THE VALUE OF STORMWATER INFRASTRUCTURE INVESTMENTS: A NATIONAL SCALE INPUT-OUTPUT ECONOMIC ANALYSIS FOR GREEN INFRASTRUCTURE

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EXECUTIVE SUMMARY

Green infrastructure (GI) is a growing area of investment. Increasingly, GI is being used by municipal stormwater managers and land developers to meet Clean Water regulations as well as to mitigate for water quality and quantity impacts. Drivers for this increased use is based, in part, upon the increased adoption of retention-based permit requirements, but the motivation for the expansion of GI investments has roots in the multiple social and economic benefits that increase the overall value of GI practices to communities.

An under-appreciated and less understood aspect of the importance of GI and stormwater infrastructure overall is the value of these types of practices to drive economic activity and output. This report seeks to expand the understanding of this type of value by leveraging previous initial efforts and expanding the reach and scope of the analysis.

Researchers and experts investigating the nature of GI jobs, goods and services provided the base information needed for mapping the various occupations associated with GI using industry standard codes. Using this information, IMPLAN input/output models were established for 12 locations across the U.S., with a special focus on the Chesapeake Bay watershed region. These locations were chosen as they reflect a diverse set of climate and physiographic regions as well as varying community types and sizes. Hypothetical levels of economic inputs were established for the communities included in the analysis through a consistent methodology to enable a comparative analysis as well as bundling these together to generate a macro-scale view of GI investment impacts.

Modeling results show a range of positive economic outputs for GI investments. All 12 studied locations generated outputs reflecting an economic value gained from GI investments. Specifically, the return on $1 of input for GI investments generated a range of $1.34 to $1.74 in economic output, with an overall average value of $1.55 across the 12 locations. The number of jobs created per $1 million of investment in GI range from 8 to 17 with an overall average of 13. Economic outputs for Chesapeake Bay areas were generally higher than the population in the analysis, which suggests that the value of investments in GI in this region are even higher than in other parts of the U.S.

The economic outputs associated with GI investment are relatively consistent with those from other sectors. Green industries, such as clean energy and energy efficiency investments, generate favorable outputs, so it is not surprising that GI investments also generate strong economic and job creation outputs and activities. Job creation for GI is also similar to those in other water sub-sectors, but economic output of GI lags behind modeled results of SRF-supported water sub-sectors. It is surmised that the strong support (federal funding) of these sub-sectors by SRF assistance explains, in part, the difference seen in economic return on investments between GI and other water subsectors.

Although not included in this effort formally, information is highlighted on the broader view of the value of GI investments to society. Improvement to water quality and alleviation of localized flooding is a clear benefit associated with GI, but other research highlights that benefits also include enhanced property values, improved public health conditions, and social resilience that include support during episodes of pandemic impacts.

This report illustrates the economic value of GI investments using an industry standard input/output modeling platform and represents an initial step towards a deeper understanding of this economic value. Additional work is needed to broaden this level of understanding and appreciation of economic value, such as a sensitivity analysis of factors such as job codes and local purchasing percentage, inclusion of additional communities varying in location and size, and the impact of Community-Based Public-Private Partnerships (CBP3s) in enhancing economic outputs compared with traditional project delivery.

1. INTRODUCTION

The project team has developed an economic analysis approach tailored to green infrastructure (GI) investment to explore the value of GI investments in the context of economic output generated through an economic input/output (I/O) modeling approach. Locations from various regions and climates were chosen to be part of this analysis to capture a broad picture of dynamics in the stormwater industry. The intent of this effort is to illustrate the significant value created by stormwater investments, especially green stormwater infrastructure.

This analysis leverages upon a previous effort funded by the Chesapeake Bay Trust in 2017. Other studies and research efforts have focused on various aspects of understanding the nature of GI job creation and support. However, none provided a quantified analysis of economic benefits and job creation/support specifically tailored to GI, which the 2017 effort and the current analysis presented in this report do. The question on the number of jobs generated through GI investments is oft discussed in generalities, but not quantified. The goal in this effort is to put numbers to these generalities in terms of both job creation as well as economic output.

2. METHODOLOGY

The analysis presented in this report is based upon input provide to and output generated by IMPLAN, which is a standard industry software developed by the U.S. Department of Agriculture and used widely by federal, state, and local officials as well as those in the private sector. IMPLAN is to estimate the direct, indirect, and induced economic outputs based upon investment scenarios that are framed by economic inputs over a specific timeframe as well as by specific job or occupation sector.

A total of 12 locations were chosen from across the country. These locations are listed below and shown in Figure 1.

- Allegheny County, PA
- Prince Georgeo's County, MD
- Douglas County, NE
- Fairfax County, VA
- Fulton County, GA
- Harris County, TX
- Hennepin County, MN
- Hudson County, NJ
- King County, WA
- Lancaster County, PA
- Rockingham County, NH
- San Diego County, CA

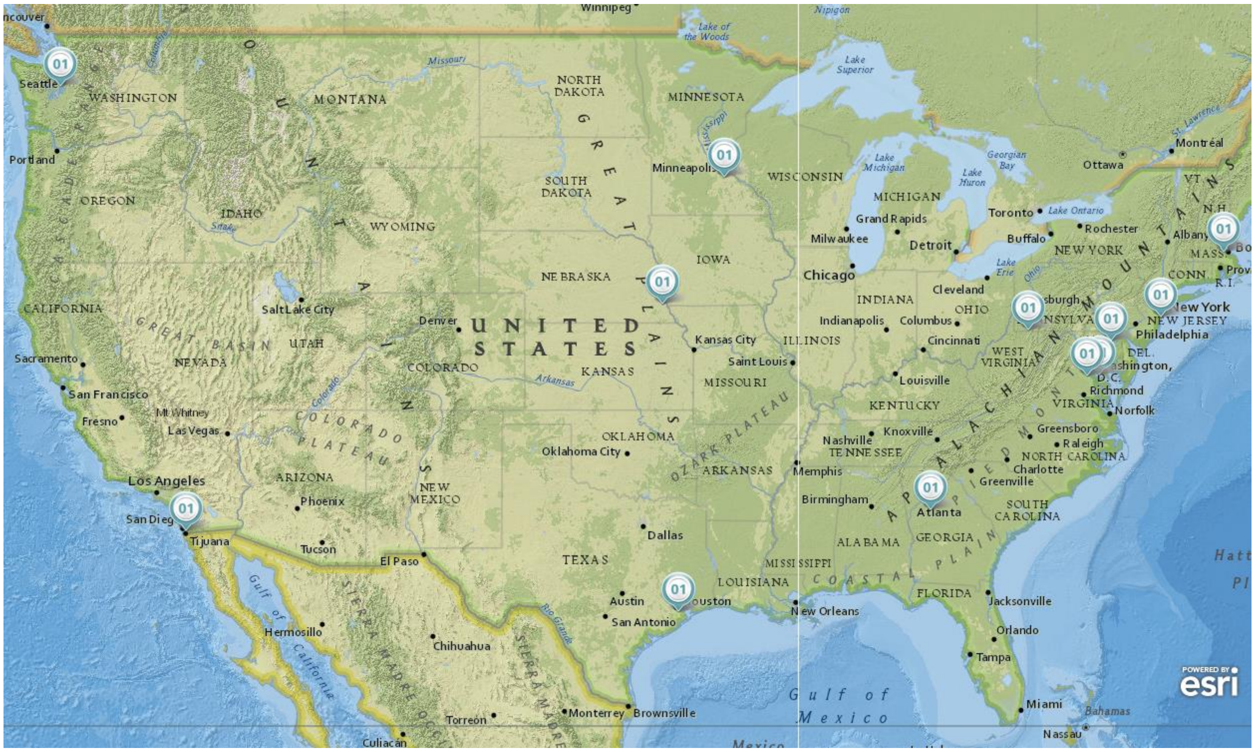

Figure 1 - Locations for the Input-Output Analysis

All of the entities used in the I/O analysis are counties, as this enabled potential to capture both urban and suburban stormwater dynamics. Also, these counties are located in or near large urban areas, which is consistent with areas that have significant stormwater needs. There was an effort to identify locations in a variety of contexts. We also wanted to focus on one specific region, the Chesapeake Bay watershed, in order to highlight regional dynamics as well as national dynamics.

After identifying locations, the next step was to develop the input needed for the IMPLAN analysis. Since we are building upon previous work in this technical area, we were able to refer to the previous approach to map out IMPLAN job or occupation code that corresponds with the GI sector. A report performed by Jobs for the Future (JFF) titled, "Exploring the Green Infrastructure Workforce," identified 30 Standard Occupational Classification (SOC) occupation codes that have been identified as corresponding with the occupations associated with GI[1]. The JFF report also noted that, while jobs associated with these 30 SOC codes, those that are normally associated specifically with GI investments comprise approximately 6% of all total jobs and economic output associated with these jobs. These 30 total SOC codes are grouped in 8 categories, as listed in Table 1.

The project team mapped the SOC job codes to IMPLAN industry segment codes through an analytical process. The JFF report specified that the industry sectors represented by the occupations were "construction, landscaping, groundskeeping, urban forestry, tree care, ecological restoration, and water/wastewater." Appendix A details how the jobs and industry sectors were analyzed to create the initial assumptions for capital investment, O&M labor, and O&M materials to serve as inputs to the IMPLAN model. Since the 2017 analysis, the IMPLAN job codes have changed so efforts were made to

[1] https://www.jff.org/resources/exploring-green-infrastructure-workforce/

adjust the 2017 version input information into the most up-to-date job codes. Appendix A information reflects the most current version of IMPLAN information.

Table 1 - IMPLAN Job Categories

Job Categories
Architecture and Engineering Occupations
Life, Physical and Social Science Occupations
Building and Grounds Cleaning and Maintenance Occupations
Fishing, Farming and Forestry Occupations
Construction, and Extraction Occupations
Installation, Maintenance and Repair Occupations
Production Occupations
Transportation and Materials Moving Occupations

After developing a process to target GI occupations and investment levels, the project team focused on the level of investment in GI associated with each project location. In the spirit of the research goal focusing on the economic impacts of GI investments, the project team decided to allocate investments consistently across all the locations based upon population. The basis for this allocation is the median value for total annual stormwater revenue generated per capita within stormwater utilities as identified in the 2018 Black and Veatch Stormwater Utility Survey, which was found to be $54[2]. Using this value, an estimated annual stormwater revenue was determined for each location, which represents an idealized hypothetical revenue scenario.

The IMPLAN input was based upon capital investments annually as well as annual O&M investments and the commodities associated with these investments. The listing of IMPLAN Commodity Code information is provided in Appendix A along with other IMPLAN information on Job Code data. The project team assumed that 2/3 of total annual stormwater utility revenues would go to project implementation with the remaining 33% split between administrative expenses and O&M expenses. The O&M expenses were based upon 5% of capital investments. Input was then developed for a 20-year time period. O&M investments increased over time as each year saw an increase in capital investment that requires additional O&M support. Total annual investments were determined by adding the cumulative capital and annual O&M investments. The total annual investment after 20 years represents the input to GI for that community.

IMPLAN modeling uses a variable referred to as Local Purchase Percentage (LPP), which is used to determine what percentage of sales is applied to the county and state multipliers. The default assumption in IMPLAN is for LPP to be set to 100% local, that is, all labor and materials are from the study area (county) and results are accrued in the county. This assumption should be used in almost every situation according

[2] https://www.bv.com/sites/default/files/2019-10/18%20Stormwater%20Utility%20Survey%20Report%20WEB_0.pdf

to technical sources[3]. Table 2 lists the input data for Prince George's County, Maryland to illustrate this information in tabular format. A listing of similar information for all locations in the analysis is provided in Appendix B.

Table 2 - 20-year Stormwater Investment Scenario - Prince George's County, MD

Year	*Annual capital investment ($M)*	*Cumulative capital investment ($M)*	*Annual O&M ($M)*	*Total Annual Investments ($M)*
0 (2020)	$0	$0.00	$0.00	$0.00
1 (2021)	$32.4	$32.40	$1.62	$34.02
2 (2022)	$32.4	$64.80	$3.24	$69.66
3 (2023)	$32.4	$97.20	$4.86	$106.92
4 (2024)	$32.4	$129.60	$6.48	$145.80
5 (2025)	$32.4	$162.00	$8.10	$186.30
6 (2026)	$32.4	$194.40	$9.72	$228.42
7 (2027)	$32.4	$226.80	$11.34	$272.16
8 (2028)	$32.4	$259.20	$12.96	$317.52
9 (2029)	$32.4	$291.60	$14.58	$364.50
10 (2030)	$32.4	$324.00	$16.20	$413.10
11 (2031)	$32.4	$356.40	$17.82	$463.32
12 (2032)	$32.4	$388.80	$19.44	$515.16
13 (2033)	$32.4	$421.20	$21.06	$568.62
14 (2034)	$32.4	$453.60	$22.68	$623.70
15 (2035)	$32.4	$486.00	$24.30	$680.40
16 (2036)	$32.4	$518.40	$25.92	$738.72
17 (2037)	$32.4	$550.80	$27.54	$798.66
18 (2038)	$32.4	$583.20	$29.16	$860.22
19 (2039)	$32.4	$615.60	$30.78	$923.40
20 (2040)	$32.4	$648.00	$32.40	$988.20

3. RESULTS

IMPLAN translates input into a variety of resulting figures that provide insights on the economic value and return of investments. Figure 2 provides an overview of the type of information that is generated as model output in IMPLAN. The Total Output is defined as the Value Added combined with Intermediate Input, with Value Added being comprised, generally, of Labor Income and tax revenues.

The macro-scale view for the I/O results is that investments in specific industries generate a variety of economic activities that collectively produces economic output in the form of material goods bought/sold, labor income paid/received, and taxes generated and paid. Output can take the form of direct, indirect or induced economic impacts. Direct impacts are those economic activities tied directly to the industry that is receiving the investment while indirect impacts are based upon activities that

[3] https://implanhelp.zendesk.com/hc/en-us/articles/115009548047-IMPLAN-Pro-Using-the-Local-Purchase-Percentage-Field

have secondary connectivity with said industry. Induced economic impacts are those activities that are generated by the direct and indirect activities but are not connected to the industry of interest in any specific ways. The glossary in this document provides additional technical details on these terms as well as examples for some of these for real-world illustrative purposes.

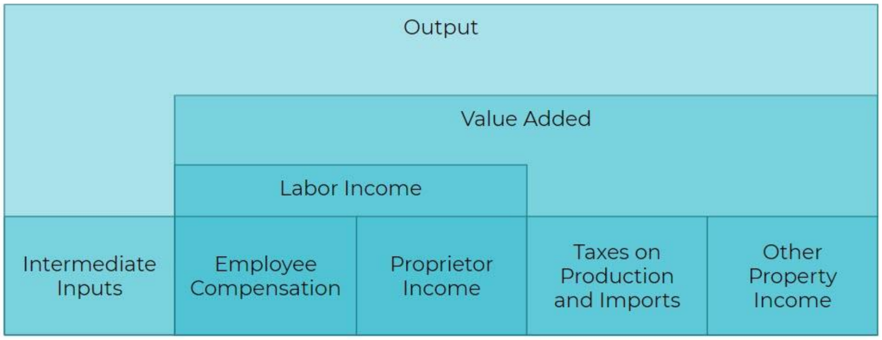

Figure 2 - IMPLAN Output Overview

Table 3 provides a summary of output from Prince George's County, Maryland. This output lists direct, indirect and induced effects tied to employment, income generated from labor, value added, and the output associated with each effect. Cumulative totals are provided for each output category is provided as well. Appendix C provides similar information for each location used in the I/O analysis.

The input information provided in Table 2 and the output shown in Table 3 suggests that approximately $988.40 million in investments in GI over 20 years will generate a total of 12,863 jobs and create $1,328.69 million in economic output. Put another way, approximately 13 total jobs will be created and support per $1M of investment in GI. Similarly, the I/O results for this jurisdiction suggests that every dollar of investment in GI will generate $1.34 of economic return to the community and that the GI industry has an employment multiplier of 1.20 in Prince George's County.

The output listed in Table 3 is consistent with the output for other locations modeled in the specific area of employment. Compared with other industries, the number of indirect and induced jobs created compared with direct jobs is limited for GI investments. This pattern limits overall economic output as well as job creation overall compared with other industries. The smaller indirect and induced effects of GI investment may be because of many reasons, potentially including:

- GI is labor intensive as opposed to material or product intensive industries
- GI does not have direct retail effects, which may lessen the multipliers
- GI tax impacts (other than income tax) are probably shown on property taxes as opposed to sales taxes

Table 3 – Economic Output Based Upon GI Investment for Prince George's County, Maryland

Prince Georges County, MD

Impact Type	Employment	Labor Income ($)	Value Added ($)	Output ($)
Direct Effect	10,724	$420,993,173.72	$539,736,991.18	$988,456,260.17
Indirect Effect	1,233	$63,411,320.38	$106,556,814.66	$201,967,537.21
Induced Effect	906	$38,464,428.99	$83,308,908.23	$138,270,864.78
Total Effect	12,863	$522,868,923.09	$729,602,714.07	$1,328,694,662.15

Using input and output information as listed in Tables 2 and 3 for each location, a series of normalizing figures was developed to enable comparative analysis between jurisdictions, as well as to explore patterns within the GI industry at a larger scale. The specific figures used includes economic output per dollar of input, the total jobs created/supported per $1 million of input, and the employment multiplier. The last term is expressed as the ratio of the total number of jobs (direct, indirect, induced) divided by the total number of direct jobs. Table 4 lists these values for all locations used in the analysis.

A review of information in Table 4 reveals that the GI industry generates relatively consistent outputs across the country. Specifically, the values of economic output per dollar of input for the jurisdictions used in the analysis ranges from $1.34 to $1.74 with an average value of $1.55 (standard deviation $0.13). The total jobs created/supported per million dollars of input ranges from 8 to 17 with an average value of 13 (s.d. 2.2), and the employment multiplier ranges from 1.14 to 1.40 with an average value of 1.32 (s.d. 0.09). The relative standard deviations for these values are 8.2%, 17.1% and 6.7%, which suggest that there is relatively little variability in these values across the locations included in the analysis.

Table 4 - Summary of Economic Output and Job Creation/Support for All Jurisdictions in Analysis

Jurisdiction	*Economic Output per $1 of Input*	*Total Jobs Created/Supported per $1M of Input*	*Employment Multiplier*
Allegheny County, PA	$1.74	14	1.40
Prince George's County, MD	$1.34	13	1.20
Douglas County, NE	$1.67	13	1.39
Fairfax County, VA	$1.42	17	1.14
Fulton County, GA	$1.44	11	1.25
Harris County, TX	$1.64	13	1.35
Hennepin County, MN	$1.62	12	1.36
Hudson County, NJ	$1.43	8	1.40
King County, WA	$1.50	11	1.26
Lancaster County, PA	$1.58	14	1.37
Rockingham County, NH	$1.56	13	1.32
San Diego, CA	$1.71	14	1.41
Average Values	$1.55	13	1.32

While modeled output expressed relatively limited overall variability, patterns of regional differences do exist in the context of economic output. Two of the three Chesapeake Bay communities included in the analysis (Fairfax County and Lancaster County) have economic outputs that are above the overall average values within the study. The above-average values suggest that the positive economic impact of GI investments are higher in the Chesapeake Bay than in other areas across the U.S. The economic output modeled for Prince George's County does not account for the Community-Based Public-Private Partnership (CBP3) program, known as the Clean Water Partnerships (CWP), that has been established.

The CWP is successfully implementing large-scale investments in integrated GI and an increased pace and at a cost that is 30-40% lower than the conventional cost for traditional stormwater and GI project delivery. An important aspect of the CWP program is the requirement to utilize high amounts of County workers in the program as well as local, small, and minority-owned businesses[4]. These requirements

[4] https://thecleanwaterpartnership.com/

were implemented specifically to reduce economic leakage. The success of this program suggests the economic output and total jobs created/supported are likely to be higher in reality than the results produced by IMPLAN in this analysis.

4. DISCUSSION

Modeled Economic Impacts

The values produced in the IMPLAN analysis are consistent with other similar analyses. To provide some context on the analysis output, a comparison can be made with the results of an analysis performed by the Environmental Finance Center (EFC) in 2014[5] that investigated the dynamics of job creation and economic output associated with stormwater management investment in three communities in the Chesapeake Bay Watershed; Anne Arundel (AA) County, MD; Baltimore City, MD, and Lynchburg, VA. The results of this analysis reflected a range of economic output per $1 of investment in stormwater of $1.15 (AA County), $0.76 (Baltimore), and $1.74 (Lynchburg). Similarly, the analysis output for jobs created per $1M of stormwater investment was found to be 7.8 (AA County), 3.4 (Baltimore), and 14.4 (Lynchburg).

For the 2017 analysis, the results were that $750 million capital investment in Prince Georges County, MD is estimated to produce 18 direct jobs per million dollars and $1.81 in total output for every $1 in capital invested. In Albemarle, VA, $1 million capital investment is expected to create over 21 direct jobs and $1.63 per $1 of capital investment.

The results from the current analysis produce results that have less variability compared to the EFC study results and are slightly less impactful in terms of jobs and output generated than the 2017 analysis. However, the values from the current analysis are highly consistent with the previous analysis. Economic multipliers can vary across regions due to factors. For instance, job multipliers can vary due to the nature and condition of local supplier industries, ability for local workers to purchase local goods and services, the nature of the local workforce, and local conditions associated with land value, infrastructure condition and negative externalities such as traffic congestion and air quality[6]. These factors also tie to economic leakage, which is the term describing the portion of expenditures made outside of a local economy and/or inputs gained from outside the region. For instance, more isolated communities may have reduced economic leakage, as there are few other economic centers in the region. However, these isolated communities may have limited local suppliers and options for induced spending.

Another question is how the economic and employment multipliers as well as job creation index compares with other industries. The overall average number of jobs created in the use per $1 million invested is 17, but this value varies by sector. For instance, the construction industry creates 20.3 jobs per $1 million of investment while the energy sector will create 9.9[7]. New data suggests that investments in green industries generate more significant job creation benefits, as evident by

[5] Environmental Finance Center, 2013. *Stormwater Financing Report to Lynchburg, VA.* Accessed December 28, 2017. https://efc.umd.edu/lynchburg

[6] https://research.upjohn.org/cgi/viewcontent.cgi?article=1319&context=up_workingpapers

[7] https://www.aceee.org/files/pdf/fact-sheet/ee-job-creation.pdf

investments in solar PV and clean energy retrofits creating 12-15 jobs per $1 million invested[8]. The value of 13 jobs crated per $1 million invested is more impactful than some industries and is consistent with other green-based industries. Table 5 summarizes the comparison of GI economic metrics with other industries.

When considering the water sector as a whole, investments in GI are at par with other water sub-sectors other general sectors and exceed some sectors such as energy. A study by the Water Research Foundation found that 16 jobs are created for every $1 million invested in the water, wastewater and stormwater service sectors[9]. When considering the economic return on investment, the current analysis estimates an average output of $1.55 for every $1 invested. A study by the Water Environment Fedration (WEF) and the WateReuse Association determined that $2.95 in output occurs for every $1 invested in the State Revolving Fund (SRF) programs for the clean water and drinking water sectors[10]. This high output is likely is due in part to the fact that federal SRF allocations account for 23% of total SRF spending, with the balance provided by state matching investments. The SRF program is clearly a successful program when considering economic output due to this state-leveraged investment construct.

Table 5 - Economic and Job Creation Metrics for Various Industries

Industry/Sector	*Economic Output per $1 of Input*	*Total Jobs Created/Supported per $1M of Input*
U.S. National Average	-	17[8]
Green Infrastructure	$1.55	13[8]
Construction	$3.08[11]	20[8]
Manufacturing	$3.79[12]	14[8]
Solar PV	$4.50[13]	12[8]
Weatherization / Energy Efficiency Retrofit	$1.67-2.09[14]	11-15[8,14]
Coal-fired Energy	-	6

Table 6 - Economic Output and Job Creation for Water Sector

Industry/Sector/Investment Type	*Economic Output per $1 of Input*	*Total Jobs Created/Supported per $1M of Input*
State Revolving Fund	$2.95	16
Green Infrastructure	$1.55	13
Drinking Water, Wastewater, Stormwater	$2.26	16

[8] https://www.iea.org/data-and-statistics/charts/construction-and-manufacturing-jobs-created-per-million-dollars-of-capital-investment-in-the-sustainable-recovery-plan
[9] https://www.bafuture.org/sites/default/files/key-topics/attachments/impacts-of-water-utility-sector.pdf
[10] https://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
[11] https://leadingbuilders.org/wp-content/uploads/2020/07/Residential-Construction-Economic-Study-5-2020.pdf
[12] https://www.nam.org/facts-about-manufacturing/
[13] https://www1.eere.energy.gov/wip/solutioncenter/pdfs/clean_energy_investment_cases.pdf
[14] https://www.epa.gov/sites/production/files/2018-07/documents/mbg_2-5_economicbenefits.pdf

Unfortunately, the stormwater sector has been almost completely shut out of SRF investments when compared to other water sub-sectors. Figure 3 provides a breakdown of Clean Water SRF assistance by sector and illustrates that the stormwater sector has received only 1.8% of all total assistance over the lifetime of the program. Figure 4 provides a breakdown of this percentage over time (broken into 5-year increments) and shows that it will take 60 years for CWSRF assistance to rise to a total of 10% of all assistance for stormwater projects based upon current trends. It is suggested that a more equitable inclusion of the stormwater sector in Clean Water SRF investments would lead to a significant return on investment for green infrastructure projects, similar to the returns on investment identified in the WEF/WateReuse report.

Regarding the impacts of GI investments across the nation, the Water Environment Federation (WEF) estimated a range of $18-$24 billion is dedicated to MS4 budgets across the country in their 2020 MS4 Needs Assessment Survey[15]. This same report estimates an annual funding gap for MS4s of $8.5 billion. Using the average values for economic output per dollar of input as well as total jobs created/support per $1M of input as shown in Table 4 along with the WEF MS4 Survey Assessment Survey results can drive estimates of the total potential for economic output and jobs associated with GI investments at a national scale.

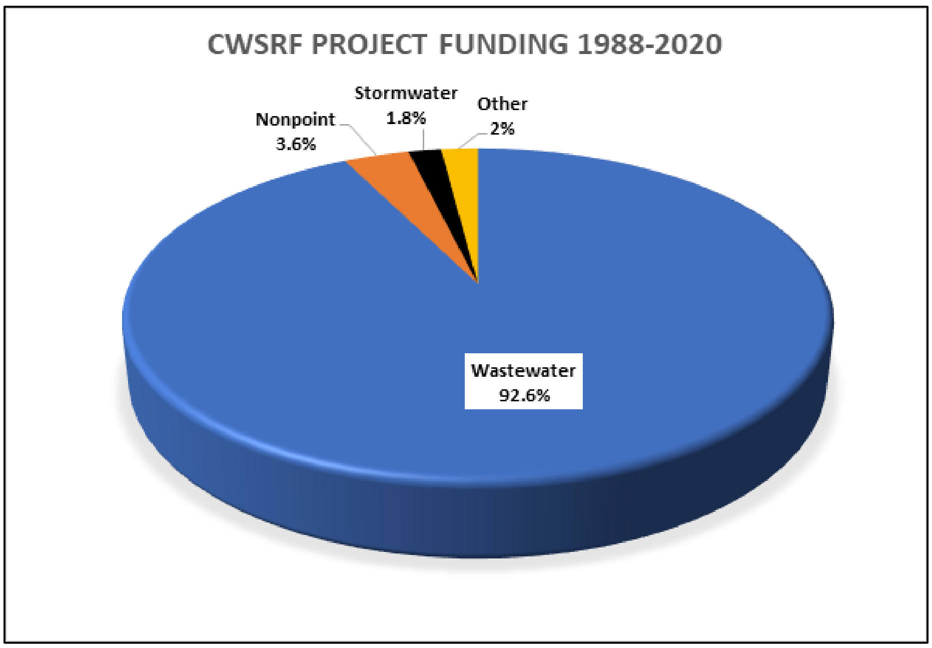

Figure 3 - Clean Water SRF Investments, Source EPA, 2021[16]

Assuming that the total annual MS4 budgets across the U.S. are $21 billion and the annual funding gap is $8.5 billion, there is a potential to create $32.6 billion in economic output from current budgets and an additional $13.2 billion if funding gap needs were fully addressed, for a total of $45.8 billion. Using a similar approach, a total of 267,750 jobs could be associated with the current budget level and an additional 108,375 associated with the funding gap, for a total of 376,125 jobs. In an era where federal

[15] https://wefstormwaterinstitute.org/wp-content/uploads/2021/02/WEF_MS4_Needs_Assessment_Survey_Full_Report_2020_Final.pdf
[16] Percentages determined by NMSA through analysis of data provided by EPA, 2021

legislation is suggesting investments of trillions of dollars in infrastructure, it is clear that the stormwater sector is a valuable industry that is ripe for investment, especially for green infrastructure practice investments.

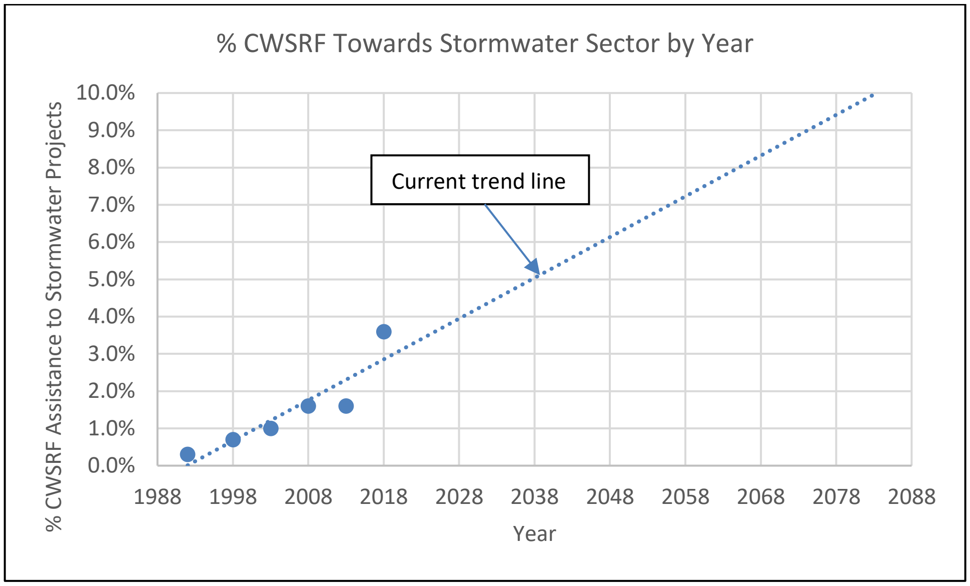

Figure 4 - Percentage of Total Clean Water State Revolving Fund Assistance Invested in Stormwater Projects between 1988 and 2020, Source EPA, 2021[17]

Additional Economic and Social Benefits of Traditional and Green Stormwater Infrastructure

The economic modeling results presented in this report indicate and reinforce that GI and stormwater infrastructure is a value-driven investment in terms of economic output and job creation for communities regardless of region. An advantage not captured by the I/O analysis are the many benefits and co-benefits of traditional stormwater infrastructure and GI.

Ecosystem services, defined by U.S. EPA as, "goods and services…we receive from nature, such as clean air and water, fertile soil for crop production, pollination, and flood control[18]." Green infrastructure used in urban areas has the potential to be highly impactful in terms of ecosystem services (ES). For instance, green roofs have been shown to reduce total annual runoff for building footprints by up to 70%[19] and reduce rooftop temperatures in dense urban areas by up to 60 degrees Fahrenheit[20]. A 2019 research effort captured the opinions of academic experts regarding the ES benefits associated with 14 types of GI practices/features. A total of 22 ecosystem services were included in the analysis and experts were asked to rank the positive or negative benefit of each GI practice/feature in the context of each ES type listed using a 7-point Linkert-style rating system. Results of this efforts reflects that 13 ES types shows moderate to strong consensus on the benefits of at least half of the GI practices reviewed and 19 ES benefit types reflecting strong consensus among the experts for at least one GI type. This

[17] Percentages determined by NMSA through analysis of data provided by EPA, 2021
[18] https://www.epa.gov/eco-research/ecosystem-services
[19] Köhler, M. 2006. Long-term Vegetation Research on Two Extensive Green Roofs in Berlin. Urban Habitats, 4(1), 3-25.
[20] Gaffin, S., et al. 2005. Energy Balance Modeling Applied to a Comparison of White and Green Roof Cooling Efficiency. Proceedings of the 3rd Annual Greening Rooftops for Sustainable Cities.

type of effort highlights the broad array of ES benefits associated with GI practices as identified by GI experts[21]. Figure 5 provides a summary of the results of this analysis.

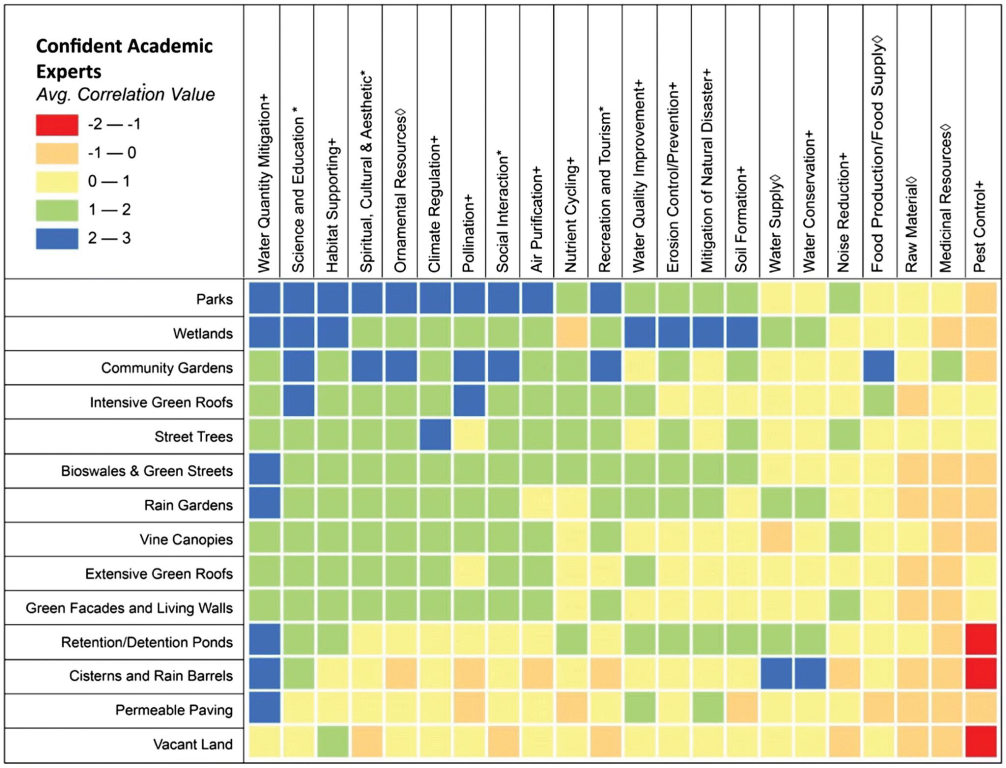

Figure 5 - Summary of GI Expert Consensus Opinions on GI Practices and Ecosystem Services (Elliot et al 2019)

A Triple-Bottom Line (TBL) analysis comparing traditional combined sewer overflow (CSO) mitigation with GI to mitigate for CSO impacts in Philadelphia found that using GI would generate over $34 million in energy savings due to reduced urban heat island effects, $134 million in savings associated with air quality issues, such as asthma, heart attacks, and respiratory illnesses, property values would increase by $575 million, and $1.1 billion in benefits associated with public health issues related to reduced health-related premature fatalities would be realized[22]. Overall, the Philadelphia TBL analysis highlights that GI derives 20 times the amount of benefits and co-benefits compared to underground tank/tunnel CSO mitigation[23].

Flooding is the leading natural catastrophe occurrence in terms of costs in the U.S., and these costs are growing due to climate change impacts[24]. A significant benefit for GI is the ability to absorb and either retain or detain excess runoff in urban areas, which reduces downstream impacts due to flooding and water quality impacts. Braden and Price (2006) determined that the use of GI in a 73 square mile urban watershed in the Chicago area could decrease peak flows for a 50-year and 100-year storm event by 25% and 22%, respectively. Further, this study included the finding that the reduced flood water

[21] https://news.climate.columbia.edu/2019/09/03/hidden-benefits-green-infrastructure/

[22] Stratus Consulting. 2009 (August). A Triple Bottom Line Assessment of Traditional and Green Infrastructure Options for Controlling CSO Events in Philadelphia's Watersheds. Prepared for City of Philadelphia Office of Watersheds.

[23] Ibid

[24] https://www.scientificamerican.com/article/rising-costs-of-u-s-flood-damage-linked-to-climate-change/

surface elevations could increase property values by approximately 5% and lead to $3 million in avoided costs due to flood reductions[25].

Bottom line economic benefits focusing on GI investments are favorable when considering input-output dynamics and job creation/support alone, but the benefits associated with stormwater infrastructure and GI practices goes far beyond bottom line economics. Stormwater infrastructure is located across the landscape in communities in both public and private spaces and properties. This infrastructure also generates positive externalities that can be captured quantitatively through the use of TBL analysis. This broader view of value reflects the multi-purpose, multi-purpose and overall socially and economically holistic nature of stormwater infrastructure and GI practices.

5. CONCLUSION

This effort focused on the quantification of economic impacts for GI investments across the U.S. A total of 12 communities were included in the I/O analysis implemented via IMPLAN, which is a standard economic modeling platform. The methodology for input development in the analysis was based upon a 2017 analysis that focused on the mapping of standard industry job codes into IMPLAN to enable the modeling of GI investments. Using this methodology, the economic impacts of capital and O&M investments in GI over a 20-year period were modeled for the selected communities using investment input levels based upon revenues scaled by community population.

The model results show that every dollar invested in GI capital projects and associated O&M activities returns $1.55 economically through purchased services and goods, labor income for direct, indirect and induced jobs, and tax revenues generated. In addition, the IMPLAN modeling suggests that for every $1 million invested in GI capital and O&M, there will be 13 jobs created, which is similar to the rate of job creation in other infrastructure and industry sectors. As noted, the robust job creation associated occurs even with limited indirect and induced economic impacts, which illustrates the significant source of direct job growth in response to GI investments. The economic return is comparable with other industry sectors and shows that investments in GI capital and O&M will produce positive economic results for the local and regional economy.

Investments in other water sub-sectors lead to similar job creation outputs produced by GI investments. The economic output associated with SRF investments into these sub-sectors outpaces the economic return modeled for GI investments, but the context of equitable involvement in the SRF needs to be appreciated and acknowledged as this difference in economic output is likely attributable to the investments from the federal government being leveraged by states to increase the overall investment capacity. If investments in stormwater were increased SRF programs, it is likely that economic returns for the GI sector would increase due to state-matching investments.

For example, there are benefits for GI and stormwater infrastructure investments that go beyond economic output and job creation. These benefits include increased property values and associated fixes to urban blight, public health improvement due to reduced air particulates and urban heat island impacts, and of course, enhanced water quality conditions as well as avoided costs due associated with flooding impacts. All of these factors have economic benefits that, if accounted for in cost-benefit

[25] Johnston, D.M., J.B. Braden and T.H. Price, (2006), "Downstream Economic Benefits of Conservation Development," Journal of Water Resources Planning and Management, American Society of Civil Engineers, 132(1): p 35–43.

analyses, will illustrate that the advantage of stormwater and GI investments are both bottom-line in ways that cannot be captured simply through an I/O analysis effort.

Another significant benefit that is relevant in the current pandemic is that green space and associated GI features have provided a well-needed and safe respite from the risks of COVID-19. As with the 1918 Flu pandemic, people have chosen to flock to outdoor spaces and parks. Figure 6 shows that with onset of the pandemic, Americans chose to stay home at an increased rate, but when they did leave the house, they chose to go to parks at a rate of 60-80% compared with pre-pandemic levels[26].

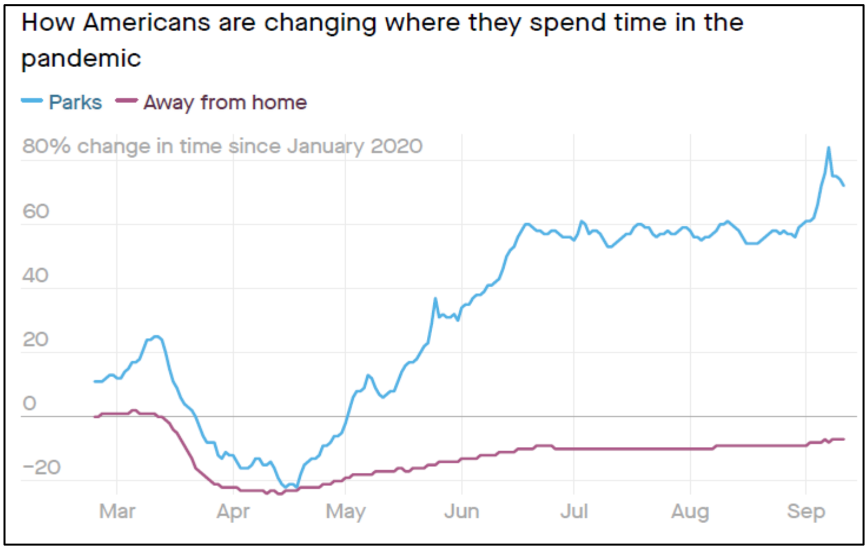

Figure 6 - How Americans are Choosing to Spend Time in Context of Parks, Source qz.com, 2021

The growing interest in green and natural infrastructure solutions over the last two decades may be kicked into high gear due to the response to the pandemic, which also occurred after the 1918 flu pandemic. The interest in utilizing outdoor space for health and recreation as well as leveraging nature in architectural design may very well drive biophilic design and a "living architecture" aesthetic in future development efforts[27]. COVID-19 has further exposed the magnitude of impacts associated with environmental justice, as people of color have been disproportionately impacted by the virus. It is not hard to see how people of color who live in areas with significantly higher environmental toxins and who are exposed to much more significant rates of soot and other particulate matter have been made more vulnerable to the impacts of the virus[28]. An increase in GI investments could greatly improve the well-being and health of residents in environmental justice (EJ) communities as well as enhance the resilience to flooding and future potential virus-driven pandemics. All of these aspects of improvement have positive economic and social value.

The field of environmental economics is just beginning to gain an appreciation of the quantifiable benefits of GI and the stormwater sector overall. As the profile of stormwater rises in the eyes of the public and for decision makers, there will be continued interest in how GI and stormwater infrastructure investments can be expanded to create jobs, drive economic activities and output, and enhance the environment as well as the health and condition of the public.

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[26] https://qz.com/1908674/covid-19-has-americans-visiting-national-parks-in-record-numbers/
[27] https://www.estormwater.com/coronavirus/analyzing-value-green-infrastructure-during-covid-19
[28] Ibid

GLOSSARY

Terminology used in this document is defined as shown in the listing below.

Input-Output Analysis: A modeling technique that divides the economy into final demand and production and accounts for the direct and indirect interdependencies among different sectors.

Intermediate Inputs: Goods and services that are used in the production process of other goods and services and are not sold in final-demand markets.

Labor Income: This term reflects the combined cost of total payroll paid to employees (e.g. wages and salaries, benefits, payroll taxes) and payments received by self-employed individuals and/or unincorporated business owners across the defined economy.

Value Added: Economic output that includes total labor income output plus tax revenues generated.

Total Inputs: The total amount of money invested in GI capital projects as well as investments made to properly support the operations and maintenance of GI investments made.

Total Outputs: The total economic output generated from labor Value Added plus Intermediate Inputs. Total Output represents the value of industry production.

Direct Economic Impacts: The economic impacts that have direct ties to the goods and services associated with the input activities and associated activities. Example: A landscaping company that provides O&M support for GI infrastructure generates a profit and pays hired laborers who pay taxes based upon income received.

Indirect Economic Impacts: The economic impacts driven by transactions that are indirectly associated with the goods and services tied to the modeled inputs. Example: A supplier of sand and gravel that is used in GI practices hires a lawyer and a bookkeeper to ensure that they are paying employees accurately and providing employees with proper human resources support.

Induced Economic Impacts: The economic impacts that have neither a direct nor an indirect tie to the goods and services associated with the modeled inputs. Example: Workers who are inspecting and maintaining GI practices eat lunch at a local restaurant that employs cooks, wait staff and other support workers as well as generating a profit for the restaurant owner.

Employment or Jobs Multiplier: The total number of jobs associated with a direct effect job. Example: If an investment in an industry creates one direct job and two additional jobs (one indirect and one induced), the employment multiplier for that industry in that analysis is three (one direct, one indirect and one induced).

Economic Leakage: The occurrence of expenditures made outside of a local economy as well as inputs gained from outside of said economy.

Appendix A – IMPLAN Modeling Assumptions

In mapping the occupations to the industry sectors, the amount of people in an occupation who participate in green infrastructure was analyzed based on the results of the Jobs for the Future study, *Exploring the Green Infrastructure Workforce,* as shown in Table A1.

Table A1 - Types of Occupations Involved in Green Infrastructure

Job Codes	*Occupational involvement in GI*
Architecture and Engineering Occupations	
17-3025 Environmental Engineering Technicians	5%-10%
Life, Physical, and Social Science Occupations	
19-4093 Forest and Conservation Technicians	5%-10%
Building and Grounds Cleaning and Maintenance Occupations	
37-1012 First-Line Sup. of Landscaping, Lawn Service, and Groundskeeping	10%-15%
37-3011 Landscaping and Groundskeeping Workers	15%-25%
37-3012 Pesticide Handlers, Sprayers, and Applicators, Vegetation	10%-15%
37-3013 Tree Trimmers and Pruners	25%-75%
Fishing, Farming, and Forestry Occupations	
45-1011 First-Line Supervisors of Farming, Fishing, and Forestry Workers	5%-10%
45-2092 Farmworkers and Laborers, Crop, Nursery, and Greenhouse	10%-15%
45-4011 Forest and Conservation Workers	15%-25%
Construction and Extraction Occupations	
47-1011 First-Line Supervisors, Construction Trades and Extraction Workers	5% or less
47-2051 Cement Masons and Concrete Finishers	5% or less
47-2061 Construction Laborers	5% or less
47-2071 Paving, Surfacing, and Tamping Equipment Operators	5% or less
47-2073 Operating Engineers and other Construction Equipment Operators	5% or less
47-2151 Pipelayers	5% or less
47-2181 Roofers	5% or less
47-3015 Helpers—Pipelayers, Plumbers, Pipefitters, and Steamfitters	5% or less
47-3016 Helpers—Roofers	5% or less
47-4011 Construction and Building Inspectors	10%-15%
47-4071 Septic Tank Servicers and Sewer Pipe Cleaners	5%-10%
47-4091 Segmental Pavers	5%-10%
47-5021 Earth Drillers, Except Oil and Gas	5% or less
Installation, Maintenance, and Repair Occupations	
49-9012 Control and Valve Installers and Repairers, Minus Mechanical Door	5% or less
49-9071 Maintenance and Repair Workers, General	5%-10%
49-9098 Helpers—Installation, Maintenance, and Repair Workers	5%-10%
Production Occupations	
51-8031 Water and Wastewater Treatment Plant and System Operators	5% or less
Transportation and Materials Moving Occupations	5%-10%
53-7032 Excavating and Loading Machine and Dragline Operators	5%-10%
53-7051 Industrial Truck and Tractor Operators	5% or less
53-7062 Laborers and Freight, Stock, and Material Movers, Hand	5% or less

Job Codes	Occupational involvement in GI
53-7072 Pump Operators, Except Wellhead Pumpers	5% or less

Source: Jobs for the Future. 2017. Exploring the Green Infrastructure Workforce. Boston, MA

The occupations in Table A1 were applied to the "construction, landscaping, groundskeeping, urban forestry, tree care, ecological restoration, and water/wastewater" industry sectors, as mentioned in the Jobs for the Future brief. Since IMPLAN uses a different set of industry sector definitions, the team selected the following sectors shown in Table A2. In the initial estimate, single family residential construction was not included due to the assumption that commercial, multifamily, and other higher density construction would be the primary focus for GI efforts. Based on a crosswalk with the industry sector and the occupational participation, the team developed the preliminary allocation of capital investment to each of the sectors as shown in Table A2.

Table A2 – Industry Sector Allocation of Green Infrastructure Capital Investment

IMPLAN Industry Sector	Sector Description	Allocation of investment
6	Greenhouse, nursery, and floriculture production	5.0%
49	Water, sewage and other systems	1.6%
54	Construction of new highways and streets	1.8%
55	Construction of new commercial structures, including farm structures	1.4%
56	Construction of other new nonresidential structures	1.4%
58	Construction of new multifamily residential structures	1.4%
59	Construction of other new residential structures	1.4%
60	Maintenance and repair construction of nonresidential structures	1.7%
62	Maintenance and repair construction of highways, streets, bridges, and tunnels	1.7%
417	Truck transportation	0.2%
419	Pipeline transportation	1.6%
422	Warehousing and storage	0.2%
463	Environmental and other technical consulting services	1.4%
477	Landscape and horticultural services	79.1%

In addition to the capital investment, the corresponding O&M costs were also added as an economic impact. As the area of GI increases each year due to additional capital investment, the O&M costs are assumed to increase annually at the same ratio as the incremental capital investment. These O&M labor costs were allocated to the Maintenance and Landscape sectors. The team began with an assumption that 80% of the investment would be covered in Landscape sector (similar to the capital assumption), the remainder was spread equally to the two maintenance sectors, as shown in Table A3.

Table A3 – Industry Sector Allocation of Green Infrastructure O&M Labor Investment

IMPLAN Industry Sector	Sector Description	Allocation of investment
60	Maintenance and repair construction of nonresidential structures	10%

62	Maintenance and repair construction of highways, streets, bridges, and tunnels	10%
477	Landscape and horticultural services	80%

The final component of economic intervention is materials used during O&M. Materials used during initial construction are assumed to be calculated in the capital costs. In the recent ASCE book, *Cost of Maintaining Green Infrastructure*, examples show that labor represents 95 percent of O&M costs and materials are 5 percent. Unit cost data for vegetated swale, wet pond, dry pond, sand filter, gravel wetland, bioretention and porous asphalt showed that materials used in O&M ranged from 0 percent of the total cost (porous asphalt) to 11 percent (vegetated swales), with a median around 5 percent. The team assumed that half of the materials cost would be to buying vegetation (sector 6) and half to sand or other garden supplies (sector 399) as shown in Table A4.

Table A4 – Industry Sector Allocation of Green Infrastructure O&M Materials Investment

IMPLAN Commodity Code	*Sector Description*	*Allocation of investment*
3006	Greenhouse, nursery, and floriculture production	50%
3405	Building material and garden equipment and supplies stores	50%

Source: Clary, J. and Piza, H. (2017). Cost of Maintaining Green Infrastructure. American Society of Civil Engineers, Reston, VA

Appendix B – IMPLAN Modeling Input

The input used in the IMPLAN I/O analysis for each location is listed in this appendix. See the Glossary for details on the terminology expressed in these tables.

Allegheny County, PA Scenario			Millions of US Dollars	Millions of US Dollars	Millions of US Dollars
Year	Year	Annual capital investment	Total capital investment	Annual O&M	Total Annual Investments
0	2020	$0.0	$0.00	$0.00	$0.00
1	2021	$43.3	$43.30	$2.17	$45.47
2	2022	$43.3	$86.60	$4.33	$93.10
3	2023	$43.3	$129.90	$6.50	$142.89
4	2024	$43.3	$173.20	$8.66	$194.85
5	2025	$43.3	$216.50	$10.83	$248.98
6	2026	$43.3	$259.80	$12.99	$305.27
7	2027	$43.3	$303.10	$15.16	$363.72
8	2028	$43.3	$346.40	$17.32	$424.34
9	2029	$43.3	$389.70	$19.49	$487.13
10	2030	$43.3	$433.00	$21.65	$552.08
11	2031	$43.3	$476.30	$23.82	$619.19
12	2032	$43.3	$519.60	$25.98	$688.47
13	2033	$43.3	$562.90	$28.15	$759.92
14	2034	$43.3	$606.20	$30.31	$833.53
15	2035	$43.3	$649.50	$32.48	$909.30
16	2036	$43.3	$692.80	$34.64	$987.24
17	2037	$43.3	$736.10	$36.81	$1,067.35
18	2038	$43.3	$779.40	$38.97	$1,149.62
19	2039	$43.3	$822.70	$41.14	$1,234.05
20	2040	$43.3	$866.00	$43.30	$1,320.65

Prince George's County, MD Scenario			Millions of US Dollars	Millions of US Dollars	Millions of US Dollars
Year	Year	Annual capital investment	Total capital investment	Annual O&M	Total Annual Investments
0	2020	$0.0	$0.00	$0.00	$0.00
1	2021	$32.4	$32.40	$1.62	$34.02
2	2022	$32.4	$64.80	$3.24	$69.66
3	2023	$32.4	$97.20	$4.86	$106.92
4	2024	$32.4	$129.60	$6.48	$145.80
5	2025	$32.4	$162.00	$8.10	$186.30
6	2026	$32.4	$194.40	$9.72	$228.42
7	2027	$32.4	$226.80	$11.34	$272.16
8	2028	$32.4	$259.20	$12.96	$317.52
9	2029	$32.4	$291.60	$14.58	$364.50
10	2030	$32.4	$324.00	$16.20	$413.10
11	2031	$32.4	$356.40	$17.82	$463.32
12	2032	$32.4	$388.80	$19.44	$515.16
13	2033	$32.4	$421.20	$21.06	$568.62
14	2034	$32.4	$453.60	$22.68	$623.70
15	2035	$32.4	$486.00	$24.30	$680.40
16	2036	$32.4	$518.40	$25.92	$738.72
17	2037	$32.4	$550.80	$27.54	$798.66
18	2038	$32.4	$583.20	$29.16	$860.22
19	2039	$32.4	$615.60	$30.78	$923.40
20	2040	$32.4	$648.00	$32.40	$988.20

Douglas County, NE Scenario			Millions of US Dollars	Millions of US Dollars	Millions of US Dollars
Year	Year	Annual capital investment	Total capital investment	Annual O&M	Total Annual Investments
0	2020	$0.0	$0.00	$0.00	$0.00
1	2021	$20.4	$20.40	$1.02	$21.42
2	2022	$20.4	$40.80	$2.04	$43.86
3	2023	$20.4	$61.20	$3.06	$67.32
4	2024	$20.4	$81.60	$4.08	$91.80
5	2025	$20.4	$102.00	$5.10	$117.30
6	2026	$20.4	$122.40	$6.12	$143.82
7	2027	$20.4	$142.80	$7.14	$171.36
8	2028	$20.4	$163.20	$8.16	$199.92
9	2029	$20.4	$183.60	$9.18	$229.50
10	2030	$20.4	$204.00	$10.20	$260.10
11	2031	$20.4	$224.40	$11.22	$291.72
12	2032	$20.4	$244.80	$12.24	$324.36
13	2033	$20.4	$265.20	$13.26	$358.02
14	2034	$20.4	$285.60	$14.28	$392.70
15	2035	$20.4	$306.00	$15.30	$428.40
16	2036	$20.4	$326.40	$16.32	$465.12
17	2037	$20.4	$346.80	$17.34	$502.86
18	2038	$20.4	$367.20	$18.36	$541.62
19	2039	$20.4	$387.60	$19.38	$581.40
20	2040	$20.4	$408.00	$20.40	$622.20

Fairfax County, VA Scenario			Millions of US Dollars	Millions of US Dollars	Millions of US Dollars
Year	Year	Annual capital investment	Total capital investment	Annual O&M	Total Annual Investments
0	2020	$0.0	$0.00	$0.00	$0.00
1	2021	$40.8	$40.80	$2.04	$42.84
2	2022	$40.8	$81.60	$4.08	$87.72
3	2023	$40.8	$122.40	$6.12	$134.64
4	2024	$40.8	$163.20	$8.16	$183.60
5	2025	$40.8	$204.00	$10.20	$234.60
6	2026	$40.8	$244.80	$12.24	$287.64
7	2027	$40.8	$285.60	$14.28	$342.72
8	2028	$40.8	$326.40	$16.32	$399.84
9	2029	$40.8	$367.20	$18.36	$459.00
10	2030	$40.8	$408.00	$20.40	$520.20
11	2031	$40.8	$448.80	$22.44	$583.44
12	2032	$40.8	$489.60	$24.48	$648.72
13	2033	$40.8	$530.40	$26.52	$716.04
14	2034	$40.8	$571.20	$28.56	$785.40
15	2035	$40.8	$612.00	$30.60	$856.80
16	2036	$40.8	$652.80	$32.64	$930.24
17	2037	$40.8	$693.60	$34.68	$1,005.72
18	2038	$40.8	$734.40	$36.72	$1,083.24
19	2039	$40.8	$775.20	$38.76	$1,162.80
20	2040	$40.8	$816.00	$40.80	$1,244.40

Fulton County, GA Scenario			Millions of US Dollars	Millions of US Dollars	Millions of US Dollars
Year	Year	Annual capital investment	Total capital investment	Annual O&M	Total Annual Investments
0	2020	$0.0	$0.00	$0.00	$0.00
1	2021	$37.9	$37.90	$1.90	$39.80
2	2022	$37.9	$75.80	$3.79	$81.49
3	2023	$37.9	$113.70	$5.69	$125.07
4	2024	$37.9	$151.60	$7.58	$170.55
5	2025	$37.9	$189.50	$9.48	$217.93
6	2026	$37.9	$227.40	$11.37	$267.20
7	2027	$37.9	$265.30	$13.27	$318.36
8	2028	$37.9	$303.20	$15.16	$371.42
9	2029	$37.9	$341.10	$17.06	$426.38
10	2030	$37.9	$379.00	$18.95	$483.23
11	2031	$37.9	$416.90	$20.85	$541.97
12	2032	$37.9	$454.80	$22.74	$602.61
13	2033	$37.9	$492.70	$24.64	$665.15
14	2034	$37.9	$530.60	$26.53	$729.58
15	2035	$37.9	$568.50	$28.43	$795.90
16	2036	$37.9	$606.40	$30.32	$864.12
17	2037	$37.9	$644.30	$32.22	$934.24
18	2038	$37.9	$682.20	$34.11	$1,006.25
19	2039	$37.9	$720.10	$36.01	$1,080.15
20	2040	$37.9	$758.00	$37.90	$1,155.95

Harris County, TX Scenario			Millions of US Dollars	Millions of US Dollars	Millions of US Dollars
Year	Year	Annual capital investment	Total capital investment	Annual O&M	Total Annual Investments
0	2020	$0.0	$0.00	$0.00	$0.00
1	2021	$168.0	$168.00	$8.40	$176.40
2	2022	$168.0	$336.00	$16.80	$361.20
3	2023	$168.0	$504.00	$25.20	$554.40
4	2024	$168.0	$672.00	$33.60	$756.00
5	2025	$168.0	$840.00	$42.00	$966.00
6	2026	$168.0	$1,008.00	$50.40	$1,184.40
7	2027	$168.0	$1,176.00	$58.80	$1,411.20
8	2028	$168.0	$1,344.00	$67.20	$1,646.40
9	2029	$168.0	$1,512.00	$75.60	$1,890.00
10	2030	$168.0	$1,680.00	$84.00	$2,142.00
11	2031	$168.0	$1,848.00	$92.40	$2,402.40
12	2032	$168.0	$2,016.00	$100.80	$2,671.20
13	2033	$168.0	$2,184.00	$109.20	$2,948.40
14	2034	$168.0	$2,352.00	$117.60	$3,234.00
15	2035	$168.0	$2,520.00	$126.00	$3,528.00
16	2036	$168.0	$2,688.00	$134.40	$3,830.40
17	2037	$168.0	$2,856.00	$142.80	$4,141.20
18	2038	$168.0	$3,024.00	$151.20	$4,460.40
19	2039	$168.0	$3,192.00	$159.60	$4,788.00
20	2040	$168.0	$3,360.00	$168.00	$5,124.00

Hennepin County, MN Scenario			Millions of US Dollars	Millions of US Dollars	Millions of US Dollars
Year	Year	Annual capital investment	Total capital investment	Annual O&M	Total Annual Investments
0	2020	$0.0	$0.00	$0.00	$0.00
1	2021	$45.1	$45.10	$2.26	$47.36
2	2022	$45.1	$90.20	$4.51	$96.97
3	2023	$45.1	$135.30	$6.77	$148.83
4	2024	$45.1	$180.40	$9.02	$202.95
5	2025	$45.1	$225.50	$11.28	$259.33
6	2026	$45.1	$270.60	$13.53	$317.96
7	2027	$45.1	$315.70	$15.79	$378.84
8	2028	$45.1	$360.80	$18.04	$441.98
9	2029	$45.1	$405.90	$20.30	$507.38
10	2030	$45.1	$451.00	$22.55	$575.03
11	2031	$45.1	$496.10	$24.81	$644.93
12	2032	$45.1	$541.20	$27.06	$717.09
13	2033	$45.1	$586.30	$29.32	$791.51
14	2034	$45.1	$631.40	$31.57	$868.18
15	2035	$45.1	$676.50	$33.83	$947.10
16	2036	$45.1	$721.60	$36.08	$1,028.28
17	2037	$45.1	$766.70	$38.34	$1,111.72
18	2038	$45.1	$811.80	$40.59	$1,197.41
19	2039	$45.1	$856.90	$42.85	$1,285.35
20	2040	$45.1	$902.00	$45.10	$1,375.55

Hudson County, NJ Scenario			Millions of US Dollars	Millions of US Dollars	Millions of US Dollars
Year	Year	Annual capital investment	Total capital investment	Annual O&M	Total Annual Investments
0	2020	$0.0	$0.00	$0.00	$0.00
1	2021	$24.0	$24.00	$1.20	$25.20
2	2022	$24.0	$48.00	$2.40	$51.60
3	2023	$24.0	$72.00	$3.60	$79.20
4	2024	$24.0	$96.00	$4.80	$108.00
5	2025	$24.0	$120.00	$6.00	$138.00
6	2026	$24.0	$144.00	$7.20	$169.20
7	2027	$24.0	$168.00	$8.40	$201.60
8	2028	$24.0	$192.00	$9.60	$235.20
9	2029	$24.0	$216.00	$10.80	$270.00
10	2030	$24.0	$240.00	$12.00	$306.00
11	2031	$24.0	$264.00	$13.20	$343.20
12	2032	$24.0	$288.00	$14.40	$381.60
13	2033	$24.0	$312.00	$15.60	$421.20
14	2034	$24.0	$336.00	$16.80	$462.00
15	2035	$24.0	$360.00	$18.00	$504.00
16	2036	$24.0	$384.00	$19.20	$547.20
17	2037	$24.0	$408.00	$20.40	$591.60
18	2038	$24.0	$432.00	$21.60	$637.20
19	2039	$24.0	$456.00	$22.80	$684.00
20	2040	$24.0	$480.00	$24.00	$732.00

King County, WA Scenario			Millions of US Dollars	Millions of US Dollars	Millions of US Dollars
Year	Year	Annual capital investment	Total capital investment	Annual O&M	Total Annual Investments
0	2020	$0.0	$0.00	$0.00	$0.00
1	2021	$80.3	$80.30	$4.02	$84.32
2	2022	$80.3	$160.60	$8.03	$172.65
3	2023	$80.3	$240.90	$12.05	$264.99
4	2024	$80.3	$321.20	$16.06	$361.35
5	2025	$80.3	$401.50	$20.08	$461.73
6	2026	$80.3	$481.80	$24.09	$566.12
7	2027	$80.3	$562.10	$28.11	$674.52
8	2028	$80.3	$642.40	$32.12	$786.94
9	2029	$80.3	$722.70	$36.14	$903.38
10	2030	$80.3	$803.00	$40.15	$1,023.83
11	2031	$80.3	$883.30	$44.17	$1,148.29
12	2032	$80.3	$963.60	$48.18	$1,276.77
13	2033	$80.3	$1,043.90	$52.20	$1,409.27
14	2034	$80.3	$1,124.20	$56.21	$1,545.78
15	2035	$80.3	$1,204.50	$60.23	$1,686.30
16	2036	$80.3	$1,284.80	$64.24	$1,830.84
17	2037	$80.3	$1,365.10	$68.26	$1,979.40
18	2038	$80.3	$1,445.40	$72.27	$2,131.97
19	2039	$80.3	$1,525.70	$76.29	$2,288.55
20	2040	$80.3	$1,606.00	$80.30	$2,449.15

Lancaster County, PA Scenario			Millions of US Dollars	Millions of US Dollars	Millions of US Dollars
Year	Year	Annual capital investment	Total capital investment	Annual O&M	Total Annual Investments
0	2020	$0.0	$0.00	$0.00	$0.00
1	2021	$19.5	$19.50	$0.98	$20.48
2	2022	$19.5	$39.00	$1.95	$41.93
3	2023	$19.5	$58.50	$2.93	$64.35
4	2024	$19.5	$78.00	$3.90	$87.75
5	2025	$19.5	$97.50	$4.88	$112.13
6	2026	$19.5	$117.00	$5.85	$137.48
7	2027	$19.5	$136.50	$6.83	$163.80
8	2028	$19.5	$156.00	$7.80	$191.10
9	2029	$19.5	$175.50	$8.78	$219.38
10	2030	$19.5	$195.00	$9.75	$248.63
11	2031	$19.5	$214.50	$10.73	$278.85
12	2032	$19.5	$234.00	$11.70	$310.05
13	2033	$19.5	$253.50	$12.68	$342.23
14	2034	$19.5	$273.00	$13.65	$375.38
15	2035	$19.5	$292.50	$14.63	$409.50
16	2036	$19.5	$312.00	$15.60	$444.60
17	2037	$19.5	$331.50	$16.58	$480.68
18	2038	$19.5	$351.00	$17.55	$517.73
19	2039	$19.5	$370.50	$18.53	$555.75
20	2040	$19.5	$390.00	$19.50	$594.75

Rockingham County, NH Scenario			Millions of US Dollars	Millions of US Dollars	Millions of US Dollars
Year	Year	Annual capital investment	Total capital investment	Annual O&M	Total Annual Investments
0	2020	$0.0	$0.00	$0.00	$0.00
1	2021	$11.0	$11.00	$0.55	$11.55
2	2022	$11.0	$22.00	$1.10	$23.65
3	2023	$11.0	$33.00	$1.65	$36.30
4	2024	$11.0	$44.00	$2.20	$49.50
5	2025	$11.0	$55.00	$2.75	$63.25
6	2026	$11.0	$66.00	$3.30	$77.55
7	2027	$11.0	$77.00	$3.85	$92.40
8	2028	$11.0	$88.00	$4.40	$107.80
9	2029	$11.0	$99.00	$4.95	$123.75
10	2030	$11.0	$110.00	$5.50	$140.25
11	2031	$11.0	$121.00	$6.05	$157.30
12	2032	$11.0	$132.00	$6.60	$174.90
13	2033	$11.0	$143.00	$7.15	$193.05
14	2034	$11.0	$154.00	$7.70	$211.75
15	2035	$11.0	$165.00	$8.25	$231.00
16	2036	$11.0	$176.00	$8.80	$250.80
17	2037	$11.0	$187.00	$9.35	$271.15
18	2038	$11.0	$198.00	$9.90	$292.05
19	2039	$11.0	$209.00	$10.45	$313.50
20	2040	$11.0	$220.00	$11.00	$335.50

Appendix C – IMPLAN Modeling Output

The output generated from the IMPLAN I/O analysis for each location is listed in this appendix. See the Glossary for details on the terminology expressed in these tables.

Allegheny County, PA Scenario				
Impact	Employment	Labor Income	Value Added	Output
1 - Direct	13,599	$648,397,712.04	$783,277,152.59	$1,321,815,033.75
2 - Indirect	1,951	$141,275,026.58	$236,240,654.11	$405,975,858.05
3 - Induced	3,448	$203,809,147.86	$345,715,033.64	$570,938,034.80
Total	**18,998**	**$993,481,886.48**	**$1,365,232,840.34**	**$2,298,728,926.60**

Prince George's County, MD Scenario				
Impact	Employment	Labor Income	Value Added	Output
1 - Direct	10,724	$420,993,173.72	$539,736,991.18	$988,456,260.17
2 - Indirect	1,233	$63,411,320.38	$106,556,814.66	$201,967,537.21
3 - Induced	906	$38,464,428.99	$83,308,908.23	$138,270,864.78
Total	**12,863**	**$522,868,923.09**	**$729,602,714.07**	**$1,328,694,662.15**

Douglas County, NE Scenario				
Impact	Employment	Labor Income	Value Added	Output
1 - Direct	6,015	$284,841,291.66	$347,342,787.95	$621,043,884.25
2 - Indirect	1,118	$72,287,175.06	$122,982,221.37	$215,487,841.39
3 - Induced	1,239	$68,533,716.04	$122,148,885.97	$204,134,443.30
Total	**8,372**	**$425,662,182.76**	**$592,473,895.28**	**$1,040,666,168.93**

Fairfax County, VA Scenario				
Impact	Employment	Labor Income	Value Added	Output
1 - Direct	18,765	$756,881,007.19	$790,190,498.88	$1,245,718,306.45
2 - Indirect	1,173	$94,720,355.90	$164,463,551.58	$265,434,485.13
3 - Induced	1,378	$83,358,372.01	$164,190,153.17	$252,632,072.39
Total	**21,315**	**$934,959,735.10**	**$1,118,844,203.63**	**$1,763,784,863.97**

Fulton County, GA Scenario				
Impact	Employment	Labor Income	Value Added	Output
1 - Direct	9,989	$667,958,764.26	$797,671,572.53	$1,156,541,502.13
2 - Indirect	1,245	$106,434,541.71	$181,493,156.99	$289,558,001.57
3 - Induced	1,223	$78,794,774.86	$141,873,859.89	$218,438,651.61
Total	**12,457**	**$853,188,080.84**	**$1,121,038,589.41**	**$1,664,538,155.32**

Harris County, TX Scenario				
Impact	Employment	Labor Income	Value Added	Output
1 - Direct	50,228	$2,472,612,708.81	$3,026,485,108.23	$5,123,123,684.03
2 - Indirect	7,916	$621,615,306.38	$985,747,904.06	$1,724,909,367.98
3 - Induced	9,770	$566,190,266.14	$956,520,529.93	$1,576,083,782.60
Total	**67,914**	**$3,660,418,281.33**	**$4,968,753,542.22**	**$8,424,116,834.60**

Hennepin County, MN Scenario				
Impact	Employment	Labor Income	Value Added	Output
1 - Direct	12,340	$689,183,583.03	$832,480,650.53	$1,376,167,242.80
2 - Indirect	1,981	$156,651,736.34	$254,344,094.75	$421,377,325.51
3 - Induced	2,491	$159,568,219.74	$269,321,082.26	$426,901,446.93
Total	**16,811**	**$1,005,403,539.11**	**$1,356,145,827.54**	**$2,224,446,015.24**

Hudson County, NJ Scenario				
Impact	Employment	Labor Income	Value Added	Output
1 - Direct	4,100	$455,179,782.05	$518,210,031.61	$706,921,683.16
2 - Indirect	525	$48,682,713.36	$74,391,010.10	$120,508,140.44
3 - Induced	1,128	$81,497,008.20	$145,637,802.94	$220,564,122.65
Total	**5,754**	**$585,359,503.61**	**$738,238,844.65**	**$1,047,993,946.25**

King County, WA Scenario				
Impact	Employment	Labor Income	Value Added	Output
1 - Direct	21,166	$1,228,692,695.98	$1,564,277,288.42	$2,449,053,604.23
2 - Indirect	2,299	$200,395,222.64	$359,503,165.80	$573,848,987.28
3 - Induced	3,293	$237,399,270.01	$435,052,441.34	$650,273,767.89
Total	**26,759**	**$1,666,487,188.63**	**$2,358,832,895.57**	**$3,673,176,359.40**

Lancaster County, PA Scenario				
Impact	Employment	Labor Income	Value Added	Output
1 - Direct	6,142	$284,180,938.20	$332,720,550.46	$593,212,689.40
2 - Indirect	879	$51,042,552.62	$77,817,845.68	$147,439,072.25
3 - Induced	1,413	$71,048,174.46	$118,211,484.30	$200,977,751.04
Total	**8,434**	**$406,271,665.27**	**$528,749,880.44**	**$941,629,512.70**

Rockingham County, NH Scenario				
Impact	Employment	Labor Income	Value Added	Output
1 - Direct	3,401	$174,447,376.89	$197,798,707.33	$336,725,120.22
2 - Indirect	510	$35,021,668.16	$54,342,885.97	$94,485,135.70
3 - Induced	572	$32,980,169.27	$57,541,956.39	$92,243,708.01
Total	**4,483**	**$242,449,214.33**	**$309,683,549.70**	**$523,453,963.94**

San Diego, CA Scenario				
Impact	Employment	Labor Income	Value Added	Output
1 - Direct	35,509	$1,706,961,640.86	$2,091,866,547.46	$3,628,473,194.02
2 - Indirect	5,625	$378,422,895.18	$628,654,611.78	$1,096,725,218.51
3 - Induced	8,950	$478,903,398.67	$937,301,874.00	$1,496,451,552.04
Total	**50,084**	**$2,564,287,934.70**	**$3,657,823,033.24**	**$6,221,649,964.57**