FINAL REPORT

Zero Waste Strategic Plan: A Quantifiable Approach

For the City of Sunnyvale

February 2013

R3 Consulting Group, Inc.
Resources, Respect, Responsibility

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1.0 Executive Summary

1.1 Overview

The City of Sunnyvale (City) has a long history of progressive waste management policies, programs and facilities. The City was the first jurisdiction in California to adopt its AB 939 Source Reduction and Recycling Element (SRRE), and its 2011 diversion rate is calculated at 66 percent. This diversion rate is the result of effective source separated recycling diversion programs, as well as the diversion of mixed waste received and processed at the City's SMaRT Station® (material recovery facility). The City's residential curbside recycling and yard trimmings programs diverted more than 48 percent of the residential waste stream in 2011, while the SMaRT Station diverted approximately 15 percent of the mixed residential, commercial, roll-off and public haul waste it received through manual and mechanical sorting processes. While diversion of the City's commercial waste stream through the existing franchised commercial hauler's cardboard and office paper source separation programs is relatively limited, additional commercial recycling is provided by non-franchised commercial haulers.[1]

In 2008 the City adopted a Zero Waste Policy that calls for a reduction in the amount of waste being disposed, as well as efforts to minimize upstream impacts on materials through sustainable manufacturing and consumerism. That policy, however, did not establish a quantifiable diversion goal. As part of the development of the Zero Waste Strategic Plan, City staff is recommending three progressive goals to get to Zero Waste: 75 percent diversion by 2020; 80 percent by 2025; and 90 percent by 2030 (100 percent diversion is unlikely due to the need to landfill materials that are not recyclable or need to be disposed at a hazardous waste landfill). The City's 2020 75 percent diversion goal parallels CalRecycle's goal of 75 percent statewide recycling by 2020.

To address the Zero Waste Policy goals, the City has developed this Zero Waste Strategic Plan, with specific emphasis on quantifiable goals and analysis of the diversion potential associated with various diversion options. For purposes of analysis, four Zero Waste System Scenarios were developed to provide the City with an understanding of:

- How much additional diversion it could expect to achieve by simply enhancing its existing source separation programs;

[1] Non-franchised commercial haulers that charge for collection are operating in violation of the City's exclusive franchise with Specialty Solid Waste and Recycling.

- What types of enhancements to existing source separation programs and new source separation programs would need to be implemented to achieve a 75 percent diversion rate;
- What level of additional recovery of mixed waste through the SMaRT Station would be required to achieve a 75 percent diversion rate; and
- What level of diversion may potentially be achieved by using conversion technology to process the SMaRT Station's mixed waste residue, assuming that is a viable option in the future.

A summary of each of the four Zero Waste System Scenarios, as well as the associated diversion rates and additional costs, are provided in the following table. As shown, the City will need to significantly expand its source separation programs or significantly increase the diversion of materials through the SMaRT Station if it is to achieve a 75 percent diversion rate. This is followed by Key Findings and Recommendations, along with a brief outline of the major sections of this Zero Waste Strategic Plan.

Table EX – 1
Summary of System Scenarios

Scenario	Resulting Diversion Rate	Additional Cost (Rate Impact)
Scenario 1 Maximize Diversion of Existing Source Separation Programs[2] (a) Capture 50% of the remaining materials targeted by the existing single-family curbside recycling and yard trimmings programs, multi-family recycling program and commercial cardboard and office paper programs; and (b) add new materials (mixed plastics, mixed metals and textiles) to the existing single-family and multi-family residential recycling programs and capture 50% of those materials.	69.4%	$335,000 (1.0%)
Scenario 2 Maximize Diversion of Existing Source Separation Programs and Implement New Source Separation Programs[3] Same as Scenario 1 with (a) implementation of multi-material commercial recycling program; (b) expansion of single-family yard trimmings program to the multi-family and commercial sectors; and (c) implementation of residential and commercial organics program, and capture 50% of all targeted materials.	75.1%	$2,349,000 (6.7%)
Scenario 3 Source Separation Program Status Quo with Increased Recovery of SMaRT Small Organics and Mixed Waste Residue (a) Processing and diversion of 75 percent of the SMaRT Station small organics fraction (assumes 25% contamination); (b) divert ~500 additional C&D tons; and (c) enhanced SMaRT Station mixed waste sorting and recovery of approximately 20% (15,000 tons) of the recyclable, potentially recyclable and compostable materials in the SMaRT Station residue stream that is currently landfilled.[4]	75.0%	$1,455,000 (4.2%)
Scenario 4 Source Separation Program Status Quo with Increased Recovery of SMaRT Small Organics and Processing of Mixed Waste with Conversion Technology (a) Processing and diversion of 75 percent of the SMaRT Station small organics fraction (assumes 25% contamination); and (b) gasification or pyrolysis of 75 percent of the mixed waste residue stream with 10 percent residue.	90.0%	$5,002,000 (14.4%)

[2] Capture rates are net of any existing recovery of the targeted materials at the SMaRT Station.

[3] Capture rates are net of any existing recovery of the targeted materials at the SMaRT Station.

[4] This is equivalent to diverting an additional 14 percent of the total tons of mixed waste processed and would require essentially doubling the overall mixed waste diversion rate of the facility.

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1.2 Key Findings

- In 2011, the City disposed 86,000 tons, and diverted approximately 172,000 tons.
- For the City to achieve a 75 percent diversion rate, an additional 21,700 tons of material that is currently disposed will need to be diverted (i.e., the City will need to increase its diversion rate by 8%).
- The City is highly invested in the processing of mixed waste at the SMaRT Station and has implemented source separation programs that serve all major customers at varying levels.
- Diversion from new or enhanced existing source separation programs will "compete" for materials that are already recovered at the SMaRT Station.
- The City has two major options for increasing its diversion rate, and has and should continue to use the net cost per ton of additional diversion as the basis for determining which options to pursue:
    - Increase diversion through the SMaRT Station; and/or
    - Increase diversion through existing source separation programs and implement additional source separation programs.
- Source separation programs alone may not be able to achieve a 75 percent diversion rate:
    - Only 2 percent to 3 percent additional diversion can be achieved by maximizing the effectiveness of existing single-family, multi-family and commercial source separation programs;
    - Increasing the diversion of existing source separation programs and implementing multi-material commercial recycling, multi-family and commercial yard trimmings collection, and residential and commercial organics programs would be needed for the City to potentially achieve a 75 percent diversion rate; and
    - Implementation and enforcement of mandatory residential and commercial recycling ordinances and material bans (e.g., food and yard trimmings) will likely be required in conjunction with the increased source separation programs noted above if the City is to achieve a 75 percent diversion rate through source separation programs alone.

- Increasing recovery of the mixed waste stream through the SMaRT Station alone may not be able to achieve a 75 percent diversion rate:
    - 80 percent of the SMaRT Station's residual waste stream that is landfilled is comprised of recyclable and compostable material;
    - Diverting the small organics waste stream (fines) that is not currently diverted could increase diversion by 3.5 percent (9,000 tons) and may offer the most cost-effective option for significant additional diversion;
    - For the City to achieve a 75 percent diversion rate through the SMaRT Station's mixed waste processing operations, it will need to divert the 9,000 tons of small organics listed above, plus an additional 14 percent of the mixed waste stream that is processed (essentially doubling the current SMaRT Station mixed waste diversion rate);
    - Significant increased diversion through the SMaRT Station's mixed waste processing operation is not feasible without changes to the design and/or operation of the facility;
    - The SMaRT Station's operating agreement expires December 31, 2014, which will provide the City with the opportunity to restructure the agreement to support increased diversion at the SMaRT Station; and
    - While it may be possible to restructure the agreement to support increased diversion, significant changes to the design of the SMaRT Station may be required to realize significant additional diversion from the mixed waste stream.
- Conversion technology facilities in California are in the pilot stage:
    - The use of conversion technology using thermal treatment such as gasification and pyrolysis to process SMaRT Station's residue could "divert" an additional 20 percent or more of the City's waste stream, enabling the City to potentially achieve a 90 percent diversion rate; and
    - No commercially viable conversion technology facilities are operating in California and the California Department of Resources Recycling and Recovery recently reversed its decision on whether gasification technology qualifies as green energy.

- Additional funding will be needed to reach a 75 percent diversion rate:
    - The City's current diversion programs are cost effective and customer rates are comparable to other San Francisco Bay Area communities;
    - Increasing diversion to 75 percent will require significant additional costs related to new source separation programs and/or changes to the design/operation of the SMaRT Station; and
    - The expiration of the current put-or-pay disposal agreement with Kirby Canyon Landfill in 2021 may help offset increased costs to reach 75 percent diversion.

1.3 Recommendations

The following recommendations are presented in support of the City's efforts to achieve a 75 percent diversion rate by 2020:

- Maximize Mixed Waste Recovery at the SMaRT Station:
    - Complete current review of options to improve the quality of the SMaRT Station small organics fraction to enable the diversion of additional portions of this waste stream;
    - Conduct pilot studies to determine the potential for additional diversion of the SMaRT Station mixed waste stream and pursue options as deemed appropriate;
    - Competitively bid or sole-source negotiate the new SMaRT Station operating agreement to require additional diversion.
- Improve Existing Source Separation Programs:
    - Adopt and enforce a mandatory residential recycling ordinance;
    - Consider adding additional materials to the curbside program as viable markets allow (e.g., textiles and mixed plastics);[5]
    - Adopt and enforce specific material disposal bans, including residential recyclables and yard trimmings; and
    - Expand the commercial food waste pilot program to all commercial food waste

[5] It should be noted that many of the potential new materials that the City may wish to consider adding to the curbside recycling program have marginal and/or inconsistent markets. Should such materials be added to the program it should be understood that at certain times these materials may need to be landfilled if markets are not available.

generators and implement a mandatory commercial organics diversion ordinance.

- Implement New Source Separation Programs:
    - Implement a multi-family and commercial yard trimmings diversion program and adopt and enforce a yard trimmings disposal ban; and
    - Evaluate the costs/benefits of new source separation programs including commercial commingled recyclables and implement as appropriate.
- Conversion Technology Facilities:
    - Continue to monitor conversion technology projects within the State and nation, and assess the potential for the application of a conversion technology facility(ies) to process portions of the City's waste stream in the future.
- City Programs and Policies:
    - Adopt City Zero Waste goals of 75 percent diversion by 2020, 80 percent by 2025 and 90 percent by 2030;
    - Establish the City as a Zero Waste "Success Model" by implementing and maximizing upstream and downstream material management options in all City buildings;
    - Adopt a mandatory recycling ordinance and material bans, as discussed above;
    - Continue to actively support Extended Producer Responsibility and Product Stewardship efforts at the local, state and federal levels;
    - Strengthen the City's Environmental Procurement Policy contracting and purchasing policies to consistently provide for the use of less toxic, more durable, higher recycled content and recyclable products by all City departments and contractors;
    - Develop an enhanced outreach program that:
        - ✓ Provides additional focus and resources related to waste reduction, reuse and environmental purchasing;
        - ✓ Incorporates comprehensive sustainability options (e.g., Zero Waste, water and energy conservation, pollution reduction, etc.); and
        - ✓ Is coordinated with sustainability efforts of other City departments (and regional agencies, as appropriate).

- Conduct Zero Waste / Green Business Sustainability Audits of all City buildings, including the top 20 percent largest commercial waste generators, all schools that subscribe to City solid waste management services and all large venue events.

1.4 Zero Waste Strategic Plan Outline

This Zero Waste Strategic Plan includes the following sections:

- ***Background*** – Information on the City's current solid waste management policies, programs and services and its current and historical diversion rates;
- ***Tonnage Data*** – Information on the current and historical disposal tonnage volumes and the quantity of waste landfilled by disposal facility;
- ***Waste Composition Study*** – Information on the composition of the City's waste stream;
- ***Opportunities Assessment*** – Quantitative analysis of the potential diversion associated with various diversion options;
- ***Zero Waste Scenario Modeling*** – Presentation of the Zero Waste System Scenarios and associated diversion rates and costs; and
- ***Findings and Recommendations***.

2.0 Introduction

2.1 Zero Waste Policy

On December 9, 2008, the City of Sunnyvale (City) City Council adopted a Zero Waste Policy. That policy lays out a clear vision of Zero Waste for the City, the purposes of which are to:

1. Protect the environment and conserve natural resources;
2. Help prevent pollutants from entering the air, land and water;
3. Create a more efficient economy; and
4. Preserve the environment for future generations.

The Zero Waste Policy establishes the following Zero Waste Policy Objectives:

1. Reduce the amount of Sunnyvale waste being disposed;
2. Encourage residents, businesses and agencies to reuse, reduce and recycle materials judiciously;
3. Empower consumers to use their buying power to demand non-toxic, easily reused, recycled or composted products;
4. Encourage manufacturers to produce and market less toxic and more durable, repairable, reusable, recycled and recyclable products;
5. Lobby regional, state and federal legislators to implement laws, policies and regulations that promote Zero Waste;
6. Work locally and regionally to assist in Zero Waste planning;
7. Lead by example and implement Zero Waste goals for all City buildings;
8. Put policies in place that favor environmentally sustainable practices; and
9. Provide the community with information about Zero Waste that includes periodic reports that measure progress.

In support of its Zero Waste Policy, the City issued a request for proposals to develop a ***fact based*** Zero Waste Strategic Plan. The plan was to be based on the results of the City's recent waste characterization study and provide a ***quantitative analysis*** of the projected diversion associated with various Zero Waste options. Using the results of that quantitative analysis, specific recommendations were to be developed based on the ability of those options to cost effectively achieve the City's Zero Waste diversion objectives.

2.2 Vision of Zero Waste (Zero Waste Diversion Goals)

While the City's Zero Waste Policy establishes the general goal of reducing the amount of City waste being disposed, it did not establish a quantifiable diversion goal. As part of the preparation of this Zero Waste Plan, the City created a Zero Waste Vision and Zero Waste Diversion Goals.

Vision:

By 2030, Sunnyvale will achieve 90 percent diversion from the landfill. All discarded materials in Sunnyvale are recovered for their highest and best use, and minimal materials are disposed.

To achieve this vision, Sunnyvale will work toward Zero Waste by:

1. Educating and engaging businesses, organizations, public agencies and residents to encourage zero waste behavior change;
2. Continuing to implement activities and programs that support the City's Zero Waste Policy;
3. Supporting legislation and adopting policies that require minimized environmental impacts through improved product design; and
4. Ensuring that facilities and infrastructure are in place to properly manage all recovered materials.

Three goals are proposed to measure the City's progress in achieving the Zero Waste Vision:

1. 75 percent diversion by 2020, or 21,787 additional tons diverted;
2. 80 percent diversion by 2025, or 34,712 additional tons diverted; and
3. 90 percent diversion by 2030, or 60,562 additional tons diverted.

These goals are shown in Table 1, below.

Table 1
Zero Waste Diversion Goals

Diversion Rate	Annual Tons Landfilled	Tons Diverted to Meet Goal	Time Period
66% Diversion **(current diversion rate)**	86,412	NA	2011
75% Diversion	64,625	21,787	2020
80% Diversion	51,700	34,712	2025
90% Diversion **(Zero Waste Target)**	25,850	60,562	2030

2.3 Framework for Consideration of Zero Waste Options

In assessing the various available diversion options, the quantities of material diverted and the associated cost per diverted ton are important considerations. The extent to which the City places a value on higher and better use of diverted material (if not the highest and best use), is also an important consideration. The diversion options that the City implements, therefore, need to strike an appropriate balance between the quantity, quality, and cost of diversion.

In addition to considering "downstream" diversion options, focusing attention on "upstream" options to reduce the amount and toxicity of waste generated, and increase the recyclability and recycled content of generated materials, is a key component of a Zero Waste system. While the public sector has limited ability to directly affect the type and quality of waste that is generated, it can support efforts to hold manufacturers responsible for the safe and effective management of the products and materials that they generate. This includes efforts to support and implement widespread Extended Producer Responsibility (EPR), such as writing letters of support for EPR bills and considering local ordinances requiring manufacturers/retailers to take back products for recycling/disposal.[6]

[6] Extended Producer Responsibility (EPR), or Product Stewardship, uses financial incentives to encourage manufacturers to design environmentally-friendly products by holding producers liable for the costs of managing their products at end of life. This tactic attempts to relieve local governments of the costs of managing certain priority products by forcing manufacturers to internalize the cost of recycling within the product price. EPR promotes that producers (usually brand owners) have the greatest control over product design and marketing, and therefore have the greatest ability and responsibility

The City has taken a number of specific steps in support of EPR, including becoming a member of the California Product Stewardship Council and the Santa Clara County Product Stewardship Council. The City has also passed an EPR Ordinance that urges, among other things, that the California Legislature enact framework EPR legislation that shifts Universal waste (U-waste) and other waste management costs from local government to the producers of the products.

While the need for EPR as a key component of the City's future solid waste management system is clear, beyond that the selection of specific programs, services and/or facilities that strike the desired balance between the quantity, quality, and cost of diversion is likely to be open to debate. This is particularly true when determining the appropriate balance between new or expanded source separation programs and/or focusing on additional processing and recovery of materials from the mixed waste stream that passes through the Sunnyvale Materials Recovery and Transfer Station (SMaRT Station®), including the potential for conversion technologies[7] as a future component of the City's solid waste management system.

to reduce toxicity and waste (Source: Sierra Club. "Producer Responsibility Recycling; http://www.sierraclub.org/committees/ zero waste/producer responsibility/index.asp. May 2009).

[7] Conversion technologies refer to a wide range of both thermochemical and biochemical processes capable of converting organic materials, including the organic fraction of the municipal solid waste stream, into useful products, such as green fuels and renewable energy. Conversion technologies are successfully used to manage solid waste throughout Europe, Israel, Japan and other countries in Asia, but are not yet in commercial operation in the United States. While there are a number of jurisdictions, including Los Angeles and Santa Barbara counties and the Salinas Valley Solid Waste Management Authority, that are actively considering conversion technologies there are also members of the solid waste management community that are opposed to their use in lieu of more traditional recycling programs to achieve Zero Waste.

3.0 Organization of Report

This report contains the following sections in order:

- Background;
- Tonnage Data;
- Waste Composition Study;
- Opportunities Assessment;
- Zero Waste Scenario Modeling; and
- Findings and Recommendations.

The ***Background*** section provides information on the City's current solid waste management policies, programs and services, and its current and historical diversion rate. Information on the City's solid waste collection franchise, the City's SMaRT Station, and its Kirby Canyon Landfill agreement is also provided along with cost per ton data for the City's source separation programs and the SMaRT Station's mixed waste recovery operations.

The ***Tonnage Data*** section provides information on the current and historical disposal tonnage volumes and the quantities of waste landfilled by disposal facility. This is followed by information on the composition of the City's waste stream based on the ***Waste Composition Study*** that was jointly conducted by the City and the City of Mountain View in 2010.

The data from the Waste Composition Study, the current diversion and disposal tonnages, and the City's Vision of Zero Waste serve as the basis for the review and analysis of diversion options that is presented in the ***Opportunities Assessment*** section of this report. The Opportunities Assessment includes an "Additional Diversion Potential Analysis" of the City's existing source separation programs and the SMaRT Station's mixed waste processing operations, as well as the diversion potential associated with various other source separation and mixed waste processing options. Planning level costs for the various options are also provided.

For purposes of projecting the costs and diversion potential associated with system-wide diversion options, various diversion options were selected for modeling as part of the ***Zero Waste Scenario Modeling*** section. The objective of this analysis is to provide the City with additional understanding of the types of programs that may be needed to achieve increasingly higher levels of diversion and the associated cost impacts. Finally, overall findings and recommendations are presented in the ***Findings and Recommendations*** section of the report.

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4.0 Background

4.1 Current Services

The City has a long history of progressive solid waste management, including regional cooperation in support of effective solid waste management policies and the development of its solid waste management infrastructure. Sunnyvale's current solid waste management programs include outreach, collection programs, special events and operation of the SMaRT Station. The curbside collection program for single-family homes has been in place since 1982, the yard trimming collection program was added in 1996, and the recycling program was expanded to multi-family complexes in 1997. As a result, Sunnyvale's diversion has increased from 18 percent in 1990 to 66 percent in 2011. The City's current outreach and collection programs include:

- **Outreach and Technical Assistance** – Staff provide outreach using multiple approaches, including electronic and paper newsletters, advertisements in the local paper, website, Twitter, Facebook, and regular mailings to schools, commercial accounts, and single-family and multi-family residences. Technical assistance is also provided to commercial sites and apartment/condominium complexes to assist with garbage and recycling.
- **Collection Programs**[8]
    - **Single-family Recycling Collection** (includes duplexes, tri-plexes and mobile homes) – Dual stream curbside cart collection of newsprint/mixed paper and glass, metal and plastic containers (#1 - #7), yard trimmings, household batteries, used motor oil and oil filters, and cardboard.
    - **Multi-Family Recycling Collection** (4 or more units) – Two-cart service for newsprint/mixed paper and glass, metal and plastic containers (#1 - #7), and for participating complexes, used motor oil and oil filter collection.
    - **Commercial Recycling** – Cardboard collection using three and six cubic yard bins.
    - **On-Call Collection** – Twice yearly curbside collection of household items, including two bulky items per collection.

[8] Note: Non-franchised, undocumented hauling is occurring citywide, but there is no data available to indicate the amount of material captured by these activities.

- **City Facilities, Chamber of Commerce, Schools, Parks**
  - ✓ Weekly collection of office paper and beverage containers.
  - ✓ Corporation Yard debris boxes for inerts and yard trimmings.

- Special Events
  - **Backyard compost training** – Monthly classes taught by "Master Composters" on the benefits and use of compost.
  - **City-wide Garage Sale Day – Held in the fall each year to encourage residents to sell items to be reused and "repurposed" instead of throwing them away.**
  - **Extra Dump Weekends** – No charge dump weekends at the SMaRT Station twice per year in the spring and fall.
  - **Household Hazardous Waste Events** – Drop-off events at 164 Carl Road the third Saturday of each month except December.
  - **Regularly Scheduled Shredding Events** – Drop-off events held at the SMaRT Station.
- **SMaRT Station** –The SMaRT Station was opened in 1994 to handle waste and recyclable materials from the cities of Palo Alto, Mountain View and Sunnyvale. It is unique in that it operates as a mixed waste material recovery facility (dirty MRF). This means that, after recyclables are captured by source-separation collection programs, the remaining trash from residential and commercial sites is collected and brought to the facility. There, it is mechanically and manually sorted to pull out up to 25 percent of recyclables from the waste stream. The facility also operates a "clean" recycling line where the curbside recyclables are manually sorted to remove contaminants. These efforts have helped the three cities exceed the State-required 50 percent diversion rate established by AB 939. The SMaRT Station Materials Recovery Operations include:
  - Two MRF mixed waste sorting lines (18-25% diversion).
    - ✓ Size separation with trommels and disk screens;
    - ✓ Magnets and eddy currents extract metals;
    - ✓ Sorters remove fibers, plastic containers, wood and inert materials; and
    - ✓ Fines ("two inch minus") are composted.

- **Curbside recyclables processing line** – Recyclables from single-family and multi-family collection are sorted and separated by:
  - ✓ Glass color;
  - ✓ Type of metal (e.g. aluminum vs. steel cans)
  - ✓ Type of plastic (HDPE, PET, etc.); and
  - ✓ Paper grade (cardboard, newspaper, mixed paper).
- **Construction & demolition waste hand sorting** – Materials recovered on the tipping floor (75% diversion) including metals, wood, inert materials (e.g., concrete, dirt, rock), corrugated cardboard and rigid plastics.
- **SMaRT Station Recycling and Buy-Back Center** – Residents can bring a variety of materials including metal, glass, plastic, paper, shoes and textiles, electronics, fluorescent bulbs, batteries, motor oil, oil filters, cooking oil, and sharps. Compost and mulch are also available free of charge.

- **Concrete Recycling Lessee on closed Sunnyvale Landfill –** The City leases space on its closed landfill to Stevens Creek Quarry, which accepts (for a fee) and recycles clean concrete, dirt and asphalt from residents and businesses.

In addition, the City has passed a number of policies in support of Zero Waste and responsible solid waste management, including a resolution supporting EPR (as discussed previously), an Environmentally Preferable Purchasing Policy, an Integrated Pest Management Plan, and the ban of City funds for the purchase of single-use water bottles and polystyrene foam food containers.

4.2 Diversion Rate

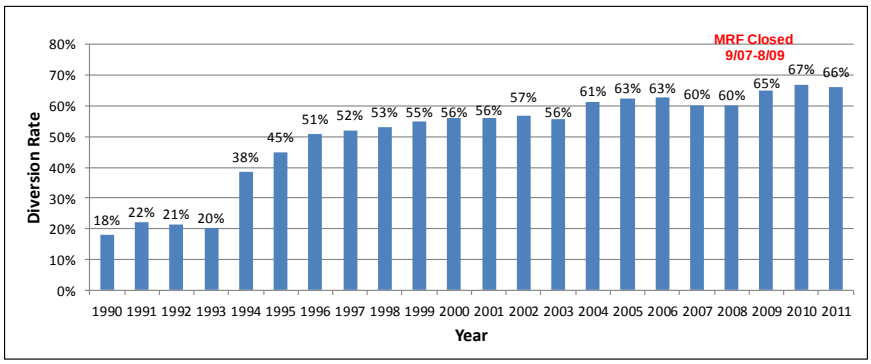
The California Integrated Waste Management Board (now CalRecycle) calculated the City's 2006 diversion rate at 63 percent. Under the new Disposal Based Reporting System that was established in 2007 to track jurisdictional compliance with State diversion mandates, CalRecycle set the City's generation rate at 10 pounds per day (PPD) per resident and 16.6 PPD per employee. For 2011, the Disposal Based Reporting System reported disposal rates of 3.4 PPD per resident and 5.8 PPD per employee versus targets of 5.0 PPD and 8.3 PPD, respectively (a diversion rate of approximately 66%).[9]

The City's historical diversion rates for 1990 through 2011, as reported by the State, are provided in Figure 1. The SMaRT

[9] 10 PPD generated – 3.4 PPD disposed = 6.6 PPD diverted. 6.6 PPD diverted / 10 PPD generated = 66 percent diversion rate.

Station began recovery operations in 1994, which accounts for the significant increase in diversion at that time. Between September 2007 and August 2009, recovery operations were temporarily discontinued while the facility was renovated, which accounts in part for the decreased diversion rate in 2007 and 2008.

Figure 1
Historical Diversion Rates



4.3 Residential Rate Structure and Historical Subscription Levels

4.3.1 Residential Garbage Rate Structure

The City's current residential rate structure, also known as a "Variable Rate" or "Pay-As-You-Throw" rate system, was put in place to provide a financial incentive for residents to reduce waste. With a Pay-As-You-Throw system, the fee charged for collection and disposal increases with the amount of garbage thrown away, which in turn can and has led to lower transportation and disposal costs for the City and increased use of yard trimmings and recycling services. This rate structure was implemented in conjunction with the implementation of the City's ChoiceCollect™ program in October 2008.

Table 2
Residential Rate Structure

Size (Gallons)	Current Monthly Rate (Effective 7/1/11)
35	$30.42
65	$37.15
95	$43.88

The ChoiceCollect™ program provided single-family, multi-family and commercial cart accounts with the option of 35-, 65- and 95-gallon wheeled carts for automated solid waste collection. Prior to that program, residents had a choice of "Unlimited" (96-gallon cart provided by hauler) or "Baseline" (32-gallon can provided by

customer) service. At the same time, the City implemented on-call bulky goods collection (twice per year), which replaced a program that operated 8 weeks per year (4 weeks spring, 4 weeks fall) and offered unlimited curbside bulky goods pickup service, including on-call bulky pickup on a week chosen by the customer.

The ChoiceCollect™ program has been very successful, as measured by both the increased residential diversion rate and the migration of residential customers to smaller weekly solid waste service volumes, as discussed below. During the first six months after ChoiceCollect™ implementation, single-family results included:

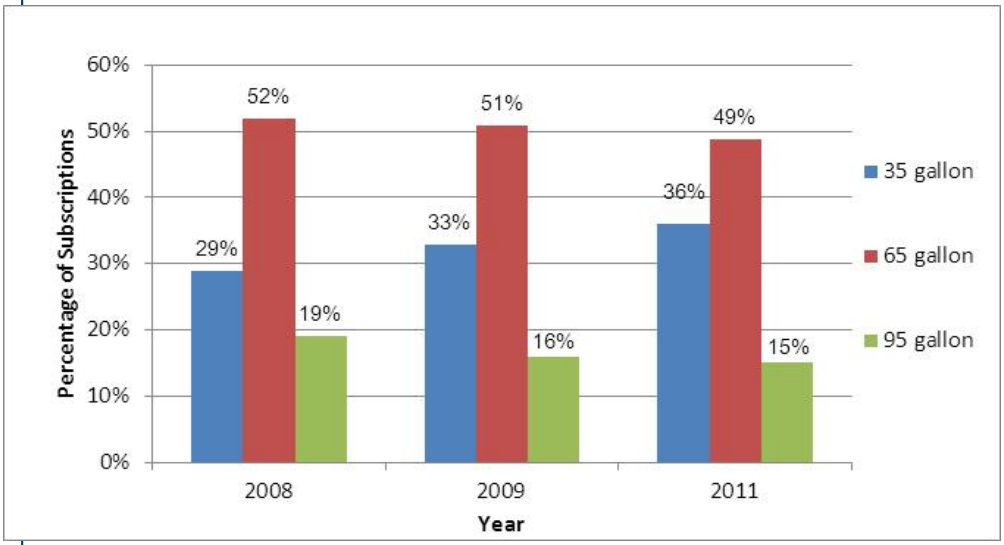
- Curbside paper recycling tonnage increased by 12 percent (including 500 tons of mixed paper, which was added to the curbside program as part of ChoiceCollect™);
- Curbside can/bottle/container recycling and yard trimmings tonnage both increased by 5 percent;
- Residential garbage collection tonnage decreased by 22 percent;
- Total tons of garbage decreased by approximately 1,500 tons per year;[10]
- The number of residential garbage routes decreased from ten to nine (then eight, in April 2011);
- Five old, non-compliant diesel trucks were taken out of service (these had been used just eight weeks per year, for cleanups);
- Ongoing annual ratepayer cost savings were estimated at $269,000; and
- A majority of residential customers paid less for garbage service than they did the previous year.

4.3.2 Historical Subscription Levels

As shown in Figure 2 below, the percentage of residential customers subscribing to 95- and 65-gallon service decreased steadily from 2008 through 2011, while the number of customers subscribing to the 35-gallon service level increased by approximately 25 percent (from 29% to 36% of all residential accounts). This shift in service volumes coincided with a significant increase in the residential diversion rate over that same period.

[10] This value was calculated after accounting for the flow changes in the single family waste streams (e.g., increases in recycling and self-haul garbage versus decreases in garbage collected).

Figure 2
Historical Subscription Rates



4.4 Solid Waste Collection Franchise

Residential, commercial and roll-off solid waste and recycling services in the City are provided by Specialty Solid Waste and Recycling (Specialty) under an exclusive franchise agreement that expires June 30, 2021. All solid waste, source separated residential and commercial recyclables, and yard trimmings collected by Specialty are taken to the SMaRT Station. Programs provided by Specialty under its franchise with the City, in addition to solid waste collection, include the single-family and multi-family curbside recycling program, commercial cardboard and City and school recycling programs and the residential yard trimmings collection program.

Table 3 below, provides a summary of the franchised waste stream diversion and disposal tonnages for the past three fiscal years.

Table 3
Franchised Tonnage Diverted and Disposed by Source-Separation Programs

Service	Tons			
	2007-2008	2008-2009	2009-2010	2010-2011
COMMERCIAL SERVICE				
REFUSE				
Dept 100 - F/L Refuse	48,955	46,507	45,500	45,567
Dept 200 - R/O Refuse	17,562	14,775	13,231	13,387
RECYCLING				
Cardboard	2,641	2,555	2,525	2,245
Office Paper	188	126	154	133
Multi-Family Recycling Program	1,518	1,328	1,359	1,370
Recycling Subtotal	4,347	4,009	4,038	3,748
Refuse	66,518	61,282	58,731	58,954
Total Commercial Tons	70,865	65,291	62,769	62,702
Commercial Diversion Rate	**6%**	**6%**	**6%**	**6%**
RESIDENTIAL SERVICE				
REFUSE				
Dept 300 - Res Refuse	29,031.7	24,005.5	23,048.7	22,658.2
RECYCLING				
Yard Waste	13,681	14,284	14,683	13,972
Curbside Tons	6,548	6,958	6,965	7,204
Recycling Subtotal	20,229	21,242	21,648	21,176
Refuse	29,032	24,006	23,049	23,049
Total Residential Tons	49,261	45,248	44,696	44,224
Residential Diversion Rate	**41%**	**47%**	**48%**	**48%**
TOTAL				
Recycling Tons	24,576	25,251	25,686	24,924
Total Tons Disposed	95,549	85,288	81,779	82,003
Total Tons	120,126	110,539	107,465	107,466
Overall Franchised Diversion Rate	**20%**	**23%**	**24%**	**23%**

Source: Specialty Solid Waste and Recycling Operating Statistics

As shown:

- The residential source separated recycling diversion rate has increased fairly significantly; from approximately 41 percent in FY 2008 to 48 percent in FY 2011, reflecting an increase in both yard trimmings and curbside recycling tonnages;
- The franchised commercial source separated recycling diversion rate has remained consistent at 6 percent. This figure does not include source separated material diverted from the commercial waste stream by non-franchised private recycling service providers operating in the City, or recyclable material managed directly by the generator; and
- The overall franchised source separated recycling diversion rate increased from 20 percent in FY 2008 to 23 percent in FY 2011.

4.5 SMaRT Station

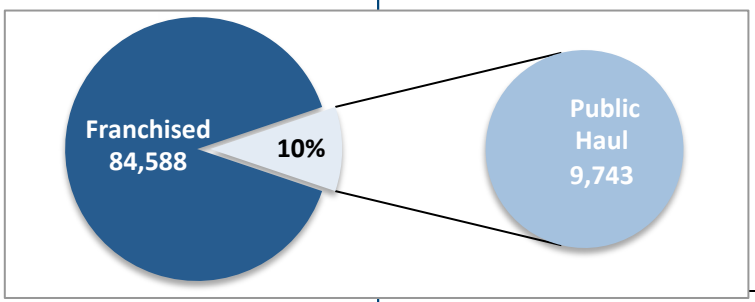
4.5.1 Overview

The SMaRT Station, which was created through a partnership among the cities of Mountain View, Palo Alto and Sunnyvale, began transfer operations in October 1993 and MRF operations in 1994. The SMaRT Station has been operated by Bay Counties Waste Services (a related party of Specialty) since January 1, 2008 under an agreement that expires December 31, 2014. As an incentive to maximize both the quantity and quality of materials recovered, the operating contract provides for the contractor to retain a percentage of the gross revenues from the sale of recovered materials, which is tied to the level of recovery achieved.

The facility, which is permitted to process up to 1,500 tons per day of combined solid waste and recyclables, was designed to serve five main purposes:[11]

- Receive and recover recyclable materials from garbage collected in the three cities;
- Transfer the unrecycled portion of the garbage to the Kirby Canyon Landfill for disposal;
- Receive, process, and ship to composting facilities the yard trimmings collected by the cities;
- Receive, sort, and prepare the recyclables collected at curbside for market; and
- Provide a recycling center where residents can drop off a variety of recyclable materials and receive cash for bottles and cans covered by California's "Bottle Bill" system.

With the exception of self-haul and uncompacted debris box materials (which are manually sorted) and certain compactor loads (which are sent directly to disposal), all mixed residential and commercial waste is processed for recovery through the SMaRT Station MRF.



4.5.2 Source of Delivered Tonnage

Of the City's total mixed waste stream delivered to the SMaRT Station, 91 percent is franchised residential, commercial and roll-off waste delivered by Specialty, while nine percent is

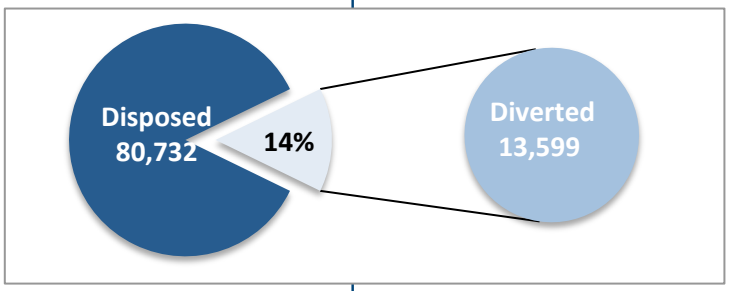
[11] Some municipal solid waste from the City of Palo Alto had been taken directly to the Palo Alto Landfill; however, the landfill closed on June 30, 2011, which ended that practice. In addition, curbside recyclable material from Palo Alto is not processed at the SMaRT Station.

R3

residential and commercial self-haul loads. If the City is to realize significant additional diversion, the majority of that diversion will come from the franchised waste stream through either expanded source separation programs, increased SMaRT Station mixed waste recovery, and/or further processing of SMaRT Station residuals (i.e., mixed waste processing residuals and/or the portion of the small organics waste stream ("two inch minus" fines) that is not currently delivered to the Z-Best Composting Facility for processing).

Mixed Waste Diversion

As discussed above, with the exception of self-haul and uncompacted debris box materials (which are manually sorted), and certain compactor loads (which are sent directly to disposal), all mixed residential and commercial waste is processed for recovery through the SMaRT Station MRF. Mixed waste passes through a series of manual and mechanical sorting processes that recover a wide range of recyclable materials including paper, plastics and metals. A "small organics" fraction of the waste stream is also recovered, a portion of which is currently composted. The SMaRT Station floor-sort and mixed waste processing operations currently divert approximately 15% of the mixed waste and self-haul waste received at the facility. Appendix A provides a flow diagram and fact sheet for the SMaRT Station.



4.6 Costs per Ton Diverted

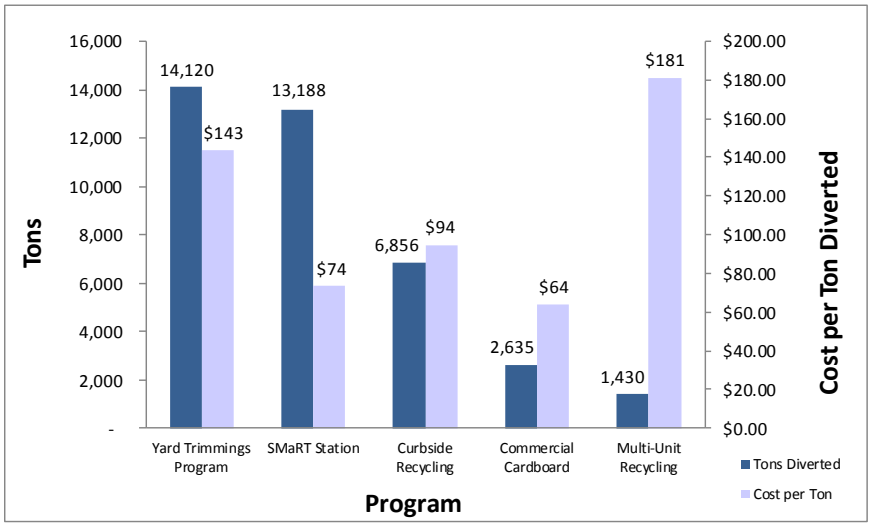
Figure 3 below, provides data for the average number of tons diverted and the average cost per ton diverted for the following programs, as well as the SMaRT Station's mixed waste recovery operations for City-allocated tonnages:

- Yard trimmings collection;
- Commercial cardboard pickup;
- Curbside recycling; and
- Multi-family recycling.

As shown, the City's single-family residential yard trimmings collection program accounted for the most tonnage diverted (37% of total) followed by the SMaRT Station's mixed recovery operations (34%), the residential curbside recycling program (18%), commercial cardboard program (7%) and the multi-family recycling program (4%). The commercial cardboard recycling program was the most cost effective, followed by the SMaRT Station's mixed waste recovery operations. The multi-family recycling program was the least cost effective program, which

highlights an industry-wide challenge: the high cost and relatively low diversion rate for multi-family recycling programs.

Figure 3
Tons Diverted and Cost per Ton Diverted



4.7 Kirby Canyon Landfill Agreement

All material delivered to the SMaRT Station that is not recovered is sent to the Kirby Canyon Landfill in San Jose, which is owned by Waste Management, Inc. The contract with Kirby Canyon Landfill, which expires in October 2021, has a "put or pay" provision that requires the City to deliver a minimum amount of waste to the landfill each year or pay Waste Management a fee for every ton that falls short of the annual commitment. Due to a variety of factors, including the City's success diverting material from disposal and the more recent downturn in the economy, the tonnage the City has delivered to the Kirby Canyon Landfill for disposal has triggered the "put or pay" clause of the contract for each year from 2002 through 2010, with the exception of 2008. Over that period, the City has paid approximately $2.5 million for approximately 72,000 tons of material not disposed. Once the contract with Kirby Canyon ends in 2021, the put-or-pay requirement can be eliminated or updated to better fit the current needs of the SMaRT partners. Because the "put-or-pay" concept can reduce the landfill operator's risk by assuring a baseline cash flow to cover fixed costs, eliminating put or pay commitments could increase overall City disposal costs. If a put-or-pay is used, the minimum disposal amounts must be carefully determined with future Zero Waste diversion in mind.

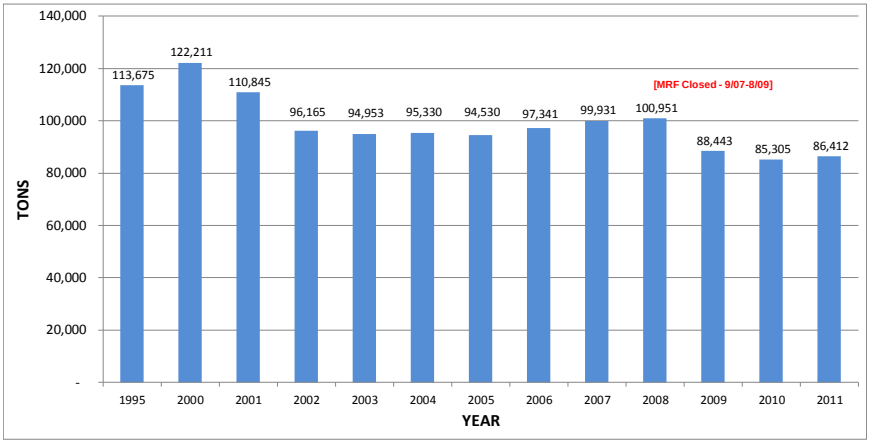
4.8 Tonnage Data

4.8.1 Historical Disposal Tonnages

Figure 4 below, provides a graphic representation of the total City tons disposed for 1995, and 2000 through 2011. As shown, a total

of 86,413 tons were disposed in 2011. As previously discussed, between September 2007 and August 2009, SMaRT Station MRF recovery operations were temporarily discontinued due to construction of the new MRF . This accounts for, at least in part, the higher disposal tonnages in 2007 and 2008.

Figure 4
Historical Disposal Tonnages



4.8.2 Disposal Sites

Of the total of 86,413 tons of City waste disposed in 2011, 93% (80,732 tons) came from the SMaRT Station and was disposed at the Kirby Canyon Landfill. The remaining seven percent of City waste was disposed at more than a dozen different landfills. Table 4 provides the destination facilities for all disposal tons attributed to the City in 2011.

Table 4
Disposal Tonnage by Facility (2011)

Table 4
Sunnyvale 2011 Disposal by Facility

Destination Facility	Instate Ton	% of Total	Transform Ton	Total ADC	Total AIC
Kirby Canyon Recycl.& Disp. Facility - SMaRT Station	80,732	93.4%	-	57	-
Kirby Canyon Recycl.& Disp. Facility - Self Haul	53	0.1%	-	-	-
Altamont Landfill & Resource Recovery	504	0.6%	-	917	-
Azusa Land Reclamation Co. Landfill	7	0.0%	-	-	-
Covanta Stanislaus, Inc.	-	0.0%	80	-	-
Corinda Los Trancos Landfill	115	0.1%	-	41	-
CWMI, KHF (MSW Landfill B-19)	86	0.1%			-
Guadalupe Sanitary Landfill	583	0.7%	-	10	-
Keller Canyon Landfill	19	0.0%	-	-	-
Monterey Peninsula Landfill	2,430	2.8%	-	116	-
Newby Island Sanitary Landfill	91	0.1%	-	143	143
Potrero Hills Landfill	524	0.6%	-	-	-
Recology Hay Road	495	0.6%	-	-	-
Vasco Road Sanitary Landfill	156	0.2%	-	-	-
Zanker Material Processing Facility	604	0.7%	-	496	-
Zanker Road Class III Landfill	14	0.0%	-	1	-
Yearly Totals:	**86,413**	**100.0%**	**80**	**1,781**	**143**

Kirby Tons (80,732)

Non-franchise tons + franchised tons collected by non-franchised recycling collectors

Source: CalRecycle; Jurisdictional Disposal by Facility, 2011

As shown, the vast majority of the City's waste stream (93%) is SMaRT Station residue disposed at the Kirby Canyon Landfill. The

remaining 5,681 tons have left the City's exclusive franchise system in one of three major ways:

1. Collected and hauled to disposal sites other than the SMaRT Station under one of a small number of "exclusions" allowed in the municipal code. For example, a licensed contractor doing construction or demolition work under a contract may haul the waste with his own vehicle and employees.
2. Contaminated soils and other special wastes (e.g. asbestos) disposed at sites that have special permits to accept those materials.
3. Collection by haulers who lack a franchise or license from the City. This work is often done in violation of the Municipal Code and is detrimental to the community in a number of ways. For example, unlicensed haulers generally do not conform to the same standards that the franchised hauler must meet, for example:
    - Hours of operation/noise;
    - Appearance of trucks and containers;
    - Clean air fuels; and
    - Labor standards.

Financially, unlicensed haulers damage City ratepayers by diverting revenues needed to cover the fixed costs incurred by the Solid Waste Fund, including debt service. In doing so, these haulers cause collection rates to rise to compensate for the missing revenues. The City can take steps to bring some of this material back into the franchise by strengthening municipal code language and enforcement.

In terms of diversion, materials that avoid processing at the SMaRT Station represent lost opportunities for diversion. Although some unlicensed haulers claim to sort collected materials to remove the more valuable recyclables, the fact that more than 5,000 tons were disposed outside the franchise system indicate that relying on unlicensed haulers is not an effective diversion strategy.

To the extent that the City can gain control of some or all of that tonnage, it may be possible to divert additional portions of that material. At a minimum, it would help to offset any City "put or pay" tonnage obligations. A copy of a white paper the City prepared on options for dealing with this waste stream is included in Appendix B.

4.9 Waste Composition Study

As a first step in determining possible Zero Waste goals, the City and the City of Mountain View commissioned a waste composition study by Cascadia Consulting Group. The objectives of that study were to:

- Provide detailed waste composition and quantity information for the Sunnyvale SMaRT Station, including materials from residuals and four waste sectors: single-family residential, multi-family residential, commercial, and construction and demolition (C&D);
- Identify key opportunities for diversion, recovery, or reuse of specific material categories; and
- Determine the presence or absence of five unique material categories (Recyclable Paper, Other Recyclables, Compostable/Potentially Compostable, Potentially Recyclable, and Problem Materials).

A copy of the Waste Characterization Report can be found on the City's website.[12]

4.9.1 Incoming Waste Stream

Table 5 below, taken from the waste composition study, provides a breakdown of the incoming SMaRT Station residential and commercial waste streams based on the five identified material categories.

Table 5
SMaRT Station Incoming Residential and Commercial Waste Stream Composition

Material Class	Est. %	Est. Tons
Compostable/Potentially Compostable	41.8%	29,527
Recyclable Paper	13.9%	9,855
Other Recyclables	19.6%	13,851
Potentially Recyclable	5.2%	3,710
Problem Materials	19.5%	13,780
Total	**100%**	**70,723**

The analysis of the SMaRT Station's incoming residential and commercial waste streams shows that there is potential to capture additional compostable materials, as well as recyclable paper and other recyclables, at the front end of the collection system through existing and new source separation programs.

4.9.2 Residual Materials

Table 6 below, provides the characterization of the SMaRT Station residual waste stream, as reported in the Waste Characterization

[12] http://sunnyvale.ca.gov/Portals/0/Sunnyvale/DPW/recycling/SV_ReportUpdate_FINALV3KG.pdf

Report and represents combined tonnage from Mountain View and Sunnyvale.[13]

Table 6
MRF Residuals Waste Composition

Material Class	Est. %	Est. Tons
Compostable/Potentially Compostable	57.1%	79,689
Recyclable Paper	14.0%	19,580
Other Recyclables	12.8%	17,784
Potentially Recyclable	4.5%	6,256
Problem Materials	11.6%	16,170
Total	**100%**	**139,479**

The analysis of the SMaRT Station residual waste stream shows that the majority of the residual material (which is destined for landfill) is either compostable or recyclable, including approximately 20,000 tons of recyclable paper.

It should also be noted that the majority of the remaining residual materials (recyclable paper, other recyclables, potentially recyclable and problem materials) are appropriate feed stock for conversion technologies such as anaerobic digestion, pyrolysis, gasification, and/or plasma arc gasification.

[13] The residual samples collected and characterized for the study did not include "two inch minus" fines separated by the MRF equipment screens. It is estimated that these fines represent approximately 18 percent of the incoming waste stream.

5.0 Opportunities Assessment

Sunnyvale's long history of progressive solid waste management systems has brought the City to its current 66 percent State reported diversion rate, which is well in excess of the State mandated 50 percent diversion rate. Achieving the City's Vision of Zero Waste (i.e., a 90% State reported diversion rate) and establishing a truly sustainable waste management system, however, will be extremely challenging. All of the relatively simple diversion opportunities have long since been realized by the City through its substantial and effective solid waste management efforts to date. As such, achieving the City's initial diversion goals, and doing so cost effectively, will require careful review and selection of appropriate waste reduction, reuse, source separation, and mixed waste diversion options.

5.1 Review and Analysis of Diversion Options

The review of options in support of the City's efforts to reduce, reuse and divert materials included consideration of a wide range of policies, programs, services and facilities, including those:

- Identified during the City's community discussion on Zero Waste conducted in April 2008;
- Identified as part of the community workshops held as part of the development of this Zero Waste Strategic Plan;
- Listed in various Zero Waste plans developed by other jurisdictions in California and throughout the United States;
- Supported by various Zero Waste related industry groups (e.g., various Zero Waste alliances and product stewardship councils); and
- Supported by the Environmental Protection Agency's Materials Management framework, which shifts the focus from managing the disposal of materials to how our economy uses and manages materials and products before they are disposed.

Many of the options presented in support of the development of a "closed-loop" Zero Waste society are focused on "upstream" actions. Specifically, this includes sustainable purchasing, using/reusing resources more productively and sustainably throughout their life cycles, minimizing the amount of material, and producing materials that are less toxic, have high recycled material content, and are readily recyclable. Those actions may not have a significant impact in the short-term with respect to diverting City tons from the landfill, but are critical to forming the foundation required for a long-term solution to managing Sunnyvale's materials and waste.

With that said, it is important that the City's Zero Waste Strategic Plan strike a balance between "upstream" efforts in support of broad based changes in the way products are manufactured and managed after production, and "downstream" efforts to increase the diversion of that material which is generated. The review of the range of "upstream" options available to the City, including policy options in support of efforts to divert material that is generated, was undertaken as part of the development of the specific recommendations that are presented later in this report. Consideration of the range of "downstream" options to increase the diversion of generated material was undertaken within the context of the findings of the Additional Diversion Potential Analysis, which is discussed below.

5.2 Additional Diversion Potential Analysis

To quantitatively assess various options available to the City in support of its efforts to increase diversion, an Additional Diversion Potential Analysis was undertaken. That analysis, which is consistent with the City's desire for a "fact based approach" to Zero Waste Planning, projected the additional diversion associated with the following options:[14]

- Source Separation Programs:[15]
    - Single-Family Residential Waste Stream;
      ***Additional Diversion Potential* = 3.0%**
    - Multi-Family Residential Waste Stream;
      Additional Diversion Potential = 1.2%
    - Commercial Waste Stream;
      Additional Diversion Potential = 3.9%

[14] The analysis uses existing tonnage and waste composition data to determine the tonnage of the materials targeted for diversion by the various source separation programs and mixed waste recovery options that are not currently being captured. The additional tonnages diverted by the various program and facility options were then projected based on assumed capture rates for the targeted materials.

[15] For planning purposes, a capture rate of 50 percent was assumed for the various source separation program options (net of any portion of those materials currently diverted by the SMaRT Station's mixed waste recovery operation). This level of recovery is considered aggressive, but was chosen for purposes of developing "best case" planning level diversion tonnage projections. The actual capture rate that might be realized for a specific program or activity is dependent on a number of factors, and achieving high diversion rates may require implementing and enforcing mandatory recycling ordinances and/or increased public education and outreach efforts, additional staffing, and funding to support those activities. We recommend that the City analyze the impact of changes to this assumed capture rate as part of any further consideration of specific options.

- SMaRT Station Mixed Waste Diversion:
    - Increasing the recovery of C&D debris by 50%;

      Additional Diversion Potential = 0.2%
    - Recover an additional 14 percent of the incoming SMaRT Station mixed waste stream (approximately 25% of recyclable and compostable materials);

      Additional Diversion Potential = 5.0%
    - Increasing diversion of the small organics fraction of the waste stream (75% overall diversion rate);

      Additional Diversion Potential = 3.5%
    - Processing the SMaRT Station's mixed waste residual waste stream with conversion technologies.

      Additional Diversion Potential = 20.9%

The results of the Additional Diversion Potential Analysis are provided in Appendix C. A summary of Key Findings is provided below, followed by a more detailed analysis of each of the source separation and mixed waste processing options listed above.

Note: In reviewing the findings of the Additional Diversion Potential Analysis presented below, it is important to note that the existing and potential new source separation programs and the SMaRT Station's mixed waste processing operations target many of the same material types. Accordingly, the effect of capturing additional materials through existing or new source separation programs is reduced to the extent that portions of those materials are already being recovered at the SMaRT Station. As such, the cost for any additional tons diverted through source separation programs will be higher than that of similar programs in other jurisdictions, all other factors the same, due to the lower net additional tons diverted.

5.3 Key Findings

- ***The City's current diversion rate is 66 percent*** – To achieve a 75 percent diversion rate the City will need to divert approximately 21,700 additional tons.[16]
- ***Capturing 50 percent of the remaining materials targeted by the existing source separation programs***

[16] Each one percent (1%) increase in diversion is equivalent to 2,585 tons based on a total State Disposal Based waste generation rate of 258,500 tons.

will increase diversion by ~4,700 tons – 1.8 percent additional diversion (67.8% overall City diversion rate).

- ***Adding new materials to existing single and multi-family source separation recycling programs (i.e., textiles and mixed plastics and metals) and capturing 50 percent of those materials will increase diversion by ~1,500 tons*** – 0.6 percent additional diversion (66.6% overall City diversion rate).
- ***Expanding existing source separation recycling programs to all sectors and diverting 50 percent of the targeted materials will increase diversion by ~4,200 tons*** – 1.6 percent additional diversion (67.6% overall City diversion rate).
- ***Diverting 50 percent of the food waste and compostable paper in the residential and commercial waste streams will increase diversion by ~9,300 tons*** – 3.6 percent additional diversion (69.6% overall City diversion rate).[17]
- ***Diverting the entire SMaRT Station small organics fraction will increase diversion by ~9,000 additional tons*** – 3.5 percent additional diversion (69.5% overall City diversion rate).
- For the City to achieve a 75 percent diversion rate through the SMaRT Station's mixed waste processing operations, it will need to divert the 9,000 tons of small organics listed

[17] Approximately eight percent of the SMaRT Station's residual mixed waste stream (not including the small organics fraction) is comprised of waste (~6,400 City tons). Another 39 percent is compostable paper (~31,000 tons). As such, there is additional diversion potential associated with organic materials that cannot be realized through diversion of the small organics fraction of the SMaRT Station waste stream. If the City were to implement a residential and commercial organics collection program targeting food waste and compostable paper and capture 50 percent of the available material (net of any diversion of the small organics fraction of the waste stream), this would result in approximately 9,300 additional tons diverted (this data is based on the waste composition of the City's residential and commercial waste streams received at the SMaRT Station prior to processing).

Approximately 50 percent of those 9,300 tons are from the single-family waste stream, which would be collected through the existing single-family residential yard trimmings collection program. The cost to divert this material would be very expensive (~$250 to $500 per ton based on net capture rates of 50% and 25%, respectively) due to the increased organics tip fee that would also be applied to the 14,700 tons of yard trimmings currently being diverted at a much lower tip fee. The projected cost of a commercial organics program is projected to be substantially less but still significant (~$125 to $175 per ton).

above, plus an additional 14 percent of the mixed waste stream that is processed (essentially doubling the current SMaRT Station diversion rate).

- ***Processing the SMaRT Station's mixed waste residue with thermal conversion technology will increase diversion by 54,000 tons or more*** – 20.9 percent additional diversion (85.9% overall City diversion rate).

5.4 Detailed Analysis by Waste Stream[18]

The following information summarizes the Additional Diversion Potential Analysis (Appendix C) for each of the various source separation and mixed waste processing options considered. Table 7, below, provides a comparison of the projected cost and diversion associated with each of those options.

Table 7
Summary of Cost and Additional Diversion Potential of Program and Facility Options

	Program / Facility Diversion Option	Recovery Rate [1]	Additional Diversion Rate		Cost Range	
			Tons	Percent	General	Cost / Ton
1	**Single-Family Residential Waste Stream**					
a	Increase Recovery Rate of Existing Programs	50%	2,428	0.9%	Low	$0 - $50
b	Add New Materials	50%	964	0.4%	Low	$0 - $50
c	Add Food Waste to Yard Trimmings Program	50%	4,565	1.8%	Very High	$250 - $500
	Total		7,957	3.0%		
2	**Multi-Family Residential Waste Stream**					
a	Increase Recovery Rate of Recycling Program	50%	1,490	0.6%	Low	$0 - $50
b	Add New Materials	50%	514	0.2%	Low	$0 - $50
c	Implement Multi-Family Yard Trimmings Program	50%	1,025	0.4%	High	$100 - $150
	Total		3,029	1.2%		
3	**Commercial Waste Stream**					
a	Increase Recovery of Cardboard	50%	450	0.2%	High	$100 - $150
b	Increase Recovery of Office Paper	50%	303	0.1%	High	$100 - $150
c	Implement Multi-Material Recycling Program	50%	1,658	0.6%	High	$100 - $150
d	Add New Materials to Recycling Program	50%	1,301	0.5%	Low	$0 - $50
e	Implement Commercial Food Waste Program	50%	4,773	1.8%	High	$125 - $175
f	Implement Commercial Yard Trimmings Program	50%	1,520	0.6%	High	$100 - $150
	Total		10,005	3.9%		
4	**SMaRT Station Residual Waste Stream**					
a	Increase Diversion of C&D Debris	50%	498	0.2%	Low	$0 - $50
b	Increase Diversion of Small Organics	75%	9,000	3.5%	Moderate [2]	$50 - $100
c	Increase Diversion from Mixed Waste Stream [3]	16%	15,380	5.9%	Moderate/High [4]	$50 - $250
	Subtotal		24,878	9.6%		
d	Process Mixed Waste with Thermal Conversion Technology	90%	54,030	20.9%	High	$100 - $250
	Total	Not Additive				

Note: Numbers may not total exactly due to rounding
[1] Assumed recovery rates are aggressive and are intended to represent 'best case" planning level scenarios.
[2] Pending additional review and analysis by City.
[3] 16% represents additional percentage of overall SMaRT Station mixed waste stream diverted.
[4] Depends in large part on the extent to which the facility must be redesigned and any associated capital costs.

[18] Diversion rates are net of any existing recovery of the targeted materials at the SMaRT Station.

Table 7.1
Single-Family Residential Waste Stream

	Program / Facility Diversion Option	Recovery Rate [1]	Additional Diversion Rate		Cost Range	
			Tons	Percent	General	Cost / Ton
1	**Single-Family Residential Waste Stream**					
a	Increase Recovery Rate of Existing Programs	50%	2,428	0.9%	Low	$0 - $50
b	Add New Materials	50%	964	0.4%	Low	$0 - $50
c	Add Food Waste to Yard Trimmings Program	50%	4,565	1.8%	Very High	$250 - $500
	Total		7,957	3.0%		

a) Increase Recovery Rate of Existing Curbside and Yard Trimmings Programs

- Current Diversion Rate – The residential single-family curbside recycling and yard trimmings programs are diverting the majority of the targeted material from those waste streams (63% and 95%, respectively).[19]
- Additional Diversion Potential – If those programs were able to divert 50 percent of the remaining targeted materials that are not currently recovered, this would result in approximately 2,400 additional tons diverted (0.9% additional diversion).
- Projected Cost – ***Low*** (~$0 to $50 per ton)

Increased recovery of these materials would likely result in little if any additional collection costs. Any associated cost would be related largely to the cost of specific actions taken to support additional diversion (e.g., additional targeted public education and outreach (door-to-door marketing), mandatory recycling ordinance enforcement, etc.). Revenues from recyclable materials would also be generated.

b) Add New Materials to Existing Curbside Program

- Additional Diversion Potential – Adding new materials (i.e., miscellaneous plastics and metals and textiles) to the residential single-family curbside recycling program and capturing 50 percent of those materials would divert approximately 1,000 additional tons (0.4% additional diversion).
- Projected Cost – ***Low*** (~$0 to $50 per ton)

[19] Refer to Appendix C, Additional Diversion Potential (Source Separated Programs) for Existing Program Capture Rates.

Recovery of new materials would result in little if any additional collection costs; however, processing operations would need to change to accommodate additional materials.

c) Add Food Waste to Existing Yard Trimmings Program

- Additional Diversion Potential - Adding food waste and compostable paper to the residential single-family yard trimmings program and capturing 50 percent of those materials would divert approximately 4,600 additional tons (1.8% additional diversion).
- Projected Cost – ***Very High*** ($250 to $500 per ton, depending on actual capture rate)[20]

The addition of organics to the single-family yard trimmings program would result in little if any additional collection cost. The higher tipping fee that would apply to the yard trimmings currently collected is the primary factor impacting the cost.

Table 7.2
Multi-Family Residential Waste Stream

	Program / Facility Diversion Option	Recovery Rate (1)	Additional Diversion Rate		Cost Range	
			Tons	Percent	General	Cost / Ton
2	**Multi-Family Residential Waste Stream**					
a	Increase Recovery Rate of Recycling Program	50%	1,490	0.6%	Low	$0 - $50
b	Add New Materials	50%	514	0.2%	Low	$0 - $50
c	Implement Multi-Family Yard Trimmings Program	50%	1,025	0.4%	High	$100 - $150
	Total		3,029	1.2%		

a) Increase Recovery Rate of Existing Multi-Family Recycling Program

- Current Diversion Rate – The multi-family curbside recycling program is diverting approximately 31 percent of the targeted material types.
- Additional Diversion Potential – Capturing 50 percent of the remaining targeted materials that are not currently recovered would divert approximately 1,500 additional tons (0.6% additional diversion).
- Projected Cost – ***Low*** (~$0 to $50 per ton)

Increased recovery of these materials would likely result in little, if any, additional collection costs. Any associated cost would be largely related to the cost

[20] The cost per ton has a direct relationship to the capture rate, with the cost per ton increasing as the capture rate decreases.

of specific actions taken to support additional diversion (e.g., Additional targeted public education and outreach (door-to-door marketing); mandatory recycling ordinance enforcement, etc.). Revenues from recyclable materials would also be generated.

b) Add New Materials to Existing Multi-Family Recycling Program

- o Additional Diversion Potential – Adding new materials (i.e., miscellaneous plastics and metals and textiles) to the multi-family curbside recycling program and capturing 50 percent of the targeted materials would divert approximately 500 additional tons (0.2% additional diversion).
- o Projected Cost – ***Low*** (~$0 to $50 per ton)

Recovery of new materials would result in little if any additional collection costs, however processing operations would need to change to accommodate additional materials.

c) Implement Multi-Family Yard Trimmings Program

- o Additional Diversion Potential – Implementing a multi-family yard trimmings collection program and capturing 50 percent of that material would divert approximately 1,000 additional tons (0.4% additional diversion).
- o Projected Cost – ***High*** (~$100 to $150 per ton)

Requires establishing a new collection system with associated costs.

Table 7.3
Commercial Waste Stream

	Program / Facility Diversion Option	Recovery Rate [1]	Additional Diversion Rate		Cost Range	
			Tons	Percent	General	Cost / Ton
3	**Commercial Waste Stream**					
a	Increase Recovery of Cardboard	50%	450	0.2%	High	$100 - $150
b	Increase Recovery of Office Paper	50%	303	0.1%	High	$100 - $150
c	Implement Multi-Material Recycling Program	50%	1,658	0.6%	High	$100 - $150
d	Add New Materials to Recycling Program	50%	1,301	0.5%	Low	$0 - $50
e	Implement Commercial Food Waste Program	50%	4,773	1.8%	High	$125 - $175
f	Implement Commercial Yard Trimmings Program	50%	1,520	0.6%	High	$100 - $150
	Total		10,005	3.9%		

Note: Numbers may not total exactly due to rounding

[1] Assumed recovery rates are aggressive and are intended to represent 'best case" planning level scenarios.

a) Increase Recovery of Commercial Cardboard

- o Current Diversion Rate – The commercial cardboard recycling program is capturing 74 percent of the targeted materials.

R3

- Additional Diversion Potential – Capturing 50 percent of the remaining targeted materials not currently recovered would divert approximately 500 additional tons (0.2% additional diversion).
- Projected Cost – ***High*** (~$100 to $150 per ton, less any associated net revenues)

Increased recovery of these materials would increase collection costs to accommodate new accounts; however with strong markets for cardboard the net cost should be low, generally consistent with current cost of ~$32 per ton.

b) Increase Recovery of Commercial Office Paper

- Current Diversion Rate – The commercial office paper program is diverting approximately 20 percent of the targeted material.
- Additional Diversion Potential - Capturing 50 percent of the remaining targeted material would divert approximately 300 additional tons (0.1% additional diversion).
- Projected Cost – ***High*** (~$100 to $150 per ton, less any associated net revenues)

Increased recovery of these materials would increase collection costs to accommodate new accounts

c) Implement Commercial Multi-Material Recycling Program

- Additional Diversion Potential – Implementing a commercial multi-material recycling program and capturing 50 percent of the targeted material would divert approximately 1,700 additional tons (0.6% additional diversion).
- Projected Cost – ***High*** ($100 to $150 per ton, less any associated net revenues)

Requires establishing a new collection system with associated costs.

d) Add New Materials to Recycling Program

- Additional Diversion Potential – Adding additional material types (i.e., miscellaneous plastics and metals and textiles) and capturing 50 percent of those materials would divert a maximum of an additional 1,300 tons (0.5% additional diversion).
- Projected Cost – ***Low*** (~$0 to $50 per ton)

Recovery of new materials would result in little if any additional collection costs, however processing operations would need to change to accommodate additional materials.

e) Commercial Food Waste Program

- Additional Diversion Potential – Implementing a commercial food waste program and capturing 50 percent of the targeted materials (food waste plus compostable paper) would divert approximately 4,800 additional tons (1.8% additional diversion).
- Projected Cost – ***High*** ($125 to $175 per ton)

Requires establishing a new collection system with associated costs.

f) Implement Commercial Yard Trimmings Program

- Additional Diversion Potential – Implementing a commercial yard trimmings collection program and capturing 50 percent of that material would divert approximately 1,500 additional tons (0.6% additional diversion).
- Projected Cost – ***High*** (~$100 to $150 per ton)

Requires establishing a new collection system with associated costs.

Table 7.4
SMaRT Station Residual Waste Stream

	Program / Facility Diversion Option	Recovery Rate [1]	Additional Diversion Rate		Cost Range	
			Tons	Percent	General	Cost / Ton
4	**SMaRT Station Residual Waste Stream**					
a	Increase Diversion of C&D Debris	50%	498	0.2%	Low	$0 - $50
b	Increase Diversion of Small Organics	75%	9,000	3.5%	Moderate [2]	$50 - $100
c	Increase Diversion from Mixed Waste Stream [3]	16%	15,380	5.9%	Moderate/High [4]	$50 - $250
	Subtotal		24,878	9.6%		
d	Process Mixed Waste with Thermal Conversion Technology	90%	54,030	20.9%	High	$100 - $250
	Total	Not Additive				

Note: Numbers may not total exactly due to rounding
[1] Assumed recovery rates are aggressive and are intended to represent 'best case" planning level scenarios.
[2] Pending additional review and analysis by City.
[3] 16% represents additional percentage of overall SMaRT Station mixed waste stream diverted.
[4] Depends in large part on the extent to which the facility must be redesigned and any associated capital costs.

a) Increase Diversion of C&D Debris

- Additional Diversion Potential – Approximately 75 percent of the C&D material received at the SMaRT Station is recovered. If 50 percent of the remaining materials could be recovered, this would result in approximately 500 additional diverted tons (0.2% additional diversion).
- Projected Cost – ***Low*** ($0 to $50 per ton, depending on market revenue or cost for recovered materials)

b) Increase Diversion of Small Organics

- o Additional Diversion Potential – Approximately 16,000 tons of the SMaRT Station's small organics waste stream is attributed to the City, of which 3,000 tons are currently diverted. It is estimated that 25 percent of this material stream is comprised of contaminants. If the contaminants could be removed, approximately 9,000 additional tons attributed to the City could be composted (3.5% additional diversion).
- o Projected Cost – ***Moderate*** ($50 to $100 per ton, pending findings of current CalRecovery analysis)

Note: The City may wish to consider Anaerobic Digestion as an option for processing the small organic waste stream and/or other portions of the City's organic waste stream (e.g., source separated commercial food waste). This could potentially occur at the City's Water Pollution Control plant or other location.[21]

c) Increase Diversion of Materials from the Mixed Waste Stream

- o Additional Diversion Potential – The SMaRT Station mixed waste residual waste stream contains approximately 60,000 tons of Recyclable Paper, Compostable/Potentially Compostable and Other Recyclables. Diverting 12,000 of those tons (approximately 20 percent of those materials; 14% of total mixed waste processed) would result in an additional 3.5 percent overall diversion.
- o Projected Cost – ***Moderate/High*** ($50 to $250 per ton, depending in large part on the extent to which the facility would need to be redesigned and any associated capital costs)

d) Process Residue with Conversion Technology[22]

- o Additional Diversion Potential – Approximately 75 percent or more of the SMaRT Station mixed waste residual waste stream is compatible with gasification or pyrolysis conversion technology. If all of this material were processed with conversion technology, this would result in the

[21] The cities of Palo Alto and San Jose are both considering developing Anaerobic Digestion facilities.

[22] "Traditional" incineration of all or portions of the SMaRT Station residual waste stream was initially considered as an option but dismissed in favor of more environmentally preferable conversion technology options.

City diverting approximately 54,000 tons from the landfill,[23] assuming a 10 percent residual rate (20.9% "diversion rate" increase). Appendix D provides general information on conversion technologies as well as a specific analysis of conversion technologies as it relates to the SMaRT Station's residual waste stream.

- Projected Cost – ***High*** ($100 to $250 per ton, pending demonstration of economic and technical viability).

[23] At this time, the extent to which a jurisdiction would receive any "diversion" credit for material processed with gasification or pyrolysis conversion technology has yet to be established by the State. This topic is discussed further in Appendix D.

6.0 Zero Waste Scenario Modeling

6.1 Quantitative System Modeling

To assist the City with the evaluation of options to increase its diversion rate, a Microsoft Excel based "Zero Waste Quantitative Model" (Model) was developed. The Model provides a means for quantitatively evaluating the diversion impacts and costs of various "what-if" policy, program and facility options that may be required to achieve diversion rates of 75 percent and beyond.

Inputs to the Model include waste characterization data by source (e.g., single-family, multi-family, commercial, etc.), existing diversion program and facility tonnages, targeted material types, and available cost data. In conjunction with modeling diversion and cost data, the impact of the various waste reduction and diversion options on greenhouse gas emissions (GHG) was projected using the EPA's Waste Reduction Model (WARM).

6.2 Zero Waste System Scenarios

For purposes of assisting the City with its consideration of the various available source separation and mixed waste diversion options, the following four Zero Waste System Scenarios were developed to provide the City with an understanding of:

- How much additional diversion it could expect to achieve by enhancing its existing source separation programs;
- What types of enhancements to existing source separation programs and new source separation programs would need to be implemented to achieve a 75 percent diversion rate;
- What level of additional recovery of mixed waste through the SMaRT Station would be required to achieve a 75 percent diversion rate; and
- What level of diversion may be able to be achieved assuming conversion technology becomes a viable alternative in the future.

A description of each of the four scenarios is provided below.

Scenario 1: Maximize Diversion of Existing Source Separation Programs[24] – (a) Increase capture rate of existing single-family curbside and yard trimmings programs, multi-family recycling program and commercial cardboard and office paper programs; and (b) add new materials to the existing single-family and multi-family residential recycling programs. Implement and enforce a mandatory residential recycling ordinance and recyclables and

[24] Assumes capture rate of 50 percent of the targeted materials not currently diverted, net of SMaRT Station diversion rate.

yard trimmings disposal bans (cost modeling assumes $500,000 additional annual public education and enforcement cost).

Scenario 2: Maximize Diversion of Existing Source Separation Programs and Implement New Source Separation Programs[25] – Same as Scenario 1 with (a) implementation of multi-material commercial recycling program; (b) expansion of single-family yard trimmings program to the multi-family and commercial sectors; and (c) implementation of residential and commercial organics program. Implement and enforce a mandatory residential and commercial recycling ordinance and recyclables and organics disposal bans (cost modeling assumes $1,000,000 additional annual public education and enforcement cost).

Scenario 3: Source Separation Program Status Quo with Increased Recovery of SMaRT Small Organics and Mixed Waste Residue – (a) Processing and diversion of 75 percent of the SMaRT Station small organics fraction (assumes 25% contamination); (b) diversion of ~500 additional tons of C&D debris; and (c) enhanced SMaRT Station mixed waste processing and recovery of approximately 20 percent of the recyclable and compostable materials in the SMaRT Station waste stream that is currently landfilled (cost modeling assumes $1,000,000 additional annual capital and debt service / operating cost).

Scenario 4: Source Separation Program Status Quo with Increased Recovery of SMaRT Small Organics and Processing of Mixed Waste with Conversion Technology – (a) Processing and diversion of 75 percent of the SMaRT Station small organics fraction (assumes 25% contamination); and (b) gasification or pyrolysis of 75 percent of the mixed waste residue stream with 10 percent residue.

6.3 Results of Zero Waste Scenario Models

The cost modeling that was conducted for each scenario reflects the net change in the per ton collection, processing and disposal costs as compared to the existing system, multiplied by the total associated tons.

The results of that cost modeling are presented in Table 8, below, along with the associated system-wide cost impact (i.e., rate impact), diversion rate, and greenhouse gas emission reductions for each scenario. Those results include the overall system-wide costs for the scenario and a comparison of those costs to the City's 2010 system-wide costs, the additional tons diverted, and the associated overall City diversion percentage. The associated cost per ton diverted is also provided.

[25] Assumes capture rate of 50 percent of the targeted materials not currently diverted, net of SMaRT Station diversion rate.

Table 8
Comparison of Zero Waste System Scenarios

	Scenario			
	1	2	3	4
2010 System Wide Cost	$ 34,847,000	$ 34,847,000	$ 34,847,000	$ 34,847,000
System Wide Cost with New Programs	$ 35,182,000	$ 37,196,000	$ 36,302,000	$ 39,849,000
Increase (Decrease) in Cost	$ 335,000	$ 2,349,000	$ 1,455,000	$ 5,002,000
System Wide Cost Impact (Rate Impact)	**1.0%**	**6.7%**	**4.2%**	**14.4%**
Total Additional Tons Diverted	6,149	20,990	20,680	59,330
Additional Diversion Potential	2.4%	8.1%	8.0%	23.0%
Total City Diversion Percentage	**69.4%**	**75.1%**	**75.0%**	**90.0%**
Total Program Cost per Additional Ton Diverted	$ 54	$ 112	$ 70	$ 84
Greenhouse Gas Emission Reduction (MTCE)	2,236	7,641	12,591	25,333

As shown:

- Increasing diversion through the existing source separation programs (Scenario 1) represents the most cost-effective diversion available to the City, however would not achieve 75 percent diversion (would only achieve a 68.4% diversion rate). This assumes, however, that the City is willing to take the steps necessary to realize that diversion (e.g., mandatory recycling ordinance and disposal bans) and that those steps prove effective;
- Diverting additional material through The SMaRT Station (Scenario 3) may represent the best opportunity to realize significant cost-effective diversion. However, the feasibility of such additional diversion, as well as any necessary changes to the design and/or operation of the SMaRT Station and the associated costs, need to be determined; and
- While the City could potentially achieve a 75 percent diversion rate with the implementation of comprehensive source separation programs targeting all sectors, those programs will compete for material currently recovered at the SMaRT Station. Additionally, to achieve a 75 percent diversion rate, those programs will need to capture a net 50 percent or more of the targeted materials. This is particularly aggressive with respect to the recovery of residential and commercial organics and commercial mixed recyclables and will likely require significant outreach and, if necessary, enforcement of a mandatory recycling ordinance and materials disposal bans.

6.4 Greenhouse Gas Emission Impacts

In addition to the waste diversion benefits associated with the various diversion options, those options also offer the potential for greenhouse gas (GHG) emission savings. Both the consumption

and disposal of resources require energy and emit varying amounts of GHGs. When waste is sent to the landfill, it decomposes and emits methane gas. By providing additional opportunities to reduce waste generated and recycle or compost waste that cannot be eliminated, waste disposal trends within the community can be reduced. This decrease in waste disposed will result in reduced GHG emissions associated with landfilling.[26]

Assembly Bill 32, California's Global Warming Solutions Act (Act) of 2006, requires that California's GHG emissions be reduced to 1990 levels by 2020. This is a reduction of about 30 percent from projected "business as usual" levels. The Act gives the California Air Resource Board authority to identify and regulate sources of GHG emissions. In support of Statewide efforts to reduce GHG emissions, the City is in the process of preparing a Climate Action Plan that will identify ways in which Sunnyvale can reduce GHG emissions, including waste reduction and recycling.

The City's draft Climate Action Plan sets a goal of decreasing the amount of waste sent to landfill through increased recycling, composting, and materials management, including:

- Reducing the availability or use of common materials that are not recyclable or that are not cost effective to recycle; and
- Increasing the amount of waste recycled and composted by one percent per year.

Draft GHG emission reduction goals attributed to reduced landfilling, in terms of Metric Tons of Carbon Dioxide Equivalents ($MTCO_2E$) and Metric Tons of Carbon Equivalents (MTCE), are as follows: [27]

- 2020 – 56,360 $MTCO_2E$; 15,370 MTCE
- 2035 – 106,340 $MTCO_2E$; 29,000 MTCE

The reduction in GHG emissions attributed to the reduced landfill disposal is targeted at 12 percent of the City's total GHG emission reduction goal.

6.4.1 Green House Gas Emission Modeling

To determine the amount of GHG emission savings achieved as a result of implementing Scenarios 1 through 4, the EPA's WARM was used to calculate the total GHG emission savings in MTCE.

The EPA created WARM to help municipalities, managers, and policy-makers understand and compare the environmental effects of materials commonly found in the waste stream. Specifically, WARM is designed to evaluate the life-cycle GHG and energy

[26] City of Sunnyvale Draft Climate Action Plan, November 2011.

[27] [MTCE = 12/44 * $MTCO_2E$].

implications attributed to materials by comparing a current conditions scenario (e.g., landfilling) to an alternative scenario (e.g., source reduction or recycling).[28] By taking the difference in tons disposed from current conditions to each of the four scenarios and applying the City's overall waste characterization data for specific material types, R3 was able to create applicable inputs for WARM. The following information provides the results of the WARM analysis.

6.4.2 WARM Scenario Analysis

Scenario 1 GHG Analysis

If the projected diversion results of Scenario 1 were realized, the total net savings of GHG emissions would be 2,236 MTCE when compared to current conditions. This is equivalent to:

- Removing annual emissions from 1,501 passenger vehicles;
- Conserving nearly one million gallons of gasoline; or
- Conserving 43 railway cars of coal.

Scenario 2 GHG Analysis

If Scenario 2 diversion results were realized, the total net savings of GHG emissions would be 7,641 MTCE when compared to current conditions. This is equivalent to:

- Removing annual emissions from 5,132 passenger vehicles;
- Conserving approximately 3.2 million gallons of gasoline; or
- Conserving 146 railway cars of coal.

Scenario 3 GHG Analysis

If Scenario 3 diversion results were realized, the total net savings of GHG emissions would be approximately 12,591 MTCE when compared to the current conditions. This is equivalent to:

- Removing annual emissions from 8,456 passenger vehicles;
- Conserving more than 5.2 million gallons of gasoline; or
- Conserving 241 railway cars of coal.

[28] Source: Documentation for Greenhouse Gas Emission and Energy Factors Used in the Waste Reduction Model (WARM); USEPA, http://www.epa.gov/climatechange/wycd/waste/SWMGHGreport.html.

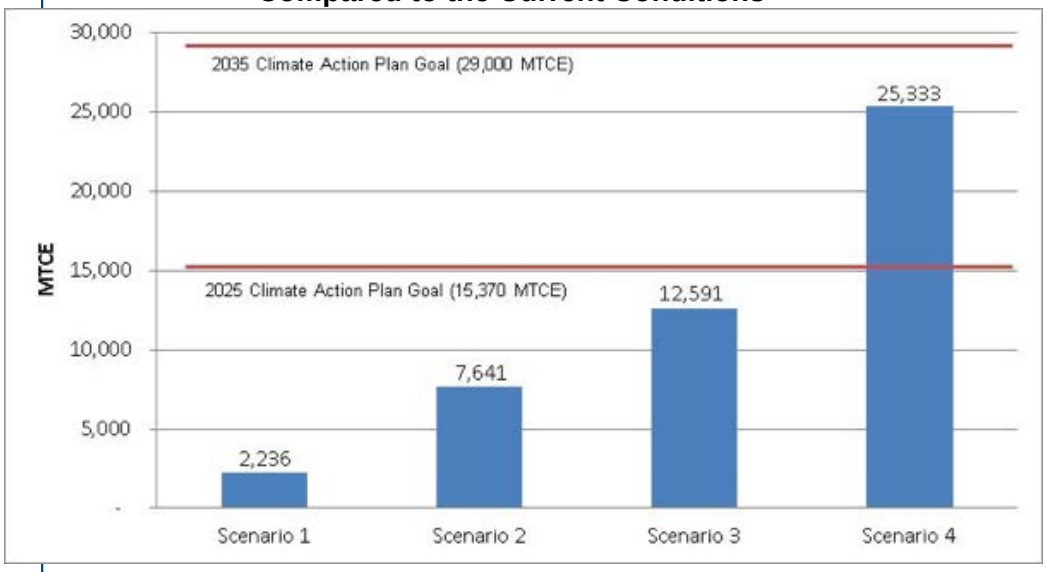
Scenario 4 GHG Analysis

If Scenario 4 diversion results were realized, the total net savings of GHG emissions would be 25,333 MTCE when compared to current conditions. This is equivalent to:

- Removing annual emissions from 17,013 passenger vehicles;
- Conserving approximately 10.5 million gallons of gasoline; or
- Conserving 485 railway cars of coal.

Figure 5, below, shows the GHG emission reductions for each scenario as compared to current conditions and the City's Draft Climate Action Plan GHG reduction goals related to reduced landfill disposal.

Figure 5
Greenhouse Gas Emission Savings for each Scenario Compared to the Current Conditions[29]



[29] Although Scenarios 2 and 3 would divert essentially the same amount of material, the large difference in GHG emissions is due to the differing WARM inputs. WARM calculates GHG emission savings based on specific material types; therefore, differences in the types of materials recycled or composted impacts the associated GHG emission impacts.

7.0 Findings and Recommendations

7.1 Summary Findings[30]

- The City has done an effective job managing its waste stream, developing its solid waste management infrastructure and educating its residents and businesses.
- The City's diversion rate has increased from 18 percent in 1990 to 66 percent in 2011.
- While the City's diversion rate has increased and the amount of waste the City has landfilled has decreased over time, it is still disposing of approximately 86,000 tons of waste annually.
- For the City to achieve a 75 percent diversion rate, it will need to divert an additional 21,700 tons of material that is currently disposed. At this point in the evolution of the City's solid waste management system there are few, if any, "low hanging fruit" options, and none that will get the City to a 75 percent diversion rate.
- The City is highly invested in the processing of mixed waste at the SMaRT Station and has implemented source separation programs that serve all major customers at varying levels;
- Diversion from new or enhanced source separation programs will "compete" for materials that are already recovered at the SMaRT Station.
- The City has two major options for increasing its diversion rate, and has and should continue to use the net cost per ton of additional diversion as the basis for determining which options to pursue:
    - Increase diversion through the SMaRT Station; and/or
    - Increase diversion through existing source separation programs and implementing additional source separation programs.
- Source separation programs alone may not be able to achieve a 75 percent diversion rate:
    - Only 2 percent to 3 percent additional diversion can be achieved by maximizing the effectiveness of existing single-family, multi-family and commercial source separation programs.

[30] Also refer to the "Key Findings" section of the Additional Diversion Potential Analysis presented in the prior section of this report.

- Increasing the diversion of existing source separation programs and implementing: multi-material commercial recycling; multi-family and commercial yard trimmings collection; and residential and commercial organics programs would be needed for the City to potentially achieve a 75 percent diversion rate; and
- Implementation and enforcement of mandatory residential and commercial recycling ordinances and material bans (e.g., food and yard trimmings) will likely be required in conjunction with the increased source separation programs noted above if the City is to achieve a 75 percent diversion rate through source separation programs alone.

- SMaRT Station mixed waste recovery operations alone may not be able to achieve a 75 percent diversion rate:
  - 80 percent of the SMaRT Station's residual waste stream that is landfilled is comprised of recyclable and compostable material;
  - Diverting the small organics waste stream (fines) that is not currently diverted could increase diversion by 3.5 percent (9,000 tons) and may offer the most cost-effective option for significant additional diversion;
  - For the City to achieve a 75 percent diversion rate through the SMaRT Station's mixed waste processing operations, it will need to divert the 9,000 tons of small organics listed above, plus an additional 14 percent of the mixed waste stream that is processed (essentially doubling the current SMaRT Station mixed waste diversion rate);
  - Significant increased diversion through the SMaRT Station's mixed waste processing operation is not feasible without changes to the design and/or operation of the facility;
  - The SMaRT Station's operating agreement expires December 31, 2014, which will provide the City with the opportunity to restructure the agreement to support increased diversion at the SMaRT Station; and
  - While it may be possible to restructure the agreement to support increased diversion, significant changes to the design of the SMaRT Station may be required to realize significant additional diversion from the mixed waste stream.

- Conversion technology facilities in California are in the pilot stage:
    - The SMaRT Station's mixed processing residue is most suitable for thermal treatment, such as gasification or pyrolysis, and would require minimal or no additional processing;
    - The use of conversion technology using thermal treatment such as gasification and pyrolysis to process SMaRT Station's residue could "divert" an additional 20 percent or more of the City's waste stream, enabling the City to potentially achieve a 90 percent diversion rate;
    - No commercially viable conversion technology facilities are operating in California, but several facilities are in the pilot stages; and
    - While the residual waste stream includes compostable paper and other compostable organics that could serve as feedstock for anaerobic digestion, there are processing limitations in separating these remaining compostable materials from the other inert and undigestable materials in the residue. As a result, a greater amount of contaminants would pass through the digestion process and end up in the compost material. There may be potential applications with wet anaerobic digestion techniques, but the material appears best suited for thermal treatment, as discussed above.
- Additional funding will be needed to reach a 75 percent diversion rate:
    - The City's current diversion programs are cost effective and customer rates are comparable to other San Francisco Bay Area communities;
    - Increasing diversion to 75 percent will require significant additional costs related to new source separation programs and/or changes to the design/operation of the SMaRT Station; and
    - The expiration of the current put-or-pay disposal agreement with Kirby Canyon Landfill in 2021 may help offset increased costs to reach 75 percent diversion.

7.2 Recommendations

7.2.1 Zero Waste Goals

Adopt City Zero Waste goals of 75 percent diversion by 2020, 80 percent by 2025 and 90 percent by 2030; establish the City as a Zero Waste "Success Model" by implementing and maximizing upstream and downstream material management options in all City buildings;

7.2.2 Contractual

1. *SMaRT Station Agreement*

Establish contractual requirements (e.g., minimum diversion requirements) and/or increased contractual incentives to support increased diversion of the SMaRT Station's mixed waste stream as part of the current and/or new operating agreement effective January 1, 2015. Requirements to consider include:

a) Processing and recovery of additional curbside recyclable materials;

b) Increased recovery of C&D materials; and

c) Increased recovery of materials from the mixed waste stream.

2. *Non-Franchised Haulers*

a) Enforce the City's exclusive franchise with Specialty and bring franchised material that is being illegally collected by non-franchised haulers back into the franchise system; and

b) Issue permits to commercial source-separation recycling companies and require them to provide tonnage reports to the City to allow the City to effectively track that portion of the waste stream. Consider assessing permit fees.

3. *Solid Waste Collection Franchise*

Establish enhanced operating requirements, as part of the City's next franchise agreement, that support the City's Zero Waste Policy and/or amend the current agreement.

4. *Landfill Agreement*

Explore options for extending the current landfill agreement that do not include future put-or-pay commitments or with reduced put-or-pay levels that are established with future Zero Waste diversion in mind.

7.2.3 Regulatory

a) Adopt and enforce a Mandatory Residential Recycling Ordinance;

b) Adopt and enforce specific material disposal bans on residential recyclables and yard trimmings;

c) Adopt and enforce a commercial food waste disposal ban in conjunction with the expansion of the commercial food waste pilot program to all commercial accounts generating food waste (see "Commercial" below); and

d) Consider implementing take-back ordinances targeting various materials including universal and electronic waste (see "Extended Producer Responsibility" below).

7.2.4 Downstream Efforts

1. *Maximize Mixed Waste Recovery at the SMaRT Station*

a) Complete current review of options to improve the quality of the SMaRT Station small organics fraction to enable the diversion of additional portions of that waste stream; and

b) Conduct pilot studies to determine the potential for additional diversion of the SMaRT Station mixed waste stream (e.g., recyclable paper and other recyclable materials, and compostable paper and other organics for composting or anaerobic digestion) through additional or modified processing (e.g., sorting mixed waste residue on a second shift).

- Identify regional composting facilities that accept compostable paper and the required specifications and cost; and
- Require and/or provide incentives for additional or modified processing of the mixed waste stream as part of new SMaRT Station contract to increase the mixed waste stream diversion rate, as recommended above.

2. *Single-Family Residential*

a) Undertake enhanced public education and outreach (and enforcement as applicable) in support of the recommended mandatory residential recycling ordinance and residential recyclables and yard trimming disposal bans to increase diversion through existing residential source separation programs. Also consider additional rate incentives, including a 20-gallon mini can and every other week garbage collection;

b) Consider expanding the material types collected through the single-family and multi-family curbside recycling program (e.g., textiles and mixed plastics), provided markets exist and the materials can be recovered cost effectively. Identify potential changes to SMaRT Station operating agreement to support the processing and recovery of additional types of curbside recyclable materials; and

c) Do not implement residential organics program at this time due to cost; however, reassess if more cost-effective

processing capacity becomes available or additional diversion is required. Consider expanded residential backyard composting outreach.

3. *Multi-Family Residential*

Implement a multi-family and commercial yard trimmings diversion program in conjunction with the adoption of a yard trimmings disposal ban.

4. *Commercial*

a) In conjunction with the recommended pilot studies to determine the potential for additional diversion of the SMaRT Station mixed waste stream, evaluate the costs / benefits of implementing new source separation programs, including a comprehensive single stream commercial recycling system with a supporting mandatory commercial recycling ordinance. Implement as appropriate.

b) Implement a multi-family and commercial yard trimmings diversion program in conjunction with the adoption of a yard trimmings disposal ban;

c) Expand the commercial food waste pilot program to all commercial food waste generators in the City and adopt a commercial food waste disposal ban / mandatory commercial organics diversion ordinance.

d) Visually characterize the SMaRT Station's compactor waste stream, by individual account, and assess the "additional diversion potential" that may be realized through high-grading of compactors (e.g., dedicating compactors to recyclable materials and collecting garbage in a separate container). Pursue recovery where diversion potential exists; and

e) Document current commercial business service levels by account (i.e., weekly solid waste and recycling cubic yards of service) and update annually. Use this as a basis for identifying the largest waste generators and prioritizing commercial sector outreach efforts.

5. *Construction and Demolition Debris*

Identify and secure markets for carpet padding, asphalt shingles and/or other C&D debris that could be, but are not currently recovered. Identify potential changes to SMaRT Station operating agreement to incorporate incentives and/or requirements for recovery and marketing of expanded C&D material types.

6. *Conversion Technology*

Continue to monitor conversion technology projects within the State and nation, and assess the potential for the application of a conversion technology facility(ies) to process portions of the City's waste stream in the future.

7. *Other*

   a) Pursue future CRV beverage container and other grant funding to support efforts to increase residential and commercial source separated recycling and/or other Zero Waste goals; and

   b) Provide local no-cost Pharmaceutical and Personal Care Products (PPCP) recycling options.

7.2.5 Upstream Efforts

As mentioned previously, "upstream" efforts don't increase diversion as much as "downstream" efforts, at least initially, but provide an important framework that will create substantial behavioral changes in regards to purchasing and management of materials prior to disposal.

1. *Enhance Zero Waste Outreach*

   a) Develop enhanced residential, commercial and school[31] outreach programs that:

      - Provide additional focus and resources related to Zero Waste "upstream" options (e.g., waste reduction, reuse and environmental purchasing);
      - Incorporate comprehensive sustainability options (e.g., Zero Waste, water and energy conservation, pollution reduction, etc.); [32] and
      - Coordinate with the sustainability efforts of other City department and/or regional entities.

   b) As part of the recommended enhanced commercial outreach program, develop a Zero Waste / Green Business Sustainability Audit protocol (Note: Refer to "Lead by Example" below);

   c) Conduct informational Zero Waste / Green Business Sustainability Audits and/or interviews of all City businesses that have been certified as a Bay Area Green Business (~40 businesses). The objective of this effort is to independently document how these businesses are performing with respect to Zero Waste and overall sustainability efforts, and to gather information, ideas, and tools that can be used as part of the City's enhanced outreach efforts;

[31] Refer to Alameda "Go-Green Schools" Program; http://www.alameda.k12.ca.us/index.php/schools/go-green-schools.

[32] What is envisioned for the commercial sector is a City of Sunnyvale "Green Business Program" modeled after the Bay Area Green Business Program.

d) Coordinate with the Sunnyvale Chamber of Commerce (which is a Bay Area Green Business) to solicit commercial businesses interested in receiving a Zero Waste / Green Business Sustainability Audit or technical assistance; and

e) Conduct Zero Waste / Green Business Sustainability Audits of:

- All City buildings (see "Lead by Example" below);
- All City businesses, starting with the top 20 percent of commercial accounts (largest waste generators), as measured by weekly solid waste service volumes;
- All schools;[33] and
- All large venue events.

2. *Encourage Sustainable Consumerism (helping consumers buy less toxic, easily recycled, reused or composted products)*

a) Develop a simple, focused and prioritized residential Zero Waste website "shopping list" that provides non-toxic, easily reused, recycled or composted products for typical household staples (e.g., cleaning supplies, paper products, etc.), building upon similar information that has been developed by other entities; and

b) Incorporate CalRecycle's Waste Reduction suggestions for specific industries into Zero Waste / Green Business Sustainability Audits, as applicable.

3. *Extended Producer Responsibility (EPR)*

a) Maintain the City's membership in the California Product Stewardship Council

b) Continue efforts to lobby legislators to implement laws, policies and regulations that support Zero Waste;

c) Actively promote existing EPR programs (e.g., the statewide Paint Stewardship Program) and take-back programs (e.g., Recyclable Battery Recycling Corporation (RBRS), Thermostat Recycling Corporation (TRC), Vehicle Mercury Switch Recovery Program); and

d) Encourage local businesses to implement voluntary take-back programs (e.g., Pharmaceutical and Personal Care Products (PPCPs) and sharps collection at pharmacies; e-waste at electronics retailers).[34] If voluntary programs do

[33] Prepare and distribute report cards with the goal of certifying all schools as green schools and maintaining that certification on an ongoing basis.

[34] Refer to City of Ottawa, Canada "Take it Back" program; http://app01.ottawa.ca/takeitback/Welcome.do?lang=en.

not effectively provide for the recovery of targeted materials, consider implementing mandatory take-back ordinances.

4. *Lead by Example*

Conduct Zero Waste / Green Business Sustainability Audits of all City buildings, which include, but are not necessarily limited to:

a) Upstream Activities:

- Determining the extent to which the major products and services that are procured by each department comply with the City's environmental purchasing policy,[35] and if not determining the cause(s) of non-compliance and assessing alternatives (See "Enhanced Procurement Policy" below);
- Ensuring that all printed materials are double-sided; and
- Identifying any items that are or can be reused.

b) Downstream Activities:

- Documenting weekly solid waste, recycling and yard trimmings service levels for each City building;
- Assessing the "additional diversion potential" of each City building through visual waste audits;
- Establishing specific Zero Waste goals for each City building, if they have not already been established. We suggest that the goal include realizing 100 percent of the remaining diversion potential that exists, as well as environmental purchasing and procurement targets; and
- Developing an Action Plan for each City building to reach the established Zero Waste goals, and providing periodic follow up to assess performance.

We suggest that the results of the above efforts be presented in the form of a "report card" for each City building and presented to City Council (see "Measure and Report Progress" below).

The objective of the above actions is to establish the City as a Zero Waste "Success Model" by implementing and maximizing

[35] This should include determining the extent to which each department is using post-consumer recycled content paper and the percentage of recycled content (e.g., 100% vs. 30%), and determining if City-provided or contracted janitorial services are using less (low or no) toxic, recycled content and recyclable cleaning supplies.

upstream and downstream material management options in all City buildings.

5. *Enhance Procurement Policy*

   a) In conjunction with "Lead by Example" above, assess the effectiveness of the City's Environmental Procurement Policy in all City buildings in terms of the actual quantity or percentage of environmentally preferred products and services procured and report results to City Council.

   b) Based on the above findings, reassess the City's Environmental Procurement Policy and/or practices in support of that policy. As appropriate, strengthen contracting and purchasing policies to not simply favor, but consistently provide for the use of less toxic, more durable, higher recycled content and recyclable products by all City departments and contractors.

   c) Develop a list of environmentally preferable products and services for use by City purchasing agents, which can also be accessed by residents and businesses.

6. *Measure and Report Progress*

   a) Continue to track and report the City's annual State-reported diversion rate;

   b) Present the results of the Zero Waste / Green Business Sustainability Audits of all City buildings to the City Council, including the extent to which the City is procuring environmentally preferable products and services;

   c) Track and report on the status of Zero Waste / Green Business Sustainability Audits (e.g., number of audits conducted, and number of businesses "certified" as "Green Businesses"); and

   d) Provide an annual accounting of overall commercial business service levels (i.e., weekly solid waste and recycling cubic yards of service).

7.3 Implementation Schedule

A proposed implementation schedule for the above recommendations is provided in Appendix E. The City should review the proposed schedule and make revisions, as appropriate, based on consideration of resources and priorities.

Appendix A

SMaRT Station Flow Diagram and Facts Sheet

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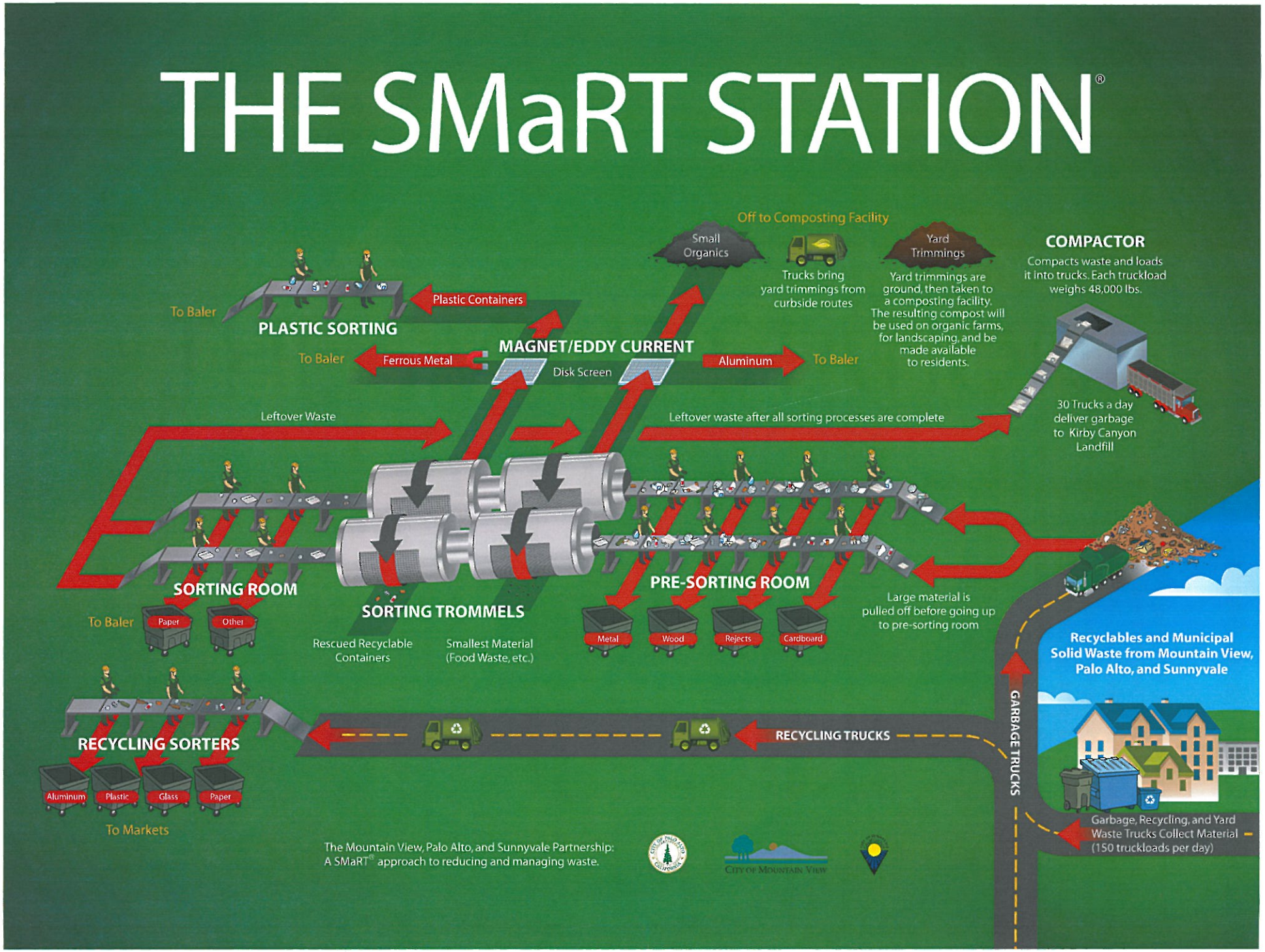
THE SMaRT STATION®



SMaRT Station® Facts Sheet

bag-breaker teeth at trommel entrance

The cities of Mountain View, Palo Alto, and Sunnyvale partnered to build the SMaRT Station, which began operation in July 1993 and serves a population of 280,000. Owned by the City of Sunnyvale and operated by Bay Counties Waste Services, the station sits on 9 acres of land, employs 122 people and handles about 950 tons of waste per day. The station is permitted to process up to 1500 tons of material per day and new Materials Recovery Equipment installed in Fall 2009 is projected to divert at least 25% of the incoming *garbage* for recycling.

Garbage and Recyclables Arriving:

How many truckloads arrive every day from pick-up routes? 150 per day

Who generates the waste? 28% residential, 69% commercial/industrial, 3% self-haul

When did the station's curbside recycling sorting area go into operation? June 2001

Garbage Getting Compacted:

How much garbage can the compactor process in an hour? 100 tons

What are the dimensions of a truckload of compacted garbage? 37 feet long, 7 feet wide

How much does a truckload of compacted garbage weigh? 24 tons

Garbage Leaving:

Where does the compacted garbage go? Kirby Canyon Recycling and Disposal Facility, located in South San Jose and operated by Waste Management

How far is it from the SMaRT Station to Kirby Canyon? 27 miles, one-way

How many truckloads of compacted garbage per day go to Kirby Canyon Landfill? 30

How many transfer trucks are there? 9

How much does it cost to dispose of garbage at Kirby Canyon? $56.44 per ton as of Fall 2009

How many tons per day go to Kirby Canyon? 665 tons

Recyclables:

What are the dimensions of a bale of recycled cans, paper, or plastic? 31" x 45" x 63"

How much does a bale of cans weigh? 1,379 lbs. average

So then how many cans are in a bale of recycled cans? 41,094!!

The Department of Conservation reports there are about 29.8 cans per pound. At 1,379 lbs each, these three bales contain over 123,000 cans!

About the SMaRT Building:

The building is 116,000 square feet, consisting of 50,000 square feel for the Tipping Floor area, 50,000 square feet for the Materials Recovery Facility and Recycling areas, 10,000 square feet for the wood and yard trimmings processing area, and 6,000 square feet for the office. Many green building elements went into the construction of the facility, including E-Coat interior and exterior paint, recycled PET carpet, recycled tire carpet, recycled bathroom partitions, and recycled tile in the bathrooms. Recycled plastic was also used to produce the tables, benches, and bollards around the exterior. Recycled aggregate secondary road base was used, along with recycled steel beams and reused office partitions. The station also uses reclaimed water for landscape irrigation and toilets.

Appendix B

White Paper – Non Franchised Haulers

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Background and Recommendation on Recycling Franchise Fees

In response to the City's budget challenges, Department of Public Works made a suggestion to increase General Fund revenue by charging a franchise fee on recycling collectors who charge for their services. This suggestion was later included in the FY 2009/10 budget adopted by Council. This white paper was written to provide background on the franchise fee issue as well as provide information on new commercial recycling reporting requirements from AB 32, the Global Warming Solutions Act of 2006.

Background:
Since about 1990, the City of Sunnyvale has provided little regulation of companies that provide large-scale recycling collection services that charge a fee. This policy direction was a response to the City's landfill capacity crisis of the late 1980s and early 1990s when there was a lack of local recycling processing infrastructure. Because of the dwindling landfill capacity, the City has allowed "mixed recyclables" generated by large industrial and commercial customers to be hauled off by recyclers. This material is typically comprised of essentially anything the waste generator discards in their debris box, compactor or dumpster. Some of the recyclers limit their collection to source separated recyclables while others collect mixed recyclables and haul the non-recyclable material to landfills for disposal. Because the City has a franchise agreement for garbage collection, these non-franchised haulers are essentially in competition with the City and its franchised hauler.

California law allows the City to control collection of recyclables for which the waste collector charges a fee to its customer (Rancho Mirage Supreme Court decision)[1], but up to this point, Sunnyvale has chosen not to use this power and instead draws the line between "solid waste" and "recyclable materials." This line is difficult to define and enforce in the field as it requires bin-by-bin analysis to determine whether the material in the bin is "recyclable" or not. In addition, with the City now owning its own materials recovery facility at the SMaRT Station, the material sorted at the SMaRT Station looks no different than the "recyclables" hauled by non-franchised collectors so the issue of not having the infrastructure to handle the material no longer exists.

Furthermore, the lack of regulation has led to a situation where the City has little information on quantities recycled and virtually no ability to enforce on these haulers the same sorts of contract service standards that apply to Specialty Solid Waste and Recycling (Specialty), the franchised refuse hauler including safety standards, appearance of vehicles, customer service standards, hours of operation, and payment of a franchise fee to the City.

To add another twist to the issue, new legislation passed in 2006 requiring reductions in greenhouse gas emissions have lead to the possible adoption of a Mandatory Commercial Recycling measure that will likely require the City to expand the recycling program and begin collecting recycling data. The current unregulated system provides the City with no information on who the haulers are or the amounts and disposition of material collected. Proposed to take effect January 1, 2012, mandatory commercial recycling is expected to result in annual reduction equivalents of at least 5 million metric tons of carbon dioxide.

[1] Waste Management of the Desert, Inc., et al. v. Palm Springs Recycling Center. (1994) 7 Cal.4th 478

Staff explored ways to generate franchise fee revenues from collection activity in response to the budget shortfall as well as to simultaneously meet the new reporting requirements.

Discussion:
While other cities take varied approaches to solid waste and recycling collection, two primary systems are in use, although they vary considerably in how they are applied and administered.

Option 1 –Franchise Boundaries Extend to "Rancho Mirage" Limits
Option 1 would be to only permit collection of source-separated recyclables that are being purchased or that are being collected at no charge (thus enforcing the limits allowed by the Rancho Mirage Supreme Court decision). In addition, require the hauler to obtain a non-exclusive franchise from the City and report on tons collected. All other garbage and recycling collection activity would be reserved for the franchised hauler, working under City direction to ensure that wastes are properly disposed and/or recycled and that service standards are enforced. Because it only has to deal with one company, this approach would give the City unlimited discretion in setting the amount of the franchise fee. Collection of the fee would be easy, since it is simply deducted from the City's monthly payments to the franchised hauler. Both of the SMaRT Station partner cities, Mountain View and Palo Alto take this approach to enforcing their franchise boundaries.

By moving more of the material currently being collected by unfranchised haulers to the publicly-owned SMaRT Station, it could increase the amount of material actually recycled while making transparent the methods and results. If 80% of the material currently being hauled by others returns to SMaRT, the $3.75 host fee charge per ton could amount to $48,000 to the City's General Fund. Furthermore, by channeling material and data through the SMaRT Station, Option 1 will assist the City in complying with the anticipated AB 32 requirements for reports on commercial recycling in the context of climate change.

Option 2 – Multiple, Non-exclusive Franchises
The second option would be to require the recycling haulers to enter into a non-exclusive franchise agreement with the City and pay the City a franchise fee that is a percent of company revenues (Specialty pays a franchise fee that is 10% of their revenue). It would require Council approval of an ordinance, which adds non-exclusive recycling franchises and a franchise fee to the Municipal Code. Requirements would include service standards as well as audit and open book inspections. This approach is used, among others, by Santa Clara and San Jose.

Annual revenues are very difficult to estimate, however, because the current unregulated system provides the City with no information on the amounts of material collected or charges billed to Sunnyvale waste generators by the various haulers. Based on a typical Bay Area fee of 10% of company revenues, the General Fund could realize an additional $40,000 annually, although the estimated .5 FT equivalent in staff time to administer could offset the revenue.

Staff anticipates that, to the extent the recycling haulers must increase their prices to recover the franchise fee, some customer accounts may move back into the solid waste collection system. Because they would go to the SMaRT Station for sorting and recycling, these materials would see a similar outcome as if they were collected by a recycler. Some additional revenue generation is an expected outcome because, as noted above, as the General Fund receives $3.75 per ton from the host fee charged there.

Conclusion

To the extent that the various franchisees accurately tracked and reported recycling data, Option 2 would be an improvement on the current system with regard to AB 32 reporting on commercial recycling. Option 1 would, however, provide more complete, easily accessed data than Option 2. Taking these actions would increase General Fund revenues, put downward pressure on refuse collection rates for existing customers and assure that community standards for operating hours, truck/container appearance, wages and other standards can be effectively enforced. A measure to maximize AB 32's environmental benefits by expanding commercial recycling requirements to include food waste is currently being reviewed. The City will be better poised to meet future, as yet undetermined, reporting requirements with these proposed changes, as well as contribute to the General Fund.

Appendix C

Additional Diversion Analysis

- Source Separation Programs
- SMaRT Station Mixed Waste Processing

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Appendix C

Additional Diversion Potential Analysis
(Source Separation Programs)

	Single Family				Multi-Family				Commercial				TOTAL Source Separated Programs			
Existing Programs	Tons		Additional Diversion Potential	Current Capture Rate	Tons		Additional Diversion Potential	Current Capture Rate	Tons		Additional Diversion Potential	Current Capture Rate	TOTAL Tons		Additional Diversion Potential	Current Capture Rate
	Diverted	Available			Diverted	Available			Diverted	Available			Diverted	Available		
Multi-Material Recycling Program	6,965	4,059	1.6%	63%	1,359	2,980	1.2%	31%		3,400	1.3%		8,324	10,439	4.0%	44%
Yard Waste Program	14,683	798	0.3%	95%		2,049	0.8%			3,040	1.2%		14,683	5,887	2.3%	71%
Commercial Cardboard									2,525	899	0.3%	74%	2,525	899	0.3%	74%
Commercial White Office Paper									154	606	0.2%	20%	154	606	0.2%	20%
Total Potential Additional Tons	**21,648**	**4,857**	1.9%	**82%**	**1,359**	**5,029**	1.9%	**21%**	**2,679**	**7,946**	3.1%	**25%**	**25,686**	**17,832**	6.9%	**59%**
Increase Diversion through Existing Programs		**Tons**	**Additional Diversion**			**Tons**	**Additional Diversion**			**Tons**	**Additional Diversion**			**Tons**	**Additional Diversion**	
Dual-Stream Recycling Program		**2,030**	**0.8%**	**50%**		**1,490**	**0.6%**	**50%**						**3,520**	**1.4%**	**50%**
Yard Waste Program		**399**	**0.2%**	**50%**										**399**	**0.2%**	**50%**
Commercial Cardboard										**450**	**0.2%**	**50%**		**450**	**0.2%**	**50%**
Commercial White Office Paper										**303**	**0.1%**	**50%**		**303**	**0.1%**	**50%**
Total Projected Additional Diversion		**2,428**	**0.9%**	**50%**		**1,490**	**0.6%**	**50%**		**753**	**0.3%**	**50%**		**4,671**	**1.8%**	**50%**
Implement New Programs		**Tons**	**Additional Diversion**			**Tons**	**Additional Diversion**			**Tons**	**Additional Diversion**			**Tons**	**Additional Diversion**	
Commercial Multi-Material Recycling Program										**1,658**	**0.6%**	**50%**		**1,658**	**0.6%**	**50%**
Multi-Family & Commerical Yard Waste						**1,025**	**0.4%**	**50%**		**1,520**	**0.6%**	**50%**		**2,545**	**1.0%**	**50%**
Total Projected Additional Diversion						**1,025**	**0.4%**	**50%**		**3,178**	**1.2%**	**50%**		**4,202**	**1.6%**	**50%**
Add New Materials to Existing / New Programs		**Tons**	**Additional Diversion**			**Tons**	**Additional Diversion**			**Tons**	**Additional Diversion**			**Tons**	**Additional Diversion**	
Misceallaneous Plastics		431	0.2%	50%		331	0.1%	50%		643	0.2%	50%		1,405	0.5%	50%
Miscellaneous Metals		222	0.1%	50%		20	0.0%	50%		422	0.2%	50%		663	0.3%	50%
Textiles		311	0.1%	50%		163	0.1%	50%		236	0.1%	50%		710	0.3%	50%
Total Projected Additional Diversion		**964**	**0.4%**	**50%**		**514**	**0.2%**	**50%**		**1,301**	**0.5%**	**50%**		**2,779**	**1.1%**	**50%**
Implement Mixed Organics Programs		**Tons**	**Additional Diversion**			**Tons**	**Additional Diversion**			**Tons**	**Additional Diversion**			**Tons**	**Additional Diversion**	
Food Waste		3,814	1.5%	50%						3,457	1.3%	50%		7,271	2.8%	50%
Compostable Paper		750	0.3%	50%						1,316	0.5%	50%		2,066	0.8%	50%
Total Projected Additional Diversion		**4,565**	**1.8%**	**50%**						**4,773**	**1.8%**	**50%**		**9,338**	**3.6%**	**50%**

Appendix C

Additional Diversion Potential Analysis
(SMaRT Station Mixed Waste Diversion)

	City Portion of SMaRT Station Tonnage			
C&D Diversion	**Tons**		**Additional Diversion Potential**	**Capture Rate**
	Diverted	**Available**		
SMaRT Station C&D Diversion	3,290	996	0.4%	75%
Total Projected Additional Diversion		**498**	**0.2%**	**50%**

Small Organics	**Tons**		**Additional Diversion Potential**	**Capture Rate**
	Diverted	**Available** [(1)]		
Small Organics		16,000	6.2%	100%
Residue Percentage		25%		
Theoretical Maximum Tons		12,000	4.6%	100%
Current City Small Organics Diversion		3,000	1.2%	100%
Total Projected Additional Diversion		**9,000**	**3.5%**	**100%**

[(1)] Per City 02/23/12

Mixed Waste Residue	**Tons**		**Additional Diversion Potential**	**Capture Rate**
	Diverted	**Available**		
Recyclable Paper		9,547	3.7%	100%
Compostable Paper		47,883	18.5%	100%
Other Recyclables		6,922	2.7%	100%
Potentially Recyclable		4,800	1.9%	100%
Problem Materials		10,893	4.2%	100%
Total Tons		80,045		
Total Tons (w/o Problem Materials)		69,152	26.8%	100%
Additional Diversion Required to Achieve 75% [(2)]		**14,882**	**5.8%**	**100%**
% Recovery of Total Tons (w/o Problem Materials)		**21.5%**		

[(2)] With 5,300 tons additional Small Organics and 498 tons additional C&D Diversion = 20,680 tons (8% Additional Overall Diversion)

Gasification / Pyrolysis	**Tons**		**Additional Diversion Potential**	**Capture Rate**
	Diverted	**Available**		
		60,034	23.2%	100%
Theoretical Maximum Disposal Tonnage Reduction		60,034	23.2%	100%
Total Projected Additional Diversion		**54,030**	**20.9%**	**90%**

Appendix D

Conversion Technologies

- Conversion Technology Overview
- Conversion Technology Options for Sunnyvale SMaRT Station

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Conversion Technology Overview[1]

Conversion technologies refer to a wide array of state of the art technologies capable of converting organic materials, including the organic fraction of the municipal solid waste stream, into useful products, such as green fuels and renewable energy, in an environmentally beneficial way. Conversion technologies include both thermochemical and biochemical processes. A brief discussion of each of these technologies is provided below.

Thermochemical Conversion

Thermochemical conversion technologies include pyrolysis, gasification and plasma arc. Pyrolysis and gasification are not new technologies, having been used for coal since the early 20th century. The application of these technologies to solid waste feed stocks, however, is new and emerging.

Gasification

Gasification typically refers to the conversion of feedstock material by either direct or indirect heating, depending on the specific configuration of the gasification system. While gasification processes vary considerably, typical gasifiers operate from 1300^0F and higher and from atmospheric pressure to five atmospheres or higher. The process is optimized to produce fuel gases (methane and lighter hydrocarbons) and synthetic gases (carbon monoxide, hydrogen), hence the term gasification. The product fuels can be used in internal and external combustion engines and fuel cells. Synthetic gases can be used to produce methanol, ethanol and other fuel liquids and chemicals.

Pyrolysis

Pyrolysis is the process that produces pyrolytic oils and fuel gases that can be used directly as boiler fuel or refined for higher quality uses such as engine fuels, chemicals, adhesives and other products. Pyrolysis typically occurs at temperatures in the range of 750 – $1{,}500^0$F and thermochemically degrades the feed stock without the addition of air or oxygen. Because air or oxygen is not intentionally introduced or used in the reaction, pyrolysis requires thermal energy, which is typically applied indirectly by thermal conduction through the walls of the containment reactor. The reactor is usually filled with an inert gas to aid in heat transfer from the reactor walls and to provide a transport medium for removal of the gaseous products.

Plasma Arc

Plasma Arc is a technology that can be used in both pyrolysis and gasification systems. The technology was developed for the metals industry in the late 19th century. Plasma is a collection of free-moving electrons and ions that is typically formed by applying a large voltage across a gas volume at reduced or atmospheric pressure. When the voltage is high enough and the gas pressure low enough, electrons in the gas molecules break away and flow towards the positive side of the applied voltage. The gas molecules become positively charged ions that are capable of transporting an electrical current and generating heat. This is the same phenomenon that creates lightening. Very high temperatures are created in the ionized plasma (i.e., $7{,}000^0$F and above). For applications in processing solid waste the intense heat actually breaks up the molecular structure of the organic material to produce simpler gaseous molecules such as carbon monoxide (CO), hydrogen (H) and carbon dioxide (CO2).

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[1] Source: Conversion Technologies Report to the Legislature, CIWMB, February 2005

Biochemical Conversion

Biochemical conversion processes, such as anaerobic digestion and fermentation, occur at lower temperatures than thermochemical processes. Higher moisture feed stocks are generally better candidates for biochemical processes. Non-biodegradable feed stocks such as plastics and metals are not suitable for biochemical conversion and are not converted. Applying biochemical processes to solid waste as a pre-treatment prior to landfilling can reduce both the volume of material being landfilled and the production of leachate while at the same time extracting the embodied energy value from the feed stock. There are a large number of anaerobic digestion facilities operating in Europe and Canada that utilize unsorted municipal solid waste as feed stock.

Anaerobic Digestion

Anaerobic digestion is the bacterial breakdown of biodegradable organic material in the absence of oxygen and can occur over a wide temperature range from 50 – 160^0F. Anaerobic digestion produces a gas principally composed of methane (CH4) and carbon dioxide (CO2) but also has impurities such as hydrogen sulfide (H2S). This gas is produced from feed stocks such as sewage sludge, livestock manure and other wet organic wastes. Depending on the waste feed stock and the system design biogas is typically 55 to 75 percent pure methane, although state-of-the-art systems report producing biogas that is more than 95 percent pure methane. Biogas can be used as a fuel for engines, gas turbines, fuel cells, boilers, industrial heaters other processes and the manufacturing of chemicals.

Fermentation

Fermentation is an anaerobic process that is used to produce fuel liquids such as ethanol and other chemicals. Although fermentation and anaerobic digestion are commonly classified separately, both are fermentation methods designed to produce different products.

Status of Conversion Technologies

Conversion technologies are successfully used to manage solid waste throughout Europe, Israel, Japan and other countries in Asia, but are not yet in commercial operation in the United States. While there are and have been pilot demonstrations of conversion technologies in the United States, the absence of larger scale demonstration facilities and commercial facilities in this country is an obstacle to demonstrating the benefits these technologies can offer. In addition to lack of experience in the United States, specific development hurdles for conversion technologies in California may include: cost, especially when compared to the current, relatively inexpensive cost of landfill disposal; the lack of clear permitting and regulatory pathway; a lack of diversion credit, renewable energy credit, or other incentives for the development of emerging technologies; and misconceptions regarding the performance of these technologies.[2]

While there are no commercial scale conversion technologies in California or the United States, interest in conversion technologies has been growing. Attachment 1 provides a memorandum prepared by the City of San Jose that includes the status of municipalities pursuing conversion technologies in the United States and "lessons learned". Within California a number of jurisdictions are actively pursuing the implementation of conversion technologies (including gasification), including:

- The County of Los Angeles;

[2] Los Angeles County Conversion Technology Evaluation Report; Phase II Assessment, October 2007 (pg ES-1).

- The County of Santa Barbara; and
- The Salinas Valley Solid Waste Authority.

Additional information on a status of those efforts is provided below.

Los Angeles County

After an extensive, multi-year evaluation process of Conversion Technologies for processing MSW (including gasification), which included facility site visits, stakeholder meetings and economic, environmental and technical feasibility assessments, the Los Angeles County Board of Supervisors on April 20, 1010 unanimously approved recommendations from the Los Angeles County Department of Public Works that included:

- Approval of Memorandums of Understanding (MOU) between the County and three different conversion technology project development teams (copies of the MOU's have been provided to the City under separate cover):
    - Arrow Ecology and Engineering & CR&R Incorporated proposing a 150 ton per day **anaerobic digestion process** in the City of Perris, to be located at the MRF/TS owned and operated by CR&R Incorporated.
    - International Environmental Solutions & Burrtec Waste Industries proposing a 184 ton per day **pyrolysis process** in unincorporated Riverside County, to be located at the MRF/TS owned and operated by Burrtec.
    - Entech Renewable Energy Solutions & Rainbow Disposal Company proposing a 360 ton per day **gasification process** in the City of Huntington Beach to be located at the MRF/TS owned and operated by Rainbow Disposal Company. The proposed Entech gasification technology has been in use since the first unit was installed in 1989. Since that time over 100 Entech gasification units have been installed with more than 20 of those installations fueled with municipal solid waste.[3]
- Approval of a four-year consultant contract with Alternative Resources Inc. (ARI) to provide technical, permitting, and funding procurement assistance to each of the demonstration projects and to assist with the technology evaluation and development of Phase IV commercial projects within LA County.

The consultant contract with ARI is for a total not-to-exceed amount of $1,290,600. Each of the three demonstration projects will be financed by the respective project developer. Upon execution of the MOUs, for a term of 16 months, each project developer and the County will jointly attempt to obtain grants and/or loans to be applied against the cost of constructing and completing the project.

Santa Barbara County

The County of Santa Barbara and the cities of Santa Barbara, Goleta, Solvang and Buellton joined together to identify and evaluate the feasibility of various conversion technologies as alternatives to landfilling solid waste in southern Santa Barbara County. After a three year process including the development of a feasibility report, extensive public outreach and an extensive request for proposal (RFP) process, four companies submitted formal proposals to build and operate a conversion technology facility:

- International Environmental Solutions (**Pyrolysis**);

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[3] Los Angeles County Conversion Technology Evaluation Report; Phase II Assessment, October 2007.

- Mustang Renewable Power Ventures;[4]
- NRG Energy (**Plasma Gasification**); and
- Plasco Energy Group (**Plasma Gasification**).

The County is currently evaluating proposals and hopes to make that evaluation public early next year. A project representative reported that the project has cost approximately $1.0 million to date, with most of which have been internal costs, although approximately $300,000 has been paid to a consultant that has been providing project assistance since 2007.

Salinas Valley Solid Waste Authority

The Board of Directors of the Salinas Valley Solid Waste Authority (Authority) began investigating alternatives to landfill disposal of solid waste in February 2005 with a series of study sessions. In March 2007 a four-member Conversion Technology Commission (Commission) was formed to investigate viable conversion technologies. The Authority issued a request for Statement of Qualifications to more than 70 firms and selected nine (9) vendors to receive a Request for Proposals. Three proposals were received by the August 2008 deadline and were ranked from highest to lowest as follows:

- Plasco Energy Group (**Plasma Arc Gasification**);
- Urbaser, S.A. (**MRF/Anaerobic Digestion/Compost/WTE/Others**); and
- Interstate Technologies, Inc. (**Gasification**).

The Commission has recommended that the Authority negotiate with the top two ranked proposers. The cost associated with the technology evaluation and proposal process has been approximately $320,000. Staff anticipates support from consultants to negotiate with the vendors, and General Counsel time to complete the letter of intent will be an additional $30,000. The company that is ultimately selected will be required to reimburse the Authority for expenses related to the investigation of conversion technologies and waste treatment processes in the amount of $100,000.

Status of Conversion Technology Diversion Credit

Under the State's current 50 percent diversion requirement *" the most important aspect of compliance is program implementation. To evaluate compliance, CalRecycle will look at a jurisdiction's unique per capita disposal rate as an indicator of how well its programs are doing to keep disposal at or below a jurisdictions 50 percent equivalent per capital disposal target. But this number does not determine compliance. Compliance is based on CalRecycle evaluating that a jurisdiction is continuing to implement the programs it chose and is making progress in meeting its target."*[5]

The City's diversion rate was 45 percent in 2000 as compared to the State mandated 50 percent diversion rate. The City received Board Approved Time Extensions for 2000 through 2004 and a Board Approved Good Faith Effort[6] for 2005 and 2006, when its diversion rate was 47 and 48 percent respectively. Under the new disposal based reporting system, which became effective in 2007, the City exceeded CalRecycle's target per capita disposal amount in 2007 (6.3 pounds per

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[4] Mustang Renewable Power Ventures is run by a developer who has acquired licenses for anaerobic digestion, gasification and material recovery facility (MRF) technologies and is marketing packages based on a specific jurisdictions interest / needs.

resident per day (PPD) versus the 5.9 PPD target). The City's 2008 per capital disposal rate of 4.9 PPD, however, was below the 5.9 PPD target (i.e., the City's diversion level was above 50 percent). Data for 2009 has not yet been reported.

While gasification can result in 94 to 100 percent landfill diversion by weight,[7] CalRecycle staff report that any tonnage handled in a gasification facility would currently be considered disposed. There was proposed legislation (AB 222) that would have credited the diversion associated with a "Biorefinery"[8] for purposes of meeting a solid waste diversion level above 50 percent, provided that the Biorefinery satisfies certain criteria including: *"preprocesses the solid waste feedstock to remove, to the maximum extent feasible, all recyclable materials prior to the conversion process"*. That bill, however, died with the close of the most recent legislative session. AB 222 passed the Senate Environmental Quality Committee and was awaiting a hearing on the Senate floor. It previously passed the Senate Energy Utilities and Communications Committee, as well as the Assembly Policy and Fiscal Committees. While there are many parties that supported AB 222 there was also significant opposition.

Emissions from Conversion Technology Facilities

A report prepared by the University of California, Riverside in 2009 reported that pyrolysis and gasification facilities currently operating throughout the world with waste feed stocks meet each of their respective air quality emission limits. With few exceptions, most meet all of the current emission limits mandated in California, the United States, the European Union and Japan. In the case of toxic air contaminants (dioxins/furans and mercury), every process evaluated met the most stringent emission standards worldwide. Facilities with advanced environmental controls are most likely to meet regulatory requirements in California. The actual impacts of specific facilities will need to be evaluated on a case-by-case basis as part of a local permitting process.[9]

Local regulations for conversion technologies have not been established and it is important to note that any conversion technology facility constructed in the Bay Area will likely be subject to more stringent permitting requirements than those evaluated in the UC Riverside Study.

Attachment 2 provides a Fact Sheet for the LA County Conversion Technology Demonstration Project that includes the following findings:

- Conversion technologies are capable of meeting the most stringent air emission standards;
- Conversion technologies can actually make our air cleaner; and
- Conversion technologies can help address climate change.

CITY OF SAN JOSE
CAPITAL OF SILICON VALLEY
Environmental Services
A Certified Green Business

M E M O R A N D U M

To: Michele Young
From: Jaqui Guzmán
Date: 1/6/2010
Re: Lessons Learned in Developing Municipal Conversion Technology Projects

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Conversion technologies (CT) use carbon-based waste to produce clean burning fuel to generate electricity or a renewable fuel. These technologies recover more energy than the capture of landfill gas, while diverting the residual carbon-based waste resulting from recycling and composting processes from landfills. Given the City's ambitious Zero Waste goal, the Environmental Services Department is exploring conversion technologies as a key strategy for reducing post-recycling and post-composting residuals.

This memo presents findings and lessons learned from research on municipal waste conversion projects and interviews with lead project staff. These lessons learned will help inform the City's own process as it pursues CT.

Scope

I conducted basic internet research to identify municipalities that were actively pursuing CT projects. This included browsing government websites and reviewing reports related to municipal waste conversion projects. In identifying municipalities, I limited my research to North America and focused particularly on California because these municipalities face similar environmental and political circumstances as San José. In addition, I looked only at projects that used municipal solid waste (MSW) as feedstock. Given that this technology is fairly new and has yet to be developed using MSW on a commercial scale in North America, we identified only 17 municipal conversion projects.

Of the 17 municipalities I contacted, I was able to conduct ten interviews with lead project staff. (See Appendix A for full contact information and Appendix B for interview questions.) The chart on the next page briefly describes the CT projects initiated by the 17 municipalities we identified for this lessons learned memo.

Findings

In researching municipal waste conversion projects, reviewing project reports, and interviewing project representatives, a number of key findings and recommendations emerged.

As you can see in the chart on the following page, every municipality has a unique project and is at a different stage of development; however, I also discovered many similarities in what they described as their motivations, process, and challenges. On page 3, I describe six key findings from my research and interviews with municipal government representatives.

Attachment 1

Municipalities Pursuing Conversion Technologies Project

Municipality	Project Description	Development Stage
Interviewed		
City and County of Santa Barbara	Pursuing the development of a conversion facility at Tejiguas landfill. They are open to all conversion technologies.	RFP released
City of Los Angeles	Developing a plan to process MSW with waste-to-energy and conversion technologies.	Selecting vendor, Selecting project site
City of Sacramento	Abandoned plasma arc gasification project. Developing a strategic plan for a waste technology park that will feature multiple conversion technologies that convert MSW into energy.	First project abandoned, Strategic planning for second attempt
City of San Diego	Included a conversion technologies evaluation within Long Term Resource Management Options Strategic Plan. Taking a "watch and see others" approach before taking the next step toward developing a project.	Preliminary evaluation, No project planned
City of Tallahassee	Vendor approached municipality with a plasma arc gasification proposal for MSW. Power Purchase Agreement approved in 6.2007. Currently identifying sites, but estimating that facility will be operational in 2013.	Power Purchase Agreement signed, Selecting project site
City of Toronto	Anaerobic digestion facility using BTA as vendor.	Vendor selected
County of Santa Cruz	Approached by an interested vendor but negotiations fell apart because vendor lacked sufficient data on environmental impact and opposition from environmental groups.	Project abandoned
Lee County Solid Waste Division	Sought a public-private partnership to generate energy from fats, oils, and greases (FOG); however, the project was abandoned. Will possibly continue as private initiative.	Project abandoned
Los Angeles County	Developing demonstration projects with three short-listed vendors—IES (pyrolysis), EnTech (gasification), and Aerobio (anaerobic digestion)—with the goal of developing a commercial-scale project.	Shortlisted vendors, Selecting project site
New York City	Identifying a site for CT project through a siting task force. Planning to release an RFP in 12-18 months. Have yet to identify a technology.	Selecting project site
Saint Lucie County	Developing plasma arc gasification facility on landfill using GEOPLASMA as vendor.	Permitting
Salinas Valley Solid Waste Authority	Exploring projects with two vendors—Plasco Energy (gasification) and Urbaser (anaerobic digestion with gasification).	Initial vendor negotiations
Not Interviewed		
City of Huntsville	Developing plasma arc gasification project.	Unknown
City of Taunton	Developing conversion technology project to process 1,000 tons per day of MSW.	Unknown
East Bay MUD	Developing anaerobic digestion project.	Unknown
Orange County	Completed a comprehensive evaluation of conversion technologies.	Evaluation completed
City of Ottawa	Operating a 100 ton per day pilot plasma arc gasification facility since 2008.	Operational

- ***Most Projects Driven by Diversion Goals.*** Of the twelve municipalities we contacted, ten either had ambitious diversion goals or sought CT for purposes of waste diversion. These municipalities were generally driven by landfill closings, long-term strategic planning, or vendor interest. Only two municipalities were driven by the desire to produce energy.

- ***Projects Generally Follow Same Development Process But Steps Vary Widely.*** Municipalities have generally followed the same path in pursuit of CT; however, the steps taken along that path have varied widely. Most began with a general review of available CT with some analysis of the feasibility of developing a CT project in their communities. They subsequently moved on to strategic planning and more extensive technical analyses, and then sought vendor proposals. However, municipalities varied in when and if they shortlisted vendors or released a request for information. Some municipalities included public outreach from the onset, while others waited until much later in the process. They also differed in when each identified a project site.

- ***Speeding the Development Process Led to Failure for Some.*** Two of the twelve municipalities interviewed, Lee County and Santa Cruz County, followed very different paths. Regrettably, their attempt to speed the process led to failure. In the case of Lee County, it applied for a grant to develop a CT facility for purposes of generating energy from FOG without carefully analyzing the feasibility of the project. Later staff found that the collection infrastructure did not exist, meaning the county would need to enter the hauling business to make the project work. This led to public outcry and ultimately the county removed itself from the project and instead provided seed money for a private initiative. Likewise, Santa Cruz tried to speed the process by moving straight to negotiations when approached by an interested vendor. When faced with public opposition from environmental groups, it had no CT literature, feasibility study, or data on emissions to quell the opposition and the project was abandoned.

- ***Biggest Challenges Related to Misinformation and Lack of Credible Information.*** The most cited challenge faced by the municipalities I interviewed was misinformation and lack of credible information. Many municipalities faced fierce opposition from anti-incineration groups that claim thermal technologies are "incineration in disguise." These groups mobilized to spread misinformation in communities considering CT. Some municipalities expressed frustration at not being able to counter claims that CT facilities would emit large amounts of dangerous emissions because good and reliable data on CT facilities is not readily available.

- ***UC Riverside Report Finds Acceptable Emissions.*** Better data on emissions is starting to emerge. UC Riverside recently released a report that found CT facilities worldwide are meeting emissions standards. They also found the vast majority of these facilities meet California's rigorous emissions standards. Thus, they conclude that CT facilities could be permitted in the state. This study will no doubt help municipalities pursuing CT.

- ***Everyone is Learning as They Go.*** Municipalities pursuing CT are at the forefront and are continuously learning as they go because there is no clear path to success. CT is a very new technology for North America. According to a UC Riverside report released in

2009, there are only a handful of operational CT facilities (operating under research permits) in North America using MSW as feedstock. Of the municipalities I interviewed, none had an operational CT facility. St. Lucie County and Toronto, now in the permitting phase, are furthest along.

Best Practices in Municipal Conversion Technology Project Development

In assessing the feedback I received from municipalities, four messages stood out as the most important lessons that San José should keep in mind as it develops its conversion technology project. Below, I describe these four best practices.

- ***Stakeholder Outreach.*** Most municipalities I interviewed emphasized the importance of educating and engaging the community when pursuing CT. Community involvement was particularly important for municipalities in California, given the concentration of environmental groups concerned with the impact CT could have on air quality and the waste hierarchy. Those municipalities that have been successfully moving forward—the City and County of Santa Barbara, Los Angeles County, and Saint Lucie County—credit their success in large part to their early outreach efforts. Conversely, those municipalities whose CT projects have been thwarted by opposition, like the City of Santa Cruz, lamented not implementing a robust public outreach effort early on in the process.

- ***Realistic and Flexible Timelines.*** Every municipality I interviewed has experienced setbacks in developing CT projects. These setbacks have caused municipalities to extend their timelines, which can cause frustration among stakeholders. Thus, they expressed the importance of developing realistic and flexible timelines, as well as processes for dealing with project problems and delays.

- ***Strong Group of Advisors.*** Several municipalities valued the advice and contributions of advisory groups formed to help guide the development of CT projects. Most advisory groups included technical experts, such as professors or consultants, that provided expert technical support. Some advisory groups also included municipal leadership that could help champion the project and lobby other decision-makers. The City of Los Angeles, in particular, credited a councilmember for keeping the project alive despite numerous delays.

- ***Learn From Other Municipalities.*** More than a few municipalities suggested learning from the experiences of other public entities pursuing CT. Moreover, they suggested using existing resources, like technical work, if feasible, particularly if using the same consultant and/or vendor as another municipality.

Recommendations

The City should consider the lessons learned and best practices gleaned from other municipalities as it moves forward with the development of CT in San José. With this memo, the City is already taking steps towards learning from the experiences of other municipalities and

taking stock of available resources. However, the City currently is moving forward on CT efforts with very limited stakeholder outreach and an undefined project development process, which can lead to difficulties as the City moves forward. Below, I present five recommendations to help the City avoid some of the pitfalls other municipalities have experienced in pursuing CT projects.

- ***Use Existing Negotiations and Planning to Begin Community Outreach.*** Understanding that the City has limited resources, the City should consider requiring Greenwaste Recovery to hire a public relations firm or fund a part-time community outreach position as part of the lease negotiations. This requirement should also be considered for any CT RFP. Additionally, the City should take advantage of the current Plant Master Plan process to educate the community on conversion technologies that could be located on the Plant in the future. To minimize efforts, the City could borrow from existing outreach campaigns from municipalities identified in this memo.

- ***Consider Forming a CT Committee.*** The City should also consider forming a CT Committee to help champion and guide the City's CT efforts. This committee should be composed of ESD staff, CMO staff, Councilmember staff, and technical experts in CT. Such an advisory committee could help the City face bureaucratic, political, and technical challenges.

- ***Further Develop the City's Conversion Technology Strategic Plan.*** Rather than move forward with grants and vendor negotiations, the City should step back and fully develop its Conversion Technologies Strategic Plan. While staff already has a draft, this could be the CT Committees first task. Having a well defined strategic plan backed by leadership will help facilitate stakeholder engagement and guide how the City pursues CT.

- ***Create a Project Development Manual for CT Projects.*** Prior to pursuing CT, the City should create a project development manual to help guide the development of CT projects. This manual should include step-by-step instructions, including local, state, and federal requirements for these types of projects. It also should link these requirements with appropriate lead departments. Such a manual will require substantial staff time and collaboration with relevant departments like the City Manager's Office, Attorney's Office, General Services (Real Estate), Planning, etc. This manual could be developed as the City navigates through the current 9-Par negotiations.

- ***Use Existing Technical Analyses, If Feasible.*** Extensive analysis of CT technologies, permitting issues, and other CT-related issues already exists. The City should avoid duplicating these existing resources. For example, many of the vendors submitting proposals for a CT project in San José may have submitted proposals to other municipalities. If a technical analysis of these vendors' technology already exists, there is no need to hire a consultant to duplicate that analysis. The City can simply review the existing analysis.

Attachment 1

Appendix A: Contact Information

Municipality	Contact	Phone	Email
City of Los Angeles	Miguel Zermeno	(213) 485-3611	miguel.zermeno@lacity.org
Los Angeles County	Coby Skye	(626) 458-5163	cskye@dpw.lacounty.gov
East Bay MUD	Sophia Skoda	(510) 287-1542	sskoda@ebmud.com
Salinas Valley Solid Waste Authority	Susan Warner	(831) 775-3002	susanw@svswa.org
City of Huntsville, AL	John "Doc" Holladay	(256) 880-6054	doc@swdahsv.org
Lee County Solid Waste Division	Keith Howard	(239) 533-8917	
City and County of Santa Barbara	Carlyle Johnston	(805) 882-3617	cjohnst@cosbpw.net
City of Sacramento	Edison Hicks	(916) 808-4949	EHicks@cityofsacramento.org
New York City	Venetia Lannon	(212) 312-4229	vlannon@nycedc.com
County of Santa Cruz	Melodye Serino	(831) 454-2160	
City of San Diego	Barbara Lamb	(619) 236-7789	BLamb@sandiego.gov
Orange County	Don Reeves	(714) 834-4000	
Saint Lucie County, FL	Ron Roberts	(772) 462-1768	robertsr@stlucieco.gov
City of Tallahassee, FL	Ben A. Cowart	(850) 891-6893	Ben.cowart@talgov.com
City of Taunton, MA	Steven Torres	(508) 821-1036	
City of Toronto	Brian Van Opstal		bvanops@toronto.ca

Appendix B: Questionnaire

Questions for Municipalities with Conversion Technology Projects:

Strategic Planning Process:

1. How did this project emerge? What were the goals/objectives of the program? (Was the main goal of this project to divert material from landfill or to create energy?)
    a. Would you share your planning documents with us (initial work plan)? Timeline?

2. Which, if any, consulting firms did you contract with to help devise or execute the project?
    a. What types of tasks were asked of your consultants?
    b. Would you share the scope of services with us?

Analyses Completed:

3. What types of feasibility or other analyses related to the project were conducted? (feedstock, diversion potential, energy generation potential, funding, etc)
    a. Would you share any analyses or other studies related to the project with us?

4. Was community input requested or a communication plan established as part of the pre-project work?

Lesson's Learned:

5. Did you release an RFI and/or RFP?
    a. Would you share your project description and/or RFI/RFP with us?
    b. Looking back, would you have made changes to the RFI/RFP?

6. What criteria did you use to evaluate the RFI and/or RFP responses?
    a. Would you share your evaluation criteria with us?

7. What worked well for you in the process?

8. What were your biggest challenges/obstacles?
    a. Looking back, how would you have approached these challenges/obstacles?

9. What advice do you have for cities who are contemplating a conversion technology project?

Attachment 2

Los Angeles County

Conversion Technology Demonstration Project

OVERVIEW: Conversion Technology Environmental Fact Sheet

Conversion technologies provide an opportunity to reduce our dependence on landfill disposal while reducing air emissions, including greenhouse gases. These are state-of-the-art processes capable of creating useful products, green fuels, and clean, renewable energy from solid waste. More than 130 commercial facilities operate in Europe and Asia as a safe and clean alternative to traditional waste management practices.

Following a decade of research, the County Los Angeles Department of Public Works has compiled this environmental fact sheet to summarize publicly available data, demonstrating that conversion technologies are a superior option to traditional solid waste management practices such as landfilling and waste-to-energy and more than capable of meeting the most stringent air quality standards.

Key Findings

Conversion technologies are capable of fully complying with the most stringent air emissions standards

Conversion technologies have been shown in actual operation to reduce dioxin and furan emissions in amounts dramatically below the already low EPA limits (see graph 1)

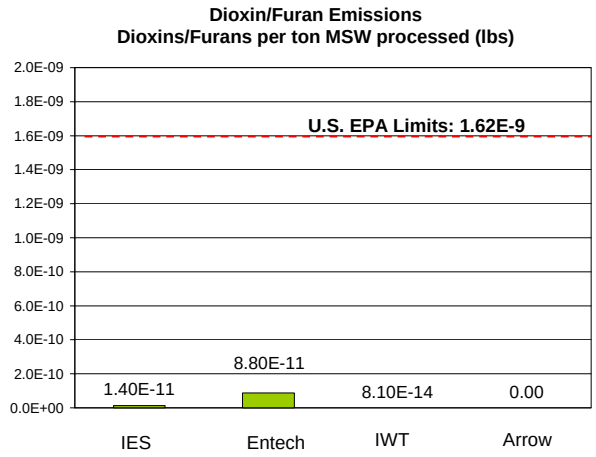
Conversion technologies actually make our air CLEANER

On a net-basis, conversion technologies can actually help make our air cleaner (see graph 2) by offsetting higher emissions from other sources, including greenhouse gas (GHG) emissions

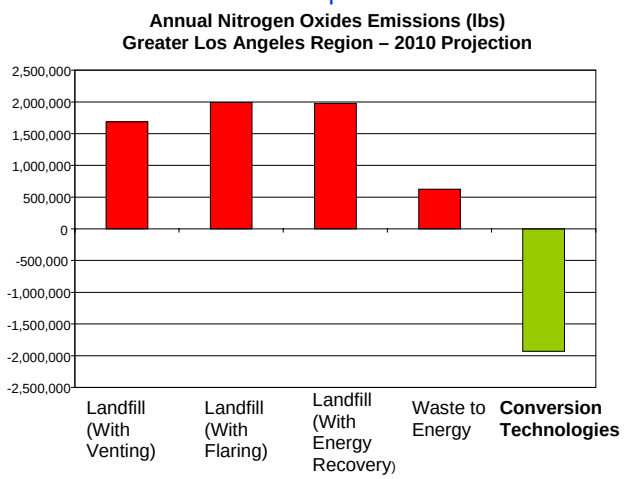
Conversion technologies can help us address climate change

Conversion technologies have the potential to reduce GHG emissions each year by millions of tons of CO_2 equivalent in California alone

Graph 1



Graph 2



Attached is an environmental fact sheet summarizing public data that substantiates these findings. For more information, please visit: www.SoCalConversion.org

Los Angeles County

Conversion Technology Demonstration Project

Conversion Technologies: A Clean Solid Waste Alternative

The Los Angeles County Department of Public Works (County) is taking an active role in developing environmentally-sound alternatives to landfilling and waste-to-energy that would convert post-recycled residual solid waste into useful products, green fuels, and clean, renewable energy. These technologies may include biological, thermal, chemical, and mechanical processes; however they do not include waste-to-energy (combustion) as the trash is not actually burned. Public agencies and universities alike have studied air emissions from conversion technologies and concluded that they are capable of operating within regulatory limits. More than 130 commercial facilities, processing a wide variety of wastestreams, operate in Europe and Asia[1] as a safe and clean alternative to traditional waste management practices such as landfilling or waste-to-energy.

Sample Conversion Technologies From Around the World


Germany


Malaysia


Japan


Southern California

Independent, Peer-Reviewed Studies

Extensive studies have recently been completed by trusted California authorities. For example, a 2006 peer-reviewed study conducted by the University of California, Riverside, on behalf of the California Integrated Waste Management Board, analyzed third-party emissions data from three thermal technology facilities:

- *International Environmental Solutions* - Operates a pyrolysis facility in Romoland, California that utilizes solid waste
- *BRI Energy* - Operates a gasification facility in Fayetteville, Arkansas that was tested with solid waste from California
- *Integrated Environmental Technologies* - Operates a gasification process in Richland, Washington and other parts of the world that utilizes medical waste among other feedstocks

Additionally, Los Angeles County has been evaluating conversion technologies for more than a decade. After review of over 100 technology companies from around the world, the County is considering four technology companies to develop one or more demonstration facilities in Southern California. All four companies

participating in the process have demonstrated the ability to divert at least 87 percent of waste away from disposal, and in some cases 100 percent of the waste. The technology companies being considered by the County are the following:

- *Arrow Ecology and Engineering (Arrow)* - Operates anaerobic digestion facilities in Israel and Australia that process solid waste
- *Entech* – Operates a gasification facilities in Poland, England and Malaysia that process various forms of waste including solid waste, medical waste, and mixed plastics
- *International Environmental Solutions (IES)* - Operates a pyrolysis facility in Romoland, California that utilizes solid waste
- *Interstate Waste Technologies (IWT)* - Operates gasification/ pyrolysis facilities in Japan that process various forms of solid waste

The 2006 UC Riverside study, the County's conversion technology reports, and other key reports can be found online at www.SoCalConversion.org.

Conversion Technologies Meet Environmental Regulations

Since local regulations for conversion processes have not yet been established, UC Riverside researchers compared emissions data to similar known limits, including U.S. EPA limits for starved air solid waste combustors and German thermal conversion regulatory limits. All three conversion facilities studied were, or will likely be, below these regulatory limits (see below).

Air Emissions Comparison of Regulations and Three Thermal Technologies[2]

REGULATORY LIMITS	Particulate Matter	Nitrogen Oxides	Cadmium	Lead	Mercury
US EPA Limits	18.0	220	0.01500	0.15000	0.01500
German Limits	14.0	281	0.04200	0.70000	0.04200
ACTUAL FACILITY EMISSIONS[3]					
International Environmental Solutions	3.9	275[4]	0.000150	0.00028	0.00056
BRI Energy	2.0	10	0.005000	0.02000	0.00010
Integrated Environmental Technologies	<3.3	162	0.000027	0.01100	0.00067

(All limits normalized to mg/N-m^3 at 7% O_2)

Los Angeles County also analyzed dioxin/furan data from the four conversion processes currently under consideration in our process. Our research and review of emissions test results reveals that these conversion technologies should have no issues complying with U.S. EPA regulations. In fact, these conversion technologies have been shown in actual operation to produce dioxins and furans in amounts dramatically lower than the already low U.S. EPA limits, far less than many commonplace and natural activities such as a wood burning fireplace, and well within safe guidelines (see below).

Air Emissions Comparison of Dioxin/Furan Regulation[5]

REGULATORY LIMITS	Dioxin/Furan
US EPA Limits (for new sources)	0.000000001617131 (1.62 x10^{-9})
ACTUAL FACILITY EMISSIONS[6]	
International Environment Solutions	0.000000000014174 (1.42 x10^{-11})
Entech Environmental	0.000000000087715 (8.77 x10^{-11})
Interstate Waste Technologies	0.000000000000081 (8.10 x10^{-14})
Arrow Ecology and Engineering	This biological process does not produce dioxins or furans

(All limits normalized to lbs dioxins/furans per ton municipal solid waste)[7]

It's important to note that any conversion technology facility constructed in the South Coast Air Quality Management District (SCAQMD) will be subject to even more stringent permitting conditions than the limits above. SCAQMD is the air pollution control agency for Orange County and the urban portions of Los Angeles, Riverside, and San Bernardino counties. Because this region does not meet the Clean Air Act standard for healthy air, it is identified as a "non-attainment" area, requiring a "New Source Review"[8] for all new and modified sources in the area. Any facility or process that still produces emissions after the best available controls are implemented (above a very low threshold level) are required to offset those emissions in excess of the emissions generated, typically at a ratio of 1.2 to 1. After an extensive vetting process, the County is confident that the four technology companies under consideration by the County (i.e. Arrow, Entech, IES, and IWT) will operate within all regulatory guidelines.

Conversion Technologies Are By Far The Most Energy-Efficient Waste Management Practices, And Can Reduce Net Air Emissions

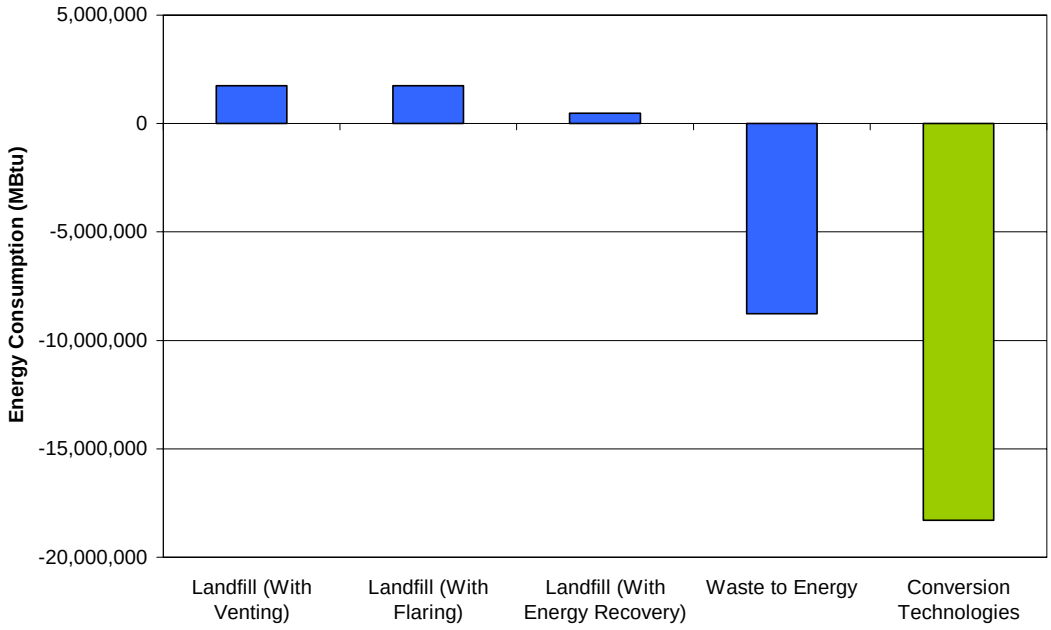
In the 2007 Staff Report to the Board entitled *New and Emerging Conversion Technologies*[9], the California Integrated Waste Management Board (CIWMB) developed several hypothetical waste management scenarios for a projected amount of waste generated in the year 2010. As noted in the CIWMB report, energy is an important factor when conducting a lifecycle analysis of a waste management scenario because air and water emissions are often a result of energy production. The report found that "as compared to the alternative management scenarios, the conversion technology scenario ranges from two times lower in net energy consumption when compared to the waste-to-energy scenario, to 11 times lower than the landfill without energy recovery scenarios[10]".

The CIWMB report attributes these conversion technology savings are to:

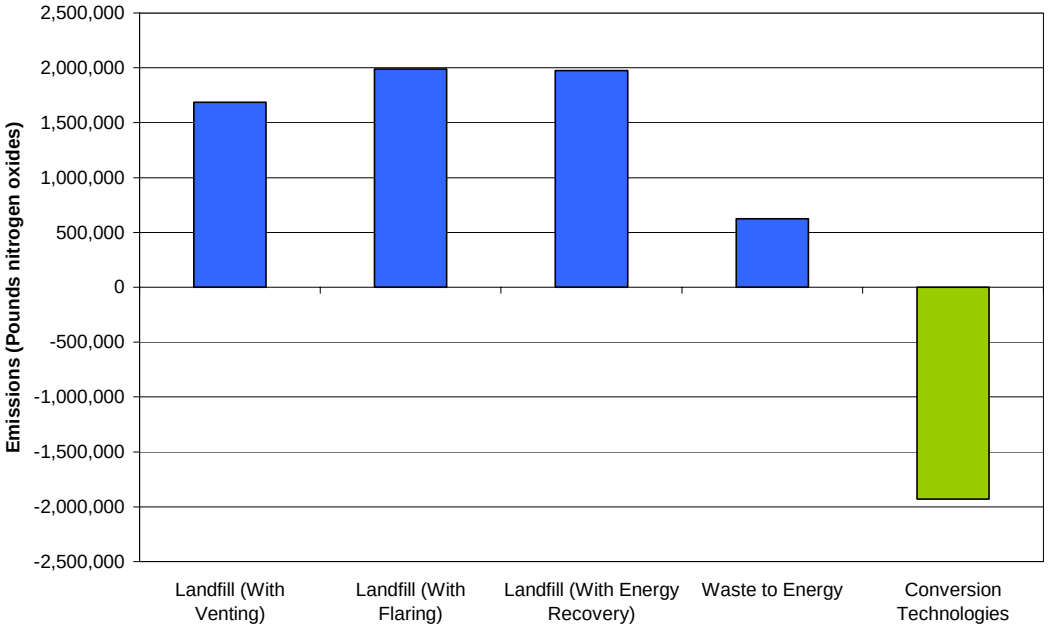
1) electricity production which offsets electricity produced by the utility sector;
2) biofuels production which offsets fuel production from fossil fuel sources; and
3) recyclable and reusable materials that are recovered, which offset the production of these products from virgin resources.

The CIWMB developed the following graphs, which compare emissions from landfills, waste-to-energy, and conversion technologies. The research indicates the conversion technologies have the lowest net criteria air pollutant levels and GHG emissions, and can actually help make our air cleaner by offsetting higher emissions from other sources:

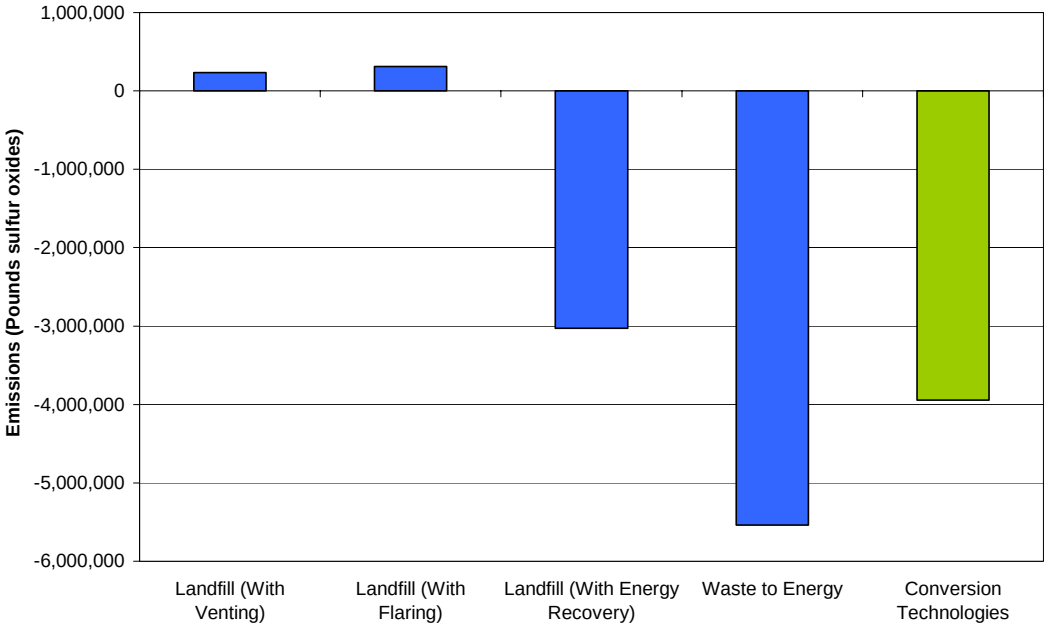
Annual Net Energy Consumption - Greater Los Angeles Region
2010



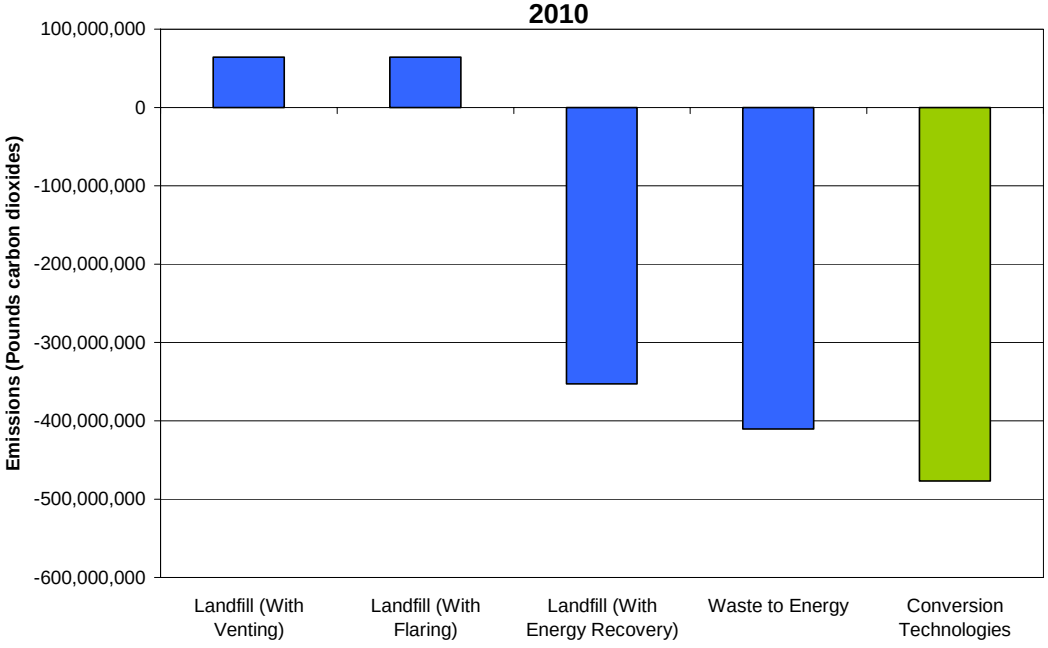
Annual Nitrogen Oxides Emissions - Greater Los Angeles Region
2010



Annual Sulfur Oxides Emissions - Greater Los Angeles Region
2010



Annual Carbon Dioxide (from Fossil Fuels) Emissions - Greater Los Angeles Region
2010



Conversion Technologies Are An Integral Climate Change Solution

In February 2008, the California Air Resources Board's Economic and Technology Advancement Advisory Committee (ETAAC) released a report noting that *by conservative estimates,* conversion technologies have the potential to reduce annual GHG emissions by approximately five million metric tons of CO_2 equivalent in California.[11]

In fact, the potential GHG reduction of conversion technologies may be significantly greater, since conversion technologies have a simultaneous triple benefit to the environment: 1) reduction of transportation emissions resulting from long distance shipping of waste; 2) prevention of methane and other emissions from waste that would otherwise be landfilled; and 3) displacement of the use of fossil fuels from the energy (fuel and electricity) produced by conversion technologies. The ETAAC report only estimated reductions from this third benefit.

Conversion Technologies vs. Current Energy Production Practices

According to the U.S. Department of Energy and the California Energy Commission, approximately half of the electricity used in the United States and about one-sixth of California's electricity is generated by coal combustion[12]. Coal has the highest carbon intensity among fossil fuels, resulting in coal-fired plants having the highest output rate of carbon dioxide per kilowatt hour[13]. Emissions from coal combustion for electricity constitute 32 percent of total U.S. carbon dioxide emissions[14]. For comparison purposes, the following table illustrates the difference in emissions between a typical coal plant and a theoretical IES pyrolytic facility operating in Southern California. In all categories, the IES facility emits fewer pollutants including 67 percent less CO_2 than the coal plant.

Air Emissions Comparison of Equivalent-Sized Coal and Conversion Technology Facilities

POLLUTANT	10 MW COAL PLANT[15]	10 MW IES CONVERSION TECHNOLOGY FACILITY[16]
Sulfur Dioxide	400,000	230
Nitrogen Oxide	408,000	76,755
Carbon Dioxide	148,000,000	49,033,364
Small Particles	20,000	1,701
Hydrocarbons	8,800	1,555
Carbon Monoxide	28,800	0.00
Arsenic	4.50	0.03
Lead	2.28	0.01
Cadmium	0.08	0.01
Mercury	3.69	0.09

(All pollutants measured in pounds/year)

Conclusion

Managing our waste through the best available conversion technologies rather than relying on current disposal options can lead to a net reduction in air emissions. These technologies have been used successfully in other parts of the world. Any new facilities developed would be required to comply with the most stringent air emissions controls and standards in the U.S., and are capable of doing so. Conversion technologies have the potential to provide real benefits to our ability to address the energy, solid waste and climate change crises. For more information and to download copies of key reports, please visit: www.SoCalConversion.org

A Project of Los Angeles County Department of Public Works

"Communities where residents live and work in a safe, clean and sustainable environment"

[1] California Integrated Waste Management Board, *Staff Report to the Board: New and Emerging Conversion Technologies,* 2007 pg 10

[2] Adapted from University of CA, Riverside "Evaluation of Environmental Impacts of Thermochemical Conversion Technologies Using Municipal Solid Waste Feedstocks: Final Summary Report", 2006

[3] Significant figures are provided for ease of comparison; however, the actual measurements may not be accurate to this level of detail.

[4] IES utilized selective non-catalytic reduction (SNCR) for controlling nitrogen oxide emissions. Typically SNCR control efficiency ranges from 10 - 40%. This control technology was utilized in source testing due to engineering and manufacturing time schedules. Additionally SNCR lowered the nitrogen oxide emissions below SCAQMD permit limit for 24/7 operation. Although the use of SNCR brought these emissions during source testing into compliance, future IES facilities are being designed to use selective catalytic reduction (SCR) for nitrogen oxide control. This technology is proven to reduce nitrogen oxide emissions from 65 - 90%. It is anticipated that the use of SCR will bring the nitrogen oxide emissions well within the EPA limit.

[5] Adapted from *Los Angeles County Conversion Technology Evaluation Report - Phase II Assessment,* prepared for Los Angeles County Department of Public Works by Alternative Resources, Inc, 2007

[6] Significant figures are provided for ease of comparison; however, the actual measurements may not be accurate to this level of detail.

[7] Dioxin and furan emissions listed herein are evaluated on a basis known as ITEQ (International Toxic Equivalents), which accounts for the relative toxicity of the individual compounds. In the United States, dioxin and furan emissions are often reported on a total mass basis, which does not account for the toxicity of the individual compounds. U.S. EPA published an equivalency between total mass and toxic equivalents, specifically for traditional waste-to-energy technology, in 60 FR 65396. The total mass statistics available in the United States were converted to ITEQ. For comparison, traditional waste-to-energy facilities in California, on average, generate 0.000000000540838 (5.41x 10-10) Lbs Dioxins/Furans per ton MSW processed, also well below the U.S. EPA limit for new sources.

[8] South Coast Air Quality Management District: "New Source Review" http://www.aqmd.gov/prdas/NSR/index.html

[9] California Integrated Waste Management Board, *Staff Report to the Board: New and Emerging Conversion Technologies,* 2007, pp 60-64

[10] Ibid, pg 60

[11] Economic and Technology Advancement Advisory Committee, "*Technologies and Policies to Consider for Reducing Greenhouse Gas Emissions in California",* 2008

[12] Energy Information Administration (EIA) http://www.eia.doe.gov/fuelelectric.html

[13] US Dept. of Energy, *Carbon Dioxide Emissions from the Generation of Electric Power in the United States,* 2000

[14] Energy Information Administration (EIA) Annual energy outlook And EIA 2007 Emission of greenhouse gases in the U.S., 2008

[15] Union of Concerned Scientists, *"How Coal Works"* (values prorated from a 500 MW coal plant), http://www.ucsusa.org, 2008

[16] International Environmental Solutions (IES), 2006 Air Kinetics Report, values prorated from testing of 13.36 tpd MSW

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Memorandum

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TO: William Schoen, R3 Consulting Group

FROM: Jim Binder, Sue Higgins

DATE: July 5, 2011

SUBJECT: Conversion Technology Options for SMaRT Station®

Data provided to ARI in the SMaRT Station Residue Waste Composition File (June 9, 2011) shows that in 2010 the SMaRT Station received 179,230 tons of MSW for processing through the mixed MSW sorting lines. Approximately 15% of this MSW (26,799 tons) was recovered and diverted to recycling markets. The remaining material consisted of a fine fraction (minus 2" material) and residual waste. The data provided show that 30,276 tons of minus 2" material was generated in 2010, of which 7,357 tons were reported as being marketed. The unmarketed minus 2" material (22,919 tons) and the residual waste (122,155 tons) were delivered to the Kirby Canyon Landfill for disposal (145,074 tons disposed, in total).

ARI has reviewed the waste characterization data to determine the potential to process the residual waste and the minus 2" material from the SMaRT station using anaerobic digestion and thermal conversion technologies. Our findings are presented below, along with key information pertaining to energy/material outputs, residue requiring landfilling, and planning level tipping fees (cost).

Processing and Management of the Residue

In 2010, the SMaRT Station generated 122,155 tons of residual waste that was delivered to the Kirby Canyon Landfill for disposal. Based on the City of Sunnyvale Waste Characterization Study (2010) and the corresponding SMaRT Station Residue Waste Composition File (June 9, 2011), this residue is generally characterized as follows:

Material	Percent by Weight
Paper	52.4%
Plastic	11.7%
Glass	0.1%
Metal	1.7%
Organics	24.0%
Electronics	0.0%
Inerts	3.2%
HHW	0.3%
Special Waste	2.7%
Mixed Residue	3.9%
Total	100.0%

This material is most suitable for thermal treatment, such as pyrolysis or gasification, and less suitable for anaerobic digestion. Although the feedstock includes compostable paper and other compostable organics, there are processing limitations in separating these remaining compostable materials from the other inert and undigestable materials in the residue. As a result, a greater amount of contaminants would pass through the digestion process and end up in the compost material. There may be potential applications with wet anaerobic digestion technologies, such as those that employ water-based sorting and separation techniques, but the material appears best suited for thermal treatment.

A gasification facility designed to receive and process mixed residue from the SMaRT station would require minimal or no front-end processing, since processing is already accomplished at the SMaRT station. For some technologies, a limited amount of additional waste processing may be implemented, such as shredding and/or drying. The facility could be configured to generate electricity for sale or to produce other energy products. Based on the characteristics of the feedstock (i.e., predominantly paper, plastic and wood), gross electricity generation would be on the order of 720 kWh/ton of preprocessed feedstock, which in this application would be the MRF residue received from the SMaRT Station; actual output may vary, depending on the heating value of the feedstock material as well as the type of power generation equipment used. The process would generate a char or an ash residue that is assumed to be disposed of in a landfill; the residue generation rate could range from approximately 10-20% by weight of the feedstock received for processing. Certain thermal technologies, such as high temperature gasification and plasma gasification, produce less ash residue, replacing it in whole or part with a vitrified aggregate byproduct. However, these types of thermal technologies are more costly and have a higher capital and operating cost profile, generally making them less suitable for smaller-

scale applications (such as the SMaRT Station) and more suitable for larger-scale applications (i.e., 500-1000 tpd or larger plants).

A planning level estimated cost for a gasification facility designed to process approximately 122,000 tpy of mixed residue from the SMaRT Station ranges from approximately $69 (Case 1) to $133 (Case 2) per ton. This estimated planning level cost range is based on key assumptions including average capital and operating costs for a number of different thermal technologies, which individually can have different costs based on the technology employed and unique performance and cost profiles. Other key assumptions include the financing approach (public or private financing), the amount of electricity generated for sale and the value of the electricity sold, and the amount of residue requiring landfill disposal. The ability to obtain grant funding can also have a measurable, positive impact on costs. ARI's estimates are provided below, as two cases which frame the overall range:

- **Case 1.** The lower end of the cost range is based on the assumption that the technology minimizes residue requiring landfill disposal to 10% by weight of the feedstock received for processing. The residue is assumed to be disposed of at the Kirby Canyon Landfill, at a cost of $70 per ton for transport and disposal. The lower end of the cost range also assumes that the facility maximizes electricity output at 720 kWh/ton, with sale of the electricity at a levelized price of $0.142 per kWh. This assumed electricity sale price is based on a recent estimate by the municipal utility in Palo Alto for an anaerobic digestion facility feasibility study. It is inclusive of capacity payments and any and all renewable and environmental attributes, accounting for the impact of the Renewable Energy Act that was passed in April 2011. This renewable pricing is assumed to apply, based on recent determinations by CalRecycle and CEC that found certain thermal technologies eligible. However, future determination of renewable eligibility is not certain, and would be technology-dependent. It is assumed that all of the electricity generated is sold, with the facility purchasing electricity to meet its internal needs. The project is assumed to be publicly financed at a debt interest rate of 5%; other financing assumptions include amortization of the debt over a 20-year project period, and application of a 15% factor for financing soft costs and reserve fund. Public financing scenarios would accommodate project delivery methods such as design-build (DB) or design-build-operate (DBO). Based on these assumptions, the estimated cost is on the order of $82 per ton. As noted above, grant funding can have a measurable, positive impact on costs. For this Case 1, a grant of $15 million, which is approximately 15% of total project planning, development and construction cost, would lower the estimated cost to approximately $69 per ton.

- **Case 2.** The higher end of the cost range is based on the assumption that the facility generates residue requiring landfill disposal at a rate equal to 20% by weight of the feedstock received for processing. The residue is assumed to be disposed of at the Kirby Canyon Landfill, at a cost of $70 per ton for transport and disposal. The higher end of the cost range also assumes a more conservative net electricity output of 500 kWh/ton, with sale of the net electricity at a levelized price of $0.142 per kWh (inclusive of capacity payments and any and all renewable and environmental attributes, as discussed above). It is assumed that all of the electricity generated is

sold, with the facility purchasing electricity to meet its internal needs. The project is assumed to be privately financed and developed, with generally conservative financing assumptions (e.g., equity requirement of 30%; a return on equity of 25%; a 5.25% debt interest rate; debt service amortized over a 20-year project period, and a 15% factor for financing soft costs and reserve fund). Based on these assumptions, the estimated cost is on the order of $151 per ton. As noted above, grant funding can have a measurable, positive impact on costs. For this Case 2, a grant of $15 million, which is approximately 15% of total project planning, development and construction cost, would lower the estimated cost to approximately $133 per ton.

Processing and Management of the Minus 2" Material

In 2010, the SMaRT Station generated 30,276 tons of minus 2" material. The City of Sunnyvale Waste Characterization Study (2010) and the corresponding SMaRT Station Residue Waste Composition File (June 9, 2011) did not include sampling and characterization of the minus 2" material. However, the fine fraction resulting from similar sorting and separation of mixed MSW at other comparable facilities is typically an organically-rich stream, largely inclusive of food scraps along with other organic materials that have not been separately recovered. Although this material is also expected to include small pieces of glass, metal, plastic, rocks, dirt and other fine inerts, it can typically have an organic content of 75-90% by weight. Assuming the minus 2" material from the SMaRT Station is similarly organically rich, this material is suitable for anaerobic digestion, which performs well with organically rich feedstocks.

An anaerobic digestion facility designed to receive and process the organically-rich, minus 2" material (which would include the minus 2" material currently sold) would require minimal or no front-end processing, since the necessary processing is already accomplished at the SMaRT station. The facility could be configured to generate electricity or pipeline quality natural gas as the key energy output. Assuming the feedstock is approximately 85-90% organic in content, gross electricity generation could be on the order of 180 kWh/ton of received feedstock; gross output of pipeline-quality natural gas could be on the order of 118,000,000 scf per year. The process would generate compost that could be marketed for beneficial use. The amount of compost that would be generated could range from approximately 25-30% by weight of the feedstock received for processing. Residue requiring landfill disposal could range from 10-25% by weight of the feedstock received for processing, depending on the amount of inert or otherwise undigestible materials present in the feedstock and the specific technology employed, as well as the extent of post-processing required to meet market specifications for the compost (e.g., compost screening).

A planning level estimated cost for an anaerobic digestion facility designed to process approximately 30,000 tons per year of organically rich fines from the SMaRT Station ranges from approximately $62 (Case 1)to $96 (Case 2) per ton. This estimated planning level cost range is based on key assumptions including average capital and operating costs for a number of different anaerobic digestion technologies, which individually can have different costs based on the technology employed and unique performance and cost profiles. Other key assumptions include the financing approach (public or private financing), the amount of

electricity generated for sale and its sale price, the amount of compost generated and the value of the compost, and the amount of residue requiring landfill disposal. The ability to obtain grant funding can also have a measurable, positive impact on costs. ARI's estimates are provided below, as two cases which frame the overall range:

- **Case 1.** The lower end of the cost range is based on the assumption that the minus 2" fines are approximately 90% organic in content, resulting in approximately 10% residue requiring disposal. The residue is assumed to be disposed of at the Kirby Canyon Landfill, at a cost of $70 per ton for transport and disposal. Compost is assumed to be generated at a rate of 30% by weight of the feedstock received for processing, and sold at a value of $5 per ton. The assumed electricity generation rate is 180 kWh/ton of feedstock. The total amount of electricity generated is assumed to be sold (i.e., with electricity purchased to meet internal project needs), at a levelized sale price of $0.142 per kWh. This assumed electricity sale price is based on a recent estimate by the municipal utility in Palo Alto for an anaerobic digestion facility feasibility study. It is inclusive of capacity payments and any and all renewable and environmental attributes, accounting for the impact of the Renewable Energy Act that was passed in April 2011. The project is assumed to be publicly financed at a debt interest rate of 5%; other financing assumptions include amortization of the debt over a 20-year project period, and application of a 15% factor for financing soft costs and reserve fund. Public financing scenarios would accommodate project delivery methods such as design-build (DB) or design-build-operate (DBO). Based on these assumptions, the estimated cost is on the order of $68 per ton. As noted above, grant funding can have a measurable, positive impact on costs. For this Case 1, a grant of $2 million, which is approximately 15% of total project planning, development and construction cost, would lower the estimated cost to approximately $62 per ton.

- **Case 2.** The higher end of the cost range is based on the assumption that the minus 2" fines are approximately 75% organic in content, resulting in approximately 25% residue requiring disposal and 25% compost. The residue is assumed to be disposed of at the Kirby Canyon Landfill, at a cost of $70 per ton for transport and disposal. The compost is assumed to be beneficially used, but at no net value (i.e., the compost is essentially given away or sold at a nominal price to offset the cost of transport to market). The assumed electricity generation rate is 150 kWh/ton of feedstock. The total amount of electricity generated is assumed to be sold at a levelized sale price of $0.142 per kWh (inclusive of capacity payments and any and all renewable and environmental attributes, as discussed above). The project is assumed to be privately financed and developed, with generally conservative financing assumptions (e.g., equity requirement of 30%, a return on equity of 25%, a 5.25% debt interest rate; debt service amortized over a 20-year project period; and a 15% factor for financing soft costs and reserve fund). Based on these assumptions, the estimated cost is on the order of $109 per ton. As noted above, grant funding can have a measurable, positive impact on costs. For this Case 2, a grant of $2 million, which is approximately 15% of total project planning, development and construction cost, would lower the estimated cost to approximately $96 per ton.

Summary

The waste characterization of the SMaRT Station indicates the residue remaining after recovery of recyclables and separation of the organically-rich fines fraction would be suitable for thermal processing. Based on key assumptions disclosed herein, a planning level estimated cost for a gasification facility designed to process approximately 122,000 tpy of this residue ranges from $69 (Case 1) to $133 (Case 2) per ton. The organically-rich fines fraction would be suitable for anaerobic digestion. Based on key assumptions disclosed herein, a planning level estimated cost for an anaerobic digestion facility designed to process approximately 30,000 tpy of the fines ranges from $62 (Case 1) to $96 (Case 2) per ton.

The estimated costs presented herein are based on information available from proposed projects in other California locations. The estimates, therefore, exclude any unique site-specific considerations, such as unique requirements associated with site development activities, and costs to purchase or lease land. The costs are representative of a stand-alone facility, and do not include any cost savings that could be realized from the use of existing infrastructure, including, for example, use (or partial use) of existing buildings, roadways, scalehouse, office areas, utility interconnections, and the like. A site specific analysis, beyond the scope of this study, would be required to evaluate the potential value of existing infrastructure.

Appendix E

Implementation Schedule

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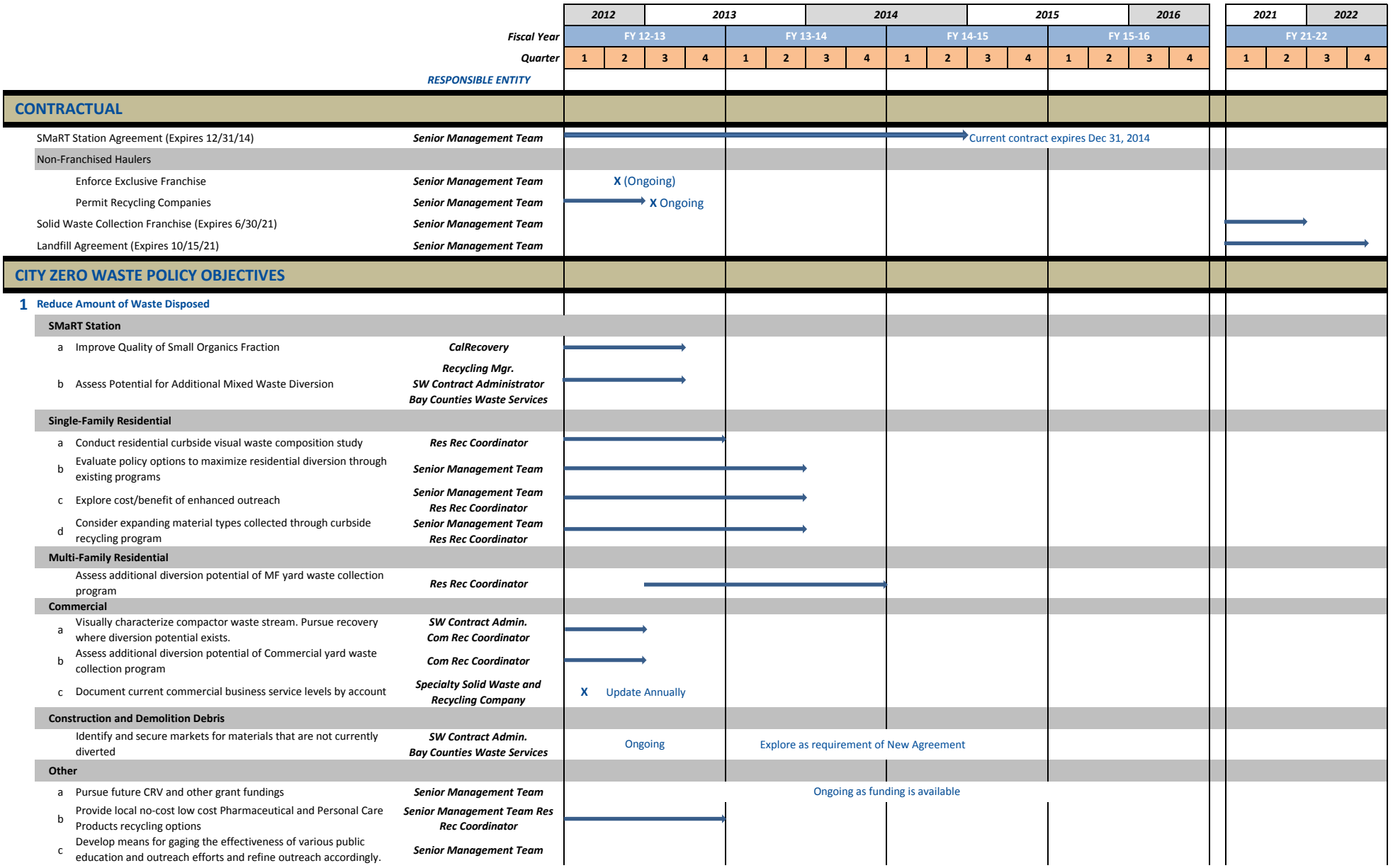
Appendix E
Implemenation Schedule



Appendix E
Implemenation Schedule

		RESPONSIBLE ENTITY	2012		2013		2014				2015				2016		2021		2022	
			FY 12-13				FY 13-14				FY 14-15				FY 15-16				FY 21-22	
			1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
2	**Encourage Residents and Busiensses and Agencies to Reduce, Reuse and Recycle Judisiously**																					
	a Develop enhanced outreach program	***Recycling Manager*** ***Com Rec Coordinator***																				
	b Develop Audit Protocol																					
	c Conduct Informational Audits																					
	d Coordinate with Chamber of Commerce																					
	e Conduct Zero Waste Audits / Green Business Audits																					
	All City Departments																					
	All Schools																					
	Large Venues																					
	All Commercial Businesses															X Ongoing						
3	**Empower Consumers to use their buying poer to demand non-toxic, easily reused, recycled or composted products**																					
	a Develop Residential Zero Waste "Shopping List"	***Recycling Manager*** ***Res Rec Coordinator***																				
	b Incorporate CalRecycle's Waste Reduction suggestions for specific industriles into proactive prioritized outreach to commercial sector	***Recycling Manager*** ***Com Rec Coordinator***	Ongoing in conjunction with commercial Zero Waste Audits (2a)																			
4	**Encourage manufacturers to produce and market less toxic and more durable, repairable, reusable, recycled and recyclable products**																					
	a Maintain CPSC and SCCPSC Memberships	***Senior Management Team*** ***Com Rec Coordinator***		Ongoing																		
	b Continue Lobbying Efforts			Ongoing																		
	c Actively promote existing EPR Programs			Ongoing																		
	d Encourage Local Businesses to Implement voluntary take back programs			Ongoing																		
5	**Lobby regional, state and federal legislators to implement laws, policies and regulations that promote Zero Waste**																					
	a Maintain CPSC and SCCPSC Memberships	***Senior Management Team***		Ongoing																		
	b Continue Lobbying Efforts			Ongoing																		
6	**Work locally and regionally to assist in Zero Waste planning**	***Senior Management Team***		Ongoing																		
7	**Lead by example and implement Zero Waste goals for all City buildings**																					
	Conduct Zero Waste Audits of all City Departments	***Recycling Manager*** ***Com Rec Coordinator***																				
8	**Put policies in place that favor environmentally sustainable practices**	***Senior Management Team***		In conjunction with Policy Objective #7																		
9	**Provide the community with information about Zero Waste that includes periodic reports that measure progress**	***Senior Management Team***		Ongoing																		