



# Metro Solid Waste System

## Economic Footprint Report

# NeRC

Northwest Economic Research Center  
College of Urban and Public Affairs

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# NeRC

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Cover image: Oregon City solid waste transfer station. (2013.) Retrieved from OregonMetro.gov.

Contents image: Columbia Ridge Landfill, Arlington OR. (2015.) Retrieved from OregonMetro.gov.

## ACKNOWLEDGEMENTS

This report was researched and produced by the Northwest Economic Research Center (NERC) with support from Metro.



**Metro** Metro serves more than 1.5 million people in Clackamas, Multnomah and Washington

counties. The agency's boundary encompasses Portland, Oregon and 23 other cities – from the Columbia River in the north to the bend of the Willamette River near Wilsonville, and from the foothills of the Coast Range near Forest Grove to the banks of the Sandy River at Troutdale.

As one of its public services, Metro plans and oversees the region's solid waste system, working with local communities and industry partners to reduce waste while managing garbage, recycling and composting in a safe, healthy and cost-effective manner. Metro owns and operates two garbage and recycling stations and hazardous waste facilities. A hotline and an online search tool help people recycle everything from batteries to leftover paint to construction debris. Education and outreach programs offer tips and tools for saving resources and protecting clean air and water at home and on the job.



NERC is based at Portland State University in the College of Urban and Public Affairs. The Center focuses on economic research that supports public-policy decision-making, and relates to issues important to Oregon and the Portland Metropolitan Area. NERC serves the public, nonprofit, and private sector community with high quality, unbiased, and credible economic analysis. Dr. Tom Potiowsky is the Director of NERC and former Chair of the Department of Economics at Portland State University. Dr. Jenny H. Liu is NERC's Assistant Director and Associate Professor in the Toulan School of Urban Studies and Planning. This report was researched and written by Peter Hulseman, Adam Rovang, Devin Bales, and Emma Willingham.



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## Executive Summary

The Regional Waste Plan is the blueprint for how Metro handles over two million tons of material a year including garbage, recyclables, food scraps, yard debris, and food waste in the Metro region. The previous update to the Regional Waste Plan was in 2008, and the Metro Council will adopt a new plan in 2019. In order for Metro Solid Waste to plan effectively for the future, it is essential to understand the size, scope, and economic presence of the industry. To inform this process, Metro contracted with the Northwest Economic Research Center (NERC) to perform an economic footprint analysis of the solid waste industry in the three Metro counties: Clackamas, Multnomah, and Washington. Notably, this includes breaking down the industry into seven subindustries<sup>1</sup>: collection, transfer, material recovery, transport, government, disposal, and recycling and composting. This analysis does not include the treatment of hazardous waste, the activity of reuse facilities, or solid waste employment or spending that takes place outside of the three Metro counties.

To capture this granularity NERC surveyed each of the seven subindustries to determine full-time equivalent (FTE) employment, gross wages, and spending patterns. Combined with employment data from the Oregon Employment Department (OED), NERC was able to produce estimates for the number of FTE employed in each subsector as well as their gross wages. Using this spending pattern data and economic impact modelling software (IMPLAN), NERC estimated the economic activity supported by these employees and firms – known as the total effect.

Since four of these subindustries—collection, transfer, material recovery, and disposal—are undefined in the IMPLAN model, NERC needed to determine their spending patterns and input them manually using the “analysis by parts” method. To accomplish this, and to obtain estimates of FTE employment and gross wages, NERC surveyed firms and agencies active within the solid waste system. Some firms either chose not to respond to the survey, or were not able to provide complete information, so calculated data was produced using conservative assumptions. This data was then used as inputs for the IMPLAN model in order to estimate the economic activity supported by each of the seven subindustries in 2017.

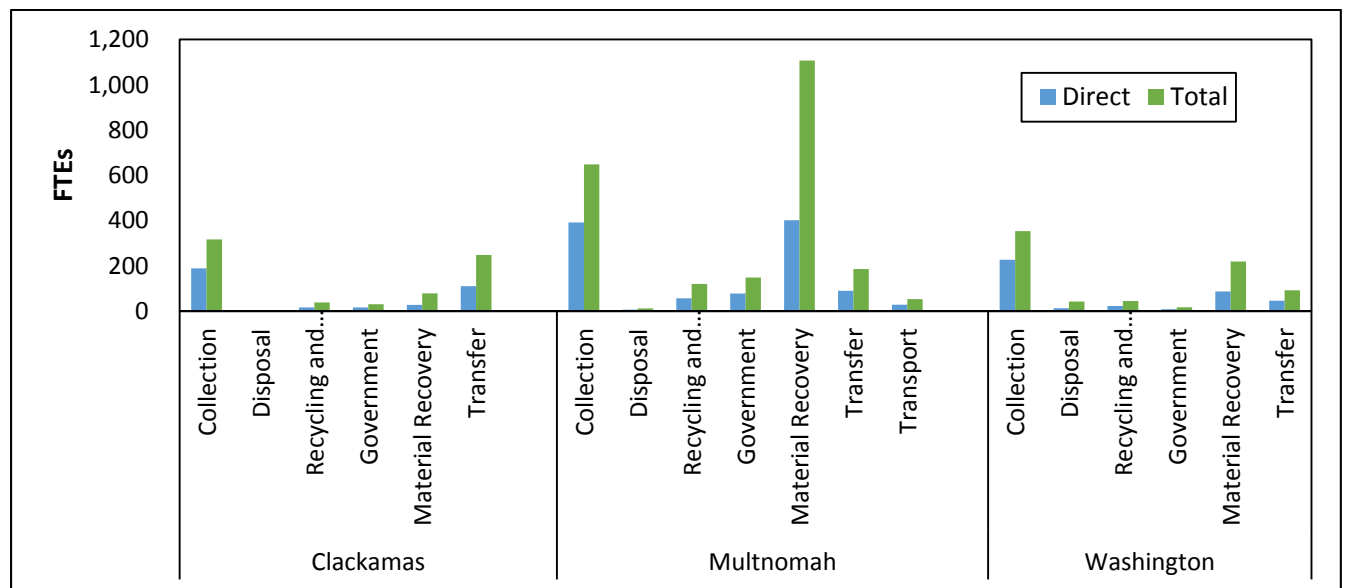
**Table 1: All Counties, All Subindustries, 2017**

Effect	Employment	Labor Income	Total Value Added	Output
Direct Effect	1,823	\$91,343,349	-	\$278,457,566
Indirect Effect	1,262	\$70,295,185	\$108,573,502	\$167,195,567
Induced Effect	681	\$32,093,535	\$55,085,529	\$91,724,897
<b>Total Effect</b>	<b>3,766</b>	<b>\$193,732,069</b>	<b>\$183,270,407</b>	<b>\$537,378,031</b>

<sup>1</sup> For this report, Solid Waste is the ‘industry’, and each of the seven component industries is referred to as a ‘subindustry’.

Table 1 (above) and Graph 1 (below) show the results of the IMPLAN model. Overall, in 2017, the Solid Waste industry directly employed 1,823 FTEs and supported an additional 1,943 FTEs through capital expenditures and employee spending (for a total of 3,766 FTEs). Of the 3,766 total FTE jobs, 2,277 workers resided in Multnomah County while 771 and 718 of them resided in Washington and Clackamas counties respectively. Most of these jobs came from material recovery and collection (72% together), followed by transfer (14%), government (6%), and recycling and composting (5%). For context, these FTEs could be anything from collectors, processors, and contract employees working on capital improvements, to restaurant workers that serve solid waste system employees. Total Value Added is the difference between the value of an industry’s or firm’s output and what it bought from other industries to make its products. NERC did not collect data on profits or taxes paid – the two major components of Total Value Added – so those estimates are not emphasized in this report.

**Graph 1: Direct and Total Employment by County and Subindustry, 2017**

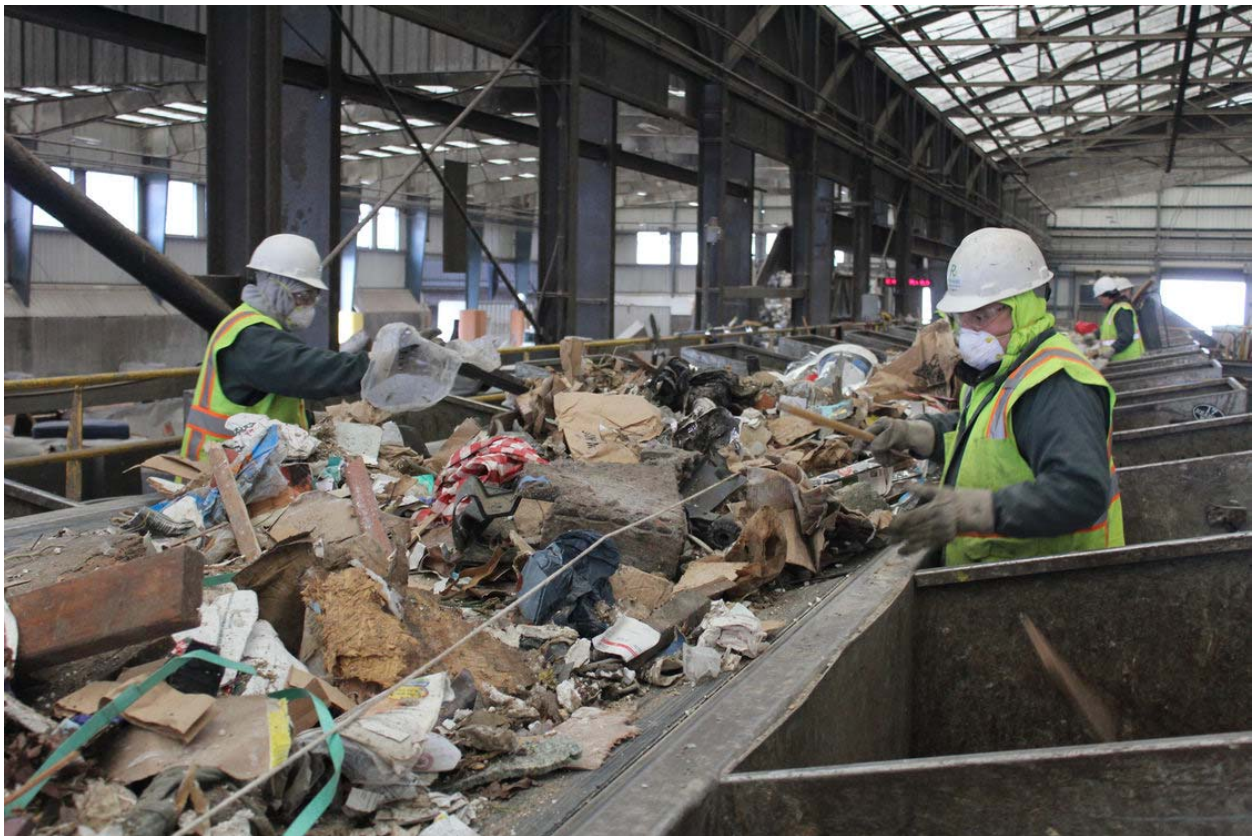


NERC estimates that the solid waste industry directly employed 1,823 FTEs in Clackamas, Multnomah, and Washington counties in 2017. This direct activity, in turn, supported an additional 1,943 FTEs for a total economic footprint of 3,766 FTEs. This report highlights what subindustry those employees can be attributed to, as well as their gross wages. Notably, material recovery has a similar direct impact to that of collection in Multnomah County, but its total effect is much higher. This is due to the amount of capital spending the material recovery subindustry requires. The extra money spent on inputs, such as facilities and machinery, supports additional jobs and spending in other industries – making the material recovery subindustry relatively ‘high impact’ per employee. Highlights from the study include:

- 3,766 total full-time jobs supported
- \$193.7 total labor income impact
- More than \$500 million in total output (spending)

A major benefit of this project is that estimating production functions for the subindustries and establishing a thorough methodology laid the groundwork for future studies. This is the region's first analysis of the industry's impacts, and like any baseline, grows more useful with continuous updates so that trends can be examined. The more system participants providing input data, the more accurate the results. A goal of future iterations would be to achieve a higher response rate.

NERC thanks all the system participants who shared information, as the research could not have been completed without their assistance.



*Workers sorting through waste at the Metro Central transfer station*

*Source: OregonMetro.gov*

## Introduction

The Regional Waste Plan is the blueprint for how Metro handles over two million tons of material a year including garbage, recyclables, food scraps, yard debris, and food waste in the Metro region. The previous update to the Regional Waste Plan was in 2008, and the Metro Council will adopt a new plan in 2019. To inform this process, Metro contracted with the Northwest Economic Research Center (NERC) to measure the size, scope, and economic presence of the solid waste industry in the three Metro counties: Clackamas, Multnomah, and Washington. Notably, this includes breaking down the industry into seven subindustries<sup>2</sup>: collection, transfer, material recovery, transport, government, disposal, and recycling and composting.

To capture this granularity NERC surveyed each of the seven subindustries to determine full-time equivalent employment, gross wages, and spending patterns. Combined with employment data from the Oregon Employment Department (OED), NERC was able to produce estimates for the number employed in each subsector as well as their gross wages. Using spending pattern data and the economic impact modelling software package IMPLAN (described in detail below), NERC estimated the economic activity supported by these employees and firms – known as the total effect.

The following section describes the Metro Solid Waste System, and each of the subindustries. The next section is a detailed review of the IMPLAN model, followed by a description of the data and methodology, followed by a concluding summary.

*Left: Solid waste system stakeholder brainstorm at a December 2017 outreach event for the 2030 Regional Waste Plan.*



Source: RecyclingAdvocates.org.

<sup>2</sup> For this report, Solid Waste is the 'industry', and each of the seven component industries are referred to as 'subindustries'.

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## The Metro Solid Waste System<sup>3</sup>

Solid waste collection companies provide residential, commercial and dropbox collection services to household, business and construction site waste generators, respectively. Collection fees are assessed based on the costs incurred throughout the supply chain, which includes the transfer, material recovery, transport, disposal and recycling and composting of those wastes. Waste generators may also bypass collection service suppliers and “self-haul” their waste directly to transfer and material recovery firms in some instances. The following provides information about each of these segments in the supply chain:

- ❖ **Collection:** Metro provided NERC with a list of 47 firms that offered residential, commercial and/or dropbox collection services to waste generators in the Metro region. For residential services, local governments grant franchises to collection companies to serve specific areas. In exchange, collection company rates are regulated, based on cost-plus rate regulation. Almost all collection services within the region’s 23 local governments including cities and counties, are franchised except for the commercial collection services within the city of Portland, which are competitive.
- ❖ **Transfer (or Reload):** Metro provided NERC with a list of 21 firms in the study region that supply waste consolidation, transfer, and reload services to collection companies and generators. Metro owns two of the transfer stations that serve the region, and contracts with two separate firms for operating those stations. Transfer stations predominantly engage in the consolidation of higher volumes of waste for long-haul transfer to disposal sites, while reload facilities typically consolidate smaller volumes and haul them short distances to material recovery firms or transfer facilities.
- ❖ **Transport:** Transportation firms provide long-haul transport of solid wastes to disposal sites. Walsh Trucking is currently the sole transportation service for Metro’s two transfer stations and provides transport services for other facilities in the region.
- ❖ **Disposal:** This includes firms engaged in the disposal or incineration of wastes. The majority of the employment utilized in this study is located in Hillsboro landfill<sup>4</sup>.

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<sup>3</sup> This section is adapted from materials supplied to NERC from Metro, with additional notes and updates from the NERC team.

<sup>4</sup> There are other inert and captive waste landfills, like ESCO and others, which are small and do not handle the types of wastes that are the subject of this analysis.



- ❖ **Material Recovery Firms:** There are 36 firms in the study area engaged in the sorting, processing and recovery of recyclable materials. These firms typically receive and process source-separated (also referred to as “comingled”) materials collected at the curb from homes, apartment buildings, and businesses. Other material recovery firms specialize in specific materials such as glass. Material recovery firms primarily prepare recyclables for sale to firms that use these materials for making new products, but also send some residual waste for disposal at landfills. Many, but not all, of the material recovery facilities owned by these firms are currently regulated by Metro.
- ❖ **Recycling and Composting Firms:** This category includes firms that process specific recyclable and compostable materials into final products or for sale to other firms. This group includes composting facilities, which process yard debris and food scraps into compost products – such as mulch – that are sold to the general public. It also includes firms that collect specific materials – such as paper and cardboard – directly from the public or businesses that generate large quantities and broker or sell those materials to other firms for use in making new products. The list of firms active in this subindustry provided to NERC and included in this study may not be comprehensive.
- ❖ **Government:** The Government sector is responsible for regulation, planning, education and other activities related to solid waste and recycling. Examples include Metro and City of Portland. Special care was made not to double-count employees working for a government entity within another industry. For example, employees operating Metro’s two transfer stations are counted in Transfer and not Government. Similarly, the effects of franchise fees and other taxes are included in this sector, and therefore were excluded from other industries.



*Pride Recycling Company Transfer Station*

## IMPLAN Description

IMPLAN is an input-output (I-O) model that simulates a given region's economy – a mathematical representation of all the linkages between firms, households, governments, and other economic entities. NERC used the IMPLAN model to analyze and describe the economic impacts associated with the solid waste system. IMPLAN uses built-in industry production functions<sup>5</sup>, coupled with the number of full time equivalent (FTE) employees, and total gross wages by county in that industry to estimate direct, indirect and induced effects for the industries in question.

When conducting economic impact studies, it is important to differentiate between new economic activity, and economic activity that may just be replacing already existing activity. If expansion for one firm occurs at the expense of another, then no actual growth has been created. Since this project is focused on measuring existing economic activity as opposed to new economic activity, it is referred to as Economic Footprint Analysis.

IMPLAN models are constructed using Social Accounting Matrices (SAM) based on spending and purchasing data from the Bureau of Economic Analysis (BEA) supplemented by data from other publicly available sources. SAMs are constructed to reflect the actual industry interactions in a region and include government activities that are not traditionally reflected in this type of economic analysis.

SAMs create a map showing how money and resources flow through the economy. In a simulation, new economic activity is assumed to occur in an industry or group of industries. Based on past spending and purchasing activity, IMPLAN simulates the purchasing and spending necessary for this new economic activity to occur. IMPLAN tracks this new economic activity as it works its way through the economy. Also included in SAMs are

### IMPLAN Impacts

**Employment** represents the number of annual, 1.0 FTE jobs. These job estimates are derived from industry wage averages.

**Labor Income** is made up of total employee compensation (wages and benefits) as well as proprietor income. Proprietor income is profits earned by self-employed individuals.

**Total Value Added** is made up of labor income, property type income, and indirect business taxes collected on behalf of local government. It is the difference between the value of an industry's or firm's output and what it bought from other industries to make its products. This measure is comparable to familiar net measurements of output like gross domestic product.

**Output** is a gross measure of production. It includes the value of both intermediate and final goods. Because of this, some double counting will occur. Output is presented as a gross measure because IMPLAN is capable of analyzing custom economic zones. Producers may be creating goods that would be considered intermediate from the perspective of the greater national economy, but may leave the custom economic zone, making them a local final good.

<sup>5</sup> A production function is the relationship between the output of a product or service and the inputs (labor and capital) required to produce that product for any given industry.

household and government behavior. In addition to following purchasing and spending through the private sector, IMPLAN also estimates the impact of changes in disposable income and tax revenue.

A production function is constructed for each industry, reflecting its connections to other industries. Economic changes or events are propagated through this process as new economic activity motivates additional economic activity in other parts of the supply chain, and through changes in spending habits.

IMPLAN breaks out analysis results into three types: direct, indirect, and induced.

- ❖ **Direct Impacts:** These are defined by the modeler and placed in the appropriate industry. They are not subject to multipliers. In this case, purchasing, employment, and wage data were collected from the sources described above and placed into the appropriate industry such as garbage collection or transfer services
- ❖ **Indirect Impacts:** These impacts are estimated based on national purchasing and sales data that model the interactions between industries. This category reflects the economic activity necessary to support the new economic activity in the direct impacts by other firms in the supply chain. An example of this would be garbage collector's purchasing fuel for their trucks, creating an indirect impact through the fuel industry.
- ❖ **Induced Impacts:** These impacts are created by the change in wages and employee compensation. Employees change purchasing decisions based on changes in income and wealth.

For the impact measure of employment, for example, the direct effect is the number of employees directly used by the industry in its production activities. The indirect effect is the employment that results from the industry's intermediate spending. Finally, the induced effect is all the employment that results from households increased income. The sum of the direct, indirect and induced effects is the "total effect" on employment. Production functions are used by IMPLAN to connect industries in the economy, and to estimate the indirect and induced effects of the impact in question. The following section illustrates these various effects given a hypothetical solid waste industry.

### A Hypothetical Solid Waste Industry

		Garbage & Recycling Collection Company	Transfer Station	Transport	Solid Waste Industry Totals	
		50 employees	40 employees	10 employees	100	WITHIN SOLID WASTE INDUSTRY
		\$1,000 in revenue	\$1,000 in revenue	\$1,000 in revenue	\$3,000	
<b>SPENDING</b>						
		\$200 in transfer station services	\$300 in transport services		\$500	OTHER INDUSTRIES
INTERMEDIATE INPUTS		\$300 in purchases of diesel, office paper, truck repair services, etc.	\$100 in purchases of office supplies, accounting services, etc.	\$400 in purchases of diesel and truck repair services	\$800	
		\$400 in wages	\$500 in wages	\$500 in wages	\$1,400	
VALUE ADDED		\$100 in taxes and profit	\$100 in taxes and profit	\$100 in taxes and profit	\$300	
<b>ECONOMIC IMPACT MEASURES</b>						
<b>Total output</b>		\$1,000	\$1,000	\$1,000	\$3,000	
<b>Value added</b>		\$500	\$600	\$600	\$1,700	
<b>Labor income</b>		\$400	\$500	\$500	\$1,400	

The example above illustrates how total output, value-added, and labor income are defined in the IMPLAN model. The example shows a hypothetical solid waste industry for a given geographic region with three firms: a garbage and recycling collection company, a transfer station, and a transport firm.

**Employment** is one measure of economic activity in the IMPLAN model. In this example, the industry employs a total of 100 full-time employees, 50 of which work for the collection company.

The table also lists what each company “spends” on intermediate inputs, wages and taxes and profit. Some spending on intermediate inputs occurs within the solid waste industry. For example, the collection company purchases services from the transfer station when its trucks dump the garbage they collect onto the floor of the transfer station for processing and compacting. The transfer station, in turn, purchases the services of the transport company, which takes garbage in long-haul trucks to a landfill. Since the landfill in this example is located outside the region, the amount that the transport company pays the landfill for receiving the

garbage it transported is not included in the economic impact analysis – in other words, the landfill has no local economic impact in the region under study.

The rest of spending on intermediate inputs by all three companies goes to other producers of goods and services such as diesel and office supplies retailers and firms that provide services such as accounting and truck repair. To supply the solid waste industry, these other firms hire employees and purchase inputs. In the IMPLAN model, the extra economic activity of these suppliers is counted as the **indirect effect** of the solid waste industry.

The three solid waste firms in the example also pay wages to their employees (a total of \$1,400 in this example). In the IMPLAN model, total spending on wages by the three firms would be counted as **labor income**, which is another measure of economic impact.

Employees spend a portion of their wages on goods and services produced by firms in the region. In the IMPLAN model, this local spending by employees is counted as the **induced effect** of the solid waste industry.

Another measure of economic impact in the IMPLAN model is **total output**, which includes the total value of a firm's or industry's production. In the example above, the total output of the three firms in the solid waste industry is equal to \$3,000. This is the combined amount of revenue the three companies earned for selling their services to their customers, which may include the general public and other firms, but also other companies within the industry as in the case of the transport firm selling its services to the transfer station.

Total output tends to include some double counting of economic activity. In our hypothetical case, the spending within the solid waste industry (\$500 in total), for example, is a form of double counting since what the collection company spends on the services provided by the transfer station is counted towards the total output of both the collection company and the transfer station.

For this reason, another measure of economic activity that avoids double counting is **value added**. In the IMPLAN model, value added is calculated as total output minus spending on intermediate goods. The result is also equal to what is "spent" on wages, taxes and the surplus revenue that goes to company owners or shareholders in the form of profits. In the hypothetical solid waste industry above, total value added for the three firms in the solid waste industry is equal to \$1,700. For this report, data on profits and taxes paid were not collected and, therefore, the total value added results are not emphasized.

Finally, our hypothetical solid waste industry example can also be used to illustrate what a **production function** is in the IMPLAN model. A good way of thinking of a production function is like a recipe. In our example, the production function of the garbage and recycling company is

the recipe this company uses to provide collection services to its customers. Using the numbers in the table above, for every \$1 in collection services provided, the collection company uses \$0.20 in transfer station services; \$0.30 in purchases of other goods and services such as diesel, office paper, and truck repair services; \$0.4 in wages paid to its employees; and \$0.1 in taxes and profits.

In cases where the industry that is under analysis is very specific, or where the disaggregation of impacts along segments of the industry is required (such as is the case here), unique cost structures exist. In these cases, custom **production functions** for these industries (or segments) must be estimated to get at the indirect and induced effects of the economic impact. This process is called “**analysis by parts**” and is described in more detail in the following section.

## Data Description and Methodology

In addition to describing the size and scope of the solid waste sector within the Metro region, a major goal of this report was to identify the economic footprint of all the subindustries: collection, transfer, material recovery, transport, government, disposal, and recycling and composting. Since four of these subindustries—collection, transfer, material recovery, and disposal—are undefined in the IMPLAN model, NERC needed to determine their spending patterns and input them manually using the “analysis by parts” method as described above. To accomplish this, and to obtain estimates of FTE employment and gross wages, NERC surveyed firms and agencies active within the Portland Metro’s Solid Waste System. Some firms either chose not to respond to the survey, or were not able to provide complete information, so calculated data was produced using conservative assumptions. The following sections describe the survey methodology as well as the steps and assumptions required to create the calculated data.

### Survey Methodology

Metro provided NERC with primary contact information for all the regulated solid waste firms (by subindustry) operating within Clackamas, Multnomah, and Washington counties. NERC contacted these firms by both phone and e-mail requesting:

- 1) The number of Full-Time Equivalent (FTE) employees, broken down by subindustry and county of residence<sup>6</sup> in 2017.
- 2) Gross wages broken down by subindustry and by the county of residence in 2017.

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<sup>6</sup> Employees residing outside the three Metro counties are not included in this study, and data was not requested about any employees or spending that occurred outside the tri-county region.

- 3) Capital spending within the Metro region broken down by subindustry in 2017. Typically, this would be in the form of a list of spending by firm. NERC would then assign an IMPLAN code to each firm.

Each firm's subindustry constitutes a potential response. So, if a firm contains three subindustries, then that is three different potential responses. FTE employees, gross wages, or both was provided for 50 out of 117 potential responses. NERC did not collect data on firm's profits or taxes paid. For this reason, estimates of Total Value Added are not emphasized, but are reported for the sake of completeness. Although data on taxes paid was not collected, the impact is still included in this report in the form government expenditures.

Only a few firms provided capital expenditures. However, responses were diverse enough to estimate production functions for the necessary subindustries.

### Calculated Employment

To capture employment for the entire solid waste industry within the Metro region, NERC obtained confidential 2016 Covered Employment Data (CED) from the Oregon Employment Department. This data file provided employment estimates for each of the solid waste firms within the Metro region. However, the data were not immediately usable. For one, CED counts all employees as "one" regardless of the hours worked. Since it counts both part-time and full-time workers, it will be larger than the actual number of FTEs. CED also does not break employees within a firm into the necessary subindustries, nor does it provide the county of residence for employees.

To get from CED employment to an estimate suitable for IMPLAN, a few calculations were needed. First, NERC pulled out the firms that reported FTEs and calculated the ratio between their reported FTEs and the number reported in the CED. Using this ratio, NERC interpolated the FTEs for the firms that did not report based on the firm's CED employment number. This step not only helps to prevent counting part-time workers as FTEs, but also prevents the erroneous count of workers that live outside the area – as this ratio captures that as well.

These FTEs are then broken down into subindustries based on the makeup of other similar firms. For example, to break down a firm that works in both the collection and transfer subindustries, the ratio of other firms that also work in those industries was used for interpolation. While the CED does not include county of residence for employees, NERC placed all employees into the county where the firm was located under the implicit assumption that there would be offsetting errors between the firms.

## Calculated Wages

Similar to employment, gross wages needed to be interpolated from the data provided by firms. To do this, NERC used reported data to calculate average wages by industry and county. The appropriate average was then applied to a firm's estimate of FTEs to get gross wages for every county<sup>7</sup>. For subindustries where no gross wage data was reported, the IMPLAN model's built-in estimation was used.

## Production Functions

Industries that are too specific to be built into IMPLAN need to be estimated manually from reported data. To do this, production functions for collection, transfer, material recovery, and disposal were determined from the firms that supplied their capital spending information.

First, NERC matched each of the firms' capital expenditures<sup>8</sup> to an IMPLAN industry code. For example, a firm's spending to a local accounting firm would be matched to IMPLAN code 368—accounting, tax preparation, bookkeeping, and payroll services. After this was completed for each spending item, spending on the same codes was summed. Next all the industries were normalized to one. To illustrate, if a typical collection firm spends 5% of capital expenditures on tax preparation, then IMPLAN code 368 would be matched to a value of .05. The sum of all these values will equal one. The table that contains all these IMPLAN codes and associated proportion of expenditures is called the production function or industry spending pattern<sup>9</sup>, and is used to distribute capital spending to other industries in the IMPLAN model.

## Capital Spending

The amount of capital spending applied to the subindustry production function is determined outside of the IMPLAN model for the collection, transfer, material recovery, disposal, and government subindustries. To find this, NERC first calculated the ratio of capital spending to number of employees by subindustry for the firms that provided capital spending data. This ratio was then multiplied by the number of topline FTE employees to give a capital spending estimate for the firms that did not report. IMPLAN's built-in production functions estimated total capital spending based on FTEs for transport and recycling and composting subindustries.

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<sup>7</sup> For a given subindustry, average gross wages were different between the counties.

<sup>8</sup> Spending for capital or services outside of the firm.

<sup>9</sup> Normally a production function includes what proportion is going to wages. However, since many firms provided their exact labor income expenditures it was more accurate to model that outside of the production function.



### Final Inputs

Depending on the subindustry, final inputs into IMPLAN include a combination of calculated and reported FTE, gross wage, and capital output estimates. See Table 2 for a breakdown of data sources by subindustry.

**Table 2: Data source by subindustry**

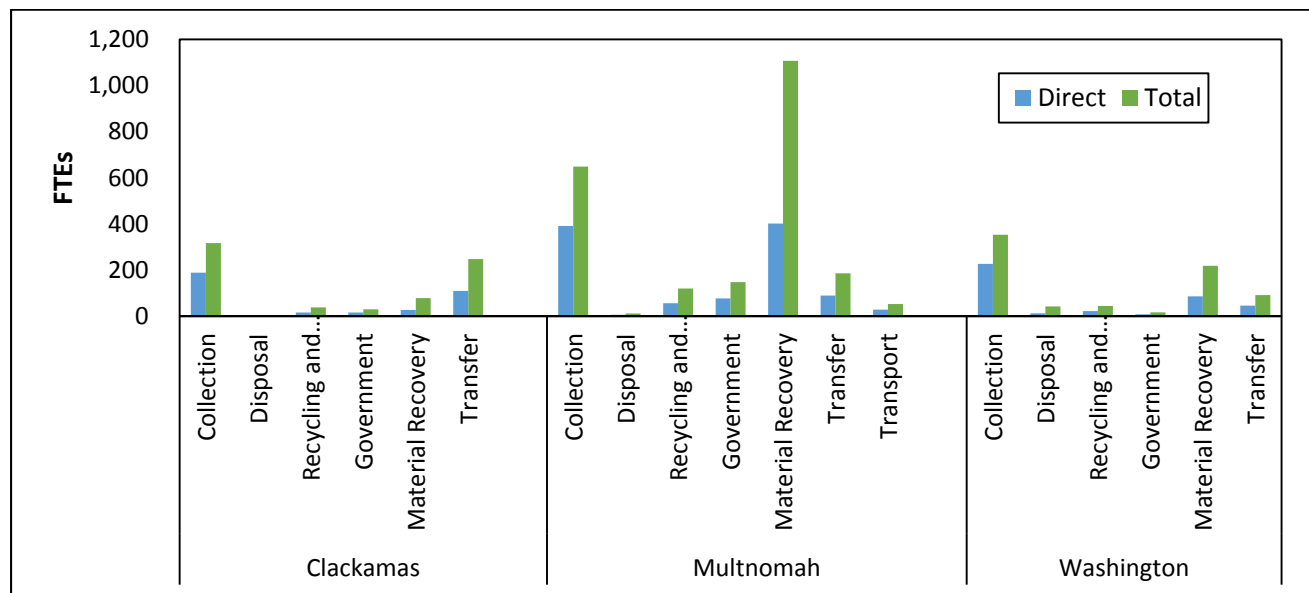
Subindustry	FTE	Gross Wages	Capital Spending	Production Function
Collection	Blue	Blue	Blue	Grey
Transfer	Blue	Blue	Blue	Grey
Material Recovery	Blue	Blue	Blue	Grey
Disposal	Blue	Blue	Blue	Grey
Transport	Blue	Blue	Orange	Purple
Recycling and Composting	Blue	Blue	Orange	Purple
Government	Light Green	Orange	Blue	Purple

Designation	Source
Blue	Reported and calculated
Light Green	Fully reported
Grey	Calculated from reported spending patterns
Orange	Data included in IMPLAN
Purple	Built into IMPLAN

## IMPLAN Results

The following bar graph summarizes the direct and total impacts of the solid waste industry on employment by subindustry for each county, while the subsequent chart parses out the industry’s direct, indirect, induced and total effects on employment, labor income, value added, and output.

**Graph 2: Direct and Total Employment by County and Subindustry<sup>10</sup>, 2017**



Notably, material recovery has a similar direct impact to that of collection in Multnomah County, but its total effect is much higher. This is due to the amount of capital spending the material recovery subindustry requires. The extra money spent on inputs, such as facilities and machinery, supports additional jobs and spending in other industries – making the material recovery subindustry relatively ‘high impact’ per employee.

**Table 3: All Counties, All Subindustries, 2017**

Effect	Employment	Labor Income	Total Value Added	Output
Direct Effect	1,823	\$91,343,349	-	\$278,457,566
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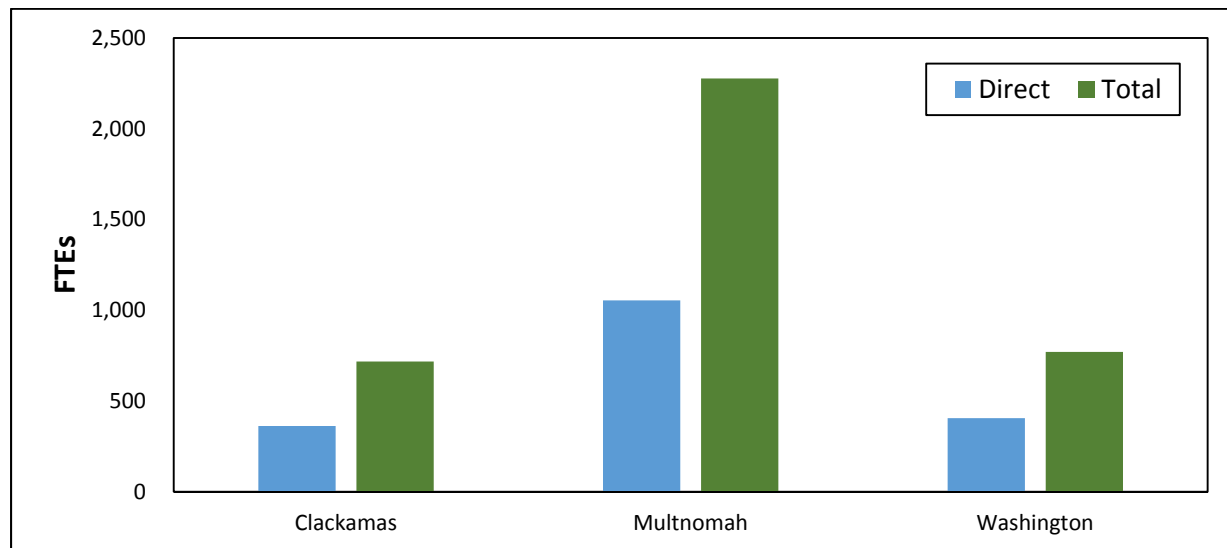
<sup>10</sup> As only one transport firm reported data, this subindustry’s impacts for Clackamas and Washington counties are not available.

Output is a combination of labor income and capital spending. Total Value Added separates out intermediate goods, but due to data constraints was not calculated for the subindustries that required analysis by parts. Overall, in 2017, the Solid Waste industry directly employees 1,823 FTEs and supports an additional 1,943 FTEs through capital expenditures and employee spending (for a total of 3,766 FTEs).

### County

Of the 3,766 FTEs, a total of 2,277 of them had residences in Multnomah County while 771 and 718 of them resided in Washington and Clackamas County respectively. Most of these jobs came from material recovery and collection (72% together), followed by transfer (14%), government (6%), and recycling and composting (5%). The Appendix (page 23) further breaks down these results by separating the impacts of each county by subindustry.

**Graph 3: Direct and Total Employment by County, 2017**



The following three tables present the same information as (table xx) above, separated by county.

**Table 4: Clackamas County, All Subindustries, 2017**

Effect	Employment	Labor Income	Total Value Added	Output
Direct Effect	362	\$15,333,830	-	\$47,821,820
Indirect Effect	231	\$10,751,026	\$17,452,780	\$29,781,405
Induced Effect	125	\$4,997,458	\$8,762,538	\$15,190,338
<b>Total Effect</b>	<b>718</b>	<b>\$31,082,314</b>	<b>\$28,528,752</b>	<b>\$92,793,563</b>

**Table 5: Multnomah County, All Subindustries, 2017**

Effect	Employment	Labor Income	Total Value Added	Output
Direct Effect	1,055	\$57,888,746	-	\$171,897,333
Indirect Effect	803	\$45,023,836	\$68,227,244	\$103,284,352
Induced Effect	419	\$20,515,631	\$34,482,051	\$57,117,539
<b>Total Effect</b>	<b>2,277</b>	<b>\$123,428,213</b>	<b>\$116,740,835</b>	<b>\$332,299,224</b>

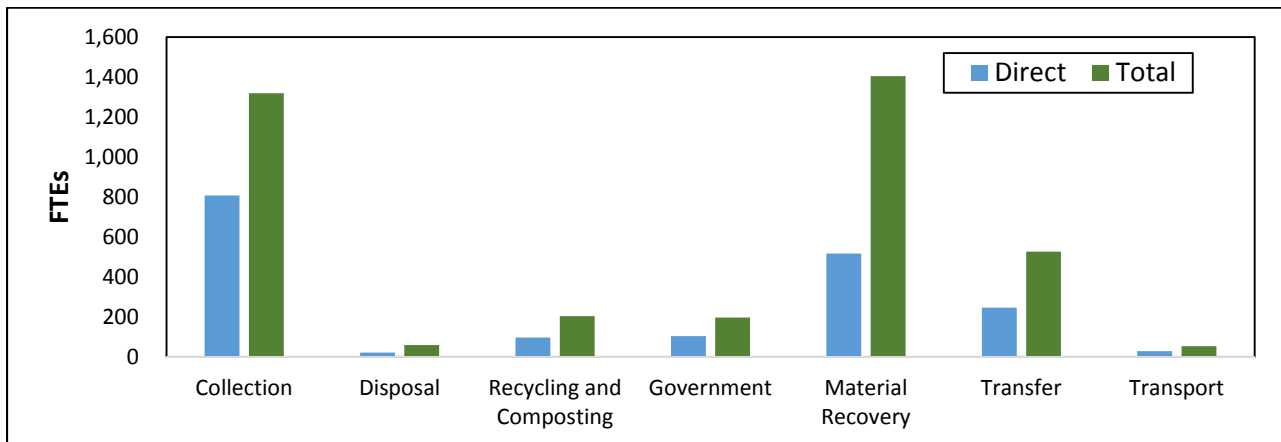
**Table 6: Washington County, All Industries, 2017**

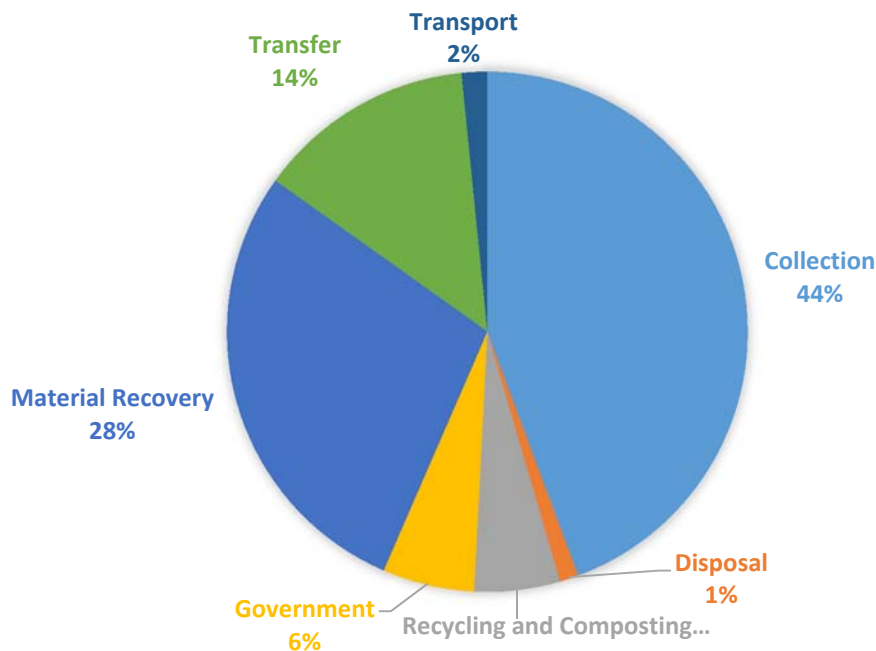
Effect	Employment	Labor Income	Total Value Added	Output
Direct Effect	406	\$18,120,773	-	\$58,738,413
Indirect Effect	229	\$14,520,323	\$22,893,478	\$34,129,810
Induced Effect	136	\$6,580,446	\$11,840,940	\$19,417,020
<b>Total Effect</b>	<b>771</b>	<b>\$39,221,542</b>	<b>\$38,000,820</b>	<b>\$112,285,243</b>

At over \$171 million, direct output in Multnomah County was more than double that of Washington’s and more than triple times the amount in Clackamas. While the population of each county is a clear driver for differing magnitude of impact, other factors include the high number of firms with headquarters in Multnomah County, and the disproportionate number of material recovery workers in the county. As mentioned above, the material recovery subindustry requires higher than average capital spending per worker.

The percent of total impact from each subindustry varies across county. As noted previously, most of the disposal employment is located at the Hillsboro Landfill, which operates in Washington County. This makes it the only county to have any substantial impact from disposal. Multiple transfer stations in Clackamas County account for the largest total impact from transfer.

**Graph 4: Direct and Total Employment by Subindustry, 2017**



**Graph 5: Proportion of Direct Employment by Subindustry, 2017**

### Subindustry

The impacts of each of the subindustries, for all counties, can be seen in the following graphs and tables. Collection, which accounted for the second highest total effect, employs the most people and is distributed across all three counties. While collection accounted for the most direct impact from its high employment (44% of the industry), material recovery's high spending led to the highest direct output and total employment.

The Metro area has only one active landfill, located in Washington County, and thus the effects for disposal are relatively small. A small number of firms reported working in the recycling and composting industry. While the work may be concentrated to few firms, their employees live in all three counties and are distributed relative to the populations for each county, with Multnomah leading the way followed by Washington and Clackamas respectively. Like the disposal subindustry, only one firm participates in transport services in the Metro area. Unlike disposal, all of transports employees live in one county--Multnomah. Despite having smaller total impacts, the transfer, disposal, and recycling and composting subindustries have higher relative impacts on employment. Transfer and recycling and composting create more than one job outside the industry for each worker in their respective subindustry. For disposal, this ratio is even higher: 1.8 jobs created for each worker within the subindustry (compared to 1.7 for material recovery).

The Appendix further breaks down these results by separating the impacts of each subindustry by county (page 23).

**Table 7: Collection, All Counties, 2017**

Effect	Employment	Labor Income	Total Value Added	Output
Direct Effect	808	\$42,745,607	-	\$78,375,029
Indirect Effect	262	\$16,049,443	\$26,660,797	\$43,566,303
Induced Effect	249	\$11,646,272	\$20,098,614	\$33,513,009
<b>Total Effect</b>	<b>1,319</b>	<b>\$70,441,322</b>	<b>\$46,759,411</b>	<b>\$155,454,341</b>

**Table 8: Disposal, All Counties, 2017**

Effect	Employment	Labor Income	Total Value Added	Output
Direct Effect	21	\$1,052,899	-	\$4,711,975
Indirect Effect	27	\$1,685,795	\$2,496,884	\$4,298,803
Induced Effect	11	\$548,391	\$971,253	\$1,601,418
<b>Total Effect</b>	<b>59</b>	<b>\$3,287,085</b>	<b>\$3,468,137</b>	<b>\$10,612,196</b>

**Table 9: Recycling and Composting, All Counties, 2017**

Effect	Employment	Labor Income	Total Value Added	Output
Direct Effect	97	\$4,613,837	\$8,991,541	\$63,088,450
Indirect Effect	68	\$4,735,329	\$7,552,291	\$13,522,420
Induced Effect	40	\$1,862,850	\$3,205,497	\$5,338,505
<b>Total Effect</b>	<b>204</b>	<b>\$11,212,016</b>	<b>\$19,749,329</b>	<b>\$81,949,375</b>

**Table 10: Government, All Counties, 2017**

Effect	Employment	Labor Income	Total Value Added	Output
Direct Effect	104	\$7,999,380	\$8,256,459	\$11,506,527
Indirect Effect	48	\$2,886,544	\$3,949,182	\$7,556,768
Induced Effect	45	\$2,163,447	\$3,684,480	\$6,123,729
<b>Total Effect</b>	<b>197</b>	<b>\$13,049,371</b>	<b>\$15,890,122</b>	<b>\$25,187,025</b>

**Table 11: Material Recovery, All Counties, 2017**

Effect	Employment	Labor Income	Total Value Added	Output
Direct Effect	517	\$22,989,111	-	\$83,741,576
Indirect Effect	650	\$34,670,613	\$50,345,651	\$70,532,963
Induced Effect	238	\$11,492,541	\$19,556,467	\$32,410,833
<b>Total Effect</b>	<b>1,405</b>	<b>\$69,152,265</b>	<b>\$69,902,118</b>	<b>\$186,685,372</b>

**Table 12: Transfer, All Counties, 2017**

Effect	Employment	Labor Income	Total Value Added	Output
Direct Effect	247	\$10,062,515	-	\$31,663,167
Indirect Effect	194	\$9,423,583	\$16,320,218	\$25,608,461
Induced Effect	86	\$3,839,546	\$6,660,713	\$11,232,578
<b>Total Effect</b>	<b>527</b>	<b>\$23,325,644</b>	<b>\$22,980,931</b>	<b>\$68,504,206</b>

**Table 13: Transport, All Counties, 2017**

Effect	Employment	Labor Income	Total Value Added	Output
Direct Effect	29	\$1,880,000	\$2,363,375	\$5,370,842
Indirect Effect	14	\$843,878	\$1,248,479	\$2,109,849
Induced Effect	11	\$540,488	\$908,505	\$1,504,825
<b>Total Effect</b>	<b>54</b>	<b>\$3,264,366</b>	<b>\$4,520,359</b>	<b>\$8,985,516</b>

### Gross Wages

The average gross wages for various subindustries may shed light on some of the previous results. For example, the government subindustry produces the highest average gross wages, but has a relatively low total impact. While the high wages here induce a decent amount of activity through employee spending, the capital spending in government is much lower than in other subindustries, resulting in a smaller total effect. For comparison, the recycling and composting subindustry employs a similar number of FTEs to government (97 to 104); however, capital spending per employee is significantly higher in the former, leading to an output estimate nearly three times larger than observed in government.

Another interesting comparison can be made between collection and material recovery, the two subindustries with the largest total effects. Nearly 300 more employees work directly in collection, and do so at an average wage over \$8,000 higher, but material recovery still produces a larger total effect. Again, this comes from higher capital spending and the resulting higher levels of output.

**Table 14: Average Gross Wages by Subindustry, 2017**

Subindustry	Average Gross Wage
Transfer	\$40,763
Material Recovery	\$44,488
Recycling and Composting	\$47,565
Disposal	\$49,759
Collection	\$52,911
Transport	\$64,828
Government	\$76,917

Average reported wages across subindustries were also significantly higher in Multnomah County. This was most apparent in collection, where the average wage in Multnomah was \$60,726 and only \$46,461 and \$44,468 in Washington and Clackamas respectively. Multnomah's higher cost of living is one plausible explanation for the disparity in wages. Similarly, gross wages in industries that have a greater share of employment in Multnomah, e.g. Government, are also likely pushed up by this higher cost of living. Another possible explanation for the disparity between industries is union representation.

## Conclusion

For Metro Solid Waste to plan effectively for the future, it is essential to understand the size and scope of the industry. This report captures the size of the industry in employment and wages and breaks down these figures into their component subindustries.

NERC estimates that the solid waste industry directly employed 1,823 FTEs in Clackamas, Multnomah, and Washington counties in 2017. This direct activity, in turn, supports an additional 1,943 FTEs for a total economic footprint of 3,766 FTEs. This report highlights what subindustry those employees can be attributed to, as well as their gross wages.

A major benefit of this project is that estimating production functions for the subindustries and establishing a thorough methodology laid the groundwork for future studies. This is the region's first analysis of the industry's impacts, like any baseline, grows more useful with continuous updates so that trends can be examined. The more system participants that provide data the more accurate the results, so a goal of future iterations would be to achieve a higher response rate.

NERC thanks all the system participants who shared information, as the research could not have been completed without their assistance.



## Appendix: Detailed IMPLAN Results

This appendix further breaks down the results by both subindustry and county.

**Table A1: Collection, Clackamas County, 2017**

Effect	Employment	Labor Income	Total Value Added	Output
Direct Effect	189	\$8,406,435	-	\$16,743,913
Indirect Effect	71	\$3,603,342	\$5,953,751	\$10,413,988
Induced Effect	58	\$2,301,927	\$4,036,490	\$6,997,205
<b>Total Effect</b>	<b>317</b>	<b>\$14,311,704</b>	<b>\$9,990,241</b>	<b>\$34,155,106</b>

**Table A2: Disposal, Clackamas County, 2017**

Effect	Employment	Labor Income	Total Value Added	Output
Direct Effect	1	\$58,406	-	\$309,492
Indirect Effect	2	\$114,327	\$166,713	\$314,918
Induced Effect	1	\$33,087	\$58,012	\$100,569
<b>Total Effect</b>	<b>4</b>	<b>\$205,820</b>	<b>\$224,725</b>	<b>\$724,979</b>

**Table A3: Recycling and Composting, Clackamas County, 2017**

Effect	Employment	Labor Income	Total Value Added	Output
Direct Effect	17	\$827,805	\$1,488,825	\$10,547,506
Indirect Effect	14	\$785,399	\$1,250,124	\$2,534,622
Induced Effect	8	\$309,060	\$541,903	\$939,420
<b>Total Effect</b>	<b>39</b>	<b>\$1,922,264</b>	<b>\$3,280,852</b>	<b>\$14,021,548</b>

**Table A4: Government, Clackamas County, 2017**

Effect	Employment	Labor Income	Total Value Added	Output
Direct Effect	17	\$734,651	\$824,608	\$2,002,597
Indirect Effect	8	\$380,160	\$511,495	\$1,115,127
Induced Effect	5	\$213,514	\$374,357	\$648,985
<b>Total Effect</b>	<b>31</b>	<b>\$1,328,325</b>	<b>\$1,710,461</b>	<b>\$3,766,710</b>

**Table A5: Material Recovery, Clackamas County, 2017**

Effect	Employment	Labor Income	Total Value Added	Output
Direct Effect	28	\$852,755	-	\$4,108,960
Indirect Effect	39	\$1,772,874	\$2,568,500	\$3,752,848
Induced Effect	13	\$503,097	\$882,149	\$1,529,236
<b>Total Effect</b>	<b>79</b>	<b>\$3,128,726</b>	<b>\$3,450,649</b>	<b>\$9,391,044</b>

**Table A6: Transfer, Clackamas County, 2017**

Effect	Employment	Labor Income	Total Value Added	Output
Direct Effect	110	\$4,453,778	-	\$14,109,351
Indirect Effect	97	\$4,094,924	\$7,002,197	\$11,649,902
Induced Effect	41	\$1,636,773	\$2,869,627	\$4,974,923
<b>Total Effect</b>	<b>248</b>	<b>\$10,185,475</b>	<b>\$9,871,824</b>	<b>\$30,734,176</b>

**Table A7: Collection, Multnomah County, 2017**

Effect	Employment	Labor Income	Total Value Added	Output
Direct Effect	392	\$23,788,298	-	\$41,064,802
Indirect Effect	127	\$8,119,340	\$13,390,892	\$21,874,868
Induced Effect	130	\$6,344,857	\$10,664,695	\$17,665,058
<b>Total Effect</b>	<b>649</b>	<b>\$38,252,495</b>	<b>\$24,055,587</b>	<b>\$80,604,728</b>

**Table A8: Disposal, Multnomah County, 2017**

Effect	Employment	Labor Income	Total Value Added	Output
Direct Effect	7	\$398,034	-	\$817,078
Indirect Effect	3	\$196,834	\$293,629	\$509,807
Induced Effect	2	\$117,969	\$198,297	\$328,452
<b>Total Effect</b>	<b>12</b>	<b>\$712,837</b>	<b>\$491,926</b>	<b>\$1,655,337</b>

**Table A9: Recycling and Composting, Multnomah County, 2017**

Effect	Employment	Labor Income	Total Value Added	Output
Direct Effect	57	\$2,711,224	\$5,481,366	\$38,030,694
Indirect Effect	41	\$2,842,615	\$4,507,019	\$7,962,996
Induced Effect	23	\$1,113,844	\$1,871,928	\$3,100,907
<b>Total Effect</b>	<b>120</b>	<b>\$6,667,683</b>	<b>\$11,860,313</b>	<b>\$49,094,597</b>

**Table A10: Government, Multnomah County, 2017**

Effect	Employment	Labor Income	Total Value Added	Output
Direct Effect	78	\$6,075,868	\$6,186,799	\$8,417,157
Indirect Effect	37	\$2,329,633	\$3,193,066	\$5,960,128
Induced Effect	34	\$1,674,574	\$2,814,603	\$4,662,202
<b>Total Effect</b>	<b>149</b>	<b>\$10,080,075</b>	<b>\$12,194,468</b>	<b>\$19,039,487</b>

**Table A11: Material Recovery, Multnomah County, 2017**

Effect	Employment	Labor Income	Total Value Added	Output
Direct Effect	402	\$19,412,726	-	\$66,675,878
Indirect Effect	515	\$27,110,422	\$39,374,032	\$55,433,983
Induced Effect	190	\$9,273,625	\$15,586,843	\$25,818,697
<b>Total Effect</b>	<b>1,107</b>	<b>\$55,796,773</b>	<b>\$54,960,875</b>	<b>\$147,928,558</b>

**Table A12: Transfer, Multnomah County, 2017**

Effect	Employment	Labor Income	Total Value Added	Output
Direct Effect	90	\$3,622,596	-	\$11,520,882
Indirect Effect	66	\$3,581,114	\$6,220,127	\$9,432,721
Induced Effect	30	\$1,450,274	\$2,437,180	\$4,037,398
<b>Total Effect</b>	<b>186</b>	<b>\$8,653,984</b>	<b>\$8,657,307</b>	<b>\$24,991,001</b>

**Table A13: Transport, Multnomah County, 2017**

Effect	Employment	Labor Income	Total Value Added	Output
Direct Effect	29	\$1,880,000	\$2,363,375	\$5,370,842
Indirect Effect	14	\$843,878	\$1,248,479	\$2,109,849
Induced Effect	11	\$540,488	\$908,505	\$1,504,825
<b>Total Effect</b>	<b>54</b>	<b>\$3,264,366</b>	<b>\$4,520,359</b>	<b>\$8,985,516</b>

**Table A14: Collection, Washington County, 2017**

Effect	Employment	Labor Income	Total Value Added	Output
Direct Effect	227	\$10,550,874	-	\$20,566,314
Indirect Effect	64	\$4,326,761	\$7,316,154	\$11,277,447
Induced Effect	62	\$2,999,488	\$5,397,429	\$8,850,746
<b>Total Effect</b>	<b>353</b>	<b>\$17,877,123</b>	<b>\$12,713,583</b>	<b>\$40,694,507</b>

**Table A15: Disposal, Washington County, 2017**

Effect	Employment	Labor Income	Total Value Added	Output
Direct Effect	13	\$596,458	-	\$3,585,405
Indirect Effect	21	\$1,374,634	\$2,036,542	\$3,474,078
Induced Effect	8	\$397,335	\$714,944	\$1,172,397
<b>Total Effect</b>	<b>43</b>	<b>\$2,368,427</b>	<b>\$2,751,486</b>	<b>\$8,231,880</b>

**Table A16: Recycling and Composting, Washington County, 2017**

Effect	Employment	Labor Income	Total Value Added	Output
Direct Effect	23	\$1,074,808	\$2,021,350	\$14,510,250
Indirect Effect	13	\$1,107,315	\$1,795,148	\$3,024,802
Induced Effect	9	\$439,946	\$791,666	\$1,298,178
<b>Total Effect</b>	<b>45</b>	<b>\$2,622,069</b>	<b>\$4,608,164</b>	<b>\$18,833,230</b>

**Table A17: Government, Washington County, 2017**

Effect	Employment	Labor Income	Total Value Added	Output
Direct Effect	9	\$1,188,861	\$1,245,052	\$1,086,773
Indirect Effect	3	\$176,751	\$244,621	\$481,513
Induced Effect	6	\$275,359	\$495,520	\$812,542
<b>Total Effect</b>	<b>18</b>	<b>\$1,640,971</b>	<b>\$1,985,193</b>	<b>\$2,380,828</b>

**Table A18: Material Recovery, Washington County, 2017**

Effect	Employment	Labor Income	Total Value Added	Output
Direct Effect	87	\$2,723,630	-	\$12,956,737
Indirect Effect	97	\$5,787,317	\$8,403,119	\$11,346,132
Induced Effect	36	\$1,715,819	\$3,087,475	\$5,062,900
<b>Total Effect</b>	<b>219</b>	<b>\$10,226,766</b>	<b>\$11,490,594</b>	<b>\$29,365,769</b>

**Table A19: Transfer, Washington County, 2017**

Effect	Employment	Labor Income	Total Value Added	Output
Direct Effect	46	\$1,986,142	-	\$6,032,934
Indirect Effect	30	\$1,747,545	\$3,097,894	\$4,525,838
Induced Effect	16	\$752,499	\$1,353,906	\$2,220,257
<b>Total Effect</b>	<b>92</b>	<b>\$4,486,186</b>	<b>\$4,451,800</b>	<b>\$12,779,029</b>

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