to Energy

Turning Onion Waste into Energy

Looking forward at the significant impact of Gills Onions' implementation of the innovative and unique Advanced Energy Recover System (AERS) on its overall energy demand and associated emissions, we felt that it deserved a more thorough and detailed explanation of how the system works. As mentioned earlier, Gills Onions has implemented a 145,000 gallon anaerobic biodigester from Biothane, LLC to convert onion waste liquids into biogas. The biogas is used to produce electricity by two 300 kW molten carbonate fuel cells manufactured by FuelCell Energy. Gills Onions calls the combination of the two systems the Advanced Energy Recovery System (AERS) and is the first company in the world to implement a system to convert onion waste to energy. The following section describes the systems themselves in more detail, the multiyear timeline of implementation and provides a comparative analysis of the environmental and economic impacts before and after the implementation of AERS.

Biodigester

On average Gills Onions generates more than 300,000 lbs of onion waste per day. The onion waste is put through a proprietary mechanical juice extraction process (screw press) where the onion waste solids are separated from the onion juice. A small application of limestone is added to aid in the juice extraction process. The solid onion waste or cake can then be sold to dairies as cattle feed that is high in nutritional value. Approximately 70% of the onion waste is extracted as onion juice[56]. Prior to being fed to the biodigester, the onion juice sits for two days so that it can ferment. It is then fed to the biodigester at a rate of 20 gallons per minute. The onion juice is diluted as it enters the digester with water at a rate of 25 gallons per minute[57]. Water is sprayed continuously at a rate of 3 gallons per minute across the top of the biodigester to reduce the amount of foam generated. The residence time of onion juice in the biodigester is 4.1 days and the effluent is directed to the onsite aerobic wastewater treatment plant.

The biodigester is kept at a temperature of 91-93°F to facilitate biogas production. Gills Onions uses the waste heat off of its Caterpillar engine to keep the digester warm. Within two hours of entering the anaerobic environment, microbes begin converting the onion juice into biogas. The biodigester produces biogas at a rate of 75-80 cubic feet per minute. Gills Onions' biogas is made up of 75-85% CH_4, 10-20% CO_2, 5% hydrogen sulfide (H_2S)and 3% water. Prior to being sent to the fuel cells, the biogas is cleaned (H_2S is removed) and dried.

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[56] Liquid onion waste is estimated to be 10.7 million gallons annually based on 2008 production data.

[57] It is important to note that as of January 2010, Gills Onions was using potable water from the city of Oxnard to supplement the onion juice production and reduce foaming in the biodigester. However, to reduce the amount of fresh water consumed, we are recommending that Gills Onions consider reusing the wastewater effluent from its onsite wastewater treatment plant instead (see Water section for a full description).

Fuel Cells

Gills Onions installed two 300 kW Direct Fuel Cell power plants that went online in January 2009. The power plants are actually comprised of multiple fuel cells in parallel which split methane (CH_4) to reform hydrogen. Combined with oxygen, the fuel cells then use an electromechanical reaction to produce direct electrical current (DC) without combustion. The molten fuel cells deployed at Gills Onions use the CO_2 from the biogas to facilitate the electromechanical reaction. The final step is the inversion of the direct current into AC power or utility grade electricity. Gills Onions estimates that it will produce enough biogas from the biodigester to fuel 75% of the total demand of the two fuel cells. The remaining gas will be supplied from natural gas. In comparison to typical fossil-fuel based power plants which operate at approximately 35% electrical power generation efficiency, the fuel cells are 47% efficient in the generation of electrical power.

Another benefit of using fuel cells is that they are efficient and have been designated by the CARB as an "Ultra-Clean" source of energy because of their low emissions. Since fuel cells use an electrochemical reaction instead of combustion, they produce low CO_2 and virtually no nitrogen oxides (NO_x) or sulfur oxides (SO_x) emissions. The small amount of CO_2 emissions that the fuel cells generate is biogenic, as they originate from onion waste. The Climate Registry does not require that biogenic emissions be reported. Using fuel cells to create electricity onsite thus provides Gills Onions with multiple environmental benefits:

1. Avoided emissions from land application,
2. Avoided emissions associated with purchased electricity that would have come from the utility grid, and
3. Avoided emissions from transporting onion waste to the fields[58].

In addition, the AERS system qualifies as a renewable energy source by the State and federal government. Should Gills Onions be interested, the system could also potentially qualify as Renewable Energy Credits (REC) which could be sold on the emerging California Cap and Trade market or directly to a company such as Google which voluntarily buys RECs to offset the emissions associated with its data centers.

Timeline

Gills Onions' two-pronged strategy to address its onion waste problem has evolved over time. The following timeline (Table A1) helps to clarify the sequence of events.

[58] All solid onion waste is now being sold to dairies as cattle feed.

Table A1 AERS Implementation Timeline	
2007	100% of onion waste was land applied. First experimentation with the mechanical process for separating onion waste solids from liquids.
2008	April, first deliveries of cake (solid onion waste) to dairies Liquid onion waste continues to be land applied December, test two new fuel cells Energy use and Emissions baseline year (pre-AERS)
2009	January, two 300 kW fuel cells go online generating electricity at the Oxnard facility from natural gas Dairies continue to buy cake, using 100% of the solid onion waste July, official launch of Advanced Energy Recovery System (AERS), equipment in place Liquid onion waste is land applied until August, then redirected to biodigester September, biodigester filled with onion juice and microbes, testing began November, fuel cells running on 75% biogas and 25% natural gas
2010	AERS system in full production mode

Economic Analysis

The Gills Onions' AERS system cost a total of $9.5 million to purchase and implement. Rewarded for the risks it took as an early adopter, Gills Onions received several grants and investment tax credits. The net cost of the system is estimated to be $3.9 million[59].

Analysis - 2009

Although the fuel cells are intended to convert biogas to electricity, for most of 2009 the fuel cells were powered by natural gas. For our analysis, we assumed natural gas was used in the fuel cells for all of 2009, creating the equivalent of 5,256,000 kWh during the year. The net savings in energy costs alone in 2009 (before the biodigester) were estimated to be $267,720 (Table A2).

[59] The calculation of payback period was based on an original project cost of $9.5 million, less grants and tax incentives, to equal $3.9 million financed by Gills Onions, subtract 2009 energy cost savings of $267,720 and then divide by the annual net savings of $588,900 equals 6.2 years.

Table A2 Estimated 2009 Savings From Displacing 5.2 million kWh of Purchased Electricity				
Electricity Cost Savings				
KW/fuel cell	kWh/yr/fuel cell	$/kWh (2008 rate)	Electricity cost savings/fuel cell	Electricity savings for two fuel cells
300	2,628,000	0.12	$315,360	$630,720
Natural Gas Costs				
BTU/scf/fuel cell	Therms/yr/fuel cell*	$/Therm (2008 rate)	Annual NG cost/ fuel cell	Annual NG costs for both fuel cells
930	184,999	0.9811	$181,502	$ 363,000
Estimated Total Energy Cost Savings (2009)				**$ 267,720**
In 2009 Gills Onions used 100% natural gas in both of the 300 kW fuel cells				

Analysis – 2010

For 2010 Gills Onions estimates that the biodigester will create enough biogas to power 100% of one fuel cell and 50% of the second fuel cell. Natural gas will provide the remaining energy requirement of the second fuel cell. We calculated that the net purchased energy cost savings from implementing AERS will be approximately $537,200 annually (Table A3).

Table A3 Estimated 2010 Net Energy Cost Savings by Implementing Biodigester & Fuel Cells			
Electricity Cost Savings			
Electricity savings for two fuel cells			$630,720
Natural Gas Costs			
BTU/scf/fuel cell	Therms/yr/50% of 1 fuel cell	$/Therm	Annual Natural Gas Cost for 1/2 of 1 fuel cell
930	95,318	$0.9811	$93,516
Estimated net energy cost savings (2010)*			**$537,204**
In 2010, Gills Onions will use 75% biogas and 25% natural gas in its two 300 kW fuel cells			

To identify the financial benefits from replacing land application of its onion waste with the AERS initiative, we compared 2007 to 2010 (Table A4). In the 2007 100% land application scenario we included the onion waste disposal fuel costs and labor fees from Rio Farms, as well as the purchased electricity cost equivalents for 5.2 million kWh of energy. The total cost of land application and energy was $1.1 million. We contrasted the 2007 analysis with the estimated 2010 scenario in which we added the fuel cell maintenance costs, the company's cost of capital for AERS, the increased water costs and the onsite maintenance costs for the biodigester. We calculated the net annual savings to be nearly $589,000 with a payback period of 6.2 years. It is important to note that the implementation of AERS provides additional economic benefits including the positive impact of putting the 30 acres of farm land back into production once the land application stops.

Table A4 Economic Impact Comparing 2007 vs. 2010		
	2007 100% Land Application	Projected 2010 with AERS
Transportation onion waste to Fields	$162,048	$ -
Disposal Labor	$332,146	$ -
Excess tipping fees*	$12,588	$ -
Energy Costs (5.256 kWh based on 2008 rates)	$630,720	$-
Net Energy Cost (natural gas)		$93,516
Cost of Maintenance (fuel cells)		$200,000
Finance Cost (annual)		$126,783
Water Costs (potable and effluent)		$88,300
Maintenance Labor Costs (biodigester)		$40,000
Net Onion Waste Costs	$1,137,502	$548,599
Net Annual savings	**$588,900**	
Payback period[60] (years)	**6.2**	

Based on 2008 onion waste of 118.2 million lbs
Economic impact of onion waste disposal methods, 2007 with 100% land application and the 2010 project scenario with 30% of the onion waste sold as cattle feed and 70% of the onion waste going to the biodigester to create biogas.
*Gills Onions incurred excess tipping fees from onion waste in garbage and onion waste contamination in the recyclables, in addition to lost recycling revenues due to contamination.

Environmental Impact – greenhouse gas emissions

2007 – 2010 Analysis

Similar to the economic analysis above, we also conducted an environmental emissions analysis comparing the 2007 scenario where Gills Onions land applied 100% of its onion waste to the projected 2010 scenario where the company diverted 100% its onion waste for the creation of biogas and for the sale as cattle feed.

In the 2007 land application scenario we calculated the greenhouse gas emissions associated with transporting the onion waste to the fields, which totaled 401.5 $mtCO_2e$ (Table A5). As discussed in the Onion Section, because calculating emissions from land application was both time consuming and controversial, we determined that doing so was out of the scope of our project.

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[60] The calculation of payback period was based on an original project cost of $9.5 million, less grants and tax incentives, to equal $3.9 million financed by Gills Onions, subtract 2009 energy cost savings of $267,720 and then divide by the annual net savings of $588,900 equals 6.2 years.

For the 2010 projected emissions we looked at the variables that impact emissions from Gills Onions' two-pronged strategy of converting onion waste to cattle feed and electricity. We included the GHG emissions associated with Gills Transport's delivery of cake to the dairies and the emissions avoided by using AERS to replace 5.2 million kWh of purchased electricity annually. Table A5 provides a summary of the 2007 vs. 2010 scenarios and the net result of 1,855 mtCO_2e of avoided emissions annually from the use of the AERS system. Avoided GHG emissions of 1,855 mtCO_2e represent a 16.6% reduction in greenhouse gas emissions from the base year of 2008[61].

Table A5 Environmental Emissions Comparing 2007 vs. 2010 (mtCO_2e)

	2007 100% Land Application	Projected 2010 with AERS
Transportation to Fields	401.54	0.00
Transportation to Dairies		280.47
Avoided Electricity Emissions		(1,733.85)
Emissions from AERS**		0.00
Net CO_2e Emissions (metric tons)	401.54	(1,453.38)
Total CO_2e Emissions Avoided	(1,854.90)	

* Based on 118.2 million lbs onion waste. Environmental impact as measured in metric tons of CO_2e of Gills Onions onion waste disposal comparing 100% land application of onion waste to the 2010 projected scenario with 30% of the onion waste (all the onion waste solids) being sold as cattle feed and 70% of the onion waste (all of the onion juice) going to the biodigester to create biogas.
**Fuel cells are designated as an "Ultra-clean" energy source by the California Air Resources Board. The Climate Registry does not include emissions from biogenic sources, such as biogas.

While a 16.6% reduction in the company's total greenhouse gas emissions is substantial, it is important to note that this amount does not include additional avoided emissions from:

1. Carbon dioxide and methane emissions that would have occurred with land application of onion waste in the fields;
2. Farm equipment fuel consumption (spreaders and tractors for tilling);
3. The reduced carbon uptake from a lower crop yield in the fields due to the high sulfur content of the onions; and
4. The reduced demand for purchased electricity from the utility, which theoretically would reduce the utility's emissions associated with producing the 5.2 million kWh of electricity.

[61] Projected CO_2e emissions avoided in 2010 of 1,855 metric tons represents a 16.6% reduction in emissions from Gills Onions' total GHG emissions in 2008 of 11,152 mtCO_2e.

While there is no or limited guidance from the Climate Registry for calculating emissions from the aforementioned sources, should Gills Onions tackle a supply chain approach to its carbon emissions, these types of emissions would become more apparent. Taken together, these uncounted emission reductions could conceivably be 10 times greater than the 1,855 mtCO_2e emission we calculated.

In conclusion, Gills Onions' decision to implement AERS to convert the company's onion waste to energy solved the onion waste problem, saved in purchased energy costs and reduced the company's environmental impacts. By converting its onion waste to energy, Gills Onions eliminated 118.2 million pounds of onion waste to produce 5.2 million kWh of electricity which represents a 47% reduction in purchased electricity demand for its Oxnard facility. In addition, by reducing its solid waste by 99.5% the company will save nearly $589,000 annually in waste disposal and purchased electricity costs and reduce its greenhouse gas emissions by at least 16.6%. By implementing AERS, Gills Onions took a huge step toward achieving its zero waste goal and significant economic and environmental savings.

Appendix B Energy

Energy is the second resource category that we evaluated. With Gills Onions' commitment to converting its onion waste to energy, the first objective for the Energy category was to create a baseline of the company's total energy consumption including electricity, natural gas, diesel, propane and gasoline. We established the baseline year as 2008 before the biodigester and fuel cells (AERS) were fully implemented. Our second object was to calculated, reported and verified Gills Onions' baseline greenhouse gas emissions (GHG) inventory to the Climate Registry. Using the 2008 baseline data of energy inputs and GHG emission outputs, our third objective was to analyze the economic and environmental impacts of Gills Onions' transition to renewable energy with its implementation of AERS.

Energy Use and Emissions Baseline

To report the baseline for energy consumption and emissions the following section is divided into three subsections; electricity, mobile sources, and stationary sources. In each subsection we describe the methods we used to compile the baseline and analyze the findings. Each subsection will describe in detail and refer to the following aggregate profiles of Gills Onions' total energy consumption (Figure B1) and associated greenhouse gas emissions (Figure B2). For the purposes of comparison, all energy usage has been converted to a common energy unit, gigajoules (GJ). Gills Onions' total energy consumption in 2008 was 155,280 GJ and GHG emissions for 2008 were 11,152 metric tons of CO_2 equivalents ($mtCO_2e$).

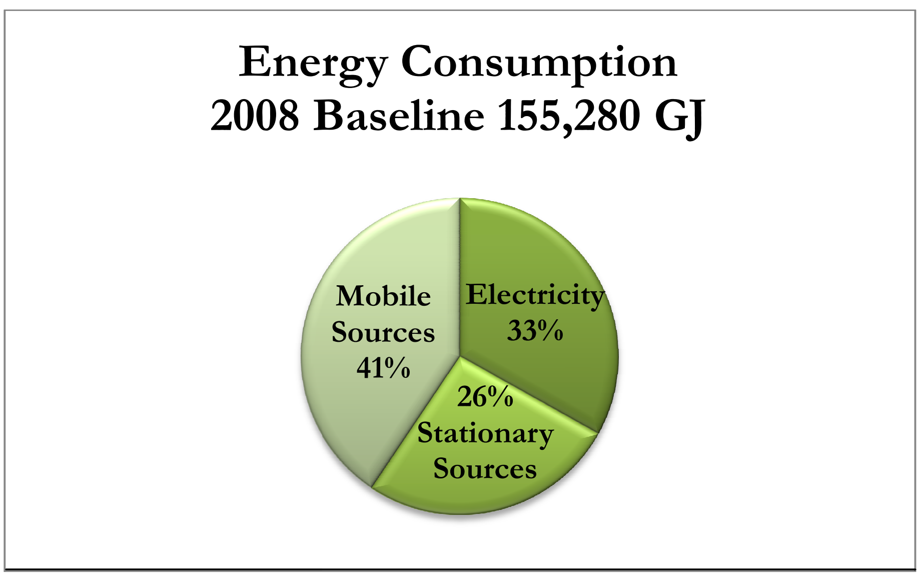

Figure B1 Aggregate profile of Gills Onions' 2008 energy consumption

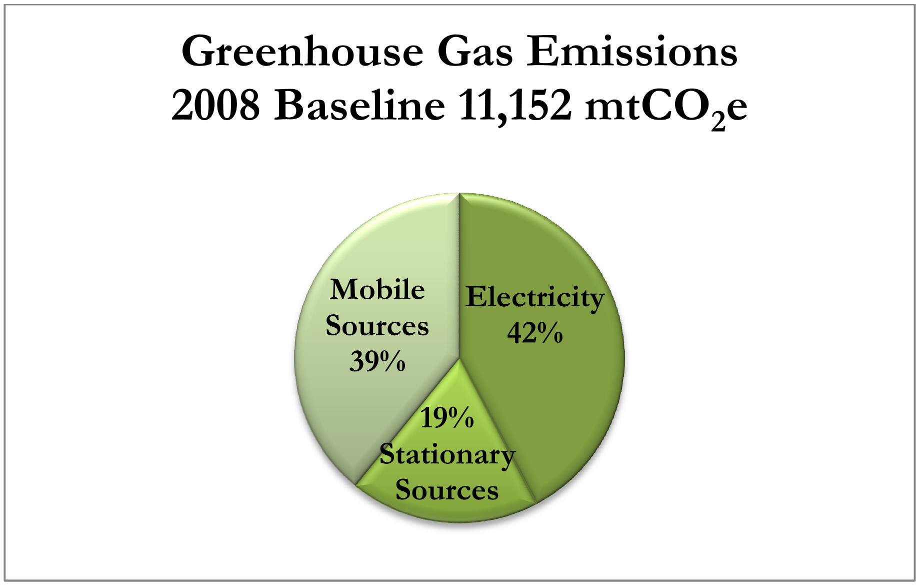

Figure B2 Aggregate profile of Gills Onions' 2008 greenhouse gas emissions

Baseline – Electricity

Total electricity consumption for 2008 was 14.3 million kWh (Table B1). The Oxnard facility used 78% of the total electricity consumption while King City Cooling used the remaining 22%. As portrayed in the aggregate profile of Gills Onions total energy use, electricity usage represents 33% of the company's total energy consumption (Figure B1).

While we did not calculate the electricity used by each individual process within the Oxnard facility, we did identify that Gills Onions' single largest demand for electricity was the ammonia compressor refrigeration system and evaporation towers. The amount of energy this system ultimately consumes is dependent on the ambient air temperature, the quantity of onions being put into storage onsite, and the temperature of the raw onions coming in from the fields. At a minimum, the refrigeration system demand is 50% of the Oxnard facility's electricity consumption and can increase to as much as 75% of the total plant electricity during peak summer production hours[62]. The King City Cooling facility also has a similar ammonia compressor refrigeration system, albeit smaller.

[62] Per Ron Starzl, Gills Onions Engineer, electricity demand for refrigeration can vary between approximately 746 kW and 1,164 kW, representing 50% to 75% of Gills Onions' average base load of 1,950 kW during the production shifts.

Table B1 2008 Electricity Baseline and Associated Emissions				
Electricity	**Inputs**		**Emissions**	
	kWh	GJ	$mtCO_2e$	Percentage
Gills Onions Oxnard Facility	11,171,162	40,216	3,685.1	78%
King City Cooling	3,120,000	11,232	1,029.1	22%
Total Electricity	14,291,162	51,448	4,714.2	

Emissions

The Climate Registry considers greenhouse gas emissions from electricity to be Scope 2 emissions or indirect emissions. Based on Gills Onions' electricity consumption and where its electricity is supplied from Gills Onions' total greenhouse gas emissions from electricity for 2008 were 4,714 metric tons of CO_2e[63,64]. Emissions from electricity represented the largest proportion (43%) of the company's total GHG emissions (Figure B2)[65].

Analysis

As illustrated in Figures B1 and B2, in 2008 electricity represented approximately 33% of Gills Onions' total energy consumption but constituted a full 43% of total GHG emissions for the company[66]. Even with Gills Onions' electricity being provided by relatively "clean" California sources (primarily natural gas), the difference between energy consumption and emissions underscores the relatively high emissions intensity of electricity as compared to the other energy sources. To compare the emissions intensities of the different energy sources, we calculated the ratio of GHG emissions in CO_2 equivalents to the quantity of gigajoules used over the year. The emissions intensity of electricity is more than 80% higher than the emission intensity of natural gas (Table B2).

Table B2 Comparison of 2008 Electricity vs. Natural Gas Emissions Intensity and Cost per Gigajoule		
	Emissions Intensity ($mtCO_2e/GJ$)	Cost per GJ ($)
Electricity	0.0916	$33.353
Natural Gas	0.0508	$9.024

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63 The CAMX sub-region called the Western Electricity Coordinating Council –WECC.

64 CO_2 tons = kWh * 1MW/1000 kW * 878.71 lbs CO_2/MWh ÷ 2204.62 lbs/metric tonCH_4 to CO2e = kWh * 1 MW/1000kW * 0.036 lbs CH_4/MWh ÷ 2204.62 lbs/mt * 21 GWP of CH_4.
N_2O to CO_2e = kWh * 1 MW/1,000kW * 0.008 lbs N_2O/MWh ÷ 2204.62 lbs/mt * 310 GWP of N_2O.

65 Electricity GHG emissions were 4,714 $mtCO_2e$ which is 43% of Gills Onions' 2008 total emissions of 11,152 $mtCO_2e$.

66 Electricity usage was converted from 14.3 million kWh to 51,448.2 GJ using the ratio of 1 kWh = 0.0036 GJ. This was compared to the total energy consumption for 2008 of 155,279.3 GJ.

In 2008 the cost of electricity per gigajoule was more than 3.5 times higher than the cost of natural gas for the same period[67]. While the cost comparison between electricity and natural gas can vary widely from year to year, looking closely at the emissions intensity and costs per gigajoule of electricity reinforces the decision by Gills Onions to reduce its reliance on purchased electricity by producing electricity onsite with AERS.

Gills Onions' AERS project consists of an anaerobic biodigester and two 300 kilowatt fuel cells which convert onion waste to electricity. The system will enable the company to reduce its electricity demand by 5.3 million kWh per year[68]. Based on the 2008 consumption baseline, this will represent a 47% reduction of the company's purchased electricity demand at the Oxnard facility[69]. In addition, the fuel cell technology Gills Onions is using is considered an "ultra-clean" energy source by the California Air Resources Board (CARB) and produces minimal GHG emissions. As a result of implementing this technology Gills Onions will therefore be able to avoid GHG emissions by reducing purchased electricity from the grid.

Baseline - Stationary Sources

To calculate the 2008 baseline for stationary source energy consumption and emissions, we created a detailed inventory of all the stationary equipment onsite and calculated the amount of fuel energy consumed. Gills Onions had not tracked fuel consumption and usage by equipment type. Therefore we had to extrapolate fuel consumption based on publicly available equipment specifications and anecdotal information from Gills Onions' employees about general usage patterns. The Climate Registry accepts a simplified estimation method for calculating the inventory as long as there is a well documented rationale for the calculation and that the emissions reported using this method constitute less than five percent of total emissions. Table B3 displays the aggregate baseline for stationary source energy usage and associated emissions by fuel type.

Table B3 2008 Stationary Sources Aggregate Baseline and Associated Emissions by Fuel Type

Stationary Sources	**Inputs**		**Emissions**	
Fuel types	Therms Gallons	GJ	CO_2e tons	Percentage
Natural Gas (Therms)	373,323	40,588	2,061.26	99.4%
Diesel (Gallons)	762	112	7.76	0.4%
Gasoline (Gallons)	570	75	5.04	0.2%
Propane (Gallons)	30	3	0.17	0.08%
Total Stationary		**40,777**	**2,074.23**	

[67] Average cost of electricity was $33.35/GJ versus the average cost of natural gas of $9.02/GJ.
[68] Electricity savings from using two 300 kW fuel cells at full capacity = 600 kW*8,760 hours/year = 5,256,000 kWh/yr.
[69] Annual electricity percentage saved from fuel cells 5,256,000 kWh/11,171,162 kWh at Oxnard, 2008.

Natural Gas

To understand the total natural gas consumed by Gills Onions we requested a summary report for 2008 by gas meter, including the natural gas consumption by month. Constellation New Energy is the supplier of the natural gas and Sempra Energy (Southern California Gas) delivers it via pipeline and invoices customers for the gas consumed. It was helpful for us to physically locate each gas meter, identify the corresponding account number and determine which piece of equipment ran off of each gas meter.

The total natural gas used by Gills Onions in 2008 was more than 373,000 therms (Table A4) which converts to approximately 40,600 GJ. Of the total stationary source energy consumption, natural gas represented 99.5% with diesel, propane and gasoline making up the remaining 0.5%. In 2008 natural gas was almost exclusively used for the air compressor which blows the peels off the onions after the tops and tails have been removed. Powered by a Caterpillar Centric 815 horsepower engine, the air compressor used 366,000 therms in 2008 representing 98% of Gills Onions' natural gas consumption. Backup generator maintenance and fuel cell testing constituted the remaining 2% of natural gas consumption[70]. Since the biodigester would not be fully implemented until the end of 2009, the company planned to generate electricity from the fuel cells using natural gas instead of biogas in the interim.

Emissions

The Climate Registry required us to identify from where the natural gas was generated and the type of equipment using the natural gas, as these factors affect combustion efficiency and the resulting emissions[71]. Total greenhouse gas emissions from natural gas were by far the most significant contributors to Gills Onions' stationary source emissions. Total natural gas GHG emissions were 2,061 metric tons of CO_2 equivalents with emissions from the air compressor (2,023 mtCO2e) constituting 98% of the total natural gas emissions.

In 2009, before the biodigester was fully implemented, Gills Onions powered the two 300 kW fuel cells with natural gas to generate electricity onsite. We estimated that the net savings between purchased electricity and self-generated electricity would be approximately $267,720 if Gills Onions were to run the fuel cells on natural gas for the full year[72].

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[70] In 2008 the back-up generator was tested twice during maintenance and consumed a total of 1,096 therms. In December 2008, Gills Onions also tested the two new 300 kW fuel cells using natural gas and consumed 6,003 therms during the test.

[71] Gills Onions' air compressor was classified as Natural Gas-fired, 4 Stroke, Rich Burn, Reciprocating Engine and the backup generator and fuel cell test run was identified as Unknown Electric Power Sector because the majority of the use was for the fuel cell test converting natural gas to electricity.

[72] See Appendix A "Onion Waste to Energy" for a detailed explanation of how costs were derived.

Baseline Stationary Sources - Propane, Diesel, Gasoline

Within the guidelines of the Climate Registry, we calculated an inventory of all the stationary equipment that used diesel, gasoline and propane. Unfortunately, the data available with regards to total consumption by fuel type for stationary sources was only somewhat accurate and the estimates by type of equipment were even less accurate. While the amount of fuel used by each individual piece of equipment was small, we did our best to estimate usage by equipment. We relied heavily on Gills Onions employee's knowledge of usage patterns and probable frequency of refills (Table B4). The Climate Registry accepts a simplified estimation method for creating the inventory as long as there is a well documented rationale and that the emissions reported using this method constitute less than five percent of total emissions.

Table B4 2008 Inventory for Stationary Sources by Fuel Type

Stationary Source Inventory by fuel type	Gallons of Fuel
Diesel	
2 Pressure Washers (5 gal tanks w/ red diesel)	748
2 Pressure Washers (usage per yard record white diesel)	14
Gasoline	
The following equipment are filled from Tony's pump	570
Stand-by waste water pump	
Portable emergency pump	
Portable generator	
2 Portable Pressure Washers	
Propane	
3 Catalytic Heaters (3 gallons ea.)	9
3 Catalytic Heaters (6 gallons ea.)	18
10 Torches (16 oz ea.)	0.5
30 Bunsen Burners (16.4 oz ea.)	1.5

Emissions

Using the Climate Registry standard protocols we calculated greenhouse gas emissions from each stationary fuel source (Table B4) which resulted in total CO_2e emissions for propane, diesel and gasoline combined of 13.1 metric tons of CO_2e[73]. Collectively this represents 2% of total stationary source emissions and only 0.001% of Gills Onions total greenhouse gas emissions for the year. Given these emissions represented such a small percentage of Gills Onions overall emissions reported to the Climate Registry for 2008,

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[73] GHG emissions calculations for Stationary Sources:

Propane = gallons propane * 5.74 kg CO_2/gallon * 1 ton/1000 kg = 0.172 mtCO_2

There are no CH4 or N2O emissions related to stationary propane use.

Diesel CO_2= gallons of diesel * 0.0101452 kg CO_2/gallon * 1 ton/1000 kg = 7.73 mtCO_2

CH_4= gallons of diesel * 4.0E-7 kg CH_4/gallon * 1 ton/1000 kg = 3.17E-4 mtCH_4

N_20= gallons of diesel * 1.0E-7 kg N_2O/gallon * 1 ton/1000 kg = 6.3E-5 mtN_2O

Gasoline CO_2= gallons of gas * 0.0088 kg CO_2/gallon * 1 ton/1000 kg = 5.02mtCO_2

CH_4= gallons of gas * 3.72E-7 kg CH_4/gallon * 1 ton/1000 kg = 2.12E-4 mtCH_4

N_20= gallons of diesel * 7.37E-8 kg N_2O/gallon * 1 ton/1000 kg = 4.2E-5 mtN_2O

we were well within the acceptable boundaries for using the simplified estimation method for fuel consumption. Our estimates and emissions calculations were verified by RMA and accepted by the Climate Registry.

Baseline - Mobile Sources

Following the Climate Registry guidelines to generate the 2008 baseline for energy consumption and emissions we created a detailed inventory of all onsite and on road vehicles. Table B5 below is the aggregate baseline for vehicle fuel usage and associated emissions by fuel type.

Table B5 2008 Mobile Source Aggregate Baseline for Energy Consumption and Emissions

Mobile Sources	**Inputs**		**Emissions**	
Fuel type	Gallons	GJ	Metric tons CO_2e	Percentage of Total
Diesel (total)	424,163	62,148	4,309.6	98.7%
Gills Onions	4,916	720	50.27	
Gills Transport	407,329	59,682	4,138.23	94.6%
Rio Farms	11,918	1,746	121.07	
Gasoline	1,696	223	14.95	0.3%
Propane	6,770	682	39.00	0.9%
Total Mobile	**432,629**	**63,053**	**4,363.56**	

While not mandatory as part of the Climate Registry reporting efforts, we made the decision to extend the boundary for the Energy Section of our group project so that we could take a closer look at the role transportation plays in Gills Onions' overall energy consumption and emissions baseline. The rationale for this decision was that Gills Transport and Rio Farms are sister companies of Gills Onions and Steve Gill has operational control over both the companies. The services Gills Transport and Rio Farms provide to Gills Onions are essential to its core business – delivering raw onions from the fields, disposing of all the onion waste and delivering approximately 30% of all finished goods to customers within a 300 mile radius of Oxnard. The 2008 aggregate mobile source fuel consumption and emissions baseline highlights the significant impact that Gills Transport's diesel fuel consumption has on overall mobile source emissions. 94.6% of the total mobile source fuel demand (Table B5) and 38.4% of Gills Onions' 2008 total energy consumption are related to Gills Transport activities[74].
The following table (Table B6) provides a comprehensive inventory of Gills Onions' vehicles and our estimates for gallons of fuel used by fuel type.

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[74] Gills Transport diesel fuel consumption of 407,329 gallons is the equivalent of 59,682 GJ which represents 38.4% of Gills Onions' total energy consumption of 155,280 GJ.

Table B6 2008 Baseline Inventory for Mobile Vehicles by Fuel Type	
Mobile Source Inventory	Gallons
Diesel – Gills Onions	**4,916**
Onsite Vehicles (red diesel/agricultural)	
1 Caterpillar Forklift (20 gal tank)	1,040
3 Yard Dogs* (50 gal tank)	1,350
1 Ford Tractor (20 gal tank)	1,040
On-Road Heavy Duty Vehicles (white diesel)	
1 Ryder Bobtail**	967
1 "Big" Flatbed Truck	261
1 Ryder 24 ft Roll-off special body***	146
On Road Light Duty Vehicles (white diesel)	
1 Ford Pickup "Tony's Old Truck" (1995) (January – August, 2008)	112
Diesel – Gills Transport and Rio Farms	**419,247**
Gills Transport	
22 Peterbilt truck engines(1998 – 2008) (435 – 500 horsepower engines)	407,329
Rio Farms	
2 tanker trucks (1,600 and 3,200 gallon capacity)	7,870
2 dump trucks (16,000 and 18,000 lbs capacity)	4,048
Gasoline	**1,696**
On-Road Heavy Duty Vehicles	
1 Ford Flatbed Truck (1990)	67
On-Road Light Duty Vehicle	
Tony's "New" Ford Pickup (2002) (formerly Arturo's Truck)	1,032
Arturo's New Ford Pickup (purchased Aug 2008)	597
Propane	**6,770**
Nissan G24 Forklift	
Nissan 3807 Washing Forklift	
Cat-Bin Dumper Forklift	
Armadillo Power Sweeper****	

*A Yard Dog is an engine with a single person cabin only used onsite to move trailers around the yard.
** A Bobtail is a small refrigeration truck used to transport product within a 20-30 mile radius of Oxnard.
***The 24' Roll-off is hauling the large dumpsters to and from the recycling center and landfill.
****The Armadillo Power Sweeper is a small street sweeper used to keep the facility grounds clean

Diesel – Gills Onions

In 2008, Gills Onions purchased two types of diesel from two different suppliers. Dewitt delivered a total of 3,430 gallons of red diesel in 2008 which was only used for onsite heavy duty equipment because it is highly polluting. Silvas is the supplier of Gills Onions white diesel which was used for on-road vehicles. In 2008, 1,500 gallons of white diesel was purchased from Silvas by individual employees using a company account.

Diesel – Gills Transport

Gills Transport provided detailed information on 2008 vehicle miles traveled per month for each of the three delivery activities; raw onions, finished goods and cattle feed. Total fuel usage by Gills Transport for 2008 was approximately 407,330 gallons to travel a total of more than 2.4 million miles (Table B7). Gills Transport represents 94.6% of the total energy consumption by mobile sources and 38.4% of Gills Onions total energy consumption.

Table B7 Gills Transport Fuel Usage and Miles Traveled by Service Provided (actual)

Deliveries	Raw Onions	Finished Goods*	Onion Waste as Cattle Feed	Total
Lbs of Onions	217,842,000	30,994,000	38,145,400	
Miles	1,831,122	409,950	165,636	2,406,708
Fuel Usage (diesel)	305,187	74,536	27,606	407,329

*Excludes finished goods transported by other carriers besides Gills Transport

Diesel - Rio Farms

Rio Farms was contracted to dispose of Gills Onions' solid and liquid onion waste in 2008, before the biodigester was implemented. We had limited data from Rio Farms as the company invoices Gills Onions based on labor hours, not number of trips. We estimated that Rio Farms use of white diesel in 2008 to have been 7,870 gallons for hauling liquid onion waste to the fields and 4,048 gallons of white diesel for hauling solid onion waste to the fields (Table B8). It is interesting to note that Gills Onions was generating so much onion waste to the fields that the tanker and dump trucks were hauling onion waste on a continuous basis averaging more than 15 trips per day.

Table B8 2008 Rio Farms estimated fuel usage and vehicle miles traveled (estimates)

Deliveries	Liquid Onion Waste	Solid Onion Waste*
Lbs of Waste	56,031,200	24,013,400
Miles	43,275	22,262
Fuel Usage (diesel)	7,870	4,048

*Gills Onions stopped sending solid onion waste to the fields in April and began selling it as cattle feed.

Gasoline

In 2008, Gills Onions purchased approximately 1,700 gallons of gasoline from Silvas which represented 0.3% of Gills Onions total mobile source energy consumption[75]. For all on-road vehicles, particularly gasoline-based, it was important to collect the model year because this affects average fuel economy due to the environmental regulations at the time of manufacture.

[75] Gasoline consumption in 2008 totaled 1,696 gallons which converts to 223 GJ of energy and represents 0.3% of the total mobile source energy consumption of 63,054.

Propane

In 2008, total propane used by Gills Onions' onsite vehicles in 2008 was 6,770 gallons representing 1% of the company's total energy consumption by mobile source[76].

Emissions

Based on the Climate Registry General Reporting Protocol, CO_2 emissions from mobile sources are calculated based on the baseline of fuel consumed and the CH_4 and N_2O emissions are based on vehicle miles traveled for each fuel type and piece of equipment. In 2008, Gills Onions emissions from mobile sources totaled 4,364 metric tons of CO_2e, representing 38.6% of the company's total greenhouse gas emissions for the year (Figure B2). The single largest contributor to the mobile source emissions was Gills Transport representing nearly 95% of the total mobile source emissions (Table A6). Rio Farms was the second largest contributor to mobile source emissions with 3% and Gills Onions' own mobile source emissions, including diesel, gasoline and propane, represented the remaining 2% of the total GHG emissions for mobile source.

Analysis

For the purposes of the Climate Registry, since Gills Onions does not have ownership of Gills Transport and Rio Farms, Gills Onions was not required to report emissions associated with these services. Consequently, Gills Onions' greenhouse gas emissions reported to the Climate Registry were 6,894 metric tons of CO_2e. In comparison, we included the collective 4,259.3 metric tons CO_2e of emissions associated with the services provided by both Gills Transport and Rio Farms for a total companywide emissions inventory of 11,152 metric tons of CO_2e. This represents a 38% difference between what was required in the Climate Registry and what we considered to be the results of Gills Onions core business decisions and practices and underscores the importance of boundary definitions in greenhouse gas inventory and emissions reporting. While Gills Onions' emissions inventory and reporting are purely voluntarily, it is easy to see how large companies who are facing mandatory reporting could find ways to hide emissions and avoid reporting by dividing a company into smaller and smaller businesses, staying under the mandatory reporting threshold of 25,000 metric tons CO_2e[77].

Summary 2008 Baseline of Energy Use and Emissions

Following is a summary of Gills Onions Baseline 2008 energy use and greenhouse gas emissions baseline (Table B9). We followed the Climate Registry General Reporting Protocol version 1.1 for calculating CO_2 equivalent emissions based on energy consumption. The total energy consumption for 2008 was 155,280 gigajoules with a mix of 33% from electricity, 26% from natural gas, 40% from diesel, and the remaining 1% from gasoline and propane consumption.

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[76] Propane consumption equaled 6,770 gallons which converts into 682 GJ and represents 1.0% of Gills Onion's total energy consumption for 2008 of 63,054 GJ.

[77] AB 32 mandatory reporting threshold is 25,000 $mtCO_2e$.

Table B9 Summary 2008 Baseline of Energy Use and Emissions				
	Inputs			Total Emissions
Electricity	Dollars	kWh	GJ	$mtCO_2e$
Gills Onions Oxnard	$ 1,341,558	11,171,162	40,216	3,685.13
King City Cooling	$ 374,400	3,120,000	11,232	1,029.10
Total Electricity	$ 1,715,958	14,291,162	51,448	4,714.23
Stationary Source	Dollars	Therm/Gal	GJ	$mtCO_2e$
Natural Gas (Therms)	$ 366,283	373,323	40,588	2,061.26
Diesel (Gallons)	$ 1,810	762	112	7.76
Gasoline (Gallons)	$ 2,280	570	75	5.04
Propane (Gallons)	$ 76	30	3	0.17
Total Stationary	$ 370,449		40,777	2,074.23
Mobile Source	Dollars	Gallons	GJ	$mtCO_2e$
Diesel -Total	$ 1,733,208	424,163	62,148	4,309.58
Gills Onions	$ 14,294	4,916	720	50.27
Gills Transport	$ 1,670,051	407,329	59,682	4,138.23
Rio Farms	$ 48,864	11,918	1,746	121.07
Gasoline	$ 6,785	1,696	223	14.95
Propane	$ 17,260	6,770	682	39.03
Total Mobile	$ 1,757,253	432,629	63,054	4,363.56
Total	**$ 3,843,661**		**155,280**	**11,152**

Gills Onions' energy consumption cost $3.8 million or an average of $24.75/GJ. Cost per gigajoule ranged from $9.02/GJ for natural gas to $33.33/GJ for electricity.

The associated greenhouse gas emission inventory in 2008 for Gills Onions was 11,152 metric tons of CO_2e. The major components of Gills Onions' GHG inventory consisted of emissions from: electricity consumption at the Oxnard facility (33%); natural gas emissions primarily do to the Caterpillar engine air compressor (18.5%); emissions from diesel consumption (38.6%), most of which was attributable to Gills Transport services. The emissions intensity ratio of GHG emissions per gigajoule ranged from a low of 0.0508 $mtCO_2e/GJ$ for natural gas to 0.0916 $mtCO_2e/GJ$ for electricity (Table B10).

Table B10 Greenhouse Gas Emissions Intensity by Fuel Source	
Fuel Source	Emissions Intensity ($mtCO_2e/GJ$)
Electricity	0.0916
Natural Gas	0.0508
Diesel	0.0698
Gasoline	0.0669
Propane	0.0570

Appendix C Water

Table C1 below indicates how water consumption and wastewater charges have increased from 2008 to 2009.

Table C1: Water Cost Summary (Consumption in Gallons)						
	2008 ($)	2009 ($)	($) Change	Percent Change	% Change in Water Consumption	% Change in Onions Shipped*
Water Purchases	$266,161	$292,990	$26,829	10.8%	-2%	-16%
Wastewater charges	$248,693	$255,531	$6,838	2.6%		
Total	$514,854	$548,521	$33,367	6.5%		

The MBBR system is expected to not only treat the wastewater to a clean enough level acceptable for the biodigester but will also be able to reduce TSS and BOD to less than 30 ppm before going to the city sewer. This reduction represents approximately a 57% decrease from current levels for BOD and a 67% decrease from current levels for TSS[78] (Table C2). Based on this assumption the MBBR system could potentially reduce BOD and TSS charges by as much as $28,000 per year.

Table C2 Additional Annual Wastewater Savings if BOD and TSS were to Decrease with the Implementation of MBBR or Filtration Technology		
% Reduction	BOD Savings	TSS Savings
10%	$ 2,392.50	$ 2,082.88
20%	$ 4,784.99	$ 4,165.76
30%	$ 7,177.49	$ 6,248.65
40%	$ 9,569.99	$ 8,331.53
50%	$11,962.49	$10,414.41
57%	$13,637.23	$11,872.43
60%	$14,354.98	$12,497.29
67%	$16,029.73	$13,955.31
70%	$16,747.48	$14,580.17
80%	$19,139.98	$16,663.06
90%	$21,532.47	$18,745.94
*Using 2010 rates and 2008 water data, and assuming no additional water diversion		

[78] Assuming average BOD is ~69 mg/l and could be reduced to 30 mg/l and TSS is 90 mg/l and could be reduced to 30 mg/l.

Recycling Wastewater for Use with Biodigester and Cooling Tower

Diverting Wastewater to the Biodigester

As mentioned earlier, fresh water is added to the biodigester to both dilute the onion juice and to reduce foaming. The biodigester came online in September, 2009 and since that point Gills Onions has been adding 28 gallons of fresh water per minute or 14.7 million gallons of water on an annualized basis to the biodigester. Assuming that 2008 water consumption levels stay constant and with the addition of the biodigester, on an annualized basis, we estimate that the biodigester would represent 15% of total water consumption[79] (Table C3).

Table C3 Projected Biodigester Water Consumption as Percent of Total Water Consumption*

Biodigester Consumption (Gallons Per Minute)	Annualized Biodigester Consumption (Gallons)	Projected Total Water Consumption**	% of Total Water Consumption
28	14,716,800	95,590,939	15%

* Gills consumption of 28 gallons per minute
**Total projected water consumption was calculated by taking 2008 water consumption and adding projected Annual Biodigester Consumption.

At present, Gills Onions purchases fresh potable water from the city of Oxnard for the biodigester. We estimate that Gills Onions will use approximately 14.7 million gallons of water for the biodigester in 2010 at an annual cost of $88,223 (Table C4). However, if Gills Onions were to sufficiently treat its wastewater to a level whereby total suspended solids were reduced, Gills Onions could use recycled water from the wastewater treatment plant for the biodigester, instead of using fresh potable water.

Table C4 Projected 2010 Biodigester Water Consumption Costs*

Annual Biodigester Consumption (Gallons)	Projected Total Water Consumption	% of Total Water Consumption	Projected Biodigester Annual Water Cost	Projected Biodigester Annual Wastewater Cost	Projected Biodigester Annual Total Water Cost
14,716,800	95,590,939	15%	$55,283	$32,940	$88,223

*Note these costs are a subset of total water costs. These are based on average water rates for 2010.
*This table is based on using average wastewater rates for 2010; Gills Onions' consumption of 28 gallons per minute or 19674 HCF annually purchased from the city of Oxnard for use with the biodigester and charged for 90.7% of consumption. This table assumes wastewater rates based on average BOD of on .576 thousand pounds per million gallons and average SS of .753 per thousand pounds per million gallons.
*Total projected water consumption was calculated by taking 2008 water consumption and adding projected Annual Biodigester Consumption.

We have been advised by Andrew Delgado of Water Street Solutions that in order to clean the water to a sufficient level that would be acceptable for the biodigester would require a Moving Bed Biofilm Reactor (MBBR).

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79 Based on biodigester using 28 g/min for 365 days.

A MBBR is a filtration system which is an add-on to the wastewater treatment system and would reduce TSS (and associated BOD) to a low enough level suitable for the biodigester[80].

We have been advised that to implement the appropriate MBBR technology for Gills Onions would cost the company approximately $225,000 for the equipment plus installation[81]. To calculate the potential savings of implementing the MBBR we calculated the following:

1. Savings from reduced fresh water consumption by the biodigester.
2. The associated decrease in wastewater charges due to decreased demand for fresh water.
3. The reduced BOD and TSS wastewater charges from the city of Oxnard.

The MBBR system is expected to not only treat the wastewater to a clean enough level acceptable for the biodigester but will also be able to reduce TSS and BOD to less than 30 ppm before going to the city sewer. This reduction represents approximately a 57% decrease from current levels for BOD and a 67% decrease from current levels for TSS[82]. Based on this assumption the MBBR system could potentially reduce BOD and TSS charges by as much as $28,000 per year (Table C2 and Table C5).

Table C5 Additional Annual Wastewater Savings if BOD and TSS were to Decrease with the Implementation of a MBBR or Filtration Technology

57% BOD Savings	67% TSS Savings	Total Potential Savings
$13,637.23	$ 13,955.31	$ 27,592.54

*Using 2010 rates and 2008 water data Assuming NO additional water diversion

80 The MBBR process is based on the aerobic biofilm principle and the basis of the process is specially designed plastic biofilm carriers or *biocarriers* that are suspended and in continuous movement within a tank or *reactor* of specified volume. The biofilm, growing within the internal structures of the biocarriers, degrade the pollutants. The pollutants that need to be removed in order to treat the wastewater are food or *substrate* for growth of the biofilm. Excess biofilm sloughs off the biocarrier in a natural way. An aeration grid located at the bottom of the reactor supplies oxygen to the biofilm along with the mixing energy required to keep the biocarriers suspended and completely mix within the reactor. Treated water flows from reactor through a grid or a sieve, which retains the MBBR biocarriers in the reactor.
81 While we were not specifically told that there would be annual maintenance and operating costs we do assume there will be additional costs for maintenance and operation (at least in terms of labor).
82 Based on the assumption that the average BOD is ~69 mg/l and could be reduced to 30 mg/l ad TSS is 90 mg/l and could be reduced to 30 mg/l.

Given this information, and assuming that the cost of the MBBR system is $225,000, Gills Onions will save over $115,000 annually in water and wastewater charges with only a two year payback period (Table C6)[83]. In addition, by implementing a MBBR system Gills Onions will be able to filter its wastewater to a level clean enough to be acceptable for use in irrigation. While we haven't calculated the economic benefit of reusing wastewater for irrigation, we do know that using recycled water for irrigation will save Gills Onions fresh water purchasing costs as well as wastewater treatment costs.

Table C6 Potential Savings by Diverting Wastewater to Biodigester with MBBR		
Item	Cost	Annual Savings
Water Consumption Charges		$55,283
Waste Water Discharge Charges		$32,940
BOD and TSS Reduction Savings with MBBR System**		$27,593
Estimated Cost of Moving Bed Biofilm Reactor	$(225,000)	
Total	$(225,000)	$115,816
Payback Period	**2 Years**	

*Based on Biodigester Consumption Volume of 28 gallons per minute at 2010 rates

**Assumes MBBR is able to reduce BOD and TSS to 30 ppm

Diverting Wastewater to the Cooling Tower

Gills Onions uses its onsite evaporative cooling tower to keep the processing facility between 32and 34º F. In 2008 Gills Onions used 10.9 million gallons of fresh potable water from the city of Oxnard in the cooling tower. In 2009 the company used 8.7 million gallons, a 20% decrease. We have been advised that the reason why the volume of water used by the cooling tower decreased in 2009 was most likely due to either the decrease in volume of onions shipped or cooler temperatures [84].

In 2008, the water used for the cooling tower represented approximately 13% of total water consumption for Gills Onions and in 2009 water for the cooling tower represented approximately 11% of total water consumption (Table C7).

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[83] Calculation does not take into consideration operation, maintenance costs, finance charges or the net present value of money.

[84] As the volume of onions shipped decreases and associated production decreases we assume that there are fewer 'warm' onions being introduced that need to be cooled and less activity overall resulting in less forklifts being moved into and out of the plant, etc. for fewer opportunities for warm air to enter the processing facility and therefore less need for the cooling tower to work as hard. Moreover, fewer double-shifts are worked when processing demand is reduced.

Table C7 Cooling Tower as a Percent of Total Water Consumption*			
Year	Cooling Tower Consumption (Gallons)	Total Water Consumption (Gallons)	% of Total Water Consumption
2008	10,873,500	80,874,139	13%
2009	8,693,400	79,247,968	11%
*Note the cooling tower water meter is read in gallons			

To purchase freshwater from the city for the cooling tower it cost Gills Onions $35,903 in 2008 and $31,979 in 2009 (Table C8).

Table C8 Cooling Tower Water Costs ($)*				
	2008	2009	$ Change	% Change
Totals	$35,903	$31,979	$(3,924)	-11%
*Note these costs are a subset of total water costs. These are assumed based on water costs **Note that these costs do not include the additional cost that is paid to treat the waste water associated with the freshwater consumption				

Gills Onions pays the city of Oxnard to discharge wastewater to the city sewer. Because there is no meter measuring the amount of wastewater that is actually delivered to the city, instead, the city of Oxnard charges Gills Onions for a percentage of the total water it consumes as the volume of water discharged. In 2008 the city of Oxnard invoiced Gills Onions for wastewater discharges representing 90.7% of the water they purchased[85]. Because Gills Onions purchases fresh water for use in the cooling tower, it is also charged to discharge a percentage of that water to the city (even though the water in the cooling towers is evaporated). For 2008, we estimate that Gills Onions paid approximately $22,553 to the city to discharge 90.7% of the water they purchased for the cooling tower even though it was evaporated (Table C9)[86].

[85] In 2008 Gills Onions purchased 108,113 HCF of water from the city of Oxnard and paid for 98,055 HCF in wastewater and associated charges.

[86] In 2008 Gills Onions purchased 13,184 HCF for their cooling tower and should have been invoiced for 90.7% of that volume for wastewater.

Table C9 2008 Total Estimated Costs for Wastewater, BOD And TSS from Using Fresh Water in Cooling Tower						
Total Volume (Millions of Gallons)	Total Charges (Wastewater Discharge	Total BOD Discharge (Thousands of Pounds)	Total Charge BOD	Total TSS Discharge (Thousands of Pounds)	Total TSS Charges	Total Estimated Costs
9.86	$18,409.73	5.68	$1,478.29	7.43	$2,665.30	$22,553.32

*This table is based on using 2008 rates and water purchased from the cooling tower in 2008 (13,184 HCF) from the city of Oxnard for cooling tower consumption. This table assumes wastewater rates based on average BOD of on .576 thousand pounds per million gallons and average SS of .753 per thousand pounds per million gallons

As mentioned above, in 2008 the city of Oxnard charged Gills Onions for wastewater discharges that were actually evaporated by the cooling tower. In 2008 the city of Oxnard invoiced Gills Onions for wastewater discharges representing 90.7% of the water purchased. This calculation assumed that 9.3% of the water that Gills Onions purchased from the city was not being returned to the city as wastewater. However, in 2008 the cooling tower actually used 13.4% of the total city water purchased resulting in Gills Onions paying 4.1% more for wastewater (and associated BOD and TSS costs) than it actually discharged. This difference resulted in an additional estimated wastewater discharge cost of $7,580 over what the company would have paid if the sewer line was metered (Table C10).

Table C10 2008 Additional Wastewater Costs of Using Fresh Water in Cooling Tower							
Total Volume (Millions of Gallons)	4.1% of Total Volume (Millions of Gallons)	Total Charges (Wastewater Discharge	Monthly BOD Discharge (Thousands of Pounds)	Total BOD Charges	Monthly TSS Discharge (Thousands of Pounds)	Total TSS Charges	Total Estimated Additional Wastewater Costs
80.87	3.32	$6,189.61	1.91	$ 497.01	2.50	$ 896.12	$7,582.75

This table is based on Using 2008 rates and the fact that in 2008 Gills Onions purchased 108,113 HCF from the city of Oxnard and was charged for 98,055 HCF of wastewater (representing 90.7% of total HCF purchased). However in 2008 Gills Onions cooling tower consumed 14,536 HCF representing 13.4% of total water purchased (a difference of 4.1%). This table assumes wastewater charges for an additional 4.1% of monthly "water" consumption with average BOD based on .576 thousand pounds per million gallons and average SS based on .753 per thousand pounds per million gallons

Because city of Oxnard rates are going up significantly in 2010, at proposed 2010 rates, the additional wastewater discharges that Gills Onions is paying for fresh water that it is actually evaporating could cost the company an additional $8,220 per year (Table C11).

Table C11 Projected 2010 Additional Wastewater (WW) Costs of Using Fresh Water in Cooling Tower							
Total Volume (Millions of Gallons)	4.1% of Total Volume (Millions of Gallons)	Total Charges (WW Discharge	Monthly BOD Discharge (Thousands of Pounds)	Total Charges (BOD)	Monthly TSS Discharge (Thousands of Pounds)	Total TSS Charges	Total Est. Additional WW Costs
80.87	3.32	$6,201	1.91	$1,081	2.50	$941	$8,223
This table is based on using 2010 rates and the fact that in 2008 Gills Onions purchased 108,113 HCF from the city of Oxnard and was charged for 98,055 HCF of wastewater (representing 90.7% of total HCF purchased). However in 2008 Gills Onions cooling tower consumed 14,536 HCF representing 13.4% of total water purchased (a difference of 4.1%). This table assumes wastewater charges for an additional 4.1% of monthly "water" consumption with average BOD based on .576 thousand pounds per million gallons and average SS based on .753 per thousand pounds per million gallons							

Gills Onions currently has a wastewater treatment plant onsite that treats and cleans the wastewater to a level acceptable by the city and then disposes of it to the sewer. The volume of wastewater produced each month averages 5.7 million gallons, more than a sufficient amount to meet the needs of the biodigester, cooling tower and irrigation.

Instead of using fresh potable water, Gills Onions could also reuse the wastewater from the treatment plant for use in the cooling tower. If Gills Onions were to reuse its wastewater for the cooling tower we project that for 2010, the company could reduce the amount of freshwater it consumes from the city by as much as 9.8 million gallons per year. This will save the company approximately $36,751 per year in water consumption costs and reduce wastewater costs by approximately $21,900 by avoiding discharge costs. In total, if Gills Onions were to divert its wastewater to the cooling tower it could save the company $58,649 annually (Table C12)[87].

[87] Based on an average of 2008 and 2009 cooling tower consumption numbers and based on average 2010 water costs at a rate of 2.81 per. Wastewater costs will be reduced each year by not being charged for disposing of 8.87 million gallons of water to the city. Savings based on assuming Gills Onions consumed 9.78 million gallons of water from the city and is charged for disposing of 90.7% of that volume (8.87 million gallons) over 12 months in 2010 (for further treatment at an average rate for 2010 of $1869 per million gallons (rate as of Dec 1, 2009 = to 1819.43 with rate increase as of 7/1/10 to $1919.43 per million gallons) and assuming an average BOD content of .576 per thousand pounds at an average rate of $565 per thousand pounds (rate as of 12/1/09 of $515.31 per 1000 lbs and rate as of 7/1/10 of $615.31 per 1000 lbs); and monthly average suspended solids at average of .753 per thousand pounds at average rate of $377 per thousand pounds (current rate of $362.26 per thousand pounds and increasing as of 7/1/10 to $391.24).

Table C12 Projected 2010 Cooling Tower Water Consumption Costs*					
Projected Annual Cooling Tower Consumption (Gallons)	Average Total Water Consumption (2008 / 2009)	Percent of Total Water Consumption	Annual Water Cost	Annual Wastewater Cost	Annual Total Water Cost
9,783,450	80,061,053	12%	$36,751	$21,898	$58,649

*Note these costs are a subset of total water costs. These are assumed based on average water rates for 2010.
*Water consumption values were derived by taking the average of 2008 and 2009 consumption for the cooling tower and the average for 2008 and 2009 of total water purchased from the City of Oxnard for use with the cooling tower assuming wastewater volumes at 90.7% of consumption. The calculations in this table are based on using average wastewater rates for 2010 based on average BOD of .576 thousand pounds per million gallons and average suspended solids of .753 per thousand pounds per million gallons

However, it is important to recognize that to divert its wastewater to the cooling tower it would require both capital investment and appropriate permitting. The cooling tower requires pure water that is free of organic content and suspended constituents to ensure that it operates smoothly and to avoid corrosion. Because the cooling tower is sensitive to particle buildup, Gills Onions already has in place a purification system that acts to clean and purify the fresh city water before it is used in the cooling tower.

This filtration system currently filters potable city water and will not be sufficient for treating Gills Onions wastewater to the level required by the cooling tower. Gills Onions' wastewater consists of a fairly high BOD and high TSS and these components could easily corrode the cooling tower if they were allowed to build up. We have been advised by Andrew Delgado of Water Street Solutions that in order to clean the wastewater sufficiently to a level that would be acceptable for the cooling tower would require additional treatment steps beyond the initial steps proposed earlier to treat the wastewater for the biodigester using the MBBR.

The additional steps required could include filtration, ultra-filtration, reverse osmosis system or some combination thereof and would need to be implemented to further filter the wastewater and remove additional constituents before it could be diverted to the cooling tower.

These additional treatment steps can cost on the order of $300,000 - $500,000 for the equipment plus installation depending on the level of treatment that is required[88].

88 We believe that there will also be ongoing maintenance and operation costs.

However, by implementing additional treatment steps and reusing wastewater in the cooling tower would allow Gills Onions to reduce the amount of freshwater it consumes from the city by as much as 9.8 million gallons per year and could save the company approximately $37,000 per year in water costs and $22,000 in wastewater costs as mentioned above (Table C12)[89]. Moreover, if the company were to run all of its wastewater through this additional filtration system, it could recognize additional savings by further reducing all of its BOD and TSS discharges costs. We have calculated that these additional BOD and TSS savings could amount to up to $40,000 each year assuming that the wastewater was cleaned to a level that reduced BOD and TSS by 90% (Table C13).

Table C13 Additional Annual Wastewater Savings if BOD and TSS were to Decrease from Implementing Filtration System

90% BOD Savings	90% TSS Savings	Total Potential Savings
$21,532.47	$ 18,745.94	$ 40,278.41
*Using 2010 rates and 2008 water data Assuming NO additional water diversion		

Given this information and assuming that the cost of the filtration components would be $300,000 we estimate that reusing wastewater for the cooling tower using such a system would result in a three year payback. Thereafter, Gills Onions could recognize annual savings of over $99,000 from avoided water and wastewater treatment costs (Table C14).[90]

Table C14 Potential Savings of Diverting Wastewater to Cooling Tower Using Additional Filtration System

Item	Cost	Annual Savings
Water Consumption Charges*		$36,750.88
Waste Water Discharge Charges*		$21,898.22
90% BOD and TSS Reduction Savings with filtration System*		$40,278.41
Potential Annual Savings		$98,927.51
Estimated Cost of Filtration System**	$(300,000.00)	
Payback Period	**3 Years**	
*Based on average of 2008 and 2009 cooling tower consumption volume and using 2010 rates for savings. Assumes Filtration System may reduce BOD and TSS by 90%. ** Does not take into consideration installation, operation, maintenance costs, finance charges or the net present value of money		

[89] Based on average 2008 and 2009 Cooling Tower water consumption values. Based on average 2010 water costs at a rate of $2.81 for per HCF over 23. Wastewater costs will be reduced by not having to dispose of 8.89 million gallons (90.7% of cooling tower consumption) of water to the city

[90] Calculation does not take into consideration installation, operation, maintenance costs, finance charges or the net present value of money, and assumes that using a filtration system to reduce 90% of BOD and TSS would be sufficient for cleaning the wastewater to a level acceptable enough for the cooling tower.

While Gills Onions would have to make a significant investment in order to divert wastewater to the cooling tower, it could result in up to or greater than 9.8 million gallons of freshwater each year and annual savings of approximately $99,000.

In conversations with Gills Onions we have been advised that they are currently in the process of reviewing both the MBBR for the biodigester and additional filtration components required for the cooling tower. We highly recommend that Gills Onions seriously pursue both of these options so the company can significantly reduce water consumption, move closer to its zero waste goal and recognize a positive economic benefit.

Appendix D Materials

Appendix D1 First Characterization Results Client Memo

To: Nikki Rodoni
From: Team Onion
Date: June 22, 2009
Re: Waste Audit – Round 1

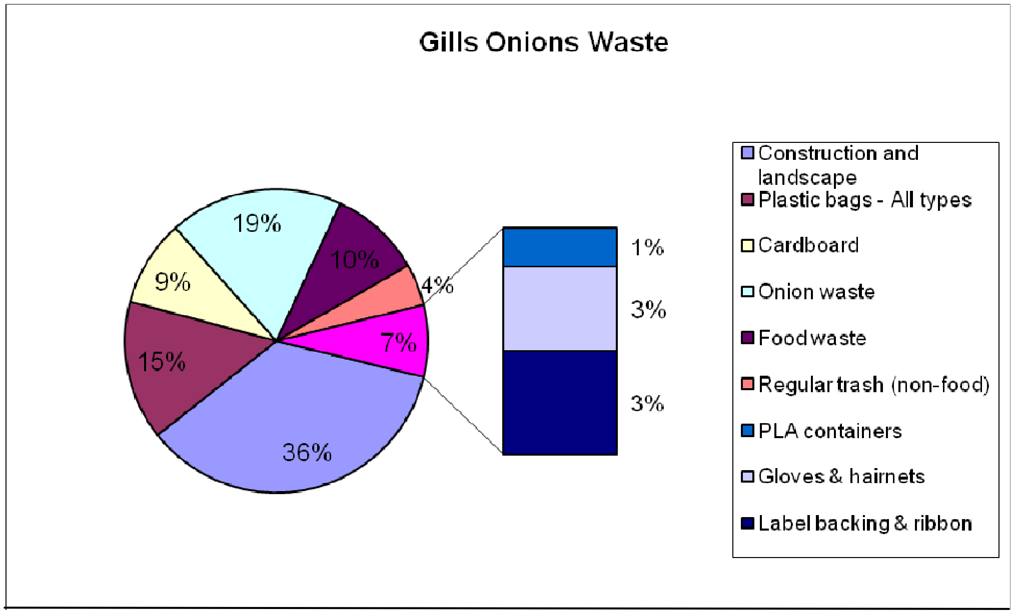
On June 12, 2009, Team Onion conducted a waste audit of the Gills Onions facility. Trash was collected as usual in the company's 1,163 ft^3 dumpster for two full days. The team's intension was to sort, characterize and quantify the entire two days of trash and then extrapolate to a full year. Unfortunately, the team under estimated the amount of waste generated at the facility and the time it would take to sort it. The team was able to sort, characterize and quantify roughly 50% of the waste by weight, while 34% of the waste was shoveled and weighed but not sorted, and the remaining 16% was estimated based on volume.

The dumpster was taken to the landfill and emptied the morning of June 10th. The audit started at 10am on June 12th and no additional trash was added to the container during the day. When the audit was started the dumpster was approximately 75-80% full. We began by selecting the most conspicuous waste streams – plastic bags and plastic tarps, label backing and ink rolls, gloves and sleeves, onion waste, construction materials and non-Gills Onions' items (hide-a-bed couch, Christmas tree). Trash bags from the lunchrooms were weighed without being sorted as an indicator of the food waste generated on the facility.

The weight of the waste generated in two days was estimated to be 4,181 lbs total. The key findings below are based on the 50% of the waste (2,110 lbs) that we sorted and characterized. While the non- Gills Onions waste (couch and Christmas tree) amounted to nearly 10% of the sorted waste, we have excluded it from the findings below to more accurately reflect the characterization of Gills Onions' waste.

Major Waste Streams

- 36% - Construction, paint and landscape materials
- 19% - Onion waste
- 15% - Plastic bags, liners and sleeves
- 10% - Food waste
- 9% - Cardboard, tissue boxes and rolls (left over from plastic bags)
- 3% - Label backing and ink rolls
- 3% - Gloves (ubiquitous)



Key Findings:

- Office Pack – Gills Onions is doing an excellent job recycling office paper as evidenced by the lack of office paper in the general trash.
- Typical recyclables – there were only a few glass bottles and aluminum cans in the trash, which is an indicator that Gills Onions employees are doing a great job recycling these items.
- Cardboard - there were no large cardboard boxes in the garbage, so Gills Onions is doing a good job with recycling these items. However, there was 175 lbs. of smaller cardboard pieces, cardboard corners, tissue boxes and cardboard rolls left over from the plastic bags which are recyclable, but not by current recycler. Identifying an alternative recycler who would accept smaller cardboard items would eliminate this waste stream.
- Plastic bags and liners – there were 282 lbs of bags and liner which are all recyclable when clean and non-contaminated. Plastic is recyclable even if it is wet or contains small amounts of onion waste.
- Gloves and onion waste – we measured 353 lbs of onion waste and 53 lbs of gloves in the trash. These items were pervasive and present a contamination issue for future recycling opportunities. All gloves are not recyclable and should be thrown away in designated locations. All onion waste should be diverted to the juicer, not to the garbage.
- Construction waste – there was 676 lbs of construction waste including a 258 lb. piece of wood that originally contained two doors. The wood is recyclable.
- Hazardous waste – there were approximately 12 aerosol paint cans, 3-4 10 gallon paint buckets, 3 batteries, and one blade from an Exacto knife. All of these items should have been treated as hazardous waste and disposed of properly.

- Non-Gills Onions waste – it represented 10% of the sorted waste or 203 lbs. Based on conversations with Jose, this is an ongoing issue. When the yard is fenced in the future, this should help to eliminate the problem.

Next steps:
Due to the time limitation and the volume of waste generated in a 2-day period, we were unable to complete a full waste audit on June 12. Consequently, we have devised a new strategy to corroborate the above findings and attain a more accurate accounting of all of Gills Onions waste streams.

- 6/25 – 1-day waste audit
- 6/30 – Recycled materials audit
- 7/2 – office and processing plant walk-through
- 7/2 – Lunch room audits
- 7/3 – Finish lunch room audits for shifts 2 and 3

Appendix D2 Waste Audits and Recommendations Client Memo

To: Nikki Rodoni
From: Team Onion

Date: July 31, 2009
Re: Results of Waste Audits

During the months of June and July 2009, Team Onion conducted a series of waste audits with the objective of obtaining information on the types and amounts of materials thrown away and recycled at Gills Onions' processing facility and administrative offices. The studies involved characterizing and weighing all materials going to disposal as well as materials diverted from landfill through recycling (plastic bags and cardboard). This analysis forms the baseline for Gills Onions Zero Waste initiative, from which the company can measure progress toward overall waste reduction and increased diversion rates.

All audit findings have been annualized and compared against existing recycling logs and records of tonnage sent to landfill to ensure that the data is within the historical range. The factor used for annualizing the data was 287, based on 5.5 work days in a week, per Fernando Luna.

Currently, Gills Onions generates about 566 tons of waste a year, of which 25% is currently diverted from landfill (138 tons). The remaining 75%, or 424 tons, is being sent to landfill at an approximate cost of $20,350 per year (Fig. 1). In the past year, Gills Onions has implemented a series of recycling programs (e.g. cardboard, film plastic and office paper). We estimate that by increasing the efficiency of the existing programs, through correctly sorting and minimizing contamination issues, the company could achieve a diversion rate of up to 53% (Fig. 2).

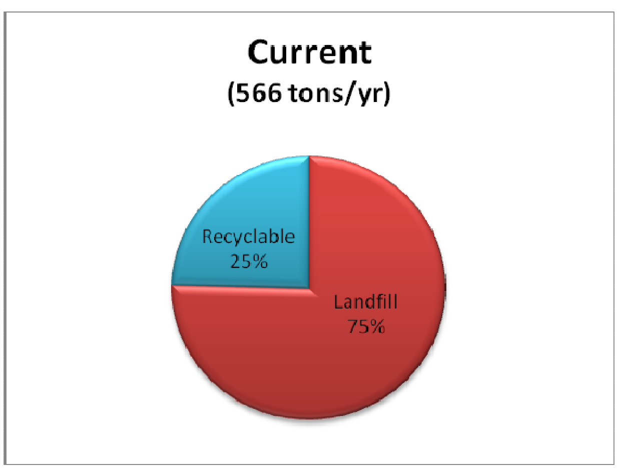


Fig. 1 Total waste generated yearly amounts to 566 tons of which 25% is currently recycled

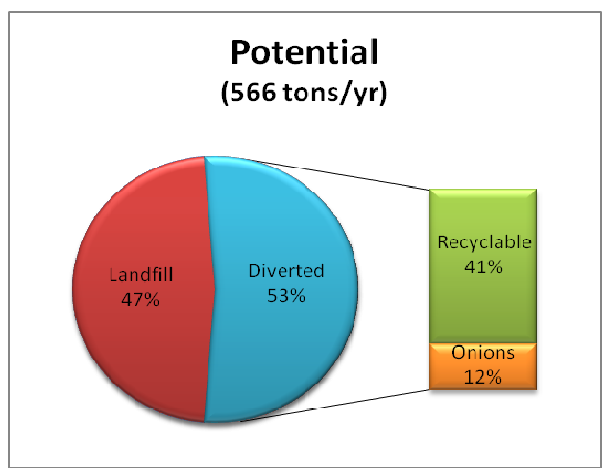


Fig. 2 Of the total waste generated, potentially 53% could be recycled without implementing new programs

Waste to Landfill (424 tn/yr)

The major waste streams currently going to landfill include:

- 39% - Trash (nitrile and latex gloves, bathroom trash, hairnets, paper cones, contaminated plastics)
- 16% - Onion waste*
- 14% - Construction & landscape materials (materials from building and demolition; dirt, green waste)
- 13% - Plastic bags, liners and sleeves*
- 7% - Cardboard, tissue boxes, corners, and rolls (left over from plastic bags)*
- 6% - Food waste (food material and compostables including paper towels and paper napkins)
- 4% - Label backing and ink rolls

*If onion waste, plastic bags and cardboard are properly sorted, the potential diversion rate would jump to 53% of the total waste.

Given that the audit is based on weight rather than by volume, some findings are not immediately obvious. For example, nitrile gloves, paper towels and tissues are ubiquitous. Although these items represent an insignificant percentage of the overall weight, the quantities were considerable and prompted us to investigate how efficiently they were being used. Additionally, we encountered a significant amount of materials that appeared to be unused or not fully consumed (e.g. two inches left on a roll of 5 lb plastic bags). In some cases it was unclear why the materials were thrown away. Conversely, it was remarkable that conventional recyclables (e.g. aluminum cans, bottles and office paper) were virtually absent from the waste going to landfill.

Waste Diverted through Recycling (142 tn/yr)

From the waste currently being recycled, the major waste streams are:

- 46% - Blue film plastic (saving $3,159/yr in tipping fees)
- 44% - Cardboard (generating $1,866/yr in revenue)
- 7% - Clear film plastic (saving $494/yr in tipping fees)
- 2% - Mixed office paper (saving $160/yr in tipping fees)

It is important to note that during the recycling audit we removed trash and onion waste from the plastic bags in the recycling container. When annualized, the onion waste amounts to 11.4 tons and the trash to 7.9 tons. The most important aspect of this finding is the degree to which onions contaminate the plastic waste, potentially rendering it “not recyclable” and being invoiced as regular trash.

In the case of both the clear and blue film plastic, there is a potential, as the recycling markets recover, to obtain revenue from these waste streams, with clear plastic having a higher economic value. While mixed office paper represents a small percentage of the overall recycling category, we observed that most of the regular daily, weekly, monthly reports were printed single-sided.

Waste Reduction Recommendations

The best way to *reduce* waste is to not produce it in the first place. Whenever possible, it is preferable to apply strategies to prevent the generation of waste, than to have to manage waste once it is produced. We believe the following source reduction strategies are good business practices with the "green" designation being an added bonus. These practices will reduce costs related to procurement of materials as well as disposal, and will also save natural resources.

A critical element for the successful implementation of a pollution prevention program is to have clear, company-wide rules that are conveyed to every employee and regularly reiterated and enforced. In addition to clear rules it is important to establish a system that tracks the use of supplies to better understand which processes or people are consuming the most. This could be accomplished by designating a person to be in charge of supplies and to keep a list of requested materials from each department within the company.

Maximizing the Utilization of Resources

To operate, an industrial facility generally creates a certain amount of waste. In order to achieve zero waste it is important first to minimize the amount of resources consumed and second find markets that can utilize the discarded materials. We encountered large amounts of materials that appeared to be unused. In some cases it was unclear why the materials were thrown away. For defective packaging, it may be helpful to contact the supplier so that the issue can be corrected and Gills Onions can get a credit for the unusable materials. For example, we found a significant number of PLA cups which had defective labels.

The photo above shows a bin filled with clean bags

Some of the unused PLA containers that were found in the trash

Unopened roll of hard plastic tape

Unfinished roll of clear plastic bags

Ongoing Education and the role of Supervisors

To make waste reduction successful, employee involvement is imperative. Most employees are excited to implement sustainable practices at the work. Your supervisors can play an important role in explaining and reinforcing new initiatives, especially if they are being evaluated by the progress their team is making toward the goal of zero waste. In fact, the supervisors could be an important source of new ideas and process improvements that could result in less waste. One suggestion is to bring all the supervisors together once a month or quarterly to provide company updates and properly train them on new sustainability programs to ensure that they are accepted and successful. This forum can also be used to launch friendly competitions between teams to encourage waste reduction and efficiency.

Another suggestion is to write sustainability practices into company statements and training guides. As Nikki did in the beginning of the recycling program, we agree that the lunchroom bulletin boards are good places to post new information and updates. The boards need to be changed at least monthly, so as to draw employee attention. Whenever possible use candid pictures of employees doing the right thing. Create and post recycling guides to remind employees what is and is not recyclable and how to recycle each item.

Onion Waste

Not surprisingly, onion waste was prevalent in all the audits performed. This is an important issue because onion contamination renders the plastic film "not recyclable". The high water-content of the onion waste, markedly increases the weight (and cost) of the waste going to disposal. And, onions found in the trash and recycling are a missed opportunity by not being routed to the juicer to create energy and cattle feed.

The photos below show that onion waste was ubiquitous not only in the regular trash audit (photo 1 & 2) but also in the recycling audit (photo 3), in which onion waste amounted to 12% of the total waste stream. Removing onion waste from the recyclables, particularly plastic bags, is essential to avoid having to pay for disposing of recyclables as if they were regular trash. Recently, a team of 2 employees have been assigned full time to the task of removing onion waste from bags before they are placed in the recycling container. Assuming a wage of $8.00/hr, this process is costing Gills Onions more than $32,000 per year, ten times more than the potential savings from tipping fees.

Photo 1

Photo 2

Photo 3

Plastic Bags and tarps

To reduce costs of plastic bag purchases and disposal, the best option would be to avoid using plastic bags and tarps within the production process. We are currently exploring alternatives to the 50 lb blue bags such as reusable bins and rolling racks to move the onions from one part of the plant to another.

Alternatively, Gills Onions can improve efficiency and reduce costs of plastic film disposal by incorporating the removal of the onions from the plastic at the processing line level. Under this system, food service and line employees would be responsible for removing onion material from the bags and liners before placing the plastic film in the recycling bins. Including this step in the processing lines will result in a streamlined practice that does not require additional sorting and ensures that all onion waste is captured and routed to the juicer. This is the type of program where Supervisor reinforcement would be invaluable.

Note: Regardless of best intentions, there will be some situations where bags are too contaminated by small pieces of onion and it may not be practical to clean each bag in order to recycle it. This situation came up recently when an order was cancelled after it was produced and the company was unable to identify another buyer for the bags of diced onions.

Trash

We define trash as being waste for which there is no other use or market. Therefore, the primary strategy is to reduce the amount of resources used in the first place. Following are recommendations for the materials most commonly found.

1. **Single-use gloves (food service and line)**

The use of nitrile gloves is important to ensure the highest levels of food safety throughout Gills Onions' operations. At this time, nitrile gloves are not recyclable, nor compostable, so they present a challenge for waste reduction. Throughout the different waste audits performed, it has become evident that single-use gloves end up in waste containers in **all** areas (including onion waste bins), as well as on the floors, in lab coat pockets, and on the counter tops. Nitrile gloves can contaminate recyclables, including plastic bags, sometimes rendering the whole consignment unusable for recycling.

Single-used gloves were found mixed with recyclables (cardboard and sleeves), regular trash, onion waste (not pictured) and amounted to 3% of total waste.

Until an alternative is identified, it is critical to concentrate on utilizing strictly what is needed. One area where the company can focus is on the dispensing of the gloves. According to company records, over 1.11 million nitrile gloves are used yearly (about 3800 per day). At $0.11 per pair, the company is spending more than $60,000 per year on single use gloves. On average a plant employee changes gloves nearly 5 times a day (based on 400 employees). This is a conservative estimate since not all employees wear this type of glove at the processing plant. During walkthrough evaluations conducted in June and July, we noticed that a considerable amount of gloves are thrown away without being used. There are several reasons why this is happening. The gloves are tightly packed inside each box making it difficult to take out only one pair at a time; the cardboard around the opening of the box breaks easily resulting in several gloves being dispensed at a time; there are numerous glove boxes available throughout the plant, which may be conducive to wasteful practices; boxes are routinely placed outside of dispensers, which in turn can lead to boxes falling on the wet floor or other wet surfaces. It is important to note that if a box gets wet, it normally ends up in the garbage since it is assumed that the gloves have been contaminated.

Following are some strategies that could help reduce the amount of gloves thrown away:

- Work with the manufacturer to identify a container that dispenses only one pair of gloves at a time
- Work with the manufacturer to identify a box that does not break so easily (particularly, when handling with wet hands)

- Mount glove dispenser on walls close to where they are needed and require that the boxes remain in the dispenser
- Require that employees sign the sheet at the lab when they take whole boxes of gloves to better track which area of the plant are using the most gloves and help identify additional strategies for these areas.

2. **Latex canners' gloves (multiple-use)**

Although currently these gloves are treated as being single-use, they can be used several times, basically until they are punctured or have cuts. The only requirement is that gloves are sanitized after each use. It is noteworthy that some employees already use the latex gloves more than once, until damaged. Implementing a charge to the employee who returns latex canner's gloves that are in good condition (consistent with the practice used for knitted gloves and headsets, among other products) will most likely result in lower generation of waste.

3. **Paper towels**

According to company's estimates, every week 160 rolls of 11" x 8.78" paper towels are consumed in the lunchrooms. These paper towels are used as napkins as well as for cleaning the tables. Currently, there is one roll of kitchen towels on each table located in the women's and the men's lunchrooms, totaling 27 rolls of paper at any one time. Conversely, in the plant #2 there is only one roll of paper towels that is visible, while the rest are stored until they are needed. The food waste audit conducted on 7/2/09 showed that most of the compostable material collected in the main lunchrooms was actually paper products. Our recommendation is to remove the rolls of paper towels from the individual tables and mount dispensers on the wall. In the women's lunchroom, four dispensers would be sufficient, while two dispensers would serve the men's lunchroom.

The photos above show possible locations where dispensers could be mounted in the women's lunchroom.

4. **Tissue Boxes**

According to estimates 22,200 boxes of 125 tissues are consumed each year at a cost of about $22,000. This is the equivalent of 77 boxes per day. Due to the nature of the product, having tissues handy appears to be indispensable. However, similar to the previous recommendations, it is crucial to conserve the resources and avoid practices that may lead to unnecessary waste. A strategy that can useful is to mount dispensers on walls or on surfaces close to where they are needed and that prevent the tissue boxes from falling on the wet floor or in the tubs filled with liquid.

Current position of the dispenser

Tissue boxes are regularly removed from dispensers for convenience

Tissue boxes are likely to fall on wet surfaces if removed from the dispensers

5. **Paper cone cups**

Currently, about 2,900 water cone cups are consumed weekly. Because of its shape, cone cups cannot be put down and therefore are disposed of immediately after a single use. The Solo disposable cone cups are not recyclable and are not compostable either since they are sealed with a fine polyethylene lining bonded to the paper. A way to eliminate this waste stream is to install water fountains in the areas where there are currently water coolers. Additionally, employees can be encouraged to bring their own reusable cup or canteen. Another alternative, although less preferable, would be to identify another disposable container to substitute for the cone cups that is either compostable or recyclable.

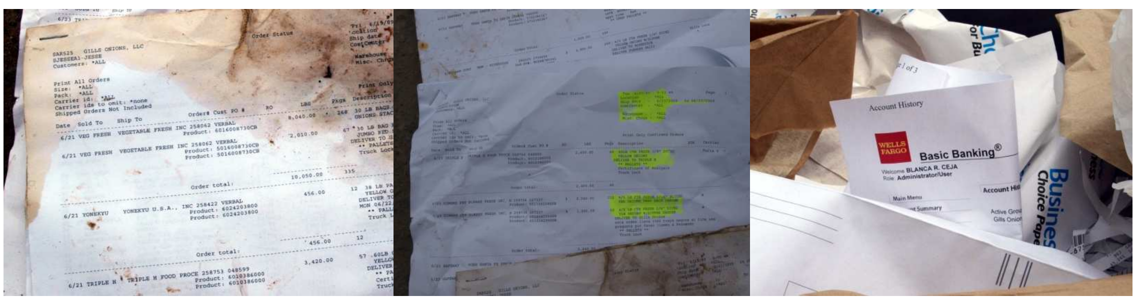
6. **Unauthorized Dumping**

While it is not represented in this baseline waste audit analysis, unauthorized dumping has been identified as an ongoing issue for Gills Onions. When we conducted the first trial audit, we found a fold-out couch, stroller and artificial Christmas tree in the dumpster. Apparently, due to the open and easy access to the company's large dumpster, it has been used by employees and others as a general tipping site. This can add to Gills Onions' tipping fees over time. This practice is likely to continue until the yard is fenced.

Office Paper

Since the implementation of the recycling program in 2008, the company has made great progress in separating, sorting and recycling office paper. A new recycling container was recently added to hold mixed office paper only. While the logistics for emptying the container periodically are still being worked out, this is a good step toward keeping each recycling streams separated, which will ultimately increase the value when the recycling market recovers.

Additional measures that could be taken in order improve efficiency and diminish the environmental impact of office paper waste would be to set the default printers to print on both sides of the page, as well as begin purchasing paper that includes post-consumer content. In order to ensure that the performance of this type of paper is satisfactory, the company could start by purchasing paper that includes 10% post-consumer content and increase the post-consumer content over time. In addition, there are specific daily, weekly and monthly reports that are printed, that appear to print on only about half of the page. There may be an opportunity to fine-tune some of these AS-400 reports so that they print more information on each page – thus requiring less paper.



Photos 1 & 2 above are from office paper found in the general trash. Photo 3 was taken at the top of the paper recycling bin that was adjacent to main dumpster during June 2009.

Although it is encouraging to see high participation in recycling activities, employees may need to be reminded to shred confidential documents prior to recycling.

Green waste

At this time, the company contracts with a landscaping service that comes weekly to maintain the grounds. Some of the maintenance services included are pruning and trimming the trees, mowing the lawn in the parking lot as well as replacing some plants and cleaning up. The islands that divide the parking lot generally have grass and rosebushes, which both require large amounts of water. Additionally, the grass is mowed weekly, a task that is sometimes difficult since vehicles are often parked on both sides of the islands. The grass clippings, along with any green waste that is generated during the weekly maintenance, are disposed of onsite in Gills Onions' dumpster for regular trash, and subsequently sent to the landfill. It is customary for landscaping services to include removal (and proper disposal) of dirt and green waste as part of its service. When done properly, these materials can be composted offsite or as part of a city-wide program.

Given the size of the company's contract with its landscaper ($2,500/mo) this service should be conducted at no additional cost. This would also help reduce the company's tipping fees over time.

Rosebushes, although aesthetically appealing, cannot actually be seen when vehicles are parked near them. Replacing grass and rosebushes by native vegetation will result in lower water consumption, upkeep costs and disposal costs, while still providing a visually attractive landscape. In the future, if the effluent off the aerobic waste water treatment plant is filtered for use in the cooling towers, the resulting potable water may be suitable for use on the landscaping, further saving water.

Garbage and recycle bins

In each lunchroom area there are currently at least three bins, generally two for garbage and one for recycling. During the food waste audit it became evident that only one set (one for garbage and one for recycling) was required for the relatively small amount of waste generated. After the busiest lunch break of the day (206 employees in the morning shift), each bin was filled to less than a quarter of its capacity. Having the additional bins in each lunch room, requires the use of more plastic bags and may result in higher contamination of recyclable materials. The reason cited for having the additional bins was convenience, but there is also the concern that employees may leave the areas unclean and not pick up the trash after their break. Implementing an education program could easily address this issue (as well as removing the paper towels from each table) and put good practices in place before launching a future composting program.

Additionally, as noted earlier, the quantity of garbage in the lunchrooms does not require that the bins are emptied several times a day. Currently, trash bins are emptied *three* times a day, requiring extra labor as well as plastic bags.

For the bins located by the entrance doors outside of the plant (see below photos), it is recommended to always have a set of garbage and recycling bins together in the same location for convenience and proper disposal. This will help to reduce contamination of recyclables or increase diversion rates.

The photos above show the current location of waste and recycling bins scattered outside of the processing plant

Conclusion

As the initial baseline for Gills Onions' Zero Waste initiative, the total waste stream of 566 tons/year and diversion rate of 25% are the key metrics to improve going forward. Specific waste reduction goals should be set and progress measured annually (or more frequently). Given a two prong strategy to achieving the goal – reduction and diversion – it will be important to continue to measure absolute quantities as well as analyze percentages. It is conceivable that while reducing the overall quantity of waste generated at the facility, the percentage of waste diverted to landfill could fluctuate up or down.

While this report has focused entirely on Gills Onions' non-onion waste, we want to acknowledge the outstanding effort the company has made to divert its onion waste to productive uses; the generation of energy and cattle feed. To put it into perspective, the onion waste contamination found during the audits in the recycling and landfill account for less than 0.2% of the company's overall onion waste. To date, Gills Onions has successfully diverted more than 31,550 tons of onion waste per year from landfill (98% of all waste) and will soon be producing enough energy to fuel two 300 kW fuel cells to meet its base load requirements.

Appendix D3 Baler Recommendation Client Memo

To: Nikki Rodoni
From: Laura Hamman, LeeAnne French
Re: Baler
Date: August 13, 2009

Steve Lorenzana from Gold Coast Recycling inspected Gills Onions onsite baler. The baler is in good condition but needs some maintenance before running. The baler can be used for both plastic and cardboard. By baling onsite, Gills Onions will be able to include all types of cardboard – including tissue and glove boxes, corners and cardboard cylinders. Baling will help save space if the plastic is baled as it comes out of the plant so that it does not have to be stacked up in the 40 yard container. Baling will reduce the number of trips to the recycler and enable the company to use a flat bed truck for delivery. Baling recyclables will make the plastic and cardboard more valuable (up to 50% more) on the recycling market.

Following are the specifics about the machine and what has been recommended to get it ready for production:

Cram-a-lot
Manufacturer – JV Manufacturing Inc. 1800-678-7320
Model # VB-60-B
Serial # VB01116-01
Mftr. date: 8/5/03

Actions:

- Electrician to connect the power. Needs 440. Arturo says the power is available in that area (waste water treatment plant uses 440), the baler just needs to be connected.
- Change out the lock, emergency stop and operation switches/lights on the electrical panel. Add "lock-out, tag-out"
- General maintenance should include:
    - Drain hydraulic fluid tank
    - Change the oil before operation to ensure there is not water in it
    - Clean (remove rust) and grease door that raises up and down
    - Clean and polish the main cylinder/piston
    - Replace all safety tape and signs in both English and Spanish. Add a new sign that says something like: "Warning: Machine can turn on by itself"
    - Baler may need to be bolted down to the cement platform
- Bale ties can be purchased by calling: 1800-678-7320. Steve L can help us also find a local supplier of bale ties.
- For baling plastic – put a layer of cardboard on the bottom or top to make it easier to bind with the ties

- There are directions on the front of the machine. We should order a new set to stick on if it cannot be cleaned up enough. These same instructions should be added into the training manual.
- Limit the number of people trained on the baler. Ensure that the training is thorough. Steve L has a video tape that we can borrow for training which shows graphically what can happen if a baler is not operated properly. Employees trained on the baler need to sign off that they have received the training.
- Order a new user manual – we placed a call
- Steve Lorenzana is the Operations Manager at Gold Coast and he would be happy to come over and check out the machine when you are ready to get it running. He has been working with this type of equipment for more than 20 years. His contact information is: (preferred) Cell 805-207-0225, office 805 642-9236 ext. 3237.

Appendix D4 Replacing Paper Towels with Electric Dryers

The six restrooms located in the processing plant are equipped with dispensers of 9.2" x 9.4" multi-fold paper towels. According to our calculations, employees use approximately 538,000 of these towels yearly at a cost of nearly $3,200, for drying their hands.

To eliminate this particular waste stream, we analyzed the environmental and economic impacts of replacing the multi-fold towels and dispensers with energy efficient hand dryers. The dryer considered was the Dyson Airblade, because it was the only dryer certified as hygienic for use in a food processing facility. In addition, this dryer is the environmentally preferred model, it is energy efficient – consuming only .00468 kWh of energy per dry -, and it is endorsed by Building Green.

Figure D4-1. SCOTT WHITE Multifold towels

Figure D4-2. Dyson airblade electric hand dryer

For the purpose of this analysis we evaluated the environmental and economic impacts of the paper towels versus the electric-hand dryer system using a cradle-to-grave approach. The dryer system involves the manufacture and supply of the dryer, the consumption of electricity for hand drying and the end-of-life disposal of the dryer. The paper towel system includes the manufacture, supply and end-of-life disposal of the bin for disposal of towels and the paper towels.

Environmental Impacts

To assess the environmental impacts we relied on a previously conducted life cycle analysis (LCA) that compared the environmental impacts of electric hand-dryers relative to paper towels. The LCA we used was conducted by Environmental Resources Management and commissioned by Airdri Ltd and Bobrick Washroom Equipment Inc.

The study evaluated the two product systems over a five year period. It assumed that the dryer was used 500 times per week for an average of 30 seconds per dry. The dryer had a power rating of 2.4 kW, which equates to an electricity consumption of 9,360MJ over the five year lifetime. For the paper towels, it was assumed that a person used two c-fold paper towels per dry. Different paper-towel scenarios were used to test the sensitivity of the paper towels.

The analysis also accounted for the paper-towel dispenser and bin using a 2.6 kg common mild steel dispenser together with a common mild steel bin weighing 6.2 kg. In addition to the bin, a polyethylene bag weighing 33g is used daily. Five bags were assumed to be used each week in conjunction with the bin. All materials were assumed to be transported an equal distance by road and sea, a total of 1,500 km and all electricity inputs to the system were modeled using an average European fuel mix. With the exception of steel the inventory data for the materials, energy, transport and waste used in the LCA were sourced from PEMS4 (Pira Environmental Management Systems). Life cycle inventory data for steel products were provided by the International Iron and Steel Institute.

Table D4-1 below shows that, for every environmental impact category, the electric dryer system performed better than the paper towel system with the exception of resources depletion.

Table D4-1. Environmental Impacts of Airdri Electric Dryer vs. Paper Towels

	Electric Dryer	Towel System Average: C-Fold Paper Towels*
Resources Depletion (kg oil equiv)	1,780	574
Total Primary Energy (MJ)	35,999	58,964
Global Warming (g CO_2 e)	1,607	4,595
Smog (kg ethylene e)	.4	2.94
Acidification (kg SO_2 e)	10.2	13.8
Ecotoxicity (Aquatic m^3)	.052	.07
Ozone Depletion (kg CFC equiv)	.0003	.0007
Human Toxicity (kg/kg)	15.7	24.5
Nutrification (kg PO4 equiv)	1.2	1.38

*These are averages of the different weights of paper towels used

The results of this LCA indicate that, generally, the electric dryer system performs better than the paper-towel system. Although the systems the LCA compares differ from the product systems we considered, we believe that the jet air dryer will still have lower environmental impacts relative to paper towels. The Dyson Airblade consumes less energy than the Airdri (.00468 kWh per dry and one watt standby power) and it is made of heat-resistant polycarbonate-ABS. According to the manufacturer, this material produces less than half the CO^2 emissions than the production of aluminum. The installation of energy-efficient dryers will minimize the consumption of paper towels and trash bags that line waste receptacles and will result in lower amount of solid waste sent to landfill.

Economic Impacts

As mentioned above, Gills Onions' employees use 538,000 paper towels yearly at a cost of nearly $3,200 ($ 0.006 per towel). In our economic analysis, we omitted the cost of the can liners since it was negligible and assumed that there was an additional labor cost associated with using paper towels, due to stocking dispensers and emptying bins. Based on an employee survey that we conducted, we estimate that for each bathroom, it would take an employee an average of 15 minutes per day to check on paper towel dispensers, visit the stockroom and replace paper towel dispensers when they are empty. This translates into 431 hours of labor annually, which results in a cost of approximately $4,100. We calculate that the waste reduction from paper towels would amount to at least one ton per year[91].

For the purpose of this analysis, we assumed that Gills Onions would purchase, install and use six Dyson Airblade electric dryers (one in each restroom). The manufacturer offers a five year parts (or 350,000 drying cycles), and one year labor warranty so we assumed that the costs for maintenance in Year 1 would be zero and the costs for maintenance in years two through five would be minimal.

Given the electricity consumed by the jet dryer, and based on the assumption that all 375 workers on site at the processing facility visit the bathrooms 2.5 times per day, we calculated that the dryers would be used a total of 938 times per day, translating into 269,000 drys. The electricity used yearly would amount to 1,259 kWh at a cost of 14.69 cents per kWh, or $185 per annum. The total electricity costs for using the electric hand dryers for one year would total $193.

Table D4-2. Year 1 Annual Economic Impacts of Purchasing 6 Dyson Airblade Electric Dryers vs. Paper Towels

Item	Electric Dryer	Towel System: C-Fold Paper Towels
6 Dyson Airblade Dryer Units*	$7,980	-
Installation of 6 Units**	$1,267	-
Maintenance Labor Costs	-	$4,133
Annual Electricity Costs	$193	-
Annual Paper Towel Cost	-	$3,194
Waste Disposal Costs***	-	$47
Total Annual Costs	**$9,440**	**$7,374**
Cost Premium for Year 1	**-$2,066**	

* Per Manufacturer's quote, each unit costs $1200 + 8.75% sales tax +$25 shipping.
**Assumes labor costs at $22 per hour +20% benefits, 8 hour installation required per unit.
***Excludes cost to transport paper towel waste to landfill.

[91] Assumes 538,000 paper towels per year, which weigh 1.65 grams each and tipping fees of $48 per ton. This calculation does not account for added water content in the towels. Disposal fees do not include the cost for labor to take the paper towel waste to landfill and for fuel costs.

Although in Year 1 Gills Onions would recognize a loss of $2,066, in Year 2 and beyond, Gills Onions would realize a net savings of $7,023 (Table D4-3 below).

Table D4-3. Year 2 and Beyond Annual Economic Impacts of Using 6 Dyson Airblade Electric Dryers vs. Paper Towels

Item	Electric Dryer	Towel System: C-Fold Paper Towels
Maintenance Labor Costs	$158	$4,133
Annual Electricity Costs	$193	-
Annual Paper Towel Cost	-	$3,194
Waste Disposal Costs***	-	$47
Total Annual Costs	**$351**	**$7,374**
Cost Savings for Year 2	**$7,023**	

***Excludes cost to transport paper towel waste to landfill.

Over a five year period, Gills Onions could expect savings of over $26,000 by switching from paper towels to energy efficient hand dryers (Table D4-4).

Table D4-4. Year Over Year Economic Impacts of Using 6 Dyson Airblade Electric Dryers vs. Paper Towels

Year	Electric Dryer	Towel System: C-Fold Paper Towels	Savings of Switching to Electric Dryer
Year 1	$9,440	$7,374	-$2,066
Year 2	$351	$7,374	$7,023
Year 3	$351	$7,374	$7,023
Year 4	$351	$7,374	$7,023
Year 5	$351	$7,374	$7,023
Total Cost	**$10,844**	**$36,869**	**$26,026**

Assumes price of electricity and paper towels do not increase in years 2-5.

However, in our calculations, we assumed that neither the price of electricity nor the price of paper towels would increase over the five year period, a scenario which is highly unlikely. To test the sensitivity of our analysis we therefore doubled the price of electricity (to 29 cents) and the result was still a saving over 5 years of nearly $25,000.

Given the environmental and economic benefits associated with replacing paper towels with jet hand dryers, we recommended to Gills Onions that it implements the retrofits.

Appendix D5 Replacing Blue Bags with reusable containers

In an effort to go beyond recycling we analyzed the possibility of eliminating the use of bags within the processing facility as well as of implementing a reverse logistics system.

Gills Onions uses blue bags to transport whole peeled onions internally from one processing station to another within the same building. Specifically, the company uses 20"x 36" disposable blue polyethylene bags (blue bag), which can hold up to 50 lbs of onions. Generally, onion-filled bags are transported to the slicing line and, after the onions are removed, the blue bags are discarded. When the whole peel line processes more onions than can be used immediately, onions are bagged and stored for up to 24 hours. The bags are stored in plastic bins, which can hold up to 1000 lbs, placed on pallets and taken to the cold storage. Once out of storage, the bags are transported to the slicing line and subsequently discarded.

We estimate that in 2008, the company used approximately 589,000 blue bags to transport onions from the whole peel station to the slicing process at a pre-tax cost of $73,600 ($0.125 per bag). These bags represent 12% (66 tons) of the total waste generated yearly (566 tons).

Given the strict food safety regulations, the bags cannot be reused. As a result, we explored the possibility of eliminating the bags entirely by implementing a reusable container system within the processing plant. Before conducting our analysis, we proposed the idea to Steve Gill, owner of Gills Onions. He was receptive to the idea and advised to consider containers that held 'less weight' since it would be better for worker safety. Other criteria that needed to be met included:

- The bin needed to be at maximum 18" x 10" x 5" tall so that it could fit within the constraints of the slicing machine and be easily maneuvered by the workers.
- The bin needed to have smooth internal surfaces so that bacteria could not build up in crevices;
- The bin needed to be easily moved from one location to another such as from the whole peel line to the slicing line or from the whole peel line to storage and back again.
- The bin needed to fit properly on a pallet.
- A sanitization method and process for cleaning would need to be implemented for each container after every use.
- A storage location within the processing facility for the unused reusable bins would need to be identified.
- The reusable container needed to be stackable and contain a lid so that the onions would not be contaminated

We identified a container that met all the requirements: a reinforced, stackable, reusable, polyester fiberglass bin with smooth internal surfaces, a lid, that measures 16 ½" x 11 3/8" x 4 5/8". It can hold up to 200 pounds with a capacity of .38 ft^3, can endure temperature extremes, is easy to clean and can be purchased with a dolly for easy mobility. This bin can be purchased from Globalindustrial.com for $13.95 (pre-tax) per unit when ordering 12 or more bins.

Given that the processing plant operates 5.5 days a week and that, in 2008 Gills Onions used 588,800 bags, we calculated that, in the first year, the company would need to purchase 977 containers. This calculation accounted for the fact that the current bags holds 50 lbs of onions while the reusable container would hold 35 lbs. In this calculation, we assumed that each container could be used three times per day. The total pre-tax cost of 977 containers amounts to $13,629.

The rolling dolly that accompanies the containers measures 25 ¾" x 17 ¾" and can hold up to 1,000 lbs. It is made of steel and costs $69.95 per unit. We assumed that each dolly would be stacked with reusable containers to a maximum of six feet and could hold up to 14 containers at a time. Due to the nature of the revolving container system, the dollies would only need to be used when moving the reusable containers directly from the whole peeled to the slicing process. Containers that were being delivered to storage could be stacked on existing pallets and moved by forklifts consistent with the current process. As a result, we assumed that Gills Onions would only need to initially order 20 dollies at a pre-tax cost of $1,400.

To sanitize the containers, we identified the Numafa TL 400C (Tote & Lid) washing & cleaning system. This system meets all Hazard Analysis and Critical Control Point (HACCP) requirements and can sanitize up to 600 bins per hour. According to the manufacturer, this model has a lifetime of 20 years and it is used by various different food processing companies throughout the world. The TL 400C washing system allows for both containers and lids to be simultaneously loaded, washed and dried. It can be located either within or outside the processing facility. It measures 5' 11" when closed.

The containers are loaded in an upside down fashion with the lids placed upright next to the bins (Figure D5.1) and it takes one hour to wash a full load of bins. The system reuses water, requiring only 50 gallons per hour (.0668 HCF/hr) or .0668 HCF per wash. During washing, the water is heated to 140°C to ensure bacterial and pathogen destruction. The system uses natural gas and requires 155,000 BTU/hr per wash.

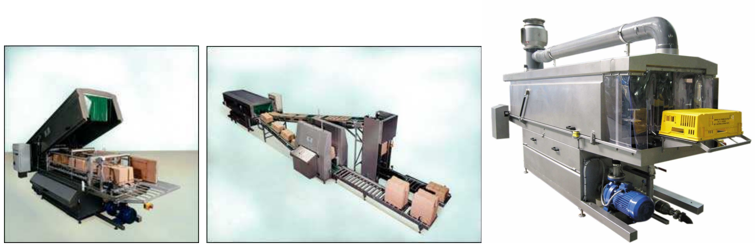


Figure D5.1. Numafa TL400C Washing & Cleaning System

According to a quote from Numafa, the pre-tax cost of the system would amount to $85,000, including freight and installation. The washing system requires a special non-foaming alkaline detergent such as Pow-R-Scrub, which is manufactured by Birko Corporation and costs $9.25 per 55 gallon drum.

Based on this information, we conducted a cost-analysis to compare the cost of switching from the current blue bag system to a reusable container system for internally transporting whole peeled onions (Table D5-1). In our cost-analysis we compared the cost of purchasing 588,800 blue bags in Year 1 with the cost of purchasing 977 reusable bins, 20 dollies, the Numafa TL 400C cleaning system, detergent for one year, and the annual cost of energy, water and labor to operate and manage the cleaning system.

Table D5-1. Cost Comparison of Single-Use Blue Bag versus Reusable Container for Internal Processes

	Blue Bag	***Reusable***
Purchase Price (per unit)	$ 0.125	$ 13.95
Black Tie	$ 0.009	
Price Per Container	$ 0.134	$ 13.95
Price Per Dolly		$ 69.95
No. of Dollys		20
No. of Units Used Per Year	588,800	977
Total Cost of Units pre tax	$ 78,899	$ 15,027
Sales Tax	$ 6,904	$ 1,315
Total Cost of Units with Tax	$ 85,803	$ 16,342
Washer Equipment Cost		$ 85,000
Sales Tax		$ 7,438
Total Cost of Washer Equipment with Tax	$ -	$ 92,438
Cleaning Cost (Labor) Per Year**		$ 22,042
Annual Water Cost***		$ 442
Annual Energy Cost****		$ 1,744
Annual Detergent cost w/ Tax*****		$ 420
Total Cost to Operate Washing Unit		$ 24,647
Replacement Cost of Trays Per Year******		$ 1,363
Annual Replacement Cost of Dollys ******		$ 140
Sales Tax		$ 131
Annual Replacement Cost of Trays and Dollys with Tax		**$ 1,634**

Assumes Sales Tax Rate of 8.75%

*Assume Numafa 400C TL model at $75,000 plus $10,000 additional freight and installation costs. Assumes no additional spacing requirements and associated costs

Note machine can wash 400 bins in one hour / 2931 bins need to be washed per day = 7.3 so 8 washes per day

**Assumes 1 person needed to run washing equipment 8 hours per day, 287 days per year at $8 p/hr + 20%

*** Assumes 8 washes per day at 1 wash per hour at 50 gallons per hour (.0668 HCF per hour), 287 days per year

****Assumes 8 washes per day at 155,000 BTU's (1.55 Therms) per wash, 287 days per year at cost of $.49 cents/therm (4.9e^-6 per BTU) = Cost per wash $ .7595

******Assumes 8 washes per day at 1 gallon of detergent required per 50 gallon wash; 287 per year: Price per 55 gallon drum at $9.25

******Assumes a replacement rate of 10% per year

Table D5-2. Cost Comparison of Single-Use Blue Bag versus Reusable Container for Internal Processes		
	Blue Bag	*Reusable Bins*
Total Cost of Units with Tax	$ (85,803)	$ 16,342
Total Cost of Washing Equipment with Tax	$ -	$ 92,438
Total Capital Equipment Costs		**$ 108,780**
Recurring Annual Cost to Operate Washing Unit		$ 24,647
Recurring Annual Replacement Cost of Trays & Dollys w/ Tax		$ 1,634
Annual Operating Costs	$ (85,803)	**$ 26,281**
Payback Period (Years)	***1.83***	

Assumes Sales Tax Rate of 8.75%
*Assume Numafa 400C TL model at $75,000 plus $10,000 additional freight and installation costs. Assumes no
Note machine can wash 400 bins in one hour / 2931 bins need to be washed per day = 7.3 so 8 washes per day
**Assumes 1 person needed to run washing equipment 8 hours per day, 287 days per year at $8 p/hr + 20% benefits.
*** Assumes 8 washes per day at 1 wash per hour at 50 gallons per hour (.0668 HCF per hour), 287 days per year =
****Assumes 8 washes per day at 155,000 BTU's (1.55 Therms) per wash, 287 days per year at cost of $.49
******Assumes 8 washes per day at 1 gallon of detergent required per 50 gallon wash; 287 per year: Price per 55 gallon
******Assumes a replacement rate of 10% per year

Table D5-3. Cost Comparison of Single-Use Blue Bag versus Reusable Container for Internal Processes		
	Blue Bag	*Reusable*
Total Cost of Units Year with Tax	$ 85,803	$ -
Total Cost of Washing Unit		$ 24,647
Total Replacement Cost of Trays and Dollys with Tax		$ 1,634
Total Cost Year 2	$ 85,803	$ 26,281
Annualized Savings Associated With Switching to Reusable		**$ 59,522**

We calculated that, to substitute the blue bags, a minimum of 977 are needed and that each container would be washed three times daily.

Water costs were calculated assuming 8 washes per day using 50 gallons (.0668 HCF) per wash, 287 days per year for a total of 114,800 gallons (153.37 HCF). Gills Onions currently pays $2.88 per HCF for every HCF used over 23 HCF and since all of the water used for the Numafa system would be in excess to their current water usage (which averages 8,827 HCF per month) we assumed that all water costs would be at this rate for a total of $442 per year. To approximate damages and losses of reusable containers, we assumed that 10% of the reusable bins and 10% of the dollies would need to be replaced each year.

Based on our analysis, Gills Onions will recognize substantial cost-savings by Year 2 by switching to reusable containers. In Year 1, the cost of implementing the system will total $49,258. This amount represents the additional expense over the $85,803 that the company is currently spending annually on blue bags. However, by Year 2 Gills Onions will spend $59,521 less each year on blue bags and therefore will be able to recoup the initial investment and recognized a net savings of $10,264. In Year 3 and beyond, Gills Onions will be able to recognize $59,522 worth of additional savings by switching to reusable containers.

Over a five year period, not taking into consideration net present value (NPV) and finance costs, this investment would thus net $188,828.

In addition to the cost-saving benefits, switching from blue bags to a reusable container system furthers Gills Onions goal of a zero waste initiative, since it would translate into less energy, solid waste and greenhouse gas emissions.

Appendix D6 Replace Corrugated Cardboard Bins and Implement Reverse Logistics for Industrial Customers

In an effort to reduce the amount of packaging that is shipped to customers, we evaluated the possibility of replacing single-use corrugated bins used for large industrial client orders, with reusable containers and implementing a reverse logistics program.

For our analysis, we relied on a Life Cycle Inventory (LCI) by Franklin Associates [xxv] that compared the environmental impact of RPCs to single use corrugated cardboard containers specifically for fresh produce delivery to retailers. The LCI compared the production of virgin polypropylene with that of corrugated cardboard containers, assuming industry average recycled content; the transportation of newly manufactured containers to the initial user; transportation of packed containers from initial user to retailer; compared backhauling, washing and reissue of RPCs with recycling of DRCs at end-of-life; and recycling and disposal of RPCs at end-of-life (Figure D6-1). The study did not include the environmental impacts associated with growing produce nor the initial packing of produce in the container. The study did not include impacts associated with printing on the cardboard or labeling of the RPCs nor did it attempt to compare the damage or spoilage of produce associated with different containers used.

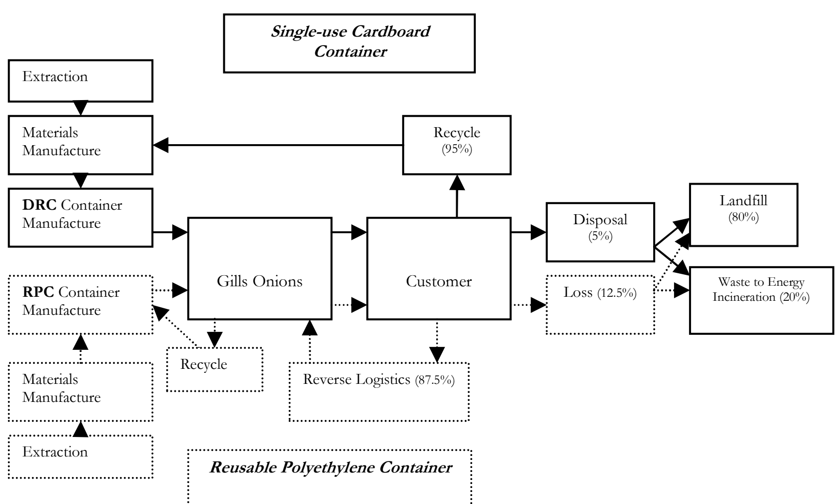


Figure D6-1. Life cycle inventory comparison between single-use cardboard container and reusable plastic container

Environmental Impacts

The LCI we used compared the reusable RPCs to single-use DRCs based on a common functional unit of 2 million pounds of product shipped to customers. Various sizes and weights of containers were analyzed for use in ten fresh produce applications including onions. The net primary energy required for a single use DRC was based on industry average data for corrugated cardboard manufacturing and production of DRCs and a very high rate (95%) of cardboard recycling at retailers, with the remaining 5% going to landfill or incineration.

Industry average data was also used to calculate the energy required for the production of polypropylene resin and the manufacture of the RPC. The energy required for the reverse logistics associated with RPCs including transportation, cleaning, processing, and loss was based on information collected from the Reusable Pallet and Container Coalition member companies assuming a shared pooling operation. Data for the average RPC lifetime, number of trips, reuse rates/loss rates and disposal rates were also based on this information. Energy associated with disposal and recycling of DRCs was based on industry average data.

The study identified and quantified energy, solid waste and total GHG emissions for both RPC and DRC packaging options (Table D6-1).

Table D6-1
Replacing Single-Use Corrugated Cardboard with Reusable Polypropylene Container for Onions

	DRC	****RPC***	***% Difference***
Total Energy (million BTU)	1,075	533	-50%
Total Solid Waste (tons)	25.7	1.1	-96%
Total Greenhouse Gas (tons CO_2e)	67	38.2	-43%

*Average scenario defined as RPC with average use/loss rates

Specifically for shipping onions, the study indicated that on average, RPCs required 50% less energy; produced 96% less total waste; and generated 43% less GHG emissions than single-use DRCs. The findings specific to onions were slightly better for RPCs than the average difference reported across all 10 fresh produce categories. According to Franklin Associates, the factor that dominated the findings was multiple trips used in an RPC closed-loop system. By getting multiple trips out of one container instead of needing new resources for single-use containers, the amount of material required was reduced which resulted in relatively low environmental burdens that were only partly offset by cleaning and transporting the containers back. In addition, total energy and GHG emissions were reduced since less material and energy are required for manufacturing and recycling.

Economic Analysis

We evaluated the cost of purchasing reusable containers and implementing a reverse logistics program for Gill Onions in place of using single-use corrugated containers (Table 6). In this scenario, reusable bins are purchased, used for sending large orders to customers, and shipped back to Gills Onions to be reused.

The cost to purchase a RPC was based on an estimate that we received for purchasing 1,000 or more collapsible, stackable, reusable, polypropylene containers from RPP Containers. The cost for each RPC container was $103. This cost was compared to Gills Onions' average cost for the single-use cardboard bin, $10. Using Gills Onions' actual large industrial customer bin data, we determined that the company uses approximately 14,000 bins yearly.

Table C7-2
Single-Use DRC vs. Reusable Plastic Container (RPC)

	DRC	***RPC***
Purchase Price (per unit)	$10.15	$103
No. of Containers Shipped Per Year	14,223	14,223
Dwell Time: (days container in loop)		28
Turns Per Year		13
Inventory of RPC containers required		1,100
RPC Container Cost Per Trip		**$1.83**
Reverse Logistics (Cost to Return One RPC)		**$1.31**
Replacement Cost (Cost to Replace One RPC)*		**0.24**
Processing Cost (Cost to Clean one RPC)**		**$1.33**
Washer Cost Per RPC		**0.05**
Total Cost Per Use	$10.15	$4.76
Total Cost Per Year	**$144,363**	**$67,701**
Cost Savings Using RPC (per unit per trip)		**$5.39**
Annual Savings Using RPC		**$76,662**

***Assumes 3% replacement rate**
****Assumes Cost of Individual Earning $8 p/hr requiring 10 minutes to clean each bin**
^The DRC costs do not include costs to replace damage product

We assumed a worst case scenario for dwell time (the time that it would take for one bin to completely cycle through the system). We assumed that each container would be in circulation within the closed loop supply chain for 28 days. This included time at Gills Onions on the front end for processing and on the back-end for cleaning, as well as travel days to/from the East Coast (farthest distance) and processing time at the customer's site. This translates into each bin completing 13.04 turns per year. The total number of RPC containers required in circulation was therefore 1,091 units, which we calculated by dividing the total number of trips by the total number of turns per year. Assuming a purchase price of $103 per unit, the total purchase cost would be $112,373.

We amortized this cost over 5 years using an annual interest rate of 6% to get an annual cost of $26,070, which equates to an average cost per trip of $1.83[92].

To estimate the return logistics, we assumed that each RPC would travel the full 3,000 miles return distance from the East Coast to California. Based on a model provided by the Reusable Packaging Association, we assumed that each truck could handle 4,000 empty RPCs at an average cost of $1.75 per mile travelled[xxvi]. The total trip cost per truckload ($1.75 x 3,000 mi) was $5,250 or $1.31 per RPC assuming that the RPCs were part of a shared pooling system and that the truck was fully loaded. We estimated an annual damage rate of 3% which means that Gills Onions would need to replace 33 containers each year due to damage ($0.24 per RPC).

Recognizing that the reusable containers would create an additional burden at Gills Onions for processing and cleaning, we estimated that it would take one worker, at $8.00 per hour, up to 10 minutes to clean each container for a cost of $1.33 plus $0.05 for water and detergent per container.

Our results indicated that based on 14,223 deliveries per year, the total cost per use for the RPC using a worst case scenario and assuming that all shipments traveled 3,000 miles from California to the East Coast, was $4.76 compared to $10.15 per use for the single use DRC. Using this scenario the potential savings for Gills Onions, could therefore amount to nearly $77,000 annually if they switch to RPCs with a shared pool reverse logistics system. Moreover, given the reality that more than half of Gills Onions industrial orders are delivered within a 500 mile radius and that approximately 40% of shipments occur within the State of California there is also reason to believe that the savings associated with using a reverse logistics system would be even greater as both RPC dwell time and miles traveled could be greatly reduced. While actual costs and company savings could vary from the model, it is still legitimate to use it as an indicator of relative costs and potential savings and for determining whether there was value in pursing the option any further.

Relationship between Environmental & Economic

Our analysis shows that there are both environmental and economic benefits of switching from the single-use corrugated DRC to the reusable RPC with a reverse logistics program. Gills Onions has the potential to realize up to a 50% economic benefit per year and at the same time experience a minimum of a 43% environmental improvement. The economic and environmental benefits both stem from being able to reuse an individual container multiple times as opposed to having to manufacture, purchase and dispose of or recycle the single-use cardboard containers. Our findings are consistent with the benefits highlighted in numerous studies comparing reusable containers versus single use system[xxvii].

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[92] Interest rate based on 6% interest annual with 60 payments over 5 years.

In addition to the potential direct cost savings, there are additional benefits to Gills Onions of switching to reusable containers. These benefits include reduced in-transit product damage costs resulting from improved container durability, and reduced costs from improved worker safety as RPCs have a better ergonomic design and eliminate box cutters, staples, debris and stray packaging[xxviii]. Moreover, reusable containers and reverse logistics can help strengthen the relationship between processer and customer and in turn secure greater customer loyalty.

Constraints & Challenges

While both the environmental and economic results appear promising, it is important to recognize that the reverse logistics aspect of our model is sensitive to real world conditions. Actual costs could vary depending on the specific locations of customers, the number of orders, the price of fuel and the feasibility of Gills Onions participation in a shared pool network. However, the sensitivity of the model does demonstrate that the reverse logistics costs could increase four fold, from $1.83 to as high as $7.22 per container and still enable Gills Onions to breakeven from an economic standpoint. Even at the economic breakeven point, the company would still realize a substantial environmental benefit.

However, there could be constraints and challenges to implementing such a system. While storage of empty containers is not an issue at Gills Onions' facility, it may be a constraint at a customer's site. Moreover, because our analysis used information based on a Unipak® collapsible container, if Gills Onions were to follow our model exactly the company would have to establish a new vendor relationship to obtain this RPC.

Consideration also has to be given to the fact that establishing and internally managing a reverse logistics program is no minor endeavor. Implementing and ensuring the integrity of a reverse logistics program could be cumbersome and require a major time commitment on the part of dedicated staff. Getting customers to buy into a reusable container program would also inevitably take negotiations and a systematic roll-out plan which too would require dedicated resources.

Lastly, if Gills Onions does not participate in a shared pooling network, the costs of the reverse logistics program could increase dramatically. Not participating in such a program would require that the company purchase more RPCs and incur the cost of individually transporting containers back to the processing plant. Because transportation costs would be based on standard freight and shipping costs the expense would be much higher than our modeled costs reflect. By not using a pooled network, environmental impacts associated with energy consumption and GHG emissions would also increase as more containers would need to be manufactured and additional transportation would be required for point-to-point routing.

Some of these concerns can be mitigated. For example, to address the storage space issue during transportation and while onsite, in our analysis we recommended a collapsible reusable container as opposed to a rigid side container to minimize space.

Furthermore, while we based our analysis on a Unipak container made by RPP containers, we were advised by Gills current vendor, Macro Plastics, that they too could provide reusable containers that met our specifications. To address the management concerns, Gills Onions could hire a third party service provider to handle the reverse logistics process in its entirety for a fee. Gills Onions already participates in CHEP's shared pooling system for pallets, so the company is familiar with the process and has access to one potential network provider. However, it is important to recognize that outsourcing the reverse logistics could diminish the economic benefit of reusable containers.

In conclusion, while using a reusable container and implementing a reverse logistics program may pose initial constraints and challenges for implementation, our analysis indicated that the environmental and economic improvements are substantial and we have therefore recommended to Gills Onions that it be advisable to pursue this alternative.

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