Low Impact Development for Stormwater on Waterfront Brownfield Sites

An Overview of Charrette Findings

Earth Day - April 22, 2008

Washington State Department of Ecology | Port of Bellingham | Chris Webb | Sustainable Connections | Christensen Design Management | CDM | Mithun

Funding Provided By

Washington State's Department of Ecology
through the Port of Bellingham

"This product was funded by the Washington State Department of Ecology. While these materials were reviewed by the Department, this does not necessarily constitute an endorsement"

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Publication Date

August 2008

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In an effort to preserve and restore water quality

in the Puget Sound and elsewhere, sustainable, Low Impact Development (LID) stormwater management strategies are being tested and proven. Waterfront Brownfield sites offer unique LID challenges that require a particularly thoughtful approach. Currently few resources exist to help designers, developers and regulators consider options. This guide for Low Impact Development for Waterfront Brownfield Sites (LID-WBS) was created following a charrette held in Bellingham, WA that benefited from the attendance of designers, engineers, regulators, developers, and other key stakeholders. The charrette and this guide were funded by the Washington State Department of Ecology.

Existing structures along Bellingham Bay

Why this Charrette was Important for the Puget Sound

Waterfront brownfield sites offer a tremendous opportunity for redevelopment for housing, commercial, civic, recreation, environmental restoration, economic development and more. This LID-WBS guide draws on charrette participants' experience in the Puget Sound region to find locally relevant issues and solutions.

The Bellingham Waterfront District was used as a touchstone site to create this guide. The site is currently in early design and clean-up, and is facing many constraints and opportunities typical of waterfront brownfields in Puget Sound.

The population pressures on the Puget Sound are increasing as more people move into the region. Figure 2-03 shows the relationship between population growth and increase in impervious surface between 1990-2001.

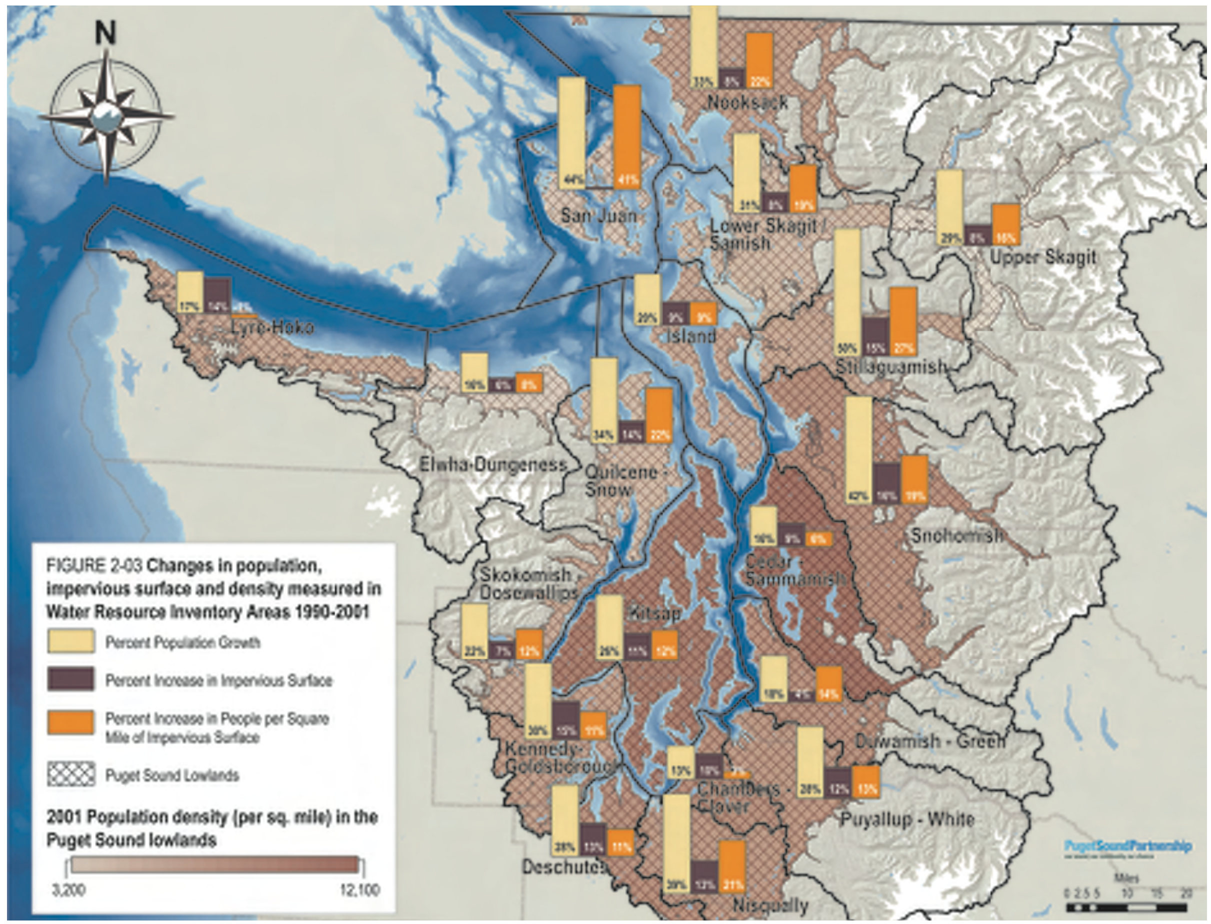


Image Courtesy of the Puget Sound Partnership

"We look out right now and it looks absolutely gorgeous, and that, my friends, is what too many of our citizens see, is how gorgeous it looks from the surface." *Governor Christine Gregoire*

"Beneath it, in some parts it is dying and in many places it's sick." *Governor Christine Gregoire*

According to the Puget Sound Partnership, on the surface, Puget Sound still looks terrific; yet underneath there are alarming signals that the ecosystem is in trouble. We must take action now to prevent irreversible decline.

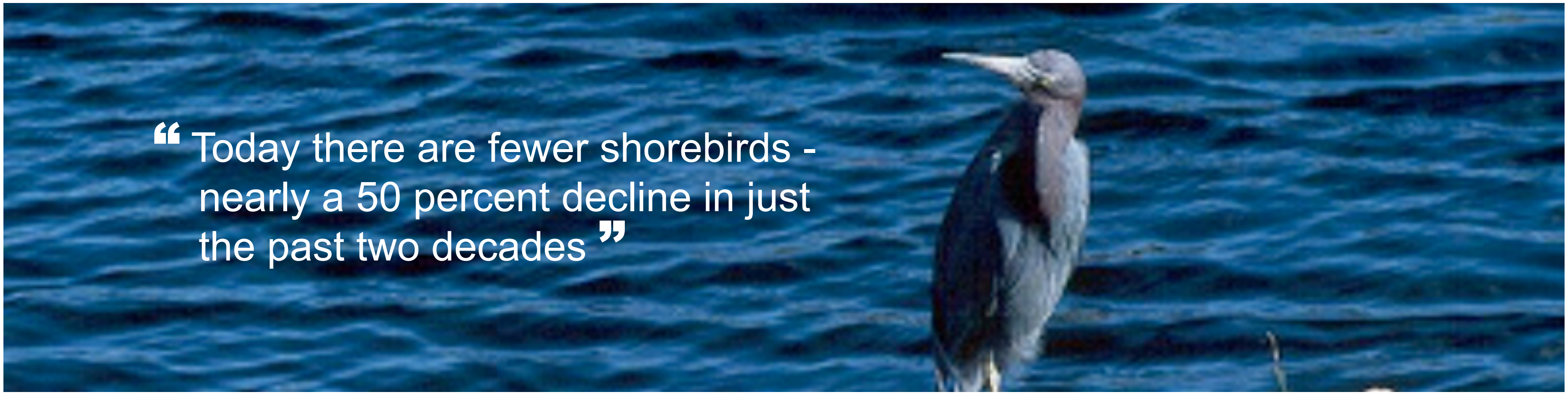
Among the many Puget Sound species listed as threatened or endangered are orcas, otters, steelhead trout, salmon, bull trout, albatross, pelicans and sea turtles.

Thousands of acres of commercial shellfish beds are closed because the clams, mussels and oysters are unsafe for us to eat.

The Washington State Department of Health keeps a list of Puget Sound beaches that are not safe for swimming because they are contaminated with bacteria.

In Hood Canal, there are dead zones (areas without enough oxygen in the water to support life) with signs that new dead zones are emerging in other parts of the Sound.

Historically, point source pollution has received the majority of attention as the contributor to the decline in water quality. However, non-point source pollution now requires as much attention. Improving management of stormwater so that water quality, habitat and aquatic resources are protected is one of eight key objectives established in law for the Puget Sound Partnership's 2020 Action Agenda.



A Brief History of Bellingham's Waterfront District

Bellingham's current waterfront is made up of land forms created by filling tidal flat areas. Before this filling occurred, the beaches and nearshore areas were used by Native American tribes for fishing and shellfish seasonal encampments and areas for harvesting. For more than the last 100 years, Bellingham's waterfront has served the regional economy as a thriving industrial area, transportation gateway and home to many maritime activities. Change began to occur in the early 1900s when the Whatcom Creek federal waterway was established and silt from the dredged waterway was used as fill along parts of the waterfront. In the years after, Pacific Coast Paper Mills and Puget Sound Pulp and Timber were founded and operated as major employers on the waterfront.

Through the 1930s and 40s, the Bellingham waterfront saw major activity related to the pulp mill and the production of ethyl alcohol (a by-product from pulp mill waste). In the early 1960s, Georgia-Pacific acquired the waterfront mill site. Operations continued through the following decades, during which industrial activities contaminated adjacent waterways and upland properties before more stringent laws were put in place. In 1999, Georgia-Pacific closed its chemical plant signally a slow decline that continued until the Bellingham facility closed permanently on December 21, 2007.

The site has supported many other industrial uses over the years, including shipyards, landfills, seafood processing, rock crushing, bulk fueling, etc, which all contributed to contamination.

There are seven state-listed clean up sites within the Waterfront District. Each of these sites has been studied extensively and is being scheduled for clean up according to strict state standards implemented by the Washington State Department of Ecology.

Mixed Commerical Uses Along the Whatcom Waterway | Photo by MITHUN

What is a Brownfield?

A brownfield is defined by the US EPA as real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant.

What is Low-Impact Development?

The Puget Sound Action Team/WSU Pierce County Extension defines Low Impact Development (LID) as a stormwater management strategy that emphasizes conservation. It stresses the use of existing natural site features integrated with distributed, small-scale stormwater controls more closely to mimic natural hydrologic patterns in residential, commercial, and industrial settings.

What is LEED-ND?

The Leadership in Energy and Environmental Design (LEED) for Neighborhood Development (ND) Rating System is a project of the US Green Building Council. It integrates the principles of smart growth, urbanism and green building into the first national system for neighborhood design. LEED certification provides independent, third-party verification that a development's location and design meet accepted high levels of environmentally responsible, sustainable development.

Former Mill Site Log Storage Pond| Photo by MITHUN

Stormwater Management Constraints and Opportunities

Historical Management Approaches to Stormwater

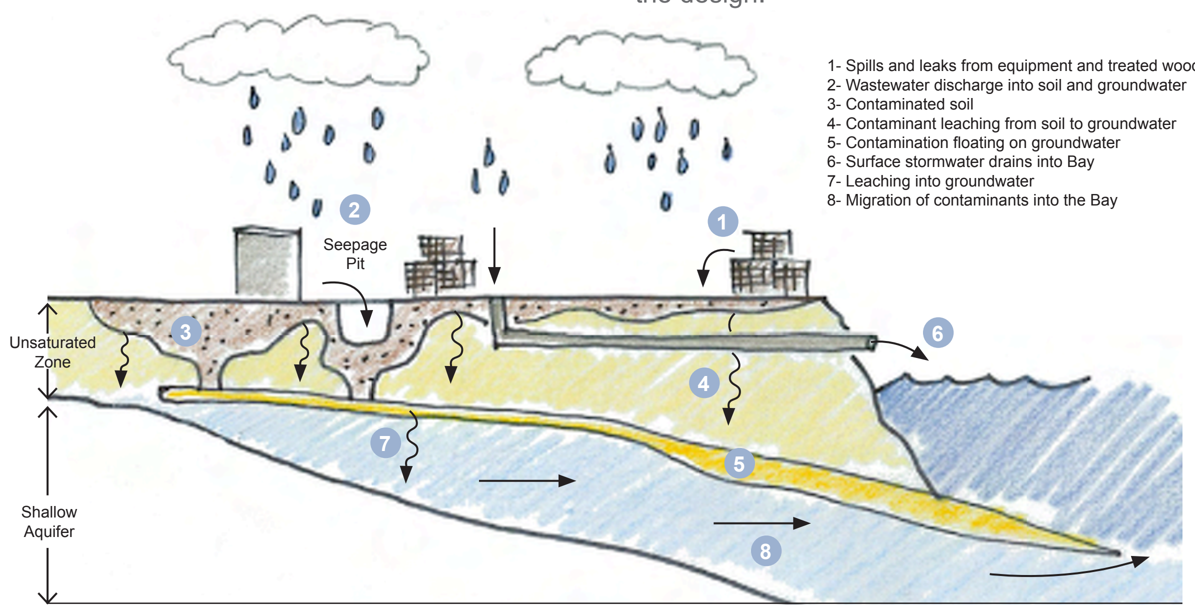
Stormwater management practices seek to control the negative environmental impact of stormwater from development in terms of water quality and water quantity. Typical native forest conditions in Puget Sound are able to return up to 40% of the rainfall back to the atmosphere through evapotranspiration. The forest soils are able to hold and slowly infiltrate a significant portion of the remaining rainfall; therefore, leaving a very small portion of the rainfall to become surface run-off. When land is developed, vegetation is removed and soils are covered with impervious surfaces such as pavement and buildings. This condition dramatically increases the amount of stormwater becoming surface run-off, reduces the amount of stormwater that enters the ground, and decreases the quality of the water leaving the site by allowing pollutants to enter. The impact of these changes are typically borne most directly by streams, wetlands, and other water bodies that provide critical habitat for threatened species of fish and other organisms.

Historically, stormwater was not very regulated, and until the early 1990's, very little was required in the Puget Sound region in the way of mitigation for water quality or quantity for development projects. While some pollution controls had been required of industry since the 1972 Clean Water Act, it was really not until the 1990's that stormwater began to be addressed in a significant way.

What are the regulatory requirements?
The current regulatory document that applies to most waterfront brownfield sites in Western Washington State is the current edition of the *Washington State Department of Ecology Stormwater Management Manual for Western Washington*, February 2005 Edition. This document requires that newly developed sites or a site that undergoes significant redevelopment will control water quality utilizing certain "Best Management Practices" (BMPs). The goal is to control stormwater quantity to levels approximately similar to what existed in pre-settlement times, typically considered to be old growth forest conditions.The manual provides an exemption from water quantity requirements for projects that drain directly to exempt water bodies, such as Puget Sound, but does require full water quality requirements to be met in all cases. Most if not all waterfront brownfield sites will be adjacent to Puget Sound or other large exempt water body and, as such, would typically qualify for the flow control exemption.

There are two water quality treatment standards: basic and enhanced. Basic treatment is required on all sites, whereas enhanced treatment is only required for commercial, industrial, multi-family and high traffic roads that drain to fish-bearing streams and lakes, or to waters or conveyance systems tributary to fish-bearing streams or lakes. Certain industrial uses will require a Stormwater Pollution Prevention Plan (SWPPP). The plan would provide source control of pollutants on-site and during construction. It requires erosion control measures to be implemented to prevent silty water leaving the site during construction.

In summary, the primary stormwater system design regulations that would apply to most waterfront brownfield sites are 1) control water quality during construction; 2) implement source control at industrial sites; and 3) provide basic water quality treatment for all pollution-generating impervious surfaces, such as roads and parking lots. Waterfront brownfield sites typically take many years to develop, frequently involving changes in land uses other than industrial. As stormwater requirements typically increase over time, it may be prudent to plan for enhanced stormwater treatment to "future proof" the design.



Typical Conceptual Model of Contaminant Migration

How are these regulations typically met?

The typical approaches for providing basic water quality treatment on a waterfront brownfield site are through the installation of engineered water treatment BMPs, such as sand filters, wet vaults, filter strips, or proprietary filter vaults. The standards can also be met through vegetated swales, wet ponds, or stormwater wetlands. In higher value real estate applications, usually there is not the room for traditional vegetated treatment systems, so projects like waterfront brownfields would utilize below grade vault systems.

LID Explained

Low Impact Development (LID) is an emerging stormwater control approach that utilizes smaller decentralized stormwater control BMPs that are located near the source of the stormwater flows. These smaller decentralized BMPs, combined with resource conservation (planning and site layout, such as clustering and avoiding impact to environmentally sensitive areas, etc.), seek to create built projects that have hydrology that mimics the natural site hydrology to a greater extent than conventional approaches. This is achieved in part by maximizing the site's infiltration capacity, even when it is relatively low. By utilizing smaller decentralized approaches, such as pervious paving, raingardens, and sheet flow, the concentration of stormwater flows is minimized or eliminated and can make effective use of relatively low-infiltration rates over large areas.

LID Principles:

- **Planning** (clustering, maximizing density where appropriate, preserving ecologically sensitive areas, site selection, etc.)
- **Street Geometrics** (narrow streets, interconnected street grid, etc.)
- **Pervious Pavements**
- **Bioretention** ("raingardens")
- **Soil Amendments** (Compost amended soils to increase water retention and reduce irrigation needs)
- **Disconnecting impervious surfaces** (curbless streets, downspouts to splash blocks that are not connected to a piped stormwater system, sheet flow to greatest extent possible, grass filter strips, etc.)
- **Green Roofs** (vegetated roof systems)
- ***Rainwater Collection and Reuse***

Example of Rainwater Collection | image by MITHUN

How is this LID approach on a brownfield different?

The goal of an LID stormwater management approach is to have the stormwater regime following construction match typical forested conditions as closely as possible by utilizing ecological means. This typically leads to maximization of any latent infiltration capabilities of the site soils, be they under pervious pavement or in a raingarden. On non-brownfield sites, these systems are designed based on the soil type, depth to groundwater, stormwater source, and other criteria.

On brownfield sites, the site soil profile often includes a "cap" of some type or another depending on the nature of any contamination. The nature of this cap may influence the design of any LID strategy that includes some amount of infiltration. LID-type stormwater infiltration is inherently distributed over large areas and can function well in areas of low infiltration rates. Traditional infiltration seeks to move large volumes of stormwater into the ground in smaller areas of high infiltration capacity. Therefore, many infiltration strategies, such as pervious paving, may function well on many cap types, but some may be incompatible with any infiltration of stormwater, even diffuse LID approaches. Locating parking within structures keeps these surfaces free of rainwater and resulting water quality issues. This approach is particularly well suited to waterfront brownfields.

Many brownfield sites are remediated through a combination of technologies. Containment of residual contamination is commonly employed

images by MITHUN

since it can mitigate risks in a cost effective manner. The type of residual contamination on waterfront brownfields varies greatly, but can generally be classified into two major groups: 1) relatively mobile; and 2) relatively immobile. The mobility of residual contamination located below the ground surface but above any groundwater table (i.e. the vadose zone) is generally a function of rainwater infiltration into the ground. Mobile contaminants dissolve in the infiltrating rainwater or can be physically transported. Immobile contaminants tend to have low solubilities or bind to soil particles.

For example, most heavy metal and heavy organic compounds are relatively immobile in

Examples of Raingardens | image by Chris Webb the environment. Lighter organic compounds, such as solvents and gasoline components, are more mobile in the environment. To contain mobile contaminants, caps are generally designed of low permeability material, such as concrete, asphalt, or clay. A building foundation or roadway could serve this same function. Rainwater does not readily permeate these caps and, therefore, percolating rainwater does not mobilize the contaminants. Rainwater infiltration is less of a concern with low mobility contaminants, as percolating rainwater does not mobilize the contamination. In this case, a cap can be made out of soil or other permeable materials (i.e. permeable asphalt). There are many examples of parks being constructed on brownfield sites where relatively immobile contaminants are present. Both permeable and impermeable caps protect from direct exposure to the contamination. In certain cases, where relatively immobile contamination remains, but where direct contact exposure is not of concern, a cap may not be needed.

Stormwater control on capped brownfield sites provides special challenges. Pushing large volumes of water into the ground at a cap location may not be preferred when less costly stormwater management strategies are available; however, infiltration should be considered as a strategy where relatively immobile contaminants are present. Alternative stormwater controls will be required for low permeability caps. The type of diffuse low-level infiltration typical of many LID strategies should be strongly considered. At most brownfield sites, maintaining the integrity of the cap is of utmost importance, particularly if direct contact is of concern.

Topography

Topography can be a constraint to the management of stormwater in many brownfields, such as on the Bellingham site. Much of the site is on fill and very flat. A large flat site can be challenging to the conveyance of stormwater. Pipes and swales are installed with slopes to convey water and can get deep. This could present challenges with contaminated soils that may be at depth and incompatible with high tides. Additionally, many waterfront brownfield sites will need to be filled and this addition can create challenges with existing grades in some areas (such as around existing buildings that will remain).

Regulatory Issues

Waterfront brownfield redevelopment is typically a heavily regulated activity. Many agencies from municipal to state and federal have jurisdiction over certain aspects of the project. These jurisdictions may be concerned over issues ranging from habitat and shorelines, marine water quality, clean-up activities, zoning and density, and transportation. Stormwater management systems inherently will impact and be affected by each of these issues. Stormwater systems typically include long linear elements transecting the site, are underground and above ground, and control water which has the ability to affect the movement of contamination, influence habitat, and be an integral part of the look and feel of the redevelopment.

Site and Stormwater Opportunities and Precedents

Improve water quality

One of the most significant opportunities to manage stormwater well is to utilize the site landscape to perform stormwater quality treatment. Hydrologically functional landscapes can be particularly cost effective since landscaping and open space may be required anyway, and the net additional cost to make it perform a stormwater function is often less than the cost of vault -based or other types of treatment systems. Many examples of utilizing site landscapes for stormwater treatment have emerged recently with the increasing use of LID stormwater management.

Express water

The expression of surface stormwater in the site design as an aesthetic element can incorperate public art to enhance the pedestrian experience and create site interest. Examples, such as "growing vine street" in Seattle, have used stormwater management as an expressive design element.

Summary

Waterfront brownfield sites are unique in that they are not typically part of a watershed with a stream resource to protect. Therefore, stormwater quantity flow control (flow rate and volume) is not required, because without a stream to protect, the typical issues of stream bank erosion and groundwater recharge do not apply. Water quality is the primary stormwater management concern. Traditional stormwater management design for a waterfront brownfield redevelopment would typically utilize below grade vaulted stormwater treatment systems. These hard piped systems meet the minimum regulatory requirements, but are costly to install and maintain. The stormwater treatment capabilities of landscape systems, such as raingardens, are superior to the vaulted systems and they can be maintained similar to the rest of the site landscaping. Some additional work is needed periodically to remove contaminated mulch, but the overall maintenance of these systems is no greater than traditional systems.

These natural approaches will be most successful when incorporated into the development in a comprehensive way, integrating them with the building architecture, other utility systems, parks and open space, and vehicle and pedestrian circulation systems. This integration is decentralized and woven through the redevelopment with smaller systems near the source of stormwater. Large centralized systems near the end of the pipe are avoided.

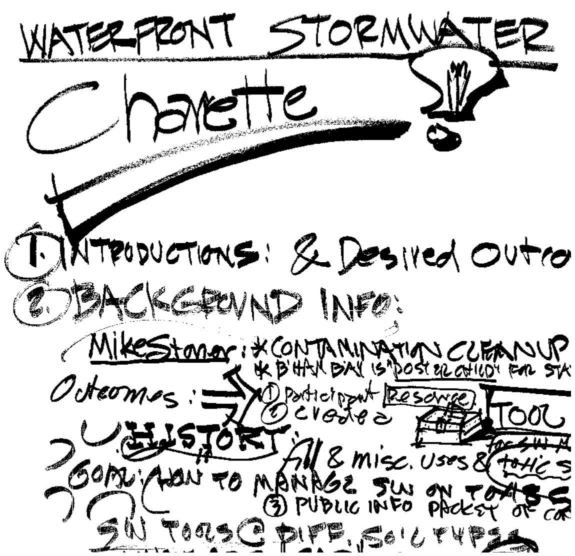
Examples of Expressing Water | images by MITHUN

Growing Vine Street| image by MITHUN

Charrette Process

What is a Charrette?

According to the National Charette Institute, the French word, “charrette,” means “cart” and is often used to describe the final, intense work effort expended by art and architecture students to meet a project deadline. The term is said to originate from the École des Beaux Arts in Paris during the 19th century, where proctors circulated a cart or “charrette” to collect final drawings while students frantically put finishing touches on their work. For this document, a one-day charrette was held, involving a highly interactive brainstorming and conceptual design session, followed by a half-day summary.



Purpose

The purpose of this charette was to generate ideas and perspectives from a broad range of stakeholders about the stormwater management issues on waterfront brownfield sites. This included a basic evaluation of stormwater management strategies and technologies at the concept level, and their application in sites such as the Bellingham Waterfront District. The discussion focused on emerging sustainable solutions and benchmarks, such as those included in LEED-ND, and approaches such as Low-Impact Development (LID).

Goals

Goals for this waterfront brownfield stormwater charette were to:

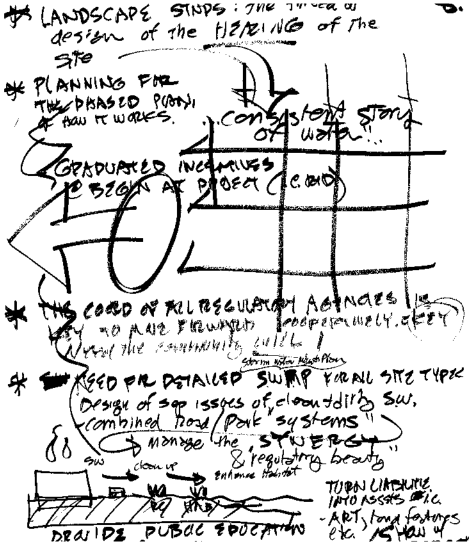
- Consider innovative approaches and evaluate application on waterfront brownfield sites.
- Identify barriers/constraints: Do they exist for innovative approaches?
- Identify stormwater management solutions.

Charrette Process | Photo by MITHUN

- Identify developer incentives: Are they needed to exceed regulatory minimums?
- Generate criteria guidelines for public realm improvement and private development.
- Produce a resource book with photos, drawings, and narrative on issues.
- Avoid obstacles: Being too specific to Bellingham Waterfront District would prevent finding outcomes that benefit a variety of waterfront brownfield sites.

On Earth Day 2008 (April 22, 2008), a broad group of stakeholders gathered for a daylong brainstorming event. The group included City of Bellingham staff, Port of Bellingham staff, consultants to the Port of Bellingham, Washington State Department of Ecology staff, representatives of Western Washington University (a proposed tenant), local architects and engineers, and staff from Sustainable Connections who hosted the event. They discussed the constraints and opportunities for stormwater management on waterfront brownfield sites using the Bellingham site as a touchstone, while working to identify issues and solutions applicable to any waterfront brownfield redevelopment.

Charrette Participants | Photo by MITHUN



Charrette Results

Principles and Objectives

Components of a sustainable community should involve an integrated, holistic manner to lessen the impact of stormwater on natural systems,and become an asset and integral part of the built environment.

Waterfront brownfield locations create unique opportunities, due to contaminant sources, a minimal requirement for any detention, and the need to nourish habitat areas. This is true for public and private land development sites, alike.

Minimum standards are not sufficient for a sustainable community. Total water planning strategies should exceed the legislated minimum -- they should integrate and enhance water, wildlife habitat and human conditions. They can be achieved using the following objectives:

1.Reduce the amount of stormwater that needs treatment.

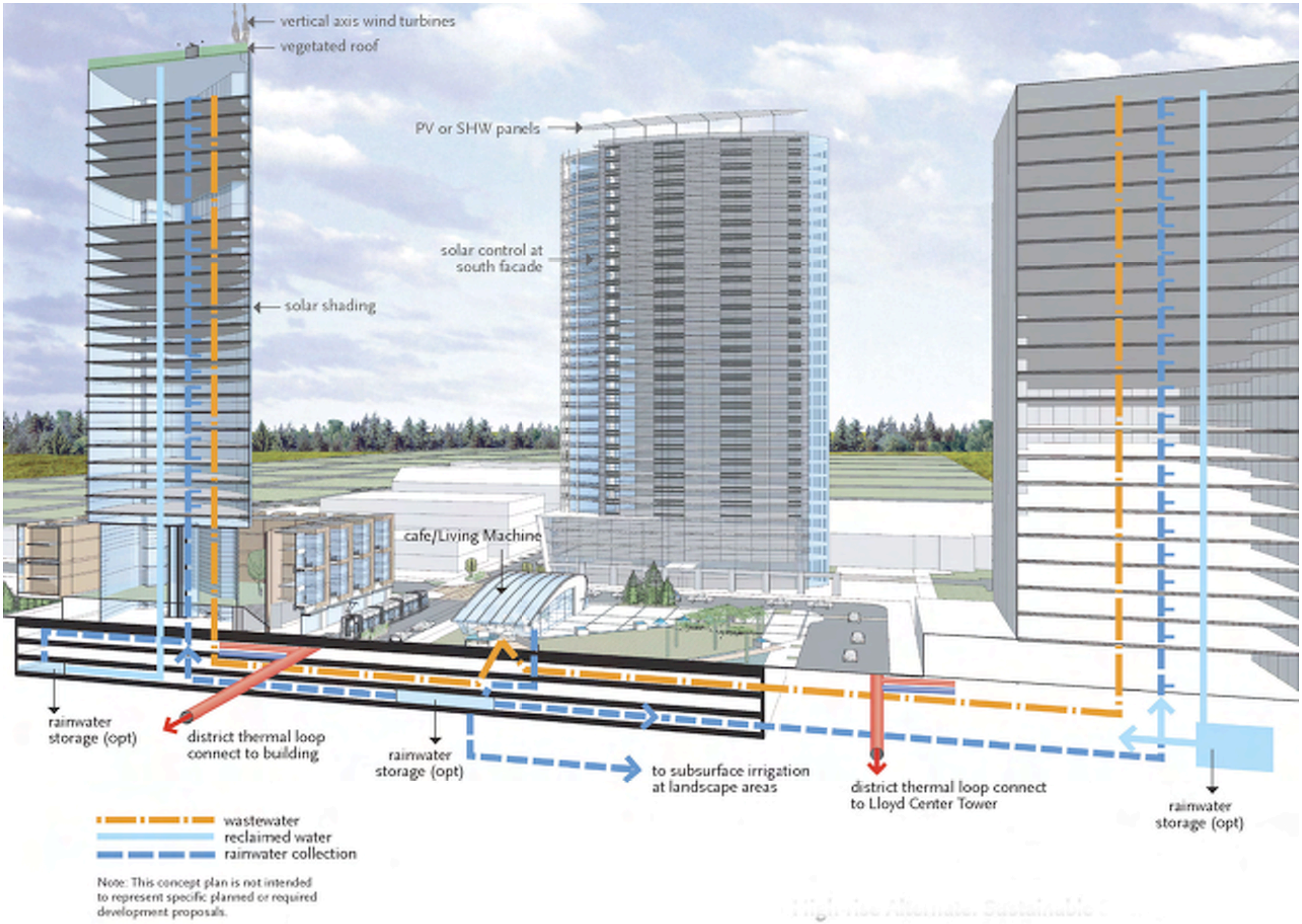
1.1. Minimize impervious surfaces in roadway and sidewalk/pathway designs, use pervious materials and reduced widths where appropriate.
1.2. Design for alternative transportation options to reduce peak hour demands.
1.3. Create alternative methods for automobile parking with covered stalls and remote location parking.

2.Provide multiple opportunities for water treatment and reuse.

2.1. Variable height amended soil treatment over toxic caps for permeable treatment opportunities.
2.2. Provide opportunities to separate and control polluting and non-polluting surfaces for possible reuse.
2.3. Provide a toolkit of preferred methods and materials for surface treatments of polluting and non-polluting surfaces.
2.4. Implement natural stormwater measures that enhance habitat values while purifying stormwater (e.g. natural treatment wetland). Additionally, direct treated stormwater to natural areas for habitat enhancement.

3.Provide for phased treatment and control strategies.

3.1. Future-proof design strategies to allow for new concepts and materials as development phases occur.
3.2. Implement robust solutions that meet today's regulatory standards and are adaptable to meet increasing standards in the future as additional development occurs.
3.3. Provide detailed design strategies for the phasing in of stormwater controls and treatments as urban development occurs.
3.4. Create a plan for using public infrastructure that can be a synergistic solution for public and private uses.



Lloyd Crossing, Integrated Water Systems Example | MITHUN

4. Stormwater management as an organizing principle

4.1. Establish public presence of water in the urban landscape.

4.2. Manage rain and surface water as an integral part of the built environment and to serve as a model for current sustainable design technology.

4.3. Develop a comprehensive system of stormwater strategies to strengthen connections between other parts of the community and the waterfront.

4.4. Create stormwater facilities that store, infiltrate and distribute as valuable elements in the urban landscape -- "place makers" that support/augment the identity of the redevelopment.

4.5. Maximize opportunities to express stormwater as public art and other amenities.

4.6. Maximize educational opportunities in designs.

Intertidal zone | watercolor by Stephanie Bower

Stormwater Boulevard | watercolor by Stephanie Bower

5.Provide a Stormwater Master Plan

5.1. Develop a hierarchy of site specific street standards that incorporates LID stormwater measures.

5.2. Develop landscape standards for the public and private realms emphasizing native/drought tolerant plants.

5.3. Dual plumb buildings to utilize non-potable water for toilet flushing and irrigation.

5.4. Develop conservation strategies that reduce water consumption and re-use water (e.g. greywater) with maximum efficiency.

5.5. Recognize rainwater as a valuable resource and take advantage of opportunities to achieve multiple goals in each system (e.g. stormwater management as landscaping).

5.6. Make water management infrastructure an integral element of neighborhood design.

5.7. Ensure that engineering elements do not detract from character-defining elements of the neighborhood.

5.8. Recognize the significant role that streets play in generating runoff and helping to filter it into the ground.

5.9. Design end-of-pipe elements as carefully as the architecture and urban design.

5.10. Manage landscaping and terrain with permanent maintenance measures that encourage long-term support for ecosystems.

5.11. Develop comprehensive and integrated infrastructure planning that maximizes efficiency of systems between private and public entities.

5.12. Encourage sustainable stormwater management investment by private entities with incentives such as density bonuses.

5.13. Ensure that permitting process of stormwater systems is efficient and predictable.

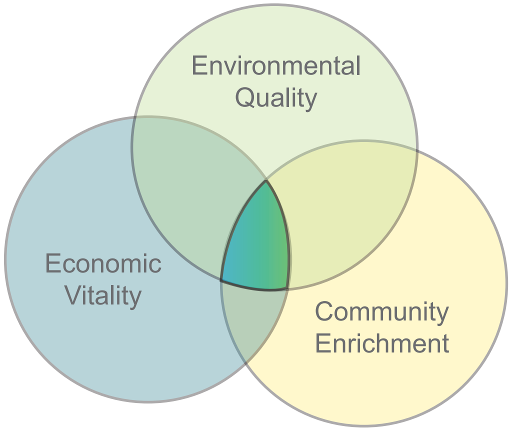
5.14. Incorporate triple bottom line analysis when developing stormwater master plan.

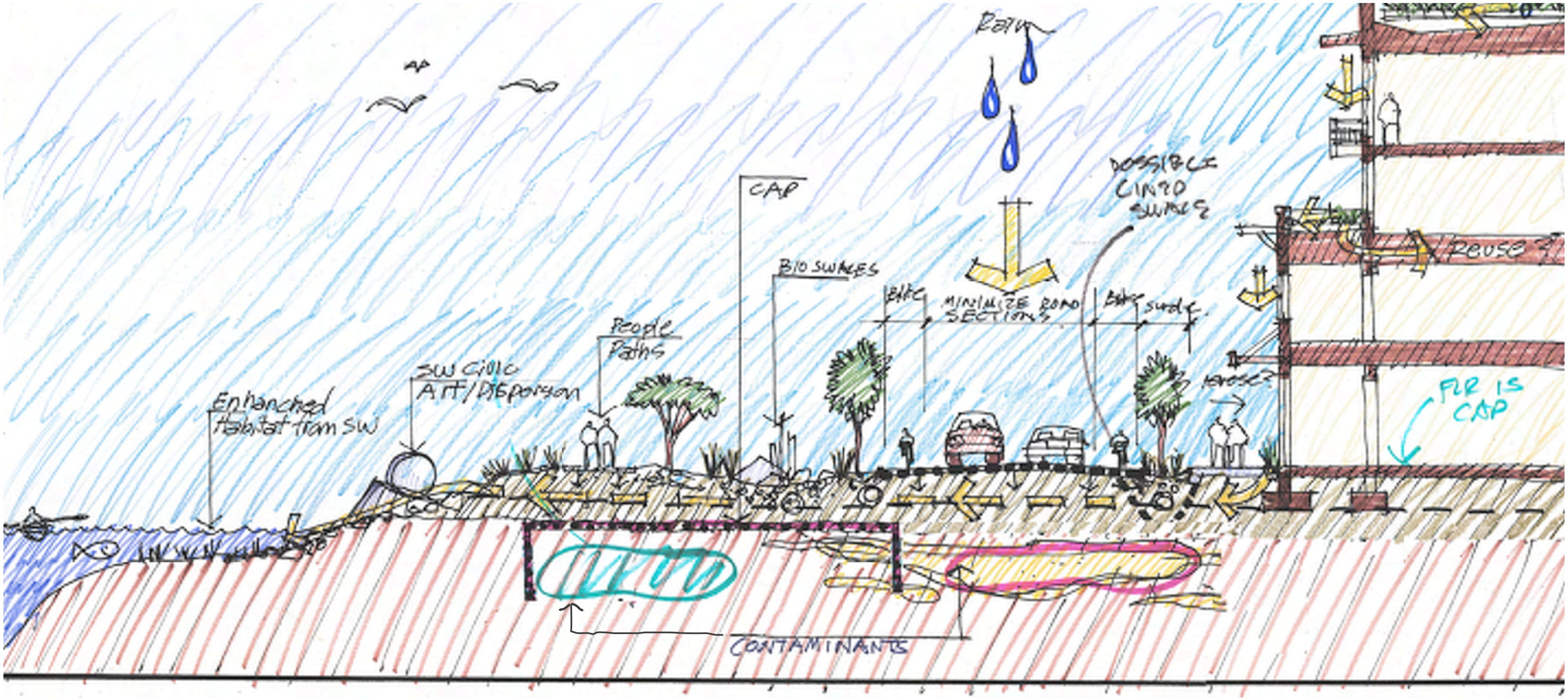
5.15. Investigate and apply for water rights as needed to achieve efficient water use and re-use.

Conceptual Street and Stormwater Hierarchy | MITHUN

Triple Bottom Line

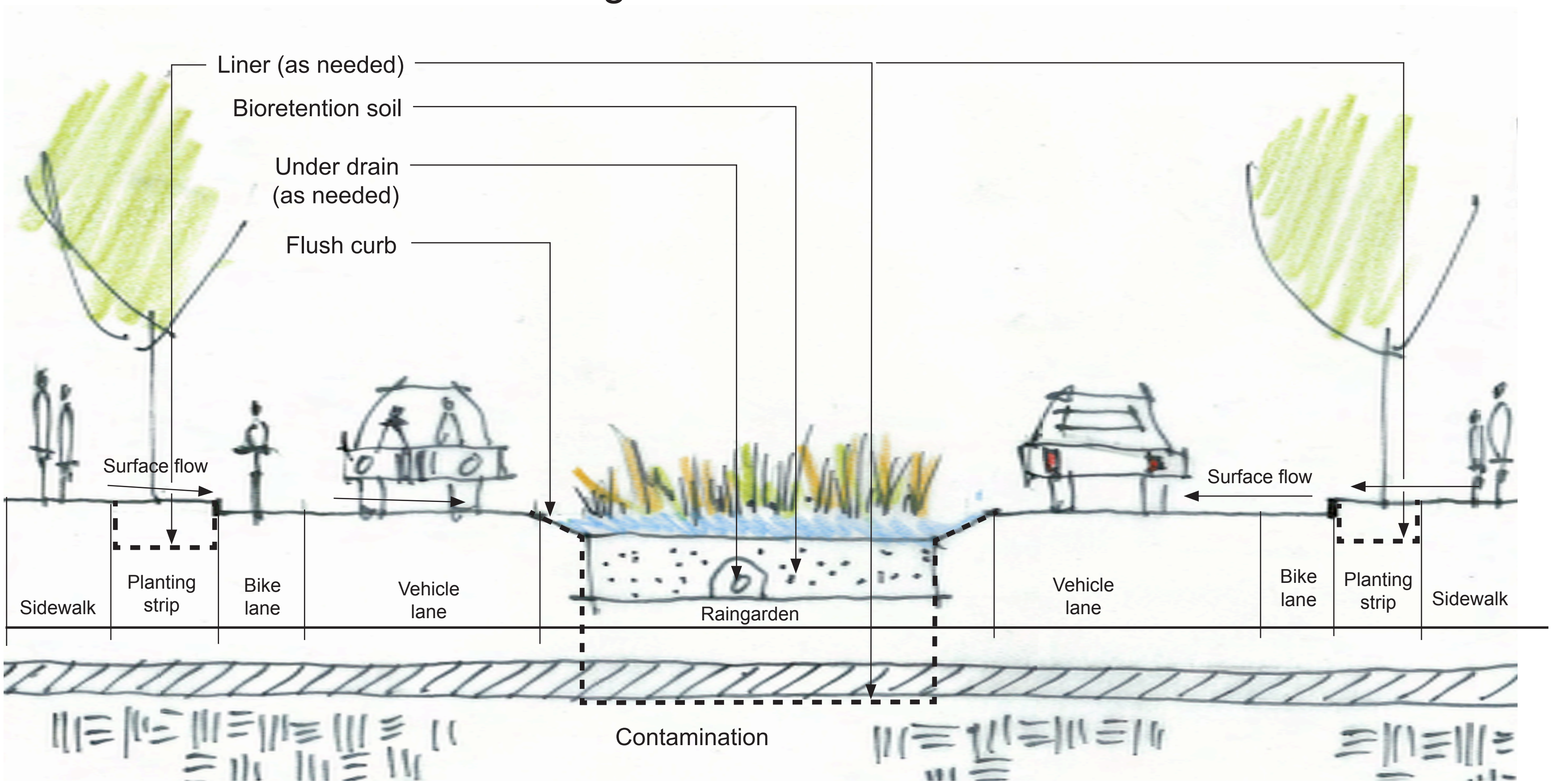
Triple Bottom Line Accounting involves the addition of social and environmental values to the traditional economic measures of a corporation or organization's success. The phrase was coined by John Elkington, co-founder of the business consultancy, SustainAbility, in his 1998 book, Cannibals with Forks: The Triple Bottom Line of 21st Century Business. Triple Bottom Line accounting ties the social and environmental impact of an organization's activities, in a measurable way, to its economic performance in order to show improvement or to deepen understanding. Currently, there are few standards for measuring these other impacts.



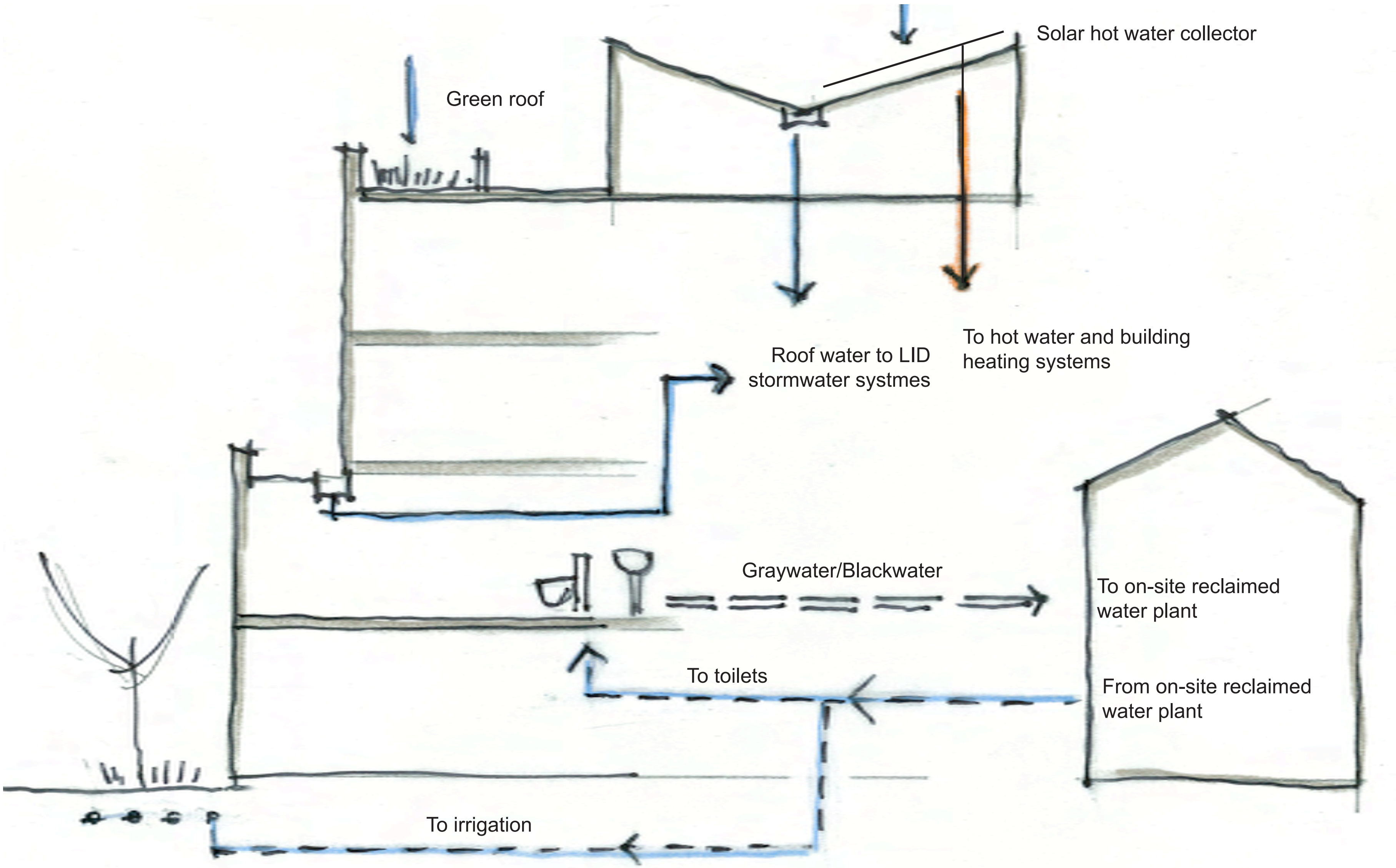


Conceptual Site Section developed at the Charrette | Dave Christensen

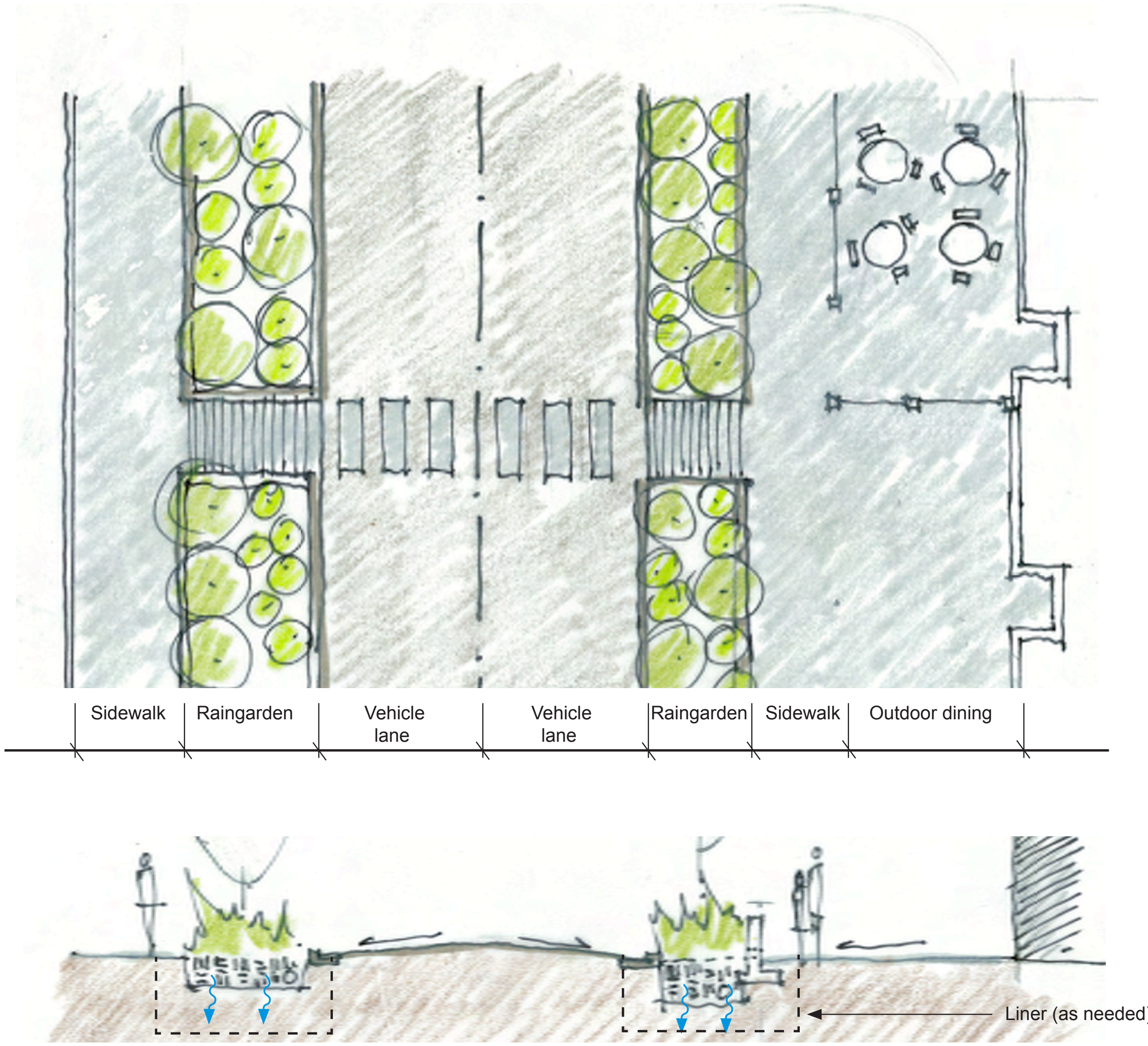
Appendix
Sustainable Stormwater Strategies from the Charrette



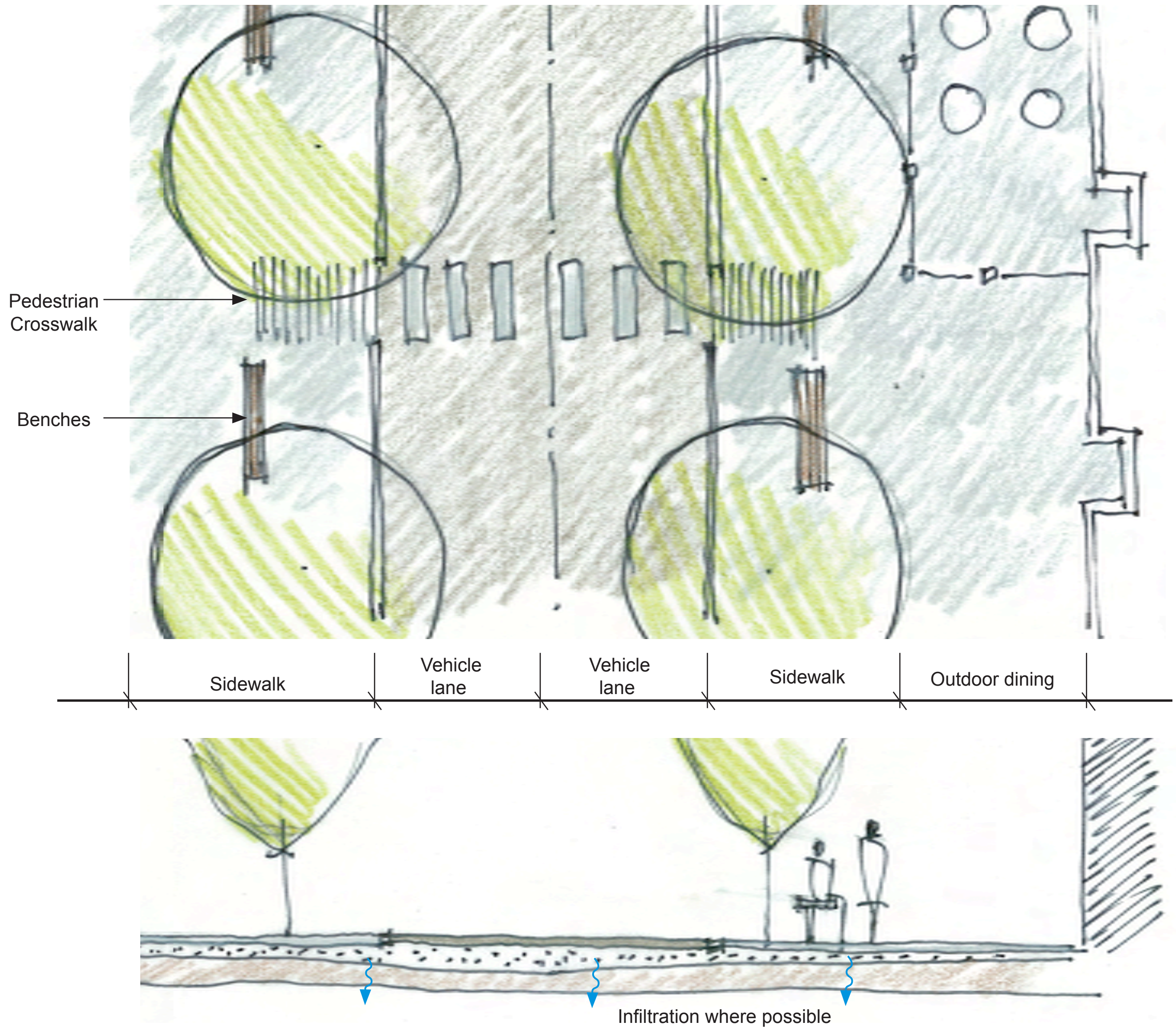
Two Lane Boulevard for Brownfield Site | MITHUN



Building Water Management Concept | MITHUN



2 Lane Urban Street wth Raingardens | MITHUN



2 Lane Urban Street wth Porous Paving | MITHUN

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