ORISN Resource Innovation and Solutions Network

Regional Circular Organic Resource System

Project Overview
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What if we could collaborate with other cities in our region to divert waste from the landfill and turn it into useful products?

A future vision... looking back from the year 2050 through the eyes of a Public Works professional

It's 2050 – the year I've been focused on for the past 40 years. I never dreamed that I'd spend the last four decades in the field of Public Works, but now that I've reached retirement age I can look back on my career with a great deal of pride. It's gone fast – but now that I have a chance to sit back and reflect, I can't believe how much has been accomplished. And I can't believe how exciting, frustrating, challenging and life-changing it has been.

When I started my career in 2010, the field of Public Works was about standard municipal services: infrastructure management, emergency response, parks and grounds, water and sewer, waste management… and we had just started learning more about sustainability principles with some of the more visionary leaders and stakeholders around the Valley.

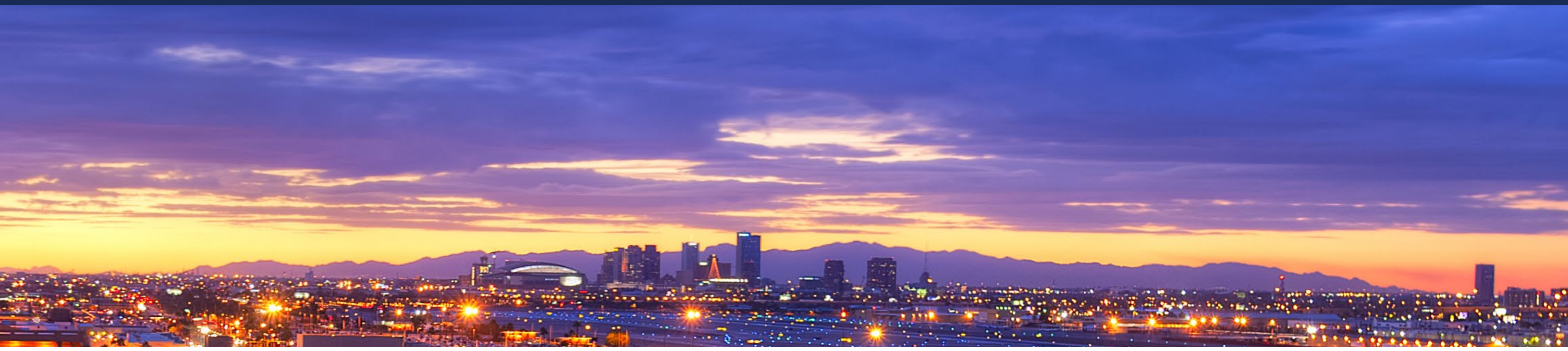
Sure, we were doing recycling, but we didn't really get on the sustainability train until regional leaders realized that there was a lot of value – for the people in our communities, for the cities' prosperity and for the welfare of the planet – in what we called, at the time, waste. The new rallying cry was "Let's turn trash into resources" through a new economic model termed "The Circular Economy," where waste is re-purposed into useful products. I have to admit that as a young person involved in Public Works, that was an inspiring and invigorating concept.

What if we could collaborate with the other cities in our region to divert waste from the landfill and turn it into useful products? What if through our work, we could make life better for our communities five, ten, 20 and even 40 years into the future? In 2010, I was newly married with our first baby on the way when this all began, so suddenly thinking about the future took on much greater importance.

The rise of Reimagine Phoenix and RISN

In 2013, the city of Phoenix, led by its mayor Greg Stanton, created the Reimagine Phoenix Initiative, with the goal of a 40% waste diversion rate for Phoenix by 2020 – a really ambitious bar to me at the time. Then Phoenix took a step further into the future when it partnered with Arizona State University to establish the Resource Innovation and Solutions Network, or RISN. RISN was a huge idea – a global knowledge network for the circular economy, with hubs across the nation and around the world, starting here in Phoenix. Ground

GOAL: 40% of green organics waste in the Phoenix Metropolitan Area from landfills by 2050



This regional organics system design scenario for the Phoenix Metropolitan Area is being offered by the Resource Innovation and Solutions Network, or RISN. RISN brings together university, government, business and non-governmental partners to transform the relationship between resources, the environment, the economy and society and create a resource-focused Ethical Circular Economy platform that replaces the linear model of produce-use-discard with a circular model in which discarded materials are transformed into usable products, essentially eliminating waste.

The critical components of RISN include the need for economic development driven by the business case for sustainability, encouraging regional public-private collaboration, delivering solutions through system design and building a Resource Innovation Campus to attract innovators and entrepreneurs to turn waste materials into resources.

From a series of regional collaborative planning meetings conducted by RISN attended by a large number of regional agencies, the issue of green organics waste emerged as a common problem across municipalities that could benefit from collaborative solutions. In June 2015 a collaboratively funded project was initiated to assess the feasibility of a regional approach to building an organics management system. This report presents one such scenario based on extensive analysis of technology, waste sheds, participating cities, logistics, collection programs, siting of facilities and potential product output and financial performance of organics processing facilities.

Current Situation

Thirty to sixty percent of the residential waste stream in the Phoenix Metropolitan Area (PMA) consists of green organic yard and landscape waste, equating to over 400,000 tons per year, the majority of which currently goes to landfill. This region is an ideal location for the siting of organic processing facilities due to the combination of high volume potential and the long growing season that generates green organic waste throughout the year. Despite this potential, there are legitimate concerns that any solution to divert this material might result in higher costs to area residents.

Based on the recognition of green organics potential, Phoenix, the Town of Gilbert, Maricopa County, the City of Mesa, the City of Peoria, Pinal County, the Salt River Pima-Maricopa Indian Community, the City of Scottsdale and the City of Tempe came together to jointly fund this regional study with a goal to:

> ***Identify plausible pathways to the achievement of a regional, multi-site green organics circular processing system that diverts 40% of green organics waste in the Phoenix Metropolitan Area from landfills by 2050.***

Research and reporting were carried out by a team from the Global Sustainability Solutions Services, a program of the Walton Sustainability Solutions Initiatives at Arizona State University (ASU) on behalf of RISN. Design support was provided by ASU's School of Geographical Sciences and Urban Planning and ASU's Decision Theater.

Research Agenda and Methodology

Key Design Questions and Drivers:

- What might be one or more scenarios that optimize the collection and processing of organics waste streams?
- How might regional collaboration play a role?
- What would be the financial performance of these collaborative solutions?
- What are the viable technical alternatives for the PMA?
- What are the policy implications in terms of collections, capital investment and shared value creation?

Design Methodology:

The project team executed the following steps to arrive at the sample scenario:

- Conduct a literature and best practices review was conducted to provide better understanding of the feasibility of implementing a green organics recovery program, by reviewing successful programs in the US.
- Develop recommended management guidelines for the planning, building and operation of an organic waste management facility was developed based on a best practices review of the literature.
- Conduct an institutional analysis of local municipal regulations, policies and practices to aid in guiding the outcomes of a regional green organics system was done based on 34 interviews with a broad cross-section of stakeholders.
- Model the regional organics system using two interconnected steps:
    - The availability (quantity and distribution) of regional organics waste resources was mapped using ArcGIS, a geographic information system. The spatial distribution around the region allowed for the optimization of location for the appropriate capacity of processing facilities.
    - The quantity of resource available as feedstock was then modeled with financial parameters to evaluate the financial performance of each facility using Python.
    - The models were then combined to define a viable regional scenario.

A Valley-Wide Scenario in Three Phases

This report presents a scenario that is one of many possible pathways to a PMA-wide organics management system. It is intended to be illustrative of these possible pathways. The scenario is in no way intended to be a recommendation or plan, but simply to investigate the possibility of a regional approach to organics management.

The goal of the scenario is to provide organics processing for as many municipalities in the PMA as would like to participate. The scenario primarily relies on securing feedstock from the larger municipalities but there is capacity for collaboration with other municipalities, counties, tribes or private partners.

A key aspect of the scenario is that it suggests that the infrastructure for a regional organics system is likely to be largely under public ownership, with public-private options for operations and management. In the scenario presented herein, 11 organic waste facility sites could be implemented in three phases by 2050. Eight of the sites are existing municipality owned, two are tribal owned and one facility is privately owned.

The scenario suggests that these facilities might be built over three broad phases between the present date and 2050: 2016-2030, 2030-2040 and 2040-2050. Figure 1 illustrates the full build out of this scenario including the distribution of each of the 11 sites around the PMA, and the organics waste sheds that they serve, based on minimizing transportation costs.

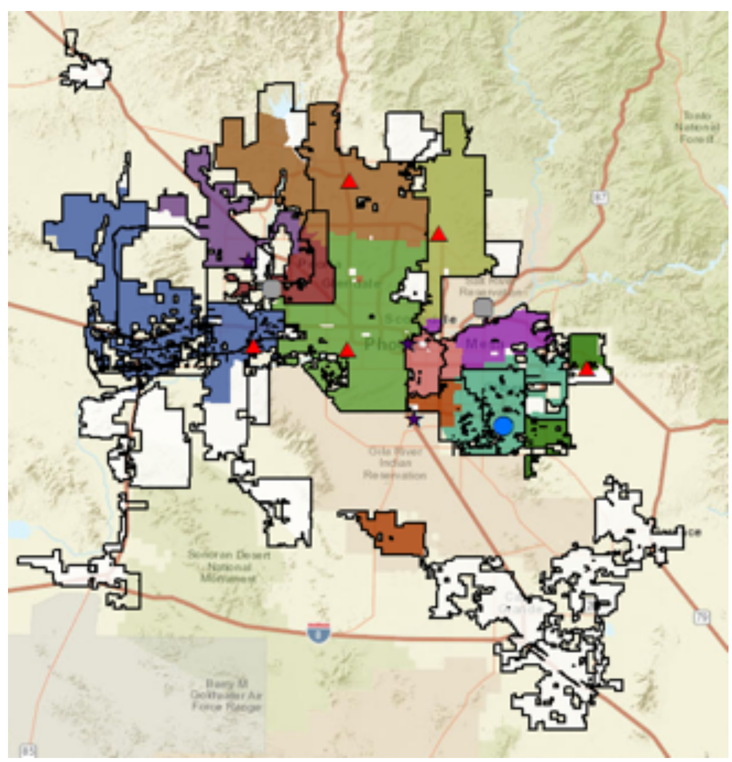


Figure 1. 2050 Built Out Scenario: Organics collection sheds and processing facilities

Key System Design Considerations and Constraints

The following system components are key considerations and constraints of the analysis and design process used:

- Types and collection of feedstock. The project began with a focus on green organics, primarily source separated organics (SSO) residential yard waste, through Third Bin programs. Research showed that food waste is both an important component for producing high quality compost and a primary input for an Anaerobic Digestion (AD) facility. This study excludes any research into residential SSO programs for food waste, but there is an increasing opportunity to establish SSO programs at restaurants, grocers and other food processing facilities. Other organic waste streams that could be a source for composting and/or AD operations include fats, oils and grease (FOG) partnerships with restaurants or animal waste SSO programs with zoos, livestock and horse owners and stables. A deeper study on seasonality, levels of contamination and the quantity and processing options of problem organics such as palm fronds, oleanders and cactus is outside of the scope of this project but is recommended as part of a feasibility study for the siting of an organics processing facility.
- Technology. The technologies available for organics processing include composting, AD, gasification and pyrolysis. Common across these technologies is the ability to extract value from organic waste. With the increasing emphasis on mitigating the consequences of global climate change, there is growing awareness of the impact of landfill-generated methane emissions. Composting and AD are currently the only commercially viable technologies, so they were the only technologies evaluated for siting purposes in this study. Composting produces usable natural fertilizer that improves the water holding capacity of soil, which is particularly important in a desert environment. Anaerobic digestion produces biogas that can be burned to produce electricity; it can also be cleaned and injected into natural gas pipelines or compressed into a vehicle fuel as compressed natural gas (CNG). AD and composting can work well together when integrated into a single facility, as they can produce a finished compost that can be sold as a high-quality fertilizer.
- Collaboration and shared value. Collaborative agreements among the municipalities in the PMA provide an opportunity to increase efficiency and reduce cost. Intergovernmental Agreements (IGA) are a mechanism to establish joint agreements between municipalities to solve problems according to specific requirements based on local conditions and needs. Many of the siting locations included in this cenario require collaboration among neighboring municipalities. These collaborations provide the opportunity to reduce transportation costs and achieve economies of scale on a regional basis but also require a commitment from each municipality. IGAs that define the roles and functions of each municipality will help facilitate this process. A long term relationship is necessary between the municipal partners and the public or private processor. These relationships must be based on a shared understanding of the goals of the agreement for all of the participants over the long term and not based solely on cost reduction. Agreements must identify expectations of initial funding requirements and ongoing operating costs, particularly considering the volatility of the markets for compost and energy. A coordinated plan for communicating to city councils and residents how shared value would benefit them could help mitigate negative publicity and public perception if/when things do not go as planned.
- Policy. At the city level, primary policy mechanisms regarding Third Bin collection programs are needed. At the county level, there should be some enforcement without regulation. A significant number of states have implemented bans on organic material from the landfill.

Scenario Modeling Support

The economic and political environment in the State of Arizona has made it challenging for municipalities to introduce new waste diversion initiatives. However, these same municipal leaders understand that in addition to the rising long-term economic costs of landfilling organics, environmental and social costs are also on the rise. Under this changing cost structure, the discussion is shifting from “if” it is viable to invest in an organics diversion initiative to “when and how” it will become viable.

In support of this, a decision support model was developed to help the municipalities evaluate the opportunity to site a technology at a specific location with a specific tonnage capacity. The model provides the functionality to analyze viable collections alternatives and the requirements for the organics processing technology that could support cost effective collections for the municipalities and financial viability for the facility.

ASU developed the Regional Circular Organic Resource System Design Model (RCORS) to support a regional approach to providing feedstock to a facility. The front end is a Geographic Information System

(ArcGIS) model that uses census tracts to identify the potential collection shed required to provide the necessary green organic feedstock. RCORS model includes the functionality to optimize collection strictly based on distance and it allows the user to select specific municipalities to participate in providing feedstock for a facility.

For evaluation of the financial viability of the organics processing facility, RCORS calculates a 20-year Internal Rate of Return utilizing estimated annual quantity and quality of organic waste feedstock from specifiable municipalities, based on proximity of the processing facility facility costs and market prices for the produced outputs.

Scenario Analysis
For each of the sites evaluated in the regional scenario, participating municipalities are assumed to collect the green organic yard waste through a Third Bin green organics program and/or in a bulk waste collections program. The Third Bin collections efficiency used for the model assumes the performance of Mesa's 3rd Bin program over 10 years, as follows:

Annual Pickup Frequency: 52
Residential Participation Rate: 30%
Weekly Resident Set-out Rate: 40%
Pounds per Household per Pickup: 50

Based on these assumptions, the maximum capacities, technologies and designed consumption for each site is shown in Table 1:

Phase	Site	Composting Capacity (tons per year, TPY)	Anaerobic Digestion Capacity (TPY)
1: 2016 - 2030	City of Phoenix 27th Avenue Transfer Station	110,000	50,000
	South Greenfield area in Gilbert	50,000	50,000
	City of Scottsdale Transfer Station	25,000	25,000
	City of Tempe SW Compost Yard	10,000	0
	Right Away Disposal (RAD) Waste and Recycling Facility	5,000	0
TOTAL PHASE 1 CAPACITY		**325,000**	
2: 2031-2040	City of Phoenix North Gateway Transfer Station	50,000	50,000
	Salt River Landfill	0	25,000
TOTAL PHASE 2 CAPACITY		**125,000**	
3: 2041 - 2050	City of Glendale Landfill	20,000	0
	City of Surprise	20,000	0
	City of Avondale Transfer Station	20,000	0
	Gila River Indian Community (GRIC)	15,000	0
TOTAL PHASE 3 CAPACITY		**65,000**	
TOTAL DIVERSION IN THE REGION		**515,000**	

Table 1. Facility and Capacities for all Phases

Diversion

The total diversion of the three phases is summarized in the Table 2. By 2050, for the participating municipalities, diversion of green organics could reach 57%.

Phase	Green Organics Waste (GO)	Cumulative GO	Food Waste (FW)	Cumulative FW	Total Organics
1	146,500	146,500	87,500	87,500	234,000
2	36,000	183,000	52,500	140,000	323,000
3	63,500	246,000	0	140,000	386,000

Table 2. Organics Diversion Tonnage resulting from 2050 Buildout Scenario

Site Analysis

Extensive capacity and financial analyses were completed for six of the eleven potential sites. Significant, but less comprehensive, analysis was done for the other six sites. The full analysis results for all eleven facilities will be found in the comprehensive report. A full site analysis includes the following:

- Pilot collection efficiency and pilot collection volumes year-over-year (YOY), as applicable
- Ongoing collection efficiency and diversion projections YOY
- Projected annual residential Third Bin program revenues
- Site financial performance based on estimated feedstock requirements and product outputs

Sample Site: South Greenfield area in Gilbert

The South Greenfield area, as seen in Figure 2, was chosen for this summary because it illustrates a collaborative opportunity. The collections shed for the South Greenfield area includes Gilbert and sections of Chandler and Mesa. It also provides an opportunity for expansion with room to potentially include a composting facility and an organics processing AD unit. The use of compost and AD as an integrated solution is evolving as a best practice approach to maximizing the efficiency, output and revenue generating potential of an organics processing site.

Figure 2: South Greenfield Area

One key advantage to this location is that both Chandler and Mesa have existing SSO diversion programs in place. Mesa collects yard waste through its Third Bin program and Chandler accepts self-haul drop off yard waste from its residents at its transfer station. Table 3 (next page) shows what volumes of green organics and food waste would be supplied to the site from the three collaborating municipalities, including their effective diversion rates. In this site analysis, Mesa is designated as the host of the facility and yard waste dropped off at the site is allocated to Mesa.

Analysis of the net hauling and tipping cost for diverting the green organic yard waste to the processing facility as opposed to taking it to the landfill indicates that the implementation of a 3rd Bin program results in a net higher cost for Chandler and a net savings for Gilbert and Mesa based on a $6 monthly residential participation fee, see Table 4 (next page). It should be noted that the miles traveled calculated for collections were done without the use of route optimization software, this likely results in an overestimation of the cost of hauling.

Table 3. South Greenfield Area Collection Efficiency

Municipality	Year	3rd Bin + Drop Off	Transfer Station Collection	% Diversion
Mesa	2018	9,500		20%
	2020	11,500		24%
	2024	12,500		26%
	2028-2030	12,500		26%
	Total:	46,000		
Chandler	2018	4,500	4,500	14%
	2020	4,900	3,000	15%
	2024	3,500	2,000	14%
	2028-3030	7,200	1,000	22%
	Total:	20,100	9,500	
Gilbert	2018	-		0%
	2020	3,400		10%
	2024	4,500		14%
	2028-2030	11,200		34%
	Total:	19,100		
TOTAL	2018	14,000		12%
	2020	19,800		18%
	2024	20,500		19%
	2028-30	30,900		27%
	Total:	85,300		

Table 3: GWRP Facility Collections Landfill vs. Diversion Cost Differential

Financial performance for the South Greenfield area 40,000 TPY windrow composting facility is outlined in Table 5:

Landfill vs. Diversion Cost Differential (2030)			
Chandler			
Annual 3rd Bin Fees Collected:	$862,596	**Facility per Ton Tipping Fee:**	$12.25
- Cost of Hauling Green Organics:	$1,105,776	**Landfill per Ton Tipping Fee:**	$26
- Processing Facility Tipping Cost:	$76,316		
+ Landfill Tipping Cost:	$161,976.36		
(Cost)/Savings:	(157,519)		
Gilbert			
Annual 3rd Bin Fees Collected:	$1,554,574	**Facility per Ton Tipping Fee:**	$12.25
- Cost of Hauling Green Organics:	$1,315,548	**Landfill per Ton Tipping Fee:**	$26
- Processing Facility Tipping Cost:	$137,537		
+ Landfill Tipping Cost:	$291,914.38		
(Cost)/Savings:	393,403		
Mesa			
Annual 3rd Bin Fees Collected:	$1,042,222	**Facility per Ton Tipping Fee:**	$12.25
- Cost of Hauling Green Organics:	$684,636	**Landfill per Ton Tipping Fee:**	$26
- Processing Facility Tipping Cost:	$92,208		
+ Landfill Tipping Cost:	$195,706.06		
(Cost)/Savings:	461,084		

Table 5: GWRP Composting Site Financial Performance

Site Financial Performance			
Financial Inputs			
Capital Expense (CAPEX):	$2,545,585	**CAPEX Per Ton:**	$64
Operating Expense (OPEX):	$560,000	**OPEX Per Ton:**	$14
Feedstock Requirements			
Site Capacity TPY:	40,000		
Green Organics TPY:	30,000	**Per Ton Tipping Fee:**	$12.25
Food Waste TPY:	10,000		
Site Performance		**Price Per Ton**	**Revenue**
Compost Produced TPY:	17,356	$25	$433,888
20 Year IRR:	**6.24%**		

Conclusions

There are some external trends that are key to the success of an organics recovery program. The price and risk volatility of the commodity produced by the processing facility (compost, electricity or fuel) are driven by the market and can affect financial performance. As a result of this volatility, the private sector is currently averse to investing in recycling or recovery businesses. Conversely, the public sector has a longer view of capital investment and resource stewardship and is more likely to implement such an organics recovery program.

Several key conclusions can be reached from this study. The first and most important finding is that the regional approach is viable and that collaborations can result in processing facilities that are financially more resilient. A related finding is that collaborations will be based on location-specific requirements. Finally, based on current investment trends, the most likely successful scenario will include public investment in land and facility infrastructure, while operations and maintenance can be publicly or privately funded.

Some of the potential next steps are to further develop the RCORS design model to integrate multi-site functionality, improve connectivity to the ArcGIS model, add environmental and social impacts, begin site specific evaluations and begin collaborative discussions. Details of these recommendations will be provided in the final comprehensive report.

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