Community, Equity, and Placemaking with Green Infrastructure in Seattle

A Visualization and Cost-Benefit Analysis

GREEN INFRASTRUCTURE FOUNDATION

A Project Of

The **Green Infrastructure Foundation** (GIF) partners with communities to shape healthy, resilient, and sustainable places using living green infrastructure. GIF is a 501(c)(3) charitable organization affiliated with Green Roofs for Healthy Cities, North America's Green Roof and Wall Industry Association. **greeinfrastructurefoundation.org**

In Partnership With

Capitol Hill Housing builds vibrant and engaged communities through affordable housing and community development. CHH owns and manages 48 affordable properties throughout the Seattle area. Since 1976, CHH has served low- and moderate-income residents and has worked to improve neighborhoods for all.

Interim CDA is a nonprofit affordable housing and community development organization based in Seattle's Chinatown/International District, with a mission to advance social justice and equity for Asians, Pacific Islanders, immigrants, refugees and low income individuals.

Participants

Summit and Belmont (Capitol Hill)

- Rohan Lilauwala, Green Infrastructure Foundation (Facilitator)
- McCaela Daffern, Capitol Hill Housing
- Amy Waterman, Seattle 2030 District
- David Okada, Arup
- Jason King, Mithun
- Chris Guillard, CMG Landscape Architecture
- Melissa Torres, University of Washington
- Cathy Hillenbrand, Capitol Hill Housing
- Dana West, King County Wastewater Treatment Division

Former King County Public Health Building and Lakewood Park (White Center)

- David Yocca, Conservation Design Forum (Facilitator)
- Joel Sisolak, Capitol Hill Housing
- Cheryl Markham, King County Department of Community and Human Services
- Mary Ann Uhlmann, Urban Horticulture Consulting
- PJ Benanati, GGLO
- Annie Alsheimer, MIG|SVR
- Mark Ufkes, White Center Community Development Association
- Henk Ufkes, University of Washington
- Ellen Southard, SalmonSafe

South Main Street (International District)

- Blaine Stand, Green Roofs for Healthy Cities (Facilitator)
- Steve Moddemeyer, CollinsWoerman (Chair, Legacy Committee)
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- Cheryl Markham, King County Department of Community and Human Services
- Joanne Rodriguez, Green Infrastructure Consultant
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Acknowledgements

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King County
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CMG Landscape Architecture

ARUP

GGLO DESIGN

MIG | SvR

Introduction

Living green infrastructure (also known as green stormwater infrastructure, or GSI) such as street trees, bioswales, green roofs, living walls, and rain gardens helps manage stormwater while providing a myriad of other benefits. These include improved water quality, reduced stress on grey infrastructure, groundwater recharge, improved air quality, greenhouse gas sequestration, improved biodiversity, reduced urban heat island, and reduced energy use.

The City of Seattle and King County are already supportive of green infrastructure, with the following programs encouraging the use of green infrastructure:

An example of a rain garden used to manage stormwater runoff in a residential area. Photo: US EPA

- RainWise: rebates and resources for installing residential rain gardens and cisterns
- Seattle Green Factor: minimum standards for the quantity and quality of plant material on new developments
- Stormwater Code: required on site stormwater management Best Management Practices for certain projects

However, there are still barriers to the widespread use of green infrastructure in the City of Seattle and King County. These barriers include a lack of a vision for how specific communities could implement green infrastructure on a large scale to meet their sustainability goals, how green infrastructure could be implemented without contributing to gentrification and displacement pressures, and how green infrastructure's many benefits could be incorporated into financial analyses to improve decision making.

The Green Infrastructure Charrette Program is a legacy project of the 15th Annual CitiesAlive Green Roof and Wall Conference, and is composed of two main elements designed to overcome these barriers:

- A green infrastructure cost-benefit matrix
- A one-day green infrastructure charrette

Green Infrastructure Cost-Benefit Matrix

The Green Infrastructure Cost-Benefit Matrix is a tool that allows for an aggregate-level economic analysis to be conducted. It includes two costs and ten benefits for fifteen different types of green infrastructure.

Costs and Benefits

- Construction Cost
- Maintenance Cost
- Stormwater Management
- Urban Heat Island Reduction
- Energy Savings
- Air Quality Improvements
- Creation of Habitat/Biodiversity
- Greenhouse Gas Sequestration
- Increase in Roof Lifespan
- Food Production
- Construction Jobs Created
- Maintenance Jobs Created

Types of Green Infrastructure

- Extensive Green Roofs
- Intensive Green Roofs
- Exterior Living Walls
- Interior Living Walls
- Green Facades
- Bioswales
- Rain Gardens/Bioretention
- Wetlands
- Planting Beds
- Small Trees
- Medium Trees
- Large Trees
- Naturalized Turf
- Active Turf
- Permeable Paving

As the green infrastructure cost-benefit matrix is an aggregate-level tool, it is not designed to analyze a specific project, but rather to start a discussion about green infrastructure's value, and set the stage for further study.

The results of the cost-benefit analysis will be conservative, because many of the benefits are not monetized. These include improved health, reduced need for and increased lifespan of grey infrastructure, and increased resilience in the face of climate change. All of these benefits could have an immense impact at a large scale. For more information about the green infrastructure cost-benefit matrix, including its methodology and limitations, see Appendix A.

Green Infrastructure Charrette

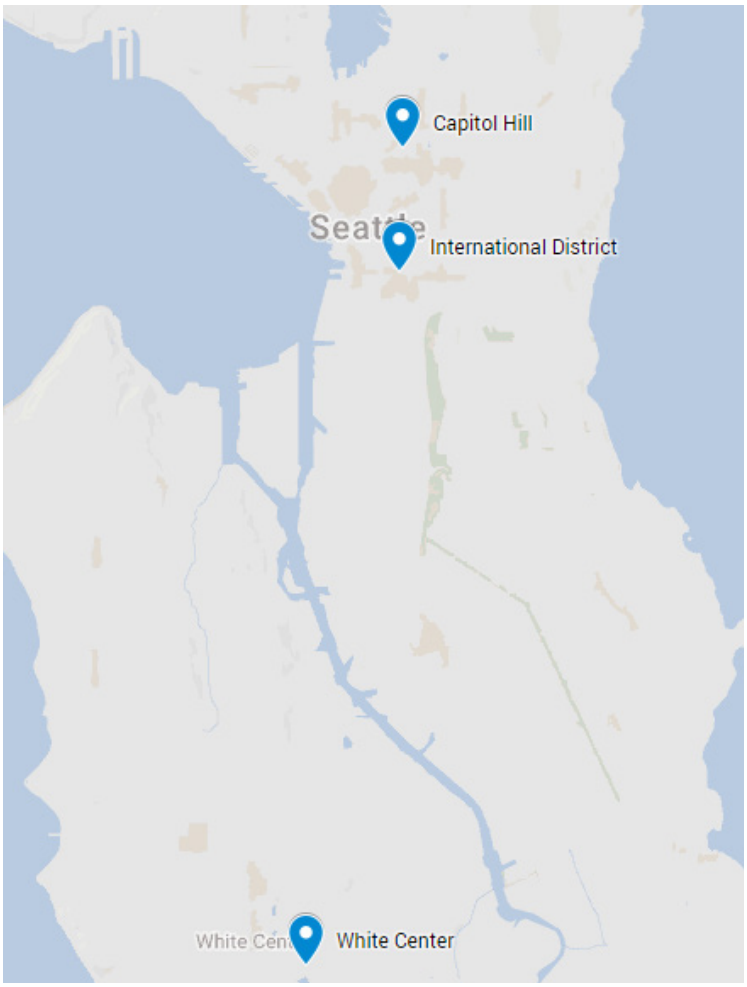
The Seattle Green Infrastructure Charrette brought together teams of interdisciplinary experts and local stakeholders. The participants were provided information about the site, including maps, photos, aerials, relevant policies, opportunities, and constraints. They were then tasked with creating conceptual plans for actual sites, using a menu of different green infrastructure technologies.

Following the charrette, the redesigns were then subjected to the cost-benefit matrix to conduct an aggregate economic analysis. The visuals and narratives created by the participants were combined with the economic analysis to develop this report. This charrette is an opportunity to

- Identify creative approaches that improve the quality of life and place
- Increase community cohesion
- Address inequities
- Reduce the amount of pollutants entering Lake Union and the Puget Sound

The ideas generated through the charrette will catalyze conversations with City and County officials, local residents and community partners about improving habitat functionality, increasing infiltration, reducing pollutants, improving stormwater, preventing displacement, increasing walkability and improving resident health and satisfaction.

Three sites in King County were examined - Summit and Belmont Avenues in Capitol Hill, Seattle; South Main Street in Seattle's International District, and the former King County Public Health Building and Lakewood park in White Center, which lies in unincorporated King County.



Summit and Belmont (Capitol Hill)

Size: Approx 7.5 acres

Site Description, Opportunities, and Challenges

Belmont and Summit Avenues between E Olive Street and E Howell Street are two mostly hidden and over-paved blocks in Seattle's Capitol Hill neighborhood. This area is home to many low-income people living in transitional or affordable apartment buildings. Both streets are very wide, dominated by parallel and back-in parking. The sidewalks are narrow and generally run from property line to curb, with no planting strip. Compared to other parts of the neighborhood, Belmont and Summit are notable for their shortage of vegetation and tree canopy. Due to the lack of greenery and permeable surface, very little stormwater is infiltrated in this two-block area, increasing the amount of pollutants that enter local surface waters.

Capitol Hill already has a good start on sustainable stormwater management; much of the neighborhood's stormwater runoff, including runoff from these two streets, is partially treated in a bioswale north of the

Summit and Belmont are both wide, over-paved streets lined with mid-high density buildings. They feature little green space and large areas devoted to car travel and parking, despite low levels of through traffic. There is an opportunity to reallocate space in a more sustainable and equitable manner.

site and across the interstate at the “Swale on Yale”, a bioswale project on Yale Avenue. However, a portion of the stormwater generated remains untreated and the stormwater released from the swale to Lake Union is not fully treated. When it rains, this water still flows across streets, collecting silts, oils, heavy metals and other pollutants before being piped downhill and into local water bodies.

Many of Capitol Hill’s most vulnerable residents call this area home. In this two-block area, there are seven low-income housing properties, including five buildings that provide transitional and permanent

There is a significant amount of medium density housing on site; the group proposed saving historical buildings of interest like the one picture at top. The low-rise building above is affordable housing owned by Capitol Hill Housing.

homes to people released from prison or jail and those in recovery from addiction. People living in this part of Capitol Hill have the highest use rate of food stamps in the neighborhood. 21 percent of area residents live in poverty with an average median household income of $35,965. This area has less tree canopy coverage than anywhere else in the neighborhood, according to a 2007 study by the City of Seattle. No other part of Capitol Hill is in greater need of greening than this small forgotten corridor. Green infrastructure could provide a restorative amenity for some of Capitol Hill’s lowest income and most vulnerable residents.

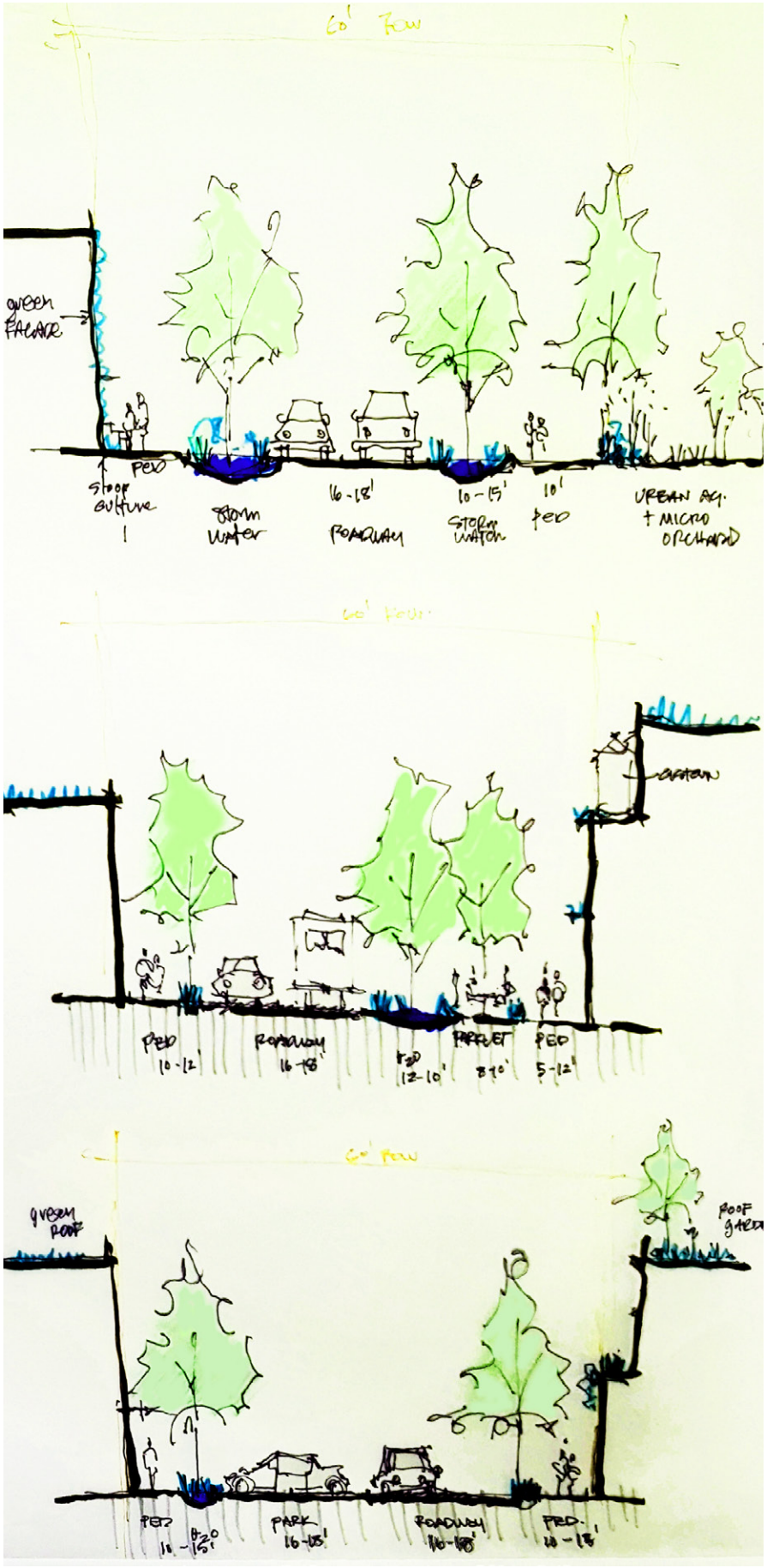
Goals

In 2016, over 50 people came to a Park(ing) Day installation on Summit Avenue to reimagine the street and in the spring of 2017, a college student developed

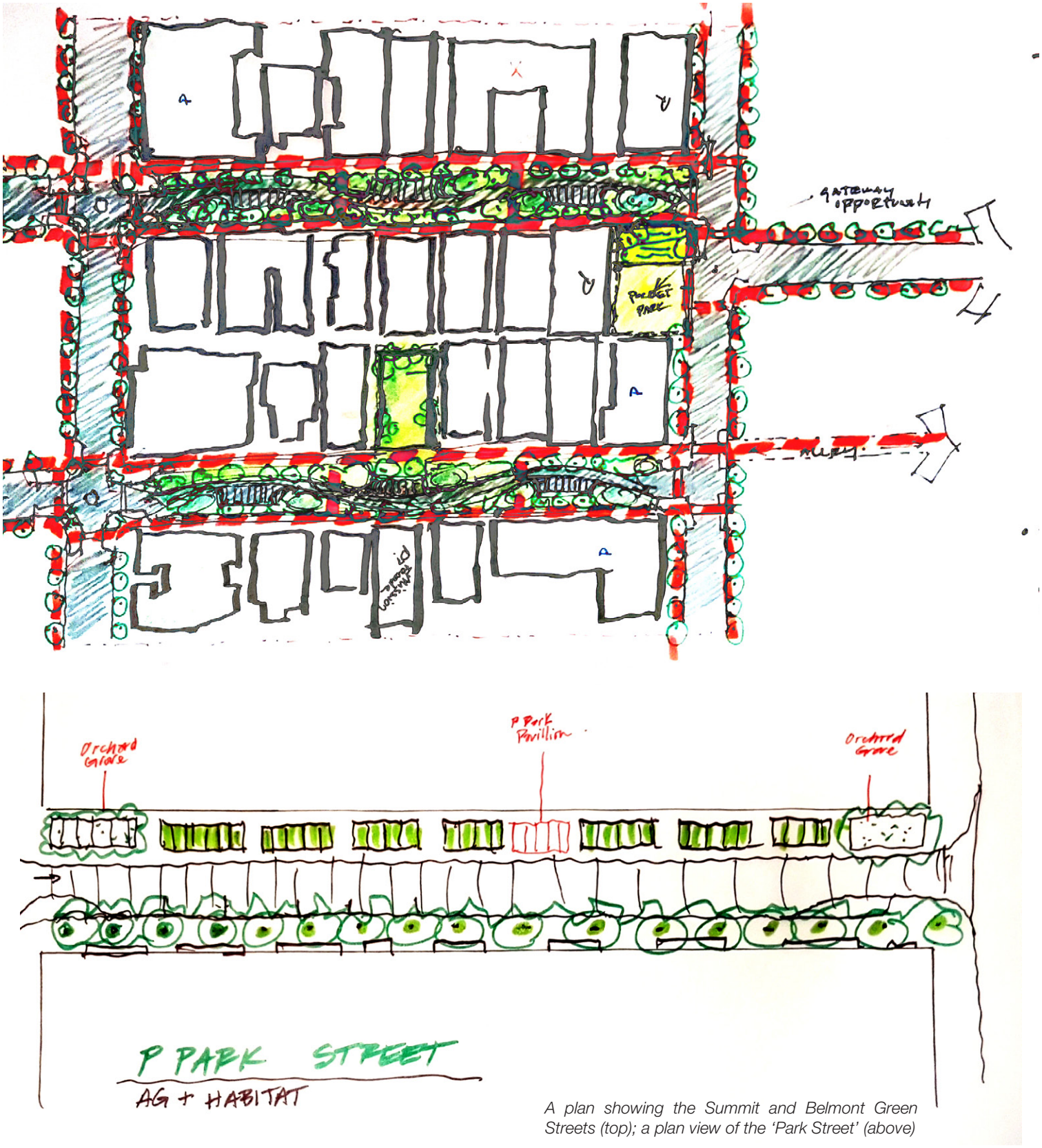
sidewalk improvement concepts for this area. Building off these efforts, charrette participants had a unique chance to explore opportunities for greening and improving site conditions in in this two-block area. These ideas will feed into a long-term effort, led by Capitol Hill Housing, to:

- Assess and identify strategies and suitable sites for greening and improvement. This may include depaving, narrowing the road on one or both sides, green stormwater infrastructure, rain gardens, tree plantings, and other natural elements.
- Develop an implementation plan and feasibility analysis for the selected site.
- Educate and involve area residents in conversations about their preferences, ways they might utilize and benefit from green infrastructure and street improvements, and work with them to prioritize which sites and strategies should move from concept to design.
- Pilot one or more habitat and/or green infrastructure initiatives in the area.
- Work with the City to develop a street improvement plan that does not rely on new development and displacement as the means for improvement.

The group identified buildings and sites that might be able to support extensive and intensive green roofs.



Section drawings for three possible right-of-way proposals



A plan showing the Summit and Belmont Green Streets (top); a plan view of the 'Park Street' (above)

Team members

- Rohan Lilauwala, Green Infrastructure Foundation (Facilitator)
- McCaela Daffern, Capitol Hill Housing
- Amy Waterman, Seattle 2030 District
- David Okada, Arup
- Jason King, Mithun
- Chris Guillard, CMG Landscape Architecture
- Melissa Torres, University of Washington

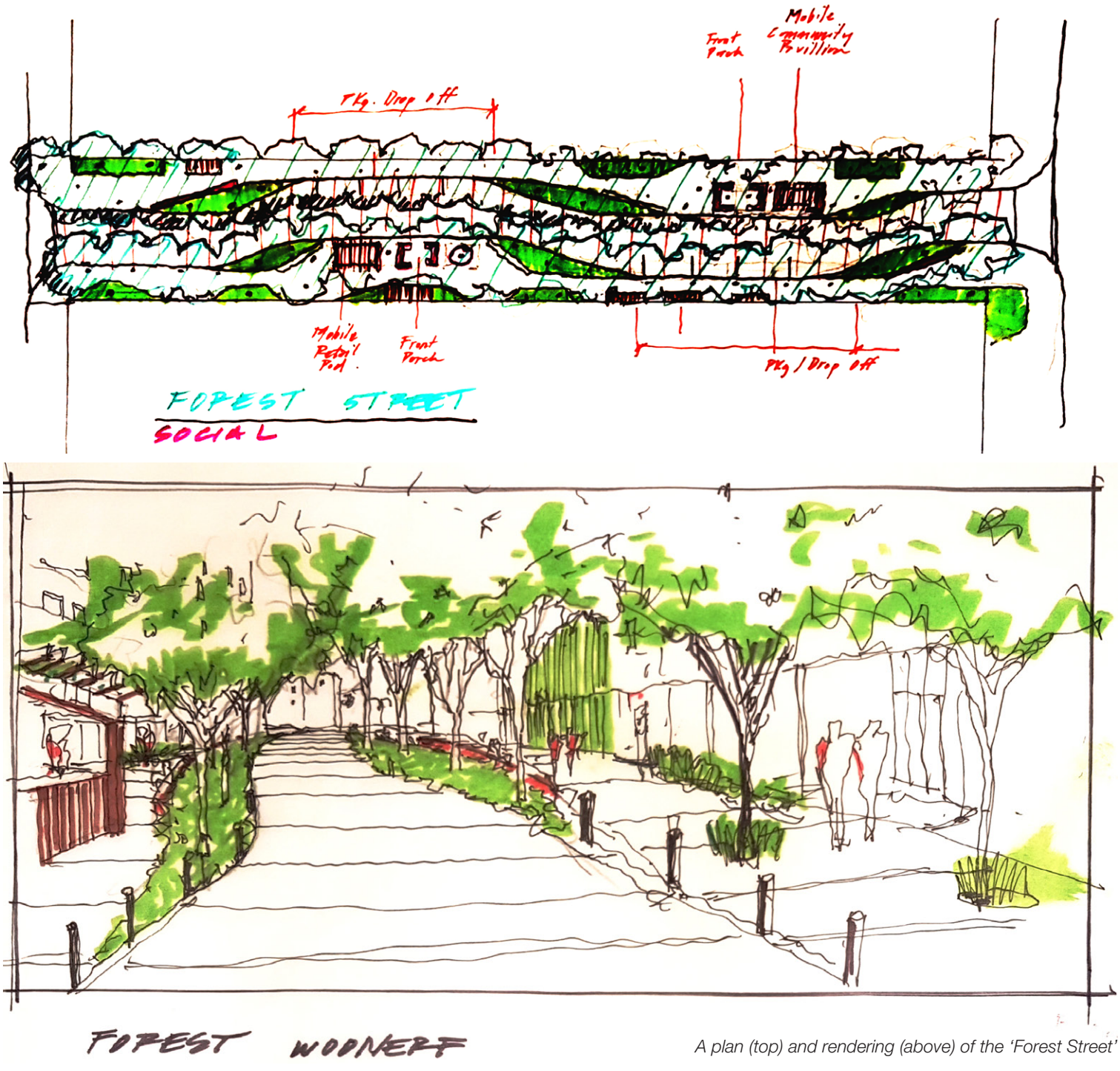
- Cathy Hillenbrand, Capitol Hill Housing
- Dana West, King County Wastewater Treatment Division

Strategy

The team focused its strategy on the idea of 'reimagining the right of way', by reclaiming space from cars for both people and the environment. Their key strategic goals fell under two broad themes that reflect this focus on both the environment, and on people:

Environmental quality and performance
- Dramatically increase planted areas
- Increase tree canopy coverage
- Use green infrastructure to manage stormwater
- Use plants that provide pollinator support

Social cohesion and inclusiveness
- Create an enhanced pedestrian environment
- Mitigate the impacts of gentrification



A plan (top) and rendering (above) of the 'Forest Street'

- Create links to workforce development, local jobs, and education
- Design for mobility and all ages

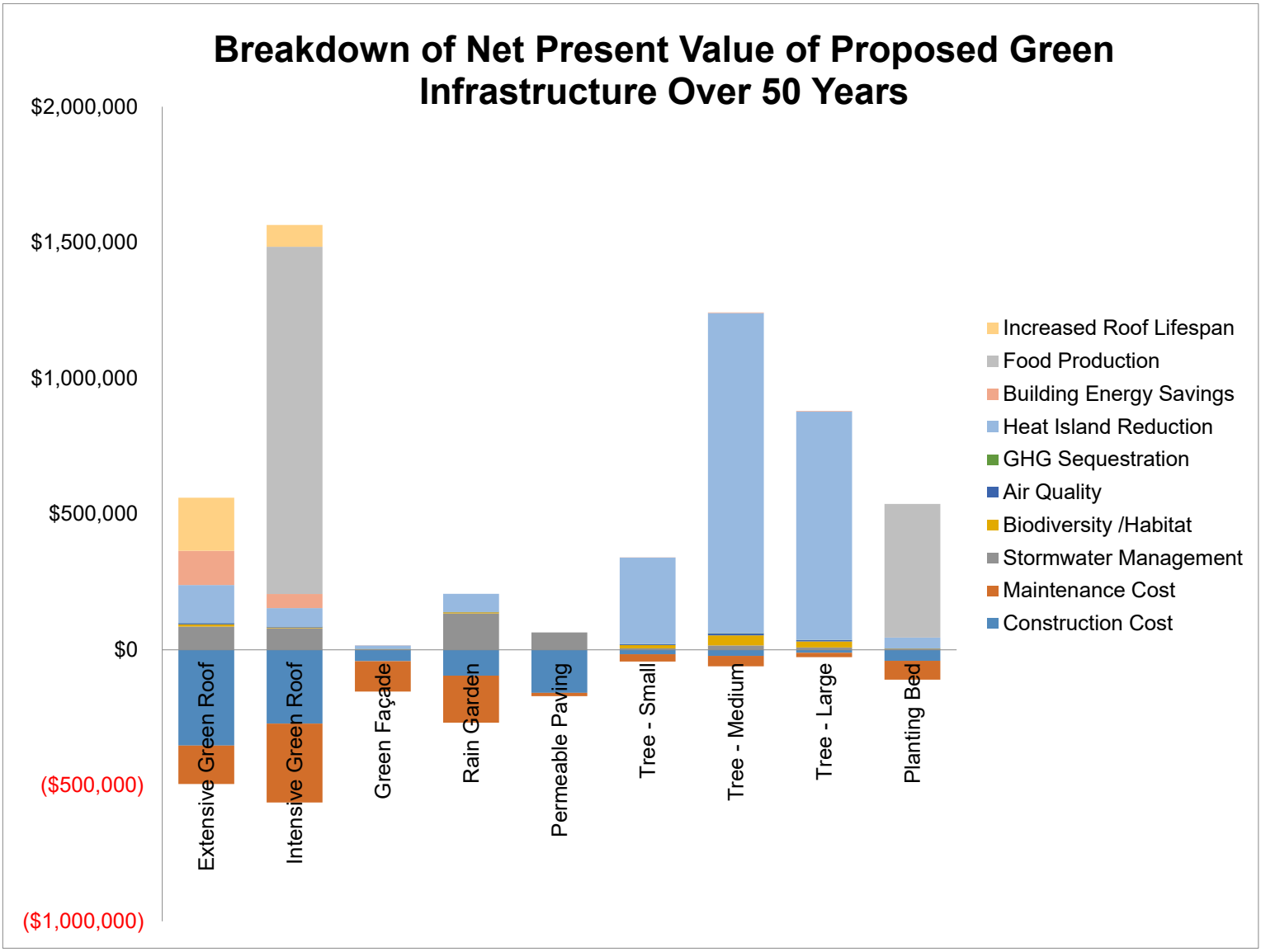
The team also articulated the idea of two distinct and complementary identities for Summit and Belmont streets: the 'Forest Street', featuring dense tree plantings, and the 'Community Street', featuring street-side plantings, food producing areas, and a more open feel.

Other key design interventions and details proposed for both streets were:

- Use chicanes and curves on the streets to slow down traffic
- Use plantings, trees, and other green infrastructure to define spaces
- Use plants that attract pollinators
- Reduce parking on streets, de-pave parking areas. This will have to be done incrementally to mitigate impact on residents and other stakeholders. First stage – reduce parking by 50%, incrementally reduce parking when opportunities present themselves, new developments have parking, etc. Establish loading zones. Conduct street use survey to determine parking/loading/delivery uses
- Bioretention to capture runoff from all impervious surfaces; sized at 6% of all impervious area
- Permeable paving in all pedestrian areas
- Intensive green roofs on all new buildings – 50% food producing
- Extensive green roofs on existing buildings where possible

Cost-Benefit Analysis

- Construction cost: $1.01 million
- Annual maintenance cost: $21,700
- One-time benefits: $88,400
- Annual benefits: $131,400
- Job-years (one job-year is one person employed full-time for one year) in construction: 17.9
- Job-years in maintenance: 0.4 annually
- Total job years over a 50 year period: 33.4
- Net Present Value (25 years): $1.55 million
- Net Present Value (50 years): $3.52 million
- Payback Period: 8.7 years
- See more information in Appendix



Net Present Value (NPV) and Jobs of Green Infrastructure on Site (over 50 years)

Type of Green Infrastructure	Area (sq. ft)	NPV of Costs	NPV of Benefits	NPV	Job-years (Construction)	Job-years (Maintenance)
Extensive Green Roof	19,000	($494,654)	$559,718	$65,064	6.23	2.50
Intensive Green Roof	7,800	($562,456)	$1,564,753	$1,002,297	4.80	5.13
Green Façade	3,000	($153,622)	$15,727	($137,895)	0.74	1.97
Rain Garden	9,000	($268,827)	$206,050	($62,776)	1.68	3.06
Permeable Paving	14,400	($170,749)	$63,870	($106,879)	2.80	0.22
Tree - Small	27 trees	($43,038)	$340,465	$297,427	0.29	0.47
Tree - Medium	38 trees	($60,670)	$1,242,395	$1,181,724	0.40	0.67
Tree - Large	18 trees	($27,175)	$879,472	$852,297	0.19	0.29
Planting Beds	3,000	($109,827)	$537,051	$427,224	0.71	1.22
TOTAL	**233,635**	**($1,891,017)**	**$5,409,500**	**$3,518,483**	**17.83**	**15.54**

Former King County Public Health Building and Lakewood Park (White Center)

Size: Approx 65 acres

About White Center

White Center is a unique community of approximately 32,000 people located primarily in unincorporated King County; bordering the City of Seattle and the City of Burien (a small suburban city). Annexation into the City of Seattle in future years is a possibility, but not a certainty. White Center has the distinct characteristics of an historic streetcar-era suburb, and has retained most of the original buildings constructed during 1912-1933. At the same time, due to a substantial amount of inexpensive, small commercial spaces and historic affordability of nearby housing, White Center has been a welcoming gateway for immigrants and refugees who arrived, settled, raised families, established businesses and grew social, cultural and religious institutions.

Market pressures in Seattle are affecting costs in communities near its borders, including White Center, and causing concerns for the stability of current residents.

According to the 2010 Census, White Center is comprised of almost 60% communities of color, largely Asian and Pacific Islander (24.4%), Latino (21.5%) and African American (8.6%).

About the Site

As part of a collaborative community-based project called Communities of Opportunity (COO), the White Center Community Development Association, King

An aerial view of the site

Hicklin Lake (top), and the rest of the park (below) are loved by the community, but could see their ecological function improve, and a stronger link forged to the surrounding educational institutions.

County and the Seattle Foundation are working with community-based partners to implement local priorities that are designed to improve community cohesion and improve health and well-being outcomes. The White Center COO partners are exploring the potential for building a community hub at the former site of the King County Public Health building. This property is now owned by the King County Department of Community & Human Services (DCHS). The County prioritizes surplus land for affordable homes and community benefits, and the County has prioritized the potential for this land to be a resource through COO. The COO partners have the opportunity to think broadly about creative ways to address community health and well-being through the property. The initial ideas being explored for the community hub includes a food bank and related food programs, social services and potential economic stability incubator, shared gathering space, and affordable housing options.

The site is located in a largely single-family residential neighborhood adjacent to a large park owned by King County Parks. King County DCHS and Parks are willing and able to work with each other and the partners to achieve public benefits. A middle school, high school and community recreation facility are located on the south side of the park.

A wetland reconnaissance study has identified critical areas as follows: The National Wetland Inventory (NWI) website shows two palustrine unconsolidated bottom, permanently flooded ponds. The larger pond is known as Hicklin Lake or Garrett Lake. No other wetlands are mapped in the vicinity. King County critical areas map shows a stream running/south just west of the property that has its origins about a half mile northwest of the property at the White Center Pond. The stream is culverted for much of its length, but flows above ground as it enters the park and flows into Hicklin Lake. There is apparently no outflow from the Lake except for a constructed overflow pipe. This watershed is considered part of the Salmon Creek

The Bethaday Community Learning Space is located on the East side of the park.

watershed despite the lack of a surface connection to the creek. Salmon Creek drains to Puget Sound. King County also maps a Category II wetland that includes the two ponds and some of the surrounding area. Hicklin Lake is shown by the Washington Department of Natural Resources to be a fish-bearing lake.

Existing vegetation on the parcel consists of a mix of native species, landscape plants, lawns and weedy species. Dominant native trees include Douglas-fir (Pseudotsuga menziesii), Western red cedar (Thuja plicata) and Pacific madrone (Arbutus menziesii). These edges are mostly present along the north half of the site, but also the east and west edges. The dominant native understory species are Salal (Gaultheria shallon) and Creeping blackberry (Rubus ursinus). The non-native Himalayan blackberry (Rubus armeniacus) is present throughout the site and forms a dense thicket along the fence on the west edge. Other weedy species include Scotch broom (Cytisus scoparius), Cherry laurel (Prunus laurocerasus), English ivy (Hedera helix) and English holly (Ilex aquifolium).

Goals

The community hub project partners envision a sustainable development with innovative approaches to green building and green stormwater infrastructure, as well as a development that integrates with the park physically and programmatically, and activates spaces that are currently dormant and overgrown.

Opportunities

Multiple King County Departments are supportive of the community hub project, increasing green infrastructure and working productively in a cross-sector manner. The Park is much-loved by the community, and there are opportunities to improve the ecology of the stream, lakes, and wetlands, as well as educational opportunities within that work.

Sidewalks and pedestrian infrastructure in the surrounding neighborhood could be improved, and integration with green infrastructure would be ideal.

Constraints

Multiple agencies have jurisdiction over the area: King County for building, site grading and storm water permits; water is provided by the City of Seattle, and sanitary sewer by the SW Suburban Sewer District.

The areas surrounding the park have poor pedestrian infrastructure, and could also use green infrastructure.

Team members

- David Yocca, Conservation Design Forum (Facilitator)
- Joel Sisolak, Capitol Hill Housing
- Cheryl Markham, King County Department of Community and Human Services
- Mary Ann Uhlmann, Urban Horticulture Consulting
- PJ Benanati, GGLO
- Annie Alsheimer, MIG|SVR
- Mark Ufkes, White Center Community Development Association
- Henk Ufkes, University of Washington
- Ellen Southard, SalmonSafe

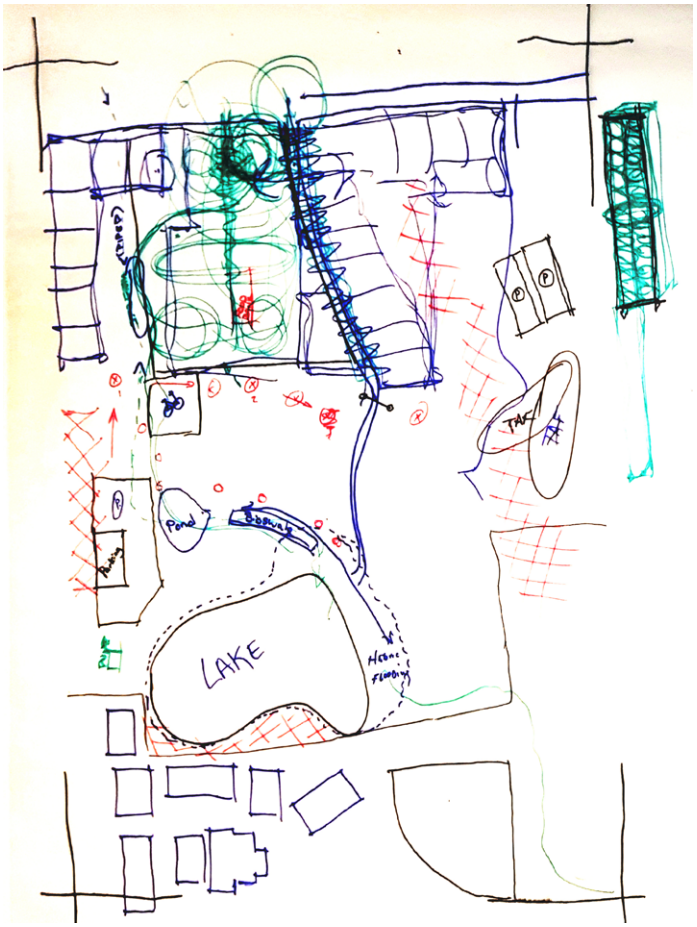
Strategy

The group established a number of principles that would inform their site plan, including:

- Manage all stormwater on site
- Improve health of the lake by addressing its ecology so it can be healthy for swimming and fishing
- Rethink access points for both biophilic and stormwater purposes
- Integrate systems connecting site and park
- Green roofs where possible, including agricultural uses
- Green jobs. E.g. urban farming, aquaponics, honey production
- Amend soil to increase water retention throughout park (incrementally)
- Engage the school as a partner and prioritize runoff from school and ballfields
- Net zero (positive) water (all water treated on site) and net zero waste on site - producing food on site and cleaning more water on site than is used
- Habitat improvements, both on site and as connected to nearby watersheds; consider SalmonSafe certification, support for pollinators, optimized habitat around lake
- Orient development to Park

In order to acheive these principals, the team proposed a number of interventions:

- Daylight stream to the west of site to create an eco-water corridor
- Orient housing and future development towards park
- Provide plaza or other public space fronting street
- Include new entry to lessen pressure on existing road: a green street with parking (50-60 cars), but with walkable environment
- Create flexible “parking lot” that can also be programmed; overflow parking to the south west with green canopy or permeable pavement
- Other building uses on opposite of new green street (woonerf concept that includes bike lane), 4 residential buildings to the south. All have green roofs
- Convert existing road (wide) to green street. Bioretention along edge. At end (where staff-only access begins), include bike and walk path
- Augment trail network from south of the development and incorporate school access to the park
- Greenhouse for both water treatment (living machine) and plant propagation at end of road, also featuring a native plant nursery
- Green roofs on schools
- Food forest/urban farm either adjacent to development and/or spread into the park.
- Cannot interfere with existing programming, like disc golf

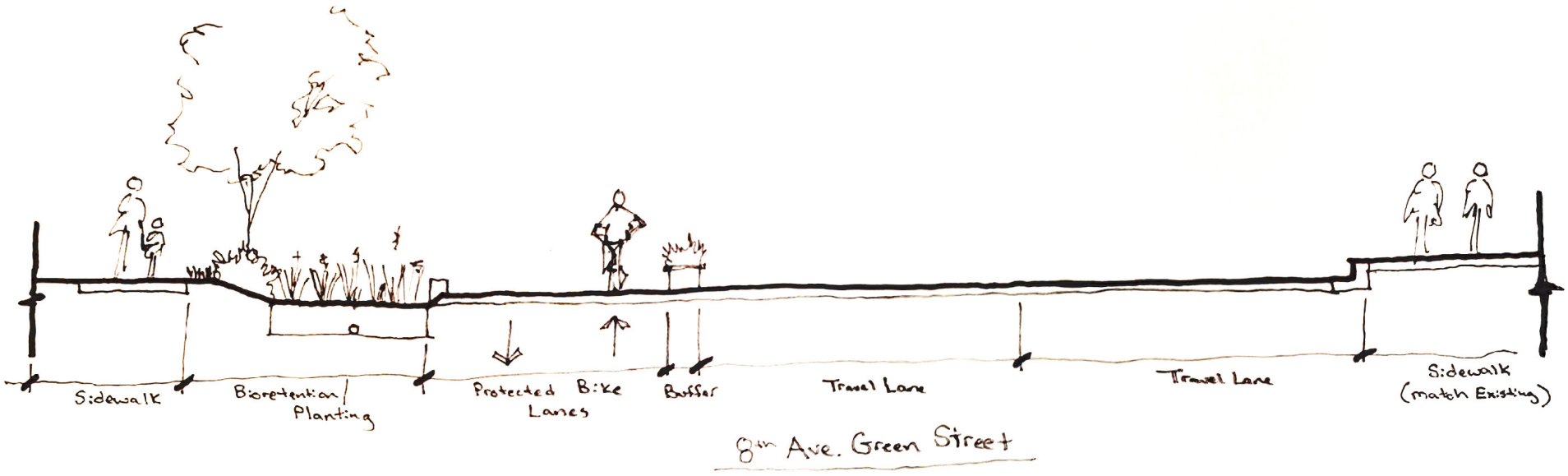


The group's initial conceptual plan

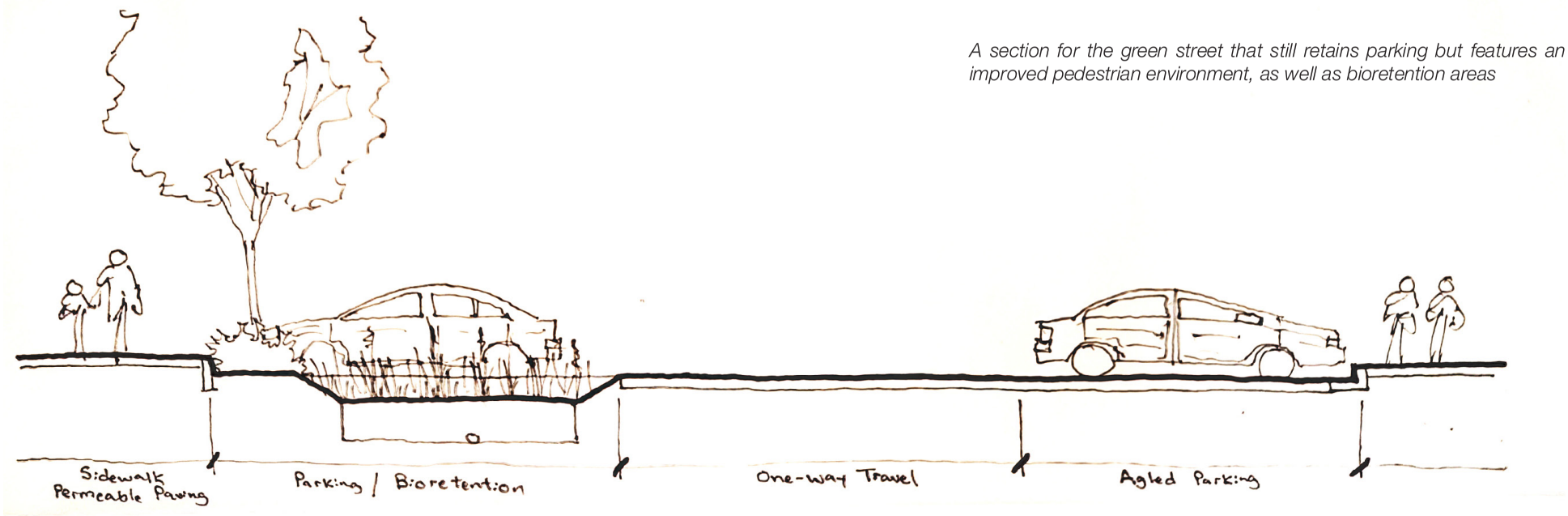
Cost-Benefit Analysis

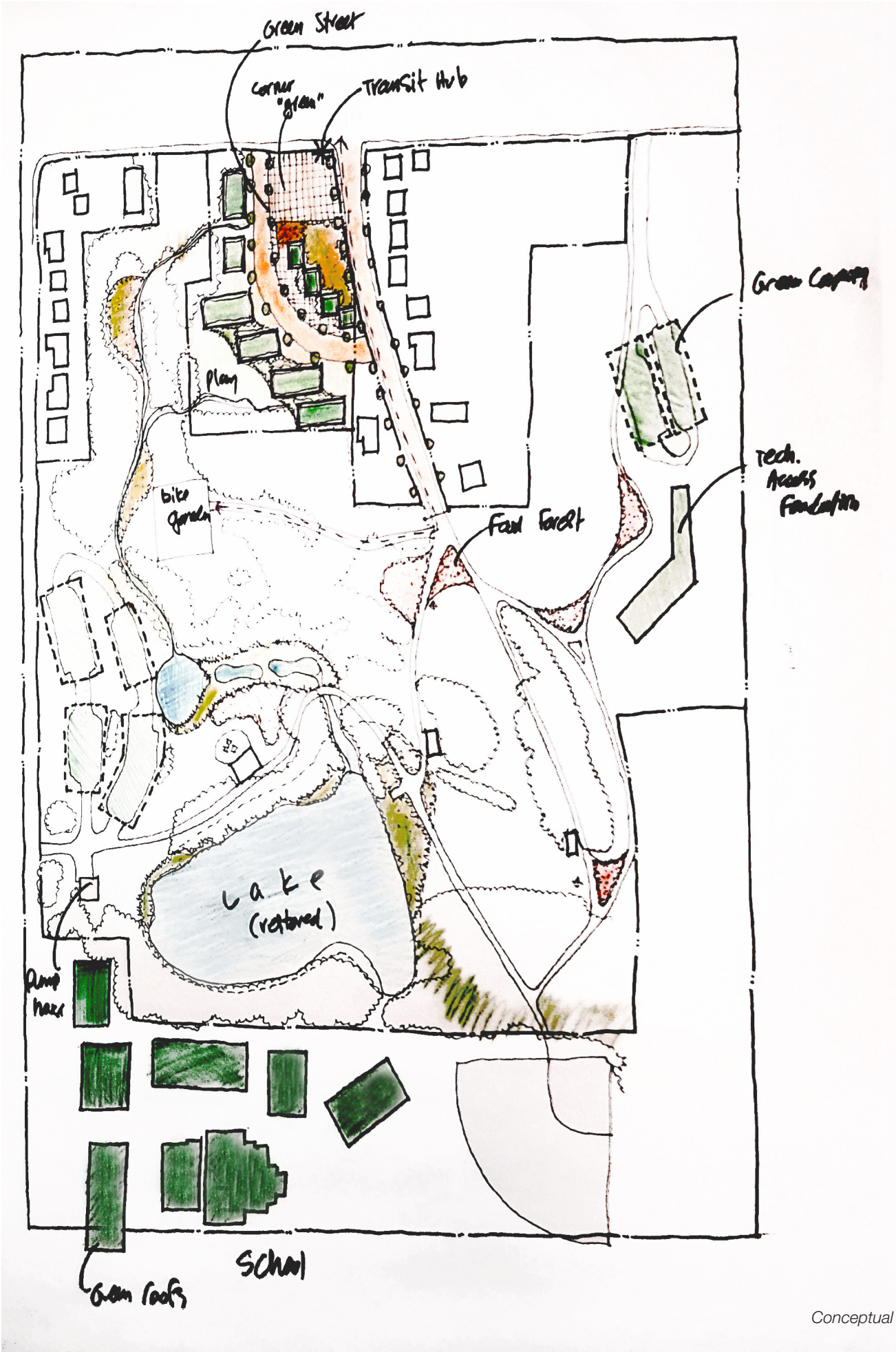
- Construction cost: $5.4 million
- Annual maintenance cost: $153,000
- One-time benefits: $219,700
- Annual benefits: $774,400
- Job-years (one job-year is one person employed full-time for one year) in construction: 96
- Job-years in maintenance: 2.7 annually
- Total job years over a 50 year period: 202.4
- Net Present Value (25 years): $8.8 million
- Net Present Value (50 years): $20 million
- Payback Period: 8.7 years
- See more information in Appendix A

A section for the proposed 8th Avenue Green Street

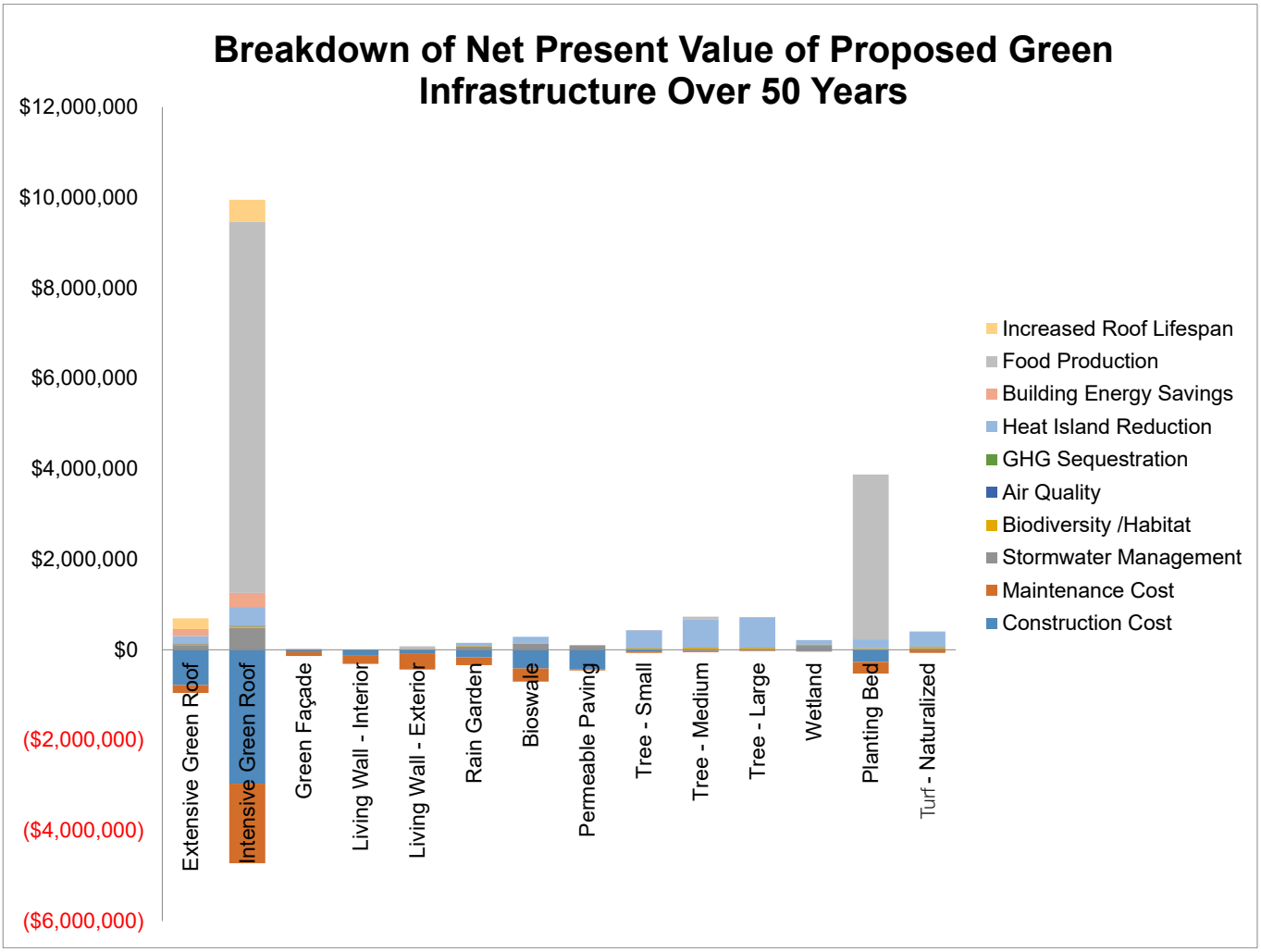


A section for the green street that still retains parking but features an improved pedestrian environment, as well as bioretention areas





Conceptual plan for the site



Net Present Value (NPV) and Jobs of Green Infrastructure on Site (over 50 years)						
Type of Green Infrastructure	**Area (sq. ft)**	**NPV of Costs**	**NPV of Benefits**	**NPV**	**Job-years (Construction)**	**Job- years (Maintenance)**
Extensive Green Roof	42,000	($1,093,447)	$1,237,272	$143,825	13.77	5.53
Intensive Green Roof	85,000	($6,129,325)	$17,871,782	$11,742,457	52.26	55.91
Green Façade	4,000	($204,829)	$20,969	($183,859)	0.98	2.63
Living Wall - Interior	400	($456,189)	$81	($456,108)	2.38	5.67
Living Wall - Exterior	800	($722,093)	$133,474	($588,619)	1.41	11.33
Rain Garden	16,000	($477,914)	$270,895	($207,019)	2.99	5.44
Bioswale	27,500	($942,408)	$509,131	($433,277)	7.28	9.35
Permeable Paving	40,000	($474,302)	$177,416	($296,886)	7.77	0.61
Tree - Small	60 trees	($95,641)	$756,589	$660,949	0.64	1.05
Tree - Medium	36 trees	($73,225)	$1,284,349	$1,211,124	0.48	0.81
Tree - Large	26 trees	($39,252)	$1,270,348	$1,231,095	0.27	0.42
Wetland	20,000	($51,657)	$380,805	$329,147	0.56	0.36
Planting Beds	20,000	($732,180)	$6,960,422	$6,228,242	4.76	8.16
Naturalized Turf	80,000	($122,532)	$697,052	$574,519	0.11	2.05
TOTAL	**593,359**	**($11,614,994)**	**$31,570,584**	**$19,955,590**	**95.67**	**109.30**

South Main Street, Japantown/International District

Size: Approx 24 acres

South Main Street from the I-5 freeway to 4th Avenue is a designated green street. A community garden and Kobe Terrace Park abuts the north side of South Main Street from the I-5 freeway for about one and a half blocks. A 6-10 foot blank retaining wall that separates the Garden from South Main stares down at the street. The community has longed for a public art piece(s) to inhabit this space. Two parcels on the south side of South Main Street from Maynard Avenue to 5th Avenue South will be developed within the next three to five years. An additional vacant parcel is being used by 'guerrilla' gardeners. InterIm CDA, a local Community Development Association based in Seattle's International District owns two properties - Nihonmachi and Hirabayashi Place - on this street. In addition, this street is in the Nihonmachi/Japantown part of the International District. The street slopes down from the I-5 on the east, to 4th Avenue on the west.

Opportunities

- South Main St. from 1-5 to 4th Ave. is a designated green street
- Existing community garden and park
- Upcoming redevelopment (2 current parking lots will be redeveloped within 3 years and another possibly within 5 years)
- InterIm ownership and management of the Danny Woo Community Garden, Nihonmachi Terrace, and Hirabayashi Place
- Leverage cultural assets in the Nihonmachi/Japantown part of the International District
- Other property owners may be interested in participating

Constraints

- 6-10 foot blank retaining wall deadens the street
- Limited retail in area
- I-5 freeway terminal point at the east side is a barrier to neighborhoods further east

Goals

- Environmental performance/green street as redevelopment occurs

An aerial view of the site; note the presence of I-5 on its eastern edge

The neighborhood has many existing assets including the Danny Woo Community Garden (top), and InterIm-owned properties Nihonmachi Terrace and Hirabayashi Place (above)

- Strengthen connections between park/community garden and street
- Increase pedestrian amenities and safety
- Advance social justice and equity for Asians, Pacific Islanders, immigrants, refugees, and low-income people
- Strengthen the cultural and social cohesion of Japantown and the International District

The parking lots in the neighborhood (above) will likely be home to new infill development in the next few years; the presence of I-5 along the site has left behind many forgotten spaces with potential for improvements (below)

Team members

- Blaine Stand, Green Roofs for Healthy Cities (Facilitator)
- Tom Im, InterIm CDA

The blank wall that abuts the Danny Woo Community Garden and Kobe Terrace Park offers opportunities for improvement (above); an illustration of the group's plan for green alleyways with permeable paving and utilization of rooftop space

- Steve Moddemeyer, CollinsWoerman
- Cheryl Markham, King County Department of Community and Human Services
- Joanne Rodriguez, Green Infrastructure Consultant
- Chuck McDowell, Mithun
- Kirstin Weeks, Arup

Strategy (Bento ~~Box~~ Blocks: Living Green for Japantown)

The Japantown neighborhood of Seattle's international district is an area underserved by open green space, stormwater infrastructure, and citizen agency protections. In an effort to make the neighborhood a safe, sustainable, and resilient community, Bento Blocks encourages a deep green infiltration with structures for stormwater management, community engagement, and workforce development and security.

The principles of the project are to:

- Improve and expand the available public space
- Maintain the cultural character of the neighborhood

Proposed view west on South Main Street, with the Danny Woo Community Garden on the right

- Create jobs and economic viability
- Enhance food security measures
- Improve local air quality and facilitate neighborhood cooling

This was accomplished by creating discrete pockets of essential services, green space, and self sustaining infrastructure systems such as water reclamation and on-site treatment. Each block has core community elements much like a bento box has individual meal servings. Neighborhood changes were made to unify nearby parks with a community underserved by green space, increase visibility to promote crime reduction, closing streets to establish greenways which support higher neighborhood engagement and improved public spaces, and bracket the defined community area with park spaces that serve double duty of water treatment, and public engagement areas. A number of discrete interventions were proposed:

- A Sustainable Living Center at the Danny Woo Garden featuring a community kitchen, classrooms, event space, roof garden with seating for meals, and resident information services
- Rainwater capture off I-5 freeway feeding an eastern integrated wetland park, a daylit stream running down a bioswale in the center of S Main St, and an aquaculture center at Jackson and 5th. This would use the natural topography of the site to create a stream
- Creation of a vegetated lid over the I-5 with a scenic overlook of Mt. Ranier, featuring tea plantings and coniferous trees, with a connection to inaccessible park spaces on the eastern side of I-5
- Securing air rights over the rail pits at the western end of the site to create deck parks with capacity for small sedum nurseries
- Utilization of rooftop space for public benefit, including green and solar roofs on all new constructions, stormwater capture to treatment and cisterns on existing buildings (with a disaster management strategy for maintaining potable water); pollinator support through local apiaries
- Creation of public arts and music spaces in pocket parks

These proposals would be supported by:

- Formula Business Restrictions to limit chain store

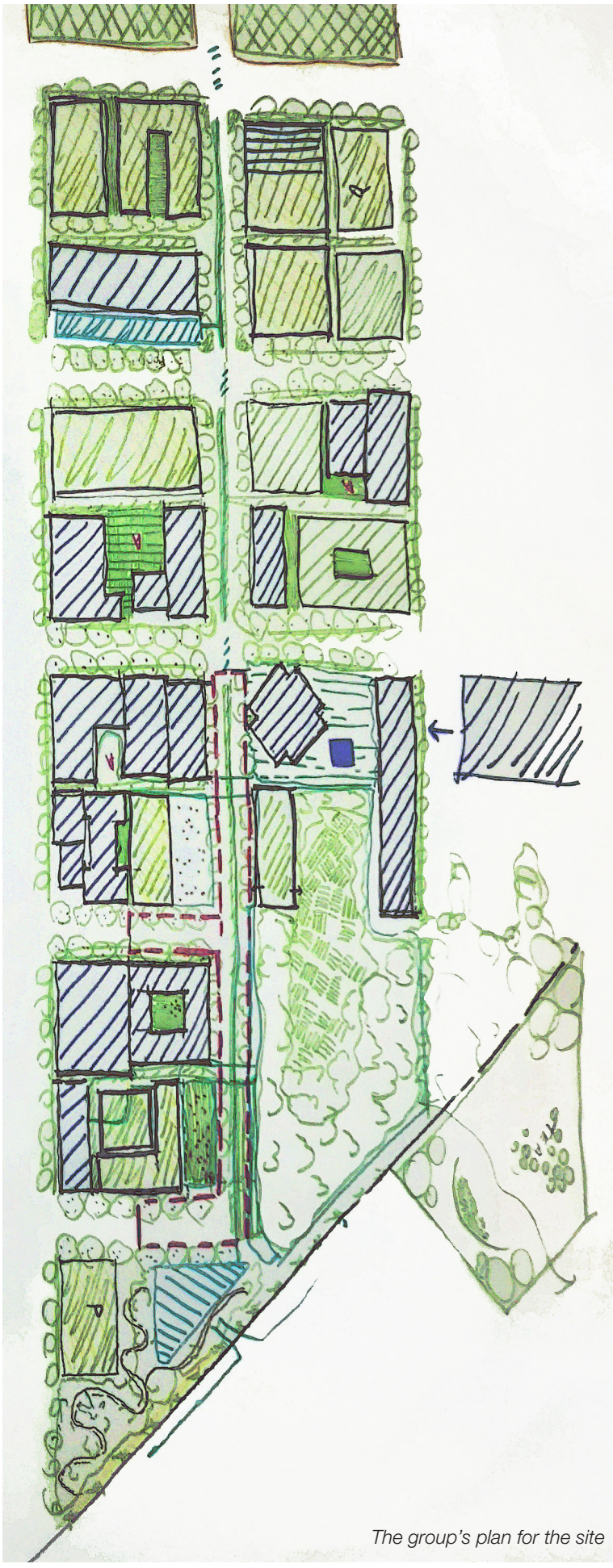
The planned lid over I-5 could be a unique community asset, like Freeway Park to the North

incursions
- Eviction Protection for residents
- Small Commercial Space requirements
- A required Green Factor of 1.0 for all public right of way
- Management assistance for small business spaces for lower rent
- Emergency drinking water measures for disaster relief
- Green roofs and façades
- Incorporation of arts/cultural elements
- Establishment of fruit trees in the public right of way, like persimmons, plums, cherries, and pears

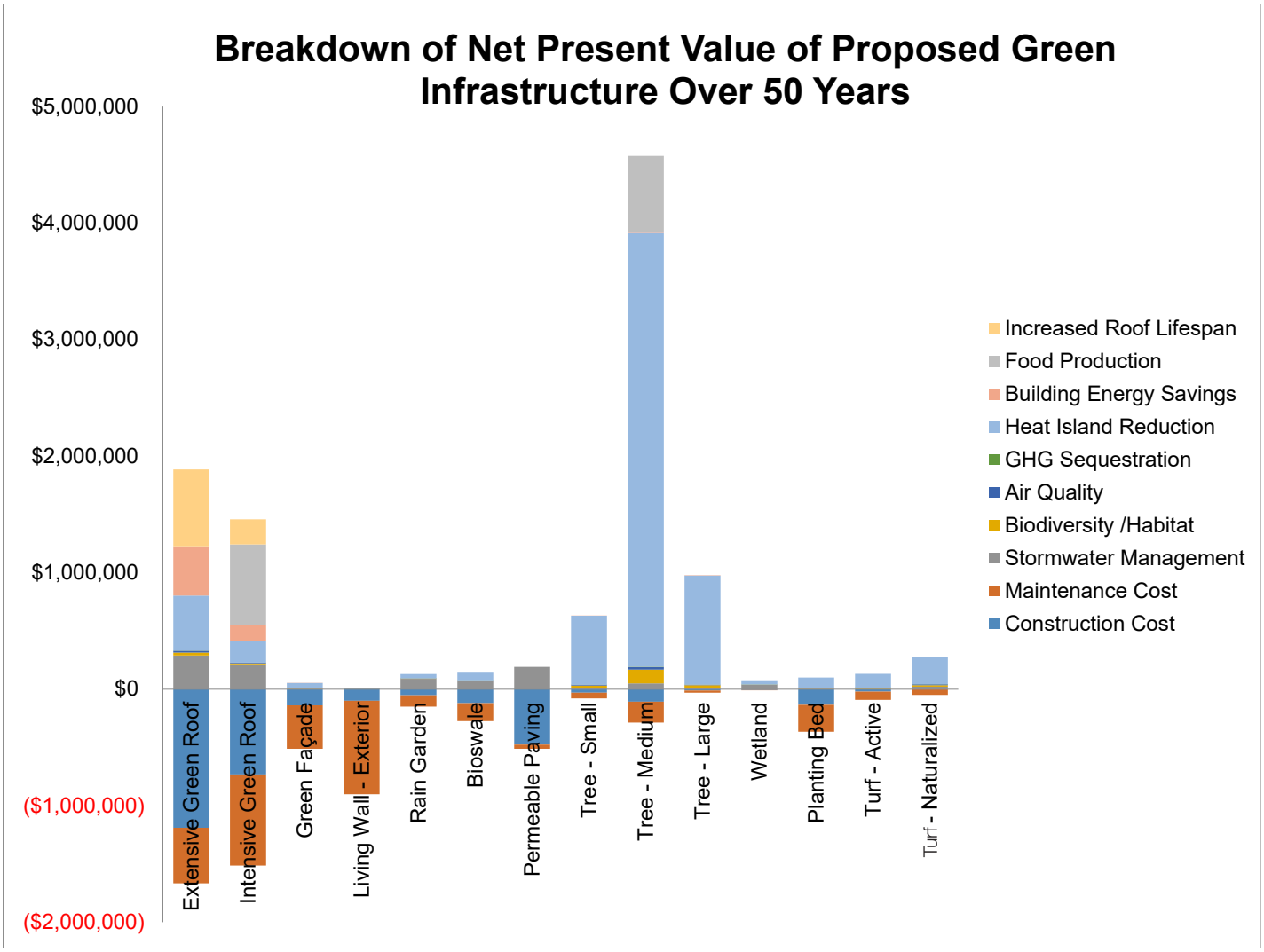
Cost-Benefit Analysis

- Construction cost: $6.4 million
- Annual maintenance cost: $82,000
- One-time benefits: $233,700
- Annual benefits: $257,000
- Job-years (one job-year is one person employed full-time for one year) in construction: 55
- Job-years in maintenance: 1.5 annually
- Total job years over a 50 year period: 113.8
- Net Present Value (25 years): $1.1 million
- Net Present Value (50 years): $4.2 million
- Payback Period: 17.8 years
- See more information in Appendix

Note: the cost-benefit analysis is limited to the green infrastructure component of the plan. Elements like building a lid covering I-5 are not included.



The group's plan for the site



Net Present Value (NPV) and Jobs of Green Infrastructure on Site (over 50 years)						
Type of Green Infrastructure	**Area (sq. ft)**	**NPV of Costs**	**NPV of Benefits**	**NPV**	**Job-years (Construction)**	**Job-years (Maintenance)**
Extensive Green Roof	64,000	($1,666,204)	$1,885,367	$219,163	20.98	8.42
Intensive Green Roof	21,000	($1,514,304)	$1,457,634	($56,670)	12.91	13.81
Green Façade	10,000	($512,072)	$52,424	($459,649)	2.46	6.58
Living Wall - Exterior	1,000	($902,616)	$5,690	($896,927)	1.76	14.16
Rain Garden	5,000	($149,348)	$129,381	($19,967)	0.94	1.70
Bioswale	8,000	($274,155)	$148,111	($126,044)	2.12	2.72
Permeable Paving	43,200	($512,246)	$191,609	($320,637)	8.39	0.65
Tree - Small	50 trees	($79,701)	$630,491	$550,791	0.53	0.88
Tree - Medium	120 trees	($287,386)	$4,576,314	$4,288,928	1.90	3.17
Tree - Large	20 trees	($30,194)	$977,191	$946,997	0.21	0.32
Wetland	4,000	($10,331)	$76,161	$65,829	0.11	0.07
Planting Beds	10,000	($366,090)	$100,128	($265,962)	2.38	4.08
Turf - Active	20,000	($92,612)	$131,823	$39,212	0.38	1.25
Tuf - Naturalized	32,000	($49,013)	$278,821	$229,808	0.04	0.82
TOTAL	**772,798**	**($6,446,272)**	**$10,641,144**	**$4,194,872**	**55.12**	**58.63**

Conclusion and Next Steps

The Seattle Green Infrastructure Charrette Project was the legacy project of the 15th Annual CitiesAlive Green Roof and Wall Conference, held in Seattle in September 2017. The project was an initial step towards conceptualizing and valuing green infrastructure in the Puget Sound region, to meet the goals of increased community cohesion, an improved sense of place, and improved equity. Underpinning all these goals is the aim to improve environmental performance and increase resilience to climate change impacts.

Despite its limitations, this project offers an opportunity for stakeholders to reconsider approaches to improvements of these communities. They could take the following steps:

- Incorporate green infrastructure benefits into more detailed cost-benefit analyses
- Identify strategies to increase benefits from green infrastructure in housing and other developments (e.g. using green roofs as event spaces, producing high value food products like micro-greens or honey, using green infrastructure to meet regulatory requirements or avoid other spending)
- Encourage long-term thinking when making decisions, for example, by considering the impact of climate change on any planned or existing infrastructure
- Capture other important benefits not incorporated into the cost-benefit analysis in this report
- While keeping in mind budgetary constraints, identify one or more design strategies and elements from the conceptual plans here for additional study, and implementation
- Identify sources of funding that do not contribute to gentrification or displacement pressures; these could include funding from RainWise or other grant programs, green infrastructure installation as part of right-of-way improvements, or community-led efforts that use volunteer labor and donated materials

By incorporating some or all of these recommendations, communities can use their limited resources to improve the efficiency of their infrastructure and receive a wider range of benefits from it. Green infrastructure also presents an opportunity to achieve environmental benefits and meet sustainability goals while cost-sharing with the private sector, reducing long-term costs for both sectors.

The flexible and decentralized nature of green infrastructure makes it an ideal part of a climate change strategy. This project hopes to advance that discussion and encourage stakeholders to think about how to move towards greener, healthier communities.

A greener future for the Puget Sound region

Appendix

Green Infrastructure Cost-Benefit Matrix (Background)

One of the challenges facing the greater utilization of green infrastructure is that society does not properly value the many benefits they provide. This lack of valuation means that green infrastructure is often not incorporated into decisions around investment or asset management.

The Green Infrastructure Cost-Benefit Matrix was developed to help policy makers and community leaders better understand the many costs and benefits associated with green infrastructure investment at an aggregate scale. It also provides a financial context and approximate values for the design work that emerged from the Charrette.

The values that the Matrix uses are averages, reflecting large-scale implementation, rather than project-specific values. Because of this, the goal of the cost-benefit analysis for the site redesigns is not so much about hitting the bullseye but rather about starting a conversation about the tangible benefits that green infrastructure can offer. The cost-benefit analysis aims to help spur and facilitate engagement with political leaders, community leaders and government officials in communities focused on the valuation of green infrastructure investments and future policy directions.

The Matrix is a unique and valuable tool that can help promote better infrastructure planning and investment. Monetizing the multi-dimensional benefits of green infrastructure is complex and challenging. These challenges can be addressed by conducting cost-benefit analyses at an aggregate level and focusing on dollars/square foot valuations.

While the lack of precision is an acknowledged limitation of the cost-benefit matrix, the **financial analysis of benefits provided is conservative.**

There are many limitations that must be taken into account when the plans and aggregate cost-benefit analyses are considered:

- Costs and benefits are on an aggregate basis, not a project basis, and are based on many assumptions and generalizations
- This is an extremely cautious analysis - all the costs (of the green infrastructure elements) have been included, but many important benefits (increased amenity space, health benefits, improved productivity, increased community cohesion, increased property value, etc.) have not been incorporated into the cost-benefit analysis
- Concepts were created with limited information, and may not be technically feasible (though many elements will be)
- The cost of conventional infrastructure was not considered - in many cases, a green approach will provide a multitude of additional benefits while also being more cost-effective
- The impacts of climate change and green infrastructure's ability to reduce vulnerabilities to its impact are not considered
- The fact that green infrastructure performance often improves over time is not factored into performance assessments

Despite these limitations, t0his project offers an opportunity for stakeholders to reconsider approaches to improvements of these communities.

The Green Infrastructure Cost-Benefit Matrix encapsulates a wide range of economic and biophysical research data tied to fifteen generic types of green infrastructure. The Matrix comprises the following components:

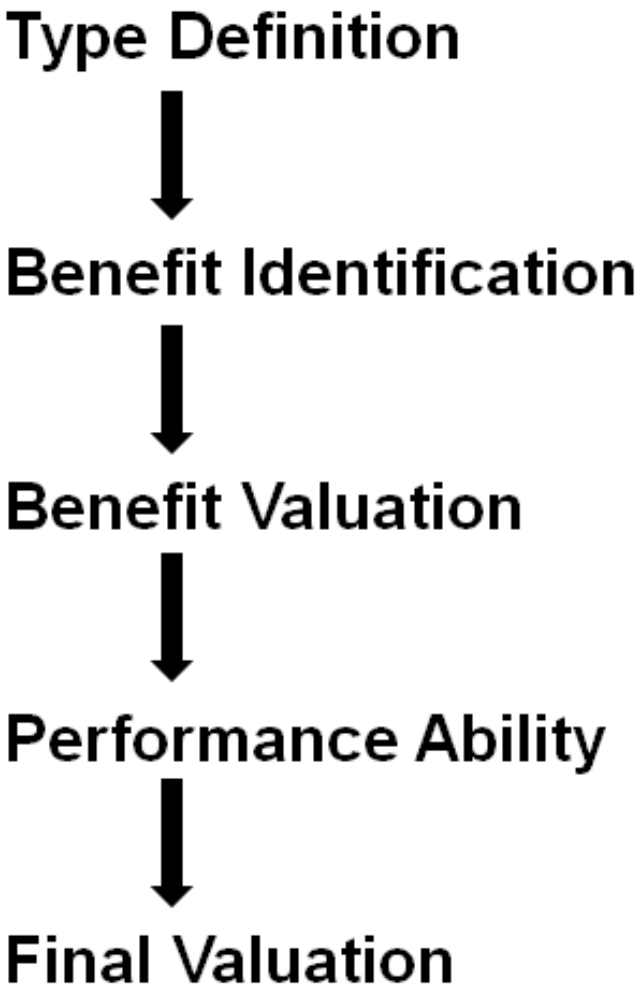
- Fifteen generic living green infrastructure types
- Two cost values per square foot derived from literature and peer reviews for capital and maintenance
- Ten benefit values for each type of generic green infrastructure
- Values for most costs and benefits are expressed in dollars per square foot of implemented green infrastructure
- Values for job creation are expressed in job-years (i.e. one job-year is equivalent to one person employed full-time for one year) based on the investment made
- Values are expressed as one time capital cost or benefit or an annual cost or benefit

The Matrix expresses most costs and benefits in dollars per square foot. This facilitates the ability to quickly provide aggregate estimates of significant green infrastructure deployment at various scales. Expressing monetary values in terms of area also provides the basis for calculating the cost and benefits of study area redesigns from the Charrette. For example, Charrette design teams may call for 1,000 square feet of extensive green roof to be developed. The area (1,000 square feet) provides the basis for estimating the resulting costs and benefits from the values ($/ft^2) in the Matrix.

For purposes of the Charrette, a cost-benefit analysis is provided that is on a first cost basis, at five years, at twenty-five years, and at fifty years.

The Matrix uses a real discount rate (after inflation) of

0.9%, the average after-inflation yield rate of 30 year US treasuries, as of February 2018. This is comparable to the Social Discount Rate used by many when measuring public investments with a long life-cycle. Monetary values presented in the literature have not been adjusted for currency differences or the impact of inflation except where it has been deemed that the gap in time has become too significant.



Cost-Benefit Valuation Methods

The Green Infrastructure Cost-Benefit Matrix is based on five stages of data aggregation and simplification, which are described below:

1. Type Definition

The first stage of aggregation involves the identification of commonly accepted generic green infrastructure types drawn from the literature. Each type is simplified. For example, vegetated buffer strips were added into the typology of 'Turf' based on their similar properties. While there are hundreds of species of trees with different properties, the categories small, medium and large are used – the area of the canopy at maturity is used in value calculations. There are several categories of wetland in the literature but only one is used.

This is justified because the Charrette is not focused on one project, such as a building or a proposed park, but on a much larger area. Furthermore, in order to be able to administer the Charrette in one day, and to derive average values, the types of green infrastructure had to be simplified. Site-specific design and cost-benefit evaluation would require a level of design detail and performance research more appropriate to a later stage.

The generic types of green infrastructure included in the Matrix are as follows:

- Green Roofs (Extensive and Intensive)
- Green Facades (Climbing vines)
- Living Walls (Interior and Exterior)
- Rain Garden
- Bioswale
- Permeable/Porous Paver
- Small, Medium and Large Trees
- Wetlands
- Planting Beds
- Turf (Active and Naturalized)

2. Benefit Identification

The second stage of aggregation concerns a comprehensive identification of benefits associated with green infrastructure that are quantifiable and non-quantifiable as seen in the literature. The values included in the Matrix cover a very wide variety of public and private costs and benefits. Some benefits are common to all green infrastructure types while others are only applicable to certain types. For example, active recreational turf will not provide habitat value.

A comprehensive listing of public and private benefits resulting from green infrastructure is as follows:

- Waste diversion
- Aesthetic improvement
- New amenity spaces
- Increased property value
- Increased rental income
- Increased retail sales
- Horticultural therapy
- Increased productivity
- Increased recreational activity
- Reduction of the urban heat island
- Energy efficiency
- Carbon sequestration
- Blockage of electromagnetic radiation

- Improved air quality (particulates and chemicals)
- Shading
- Stormwater management: quality and quantity benefits
- Noise/ sound reduction
- Improved soundscape
- Increased biodiversity (flora and fauna)
- Integrated water management
- Improved marketability of development
- Educational opportunities
- Increased membrane durability
- Increased pavement durability
- Reduced grey infrastructure capital costs
- Improved human health and well-being, (physical and mental)
- Fire retardation
- Local and regional job creation
- Enhanced photovoltaic panel performance
- Food production
- Biomass for energy production

Each of these benefits was evaluated according to its ability to be monetized. Only benefits that could be quantified and monetized were chosen for inclusion in the Matrix. It is however, a goal of the project to create a framework within which new benefits can be added as more research is published on quantitative data. Although all costs for green infrastructure can be quantified, not all benefits can be. The following costs and benefits are included in the Matrix at this stage in its development:

- Cost: Total Capital Investment
- Cost: Annual Maintenance
- Benefit: Annual - Stormwater Management
- Benefit: Capital - Biodiversity and Habitat
- Benefit: Annual - Increase in Air Quality
- Benefit: Annual - Green House Gas Sequestration
- Benefit: Annual - Reduction in Urban Heat Island
- Benefit: Annual - Reduction in Building Energy Use
- Benefit: Capital - Job Creation (Construction)
- Benefit: Annual - Job Creation (Maintenance)
- Benefit: Annual - Urban Food Production
- Benefit: Annual – Increase in Roof Lifespan

3. Benefit Valuation

The third stage of aggregation involves applying monetary values to performance. Average ecosystem, (biophysical) service values (such as gallons of stormwater retained) are monetized. The literature referenced utilizes a variety of market and non-market valuation techniques to accomplish this. These values vary considerably from community to community, particularly given the different regulatory and economic approaches to financing and operating grey infrastructure such as stormwater management and electricity production.

4. Performance Ability

The fourth stage of aggregation involves estimates of performance. Generic performance values were derived from the literature about green infrastructure ecosystem services performance. The exact performance of green infrastructure technology may vary, because it is a function of its design characteristics as well as its location. For example, a tree on the north side of a building will provide less energy savings than one located on the south side. A green roof can eliminate anywhere from 40 to 90% of the total stormwater runoff, depending on its design and the duration and frequency of the rainfall events in the region. Hence, further simplification is necessary in order to arrive at average cost and benefit values used in the Matrix.

5. Final Valuation

The fifth stage involves a combining of both the third and the fourth stages. Performance values (gallons of stormwater) are combined with monetary values ($/gallon retained) for the benefit in question. When combined, a final valuation for each benefit specific to each form of green infrastructure's performance is obtained. These values are presented in a range of high, medium, and low values due to ranges in performance as well as ranges in benefit valuation. High, medium, and low values were selected based on the unique characteristics of the Puget Sound region. For example, a Low value was chosen for energy savings, reflecting the reduced heating and cooling demand in the region.

During the Charrette process participants were asked to redesign neighborhoods using the fifteen generic types of green infrastructure used in the Matrix. This process involved exact scaled measurements to properly allow for cost-benefit analyses following the Charrette.

The results of the green infrastructure cost-benefit matrix analysis follow.

Cost-Benefit Analysis for Summit and Belmont (Capitol Hill)

Net Present Value and Jobs of Green Infrastructure on Site (over 50 years)							
Type of Green Infrastructure	**Area (ft²)**	**1 year**	**5 years**	**25 years**	**50 years**	**Job-years (Construction) (One-time)**	**Job-years (Maintenance) (Annually)**
Extensive Green Roof	19,000	($335,273)	($295,610)	($117,284)	$65,064	6.23	0.06
Intensive Green Roof	7,800	($263,069)	($241,395)	($143,950)	$1,002,297	4.80	0.13
Green Façade	3,000	($43,007)	($52,408)	($94,675)	($137,895)	0.74	0.05
Rain Garden	9,000	($91,079)	($88,275)	($75,668)	($62,776)	1.68	0.08
Permeable Paving	14,400	($157,131)	($152,153)	($129,768)	($106,879)	2.80	0.01
Tree - Small	27 trees	$3,244	$32,390	$163,431	$297,427	0.29	0.01
Tree - Medium	38 trees	$43,098	$155,905	$663,096	$1,181,724	0.40	0.02
Tree - Large	18 trees	$32,015	$113,283	$478,670	$852,297	0.19	0.01
Planting Bed	3,000	($37,133)	($31,009)	($3,473)	$427,224	0.71	0.03
TOTAL	**233,635**	**($848,335)**	**($559,271)**	**$740,379**	**$3,518,483**	**17.83**	**0.38**

Cost-Benefit Analysis for Former King County Public Health Building and Lakewood Park (White Center)

				Net Present Value and Jobs of Green Infrastructure on Site (over 50 years)			
Type of Green Infrastructure	**Area (ft²)**	**1 year**	**5 years**	**25 years**	**50 years**	**Job-years (Construction) (One-time)**	**Job-years (Maintenance) (Annually)**
Extensive Green Roof	42,000	($741,129)	($653,454)	($259,259)	$143,825	13.77	0.14
Intensive Green Roof	85,000	($2,564,779)	($1,147,315)	$5,225,708	$11,742,457	52.26	1.38
Green Façade	4,000	($57,343)	($69,877)	($126,233)	($183,859)	0.98	0.06
Living Wall - Interior	400	($143,070)	($174,083)	($313,523)	($456,108)	2.38	0.14
Living Wall - Exterior	800	($92,405)	($141,567)	($362,601)	($588,619)	1.41	0.28
Rain Garden	16,000	($164,274)	($168,509)	($187,550)	($207,019)	2.99	0.13
Bioswale	27,500	($402,264)	($405,337)	($419,151)	($433,277)	7.28	0.23
Permeable Paving	40,000	($436,476)	($422,646)	($360,467)	($296,886)	7.77	0.01
Tree - Small	60 trees	$7,210	$71,978	$363,180	$660,949	0.64	0.03
Tree - Medium	36 trees	$37,330	$153,621	$676,477	$1,211,124	0.48	0.02
Tree - Large	26 trees	$46,243	$163,630	$691,412	$1,231,095	0.27	0.01
Wetland	20,000	($14,810)	$19,267	$172,479	$329,147	0.56	0.01
Planting Bed	20,000	($93,862)	$532,489	$3,348,611	$6,228,242	4.76	0.20
Naturalized Turf	80,000	$39,344	$92,366	$330,754	$574,519	0.11	0.05
TOTAL	**593,359**	**($4,580,286)**	**($2,149,438)**	**$8,779,837**	**$19,955,590**	**95.67**	**2.70**

Cost-Benefit Analysis for South Main St (International District)

Net Present Value and Jobs of Green Infrastructure on Site (over 50 years)							
Type of Green Infrastructure	**Area (ft^2)**	**1 year**	**5 years**	**25 years**	**50 years**	**Job-years (Construction) (One-time)**	**Job-years (Maintenance) (Annually)**
Extensive Green Roof	64,000	($1,129,339)	($995,739)	($395,062)	$219,163	20.98	0.21
Intensive Green Roof	21,000	($706,715)	($642,313)	($352,756)	($56,670)	12.91	0.34
Green Façade	10,000	($143,357)	($174,693)	($315,582)	($459,649)	2.46	0.16
Living Wall - Exterior	1,000	($119,292)	($196,335)	($542,725)	($896,927)	1.76	0.35
Rain Garden	5,000	($50,231)	($47,233)	($33,752)	($19,967)	0.94	0.04
Bioswale	8,000	($117,022)	($117,916)	($121,935)	($126,044)	2.12	0.07
Permeable Paving	43,200	($471,394)	($456,458)	($389,305)	($320,637)	8.39	0.02
Tree - Small	50 trees	$6,008	$59,982	$302,650	$550,791	0.53	0.02
Tree - Medium	120 trees	$114,809	$528,352	$2,387,674	$4,288,928	1.90	0.08
Tree - Large	20 trees	$35,572	$125,869	$531,855	$946,997	0.21	0.01
Wetland	4,000	($2,962)	$3,853	$34,496	$65,829	0.11	0.00
Planting Bed	10,000	($134,332)	($147,373)	($206,006)	($265,962)	2.38	0.10
Turf - Active	20,000	($12,477)	($7,356)	$15,668	$39,212	0.38	0.03
Tuf - Naturalized	32,000	$15,738	$36,946	$132,302	$229,808	0.04	0.02
TOTAL	**772,798**	**($2,714,996)**	**($2,030,413)**	**$1,047,523**	**$4,194,872**	**55.12**	**1.45**


GREEN
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Capitol Hill
Housing


INTERIM CDA


King County
Department of Natural Resources and Parks
Wastewater Treatment Division


ARUP


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GGLO
DESIGN


M I G
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