# Economic Impact Assessment Report

# Charlotte Water

Draft Report / March 14, 2022

RAFTELIS

ONEWATER ECON

March 14, 2022

Mr. Chad Howell
Chief Financial Officer
Charlotte Water
4222 Westmont Drive
Charlotte, NC 28217

Subject: Economic Impact Assessment Report

Dear Mr. Howell,

Raftelis Financial Consultants, Inc. (Raftelis) is pleased to provide this Economic Impact Assessment Report (Report) to Charlotte Water. This report quantifies the significant benefits and economic impacts that Charlotte Water contributes to the regional economy. As documented in this report, Charlotte Water provides a tremendous economic benefit to the Charlotte Metropolitan Region by providing clean and reliable water and wastewater services to the households and businesses in your service area.

It has been a pleasure working with you, and we thank you and the Charlotte Water staff for the support provided during the course of this study. Should you have any questions regarding this report or our assessment, please do not hesitate to contact me at 518.391.8944 or jmastracchio@raftelis.com.

Sincerely,

John M. Mastracchio, ASA, CFA
Executive Vice President

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# Executive Summary

## Introduction

Charlotte Water provides safe and reliable water and wastewater services to more than one million customers within the City of Charlotte and greater Mecklenburg County in North Carolina. This report demonstrates Charlotte Water's economic contribution to the local economy by quantifying the economic benefits and impacts associated with the utility's continued investments in water and wastewater infrastructure. The analysis presented herein goes beyond a traditional economic impact assessment of direct spending by Charlotte Water to also examine the value of water supply reliability for households and businesses in the region, as well as the role of Charlotte Water in supporting economic development.

## Study Area

While Charlotte Water serves households and businesses in Mecklenburg County, economic activity does not follow county boundaries. Employees and businesses that support Charlotte Water's activities are located within the broader Charlotte region. As such, this study included the six-county region made up of Mecklenburg, Cabarrus, Gaston, Iredell, Lincoln, and Union counties in North Carolina.

The six-county region had a gross regional product of approximately $160 billion in 2019 (Table ES-1), while total economic output amounted to more than $277 billion (approximately 25% of the total economic output for the state of North Carolina). The businesses and industries in the study region employ 1.4 million people. Approximately 72% of economic output and 68% of employment in the study area is generated by businesses within Mecklenburg County.

**Table ES-1. Key Economic Indicators, Mecklenburg County and Six-County Area**

| | Mecklenburg County | Six-County Region |
|---|---|---|
| Population | **1.11 M** | **2.06 M** |
| Employment[a] | 957 K | 1.4 M |
| Economic Output[b] | $198 B | $277 B |
| Value Added (Gross Regional Product)[c] | $123B | $160 B |

Source: IMPLAN, 2019 data

a. Employment is the annual average of monthly jobs in an industry.
b. Economic output represents the total value of industry production (e.g., total sales).
c. Value added or gross regional product is the difference between the economic output of an industry and the cost of its intermediate inputs. It includes labor income, taxes on production and imports, and other property income.

## Overview of Economic Impact Assessment

An economic impact assessment estimates the change in local economic activity caused by a business, organization, policy, program, activity, or other economic event over a specified time period. In the context of this analysis, examples of economic events include spending by Charlotte Water on water and wastewater infrastructure, the loss of business revenues resulting from increased water service

disruptions, and/or the economic growth that is facilitated by the region's access to safe and reliable water and wastewater services. An economic impact assessment traces how economic activity associated with such events ripples through the local economy, including how it results in changes in economic output, value added, labor income, and employment.

Economists often use Input-Output (IO) models to conduct economic impact assessments. An IO model captures inter-industry relationships within an economy, showing how outputs from one economic sector are used as inputs by other sectors. These models can also capture how incomes from jobs created by economic events are spent in the local economy. Economic impacts are generally categorized as direct, indirect, and induced impacts. For this study, an IMPLAN model was used to assess the economic impacts of Charlotte Water's investments and services.

# Economic Impact of Charlotte Water Investments

Over the past ten years, Charlotte Water has invested an average of $194 million (2021 USD) annually to improve and expand its water and wastewater systems (i.e., capital expenditures). The utility has spent another $138 million each year (on average) to operate and maintain these systems (i.e., operating expenditures). Totaling $3.33 billion over the past decade, these investments have generated additional economic benefits in the Charlotte region as directly impacted firms and their employees spend money in the local economy (Table ES-2).

Charlotte Water's activities have supported 3,600 jobs annually over the past decade, on average. **For every $1 million in direct spending, Charlotte Water creates 10.9 jobs in the local economy**. In addition, over the ten-year analysis period, total economic output linked to Charlotte Water spending amounted to $6.19 billion. **For every dollar spent by Charlotte Water, a total of $1.86 in economic output was generated in the local economy**.

**Table ES-2: Economic Impact of Charlotte Water Operating and Capital Expenditures, FY 2012 – 2021 (in 2021 $USD)**

| Impact type | Annual Employment (jobs) | Labor income ($M) | Total value added ($M) | Economic output ($M) |
|---|---|---|---|---|
| Direct | 2,023 | $1,492 | $1,525 | $3,275 |
| Indirect | 831 | $666.5 | $1,007 | $1,715 |
| Induced | 751 | $411.4 | $766 | $1,202 |
| **Total** | **3,605** | $2,504 | $3,298 | $6,192 |

Impacts increase with spending – the above employment results reflect annual averages over the 10-year period. In 2021, Charlotte Water spent just over $500 million on capital and operating activities (which is much greater than the annual average over the past ten years). These expenditures created 5,230 total jobs, including close to 3,000 direct jobs and 2,280 indirect and induced jobs in that year.

Charlotte Water's spending results in different types of jobs and draws upon different services and inputs for implementation. The top five economic sectors impacted by Charlotte Water's expenditures (in terms of employment generated) include: construction of other new nonresidential structures; water sewage and

other systems; architectural, engineering, and related services; warehousing and storage; employment and payroll of local government.

In addition to past spending, the impacts associated with Charlotte Water's future investments were evaluated. Charlotte Water has significantly increased its planned capital expenditures for the next five to ten years to address aging infrastructure and support a growing population. For FY 2022 through FY 2026, total operating and capital expenditures are expected to amount to more than $3.4 billion. These **planned expenditures will result in $6.3 billion in economic output and generate 7,213 jobs per year** (for a total of 36,065 job-years over the 5-year period).

## Value of Reliable Water Services to Businesses and Industries

Water is an essential input for many industries; even temporary disruptions in service can have major impacts on local businesses. The economic impacts of water service disruptions on municipal and industrial customers were estimated by applying industry-specific "resiliency factors" from the literature in order to demonstrate the value of reliable water service. Resiliency factors reflect the percentage of economic output that can be achieved in different industry sectors when water service is reduced to zero.

Results indicate that **a one-day water service disruption would result in a total economic output loss of between $477 and $641 million**, depending on the length of the overall outage. Thus, an outage that lasted 1 week would reduce economic output by $3.3 billion; a water service disruption that lasted two weeks or more would result in a $4.5 billion loss.

## Water Dependent Industries

Water-dependent businesses are those that rely most on the services of water utilities to grow their business. Based on existing studies, as well as data provided by Charlotte Water on the largest water users within the service area, the contribution of water dependent industries to the local economy was identified and assessed.

Findings indicate that **water dependent industries served by Charlotte Water account for approximately 15% of total economic output and 18% of total employment within Mecklenburg County.** These businesses generate additional economic activity across the six-county region in the form of indirect and induced spending. **The total contribution of water dependent industries across the study support more than $47 billion in economic output and $25 billion in total value added within the six-county region, supporting close to 246,000 jobs**.

## Importance of Water Services in Supporting Economic Development and Growth

The significant economic growth that has occurred in the Charlotte region over the past decade could not have been achieved without Charlotte Water's provision of clean and reliable water services. Between 2011 and 2020, total economic output in Mecklenburg County grew by 35% or $52.3 billion. This economic activity generated an additional $3.32 billion in indirect and induced economic activity in the surrounding five counties. Over the time period, Charlotte Water's total expenditures amounted to $3.14 billion (total capital and operating). Thus, **every $1 million dollars spent by Charlotte Water contributed to $17.7 million in growth in economic output across the six-County region.** As the region

continues to grow at a rate much faster than the national average, Charlotte Water will continue to play a key role in attracting businesses to Mecklenburg County.

## Peer Utility Comparison

An assessment was completed of how Charlotte Water compares to its peer utilities in terms of overall spending and impacts on the local economy. To explore this topic, the average annual operating and capital expenditures from fiscal years 2019 to 2021 for 20 utilities across the country was compared. Results indicate that spending across peer utilities varies widely, with average per capita capital and operating expenditures amounting to $214 and $310, respectively. Charlotte Water falls slightly above the average for per capita capital expenditures at $258 (average over the past three years) but is well below the average for operating expenditures at $148 per capita. This analysis provides useful insights; however, results of this assessment must be carefully evaluated/interpreted as a higher (or lower) level of spending by a utility does not necessarily indicate a positive (or negative) message.

The estimated economic impacts associated with FY 2021 peer utility spending was also compared to the economic impacts of Charlotte Water FY 2021 expenditures using results from a study of the economic impacts associated with operating and capital expenditures of 30 water/wastewater utilities across the country (WRF/WERF 2014). The WRF study reported results for individual utilities based on models for the metropolitan statistical area (MSA) in which the utility service area is located. To directly compare the economic impacts generated by Charlotte Water and peer utility expenditures, the impacts were modeled using the Charlotte MSA as the study area. Thus, the multipliers are a slightly different than those reported above. This is because the model relies on averages for the MSA rather than for Mecklenburg County and its relationships with surrounding North Carolina counties.

In FY 2021, Charlotte Water's operating and capital expenditures amounted to $172.1 million and $332.3 million, respectively, totaling $504.4 million. Economic modeling results at the MSA level indicate that for every million dollars spent by Charlotte Water in 2021, 11.4 jobs were generated within the MSA. Further, the total per capita impact (based on service area population) amounted to $883 in terms of economic output. This compares to the average for peer utilities of 10.3 jobs and an economic output impact of $853 per capita.

# 1. Introduction

## 1.1 Project Background

Charlotte Water, a department of the City of Charlotte, provides water and wastewater services to more than one million customers within the City of Charlotte and greater Mecklenburg County in North Carolina. As the provider of these essential services, Charlotte Water protects the health and safety of residents, keeps businesses running, and supports economic growth across the Charlotte region.

The scope of this project and report stemmed from Charlotte Water's strategic plan and desire to analyze and report on the economic impact that Charlotte Water utility service has on the regional economy. The intent of this report is to provide information on the economic impact that Charlotte Water has on the regional economy for inclusion in various reports prepared by Charlotte Water, such as budget reports, comprehensive annual financial reports, financial plans, bond documents, and other published information about Charlotte Water. Charlotte Water also plans to use these results to develop a budget that is more predictive of the impact of its future investments in the region and to help benchmark Charlotte Water against peer utilities and cities. The target audience of this report is broad and includes the Charlotte Water staff, the Charlotte City Council, the Charlotte Water Advisory Committee, customers of Charlotte Water, and other stakeholders.

This report demonstrates Charlotte Water's important contribution to the local economy by quantifying the economic benefits and impacts associated with the utility's continued investments in water and wastewater infrastructure. It goes beyond a traditional economic impact assessment of direct spending by Charlotte Water to also examine the value of water supply reliability for households and businesses in the region and the role of safe and reliable water services in supporting economic development across industry sectors.

This report contains the following additional sections:

- Section 2 provides background on economic impact assessment and the methodology used for this report.
- Sections 3 presents findings from a review of relevant literature on the economic benefits and impacts of water and wastewater investments and water supply reliability.
- Section 4 presents the results of the economic impact assessment, including the positive economic impacts generated by Charlotte Water's capital and operating expenditures, the benefits of avoided water service disruptions due to continued investments, and the role of Charlotte Water in supporting economic growth and development.
- Section 5 compares Charlotte Water's economic impact with those of its peer utilities.

## 1.2 Economic Impact Analysis

Economies at any scale are interdependent. A dollar spent on a household need, a city expenditure, or a Federal project will ripple through the economy and generate more economic activity. An economic impact assessment estimates the change in local economic activity caused by a business, organization, policy, program, activity, or other economic event. In the context of this analysis, examples of economic events include spending by Charlotte Water on water and wastewater infrastructure, the loss of business revenues resulting from increased water service disruptions, and/or the economic growth that is facilitated by the region's access to safe and reliable water and wastewater services. An economic impact assessment traces how economic activity associated with such events ripples through the local economy, including how it results in changes in industry output, labor income, employment, and profits.

Economists often use Input-Output (IO) models to conduct economic impact assessments. An IO model captures inter-industry relationships within an economy, showing how outputs from one economic sector are used as inputs by other sectors. These models can also capture how incomes from jobs created by economic events are spent in the local economy. Economic impacts are categorized as follows:

- Direct effects are production changes associated with the immediate effects of an economic activity (e.g., loss in revenue, spending on public projects).
- Indirect effects are production changes resulting from various rounds of re-spending by industries that experience direct impacts.
- Induced effects are the changes in economic activity resulting from household spending of income earned directly or indirectly as a result of additional spending.

For example, as shown in Figure 1, replacing aging water infrastructure results in direct spending on construction contractors (direct effect). The construction contractors then spend this money on goods and services that they need to operate their businesses (indirect effect). Direct and indirect spending generate employment, creating additional income for households that results in even more spending (the induced effect). The total economic impact is the sum of direct, indirect, and induced effects.

**Figure 1:Direct, Indirect, and Induced Effects**


For this assessment, an IMPLAN model was used to assess economic impacts associated with Charlotte Water's investments and services. IMPLAN is an economic impact/IO model that uses actual dollar amounts of all business transactions occurring in a local economy, as reported each year by businesses and government agencies. IMPLAN contains this data for 546 industry sectors. IMPLAN was selected

because it is the industry standard model for analysis done at a local level. In addition, IMPLAN allows for extensive customization (as necessary) and contains significant local economic data that can be used to develop key project assumptions and cast results in context. Appendix A contains more detail on the IMPLAN model and provides a comparison of available tools for conducting economic impact analysis.

Using the IMPLAN model, the change in key economic indicators associated with direct, indirect, and induced effects can be calculated, including economic output, total value added, labor income, and employment. Economic output represents the sale of all goods and services in a local economy and the inputs required to produce those goods and services (i.e., the value of industry production). As shown in Figure 2, economic output for an industry or sector is equal to the sum of:

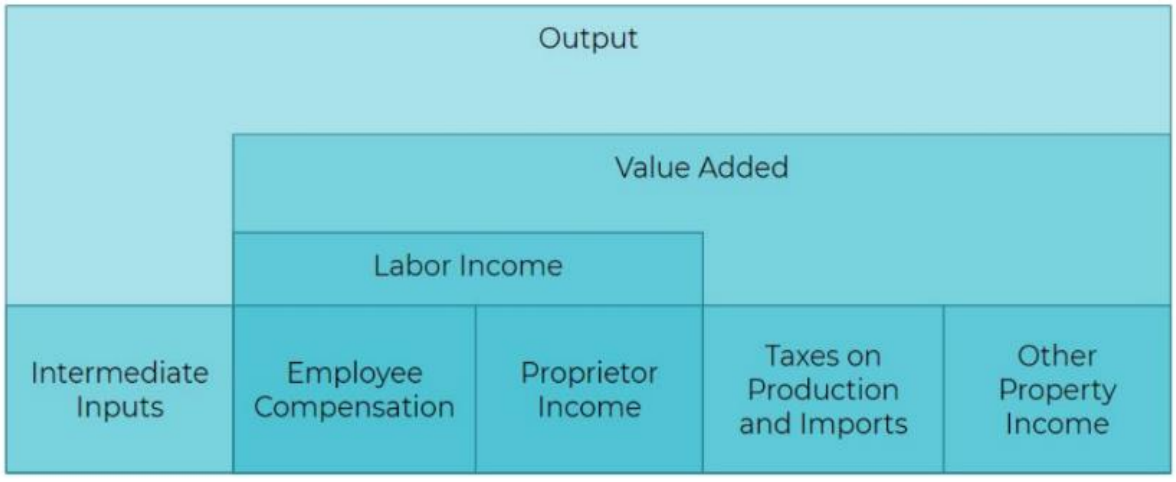
1. the amount that the industry spends on intermediate inputs; and
2. total value added.

Total value added is equal to the sum of labor income, other property income, and any taxes on production and imports that the industry pays. Labor income is the sum of employee compensation (wages and benefits) and proprietor income (profit). IMPLAN calculates employment associated with changes in economic output based on local data for relevant industries.

While this report focuses on economic impact/IO analysis, there are many ways to demonstrate the value of investments in water resources and water infrastructure and the benefits of safe and reliable water sector services. The approach to valuation varies depending on the stakeholder and circumstance in question, as well as whether ongoing expenditures, new investments, or avoided costs are being examined.

The following sections of this report provide a brief summary of studies and reports that have examined the value of water sector services. Most of the literature reviewed utilized IO analysis; however, it is noted where alternative methodologies were employed. A full review of all available valuation methodologies goes beyond the scope of this report.

**Figure 2: IMPLAN Key Terms**



# 2. Findings from the Literature

This section of the report offers a review of studies related to the economic impact of water sector spending and the value of water supply reliability for households, businesses, and local economies. The studies exemplify the range of potential benefits and economic impacts that can be examined within this context and offer results for comparison to the analysis conducted for Charlotte Water.

## 1.1 Impact of Water Sector Spending

Spending to operate, maintain, and expand water and wastewater services generates benefits in the form of direct, indirect, and induced economic activity. The following provides an overview of key findings from studies that have quantified these impacts. Results vary depending on the economic characteristics and size of the study area. Much of the research included in this review focuses on national-level assessments; the multipliers reported in these studies are larger than those reported for smaller local economies.[1] For the following studies all costs and benefits are reported in 2021 U.S. dollars (USD).

In 2014, the Water Research Foundation (WRF) and the Water Environment Research Foundation (WERF) completed a survey of 30 utilities that collectively provide water and wastewater services to 83 million people across the country. In aggregate, these utilities reported plans to spend $26.1 billion per year from 2014 to 2023, with approximately 60% spent on ongoing operating and maintenance and 40% on capital infrastructure investments. These operating and capital expenditures were estimated to generate $59 billion per year in total annual economic output over the decade after the surveys were conducted, totaling $590 billion over the analysis period. This means that every dollar spent by the utilities resulted in a total of $2.28 of spending nationally. Additionally, the expenditures were projected to support 289,000 permanent jobs annually. This survey estimated that every $1 million in direct spending by utilities generated a total of 16 jobs (Quinn et al. 2014).

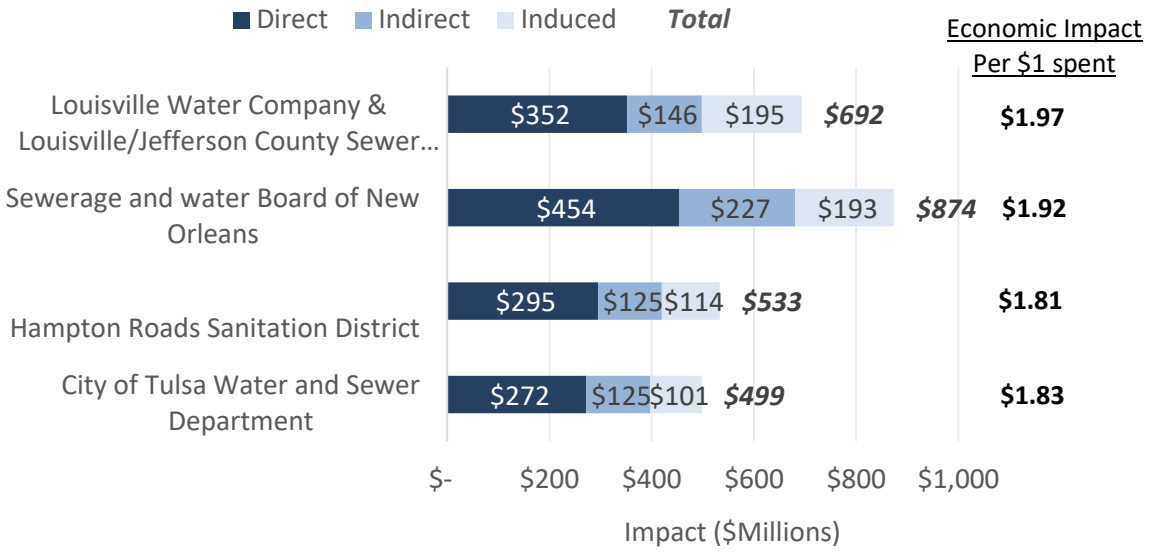
The study reported results at the national level, as well as for individual utilities. Figures 3 and 4 show results for utilities located in the southern region of the U.S. that are relatively close in size to Charlotte Water in terms of economic output and employment, respectively. Figure 3 shows that in Louisville, for example, total spending was projected to amount to $352 million over the 10-year period. The study estimated that this would result in $692 million in economic output within the local economy, meaning that every dollar spent on water and wastewater infrastructure would generate a total of $1.97 in spending. Figure 4 shows that every million dollars spent by the utility creates 12.22 local jobs for Louisville for example.

Building on the 2014 study described above, in 2016 WRF and WERF commissioned an economic impact study for the Value of Water Campaign (VOWC) to examine the effects of national investments in water, wastewater, and stormwater infrastructure on economic growth and employment. This study identified the gap between aggregate planned capital spending on water infrastructure and the estimated investment needed to achieve a state of good repair, approximately $91.8 billion per year. The study

[1]The smaller the study area the more likely it is that goods and services will be purchased from outside of it, decreasing overall impacts for the study area itself.

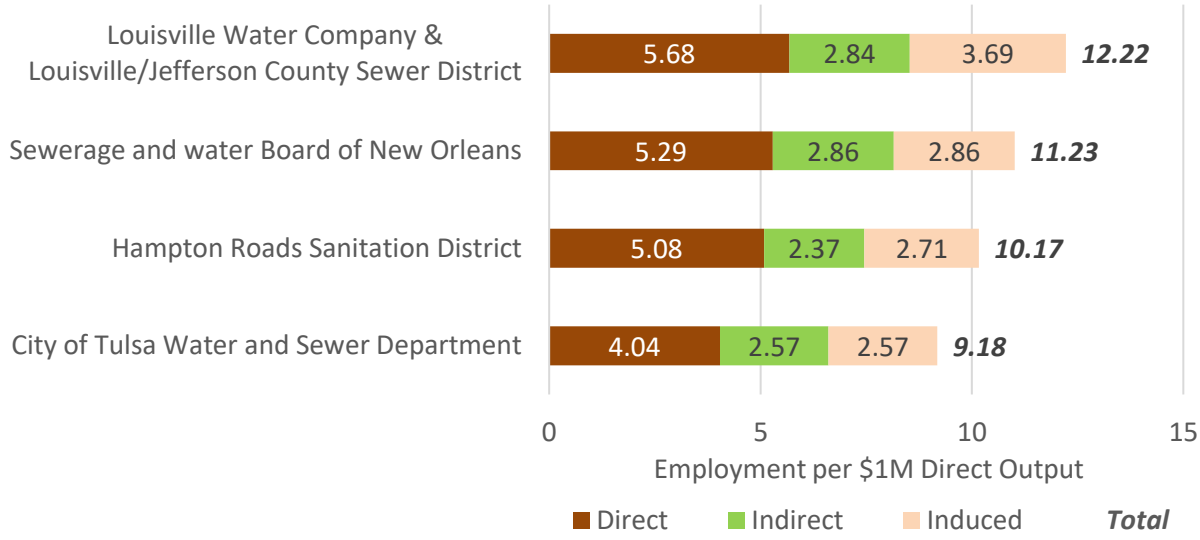
reported that if water sector infrastructure needs were fully funded, the national economy would gain over $240 billion and approximately 1.3 million jobs per year.

**Figure 3: Economic Output Impacts of Utility Spending 2014 – 2023**




*Select utilities from southern region included in WRF/WERF 2014. Note: Red numbers represent total output multipliers.

**Figure 4: Employment Impacts of Utility Spending, 2014 - 2023**




*Select utilities from southern region included in WRF/WERF 2014

The study also reported that for every $1 million invested in water sector infrastructure, upwards of 15 jobs are generated in the national economy. Six direct jobs are generated to support the design and construction of water infrastructure, and nine additional jobs are sustained by the indirect and induced spending triggered by the original investment. The authors found that this is comparable to public investments in energy, health care, and transportation, and is greater than the impact generated by military spending and personal income tax cuts, based on economic impact studies of these sectors. Further, the analysis showed that employment opportunities in water infrastructure sectors are stable, well-paying positions providing an average wage of $63,000 per year (2016 USD), approximately 20% above the national average at the time. Employment gains would be concentrated in construction-related occupations, many of which can be accessed with a high school diploma (WRF/WERF 2016).

Even without major investments in infrastructure, the annual operations and maintenance of water and wastewater services have a major impact on local and regional economies. A study conducted by the U.S. Conference of Mayors examined the Bureau of Economic Analysis (BEA) benchmark data on input-output multipliers for ongoing operations of the water service sector (Krop et al. 2008). These estimates showed that across the U.S., every $1 of output in the water and wastewater industry generates a total of $2.62 of economic output per year. Similarly, for every job in the water and wastewater sector, an additional 3.68 jobs are created across all industries.

## 2.2 Value of Water Supply Reliability

Significant portions of the nation's water and wastewater infrastructure rely on rapidly aging pipes and systems built with inadequate capacity to deliver water and manage the wastewater needs of growing populations. In some areas of the country, water supplies are becoming increasingly scarce and/or significant investments are needed to ensure that all household have access to safe, clean drinking water. Failure in water infrastructure can result in significant water loss, water disruptions, impediments to emergency response, damages to other essential infrastructure through flooding, and in extreme cases, public health issues can arise. Water is essential not only in households but as an input to many industries; even temporary minor disruptions in service can have major impacts across a localized economy.

Several studies have quantified the economic impact of water service disruptions for businesses and households. In the WRF/WERF (2016) study, the authors report that at a national scale, every day of water service disruption would result in an aggregate daily loss of $49.3 billion in sales. An average U.S. business would lose $261 in sales per employee. In businesses most reliant on water, such as many manufacturing sectors, laundry services and others, sales could drop by up to 75%, increasing losses to $6,575 per employee, on average (WRF & WERF 2016). Based on this data, the authors estimate that an eight-day national disruption in water service would amount to a 1% loss in annual GDP (in 2016) and put 1.9 million jobs at risk.

The U.S. Federal Emergency Management Agency (FEMA) requires benefit cost analysis for proposed infrastructure improvements. The FEMA standard value for loss-of-function for utilities is measured as the amount (in dollars) per person per day of lost service. The standard values for Electrical, Potable Water, and Wastewater were determined by the impact of that utility to the regional economy and to residential use. The impact to the regional economy is determined from the national Gross Domestic Product and results are divided by the United States population, resulting in an economic cost per-person, per day. FEMA values the loss of potable water services at $114 per person per day, and the loss of wastewater services at $58 per person per day (FEMA, 2021). Building on FEMA's methodology,

Aubuchon and Morley (2013) estimated per capita daily dollar values associated with water service disruptions based on different assumptions about the price elasticity of demand and basic household water requirements. The monetary value derived is $183 per person per day of total water service loss (2021 USD).

The WaterReuse Research Foundation (WRRF) published two studies on the value of water supply reliability to residential users and to commercial, institutional, and industrial (CII) users (Raucher et al. 2013 and Raucher et al. 2015, respectively). The first of these studies surveyed customers across five water utility service areas to develop estimates of households' willingness to pay (WTP) for water supply reliability. Values for reliability were determined based on household WTP to avoid future water use restrictions related to drought. Results showed that households were willing to pay $76 to $128 per year to avoid one-year of severe restrictions on outdoor water use over the next 20 years. Customer WTP to avoid less restrictive measures was significantly lower and not statistically significant from $0.

The second study focused on the value of water reliability for CII sectors (WRRF 2015). This research effort derived CII water use from utility billing data for five case study utilities, and overlayed economic data with the utility's water use data. The researchers identified the largest CII water users including industrial businesses, hospitals, hotels, and institutions (i.e., universities, parks departments, military installations). The findings of this research reveal the reliance of CII businesses on water services. In one case study for El Paso, an IMPLAN analysis showed that a water use restriction causing a 10% reduction in economic output in the hospital industry (an industry highly dependent on water) would result in a direct loss of $94.3 million and more than 600 jobs annually. For three other case studies, the report estimated revenues generated per thousand gallons (kgal) of water used and jobs supported per million gallons (MG). The industrial sector averaged $100,356/kgal in revenue, and 372 jobs/MG annually. For the commercial sector, average revenues were $33,431/kgal and 186 jobs/MG annually.

In 2019, the authors of this report completed a study on the economic impact of the potential failure of a large water supply pipeline in California that could be caused by a large catastrophic event (such as an earthquake). This study quantified the economic impacts associated with reduced water deliveries resulting from the infrastructure failure, assuming two scenarios for outage duration. As shown in Table 1, the loss in total economic output for these scenarios ranged from 1.4% (Scenario 1) up to 2.6% (Scenario 2) of total annual economic output for the County that made up most of the utility's service area. The most significant impacts of a catastrophic failure affected the finance, insurance, and real estate sectors, as well as nondurable manufacturing.

**Table 1: Outage Scenarios and Associated Economic Impacts of Infrastructure-Related Water Service Disruption, 2019 (in US Dollars)**

| | Scenario 1 | Scenario 2 |
|---|---|---|
| Municipal service impact | 30% ADD[a] for 15 days, return to 100% ADD within 30 days. | Outage for 10 days, restored to 30% ADD for days 10 - 30, 100% ADD by day 31. |
| Industrial service impact | 30% ADD for 30 days, return to 100% ADD within 60 days. | Outage for 10 days, restored to 30% ADD for days 10 - 30, 100% ADD by day 60. |
| Direct loss in economic output | $1,216 M | $2,337 M |
| Total loss in economic output | $1,777 M | $3,448 M |
| Total employment impacts (jobs lost) | 8,421 | 17,648 |
| Residential value of reduced water service | $1.3 B | $2.7 B |

[a]ADD stands for average daily demand.

# 3. Economic Impact of Charlotte Water to the Regional Economy

This section presents the results of the economic impact assessment for Charlotte Water, first providing a brief summary of economic indicators for the study region, and then presenting findings on the economic impact of Charlotte Water to the regional economy. Figure 5 provides definitions for the key terms discussed in this section. Appendix A contains additional detail on the methodology and data used to estimate economic impacts.

**Figure 5: Key Terms for Economic Impact Analysis**

**Economic output** represents the total value of industry production (e.g., total sales).

**Value added** or gross regional product is the difference between the economic output of an industry and the cost of its intermediate inputs. It includes labor income, taxes on production and imports, and other property income.

**Labor income** includes employee compensation (wages, benefits, and taxes paid by the employer) and proprietor income (one form of profit).

**Employment** is the annual average of monthly jobs in an industry. Thus, one job lasting 12 months equals two jobs each lasting six months.

## 3.1 Overview of Local Economy

While Charlotte Water serves households and businesses in Mecklenburg County, economic activity does not follow county boundaries. Employees and businesses that support Charlotte Water's activities are located within the broader Charlotte region. As such, this study includes the six-county region made up of Mecklenburg, Cabarrus, Gaston, Iredell, Lincoln, and Union counties in North Carolina.

Based on data from the IMPLAN model (Table 2), the six-county region had a gross regional product of approximately $160 billion in 2019, while total economic output amounted to more than $276 billion (approximately 25% of the total economic output for the state of North Carolina). The businesses and industries in the study region employ 1.4 million people. Approximately 72% of economic output and 68% of employment in the study area is generated by businesses within Mecklenburg County.

**Table 2: Key Economic Indicators, Mecklenburg County and Six-County Area**

| | Mecklenburg County | Six-county region |
|---|---|---|
| Population | 1.11 M | 2.06 M |
| Employment | 957 K | 1.4 M |
| Economic Output | $198 B | $277 B |
| Value Added (Gross Regional Product)[a] | $123B | $160 B |

Source: IMPLAN, 2019 data

[a]Total value added is one component of economic output (i.e., value added and economic output are not additive). It includes labor income, taxes on production/imports, and other property income.

Table 3 shows economic output for broad industry sectors within Mecklenburg County and the six-county study region. As shown, key sectors include finance, insurance, and real estate (FIRE) and business and repair services, which account for 23% and 17% of total industry output in the study area, respectively. Figure 6 presents employment by industry sector for the six-county region, showing that business and repair services, FIRE, entertainment, and government sectors account for just over 50% of employment.

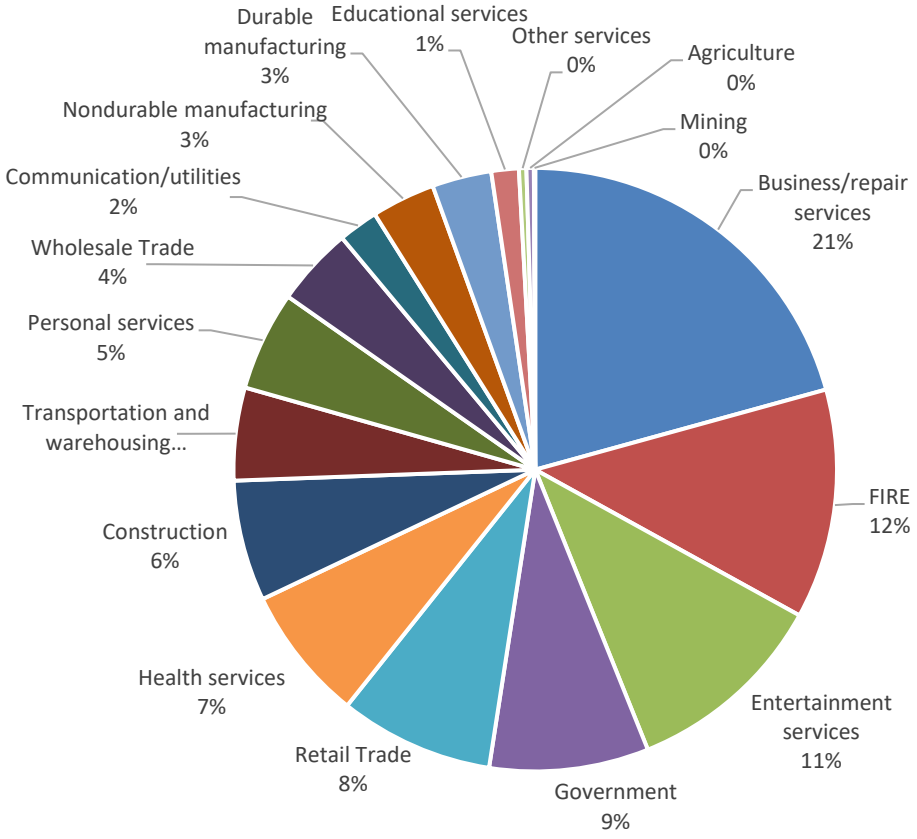
The Charlotte Region is growing in targeted ways. The Charlotte Regional Business Alliance, which covers Mecklenburg County and the surrounding 15-county region, identified advanced manufacturing, financial services, healthcare, logistics and distribution, information technology, and business headquarters as key industry clusters for targeted growth. The organization recognizes factors that will continue to attract businesses within target sectors, including Charlotte's easily accessible location, relatively low cost of living, human and intellectual capital, diverse workforce,and high quality of life. As discussed in more detail below, the provision of safe and reliable water sector services will play a key role in continuing to attract these high value industries.

## Table 3: Economic Output by Broad Industry Categories (2021 USD)

| | Total output ($M) | | % of total output | |
|---|---|---|---|---|
| Industry sector | Mecklenburg County | Six county region | Mecklenburg County | Six county region |
| Finance, insurance, real estate | $55,791 | $62,572 | 28% | 23% |
| Business/repair services | $38,324 | $47,433 | 19% | 17% |
| Manufacturing | $17,275 | $42,158 | 9% | 15% |
| Communication/utilities | $15,033 | $19,135 | 8% | 7% |
| Wholesale Trade | $13,434 | $18,198 | 7% | 7% |
| Transportation and warehousing | $9,524 | $11,451 | 5% | 4% |
| Entertainment services | $8,635 | $12,167 | 4% | 4% |
| Construction | $8,503 | $13,363 | 4% | 5% |
| Government | $7,801 | $11,468 | 4% | 4% |
| Health services | $7,725 | $11,190 | 4% | 4% |
| Retail Trade | $6,435 | $10,191 | 3% | 4% |
| Other services | $5,335 | $9,216 | 3% | 3% |
| Personal services | $3,588 | $5,849 | 2% | 2% |
| Educational services | $871 | $1,225 | 0% | 0% |
| Mining | $103 | $315 | 0% | 0% |
| Agriculture | $70 | $829 | 0% | 0% |
| Total | $198,448 | $276,761 | | |

Source: IMPLAN, 2019 data

**Figure 6: Percentage Contribution to Total Employment in the Six-County Region by Industry Category**




Source: IMPLAN, 2019 data

## 3.2 Economic Impact of Investments in Water and Wastewater Infrastructure

Over the past ten years, Charlotte Water has invested an average of $194 million (2021 USD) annually to improve and expand its water and wastewater systems (i.e., capital expenditures). The utility has spent another $138 million (2021 USD) each year (on average) to operate and maintain these systems (i.e., operating expenditures). These investments have increased significantly over time to meet needs associated with aging infrastructure and to accommodate Charlotte Water's expanding customer base. Table 4 shows Charlotte Water's operating and capital expenditures for 2012 through 2021. Over this time period, Charlotte Water has added two wastewater treatment plants and 700 miles of water and sewer mains. The population served by Charlotte Water has grown by nearly 20%.

**Table 4: Operating and Capital Expenditures, 2012 – 2021 (in $000s USD)**

| Year | Operating expenditures | Capital expenditures | Total |
|---|---|---|---|
| 2012 | $114,375 | $157,162 | $271,577 |
| 2013 | $109,867 | $169,652 | $279,559 |
| 2014 | $112,489 | $165,876 | $278,405 |
| 2015 | $132,578 | $122,410 | $255,031 |
| 2016 | $129,208 | $124,322 | $253,577 |
| 2017 | $151,209 | $178,968 | $330,225 |
| 2018 | $140,758 | $171,946 | $312,758 |
| 2019 | $148,592 | $246,282 | $394,928 |
| 2020 | $170,958 | $280,154 | $451,161 |
| 2021 | $172,125 | $332,297 | $504,481 |
| Total | $1,382,160 | $1,949,069 | $3,331,229 |

*Source: Charlotte Water Financial Statements 2012 – 2020; Data provided by Charlotte Water for 2021

The expenditures shown in Table 4 include salaries and wages for Charlotte Water employees and payments for goods and services that support the design, engineering, and construction of water and wastewater systems and/or other Charlotte Water operating activities. As described above, this spending generates additional economic benefits in the Charlotte region as directly impacted firms and their employees spend money in the local economy. A multi-regional input-output analysis (MRIO) in IMPLAN was used to evaluate these impacts. This method recognizes that while initial spending occurs in Mecklenburg County (by Charlotte Water), the County's economy is closely linked to surrounding counties. An MRIO evaluates impacts across all six counties, essentially expanding the "local economy" beyond just Mecklenburg County to better reflect actual conditions. Spending was modeled in 2021 USD; however, each year of spending was modeled in the appropriate IMPLAN data year to account for changing economic conditions over time. Operating and capital expenditures were modeled separately to account for differences in spending patterns, as was compensation for Charlotte Water employees. Debt service payments were excluded from this analysis. Finally, the analysis assumes that all capital expenditures were spent over the 10-year period.

Table 5 shows the direct, indirect, and induced employment, as well as the total labor income generated by Charlotte Water's annual spending. Results indicate that Charlotte Water has supported 3,600 jobs annually, including 2,020 direct jobs and an additional 1,580 indirect and induced jobs, over the past decade (on average). However, impacts increase with spending - in 2021, Charlotte Water spent just over

$500 million on capital and operating activities (which is much greater than the annual average over the past ten years). These expenditures created 5,230 total jobs, including close to 3,000 direct jobs and 2,280 indirect and induced jobs in that year.

**Table 5: Average Annual Employment (jobs created) and Labor Income Impacts of Charlotte Water Operating and Capital Expenditures, 2012 - 2021, 2021 USD**

| Impact type | Average annual employment (2012 – 2020) | Employment generated per $1 M spent by Charlotte Water | Average annual labor income[a] ($1,000s) |
|---|---|---|---|
| Direct | 2,023[b] | 6.1 | 142,624 |
| Indirect | 831 | 2.5 | 66,653 |
| Induced | 751 | 2.3 | 41,140 |
| Total effects | 3,605 | 10.9 | 250,417 |

a. Average annual labor income includes employee compensation and proprietor income.

b. Direct employment reflects jobs filled by Charlotte Water employees, as well as contractors and businesses hired by Charlotte Water. For direct employment, IMPLAN includes all employment created by direct spending, including jobs filled by non-residents, because these jobs occur within Mecklenburg County.

Table 5 also shows that for every $1 million in direct spending, Charlotte Water creates 6.1 direct jobs and an additional 4.8 indirect and induced jobs in the local economy. The average annual wages associated with the direct and indirect jobs supported by Charlotte Water is relatively high, averaging $61,200.[2] These wages for individuals compare to a median household income for the six-county study region of $69,767 in 2019 (ACS 2019).

Table 6 presents the direct, indirect, and induced effects of Charlotte Water's expenditures on economic output and total value added within the six-county region. Results show that over the ten-year analysis period, total economic output linked to Charlotte Water spending amounted to $6.19 billion. For every dollar spent by Charlotte Water, a total of $1.86 in economic output was generated in the local economy (output multiplier). The total value added associated with Charlotte Water expenditures amounted to $3.30 billion.

Charlotte Water's spending results in different types of jobs and draws upon different services and inputs for implementation. Table 7 shows the top ten economic sectors impacted by Charlotte Water's investments in 2021, based on total employment generated. Results for each sector include total employment, labor income, value added, and economic output generated locally.

[2] Estimated after accounting for benefits and payroll taxes, which are included in IMPLAN's labor income estimates. Assumed to be 23% of employee compensation, reflecting the average across IMPLAN sectors.

## Table 6: Total Value-Added and Economic Output Impacts of Charlotte Water Operating and Capital Expenditures (in $Millions)

| Impact type | Total value added[a] | Economic output (output multiplier) |
|---|---|---|
| Direct | $1,525 | $3,275 (0.98) |
| Indirect | $1,007 | $1,715 (0.51) |
| Induced | $766 | $1,202 (0.36) |
| Total | $3,298 | $6,192 (1.86) |

a. Total value added is one component of economic output (i.e., value added and economic output are not additive). It includes labor income, taxes on production/imports, and other property income.

## Table 7: Top Ten Economic Sectors Impacted by Charlotte Water 2021 Operating and Capital Expenditures, By Number of Jobs Generated

| Industry sector | Total employment (jobs) | Labor income ($M, 2021 USD) | Value added ($M, 2021 USD) | Economic output ($M, 2021 USD) |
|---|---|---|---|---|
| Construction of other new nonresidential structures | 1,570 | $119.09 | $125.39 | $259.19 |
| Water, sewage and other systems | 1,020 | $59.67 | $59.84 | $172.96 |
| Architectural, engineering, and related services | 338 | $37.82 | $38.08 | $59.08 |
| Warehousing and storage | 132 | $5.42 | $5.69 | $11.50 |
| Other real estate | 112 | $3.66 | $11.95 | $24.71 |
| Truck transportation | 111 | $8.12 | $8.98 | $17.89 |
| Employment services | 98 | $5.21 | $7.74 | $10.59 |
| Wholesale - Machinery, equipment, and supplies | 92 | $7.82 | $13.69 | $21.42 |
| Retail - Building material and garden equipment and supplies stores | 69 | $4.27 | $7.13 | $9.81 |
| Limited-service restaurants | 66 | $2.08 | $2.97 | $5.94 |

It is important to note the types and nature of jobs that are supported by Charlotte Water's investments. On the operating side, the utility's spending supports ongoing (i.e., relatively permanent) jobs for its employees and contractors who support Charlotte Water activities (although the companies or individuals who fill contractor roles likely change over time or by project). Capital expenditures support some permanent jobs within the utility. However, many of the jobs created by capital expenditures are short term, meaning that they may be associated with a specific project or program. IMPLAN (and most government agencies) counts jobs on an average annual basis, such that two contractors hired full time by Charlotte Water to complete two projects that last six months each would be counted as one job. While the jobs supported by Charlotte Water may be viewed as "short term" in a sense (at least for individual contractors hired on a project or program basis), continuous investments by the utility will ensure that employment opportunities are generated year after year.

In addition to past spending, the project team evaluated the impacts associated with Charlotte Water's future investments. Charlotte Water has significantly increased its planned capital expenditures for the next five to ten years to address aging infrastructure and support a growing population (based on U.S. Census American Community Survey data, the population of Mecklenburg County increased by 43 people per day between 2019 and 2020). Table 9 shows the projected capital and operating expenses for FY 2022 through FY 2026, indicating that total expenditures are expected to amount to more than $3.4 billion over this time period.

**Table 8: Operating and Capital Expenditures, 2022 – 2026 (2021 $USD)**

| Year | Operating expenditures | Capital expenditures | Total |
|---|---|---|---|
| 2022 | $177,850 | $360,590 | $538,440 |
| 2023 | $205,959 | $523,555 | $729,514 |
| 2024 | $220,767 | $478,133 | $698,900 |
| 2025 | $236,640 | $446,879 | $683,519 |
| 2026 | $253,654 | $570,060 | $823,714 |
| Total | $1,094,870 | $2,379,217 | $3,474,087 |

*Source: CIP and operating budget data provided by Charlotte Water. Operating expenditures for only 2022 and 2023 were provided by Charlotte Water. This study assumes that operating costs continue to grow at the same rate as over the past five years (approximately 7.2%).

The methodology described above was used to model the economic impacts of this spending in IMPLAN. One limitation of the IMPLAN model is that it does not project future changes in the structure of local economies. Thus, future spending was modeled based on IMPLAN's 2020 data year (the latest data available) for the study region. Table 9 summarizes the total direct, indirect, and induced effects for employment, labor income, total value added, and economic output associated with this spending. As shown, Charlotte Water's planned expenditures will result in $6.3 billion in economic output and generate 7,213 jobs per year (for a total of 36,065 job years over the 5-year analysis period).

Further, for every dollar spent by Charlotte Water, a total of $1.83 in economic output is generated in the local economy; 10.4 jobs are created in the six-County study region for every million dollars of spending.

**Table 9: Summary of Total Economic Impacts of Planned Operating and Capital Expenditures, FY 2022 – 2026 (in 2021 $USD)**

| Impact type | Annual[a] Employment (jobs) | Labor income ($M) | Total value added ($M) | Economic output ($M) |
|---|---|---|---|---|
| Direct | 4,087 | $1,492 | $1,576 | $3,405 |
| Indirect | 1,743 | $712 | $1,062 | $1,772 |
| Induced | 11,383 | $406 | $728 | $1,169 |
| Total | 7,213 | $2,610 | $3,367 | $6,347 |

a. Employment reported on an annual basis, while other economic impacts represent totals over the five-year study period.
b. Total value added is a component of economic output (i.e., value added and economic output are not additive). It includes labor income, taxes on production/imports, and other property income.

## 3.3 Value of Reliable Water Services to Businesses and Industry in Charlotte

Investments in maintaining and upgrading water infrastructure are necessary to prevent costly disruptions in water service. Water is an essential input for many industries; even temporary disruptions in service can have major impacts on local businesses. To demonstrate the value of reliable water service, the economic impacts of water service disruptions on municipal and industrial customers was estimated by applying "resiliency factors" developed by Chang et al. (2002). Resiliency factors reflect the percentage of economic output that can be achieved in different industry sectors when water service is reduced to zero.

Chang et al. estimated resiliency factors for three different water service restoration time periods - less than 1 week, 1-2 weeks, and greater than 2 weeks. For example, as shown in Table 10, this means that for a water service disruption lasting less than one week, the manufacturing sector would maintain 42% of typical economic output. If the outage lasts one to two weeks, achievable economic output decreases to 34%. The resiliency factors were used to estimate the daily loss in direct economic output associated with water service disruptions/outages of differing lengths. This information was entered into IMPLAN to estimate total economic impacts across the 418 relevant IMPLAN-defined sectors present in the Charlotte region.

**Table 10: Resiliency Factors by Industry Sector, Representing Percent Output Achieved with Disruption in Water Service**

| Business Category Description | Outage Length | | |
|---|---|---|---|
| | <1 week | 1- 2 weeks | >= 2 weeks |
| Agriculture | 0.53 | 0.35 | 0.30 |
| Mining | 0.73 | 0.48 | 0.44 |
| Construction | 0.68 | 0.47 | 0.43 |
| Manufacturing | 0.42 | 0.34 | 0.28 |
| Transportation and warehousing, communication/utilities | 0.65 | 0.49 | 0.43 |
| Wholesale trade | 0.51 | 0.36 | 0.3 |
| Retail trade | 0.46 | 0.32 | 0.28 |
| FIRE (finance, insurance, and real estate) | 0.44 | 0.27 | 0.24 |
| Business/repair, educational, personal, and entertainment services | 0.45 | 0.33 | 0.27 |
| Health services | 0.27 | 0.21 | 0.19 |
| Other services | 0.45 | 0.33 | 0.27 |

*From Chang et al. (2002)

Results indicate that *direct* losses in economic output associated with a one-day water service disruption range from $277 million to $371 million depending on the length of the overall outage. This creates ripple effects throughout the six-county region. As shown in Tables 11 and 12, a one-day outage would result in a total economic output loss of between $477 and $641 million. Thus, an outage that lasted 1 week would reduce economic output by $3.3 billion; a water service disruption that lasted two weeks or more would result in a $4.5 billion loss. This is equivalent to 1.2% and 1.6% of total economic output within the six-County region, respectively. The direct, indirect, and induced effects that would occur in Mecklenburg County under the same one-week outage scenarios amount to 1.6% and 2.2% of the County's total economic output.

**Table 11: Total Regional Economic Impacts Associated with Per Day of Water Service Disruption Lasting Less than One Week (in 2021 $USD)**

| Impact Type | Employment (jobs)[a] | Labor Income[b] ($M) | Value Added ($M) | Output ($M) |
|---|---|---|---|---|
| Direct | (1,292) | ($102.4) | ($175.4) | ($277.1) |
| Indirect | (529) | ($42.0) | ($67.3) | ($117.4) |
| Induced | (495) | ($27.2) | ($50.8) | ($82.4) |
| Total | (2,316) | ($171.6) | ($293.5) | ($476.8) |

a. Results reported for employment represent the number of jobs associated with the loss of economic output and labor income. They do not necessarily represent permanent job losses.

b. Labor income is a component of value added; total value added is the sum of labor income, taxes on production and imports, and other property income. Value added is a component of output; total economic output is the sum of value added and intermediate inputs used to produce goods and services.

**Table 12: Total Regional Economic Impacts Associated with Per Day of Water Service Disruption Lasting More than Two Weeks (in 2021 $USD)**

| Impact Type | Employment (jobs)[a] | Labor Income ($M) | Value Added ($M) | Output ($M) |
|---|---|---|---|---|
| Direct | (1,731) | ($138.0) | ($233.5) | ($370.9) |
| Indirect | (717) | ($56.8) | ($91.0) | ($159.1) |
| Induced | (669) | ($36.8) | ($68.7) | ($111.3) |
| Total Effect | (3,118) | ($231.6) | ($393.2) | ($641.3) |

a. Results reported for employment represent the number of jobs associated with the loss of economic output and labor income. They do not necessarily represent permanent job losses.

## 3.4 Water Dependent Industries

WRF (2016) defines water-dependent businesses as those that rely most on the services of water utilities to grow their business. Several studies (e.g., Raucher et al. 20154, WRF 206) have identified water dependent industries by comparing water use to industry output or sales. Based on these studies, as well as data provided by Charlotte Water on the largest water users within the service area, the project team identified and assessed the contribution of water dependent industries to the local economy. Figure 7 shows the list of industries included in this assessment.

**Figure 7: Industries Highly Dependent on the Water Sector in Mecklenburg County**

- Manufacturing
- Hospitals and other health care facilities
- Junior colleges, colleges, universities, and professional schools
- Hotels and motels
- Restaurants
- Car washes
- Dry-cleaning and laundry services
- Greenhouse, nursery, and floriculture production
- Breweries and wineries
- Waste remediation

Based on data from the IMPLAN model, water dependent industries served by Charlotte Water account for approximately 15% of total economic output and 18% of total employment within Mecklenburg County. These businesses generate additional economic activity across the six-county region in the form of indirect and induced spending. Table 13 shows the total contribution of water dependent industries across the study area – together, these industries support more than $47 billion in economic output and $25 billion in total value added within the six-county region, supporting close to 246,000 jobs.

**Table 13: Annual Contribution of Water Dependent Industries to the Six-County Region (in 2021 $USD)**

| Impact Type | Employment (jobs) | Labor Income ($M) | Value Added ($M) | Output ($M) |
|---|---|---|---|---|
| Direct | 166,232 | $10,843 | $15,429 | $30,915 |
| Indirect | 47,053 | $4,035 | $6,187 | $10,717 |
| Induced | 32,510 | $1,839 | $3,689 | $5,916 |
| Total | 245,795 | $16,718 | $25,305 | $47,549 |

## 3.5 Importance of Water Services to Support Economic Development

Between 2011 and 2020 Mecklenburg County's population grew by 20%, increasing from approximately 0.94 to 1.14 million. This represents an annual growth rate of 1.7%, compared to a national growth rate of 0.7% over the same time period. Economic activity within the County also grew significantly, with total employment and economic output increasing by 28% and 35%, respectively (reflecting annual growth rates of 2.5% and 3.0%). The jobs created over this time period were relatively high-paying, as overall labor income in the County grew by 41%.

As shown in Table 14, growth in economic output over the past ten years has varied widely across industry sectors – ranging from a 15% decline in the manufacturing sector to an increase of more than 107% in the construction industry.

**Table 14: Growth in Economic Output by Industry Sector in Mecklenburg County 2011-2020 (in 2021 $USD)**

| Industry sector | Economic output 2011 (2021 USD) | Economic output 2020 (2021 USD) | Percent change | Annual growth rate |
|---|---|---|---|---|
| Manufacturing | $20,798 | $17,719 | -15% | -1.6% |
| Transportation and warehousing | $7,447 | $7,605 | 2% | 0.2% |
| Educational services | $809 | $836 | 3% | 0.3% |
| Communication/utilities | $12,692 | $15,495 | 22% | 2.0% |
| Agriculture | $75 | $91 | 22% | 2.0% |
| Health services | $6,164 | $7,701 | 25% | 2.3% |
| Government | $6,627 | $8,338 | 26% | 2.3% |
| Entertainment services | $5,480 | $7,040 | 28% | 2.5% |
| Other services | $4,312 | $5,728 | 33% | 2.9% |
| Wholesale Trade | $10,123 | $13,680 | 35% | 3.1% |
| Business/repair services | $28,047 | $39,158 | 40% | 3.4% |
| Retail Trade | $4,873 | $6,867 | 41% | 3.5% |
| Personal services | $2,297 | $3,481 | 52% | 4.2% |
| FIRE | $37,835 | $61,514 | 63% | 5.0% |
| Mining | $80 | $155 | 94% | 6.9% |
| Construction | $4,768 | $9,882 | 107% | 7.6% |
| Total | $152,426 | $205,291 | 35% | 3.0% |

Source: IMPLAN 2021

When a business looks to expand or open in a new city or region, it considers everything from the tax rates to the quality of life. One key part of the decision lies with the availability of municipal utilities. Municipal governments as utility providers play a significant role in promoting economic development activity (MASC 2013). The significant economic growth that has occurred in the Charlotte region over the past decade could arguably not have been achieved without Charlotte Water's provision of clean and reliable water services.

The 35% growth from 2011 to 2020 represents $52.3 billion in economic output in Mecklenburg County over the ten-year period. This economic activity generated an additional $3.32 billion in indirect and induced economic activity in the surrounding five counties. Over the same time period, Charlotte Water's total expenditures amounted to $3.14 billion (total capital and operating). Thus, every dollar spent by Charlotte Water supported $17.72 of growth in economic output in the six-County region.

The Charlotte Regional Business Alliance projects that the Charlotte region will continue to outpace national trends in terms of population growth, estimating an annual increase of 1.4% through 2050 for Mecklenburg County. Charlotte Water will continue to play a key role in attracting businesses to Mecklenburg County, including key target sectors. Two of the targeted industry clusters (advanced manufacturing and health) identified by the Charlotte Regional Business Alliance (see section 4.1) are water dependent industries.

# 4. Peer Utility Review

An assessment was completed of how Charlotte Water compares to its peer utilities in terms of overall spending and impacts on the local economy. To explore this topic, average annual operating and capital expenditures were compared from fiscal years 2019 to 2021 for 20 utilities across the country. This analysis provides useful insights; however, results of this assessment must be carefully evaluated/interpreted. A higher (or lower) level of spending by a utility does not necessarily indicate a positive (or negative) message. For example, per capita capital spending can be much lower for utilities with a high population and who have a smaller geographic service area. A high per capita capital spending amount could also reflect increasing needs associated with growing populations, increased regulatory requirements, and/or aging infrastructure, as well as (or) past years of under investment. Comparison of operating expenditures per capita may be more straightforward although, several different factors (e.g., density/size of service area) can also affect this total.

Table 15 shows that spending across peer utilities varies widely (this table is sorted by total expenditures per capita from high to low). Average per capita capital and operating expenditures amount to $214 and $310, respectively. Charlotte Water falls slightly above the average for per capita capital expenditures at $258 (average over the past three years) but is well below the average for operating expenditures at $148 per capita.

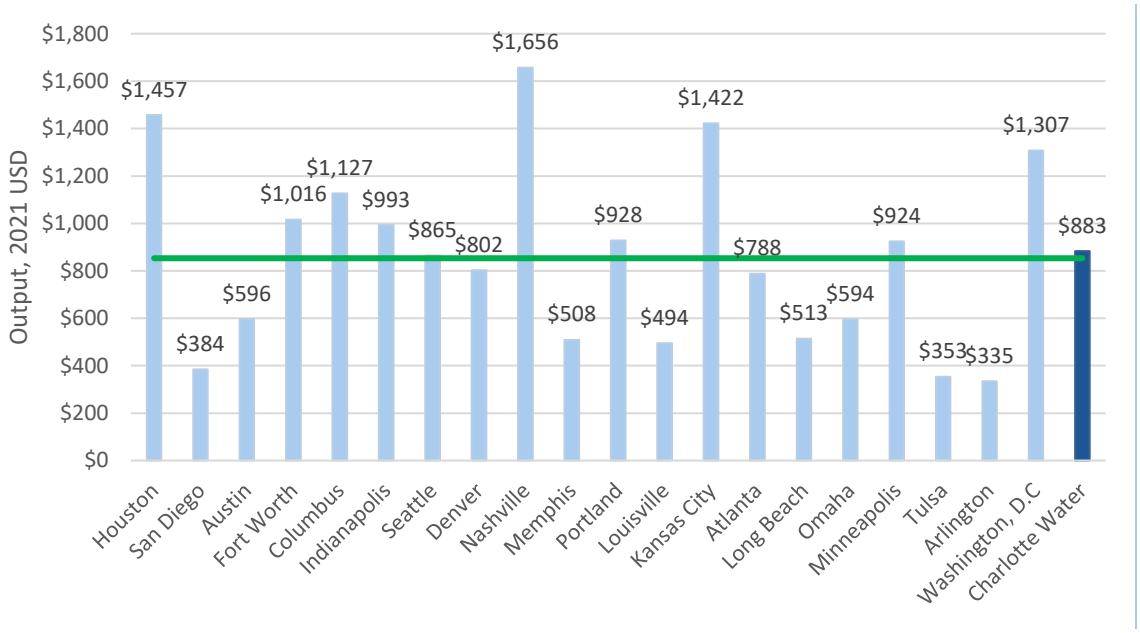
The project team also compared the estimated economic impacts associated with peer utility spending to the economic impacts of Charlotte Water expenditures. For this assessment, we relied on utility expenditures from FY 2021 and economic multipliers reported in the WRF/WERF (2014) study described in Section 2. For peer utilities that participated in the WRF study, we relied on the economic impact multipliers reported in the study for the specific utility; for others, we relied on average multipliers reported by region. The WRF study reported results for individual utilities based on models for the metropolitan statistical area (MSA) in which the utility service area is located. To be able to directly compare the economic impacts generated by Charlotte Water and peer utility expenditures, impacts using the Charlotte MSA as the study area were modeled. Thus, the multipliers are a bit different than those reported in previous sections. This is because the model relies on averages for the MSA (i.e., spending patterns, output per worker, percentage of goods and services purchased locally) rather than for Mecklenburg County and its relationships with surrounding North Carolina counties.

In FY 2021, Charlotte Water's operating and capital expenditures amounted to $172.1 million and $332.3 million, respectively, totaling $504.4 million. Using the IMPLAN results at the MSA level, it was estimated that this spending generated 5,754 total jobs, $502.2 million in total value added, and $980.7 million in economic output. For every million dollars spent by Charlotte Water in 2021, 11.4 jobs were generated within the MSA. Further, every dollar spent by Charlotte Water generated an additional $0.94 of economic activity in the local economy (for a total output multiplier of 1.94). Figures 8 and 9 compare economic output generated by utility spending on a per capita basis (based on population of the water system) and employment multipliers (i.e., jobs generated per $1 million in spending) for Charlotte Water and the peer utilities included in this study. As shown, Charlotte Water's results are slightly higher than the average across its peer utilities.

## Table 15: Average Per Capita FY 2019 – 2021 Operating and Capital Expenditures Per Capita, Charlotte Water Peer Utilities

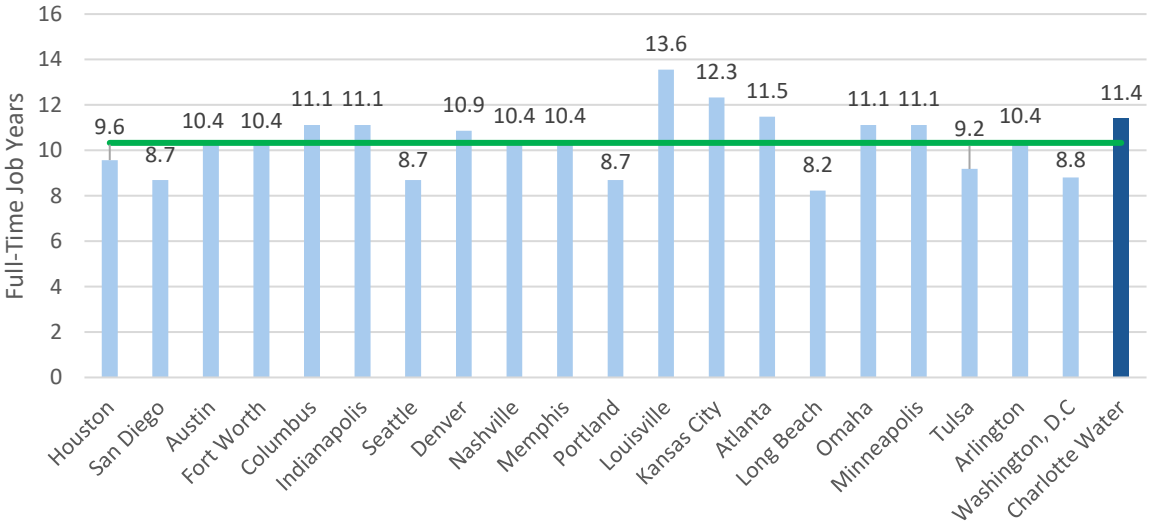
| City | Population served by water system | Operating expenditures per capita | Capital expenditures per capita | Total expenditures per capita |
|---|---|---|---|---|
| Portland, OR | 614,059 | $931 | $183 | $1,114 |
| Kansas City, MO | 471,767 | $719 | $174 | $893 |
| Washington DC | 700,000 | $705 | $162 | $867 |
| Austin, TX | 1,048,674 | $564 | $173 | $737 |
| Houston, TX | 2,221,706 | $228 | $485 | $713 |
| Nashville, TN | 722,043 | $178 | $467 | $645 |
| Atlanta, GA | 1,089,893 | $460 | $170 | $630 |
| Columbus, OH | 1,233,879 | $178 | $447 | $625 |
| Fort Worth, TX | 853,762 | $315 | $244 | $559 |
| Indianapolis, IN[a] | 836,630 | $189 | $287 | $476 |
| **Charlotte Water** | **1,110,356** | **$148** | **$258** | **$406** |
| Arlington, TX | 383,950 | $256 | $132 | $388 |
| Denver, CO | 1,362,071 | $151 | $216 | $367 |
| Long Beach, CA | 475,013 | $278 | $65 | $343 |
| Minneapolis, MN | 423,990 | $175 | $117 | $292 |
| Omaha, NE | 554,091 | $162 | $108 | $270 |
| Tulsa, OK | 471,000 | $224 | $34 | $258 |
| Memphis, TN | 699,244 | $141 | $113 | $254 |
| Louisville, KY | 764,769 | $113 | $133 | $246 |
| San Diego, CA | 1,394,515 | $88 | $110 | $198 |
| Seattle, WA | 955,506 | n/a | $417 | n/a |
| **Average** | **875,568** | **$310** | **$214** | **$524** |

## Figure 8: Estimated Economic Output Per Capita (Based on Population Served by Water System) Associated with Water / Wastewater Utility Spending, FY 2021




Note: Green line represents average across utilities

## Figure 9: Estimated Employment Generated per $1 million of Water / Wastewater Utility Spending (in FY 2021)




Note: Green line represents average across utilities

# 5. References


Chang, S., W. Svekla, and M. Shinozuka, 2002. "Linking infrastructure and urban economy: simulation of water-disruption impacts in earthquakes." *Environment and Planning B: Planning and Design*, volume 29: 281 – 301.

Krop, R.A., C. Hernick, and C. Frantz. 2008. *Local Government Investment in Municipal Water and Sewer Infrastructure – Adding Value to the National Economy*. Prepared for the U.S. Conference of Mayors. Available: Estimating the Value-Added to the National Economy from Local Government Investment in Municipal Water and Sewer (cadmusgroup.com)

FEMA. 2021. *BCA Toolkit Version 6.0.* Available: https://www.fema.gov/grants/guidance-tools/benefit-cost-analysis.

Lynch, T. 2000. *Analyzing the Economic Impact of Transportation Projects Using RIMS II, IMPLAN and REMI*. Office of Research and Special Programs, U.S. Department of Transportation. Available: https://cefa.fsu.edu/sites/g/files/imported/storage/original/application/18d780904fc532b3cf0bcdcc8a082bfa.pdf

MASC (Municipal Association of South Carolina). 2013. Municipal utilities play important role in economic development efforts. Uptown.

Quinn, A., C. Safriet, K. Feeney, and V. Lauf. 2014. *National Economic & Labor Impacts of the Water Utility Sector – Executive Report.* Water Research Foundation (WRF) and the Water Environment Research Foundation (WERF). Available: EconomicImpactsoftheWaterUtilitySectorExecutiveReport.pdf (naco.org)

Raucher, R., J. Hendreson, J. Clements, T. Meernik, M. Duckworth, J. Oxenford, J. Kiefer, and B. Dziegielewski. 2015. The Value of Water Supply Reliability in the CII Sector. WateReuse Research Foundation. Alexandria, VA.

Raucher, R. J. Clements, C. Donovan, D. Champan, R. Bishop, G. Johns, M. Hanemann, S. Rodkin and J. Garrett. 2013. The Value of Water Supply Reliability in the Residential Sector. WateReuse Research Foundation. Alexandria, VA.

Value of Water Campaign (VOWC). 2016. *The Economic Benefits of Investing in Water Infrastructure*. Available: Economic Impact of Investing in Water Infrastructure_VOW_FINAL_pages.pdf (thevalueofwater.org)

Water Environment Federation (WEF) and WateReuse Association (WRA). 2016. *The Economic, Job Creation, and Federal Tax Revenue Benefits of Increased Funding for the State Revolving Fund Programs*. Available: www.wef.org/globalassets/assets-wef/5---advocacy/legislation-and-regulation/legislative-and-regulatory-affairs/wef-wra-srf-economic-impact-study-report-april-29-2016.pdf

# APPENDIX A:

## Economic Modeling Details (IMPLAN)

# A.1 - Summary of Economic Impact Models

Input-output economic models were originally conceived by Nobel Prize winner Wassily Leontief in the 1930s as a tool to help in decision and planning of economic policies. However, IO requires so much data and so many individual calculations that its use was not widely practiced until later in the century when modern computing became widely accessible. Today there are three main programs through which IO models are processed: RIMS II, IMPLAN and REMI. This section discusses the approach and advantages of each program.

The Regional Input-Output Modeling System (RIMS II) uses an accounting framework of IO tables developed by the Bureau of Economic Analysis (BEA). For each industry, an IO table shows the industrial distribution of inputs purchased and outputs sold. The data used include BEA's national IO table, which shows the input and output structure broken out by industries, and BEA's regional economic accounts, which adjust the national IO table to a specific region's industrial structure and trading patterns. RIMS II data are updated annually for regional data, and every five years with new national benchmark input-output data. The RIMS II method uses six types of multipliers: final-demand multipliers for output, earnings, employment, and value added; and direct-effect multipliers for earnings and employment.

> *Advantages*: RIMS II multipliers can be estimated for any single or multi-county region and for any industry or group of industries in the IO table. The advantage of RIMS II is that it is affordably accessible, which keeps the cost of IO analysis relatively low. Also, since the estimating procedure is consistent nationwide, RIMS II multipliers can be compared across areas and regions. The simplicity of the tables means that RIMS II results are transparent.
>
> *Disadvantages:* RIMS analysis shows total economic impact but does not show a breakdown of impacts by industry. Since multiplier tables are generated by BEA, researchers cannot modify any inputs. RIMS II multipliers are static: results reflect industry linkages in a local economy at a given time, but do not account for price elasticities, or changes in consumer behaviors. Finally, RIMS does not allow for estimation of fiscal (tax) impacts.

IMPLAN was developed by the U.S. Forest Service in 1972, but the current IMPLAN input-output database and model is maintained and sold by Minnesota IMPLAN Group. IMPLAN uses a national input-output dollar flow table called the Social Accounting Matrix (SAM). SAM measures the economic relationships between government, industry, and household sectors, allowing IMPLAN to model transfer payments across sectors. IMPLAN contains this data for 546 industry sectors and allows for analysis at different geographic scales. IMPLAN calculates the change in key economic indicators associated with direct, indirect, and induced effects, including economic output, total value added, labor income, and employment.

> *Advantages*: IMPLAN is fully customizable, so users can modify production functions and trade flow assumptions and introduce new industries to the region being analyzed. This program also includes fiscal (tax) impact functions. The geographic scaling allows for analysis to be completed at a zip code level. Also, IMPLAN breaks out results by industry and by direct, indirect and induced impacts.
>
> *Disadvantages*: Because IMPLAN is proprietary software that does not allow users to select multipliers, the program is less transparent. The cost of purchasing county, state and national level

data may be a barrier to conducting smaller scale analysis. As with RIMS II, the analysis is static so results only represent a given timeframe and are not projected into the future.

Regional Economic Models, Inc. (REMI) is also a proprietary modeling program that combines IO analysis with econometrics. The assumption of the REMI model is based on theoretical structural restrictions rather than individual econometric estimates of single time-series observations for each region. This approach allows for dynamic modeling that predicts how impacts in an economy will occur on a year-by-year basis. REMI also models for general economic equilibrium, balancing supply and demand. The complexity of the REMI model is ideal for evaluating policies or actions that would change market dynamics and consumer behaviors on a large scale.

*Advantages*: Since REMI is dynamic, this modeling can be used to forecast direct and indirect impacts and predict results year by year into the future, unlike either IMPLAN or RIMS II. Its immense complexity leads to very comprehensive results. REMI is also the most expensive option for conducting economic impact assessments by a prohibitive magnitude.

*Disadvantages*: The complexity of the model is often excessive for small scale analysis and makes the methodology difficult both to understand and explain basic assumptions. This contributes to a loss of transparency.

# A.2 - Economic Modeling Methodology and Details

This section of the appendix provides additional detail on the modeling performed in IMPLAN to estimate economic impacts.

## Economic Impact of Charlotte Water Spending

In IMPLAN, changes in economic activity are known as "events." There are multiple event types that can be used to model the impacts of changes in economic activity. The event type used depends on the nature of the event itself, the goal of the analysis (what information is desired), as well as the data available. For example, the event type "industry contribution analysis" models the contribution of specific IMPLAN sectors to the local economy, including direct, indirect, and induced impacts. The event type "industry output" models economic impacts associated with an increase or decrease in economic output for a specific sector or sectors (e.g., an increase in economic output for the construction sector that occurs due to increased capital expenditures by Charlotte Water). Event types can also vary depending on whether changes in economic activity occur within private or government sectors.

To assess the economic impact of Charlotte Water spending, the project team separately modeled operating and capital expenditures to account for differences in spending patterns across the two categories. For operating expenditures, the project team used an "Industry Impact Analysis" event type. Previously referred to as an Analysis-by-Parts, this event type allows the user to model a change in industry production or output (e.g., spending by Charlotte Water). However, it also allows the user to enter customized values for employment, labor income, other profits, and intermediate inputs. This allowed the project team to model specific data from Charlotte water regarding employee compensation, number of employees, and non-personnel operating expenditures (i.e., intermediate inputs). To model spending on intermediate inputs, we followed the spending pattern for the IMPLAN sector "water, sewage and other systems."

For capital expenditures, we relied on methodology developed by WRF/WERF (2014) to allocate capital spending across different categories, including construction (external services); engineering, design and related services (external services); heavy equipment; and program management and other internal spending. This resulted in modeling four different events in IMPLAN to represent how these different types of capital expenditures flow through the local economy. For construction and engineering/design, we modeled an "industry output" change (event type) for the relevant industry sectors. To model Charlotte Water spending on heavy equipment and internal program management, it was necessary to use an "institutional spending pattern" event type, which reflects differences in governmental spending patterns compared to private industry. Table A-1 shows how capital expenditures were modeled in IMPLAN, including the event type and the industry sector to which spending was allocated.

To model impacts, the project team used the multi-regional input-output (MRIO) option in IMPLAN. This allows us to model direct impacts in Mecklenburg County but to capture the effects in the surrounding five North Carolina counties (which were combined in IMPLAN to create a five-county region). To assess impacts over time (2012 – 2021), we developed a separate model for each year of spending (using the applicable IMPLAN data year) to account for changes in the structure of the local Charlotte economy. For spending between 2022 and 2026 (future planned investments), impacts were

modeled in data year 2020, the latest data year available in IMPLAN. Table A-2 shows operating and capital expenditures by year, as input into IMPLAN. This data was obtained from Charlotte Water financial reports and data provided by Charlotte Water. All data is presented in 2021 USD.

**Table A-1: Capital Expenditure Modeling in IMPLAN**

| Expenditure category | % of capital spending | IMPLAN event type | IMPLAN sector |
|---|---|---|---|
| Construction (external) | 78% | Industry Output | Construction of other new non-residential structures |
| Engineering/Design (external) | 12% | Industry Output | Architectural, engineering, and related services |
| Heavy equipment | 6% | Custom institutional spending pattern | State/local government other services (customized to reflect spending pattern of construction of other new non-residential structures sector for heavy equipment only). |
| Program management and other internal activity | 4% | Institutional spending pattern | State/local government other services |

# Economic Impact of Water Service Disruptions

To evaluate the impact of water supply disruptions, the project team mapped resiliency factors developed by Change et al. (2002) to the 418 IMPLAN sectors present in Mecklenburg County. This allowed us to estimate the daily loss in economic output that each sector would experience under water outage scenarios of different lengths (i.e., where the overall outage is less than one week, 1 to 2 weeks, and more than two weeks). The loss in output represents the direct effects of a water service disruption for Mecklenburg County businesses and industries. This data was entered into IMPLAN to estimate the indirect and induced effects across the six-county region, with the loss in each sector modeled as a separate industry output event. Table A-3 shows the resiliency factors and daily output loss by broad industry sector (i.e., IMPLAN sectors aggregated into the sectors identified in Chang et al.) associated with an overall outage lasting less than one week and an overall outage lasting more than two weeks. Values were entered into IMPLAN by individual IMPLAN sector. Note that the total input values are slightly different than the direct effects (i.e., results) of water service disruptions as presented in the main body of the report. This is because results were updated to 2021 USD in the model (values were entered in 2019 USD) and IMPLAN adjusts values for retail and wholesale values to reflect marginal revenues (i.e., producer prices) rather than total prices (i.e., prices paid by final consumers).

## Table A-2. Operating and Capital Expenditures, IMPLAN Inputs (2021 USD, $1,000s)

| | FY 2012 | FY 2013 | FY 2014 | FY 2015 | FY 2016 | FY 2017 | FY 2018 | FY 2019 | FY 2020 | FY 2021 | FY 2022 - 2026 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Employee compensation | $40,033 | $39,268 | $40,471 | $42,863 | $46,456 | $47,861 | $53,849 | $53,827 | $48,553 | $59,199 | $369,906 |
| Non-personnel operating costs | $74,342 | 70,599 | 72,018 | 89,715 | 82,752) | 103,348 | $86,909, | 94,765 | 122,405 | 112,926 | $724,964 |
| **Total operating expenditures** | **$114,375** | **$109,867** | **$112,489** | **$132,578** | **$129,208** | **$151,209** | **$140,758** | **$148,592** | **$170,958** | **$172,125** | **$1,094,870** |
| Construction | $122,587 | $132,328 | $129,383 | $95,480 | $96,971 | $139,595 | $134,118 | $192,100 | $218,520 | $259,192 | $1,855,789 |
| Engineering | $18,859 | $20,358 | $19,905 | $14,689 | $14,919 | $21,476 | $20,633 | $29,554 | $33,618 | $39,876 | $285,506 |
| Equipment | $9,430 | $10,179 | $9,953 | $7,345 | $7,459 | $10,738 | $10,317 | $14,777 | $16,809 | $19,938 | $142,753 |
| Program management/other internal spending | $6,286 | $6,786 | $6,635 | $4,896 | $4,973 | $7,159 | $6,878 | $9,851 | $11,206 | $13,292 | $95,169 |
| **Total capital expenditures** | **$157,162** | **$169,652** | **$165,876** | **$122,410** | **$124,322** | **$178,968** | **$171,946** | **$246,282** | **$280,154** | **$332,297** | **$2,379,217** |

## Table A-3. Estimated (direct) daily loss in economic output under different water outage scenarios, IMPLAN inputs

| Industry sector | Resiliency factors by length of overall outage | | Daily loss in economic output by length of overall outage (direct effect) | |
|---|---|---|---|---|
| | Less than one week | Two weeks or more | Less than one week (2019 USD) | Two weeks or more (2019 USD) |
| Agriculture | 0.53 | 0.30 | $90,187 | $134,321 |
| Business/repair services | 0.45 | 0.27 | $57,748,857 | $76,648,482 |
| Communication/utilities | 0.65 | 0.43 | $14,649,468 | $23,875,096 |
| Construction | 0.68 | 0.43 | $7,454,900 | $13,279,040 |
| Durable manufacturing | 0.42 | 0.28 | $11,486,633 | $14,259,268 |
| Educational services | 0.45 | 0.27 | $1,312,536 | $1,742,093 |
| Entertainment services | 0.45 | 0.27 | $13,010,896 | $17,269,007 |
| FIRE | 0.44 | 0.24 | $85,597,689 | $116,168,292 |
| Government | 0.45 | 0.27 | $11,385,584 | $15,094,320 |
| Health services | 0.27 | 0.19 | $15,450,154 | $17,143,321 |
| Mining | 0.73 | 0.44 | $76,405 | $158,470 |
| Nondurable manufacturing | 0.42 | 0.28 | $15,963,256 | $19,816,456 |
| Other services | 0.45 | 0.27 | $14,531,152 | $14,565,730 |
| Personal services | 0.45 | 0.27 | $5,407,018 | $7,176,587 |
| Retail Trade | 0.46 | 0.28 | $9,520,902 | $12,694,536 |
| Transportation and warehousing | 0.65 | 0.43 | $9,132,735 | $14,873,311 |
| Wholesale Trade | 0.51 | 0.30 | $18,034,564 | $25,763,663 |
| **Grand Total** | **0.46** | **0.30** | **$290,852,934** | **$390,661,994** |

# Economic Contribution of Water Dependent Industries

As described in the main report, the project team relied on existing literature and data from Charlotte Water to identify water-dependent industries in Mecklenburg County (i.e., industries that rely most on the services of water utilities to grow their business). We performed an industry contribution analysis (event type) in IMPLAN to better understand how these industries contribute to the local economy. An industry contribution analysis identifies industries and the associated level of production (or output) that is supported by the current activity of the target industry or industries in the region of study (in this case, water dependent industries). The project team modeled the direct effects/contribution of water-dependent industries in Mecklenburg County because they are served by Charlotte Water. However, we used MRIO analysis to be able to also capture how water-dependent industries in Mecklenburg support economic activity throughout the six-county region in the form of indirect and induced effects. Table A-4 shows the IMPLAN sectors identified as water dependent (and their associated economic output) for the purposes of this study. Due to the large number of manufacturing sectors in IMPLAN for the Charlotte region (228), Table A-4 shows the total contribution for the aggregated manufacturing sector.

**Table A-4. Direct economic output contribution of water dependent industries in Mecklenburg County (2021 USD)**

| IMPLAN industry | Direct contribution (Mecklenburg County) |
|---|---|
| Greenhouse, nursery, and floriculture production | $30,971,471 |
| Waste management and remediation services | $471,048,731 |
| Landscape and horticultural services | $535,389,763 |
| Junior colleges, colleges, universities, and professional schools | $270,621,859 |
| Hotels and motels, including casino hotels | $534,866,745 |
| All other food and drinking places | $1,192,657,592 |
| Full-service restaurants | $1,717,728,582 |
| Limited-service restaurants | $2,028,650,419 |
| Residential mental retardation, mental health, substance abuse and other facilities | $121,469,881 |
| Outpatient care centers | $252,051,291 |
| Nursing and community care facilities | $547,621,201 |
| Offices of other health practitioners | $572,609,686 |
| Offices of dentists | $586,652,904 |
| Hospitals | $1,312,052,461 |
| Offices of physicians | $2,760,748,406 |
| Dry-cleaning and laundry services | $92,664,484 |
| Car washes | $603,676,031 |
| All manufacturing (228 IMPLAN sectors) | $17,283,720,132 |
| **Total** | **$30,915,201,639** |

## Economic Growth by Industry Sector

The project team used data from the IMPLAN model by industry sector (i.e., industry output, labor income, employment) to understand how economic activity in Mecklenburg County has changed over time. For each industry sector, we calculated the change in economic output from 2011 to 2016 and from 2016 to 2020. The change in economic output over these time periods captures total economic activity for Mecklenburg County (i.e., direct, indirect, and induced economic activity). We entered this change in into IMPLAN, using MRIO analysis, to estimate how they resulted in indirect and induced impacts in the other five counties within the study region. We modeled the change in growth from 2011 to 2016 in IMPLAN data year 2016 and the change from 2016 to 2020 in IMPLAN data year 2020 to account for changes in the structure of the economy over time (i.e., relationships between businesses, industries, and households within the study region). The total and percent change in economic output by industry sector in Mecklenburg County is presented in the main body of this report. This data was directly entered into IMPLAN to estimate the indirect and induced effects for the other counties in the study region.