Benefit-Cost Analysis Supplementary Documentation
TIGER VIII Discretionary Grant Program

I-579 “Cap” Urban Connector Project

Sports & Exhibition Authority of Pittsburgh and Allegheny County

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Benefit-Cost Analysis Supplementary Documentation

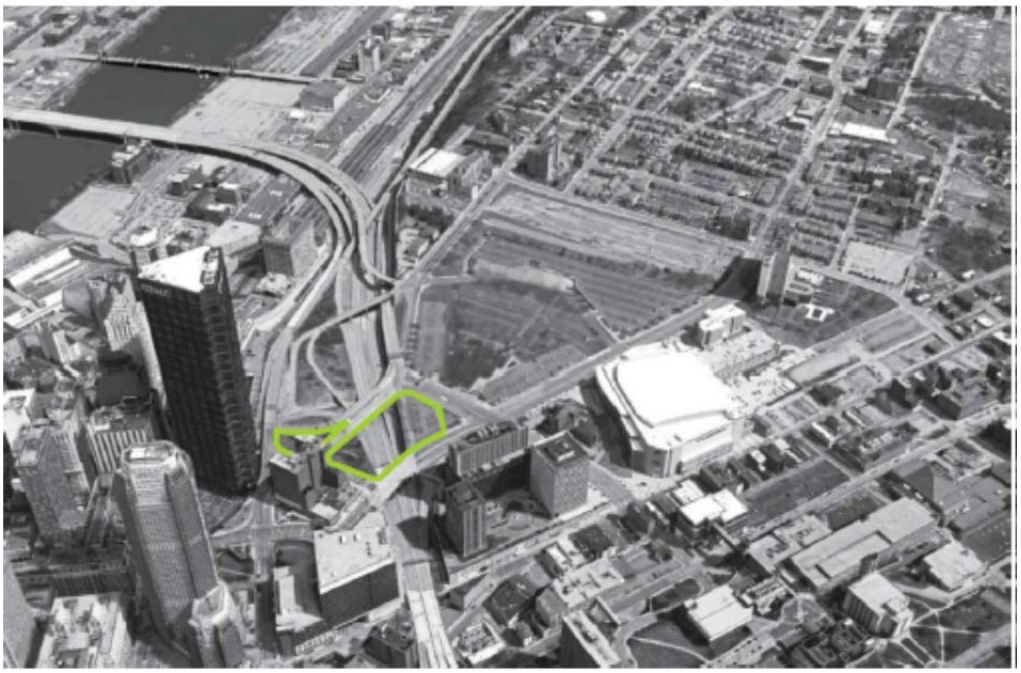
1. Executive Summary

The I-579 “Cap” Urban Connector Project (the “Cap” or “Project”) will reconnect a disadvantaged community (Hill District) to centers of employment, education and services (Downtown Pittsburgh) via the construction of a Cap structure that spans the below grade I-579 interstate highway. The Cap provides a new open space and replaces what has been a barrier between the two communities with a new connector in the urban core of Pittsburgh and includes safe and accessible bicycle and pedestrian pathways and facilities over and around its perimeter, providing a better connection for people dependent on walking or biking between the Hill District and Downtown. Improved facilities for the disabled are also a part of this project. In addition, the Cap’s “green” infrastructure is expected to minimize stormwater run-off and provide other sustainable features, another benefit to society.

Because the Cap is built over existing roadways, safety is enhanced by eliminating conflict points for pedestrians and cyclists and motorized vehicles. Additionally, some drivers may view walking or biking over the Cap preferable to navigating the roadways. These attributes, and others, are expected to induce some automobile commuters to bike and walk to their workplaces. Other “utility” users of the new Cap infrastructure (e.g., Hill District resident running errands) will also use the new facilities.

Other benefits that will potentially be generated include travel time savings for existing pedestrian commuters who save time by walking over the Cap, rather than all the way around its perimeter above an existing roadway network. Health benefits for new walkers and cyclists are also anticipated. Because existing walkers and cyclists are currently traveling in mixed traffic, the Cap will generate a benefit related to traveling in a more secure environment as well. The figure below shows the project location in green.

Figure 1: I-579 “Cap” Urban Connector Project Location



In addition to the bicycle and pedestrian facility improvements on the Cap, the project is anticipated to generate new transit options for residents. For example, the Cap will reduce the walk and cycling time to access Pittsburgh’s free light rail subway service, the “T” system. In addition, the Port Authority has indicated that if the Cap is built, they intend to add a bus stop along the perimeter of the Cap on Centre Avenue. This is likely to reduce travel time for existing transit users by providing them a closer bus stop to access transit. It will also provide a safer path for pedestrians traveling in the project area and potentially induce new users of public transportation. While travel time savings for pedestrian and commuters have been estimated for this project, no benefits associated with reduced travel

time for existing transit users or cyclists have been estimated, due to limited data for existing users and their typical trips.

Other benefits are also anticipated. For example, the Cap will support development efforts already underway nearby and potentially increase property values within 800-1,500 feet of the Cap structure because these properties will be in close proximity to an urban open green space. With the addition of a safer route for pedestrians and cyclists, along with the addition of significant green space in the city's urban core, it is anticipated that even more development may be generated. This could potentially provide new services for residents of the Hill District, as well as potential new business and employment opportunities. Project improvements to the corridor will include:

- Construction of a Cap to cover the existing below grade I-579 interstate highway;
- Elimination of an substandard, discontinuous sidewalk along Webster Avenue;
- Reconstruction and upgrade of the pedestrian crosswalk at the Bigelow Boulevard/Chatham Street intersection;
- Reconstruction of the severely deteriorated sidewalks along the perimeter of the open space including Bigelow Boulevard, Chatham Street, Washington Place and Centre Avenue;
- Construction of an ADA compliant walkway between Seventh Avenue and the new crosswalk at Chatham Street including curb cut ramps, pedestrian pushbuttons and audible countdown pedestrian signal heads;
- Construction of ADA compliant walkways throughout the open space to connect with the Washington Place crosswalks.

This project will also generate benefits to existing pedestrians and cyclists as well as new pedestrians and cyclists who take trips to work and other destinations. Other existing and new riders who will use the Cap cycling paths for purely recreational exercise purposes are also likely to benefit from the project but their benefits are not quantified in this analysis. New riders are assumed to divert from other modes creating a reduction in congestion, safety, pavement deterioration costs, and emissions for all residents and vehicle drivers. In addition, pedestrians who currently walk to work will benefit. Their travel time will be reduced because they will be able to cross over existing roadways, rather than walk around them.

Currently, there are existing bicyclists (and pedestrians) who travel in the Cap area, which is located in the middle of significant roadway infrastructure. Mobility benefits are very likely to be generated by developing a the Cap and the improved cycling paths that will mitigate these hazards for both existing and new riders, though only mobility benefits associated with new bicycle riders are included in the benefit-cost analysis. Pedestrian mobility benefits are not estimated. A table summarizing the changes expected from the Project (and the associated benefits) is provided below.

Table ES-1: Summary of Infrastructure Improvements and Associated Benefits

Benefit Category	Existing Work and Other Destination Cycling Trips	New Work and Other Destination Cycling Trips	Remaining Road Users and General Public
Cyclist Health	No	Yes	
Cyclist Mobility	No	Yes	
Cyclist and Pedestrian Safety	Yes	No	

Benefit Category	Existing Work and Other Destination Cycling Trips	New Work and Other Destination Cycling Trips	Remaining Road Users and General Public
Cyclist Auto Cost Savings	No	Yes	
Pedestrian Travel Time Savings	Yes	No	
Congestion Relief			Yes
Pavement Maintenance			Yes
Environmental Emissions			Yes

The period of analysis used in the estimation of benefits and costs corresponds to 35 years, which is the minimum estimated life of the Cap, including 2 years of construction and operations beginning in 2019. The Project capital costs are estimated to be $26.44 million. The Sports & Exhibition Authority of Pittsburgh and Allegheny County (SEA) will provide a local match of $6.44 million, representing 24.4 percent of the total project cost. SEA is requesting a TIGER grant of $20 million. In addition, operating costs to maintain the Cap are included in the analysis. These are estimated to be $165,000 per year.

Table ES-2: Summary of Project Costs and Anticipated Funding Sources, in Millions of Dollars of 2015

Funding Source	Capital Costs	Total Project Cost	Percent of Total Cost Financed by Source
Federal	$20.0	$20.0	75.6%
State	$3.4	$3.4	12.9%
Local	$2.14	$2.14	8.1%
Private	$0.9	$0.9	3.4%
TOTAL	**$26.44**	**$26.44**	100.0%

A summary of the relevant data and calculations used to derive the benefits and costs of the Project are shown in Table ES-3 (in dollars of 2015). Based on the analysis presented in the rest of this document, the Project is expected to generate $22.5 million in discounted benefits and $23.8 million in discounted costs, using a seven percent real discount rate. At a 3 percent discount rate, the discounted benefits are estimated to be $51.1 million and discounted costs are $27.5 million. Therefore, the Project is expected to generate a Net Present Value of ($1.3) million and a Benefit/Cost Ratio of 0.95 at a seven percent discount rate. At a three percent discount rate, the Net Present Value is $23.5 million and the Benefit/Cost Ratio is 1.86 percent. The internal rate of return is 6%. The BCA reflects only those benefits that can be monetized based on the availability of data. Other benefits related to the elimination of severance between the Lower Hill District and Downtown Pittsburgh, for example, are not reflected in the analysis due to methodological and data limitations.

Table ES - 3: Summary of Pertinent Data, Quantifiable Benefits and Costs

Calendar Year	Project Year	Undiscounted Benefits	Undiscounted Capital Costs	Undiscounted Operating Costs	Undiscounted Net Benefits	Discounted Net Benefits	Discounted Net Benefits
		2015	2015	2015	2015	7%	3%
2016	1	$0	$0	$0	$0	$0	$0
2017	2	$0	$8,813,333	$0	-$8,813,333	-$7,697,907	-$8,307,412
2018	3	$0	$17,626,667	$0	-$17,626,667	-$14,388,611	-$16,130,897
2019 (opening)	4	$901,025	$0	$165,000	$736,025	$561,515	$653,948
2020	5	$954,404	$0	$165,000	$789,404	$562,841	$680,947
2021	6	$1,015,151	$0	$165,000	$850,151	$566,501	$711,988
2022	7	$1,084,494	$0	$165,000	$919,494	$572,628	$747,632
2023	8	$1,163,877	$0	$165,000	$998,877	$581,373	$788,522
2024	9	$1,254,997	$0	$165,000	$1,089,997	$592,908	$835,392
2025	10	$1,359,848	$0	$165,000	$1,194,848	$607,429	$889,079
2026	11	$1,480,777	$0	$165,000	$1,315,777	$625,152	$950,546
2027	12	$1,562,638	$0	$165,000	$1,397,638	$620,610	$980,275
2028	13	$1,652,195	$0	$165,000	$1,487,195	$617,182	$1,012,707
2029	14	$1,769,374	$0	$165,000	$1,604,374	$622,262	$1,060,680
2030	15	$1,876,051	$0	$165,000	$1,711,051	$620,229	$1,098,259
2031	16	$1,993,143	$0	$165,000	$1,828,143	$619,330	$1,139,238
2032	17	$2,121,751	$0	$165,000	$1,956,751	$619,543	$1,183,867
2033	18	$2,263,103	$0	$165,000	$2,098,103	$620,850	$1,232,414
2034	19	$2,418,557	$0	$165,000	$2,253,557	$623,237	$1,285,172
2035	20	$2,589,619	$0	$165,000	$2,424,619	$626,692	$1,342,453
2036	21	$2,777,957	$0	$165,000	$2,612,957	$631,203	$1,404,593
2037	22	$2,985,420	$0	$165,000	$2,820,420	$636,763	$1,471,956
2038	23	$3,214,057	$0	$165,000	$3,049,057	$643,366	$1,544,932
2039	24	$3,466,140	$0	$165,000	$3,301,140	$651,006	$1,623,942
2040	25	$3,744,174	$0	$165,000	$3,579,174	$659,677	$1,709,433
2041	26	$4,050,956	$0	$165,000	$3,885,956	$669,383	$1,801,897
2042	27	$4,389,579	$0	$165,000	$4,224,579	$680,125	$1,901,859

Calendar Year	Project Year	Undiscounted Benefits	Undiscounted Capital Costs	Undiscounted Operating Costs	Undiscounted Net Benefits	Discounted Net Benefits	Discounted Net Benefits
		2015	2015	2015	2015	7%	3%
2043	28	$4,763,470	$0	$165,000	$4,598,470	$691,907	$2,009,884
2044	29	$5,176,426	$0	$165,000	$5,011,426	$704,734	$2,126,580
2045	30	$5,632,658	$0	$165,000	$5,467,658	$718,613	$2,252,603
2046	31	$6,136,834	$0	$165,000	$5,971,834	$733,554	$2,388,657
2047	32	$6,694,127	$0	$165,000	$6,529,127	$749,567	$2,535,502
2048	33	$7,310,272	$0	$165,000	$7,145,272	$766,665	$2,693,955
2049	34	$7,991,629	$0	$165,000	$7,826,629	$784,863	$2,864,898
2050	35	$8,745,246	$0	$165,000	$8,580,246	$804,177	$3,049,277
TOTAL		$104,539,949	$26,440,000	$5,280,000	$72,819,949	-$1,300,632	$23,534,781

In addition to the monetized benefits presented in Table ES-3, the Project would generate benefits that are difficult to quantify. A brief description of those benefits is provided below.

State of Good Repair

- The Cap Project will establish a strong backbone for improving connective multimodal transportation options. Key intersections will be improved.

Economic Competitiveness

- Facilitated access to education and employment centers will support economic opportunities in a lower income area.
- The Project will provide ladders of opportunity to the disadvantaged residents of the project area, who are particularly reliant on multimodal public transportation for their commutes.
- Some new development is currently underway in the project area. Affordable housing will be a component of these projects. Because these residents are likely more transit-dependent, the Cap will offer them an alternative mode of travel as well as better connect to existing train and bus service.

Quality of Life

- Existing recreational riders – both young and older – are likely to use the Cap trails for exercise purposes. While these trips are not for mobility per se, they generate value in the community and could be a highly significant source of unquantified benefits.
- Project features will enhance the overall perception of safety in the area, improving the quality of life for Cap visitors and residents.
- By providing a safe open space for transportation and recreation, the Project will enhance the public realm and civic life.

Environmental Sustainability

- The Project will encourage walking, cycling and transit use, and some of the new trips in the project area will represent a mode shift away from auto usage.
- The impact of diversion from buses was not estimated, but emissions impacts would likely be generated when existing bus users opt for a “greener” commute on a bike or by walking.

Safety

- Existing recreational riders will use the new bike and walking trails in part because of reduced accident risk. These benefits could be substantial but have not been quantified in the main BCA results. The impact of including these benefits is presented in the sensitivity analysis.
- Elimination of an substandard, discontinuous sidewalk along Webster Avenue will prevent pedestrians from walking across the overpass structure in the vehicular travel lane which will reduce/eliminate pedestrians from being struck with automobiles, as well as some vehicle-to-vehicle crashes as cars avoid pedestrians in the roadway.
- Reconstruction and upgrade of the pedestrian crosswalks at the Bigelow Boulevard/Chatham Street intersection will improve pedestrian and bicycle flow and remove existing conflict points between pedestrians, cyclists and automobiles.
- Reconstruction of the severely deteriorated sidewalks along the perimeter of the park including Bigelow Boulevard, Chatham Street, Washington Place and Centre Avenue will increase pedestrian safety and improve accessibility.
- Construction of an ADA compliant walkway between 7th Avenue and the new crosswalks at Chatham Street will improve accessibility to the amenities.

2. Introduction

This document provides detailed technical information on the economic analyses conducted in support of the Grant Application for the I-579 Urban Connector "Cap" Project ("Project"). Section 3, Methodological Framework, introduces the conceptual framework used in the Benefit-Cost Analysis (BCA). Section 4, Project Overview, provides an overview of the Project, including a brief description of existing conditions and proposed alternatives; a summary of cost estimates and schedule; and a description of the types of effects that the Project is expected to generate. Section 5, General Assumptions, discusses the general assumptions used in the estimation of Project costs and benefits, while estimates of travel demand and traffic growth can be found in Section 6. Specific data elements and assumptions pertaining to the long-term outcome selection criteria are presented in Section 7, Benefits Measurement, Data and Assumptions, along with associated benefit estimates. Estimates of the Project's Net Present Value (NPV), its Benefit/Cost ratio (BCR) and other Project evaluation metrics are introduced in Section 8, Summary of Findings and BCA Outcomes. Section 9, BCA Sensitivity Analysis includes the results of the sensitivity analysis on key assumptions used in the BCA. Additional data tables in Section 10, Supplementary Data Tables at the end of the document include summaries of annual estimates of benefits and costs, as well as intermediate values to assist DOT in its review of the application.[1]

Methodological Framework

Benefit-Cost Analysis (BCA) is a conceptual framework that quantifies in monetary terms as many of the costs and benefits of a project as possible. Benefits are broadly defined. They represent the extent to which people impacted by the project are made better-off, as measured by their own willingness-to-pay. In other words, central to BCA is the idea that people are best able to judge what is "good" for them, what improves their well-being or welfare.

[1] While the models and software themselves do not accompany this appendix, greater detail can be provided, including spreadsheets presenting additional interim calculations and discussions on model mechanics and coding, if requested.

BCA also adopts the view that a net increase in welfare (as measured by the summation of individual welfare changes) is a good thing, even if some groups within society are made worse-off. A project or proposal would be rated positively if the benefits to some are large enough to compensate the losses of others.

Finally, BCA is typically a forward-looking exercise, seeking to anticipate the welfare impacts of a project or proposal over its entire life-cycle. Future welfare changes are weighted against today's changes through discounting, which is meant to reflect society's general preference for the present, as well as broader inter-generational concerns.

The specific methodology for this application was developed using the above BCA principles and is consistent with the TIGER guidelines. In particular, the methodology involves:

- Establishing existing and future conditions under the build and no-build scenarios.
- Assessing benefits with respect to each of the five long-term outcomes identified in the Notice of Funding Opportunity (NOFO);
- Measuring benefits in dollar terms, whenever possible, and expressing benefits and costs in a common unit of measurement;
- Using DOT guidance for the valuation of travel time savings, safety benefits and reductions in air emissions, while relying on industry best practice for the valuation of other effects;
- Discounting future benefits and costs with the real discount rates recommended by the DOT (seven percent, and three percent for sensitivity analysis); and
- Conducting a sensitivity analysis to assess the impacts of changes in key estimating assumptions.

3. Project Overview

The Project constructs a structural Cap over existing depressed, interstate roadways, providing green space and new bicycle and transportation linkage improvements over and along the perimeter of the Cap. The majority of the Project will be developed as a Class I multi-use path. The Project enhances transit connectivity to the T and other Port Authority transit services provided in the area.

Enhancing safety is a primary objective of the project. Presently, bicyclists and pedestrians walk the perimeter of the Cap project area to access jobs, run errands, or exercise. While sidewalks do exist, they are in various states of disrepair with the sidewalks on the bridge overpasses being new and the sidewalks along the city streets being severely deteriorated. The Cap project will improve the infrastructure that is currently used by these walkers and riders, as well as build a brand new walking/cycling trail over the top.

A high traffic intersection at the corner of Chatham Street and Bigelow Boulevard will also be reconstructed and increased security will be realized as pedestrians and bicyclists no longer need to walk and ride directly within vehicular traffic. Enhancements will be added at key intersections to ensure safety and reduce conflicts between motorists, pedestrians, and bicyclists. Crosswalk markings and curb cut ramps, repainted stop bars, and signage will be provided in the Project area for pedestrians and cyclists to alert motorists to the presence of bicycle and pedestrian traffic in the crosswalk. Additionally, audible countdown pedestrian signal heads will be included for all pedestrian movements. Lighting along the perimeter of the park along the city street will be upgraded and new park lighting will be added. Signage will be added and improved throughout. ADA compliant walkways will be constructed and a discontinuous sidewalk will be removed. These enhancements and their improved safety implications will help reduce the number of pedestrian and bicycle collisions that occur each year.

Economic competitiveness is also likely to be enhanced with the Cap Project by providing better connectivity between the Lower Hill District and downtown. In addition, the Project has the potential to further catalyze development in the area; a key 28-acre transit-oriented development is currently underway near the Cap and

improved bicycle and pedestrian facilities, along with roadway improvements, may support even more development in the area. The envisioned structures include some parking, but it is relatively limited. It is expected that residents will utilize public transportation and alternative modes of transportation, like cycling and walking, to access their jobs, services, and other amenities. The Cap will support this activity.

3.1 Base Case and Alternatives

The base case for this analysis is the status quo – a network of busy and substandard roadways bisecting the Lower Hill District, the downtown, and other destinations. Baseline bicycle ridership is expected to grow only with population projections in the study area. Baseline pedestrian activity is expected to grow with population projections in the study area, adjusted to reflect that there are relatively more pedestrian commuters in this area of Pittsburgh than the rest of the County. Population projections were developed based on existing population in the Lower Hill Census Tracts, adjusted for recent and future residential development.

The Project would Cap the interstate roadways below, provide new green space in the urban core, include new bicycle and pedestrian trails, and improve intersections on the Cap perimeter. Other improvements related to safety and facility quality are also included in the Project and discussed in the main part of this application.

3.2 Types of Impacts and Affected Population

The Project will provide an essential link between the Hill District and Downtown Pittsburgh, as well as to the existing public transportation system. It will increase the safety of pedestrians and bicyclists, expanding economic opportunities in the region, and improving the overall quality of life for Hill District and other Pittsburgh residents. The project will encourage a state of good repair, improving the existing bicycle and pedestrian facilities as well as adding green space. These physical improvements will enhance the beauty of the neighborhood and expand its overall accessibility.

The Project extends significant benefits to the disadvantaged residents of the Hill District, by enhancing their ability to more safely and efficiently access services as well as education and employment centers. These improvements in mobility along the corridor will provide a safer and more efficient transportation network, reducing worker commute times, potentially enhancing the productivity of labor, and providing ladders of opportunity for low-income workers striving to attain a higher standard of living.

3.3 Project Cost and Schedule[2]

Capital costs are expected to be $26.44 million, based on the engineer's estimate developed for the Project. Construction would begin in 2017 and be completed by 2019. Operating costs of $165,000 per year are also included in the analysis to accurately reflect the true costs of the Project. Benefits are anticipated to accrue beginning in 2019, once the bicycle/pedestrian improvements are operational.

3.4 Disruptions Due to Construction

Disruptions due to construction consist of both long term interstate ramp closures, and interstate off-peak short-term stoppages and lane restrictions, and limited closures of the entire roadway overnight or on weekends. The long term ramp closures are required for contractor access and construction of the substructure units to support the new cap structure. The detour routes utilize the adjacent interstate ramps

[2] All cost estimates in this section are in millions of dollars of 2015, discounted to 2016 using a 7 percent real discount rate.

resulting in minimal added travel length and time. Adjacent city streets will not be directly impacted by the construction and only short term off-peak closures will be required during limited construction activities.

3.5 Effects on Long-Term Outcomes

The main benefit categories associated with the Project are mapped into the five long-term outcome criteria set forth by the DOT in the table below.

Table 1: Expected Effects on Long-Term Outcomes and Benefit Categories

Long-Term Outcomes	Benefit or Impact Categories	Description	Monetized	Quantified	Qualitative
State of Good Repair	Reduced pavement maintenance	Some people currently walk or cycle to access their jobs, schools, and other destinations. It is expected that the CAP and the associated bike path will induce some automobile drivers to utilize the bike path, reducing pavement wear and tear on existing roadways.	Yes	Yes	No
Economic Competitiveness	Reduced auto use and congestion costs	As some residents shift from driving to using the Cap on bike, we will see a reduction in the number of automobile drivers, in turn leading to a reduction in automobile use costs to operate and maintain the vehicle, as well as reduced congestion.	Yes	Yes	No
	Mobility benefits	Mobility will be enhanced by providing an additional transportation option. This is quantified and monetized for new riders. Benefits to pedestrians and existing users are not quantified.	Yes	Yes	Yes
	New space for retail	The Cap and the improvements on the land leading up to it will create additional space which will be leased for retail uses. Existing property values are also expected to increase due to the new green space and new bicycle and pedestrian facilities that are being built in the urban core.	Yes	Yes	Yes
	Short-term impacts	# of job-hours created from investment of public funds, using Council of Economics methodology.	No	Yes	No
Quality of Life	Travel Time Savings for Existing Commuters	Currently, pedestrians and cyclists must travel around the Cap area and the depressed highway. The Cap will create a more direct route across the Cap, reducing travel time. Pedestrian commuter travel time savings were estimated because pedestrian counts were available. Similar benefits were note estimated for cyclist.	Yes	Yes	Yes
	Health benefits	People not currently biking or walking along the route will be induced to do so as a result of the Project. Increased physical activity provides a health benefit. Benefits to existing users are not quantified.	Yes	Yes	Yes
	Recreational trips	The Cap will provide benefits to existing and new recreational riders as well. These benefits are not monetized. Benefits to pedestrians are also not quantified.	No	No	Yes
	Property Value Premiums	Residences located near the future green space are likely to generate a property value premium.	Yes	Yes	Yes

Long-Term Outcomes	Benefit or Impact Categories	Description	Monetized	Quantified	Qualitative
	Reduces 'Community Severance'	Removes space acting as a barrier between Hill District and Downtown, so that community can experience greater community cohesion with surrounding areas	No	No	Yes
Environmental Sustainability	Reduced emissions	As the number of automobiles is reduced, total emissions will also be reduced.	Yes	Yes	Yes
	Addition of green space	The Cap will be entirely green space with some hardscaping related to the bike path. The additional space can be used for recreation gatherings.	No	No	Yes
Safety	Reduced accidents	The number of accidents will be reduced by improved crossings and other safety enhancements. This may include uneven pavement benefits, accident reduction when there is less vehicular traffic, reduced accidents at intersections that will be improved.	Yes	Yes	Yes
	Insecurity Walking in Mixed Traffic	Currently, pedestrians and cyclists must walk and ride in mixed traffic. In addition, jaywalking occurs in and around the Cap. The improved walking environment will generate a level of security in traveling in the study area.	Yes	Yes	Yes

4. General Assumptions

The BCA measures benefits against costs throughout a period of analysis beginning at the start of construction in 2017 and including 30 years of operations through 2050.

The monetized benefits and costs are estimated in 2015 dollars with future dollars discounted in compliance with TIGER requirements using a seven percent real rate, and sensitivity testing at three percent.

The methodology makes several important assumptions and seeks to avoid overestimation of benefits and underestimation of costs. Specifically:

- Input prices are expressed in 2015 dollars;
- The period of analysis begins in 2016 and ends in 2050. It includes project development and construction years (2017-2018) and operations (2019-2050);
- A constant seven percent real discount rate is assumed throughout the period of analysis. A three percent real discount rate is used for sensitivity analysis;
- Opening year demand is an input to the BCA and is assumed to be fully realized in Year 1 (no ramp-up); and
- Unless specified otherwise, the results shown in this document correspond to the effects of the Full Build alternative (Construction of the Cap).

5. Demand Projections

This section of the technical documentation presents the pedestrian and cyclist projections utilized in the BCA. Data related to existing cyclist and pedestrian activity in and around the Cap was limited, but pedestrian counts were made on a typical workday. As described below, existing cyclist activity was estimated using a variety of sources.

5.1 Methodology

Existing pedestrian activity in and around the Cap area was counted by HDR. There were 6,574 per-day pedestrians counted in the potential Cap area during typical work week-day. More than 5,000 of these pedestrians were traveling during commuting hours (6:30-9:15 am and 3:00-6:00 pm). The remaining walkers are assumed to be a mix of recreational and utility walkers, where "utility" walkers are those who are walking to appointments and to run errands, for example.

Based on the population of the Hill District and the commuting patterns of Pittsburgh residents, it is estimated that there are 40 cyclist commuters. Bike share users in the area are estimated to total 246 annually, based on quarterly data made available to the Project team. It is assumed in the analysis that a small share of these bikeshare riders are commuters (5%) but that the rest are a combination of utility and recreational.

There were an estimated 9,457 residents in the Hill District in 2013. Since that time, new residences have been built and more are anticipated. Using US Census information related to household composition and data related to new development in the Hill District, estimates of new residents were made and added to the 2013 population to provide a forecast of population for this area of Pittsburgh through 2050. The average annual population growth rate was then calculated (1.7 percent).

Even in the absence of the Cap Project, it is expected that pedestrian and cyclist activity will increase over time. Cyclists in the "no-build" are assumed to grow at the same rate as population in the Hill District, 1.7 percent annually. The Hill District has a larger share of pedestrian commuters than the rest of the county. As a result, the average annual population growth was adjusted to reflect this larger share of pedestrian commuters. For the BCA, it is assumed that pedestrian activity in the no-build will grow at a rate of 5.1 percent per year.

The Cap Project will better connect the Hill District and downtown Pittsburgh. As a result, it is reasonable to expect that alternative transportation activity in the Hill District would become more similar to the downtown than it is today. According to the 2014 "Downtown Pittsburgh Pedestrian Traffic Study," pedestrian activity in downtown Pittsburgh has been growing 2.4 percent per year.

For the build scenario, it is assumed that the Cap infrastructure will induce some people to walk who are traveling some other way today. It is assumed that induced pedestrians will equate to 25 percent of the existing pedestrians. There is limited information related to the ability of pedestrian facilities to induce pedestrian activity, however, and none found that is analogous to the Cap Project. As a result, the analysis assumes 25 percent but sensitivity analyses for 0, 10, and 30 percent are offered in the BCA technical appendix. The pedestrian growth rate for the build scenario is increased to 7.1 percent, based on higher pedestrian activity experienced in Pittsburgh's Central Business District (CBD).

For new cyclists, existing cyclist estimates are adjusted using a recommended NCHRP factor for new riders and location of these cyclists relative to the Cap (i.e., how close is the Census Tract in which they reside to the Cap). NCHRP guidance recommends a new rider factor of 2.93 within 400 meters of the bicycle facility, 2.11 within 800 meters, and 1.39 within 1,600 meters[3]. The new rider factor in the BCA is assumed to be 1.46, based on residence location of existing cyclists; Census Tracts vary in terms of proximity to the Cap, so the number of existing cyclists in each of the various Census Tracts was used to weight the new rider factor. New rider growth is then increased over time based on Pittsburgh's ACS average annual growth rate for the period between 2000 and 2012 for the first 10 years. A lower rate, based on cyclist growth in Pittsburgh between 1990 and 2013, is used thereafter.

[3] "NCHRP Report 552, Guidelines for Analysis of Investments in Bicycle Facilities," Transportation Research Board.

While this approach provides an estimate of commuter and "other" pedestrians and cyclists today and over time, some of these individuals may be walking or biking for recreational purposes. As a result, data were used to estimate the actual "utility" walkers and cyclists that comprise part of the non-commuter cycling and pedestrian demand. The source of data for these trips is from the National Household Transportation Survey (2001), which is the same source of data used by the authors in the NCHRP 552 analysis. Only benefits associated with commuter and utility cyclist and pedestrian activity are included in the BCA. The benefits to recreational users (e.g., health), for example, are not included. A full discussion is provided in the Benefit-Cost Technical Appendix.

5.2 Assumptions

Key factors used in the demand estimation are presented in Table 2.

Table 2: Assumptions Used in the Estimation of Demand

Variable Name	Unit	Value	Source
Population Long Run Growth Rate	% per Year	1.7	US Census Bureau adjusted by HDR based on known and anticipated development in the area
Annual New Bicyclist Growth Rate Years 1-4	% per year	17.7	American Community Survey, Pittsburgh cyclist growth rate 2000-2012
Annual New Bicyclist Growth Rate Years 5-10	% per year	17.7	American Community Survey, Pittsburgh cyclist growth rate 2000-2012
Annual New Bicyclist Growth Rate after 10 years	% per year	10.5	American Community Survey, Pittsburgh cyclist growth rate 1990-2013
Pedestrian commuter mode share Allegheny County	%	4.4	American Community Survey, 2013
Pedestrian commuter mode share Lower Hill District (Census Tracts)	%	13.0	American Community Survey, 2013
Pedestrian Growth Rate in Downtown Pittsburgh	% per year	2.4	2014 Downtown Pittsburgh Pedestrian Traffic Study, Executive Summary
Percentage of bicycle commuters	%	1.4	American Community Survey, WHERE WE RIDE, Analysis of bicycling in American cities annual American Community Survey data report for 2012
Percentage of pedestrian commuters	%	72	HDR Pedestrian Counts on a typical week day and National Household Transportation Survey (2001)
Percentage of utility bicyclists	%	5	National Household Transportation Survey (2001)
Percentage of utility pedestrians	%	11	National Household Transportation Survey (2001)

Table 3 shows estimates for daily cycling and pedestrian demand. Total daily demand is used to estimate mobility benefits for new cyclists making commuter and other destination cycling trips. It is also used to estimate new cyclist and pedestrian health benefits, benefits due to diversion from auto to cycling, reduced pavement maintenance due to diversion from auto to cycling, emissions reduction benefits due to diversion from auto to cycling, and existing cyclist and pedestrian accident reduction benefits.

Benefits are applied to: (a) Existing cyclists and pedestrians who would have otherwise taken normal city roads; (b) New cyclists opting to commute or make a trip by bicycle to a destination (e.g., home, errand) rather than a car or other mode; and (c) Existing walkers who would have traveled the perimeter of the Cap to access their final destination.

5.1 Demand Projections

The resulting projections for bicycle and pedestrian activity are presented in the table below.

Table 3: Commuter and Destination Cyclist and Pedestrian Demand Estimates

Year	Project Year	Existing Weekday Riders and Walkers	New Weekday Riders and Walkers
2016	1	5,590	1,427
2017	2	5,869	1,534
2018	3	6,162	1,651
2019	4	6,469	1,777
2020	5	6,792	1,914
2021	6	7,131	2,063
2022	7	7,488	2,224
2023	8	7,862	2,400
2024	9	8,255	2,591
2025	10	8,668	2,799
2026	11	9,102	3,026
2027	12	9,558	3,125
2028	13	10,037	3,229
2029	14	10,540	3,338
2030	15	11,068	3,453
2031	16	11,623	3,575
2032	17	12,207	3,704
2033	18	12,819	3,840
2034	19	13,463	3,985
2035	20	14,139	4,138
2036	21	14,849	4,302
2037	22	15,595	4,476
2038	23	16,378	4,661
2039	24	17,202	4,859
2040	25	18,067	5,071
2041	26	18,975	5,298
2042	27	19,930	5,542
2043	28	20,932	5,804
2044	29	21,986	6,085
2045	30	23,093	6,389
2046	31	24,255	6,716
2047	32	25,477	7,069
2048	33	26,760	7,450
2049	34	28,108	7,864
2050	35	29,524	8,311
Total		505,974	145,691

6. Benefits Measurement, Data and Assumptions

This section describes the measurement approach used for each benefit or impact category identified in the table below (Expected Effects on Long Term Outcomes and Benefit Categories) and provides an overview of the associated methodology, assumptions, and estimates.

6.1 State of Good Repair

To quantify the benefits associated with maintaining the existing transportation network in a state of good repair, the pavement maintenance savings that are generated when existing automobile drivers shift to bicycle travel are estimated. Because the number of automobiles on the roadways will decrease with the improved bicycle facility, roadway wear and tear will be reduced. It should be noted that no diversion from automobile to pedestrian travel was assumed since the average trip length walking is only .67 miles. As a result, the state of good repair benefits are likely conservative.

METHODOLOGY

To estimate the reduced pavement maintenance costs, new cyclist estimates were utilized. These ridership figures were multiplied by the number of commuter and destination rider days, respectively, as well as a factor that reflects round trip travel to estimate trips. A pavement maintenance cost per mile was then multiplied by the number of miles per trip. The product of the trips and pavement maintenance cost per trip generates the total savings associated with reduced wear and tear on roadways. Because not all new riders will be diverting from automobiles, only 10 percent of the total benefit is included in this benefit making it a conservative estimate.

ASSUMPTIONS

The assumptions used in the estimation of State-of-Good-Repair benefits are summarized in the table below.

Table 4: Assumptions used in the Estimation of State-of-Good-Repair Benefits

Variable Name	Unit	Value	Source
Number of Commuter Days	Days	250	http://www.worldweather.org/093/c00268.htm
Commuter Annual Factor	Trips	2	HDR assumption
Number of Destination Travel Days	Days	365	http://www.worldweather.org/093/c00268.htm
Destination Travel Annual Factor	Trips	2	HDR assumption
Pavement Maintenance Cost per Mile	Dollars	$0.16	2006 NCHRP savings for urban areas; adjusted by CPI
Average Trip Length - cycling	Miles	4.52	HDR assumption based on estimated speed of cycling and average commutes
Average Trip Length- walking	Miles	0.67	HDR assumption based on estimated walk speed and average commutes
Share of New Cyclists Assumed to Divert from Automobile	%	10	HDR assumption based on average commutes

BENEFIT ESTIMATES

Pavement maintenance savings are very minimal for this Project, primarily because the analysis assumes a very small share of cyclist ridership diversion from automobiles. Based on the assumptions and methodology outlined above, less than $295,164 in pavement maintenance savings, discounted at seven percent, are generated when existing automobile users divert to the improved bicycle path.

Table 5: Estimates of State-of-Good-Repair Benefits, Millions of 2015 Dollars

	In Project Opening Year Opening Year	Over the Project Lifecycle	
		In Constant Dollars	Discounted at 7 Percent
Pavement Maintenance Savings	$4,668	$1,600,525	$295,164

6.2 Economic Competitiveness

The proposed Project would contribute to enhancing Economic Competitiveness through multi-modal time and cost savings for people's mobility across the study area. New commuter and other destination trips generate mobility benefits in the analysis. Out-of-pocket transportation cost savings and benefits associated with reduced automobile congestion are also generated.

- Mobility benefits per commuter cyclist are derived from estimates on the willingness to spend additional time cycling to ride on a safer and more directly connected trail.
- Commuters who switch from personal vehicles also save on out-of-pocket costs from vehicle use. These costs include vehicle wear and tear, fuel and oil consumption.
- Remaining roadway users benefit from a marginal reduction in drivers on the road because of commuters who switch to cycling. Fewer cars on the road lead to less congestion.

METHODOLOGY

Mobility benefits for cyclists taking new work and other destination trips are derived from estimates on the willingness to spend time in reaching the bike path. The data to estimate this value is derived from research reported in the NCHRP 552. This research entailed a stated preference survey of existing cyclists in the St. Paul / Minneapolis area who use a variety of road types when they ride and travel different distances and for different purposes (See NCHRP 552, Appendix D). This sample of respondents aimed to be representative of a wider population of cyclists in the area.

The results that are reported in Appendix D, Table 24 page D-11 of the NCHRP report indicate the willingness to spend extra travel time minutes for various improvements in cycling infrastructure. In this case, the current conditions would generally be characterized as Type E or Type D. The proposed improvements in this Project correspond to lane types A, B, and C.

Lane Type	Facility Description
A	Off-road Bike Trail
B	On-Road Bike Lane, No parking
C	On-Road Bike Lane, On street parking
D	No Bike Lane, No parking
E	No Bike Lane, On street parking

Since new cyclists are likely to ride on both types of existing and all types of new conditions, an average is taken for the extra time to travel to the better facilities. Based on computations conducted by HDR, it is

estimated that cyclists will take 19.8 minutes extra to access improved bicycle facilities, such as those proposed in this Project. It is assumed that on average all new and other destination trips would express the same willingness to spend extra time to access the new bike path. These extra minutes per trip are valued using USDOT guidelines on the value of time for non-work activities. Since additional trips entail tradeoffs in the time and out-of-pocket costs of some other mode or travel decision, the "rule-of-half" is applied to the total maximum benefits, as determined by the willingness to spend extra time on a trail and the value of time. This calculation is simply the approximation of the change in consumer surplus for a reduction in generalized travel costs.

Commuters who switch from personal vehicles also save on out-of-pocket costs from vehicle use. These costs include vehicle wear and tear, fuel and oil consumption. The benefits estimates assume that 10 percent of new cyclists are diverted from automobile travel. Remaining roadway users also benefit from a marginal reduction in drivers on the road because of commuters who switch to cycling. Fewer cars on the road lead to less congestion. The reduced number of travelers is combined with an estimate of trip length and congestion factors to estimate this benefit.

ASSUMPTIONS

The assumptions used in the estimation of mobility benefits are summarized in the table below. Mobility benefits reflect the willingness of cyclists to go out of their way to access a dedicated cycling trail. The Rule of Half is assumed to estimate the mobility benefits associated with new cyclists.

Table 6: Assumptions Used in the Estimation of Mobility Benefits for Cyclists

Variable Name	Unit	Value	Source
Number of Commuter Days	Days	250	Normal Working Days per Year (Annualization based on NCHRP 552 guidelines)
Commuter Annual Factor	Trips	2	NCHRP 552 Guidelines
Value of time	Dollars	13.60	USDOT TIGER Guidance - All purposes value of time
Willingness to Travel	Minutes	19.8	HDR calculation, based on NCHRP 552
Real wage growth rate	%	1	USDOT TIGER Guidance

Vehicle operating costs are estimated using consumption rates for fuel, oil, tires, maintenance, and depreciation. Estimates of vehicle miles traveled and unit costs are applied to these consumption rates to calculate total vehicle operating costs. The table below provides the unit cost estimates used in the analysis.

Table 7: Assumptions Used in the Estimation of Out-of-Pocket Travel Cost Savings

Variable Name	Unit	Value	Source
Share of New Cyclists Diverting from Automobile	%	10	HDR assumption
Commuter Annual Factor	Trips	2	Consistent with NCHRP 552 Guidelines
Total Ownership Costs	Per Mile	$0.24	AAA Composite Average Auto Fleet
Destination Travel Annual Factor	Trips	2	Consistent with NCHRP 552 Guidelines
Average Trip Length	Miles	4.52	HDR assumption based on estimated cycling speed and average commute by cycling

When automobile drivers are induced to travel to work and other destinations using the bike path, rather than their car, roadway congestion is reduced. The following details the assumptions used to estimate roadway congestion benefits to remaining roadway users, when other users ride their bike rather than drive.

Table 8: Assumptions Used in the Estimation of Roadway Congestion Benefits

Variable Name	Unit	Value	Source
Congestion Savings per Mile	Dollars per Mile	0.15	2006 NCHRP savings for urban areas, adjusted by CPI
Share of New Cyclists Diverting from Automobile	%	10	HDR assumption
Number of Commuter Days	Days	250	Normal Working Days per Year (Annualization based on NCHRP 552 guidelines)
Commuter Annual Factor	Trips	2	NCHRP 552 Guidelines
Number of Destination Travel Days	Days	365	Calendar Days per year (Annualization based on NCHRP 552 guidelines)
Destination Travel Annual Factor	Trips	2	NCHRP 552 Guidelines
Average Trip Length	Miles	4.52	HDR assumption

BENEFIT ESTIMATES

Congestion savings and reduced vehicle operating costs generate $130,362 in benefits over the study period. A more significant economic competitiveness benefit, however, is the new cyclist mobility benefit of $10.1 million over the Project's lifetime.

Table 9: Estimates of Economic Competitiveness Benefits, Millions of 2015 Dollars

	In Project Opening Year	Over the Project Lifecycle	
		In Constant Dollars	Discounted at 7 Percent
New Cyclist Reduced Congestion Savings	$2,039	$699,099	$130,362
New Cyclist Reduced Vehicle Operating Costs	$23	$7,787	
New Cyclist Mobility Benefit	$149,843	$55,457,850	$10,077,850

ESTIMATION OF SHORT-TERM ECONOMIC IMPACTS

To better quantify the potential impact of this Project, from an economic competitiveness standpoint, an estimate of jobs generated by the investment is made. The Council of Economic Advisors' (CEA) methodology as presented in a 2011 analysis[4] assumes that for every $76,923 of government spending, one job-year is created. Using the total cost estimate of $26.44 million, this Project investment is expected to support 344 job years.

6.3 Quality of Life

The proposed Project would contribute to enhancing quality of life in the study area by generating health benefits for new cyclists and pedestrians. Other quality of life benefits include the property value premium

[4] Executive Office of the President, Council of Economic Advisers, "Estimates of Job Creation from the American Recovery and Reinvestment Act of 2009," Washington, D.C., May 11, 2009; and September 2011 Update.

anticipated for existing residences that will benefit from the new green space offered by the Cap. Finally, travel time savings are generated when existing pedestrians save time walking over the Cap rather than around the Cap to access their destinations.

The following describes the methodology and assumptions utilized to estimate these benefits. It should be noted that there are other benefits related to quality of life that are not easily monetized. These include proximity to green space for visitors, improved walking and biking experience for existing pedestrians and cyclists due to the new facilities, and improved existing facilities, among others.

METHODOLOGY

An increase in physical activity is anticipated to reduce health care costs. An annual per-capita cost savings from physical activity of $148 was determined by NCHRP by taking the median value of ten studies (adjusted for inflation). This health benefit per user value is then multiplied by the total number of new users of the bike path to estimate an annual health benefit. For pedestrians, the annual health benefit per mile of $0.54 (adjusted for inflation) was combined with the total new pedestrians and their average trip length to estimate health benefits generated by this new pedestrian activity.

Travel time savings are also generated for existing pedestrians because their commute time is reduced. The trip is more direct, no longer circumventing the entire Cap area, to reach their final destination. Based on pedestrian counts for a typical work day, estimates related to travel time for those existing pedestrians, and estimates related to the reduced travel time to walk over the Cap when it is built, travel time for pedestrian commuters is estimated. This combined with the value of time for commuting pedestrians yields the travel time savings benefit estimate.

Finally, the property value of residential properties located in very close proximity to the Cap are anticipated to increase due to proximity to green space. Based on studies that measured the property value increase for residential properties located 800 and 1,500 feet away from the green space, along with property tax assessor data for properties falling within that catchment area, property value premiums were estimated.

ASSUMPTIONS

The assumptions used in the estimation of new cyclist and pedestrian health benefits are summarized in the table below.

Table 10: Assumptions Used in the Estimation of New Cyclist and Pedestrian Health Benefits

Variable Name	Unit	Value	Source
Annual trips required to provide health benefit	Trips	208	HDR assumption
Number of Commuter Days	Days	250	NCHRP 552 Guidelines
Commuter Annual Factor	Trips	2	Calendar Days per year (Annualization based on NCHRP 552 guidelines)
Number of Destination Travel Days	Days	365	NCHRP 552 Guidelines
Destination Travel Annual Factor	Trips	2	NCHRP 552 Guidelines
Annual health benefit per cyclist	Dollars	148	NCHRP
Annual pedestrian health benefit per mile	Dollars	0.54	Economic Value of Walkability, Victoria Transport Policy Institute

The assumptions used in the estimation of travel time savings for existing commuters are provided below.

Table 11: Assumptions Used in the Estimation of Travel Time Savings for Existing Commuters

Variable Name	Unit	Value	Source
Value of Time (walking)	Dollars	35.80	USDOT TIGER Guidance
Real wage growth rate	%	1	USDOT TIGER Guidance
Total minutes saved per day for existing pedestrians	Minutes	4,653	HDR assumption based on assumed walk speeds and distances

Based on research related to green space and property values, it is anticipated that existing residential properties in close proximity to the Cap will experience increased property values. Assumptions related to the property value premium estimates are presented below.

Table 12: Assumptions Used in the Estimation of Property Value Premiums for Existing Residential Properties

Variable Name	Unit	Value	Source
Property value premium within 800 feet of Cap	%	3	Measuring the Impact of Parks on Property Values, by Sarah Nicholls, Ph.D
Property value premium within 1,500 feet of Cap	%	3	Measuring the Impact of Parks on Property Values, by Sarah Nicholls, Ph.D
Period for full premium accrual	Years	10	HDR assumption
Starting percentage for premium	%	40	HDR assumption
Residential property value within 800 feet of Cap	Millions of Dollars	$16.5	Allegheny County Tax Assessor Data
Residential property value within 1,500 feet of Cap	Millions of Dollars	$114.8	Allegheny County Tax Assessor Data

BENEFIT ESTIMATES

Travel time savings for existing pedestrian commuters is estimated to be $4.3 million, discounted at seven percent. Property value premiums associated with residential properties located near the Cap green space are estimated to be $342,284 over the lifetime of the Project, when discounted at seven percent. New cyclists and pedestrians are assumed to generate a health benefit when they divert from their automobiles to alternative transportation. Assuming a seven percent discount rate, this benefit is estimated to be $5.6 million as shown in the table below.

Table 13: Estimates of Quality of Life Benefits, Millions of 2015 Dollars

	In Project	Over the Project Lifecycle	
	Opening Year	In Constant Dollars	Discounted at 7 Percent
Travel Time Savings - Commuting Pedestrians	$371,470	$13,927,940	$4,256,537
Property Value Premium	$19,375	$1,251,393	$342,284
New Cyclist and Pedestrian Health Benefit	$200,212	$25,806,266	$5,618,212

6.4 Environmental Sustainability

Reducing the number of vehicles on the road would contribute to Environmental Sustainability by reducing vehicle emissions when current drivers switch to biking as a result of the Project improvements. To monetize

emissions, the change in Vehicle Miles Traveled (VMT) is combined with a factor for each emission type, VOC (HC), CO, CO2, NOX, SO2, and PM.

METHODOLOGY

Emissions rates for vehicles, in grams per mile, were estimated using the EPA MOVES model. These rates were then converted from grams per mile to calculate the reduction in tonnage of emissions due to the diversion from automobile to bicycle. Each pollutant was then converted to metric tons. The cost of carbon dioxide emissions increases annually and values for these emissions are discounted at a value of three percent rather than the seven percent recommendation for all other values.

ASSUMPTIONS

The estimation of sustainability benefits applies emission rates from EPA Moves and costs per ton of each pollutant from EPA and USDOT. Costs per ton are adjusted over time for each of the pollutants.

BENEFIT ESTIMATES

The construction of the Cap and associated alternative transportation path in the Lower Hill District of Pittsburgh is estimated to decrease air contaminant emissions over the study period, as drivers divert to biking. This relatively small benefit is estimated to be approximately $14,256 when discounted by seven percent. It should be noted that these benefits are generated exclusively by diversion of existing automobile drivers to bicycle travel. No pedestrian benefits are calculated, and it is assumed that only 10 percent of new riders divert from automobile to bike.

Table 14: Estimates of Environmental Sustainability Benefits, Millions of 2015 Dollars

	In Project Opening Year	Over the Project Lifecycle	
		In Constant Dollars	Discounted at 7 Percent
Emissions Reduction Benefit	$129	$50,212	$14,526

6.5 Safety

Currently, most pedestrians and cyclists in the study area walk or ride along streets and on sidewalks because there are no formal bike/ped paths and very limited bike lanes. They also abut heavily trafficked areas and must cross busy roadways to access their destinations. This pattern of cycling and walking is extraordinarily cautionary because of the risk of accidents. Jay-walking was observed during pedestrian counting, further increasing the potential risk of accidents. Cap and perimeter improvements are expected to provide a safer walking and cycling environment.

METHODOLOGY

There were two benefits estimated for this project: accident reduction due to improved facilities in, on and around the Cap; improved security for cyclists and pedestrians who reduce the amount of time they spend traveling in mixed traffic.

Pedestrian and cyclist accident data was reviewed to determine the number of accidents per year that occur in and around the Cap. Assumptions were then made related to the potential for those accidents to be eliminated with the Cap improvements. To estimate the insecurity of walking in mixed traffic, an estimate of the distance spent walking or cycling in mixed traffic was made. This was combined with factors adapted from the Statens vegvesen, Handbok 140, 2006 from Norway.

ASSUMPTIONS

The following presents the data assembled related to accidents in and around the Cap. Data varied by year, so average annual accident estimates were calculated and used in the BCA.

Table 15: Accident Data along Cap

Accident Location	Pedestrian Accidents per Year	Cyclist Accidents per Year	Percent Accidents Reduced	Source
Centre Avenue & Chatham Street	0.5		100%	Pennsylvania Department of Transportation
Centre Avenue & Washington Place	0.4		100%	Pennsylvania Department of Transportation
Bigelow Boulevard & Chatham	0.5		100%	Pennsylvania Department of Transportation
Bigelow Boulevard & Washington Place	0		100%	Pennsylvania Department of Transportation
Accidents near Bedford and ramps	0.6		20%	Pennsylvania Department of Transportation
Centre Avenue & Washington Place		0.17	100%	http://newsinteractive.post-gazette.com/bikeAccidents/

In addition to the accident assumptions in the table above, other assumptions used to estimate safety benefits are provided below.

Table 16: Assumptions used in the Estimation of Safety Benefits

Variable Name	Unit	Value	Source
Cost – C – Possible Injury	Dollars per Injury	63,854	USDOT TIGER Recommendation
Cost – B – Non Incapacitating	Dollars per Injury	125,050	USDOT TIGER Recommendation
Share of C – Possible Injury	%	63.3	Pennsylvania Department of Transportation
Share of B – Non Incapacitating	%	36.7	Pennsylvania Department of Transportation

Finally, to estimate the benefit associated with eliminating the insecurity of walking in mixed traffic, the following assumptions were made.

Table 17: Assumptions used in the Estimation of Safety Benefits

Variable Name	Unit	Value	Source
Distance of risky mixed traffic travel near Cap	Miles	0.26	HDR assumption
Insecurity in walking/biking in mixed traffic	Dollars/mile	0.25	Statens vegvesen, Handbok 140, 2006 from Norway

BENEFIT ESTIMATES

Safety benefits generated by the improved physical condition of the Cap area sidewalks, signage, roadways, and other infrastructure, as well as the construction of a new off-road bicycle and pedestrian facility are provided below. The safety benefits generated by insecurity of walking in mixed traffic are relatively small, $52,191 when discounted at seven percent. Accident reduction benefits generated by the improved intersection and other improvements are more significant, estimated at $1.7 million over the 20-year period, when discounted at seven percent.

Table 18: Estimates of Safety Benefits, Millions of 2015 Dollars

	In Project Opening Year	Over the Project Lifecycle	
	Opening Year	In Constant Dollars	Discounted at 7 Percent
Insecurity Walking in Mixed Traffic	$4,721	$169,345	$52,191
Accident Reduction Benefit	$148,544	$5,569,531	$1,702,112

7. Summary of Findings and BCA Outcomes

A comparison of the benefits and costs of a project can provide an indication of whether or not a project is worthwhile. To be deemed economically feasible, projects must pass one or more value benchmarks: the total benefits must exceed the total costs on a present value basis; and/or the rate of return on the funds invested should exceed the cost of raising capital, often defined as the long-term treasury rate or the social discount rate. A fundamental tenet of the benefit-cost analysis approach is that only those benefits that are directly attributable to the construction and operation of the Project are included in the estimation of benefits and costs. For this analysis, the cost to build and operate represents the foregone value of an alternative investment. The benefits of the Project refer to the improvement in the social well-being delivered by the Project.

In the BCA conducted for this application, benefits are estimated for current and future users on an incremental basis; that is, the change in welfare that consumers and, more generally, society derive from the Cap Project, as compared to the current situation. As with most transportation projects, the benefits derived from the implementation of an infrastructure project are actually a reduction in the costs associated with transportation activities. The benefits of a project are the cost reductions that may result from the Project's implementation. These cost reductions may come in the form of average time saved by users, decreased levels of pollution, or more generally, a combination of multiple effects.

The tables below summarize the BCA findings. Annual costs and benefits are computed over the lifecycle of the Project. As stated earlier, construction is expected to be completed in 2019 with 2050 being the Project analysis end year. Benefits accrue during the full operation of the Project.

Table 19: Overall Results of the Benefit Cost Analysis, Millions of 2015 Dollars*

Project Evaluation Metric	7% Discount Rate	3% Discount Rate
Total Discounted Benefits	$22.5	$51.1
Total Discounted Costs	$23.8	$27.5
Net Present Value	($1.3)	$23.5
Benefit / Cost Ratio	0.95	1.86
Internal Rate of Return (%)	6%	

* Unless Specified Otherwise

Considering all monetized benefits and costs, the estimated internal rate of return of the Project is six percent. With a seven percent real discount rate, the $26.44 million investment would result in $22.5 million in total benefits and a Benefit/Cost ratio of 0.95.

With a three percent real discount rate, the Net Present Value of the Project would increase to $23.5 million, for a Benefit/Cost ratio of 1.86.

Table 20: Benefit Estimates by Long-Term Outcome for the Full Build Alternative

Long-Term Outcomes	Benefit Categories	7% Discount Rate	3% Discount Rate
State of Good Repair	Pavement Maintenance Savings	$295,164	$737,758
Economic Competitiveness*	New Cyclist Reduced Congestion Savings	$10,208,212	$25,742,363
	New Cyclist Reduced Vehicle Operating Costs		
	New Cyclist Mobility Benefit		
Quality of Life	Travel Time Savings - Commuting Pedestrians	$10,217,034	$21,284,203
	Property Value Premium		
	New Cyclist & Pedestrian Health Benefit		
Environmental Sustainability	Emissions Reduction Benefit	$14,526	$23,013

Long-Term Outcomes	Benefit Categories	7% Discount Rate	3% Discount Rate
Safety	Insecurity Walking in Mixed Traffic	$1,754,303	$3,264,424
	Accident Reduction Benefits		
Total Benefit Estimates		$22,489,239	$51,051,760

Note: * Excluding the short-term employment impacts of the Project

In addition to the monetized benefits above, there are a number of other benefits that are difficult to monetize. For example, analytical techniques related to monetizing the elimination of severance are not well-formed. As a result, the benefits generated by this project may not be fully reflected in the BCA, which is focused primarily on transportation benefits and some property value benefits generated by the addition of an urban open green space. In an effort to provide a rigorous benefit-cost analysis, traditional transportation benefits are the focus of the analysis. Other benefits are not included in the BCA because of data and/or methodological limitations in monetizing certain types of societal benefits. These "missing" benefits are provided below.

- Despite USDOT's strong support for creating ladders of opportunity through the TIGER program, the value of improved connectivity between the Lower Hill District and downtown Pittsburgh over an existing, depressed roadway system is not monetized or included in the BCA. This is due to methodological limitations associated with measuring the elimination of severance between the communities.
- Benefits associated with reduced travel time for existing transit users are not included in the BCA. The Port Authority of Allegheny County (i.e., Pittsburgh's existing transit service provider) has indicated that it will consider placement of an additional transit stop, if the Cap is built. This could reduce travel time for existing transit users who may live closer to this new bus stop than to their current stop. These potential time savings were not incorporated in the BCA.
- Cyclist time savings associated with being able to ride over the Cap, rather than around, are not included in the BCA because of limited data related to existing cyclists and their routes.
- Accident reduction benefits on the roadways, generated when existing automobile drivers are induced to walk or bike because of the Cap, are not included in the BCA. Only accident reduction for existing pedestrians and cyclists are included in the BCA, based on pedestrian and cyclist accidents in the Cap area.
- No vehicle operating cost savings were estimated for pedestrians who may divert from driving to walking to work.
- The improved experience for new cyclists is estimated in the BCA but, despite that the pedestrian experience would also be enhanced, no benefits were estimated for existing walkers.
- Benefits associated with the increased or improved access to employment opportunities in the Central Business District (CBD) for Hill District residents were not monetized.
- With the Cap, there could also be an increase in commercial activity in the Hill District community from the CBD population. The benefits associated with this economic activity were not included in the BCA.

- Benefits associated with the increased access by the Hill District community to education opportunities, which has long term benefits for society through increased wages and employability, were not estimated for the BCA.

8. BCA Sensitivity Analysis

The BCA outcomes presented in the previous sections rely on a large number of assumptions and long-term projections; both of which are subject to considerable uncertainty.

The primary purpose of the sensitivity analysis is to help identify the variables and model parameters whose variations have the greatest impact on the BCA outcomes: the "critical variables."

The sensitivity analysis can also be used to:

- Evaluate the impact of changes in individual critical variables – how much the final results would vary with reasonable departures from the "preferred" or most likely value for the variable; and
- Assess the robustness of the BCA and evaluate, in particular, whether the conclusions reached under the "preferred" set of input values are significantly altered by reasonable departures from those values.

The outcomes of the quantitative analysis for the Cap Project using a seven percent discount rate are summarized in the table below. The table provides the percentage changes in Project NPV associated with variations in variables or parameters (listed in row), as indicated in the column headers.

There were five sensitivity analyses conducted as a part of this benefit-cost analysis:

- Elimination of induced pedestrian estimate.
- Value of time for pedestrians reduced to All Purpose Value of Time of $13.60.
- Decrease capital costs by 25 percent.
- Eliminate adjustment to pedestrian growth rates to reflect larger share of Hill District residents commute by walking.
- Halve new rider growth rate after Cap is built

Table 21: Quantitative Assessment of Sensitivity, Summary

Parameters	Change in Parameter Value	New NPV	Change in NPV	New B/C Ratio
Induced Pedestrians	Zero induced pedestrians	-$3.9 million	-$2.6 million	0.83
Value of Time	Reduce value of time for pedestrians from $25.80 to $13.60	-$3.3 million	-$2.0 million	0.86
Capital Costs	Reduce capital costs by 25%	$4.2 million	$5.5 million	1.23
Pedestrian Growth	Eliminate adjustment to growth rates for pedestrians due to larger share of walkers in Lower Hill District	-$2.1 million	-$0.85 million	0.91
Cyclist Growth	Halve new rider growth rate assumptions	-$10.9 million	-$9.6 million	0.54

9. Supplementary Data Tables

This section breaks down all benefits associated with the five long-term outcome criteria (State of Good Repair, Economic Competiveness, Quality of Life, Environmental Sustainability, and Safety) in annual form for the Rail to Rail Transportation Corridor Connector Project. Supplementary data tables are also provided for some specific benefit categories. For example, tables providing estimates of annual emission reductions (in tons) are provided under Environmental Sustainability.

Table 22: Annual Estimates of Total Project Benefits and Costs

Year	Proj. Year	Undiscounted Capital Costs	Undiscounted O&M Costs	Undiscounted Benefits	Undiscounted Net Benefits	Discounted Capital Costs	Discounted O&M Costs	Discounted Benefits	Discounted Net Benefits
2016	1	$0	$0	$0	$0	$0	$0	$0	$0
2017	2	$8,813,333	$0	$0	($8,813,333)	$7,697,907	$0	$0	($7,697,907)
2018	3	$17,626,667	$0	$0	($17,626,667)	$14,388,611	$0	$0	($14,388,611)
2019	4	$0	$165,000	$901,025	$736,025	$0	$125,878	$687,392	$561,515
2020	5	$0	$165,000	$954,404	$789,404	$0	$117,643	$680,484	$562,841
2021	6	$0	$165,000	$1,015,151	$850,151	$0	$109,946	$676,448	$566,501
2022	7	$0	$165,000	$1,084,494	$919,494	$0	$102,754	$675,381	$572,628
2023	8	$0	$165,000	$1,163,877	$998,877	$0	$96,032	$677,404	$581,373
2024	9	$0	$165,000	$1,254,997	$1,089,997	$0	$89,749	$682,657	$592,908
2025	10	$0	$165,000	$1,359,848	$1,194,848	$0	$83,878	$691,306	$607,429
2026	11	$0	$165,000	$1,480,777	$1,315,777	$0	$78,390	$703,542	$625,152
2027	12	$0	$165,000	$1,562,638	$1,397,638	$0	$73,262	$693,872	$620,610
2028	13	$0	$165,000	$1,652,195	$1,487,195	$0	$68,469	$685,651	$617,182
2029	14	$0	$165,000	$1,769,374	$1,604,374	$0	$63,990	$686,252	$622,262
2030	15	$0	$165,000	$1,876,051	$1,711,051	$0	$59,804	$680,033	$620,229
2031	16	$0	$165,000	$1,993,143	$1,828,143	$0	$55,891	$675,221	$619,330
2032	17	$0	$165,000	$2,121,751	$1,956,751	$0	$52,235	$671,777	$619,543
2033	18	$0	$165,000	$2,263,103	$2,098,103	$0	$48,818	$669,668	$620,850
2034	19	$0	$165,000	$2,418,557	$2,253,557	$0	$45,624	$668,861	$623,237
2035	20	$0	$165,000	$2,589,619	$2,424,619	$0	$42,639	$669,331	$626,692
2036	21	$0	$165,000	$2,777,957	$2,612,957	$0	$39,850	$671,053	$631,203
2037	22	$0	$165,000	$2,985,420	$2,820,420	$0	$37,243	$674,006	$636,763
2038	23	$0	$165,000	$3,214,057	$3,049,057	$0	$34,806	$678,172	$643,366
2039	24	$0	$165,000	$3,466,140	$3,301,140	$0	$32,529	$683,536	$651,006
2040	25	$0	$165,000	$3,744,174	$3,579,174	$0	$30,401	$690,078	$659,677
2041	26	$0	$165,000	$4,050,956	$3,885,956	$0	$28,412	$697,795	$669,383
2042	27	$0	$165,000	$4,389,579	$4,224,579	$0	$26,554	$706,678	$680,125
2043	28	$0	$165,000	$4,763,470	$4,598,470	$0	$24,816	$716,723	$691,907
2044	29	$0	$165,000	$5,176,426	$5,011,426	$0	$23,193	$727,927	$704,734
2045	30	$0	$165,000	$5,632,658	$5,467,658	$0	$21,676	$740,289	$718,613
2046	31	$0	$165,000	$6,136,834	$5,971,834	$0	$20,258	$753,812	$733,554
2047	32	$0	$165,000	$6,694,127	$6,529,127	$0	$18,932	$768,499	$749,567
2048	33	$0	$165,000	$7,310,272	$7,145,272	$0	$17,694	$784,359	$766,665
2049	34	$0	$165,000	$7,991,629	$7,826,629	$0	$16,536	$801,400	$784,863
2050	35	$0	$165,000	$8,745,246	$8,580,246	$0	$15,454	$819,632	$804,177
Total		$26,440,000	$5,280,000	$104,539,949	$72,819,949	$22,086,517	$1,703,354	$22,489,239	($1,300,632)

Table 23: Annual Estimates of Project Benefits by Long-term Outcome

Calendar Year	Project Year	State of Good Repair	Economic Competitiveness			Quality of Life			Environmental Sustainability	Safety	
		2015	2015			2015			2015	2015	
		Pavement Maintenance Savings	New Cyclist Reduced Congestion Savings	New Cyclist Reduced Vehicle Operating Costs	New Cyclist Mobility Benefit	Travel Time Savings - Commuting Pedestrians	Property Value Premium	New Cyclist & Pedestrian Health Benefit	Emissions Reduction Benefit	Insecurity Walking in Mixed Traffic	Accident Reduction Benefits
2016	1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2017	2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2018	3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2019 (opening)	4	$4,668	$2,039	$23	$149,843	$371,470	$19,375	$200,212	$129	$4,721	$148,544
2020	5	$5,492	$2,399	$27	$176,828	$375,185	$20,171	$219,378	$153	$4,742	$150,030
2021	6	$6,461	$2,822	$31	$208,676	$378,937	$20,967	$240,780	$182	$4,764	$151,530
2022	7	$7,601	$3,320	$37	$246,266	$382,726	$21,763	$264,731	$215	$4,788	$153,045
2023	8	$8,943	$3,906	$44	$290,634	$386,554	$22,560	$291,594	$255	$4,812	$154,576
2024	9	$10,521	$4,596	$51	$343,002	$390,419	$23,356	$321,790	$302	$4,838	$156,122
2025	10	$12,378	$5,407	$60	$404,814	$394,323	$24,152	$355,808	$358	$4,865	$157,683
2026	11	$14,563	$6,361	$71	$477,776	$398,267	$24,948	$394,214	$424	$4,894	$159,260
2027	12	$16,092	$7,029	$78	$529,630	$402,249	$25,744	$415,567	$472	$4,923	$160,852
2028	13	$17,782	$7,767	$87	$587,125	$406,272	$26,541	$438,682	$525	$4,955	$162,461
2029	14	$19,649	$8,583	$96	$650,875	$410,335	$46,446	$463,730	$588	$4,987	$164,085
2030	15	$21,712	$9,484	$106	$721,563	$414,438	$46,446	$490,905	$650	$5,022	$165,726
2031	16	$23,992	$10,480	$117	$799,946	$418,582	$46,446	$520,416	$723	$5,058	$167,383
2032	17	$26,511	$11,580	$129	$886,862	$422,768	$46,446	$552,497	$804	$5,096	$169,057
2033	18	$29,295	$12,796	$143	$983,244	$426,996	$46,446	$587,406	$894	$5,135	$170,748
2034	19	$32,371	$14,139	$158	$1,090,125	$431,266	$46,446	$625,425	$995	$5,177	$172,455
2035	20	$35,770	$15,624	$174	$1,208,650	$435,578	$46,446	$666,868	$1,107	$5,221	$174,180
2036	21	$39,526	$17,265	$192	$1,340,092	$439,934	$46,446	$712,082	$1,231	$5,267	$175,922
2037	22	$43,676	$19,077	$213	$1,485,862	$444,333	$46,446	$761,447	$1,369	$5,315	$177,681
2038	23	$48,262	$21,080	$235	$1,647,524	$448,777	$46,446	$815,387	$1,523	$5,366	$179,458
2039	24	$53,329	$23,294	$259	$1,826,817	$453,265	$46,446	$874,365	$1,693	$5,419	$181,252
2040	25	$58,929	$25,740	$287	$2,025,666	$457,797	$46,446	$938,898	$1,871	$5,475	$183,065
2041	26	$65,117	$28,442	$317	$2,246,211	$462,375	$46,446	$1,009,551	$2,067	$5,533	$184,895
2042	27	$71,954	$31,429	$350	$2,490,825	$466,999	$46,446	$1,086,952	$2,285	$5,595	$186,744
2043	28	$79,509	$34,729	$387	$2,762,139	$471,669	$46,446	$1,171,795	$2,524	$5,660	$188,612
2044	29	$87,857	$38,376	$427	$3,063,076	$476,386	$46,446	$1,264,843	$2,789	$5,727	$190,498
2045	30	$97,082	$42,405	$472	$3,396,878	$481,150	$46,446	$1,366,941	$3,082	$5,798	$192,403
2046	31	$107,276	$46,857	$522	$3,767,143	$485,961	$46,446	$1,479,022	$3,406	$5,873	$194,327
2047	32	$118,540	$51,778	$577	$4,177,863	$490,821	$46,446	$1,602,117	$3,764	$5,952	$196,270
2048	33	$130,987	$57,214	$637	$4,633,468	$495,729	$46,446	$1,737,365	$4,159	$6,034	$198,233
2049	34	$144,740	$63,222	$704	$5,138,877	$500,686	$46,446	$1,886,022	$4,596	$6,121	$200,215
2050	35	$159,938	$69,860	$778	$5,699,547	$505,693	$46,446	$2,049,477	$5,078	$6,211	$202,217
Total		$1,600,525	$699,099	$7,787	$55,457,850	$13,927,940	$1,251,393	$25,806,266	$50,212	$169,345	$5,569,531