

St. Paul, VA: Managing Stormwater in Market Square



Prepared for the Town of St. Paul, VA

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The Community Design Assistance Center (CDAC) is an outreach center in the College of Architecture and Urban Studies at Virginia Tech that assists communities, neighborhood groups, and non-profit organizations in improving the natural and built environments. Assistance is provided in the areas of landscape architecture, architecture, planning, and interior design. Working with communities, the conceptual planning and design provides communities with a graphic vision of their project that can then be used for grant applications and fundraising for the next steps toward implementation.

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The U.S. Environmental Protection Agency's (EPA) Brownfields Program is designed to empower states, communities, and other stakeholders to work together in a timely manner to prevent, assess, safely clean up, and sustainably reuse brownfields. Assessment grants provide funding for brownfields inventories, planning, environmental assessments, and community outreach.



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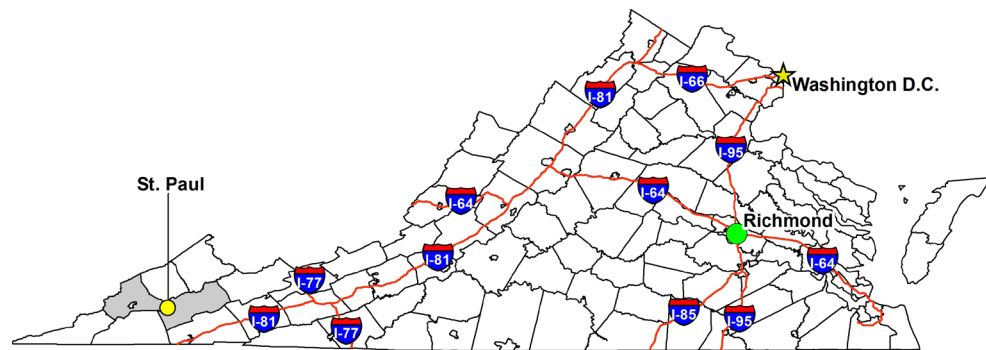
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PROJECT DESCRIPTION

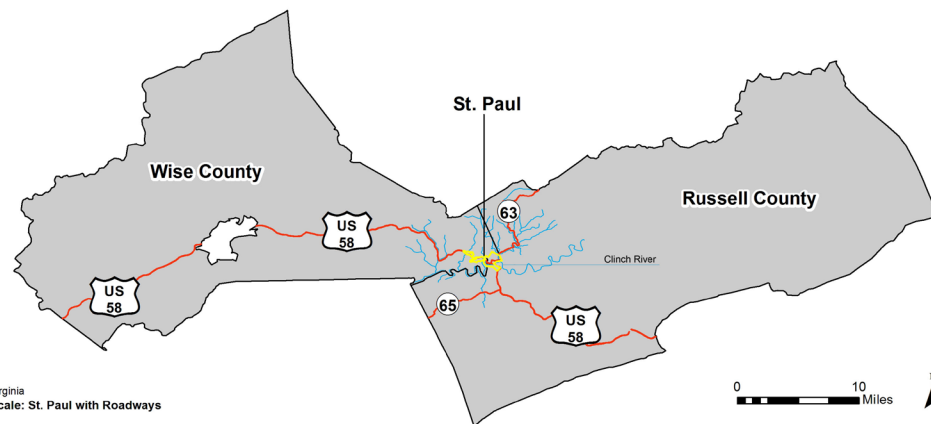
Overview

The town of St. Paul, with a population of just under 1,000 in 2013, is nestled in one of the most beautiful and diverse areas of southwest Virginia along the banks of the Clinch River with rolling hills to the south and mountain peaks to the north. Chartered in 1911, St. Paul is located in the southeastern corner of Wise County and the western side of Russell County near Interstate 81.

The project focus is on Market Square block within St. Paul, which is bounded by Broad Street to the north, Russell Street to the south, 5th Avenue to the east, and 4th Avenue to the west. This block contains an alley that runs east-west, which serves as the access road to the Clinch River Farmer's Market and other businesses within the interior of the block.



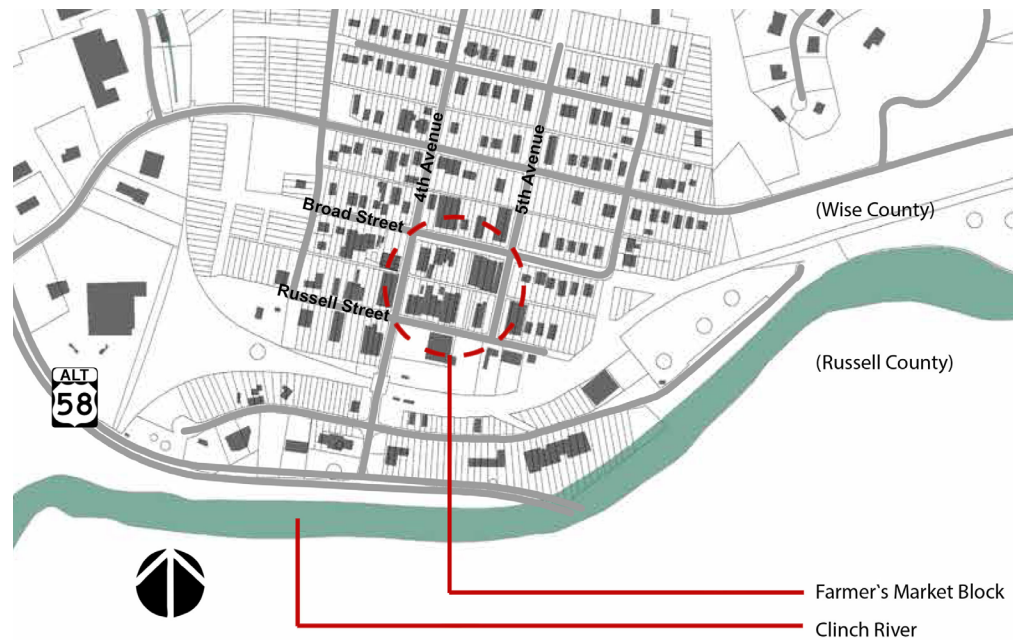
St. Paul, Virginia
State Scale: St. Paul, Wise County, & Russell County



St. Paul, Virginia
County Scale: St. Paul with Roadways

Map showing the locations of Wise and Russell Counties within Virginia and the Clinch River and the town of St. Paul within the counties.

PROJECT DESCRIPTION



Map showing the town of St. Paul, the Farmer's Market block, and the Clinch River.

St. Paul's vibrant community identity boasts a caring, small town atmosphere with deep-seated heritage. Once dependent upon the Appalachian coalfields for economic vitality, St. Paul has overcome the decline of coal mining by concentrating their efforts on a revitalization of the unique environmental setting around St. Paul and refocusing on the importance and appreciation of the diversity of the Clinch River valley. Their collective vision is to become a model downtown district, known for an environmentally-conscious, aesthetic, and campus-like atmosphere.

Community groups have spearheaded several economic developments, revitalization plans, and stormwater management projects to enhance the town. St. Paul seeks to make the Clinch River and other complimentary assets a "primary focus for a new creative economy dealing with tourism." In 2002, 9.2 miles of the Clinch River were designated a Scenic River by the State of Virginia ranging from Route 58 in St. Paul to the confluence with Guest River.

Currently stormwater runoff from urban impervious surfaces bring contaminants and large volumes of water into the Clinch River. These impurities and storm surges are detrimental to a rare species of mussels and adversely affect sensitive wildlife in the watercourse and riparian corridor. Stormwater contaminants and runoff issues are a product of natural and man-made elements, such as contaminants

PROJECT DESCRIPTION

from business and industrial uses. St. Paul understands this and seeks ways to solve stormwater runoff issues by implementing design solutions closest to the source of precipitation. These conceptual designs address stormwater contaminants and volume while envisioning a pleasing downtown experience.

In addition, this project was funded by a grant from the US E.P.A.

The following page includes a map of the project area.

PROJECT DESCRIPTION

Market Square Site Map



DESIGN PROCESS

The design process began with an initial site visit to St. Paul in August 2014. The CDAC team met with stakeholders to discuss concerns and desires for the project, walked the Market Square block, and visited the Clinch River bank and Blue Bell Island. By gathering on-site data and documenting existing conditions, the team was able to understand the opportunities and constraints of the project site. This analysis would later influence the design concepts.

The team worked closely with the stakeholders group to better understand their vision for the community. After careful consideration of all the factors, a set of preliminary conceptual design alternatives were developed. In April 2016, the CDAC team had the opportunity to meet with stakeholders to discuss preliminary design work for the site. Based on the feedback from this meeting, the Market Square designs were refined and sent to the town of St. Paul stakeholders in June 2016. The design alternatives were then refined and focused onto two immediate goals for implementation: controlling the stormwater runoff from the Lyric Theatre and Sugar Hill Brewery buildings as well as exploring remediation alternatives for the 10 ft brownfield strip between the Lyric Theatre and the Farmer's Market.



CDAC Project Manager, Melissa Philen, meeting on site with Joe Morici and Lou Wallace in December 2015.



CDAC team member, Austin Chase, presenting initial conceptual designs to a stakeholder group in April 2016.



CDAC team members, Elizabeth Gilboy, Patricia Stroud, and Amelia Hulshult, refining final designs with Virginia Tech professors CL Bohannon and Terry Clements.

Part 1: Final Conceptual Designs

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FINAL DESIGN: MARKET SQUARE BLOCK

SWOT Analysis - A Reflection on Site Analysis

Strengths:

The block contains an existing Farmer's Market structure, which provides a key cultural component to the site, activating the whole block during select times of the week. Along Russell Street there is a plot of land containing mature trees providing a softened break from the asphalt. The existing alley also provides a chance to take parking and service functions off of the street and into the interior of the block. The Heart of Appalachia Tourism Authority & Visitor Center faces onto the alley creating a great potential for gathering within the alley.

Weaknesses:

There are several zones of very steep topography along the block. The 30 feet of elevation change across the 380 foot length of the block would be manageable except that the majority of the grade change is confined to two specific areas near 5th Avenue. Another weakness is the disorganized drainage and gutter patterns onsite. As of now, water from the majority of the structures is sent directly from a downspout as a sheet flow onto the alley causing several issues. Firstly, the polluted water is sent almost directly into the biologically rich and sensitive Clinch River. Secondly, the water quickly reaches the bottom of the block causing flooding issues by 4th Avenue.

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Opportunities:

The existing Farmer's Market brings life and human activity to the interior of the block. This is supported by the alley which runs through the site providing vehicular access to the market, close-proximity parking, and pedestrian routes to the market. Business frontage along the alley activates it as a pedestrian space. The existing green spaces have grass and mature trees and could be incorporated into a park connected to the market and provide a better pedestrian environment. Open spaces at the alley's low point could be developed into rain gardens to collect water. Connections to the market could be strengthened with a pedestrian core through the alley and strengthened connections along the block edges to bring further human activity to the market. The alley conditions could be improved with recommendations to regrade and creating one way traffic to provide more structured access.

Threats (Challenges):

The challenging topography makes the site very difficult to traverse, particularly for handicapped or elderly individuals. The unstructured drainage pattern threatens to increase flooding creating obvious safety concerns as well as serious maintenance issues. Poor pedestrian

FINAL DESIGN: MARKET SQUARE BLOCK

SWOT Analysis (cont.)

accommodations, both within the interior of the block and around its perimeter, threaten to keep users away.

Opportunity- Strength Strategies:

(Use strengths to take advantage of opportunities)

- Use existing green/open space to develop pocket parks
- Use alley system to treat water
- Use system of internal alley and existing stairs to increase connectivity

Opportunity- Weakness Strategies:

(Overcome weaknesses by taking advantage of opportunities)

- Use topography to create an artful water treatment sequence
- Use park and open space as flooding mitigation
- Use areas of green space to absorb grade change where possible

Challenge-Strength Strategies: (Use strengths to avoid challenges)

- Use green space where possible to traverse steep grade and collect runoff
- Extend existing green spaces to screen trash or utility services where possible

Challenge-Weakness Strategies:

(Minimize weaknesses and avoid challenges)

- Adjust grading of alley in steep spots to maximize handicap accessibility
- Use greenery where possible to screen utility functions
- Seek to create a distinction between pedestrian and service functions
- Find areas where service areas can be multi-functional

FINAL DESIGN: MARKET SQUARE BLOCK

Design Description

The St. Paul Market Square conceptual master plan aims to further develop the town's vision to become a model downtown district known for an environmentally-conscious, vibrant, and campus-like atmosphere while preserving the diversity of the Clinch River Valley through stormwater management and brownfield remediation strategies.

Walkable streetscape strategies have been incorporated throughout the Market Square. Adding street trees on the block perimeter acts as a traffic calming measure and improves the sidewalk experience by providing shade on the sidewalk and street side parking. Providing a more comfortable street environment for pedestrians could increase visitors to the Market Square.

Stormwater runoff volume and quality has been controlled through a series of rain gardens down the alley to slow the initial velocity, diverting a substantial volume to Russell St, and filtering out contaminants before flowing into the Clinch River.

Structured parking lots with handicapped spaces have also been incorporated throughout the site to make visiting the Market Square more accessible to residents and tourists alike.

Further design strategies have been applied by dividing the Market Square Block into three zones based off of street access and usage type.

To the west there is the 4th Avenue zone which includes the Stonebriar Apartments, Fat Boy's BBQ, the Visitor's Center, and accesses Broad Street, Russell Street, and 4th Avenue. These form a zone of daily usage by town residents that necessitate accessible parking, flood zone mitigation, pedestrian circulation paths, and pocket parks to increase the aesthetic of the interior of the block.

In the center of the block is the Farmer's Market zone which includes the market pavilion, the 10 ft brownfield strip, and accesses Broad Street and the Alley. This is the heart of Market Square and needs to become developed as a destination feature for the town of St. Paul. Aesthetically pleasing additions to the market can also be functional solutions to the issues of stormwater runoff and the brownfield contaminants.

To the east is the 5th Avenue zone which includes the Lyric Theatre, Sugar Hill Brewery, Samson's Gym, and Design Printers. These

FINAL DESIGN: MARKET SQUARE BLOCK

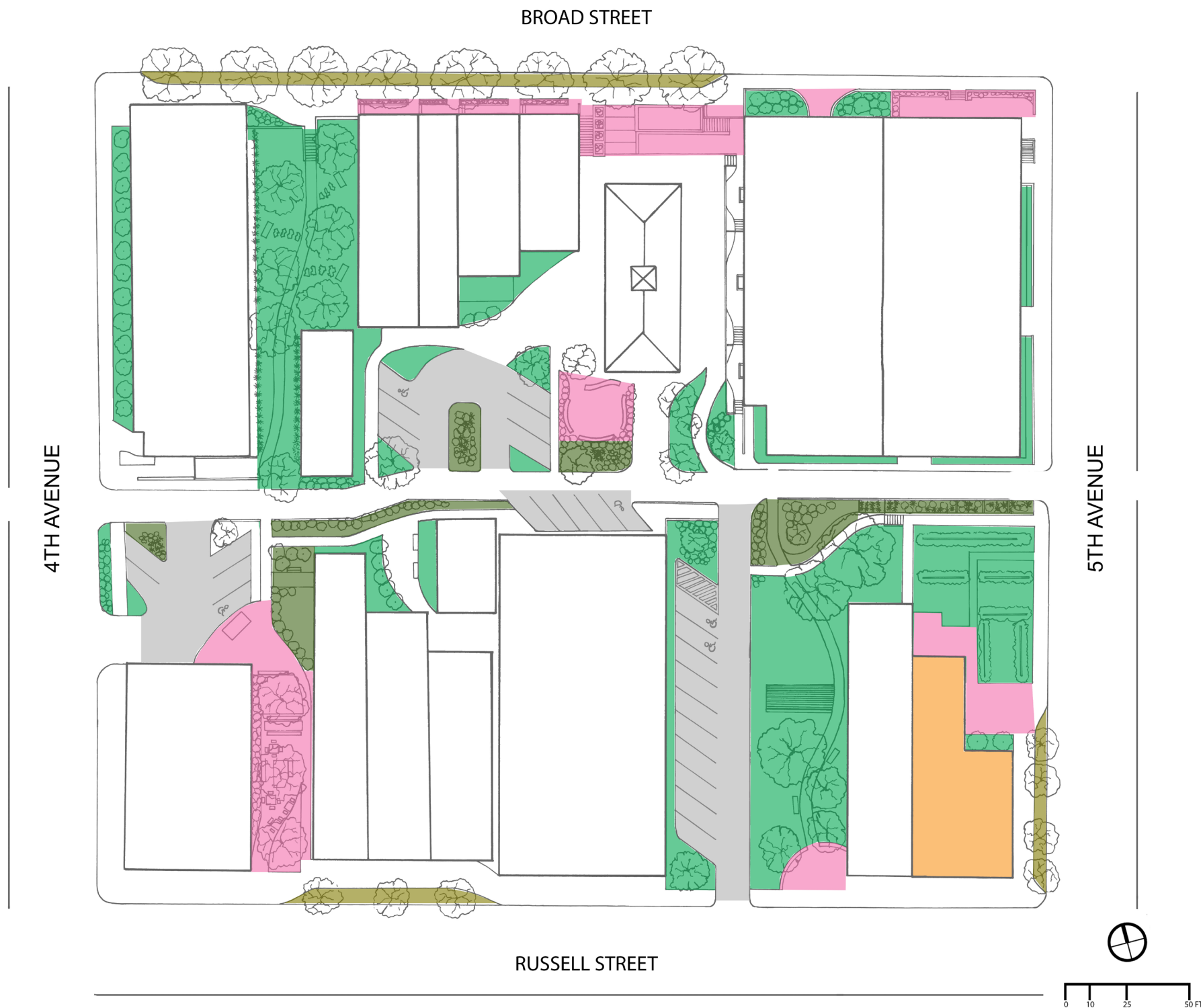
Design Description (cont.)

locations also require daily access from residents and can be considered an entertainment and educational district for St. Paul with permeable or pervious parking lot materials, rain gardens, and a stage platform in a proposed park greenspace.

On the following pages are the Market Square Conceptual Master Plan and Program Map that depict general proposed strategies in Market Square.



- 1 Blue Bell Allee
- 2 Market Stage
- 3 Market Walk
- 4 Memorial Garden
- 5 Splash Pad
- 6 Terraced Rain Gardens
- 7 Stormwater Runnel
- 8 Hops Garden
- 9 Stage Park
- 10 Design Printer's Plaza
- 11 Visitor's Center Plaza
- 12 Fat Boy's Grilling Patio
- 13 Outdoor Dining
- 14 Parking
- 15 Rain Garden



Key:

-  Parking
-  Infrastructure
-  Greenspace
-  Street Trees
-  Bioretention
-  Urban Infill

FINAL DESIGN: FARMER'S MARKET

Inventory and Analysis

The Farmer's Market has an important role as a central feature of St. Paul's vision of a revitalized downtown, yet several infrastructure improvements need to be implemented in order to accommodate the anticipated future growth. Stormwater from the roof of the Lyric Theatre is piped directly down to the market area and routed to a clogged drainage system. A lack of structured parking makes it difficult for visitors to come to events on busy market days. The steep slope along the Memorial Garden is hazardous during bad weather conditions and dangerous for handicapped or elderly visitors to the market.



Existing stormwater mitigation



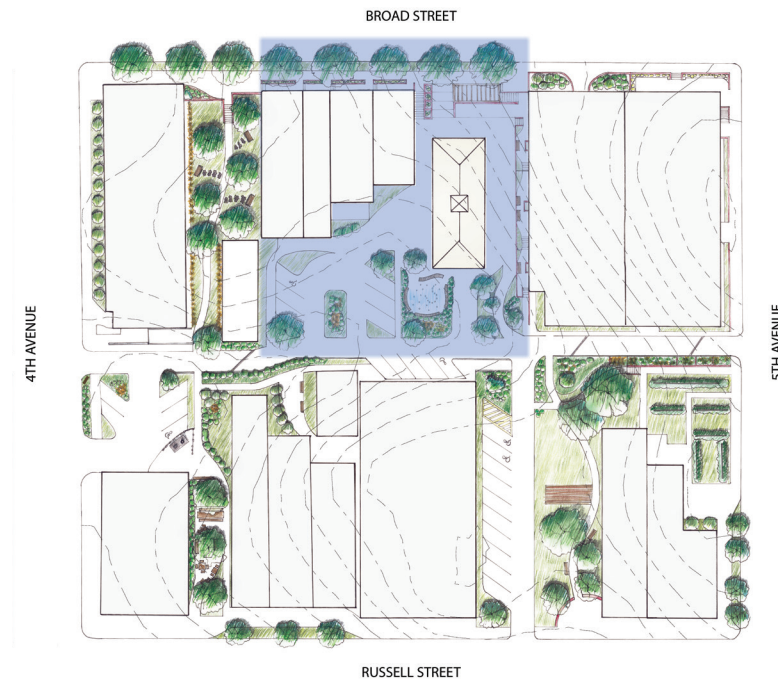
The steep slope violates ADA access standards.

Design Description

A Market Walk has been proposed to provide a safe and pleasant path from the Lyric Theatre to the Farmer's Market with plenty of bench seating, planting beds, and collection systems for stormwater runoff. The Memorial Garden could be redesigned and expanded to include a gentler sloping path for visitors through the garden with handrails for safety. The sloped rock bed by Broad St. could be transformed into Market Stage: a multipurpose platform to function as additional vendor spots, a live entertainment stage, or a platform for civic functions. A splash pad has been added to provide a playspace for children and act as a visual water feature for the market area. Structured parking is now located near the market for visitors with clear handicapped access. Street trees can be added along Broad St. as a traffic calming measure and to improve the streetscape by providing shade to the sidewalk and street parking.

The conceptual master plan for the Farmer's Market focus area can be found on the following page. A perspective of proposed improvements of the Farmer's Market follows the conceptual master plan.

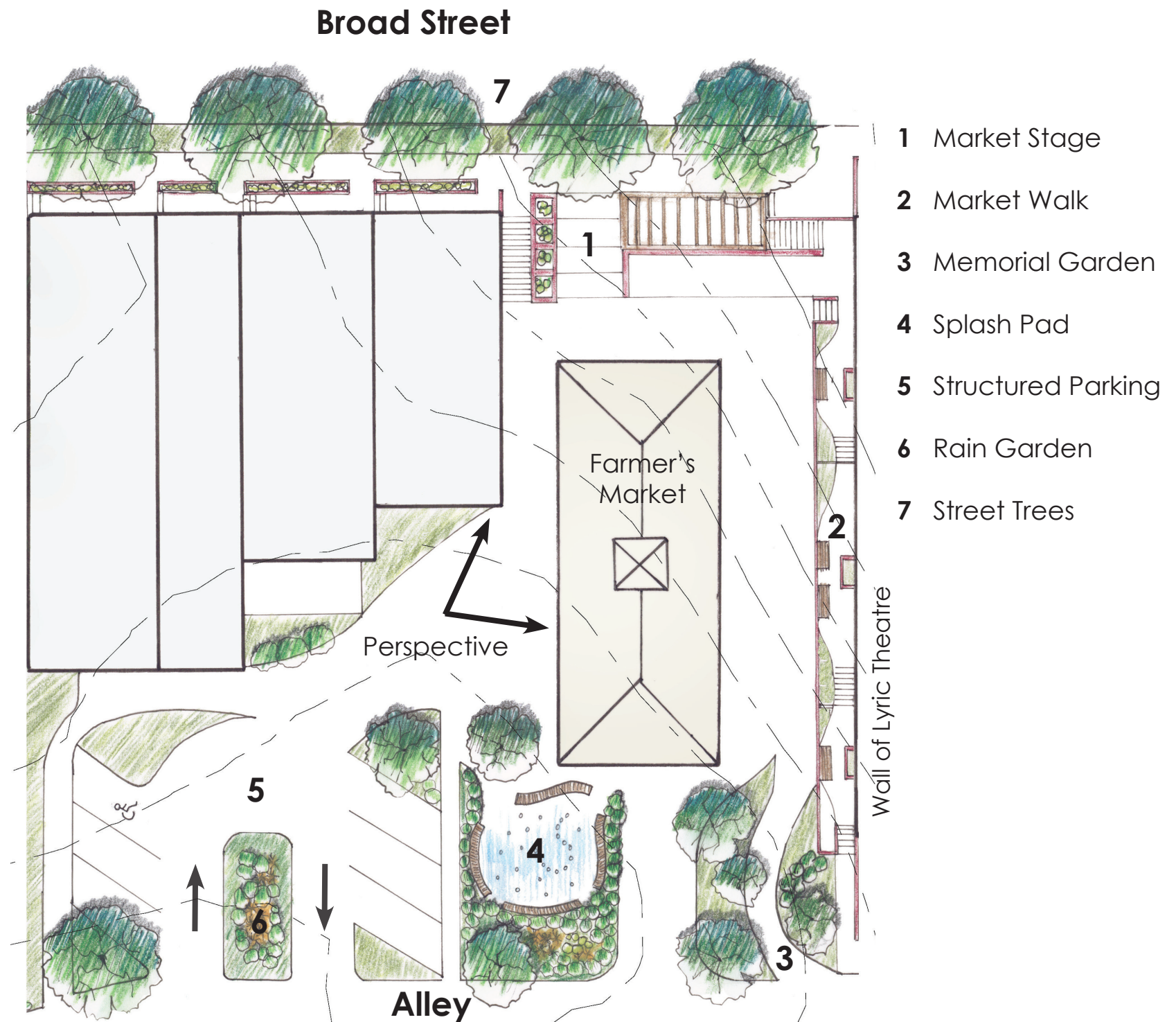
FINAL DESIGN: FARMER'S MARKET
Conceptual Master Plan



Locator Map



Existing Site Conditions



Proposed Site Design



A tiered stage would become a central landmark for St. Paul and serve multiple purposes in providing a platform for street vendors on market days, drawing pedestrians into the Farmer's Market by alternate paths, and support the town's cultural identity by serving as a stage for local musicians and community theater.

FINAL DESIGN: FARMER'S MARKET

Material and Inspiration Palette



A splash pad would add a sense of playful whimsy to the market square by providing a safe destination for children.



The addition of street trees along Broad St. would improve the streetscape by providing shade to the sidewalk and parked cars.



Additional seating throughout the Farmer's Market, along Market Walk, and on Broad St. would create a welcoming environment for visitors.



Rain gardens placed throughout the Market Square block will help to control the volume of stormwater runoff and filter contaminants.



A pergola platform on the rock bed near Broad St. will provide a multi-functional space for the town of St. Paul acting as a shade shelter for visitors, a covered table vendor space for market days, and a stage for local theatrical and musical performances in the market.



FINAL DESIGN: FARMER'S MARKET

Plant Palette

Along Broad Street:

Acer circinetum

Considered to be one of the best native trees for the home landscape, and an important part of the Northwest forest, vine maple is widely enjoyed for its rugged growth habit, interesting bark coloration, and beautiful fall leaf color.



Carex pennsylvanica

Groundcover for dry shade. Under planting for shade perennials. Lawn substitute for dry soils in shady areas (forms a turf that never needs mowing or mow 2-3 times per year to 2" tall). May be best to use purchased plants for covering large areas because this species often does not grow well from seed.



Chrysogonum virginianum

Green & Gold is a low-growing, herbaceous, perennial that is native to the Eastern US. It is primarily found along dry, woodland edges and forest clearings from Ohio to Georgia, and westward to Louisiana. Sometimes green and gold is referred to as goldenstar because of its bright yellow, star-shaped flowers.



Tradescantia

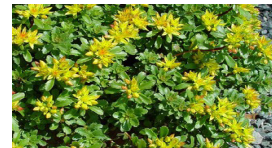
An interesting and long-blooming perennial for native plant gardens, woodland or shade gardens, wild gardens or naturalized areas.



In rain modules to control stormwater runoff:

Sedum kamtschaticum

This tough, drought-tolerant species has glossy deep green leaves and, in early summer, half-inch golden yellow flowers that open from pink buds. It grows to about 6 inches tall and a little wider and makes a good groundcover.



Sedum angelina

Brilliant chartreuse-yellow, needle-like foliage forms a quick groundcover. Adds cheery color to containers, dry slopes and flowering borders, as well as being a good bulb cover. In winter, foliage turns orange in northern climates. Perennial.



Hemerocallis

Borders. Mass over large areas or grow in clumps. Fountain-like leaves provide elegant foliage, color and texture for the garden when flowers are not in bloom. Day lilies can crowd out weeds and form a verdant ground cover.



FINAL DESIGN: FARMER'S MARKET

Plant Palette (cont.)

Boston Ivy

Popular clinging vine with purplish new growth, maturing to green before turning a brilliant dark red-purple in fall. Valued for quick cover of brick or stone walls, fences. Deciduous.



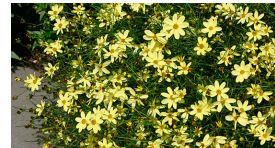
Sporobolus heterolepis (Prairie Dropseed)

Ground cover for hot, dry areas. Prairies, meadows, native plant gardens, wild areas or slopes. Also effective in large rock gardens. Accent for foundation plantings or borders.



Coreopsis verticillata

This very popular garden plant has fine, wispy foliage and showy, golden yellow blooms. Provide a sunny, well-drained site and you'll be rewarded with hardy, long-lived, long-blooming plants that are also drought-tolerant.



For phytoremediation:

Lead Uptake:

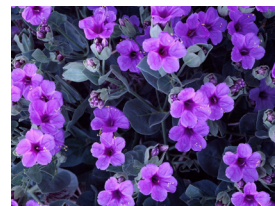
Helianthus annuus (Sunflower)

American natives, sunflowers are grown for beauty as well as harvested for seed. An annual plant, sunflowers have big, daisy-like flower faces of bright yellow petals (and occasionally red) and brown centers that ripen into heavy heads filled with seeds. Most sunflowers are remarkably tough and easy to grow as long as the soil is not waterlogged. Most are heat and drought tolerant.



Viola sp. (Violets)

Violas are primarily cool season bloomers. They are perfect for starting and ending the season in colder climates and for bridging the seasons in warmer zones, where they can remain in bloom throughout the winter. Viola is a large genus of 500 or so species of annuals, biennials, perennials, and subshrubs from temperate areas worldwide.



Cadmium Uptake:

Cerastium arvense (Field Chickweed)

Field chickweed is a spring-blooming matted or clumped perennial herb that pops up in a variety of open sunny habitats at elevations from sea level to over 12,000 feet. It is a native North American plant, grows only in wild habitats, and makes a nice addition to the spring wildflower display throughout much of North America.



FINAL DESIGN: FARMER'S MARKET

Plant Palette (cont.)

Claytonia perfoliata (Miners Lettuce)

A succulent plant with slender stems seeming to grow through middle of one circular leaf and topped by a raceme of tiny white flowers. The common name, miner's lettuce, refers to its use by California Gold Rush miners who ate it to get their vitamin C to prevent scurvy. Most commonly it is eaten raw in salads, but it is not quite as delicate as other lettuce.



Stellaria calycantha (Northern Starwort)

A species of flowering plant known by the common name northern starwort. It occurs in subalpine and alpine climates, in many types of moist, shady habitat. It is a rhizomatous perennial herb. Effective at absorbing cadmium in soils.



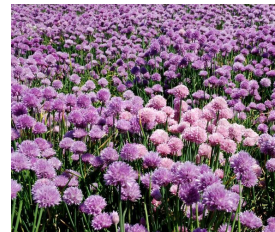
Achillea millefolium (Yarrow)

Yarrow accumulates zinc and lead in its plant parts and thus is effective at phytoremediation with heavy metals in soils. Intense red flowers surround bright yellow centers. This Achillea is a vigorous grower that will quickly form a dense weed-blocking mat. It is one of the most floriferous of the Achillea cultivars, presenting a solid block of red in early summer. An easy and rewarding production plant, it has very few pest problems.



Allium schoenoprasum (Chives)

Commonly called chives, it can be massed or use as an edger in herb gardens and vegetable gardens. Also effective as an ornamental in rock gardens or border fronts. May be grown in pots, or divisions may be potted up in fall for overwintering and continued harvest on a cool kitchen window sill. Phytoremediation in chives occurs in its ability to accumulate and tolerate cadmium although plants must be harvested.



Brassica rapa (Field Mustard)

Brassicaceae species are really useful to accumulate certain metals while producing high quantities of biomass in the process, and Indian mustard is the star of this group. Field mustard is an annual to biennial, herbaceous plant growing 8 to 36 inches tall. Its small, yellow flowers have both male and female parts, and are grouped into somewhat showy clusters at the top of each stem. The flowers are insect-pollinated.



Digitalis purpurea (Foxglove)

Tall spires provide striking color and good architectural height to the border and are particularly effective in front of dark backgrounds such as those provided by a wall or shrubs. Also effective in woodland gardens or naturalized areas. Phytoremediation takes place when the plant uptakes and accumulates toxins in its stems and leaves. Within this process the portion of the plant which is storing the toxic materials must be harvested and managed at a toxic waste site to prevent the plant from dying back and returning the toxin to the soil.



FINAL DESIGN: 4th AVENUE

Inventory and Analysis

The 4th Avenue focus area is a gateway to Market Square block in St. Paul's vision of a revitalized downtown, yet several infrastructure improvements need to be implemented in order to accommodate the anticipated future growth. Stormwater from the entire block routes down the alley causing flooding to buildings across 4th Ave. A lack of structured parking makes it difficult for visitors to come to events on busy market days. An abandoned shed structure by Fat Boy's BBQ lowers the aesthetic value of the block and has safety concerns. The alley space beside Stonebriar Apartments is used to house unsightly storage sheds.



Alley by Stonebriar Apartments currently used for storage.

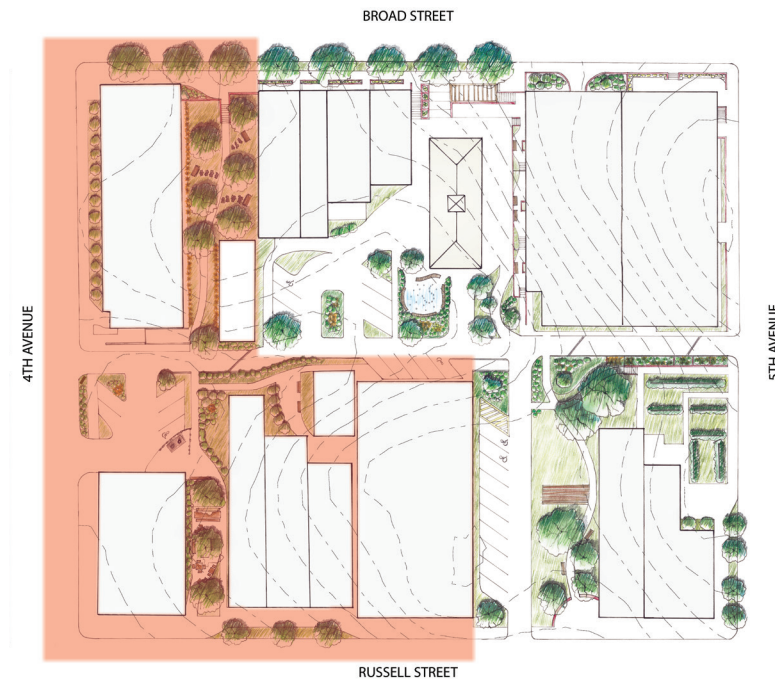


Current conditions for Fat Boy's BBQ grilling patio.

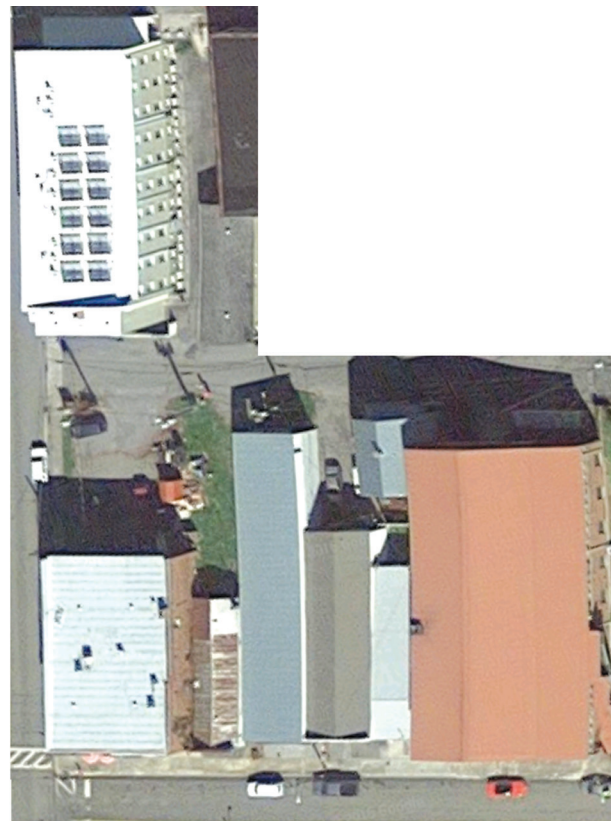
Design Description

Blue Bell Allee has been proposed as a pocket park to provide safe and pleasant pedestrian access from Broad St. to the alley with plenty of seating and blue bell planting beds. Fat Boy's BBQ's grilling area and the abandoned shed could be redesigned and expanded as a cooking patio with outdoor seating and a structured parking lot for visitors. Street trees can be added along Russell St. as a traffic calming measure and to improve the streetscape by providing shade to the sidewalk and street parking. A plaza with benches and landscaping have been proposed by the Visitor's Center to increase the visual appeal of the interior alley. Rain gardens should be added near the intersection of the alley and 4th Ave. to control stormwater runoff and prevent flooding.

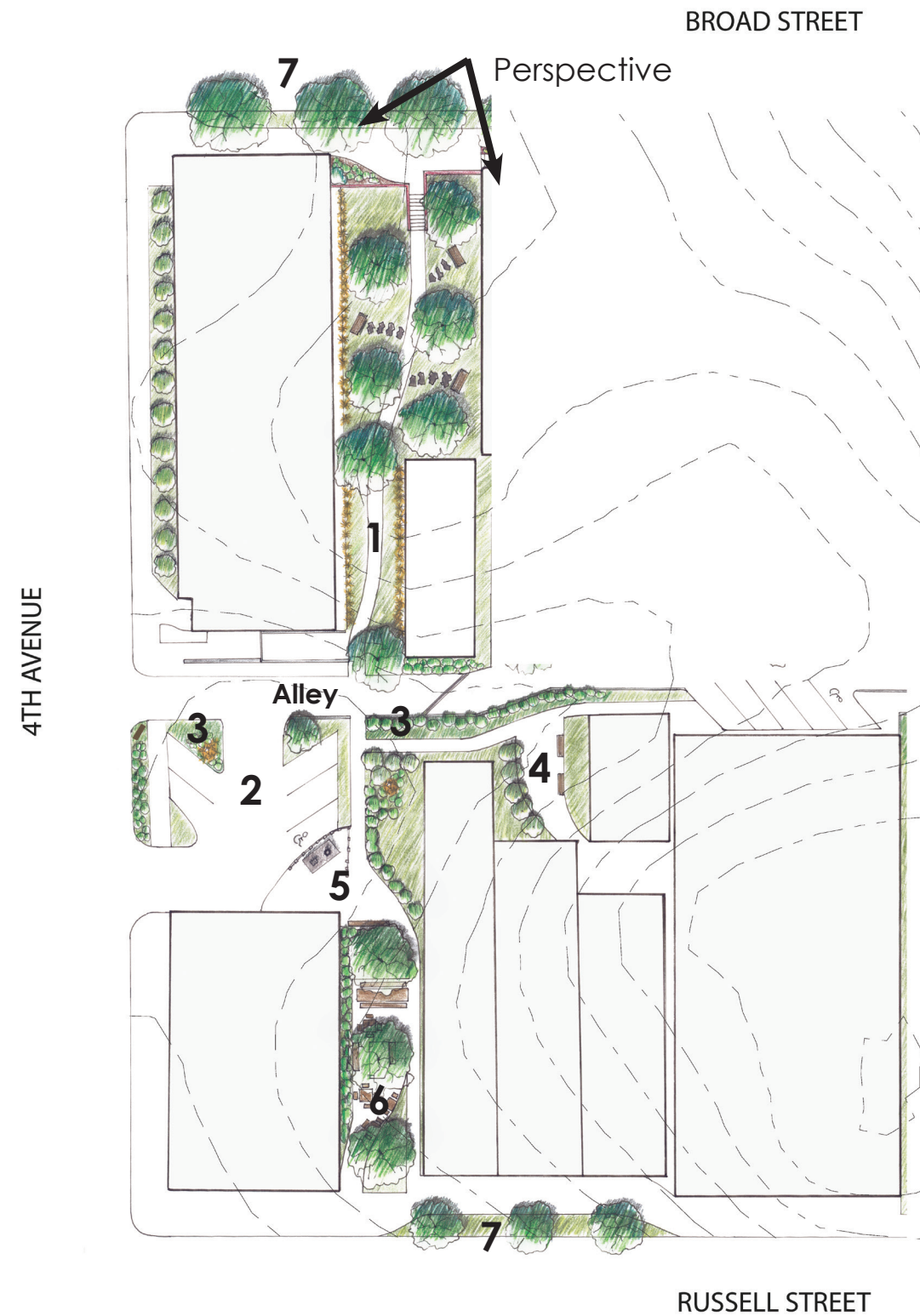
The conceptual master plan for the 4th Avenue focus area can be found on the following page with a perspective of proposed improvements of the alley following the conceptual master plan.



Locator Map



Existing Site Conditions



Proposed Site Design

- 1 Blue Bell Allee Park
- 2 Parking and Loading Zone
- 3 Rain Garden
- 4 Visitor's Center Plaza
- 5 Fat Boy's Grilling Patio
- 6 Outdoor Dining
- 7 Street Trees



Blue Bell Allee will become a featured park corridor with large shade trees, native plants, and benches for Stonebriar residents encouraging them to relax in the natural setting and to explore the path down to Fat Boy's BBQ.

FINAL DESIGN: 4th AVENUE

Plant Palette

Along Alley entrance from 4th Avenue:

Oenothera frutosa

Commonly called sundrops or southern sundrop, is an erect, day-flowering member of the evening primrose family. This native typically grows 15-30" tall and produces terminal clusters of bright yellow four-petaled flowers on stems clad with lanceolate green leaves. Each flower is short-lived, but flowers bloom in succession over a fairly long period of two months.



Phlox stolonifera

Phlox stolonifera 'Blue Ridge' is a lovely mat forming perennial wildflower. Plants have evergreen oval or oblong deep green leaves. In late spring or early summer, foliage is crowned by loose clusters of showy clear blue flowers. This cultivar is a fine groundcover for partly shaded woodlands or gardens with moist well drained soil.



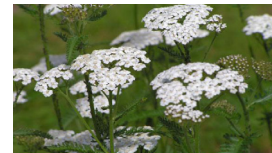
Schizachyrium scoparium

An upright and clump forming native grass with spiky blades of blue or green. Wispy silvery flowers occur in late summer, followed by a spectacular display of fall color changing from green and orange to deep burgundy.



Achillea millefolium

Finely textured, fern-like gray-green foliage create a soft background for the tall heads of bright-red flowers. A proven performer in hot, dry situations with poor soil.



By Fat Boy's BBQ:

Cephalanthus 'Sugar Shack'

Sugar Shack buttonbush is loved for its curious round summer flowers, ornamental red fruit and bright fall foliage. Its bare stems and branches are attractive in winter. This adaptable native shrub is the perfect size for small yards and gardens.



Yucca 'Color Guard'

Arching, sword-shaped, striped foliage of creamy-white against dark green that will provide great architectural interest. Spires of fragrant snow-white blooms in summer. Tolerant of wind, heat, humidity, and drought. Evergreen.



Juncus

May be grown at the edge of a pond or water garden, in boggy areas, among wet pebbles or rocks or in several inches of standing water. Good water garden accent. Effective in containers. Adds a certain amount of authenticity to transitional waterside areas. May help control soil erosion on moist banks.



FINAL DESIGN: 4th AVENUE

Plant Palette (cont.)

Along 4th Avenue between Holly trees:

Sedum ternatum

The succulent light-green leaves of Wild Stonecrop are covered with star-like white flowers in late spring and early summer. Less than a foot tall, it creeps rapidly to form a splendid groundcover in damp, rocky soils in light to medium shade. *Sedum ternatum* is native to the eastern and east-central U.S. Best in rock gardens or as a ground cover.



Iris cristata

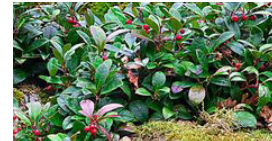
An excellent plant for early spring bloom in a shaded area of the rock garden, perennial border or woodland garden. Foliage forms a nice ground cover for woodland areas.



Blue Bell Allee by Stonebriar Apartments:

Gaultheria procumbens

Excellent ground cover for shady areas. Woodland gardens, rock gardens, foundations or native plant areas. Plants are an interesting complement to other acid-loving shrubs such as azaleas, rhododendrons, kalmias and blueberries.



Cercis (Hearts of Gold)

Exceptional native redbud displays a riot of color in early spring as brilliant lavender-purple blooms appear on bare branches. Spring foliage emerges red, maturing to gold; shaded leaves will be green. Large, heart shaped leaves are burn-resistant even in full summer sun. Feature as a specimen or mass as an informal hedge.



Carex divulsa

This sedge is one of the most adaptable of the ground-cover grasses. Its ability to look the same in sun or shade makes it a valuable asset in plantings that go in and out of full sun. Berkeley sedge is a good solution for areas under stress where lawn grasses often fail. The flowers are not particularly noteworthy.



Blue Bells

Best massed and left undisturbed in moist, shady woodland, wildflower or native plant gardens. Clumps may be sprinkled in borders or rock gardens, but, since plants go dormant in summer, they must be overplanted with annuals or used in conjunction with perennials (as ferns or hostas) which will expand as the growing season progresses. Included here because of the Blue Bells on Bluebell Island.



FINAL DESIGN: 5th AVENUE

Inventory and Analysis

The 5th Avenue focus area has an important role as an entertainment district in St. Paul's vision of a revitalized downtown, yet several infrastructure improvements need to be implemented in order to accommodate the anticipated future growth. Stormwater runoff from the roofs of the Lyric Theatre and building housing the Sugar Hill Brewery and Samson's Gym is piped directly down to the Farmer's Market and alley contributing to the 4th Avenue flooding. A lack of structured parking makes it difficult for visitors to come to Market Square events. The empty corner lot on 5th Avenue between the alley and Russell Street weakens the integrity of the block.



Existing green space to be proposed as a park and parking lot.



Empty lot by 5th Avenue discourages visitors from walking the block perimeter.

Design Description

The stormwater runoff from the Lyric Theatre, Sugar Hill Brewery, and Samson's Gym will be controlled by piping the water under the alley to terraced rain gardens to then be diverted to Russell Street. Urban infill has been proposed for the empty lot in the form of a new building, such as a cafe to draw visitors, and a hops garden to support the new brewery. Structured parking is now located between the alley and Russell Street for visitors with clear handicapped access. A park has been added beside the parking lot with a platform stage to encourage local theater and educational lectures. Street trees can be added along 5th Avenue as a traffic calming measure and to improve the streetscape by providing shade to the sidewalk and street parking. A shaded plaza has been placed near the Design Printers as an entrance to draw visitors into the park and interior of the Market Square block.

The conceptual master plan for the 5th Avenue focus area can be found on the following page. Perspectives of proposed improvements of the 5th Avenue zone follow the conceptual master plan.

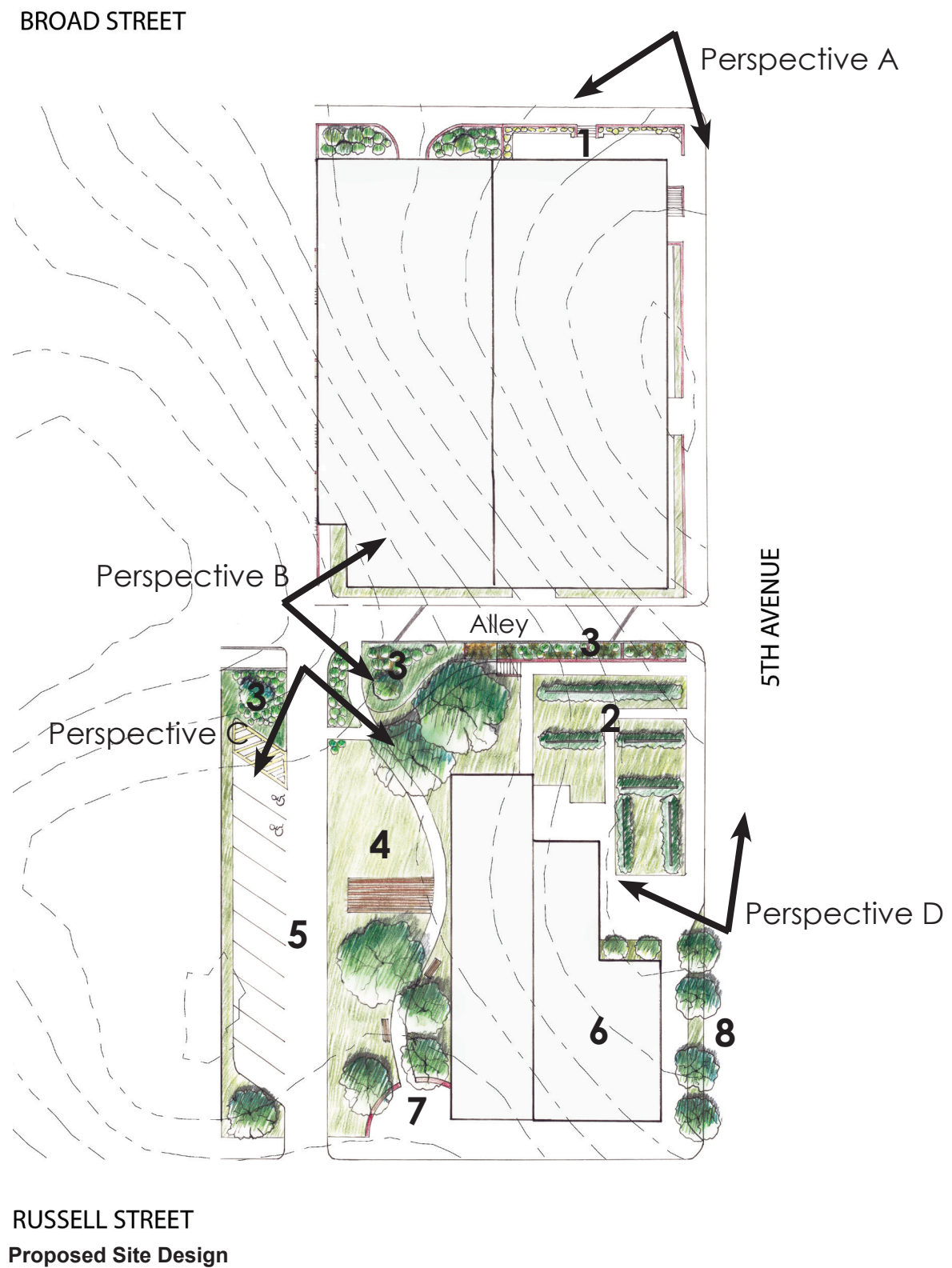
FINAL DESIGN: 5th AVENUE
Conceptual Master Plan



Locator Map



Existing Site Conditions



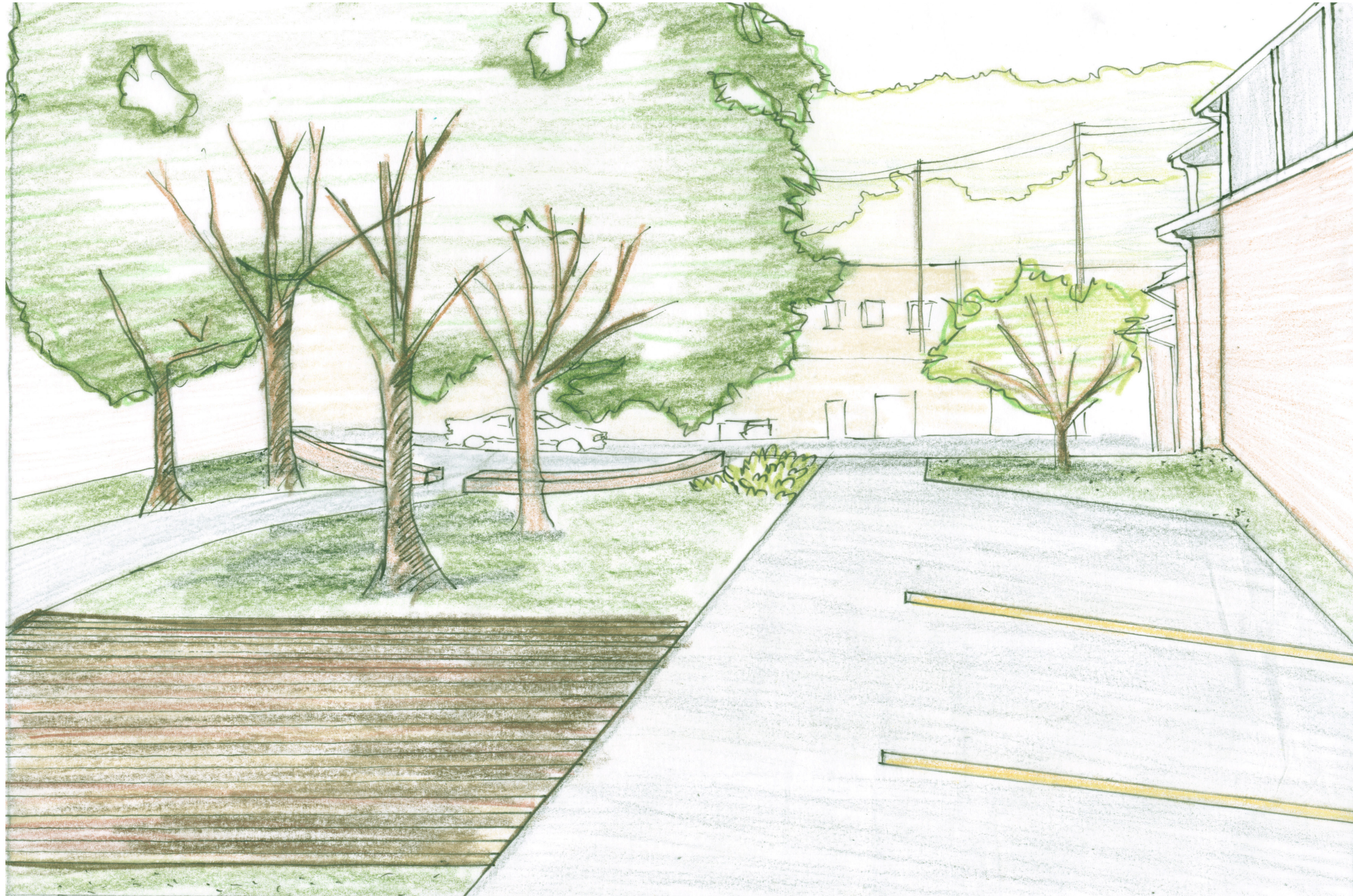
- 1 Sugar Hill Brewery Patio
- 2 Sugar Hill Brewery Hops Garden
- 3 Rain Garden
- 4 Open Stage Park
- 5 Structured Parking
- 6 Urban Infill
- 7 Design Printer's Plaza
- 8 Street Trees



Sugar Hill Brewery's opening will strengthen the identity of the 5th Street corner while a landscaped patio will encourage visitors to stay for a bit, sip a craft beer, and sightsee the rest of St. Paul's Market Square.



The addition of terraced rain gardens along the central alley will help control stormwater runoff volume while also adding landscaping and encouraging visitors to stroll along to 5th Avenue.



The Russell Street lot transforms into structured parking and a multipurpose park that includes a streetside plaza, additional rain gardens, and a wooden platform stage to add to the educational and theatrical themes of the Market Square.



Sugar Hill Brewery's hops garden will be a restful retreat for visitors from the nearby busy streets and encourage them to stay and sample some local craft beers.

FINAL DESIGN: 5th AVENUE

Material and Inspiration Palette



A simple wooden platform stage will add to the theatrical theme of the Market Square block.



The addition of street trees along 5th Avenue would improve the streetscape by providing shade to the sidewalk and parked cars.



Additional seating throughout the Open Stage Park, along 5th Avenue, and in the Design Printer's Plaza will create a welcoming environment for visitors.



Terraced rain gardens placed throughout the alley will help to control the volume of stormwater runoff and filter contaminants.



A hops garden will create a restful green space from the nearby busy streets.



Outdoor seating by the Sugar Hill Brewery will enhance the thriving main street feel of the Market Square block.

FINAL DESIGN: 5th AVENUE

Plant Palette

Along Alley exit to 5th Avenue:

Oenothera frutosa

Commonly called sundrops or southern sundrop, is an erect, day-flowering member of the evening primrose family. This native typically grows 15-30" tall and produces terminal clusters of bright yellow four-petaled flowers on stems clad with lanceolate green leaves. Each flower is short-lived, but flowers bloom in succession over a fairly long period of two months.



Phlox stolonifera

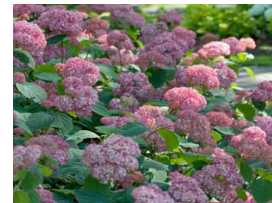
Phlox stolonifera 'Blue Ridge' is a lovely mat forming perennial wildflower. Plants have evergreen oval or oblong deep green leaves. In late spring or early summer, foliage is crowned by loose clusters of showy clear blue flowers. This cultivar is a fine groundcover for partly shaded woodlands or gardens with moist well drained soil.



Along 5th Avenue:

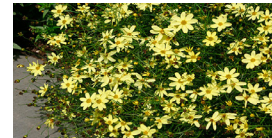
Hydrangea aborescens

Invincibelle Spirit is the first-ever pink Annabelle hydrangea, producing loads of snowball shaped blooms from early summer to first frost. Dark pink buds open to hot pink flowers, fading to soft pink and finally to green. This hardy adaptable native selection is a reliable bloomer, even after the harshest of winters, and is also quite heat tolerant. Deciduous.



Coreopsis moonbeam

Good perennial for borders. Also effective in naturalized areas, native plant gardens or cottage gardens. Good plant for areas with poor, dry soils.



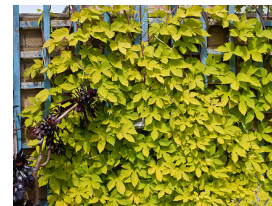
Ilex verticillata

Year round interest, highlighted by the showy display of red berries in winter. Mass or group in shrub borders, foundations, native plant areas or bird gardens. Hedge. Excellent shrub for moist soils in low spots or along streams and ponds. Although an attractive shrub, the species is infrequently sold in commerce because of the many excellent cultivars which generally produce showier flowers and larger, more abundant fruit.



Golden hops

We love golden hop vine for its spectacular golden-yellow maple-like leaves that often transform in color later in the season into a vivid lime green. These intriguing plants energetically climb walls, fences and trellises, creating breathtaking displays of vibrant color. In fall, small, aromatic funnel-like green flowers bloom in clusters with the female blossoms revealing the hops, often used in beers to add flavor.



FINAL DESIGN: 5th AVENUE

Plant Palette (cont.)

Park between Alley and Russell Street:

Ilex opaca 'Maryland Dwarf'

Foliage provides excellent color for the winter landscape, and cuttings of the same are popular additions to Christmas wreaths and decorations. Berries are attractive and a good winter food source for birds. Hedges. Woodland gardens.



Mertensia virginica

Best massed and left undisturbed in moist, shady woodland, wildflower or native plant gardens. Clumps may be sprinkled in borders or rock gardens, but, since plants go dormant in summer, they must be overplanted with annuals or used in conjunction with perennials (as ferns or hostas) which will expand as the growing season progresses.



Amelanchier

A shrub or small tree prized for its brilliant orange-red fall color and disease resistance. Clusters of fragrant white flowers give way to small purplish black fruit often used in jams and jellies. Use in shrub borders or as a small tree. Deciduous.



Along Russell Street:

Rhus

Tough groundcover for banks and areas of poor, dry soil. Divided leaves are fragrant when brushed against or crushed, foliage displays excellent red fall color. Deciduous.



Hypericum prolificum

Easily grown in average, medium, well-drained soil in full sun to part shade. Tolerates wide range of soils, including dry rocky or sandy soils. Also tolerates some drought. Mass or group in the shrub border or native plant garden.



Panicum Shenandoah

'Shenandoah' is truly a plant for all seasons. In early summer, its leaf blades are tipped in red, and by autumn, the entire leaf is a rich burgundy color, topped by pink plumes. In winter, the leaf color fades to beige; the blades persist and offer cover to birds.



Crateagus viridis

Excellent spring flowering tree for lawns and streets. Good fall color and persistent fruit help provide year round interest. Pollution tolerance makes it a good candidate for urban plantings.



PART 2: PRELIMINARY ANALYSIS AND DESIGN

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SITE INVENTORY AND ANALYSIS: MARKET SQUARE BLOCK

Poor Drainage Conditions:

A weakness is the disorganized drainage and gutter patterns on-site. Water from the majority of the structures is sent directly from a down-spout and as a sheet flow onto the alley. This causes several issues such as the polluted water flows almost directly into the biologically rich Clinch River. Secondly, the water reaches the bottom of the block along 4th Avenue quickly causing major flooding.

Steep Terrain:

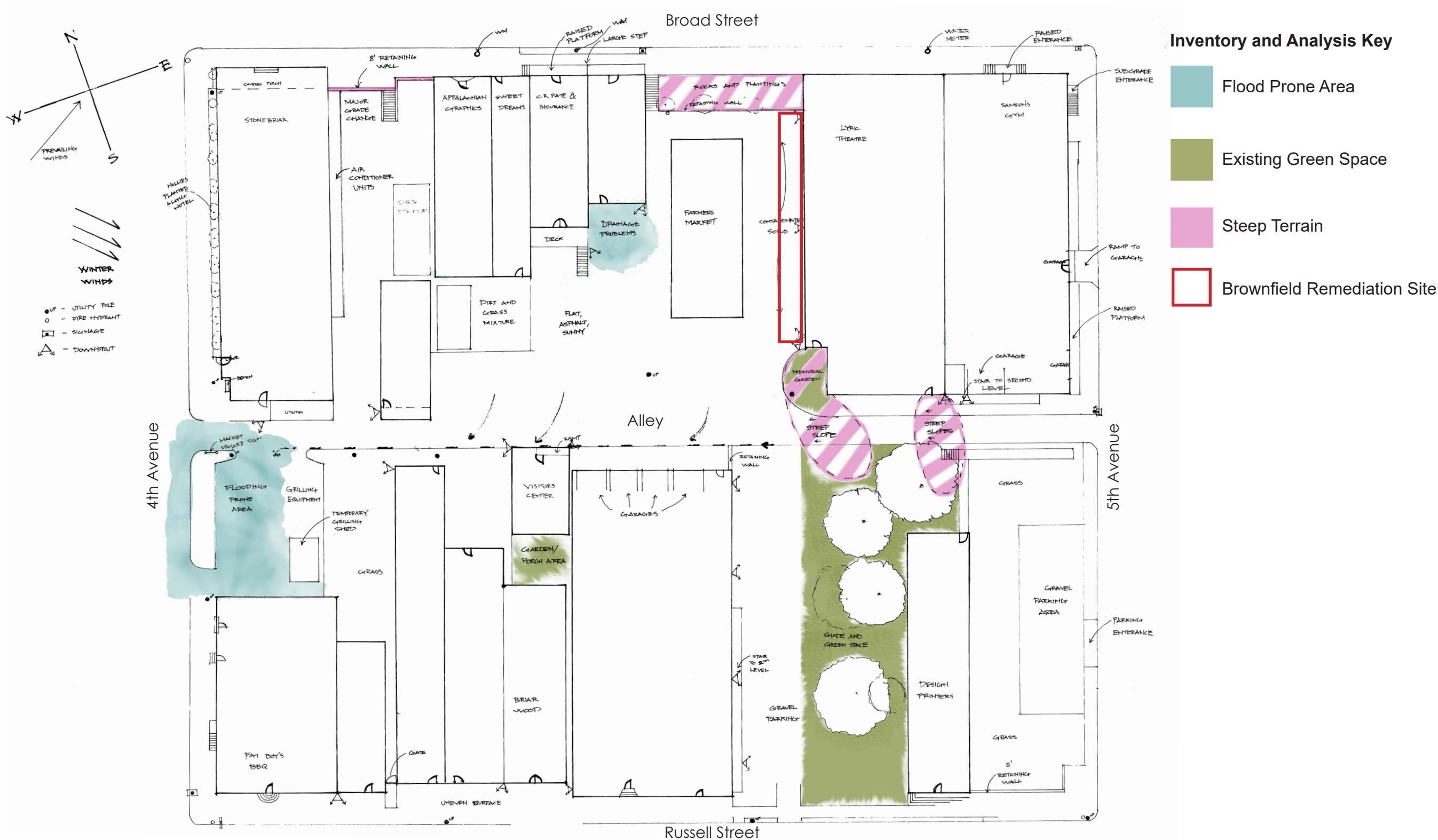
There are several zones of very steep topography on along the block. The thirty feet of elevation change across the 380 foot length of the block would be manageable except that the majority of the grade change is confined to several finite areas, particularly near 5th Avenue. The challenging topography makes the site very difficult to traverse, particularly for handicapped or elderly individuals or during treacherous weather conditions. Grading out the steep terrain benefits pedestrians, and also improves storm-water management by slowing down runoff.

Brownfield Site:

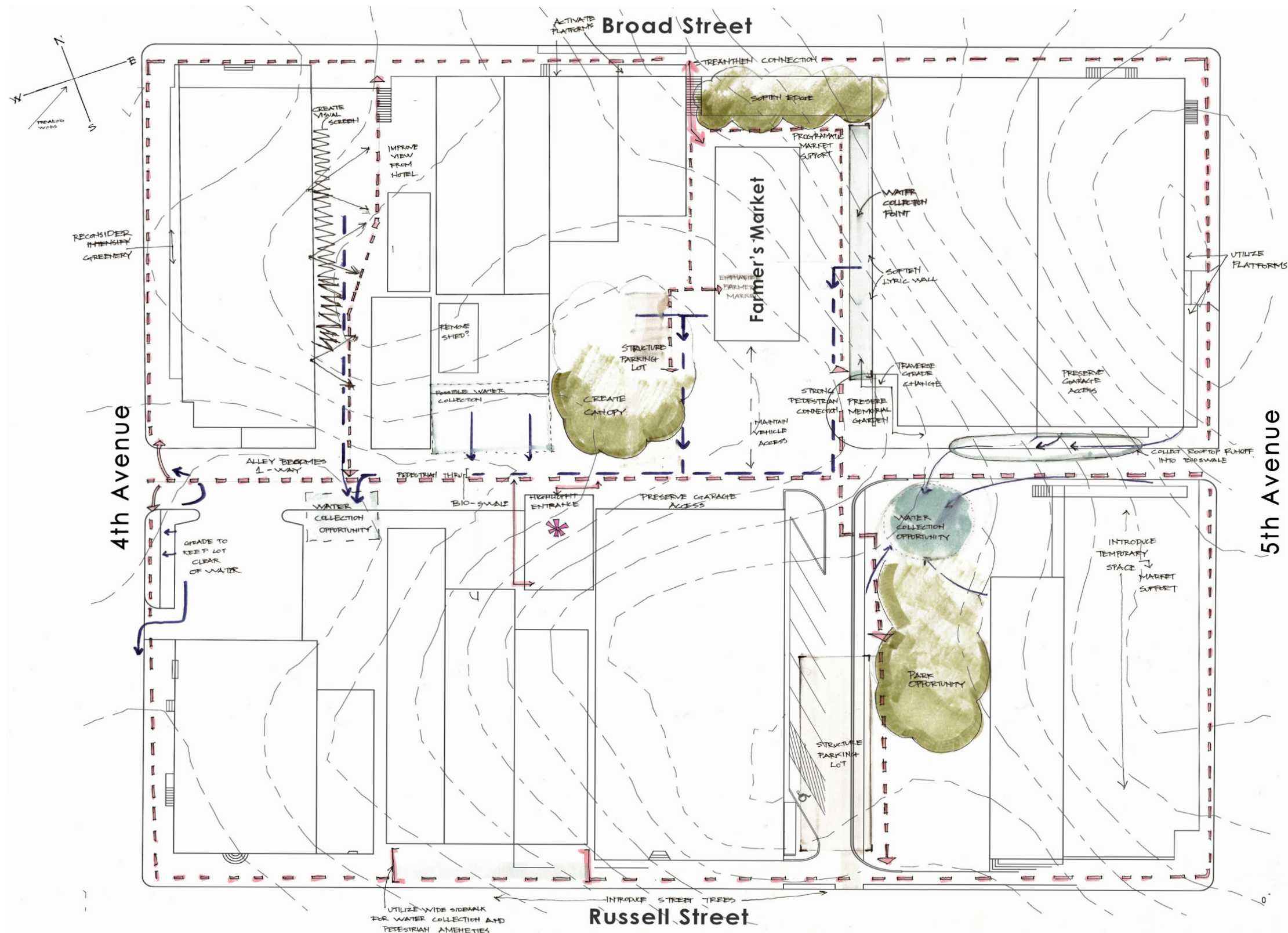
There is a designated brownfield site within the Market Square located under a 10 ft wide asphalt strip along the edge of the Lyric Theatre nearby the Farmer's Market. Cardno, an environmental services company, has conducted soil testing and determined that there are significant levels of lead and cadmium present. The existing asphalt surface acts as a cap and prevents the contaminants from infiltrating the stormwater runoff and entering the Clinch River. Should the asphalt layer be broken however, remediation actions must be taken to ensure the proper handling and disposal of contaminated materials.

The inventory and analysis maps and preliminary design concepts can be found on the following pages.

MARKET SQUARE INVENTORY AND ANALYSIS MAP



MARKET SQUARE INITIAL CONCEPT DIAGRAM



PRELIMINARY CONCEPTUAL DESIGN

Introduction

After the inventory and analysis was completed, the CDAC team had an in-house design charette and developed two preliminary conceptual design proposals, which were presented at a community meeting for feedback.

The concept diagram and conceptual design proposals can be found on the following pages.



CDAC Team Members: Ariel Barrientos, Daphne Williams, Mike Stelfox, and Elena Alves.



CDAC Team Members: Lauren Delbridge, Alex Jones, and Austin Chase.

PRELIMINARY CONCEPTUAL DESIGN

Concept Diagram



- Pedestrian Route
- Vehicular Route
- Water Movement
- Gathering Space
- Water Collection Point

The concept diagram explores the relationship between the pedestrian experience and the water flow from the top of the alley to the bottom. The pedestrian routes, defined by the dashed pink lines, follow the movement of water across the site, indicated by the dashed blue line. Water is collected in bioretention beds or in sub-surface water storage modules in the areas filled with blue. This organizes the drainage pattern while reducing the risk of flooding on the block. Major community gathering spaces are highlighted in pink and are connected to each other via pedestrian routes. The gathering spaces include outdoor dining areas, lawn seating around a stage, and the space around the existing Farmer's Market. Vehicular traffic, indicated by the orange striped line, becomes one-way through the alley with traffic moving from 4th Avenue to 5th Avenue.

PRELIMINARY CONCEPTUAL DESIGN

Conceptual Design Proposal 1



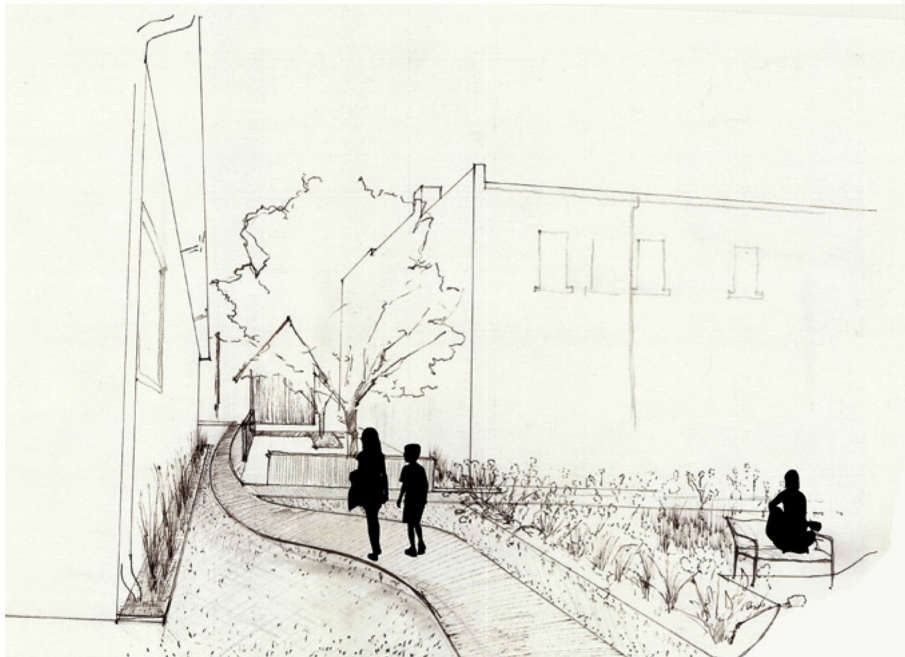
CONCEPT PLAN CALLOUTS

- ① Blue Bell Allee
- ② Grilling Area
- ③ Water Storage Garden
- ④ Outdoor Dining Area
- ⑤ Bio-retention Beds
- ⑥ Market Stage
- ⑦ Park Theatre
- ⑧ Hops Production Garden
- ⑨ Beer Garden
- ⑩ Raised Seating Platforms
- ⑪ Parking



Structured parking is introduced near the Farmer's Market with green space serving to collect rainwater and separate pedestrian paths from vehicular routes.

PRELIMINARY CONCEPTUAL DESIGN
Conceptual Design Proposal 1



Water is collected at the bottom of the block in underground rain storage modules with a low planted garden on top. Grilling operations are moved next to Fat Boy’s BBQ with an associated dining area.



Next to Stonebriar Apartments, there is a proposed allee of trees with underplantings of Virginia blue bell and native grasses to screen the air conditioner units adjacent to the building.



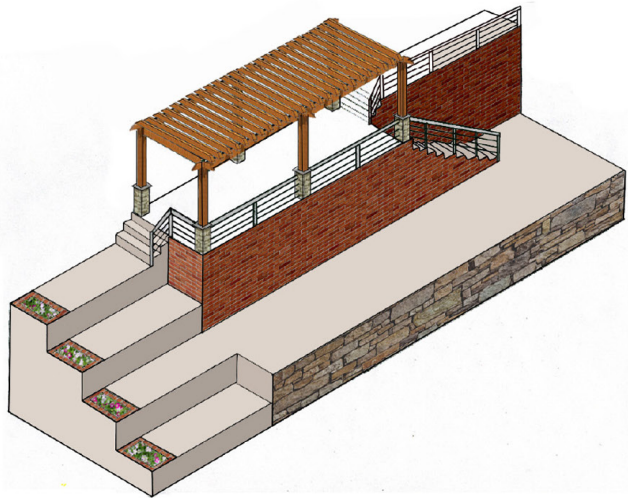
The green space adjacent to Design Printers is proposed as a park with an informal stage and lawn seating to overflow from the theatre. The green space is separated from the proposed parking lot by a linear strip of bioretention beds.

PRELIMINARY CONCEPTUAL DESIGN
Conceptual Design Proposal 2



CONCEPT PLAN CALLOUTS

- ① BBQ Grilling Area
- ② Children's Play Area & Splashpad
- ③ Sculpture Garden
- ④ Outdoor Dining Area
- ⑤ Bioretention Bed
- ⑥ Market Stage
- ⑦ Artful Water Sequence
- ⑧ Small Bridges Over Rain gardens
- ⑨ Rain Gardens
- ⑩ Proposed Urban Infill; Cafe
- ⑪ Parking



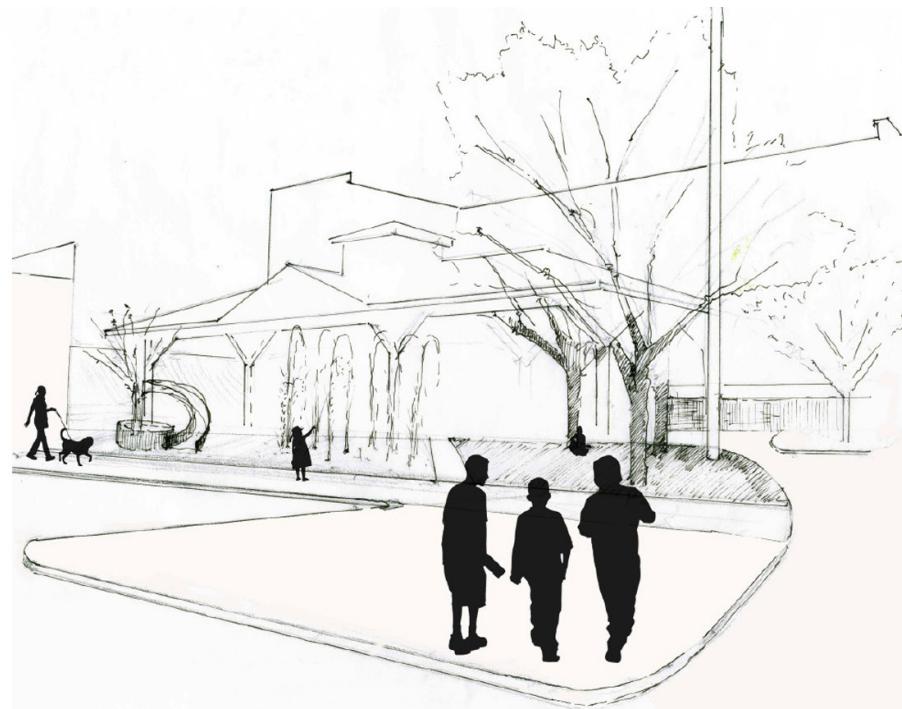
The upper market along Broad Street is supported by a pergola stage structure with platforms for table vendors.

PRELIMINARY CONCEPTUAL DESIGN

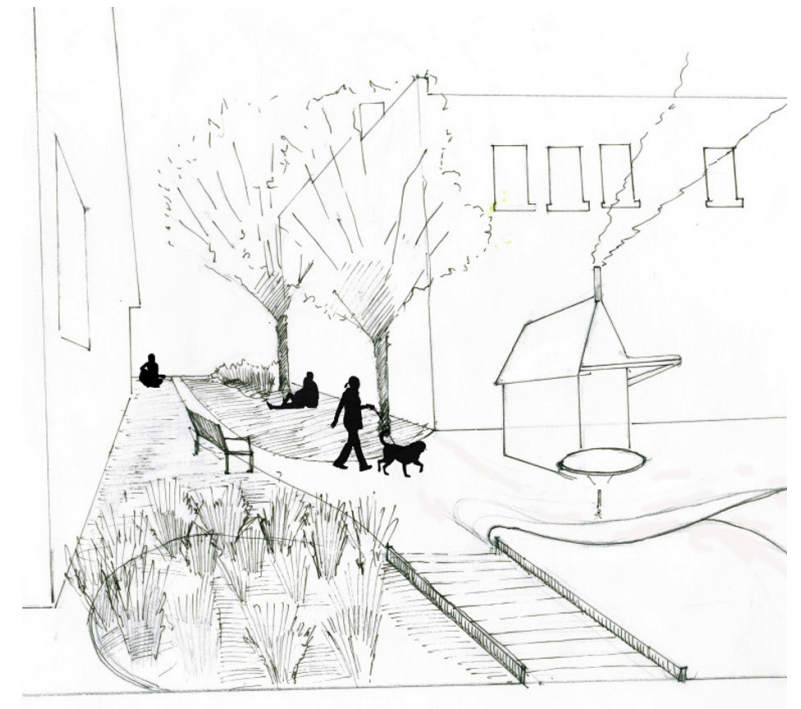
Conceptual Design Proposal 2



Existing green space is enhanced with shrubs and lower plantings, a path network, and water catchment capabilities.



A splash pad and play area is proposed next to the Farmer's Market so that children can play nearby where parents can shop.



An outdoor dining area is proposed near the BBQ area which is located near a pedestrian walkway.

Part III: Appendix

FEEDBACK FROM PRELIMINARY DESIGN PRESENTATION

4/18/2016

St. Paul Preliminary Design Presentation Meeting Notes

Sketch Pad Notes:

- 1) Non Native Plants
 - a. Check with Daphne on plant selections
- 2) One Way Alley Issue
 - a. Rescue vehicle needs two way access
- 3) Can they afford Dominion Project? Too expensive
 - a. Contractor estimated Phase One to be \$150,000
 - b. Redesign concept
 - c. Send information about Rain Modules concerning capacity and stress induced failure
- 4) Property Owner Concerns
 - a. Loss of Parking
 - b. Maintenance and H2O Treatment
 - c. Costs
- 5) Private Property at proposed parking locations
 - a. Costs associated with property parking loss
- 6) Focus points
 - a. Long term maintenance costs
 - i. Provide maintenance plan
 - b. Volume of possible water treatment
 - c. Native plants
 - d. Remove bump outs
 - i. Stuart Echols
 - ii. Bump outs in Seattle
 - e. Design 1
 - i. Pros
 1. Seating for BBQ between Buildings
 - ii. Cons
 1. Parking
 2. Tree at column regarding shade
 3. Design
 - f. Design 2
 - i. Pros
 1. Stage in regards to existing market
 2. Parking to decide entrance to market
 3. BBQ Smoker in back and seating area in back
 4. Like future parking option in front near RV
 - ii. Cons
 1. Lyric – no bump outs
 2. Visitor center front landscaping

Pros / Cons of Proposed Designs:

- 1) Design 1
 - a. Pros
 - i. Love Overall Design
 - ii. Stage location might be more affordable
 - iii. Like rain garden sites and water storage areas- looks great
 - iv. One way – good
 - v. Beautiful, multi-use, nice compliment to other improvements
 - vi. Great ideas- beautiful outcome
 - vii. Really like the brewery idea and the Hop Garden

FEEDBACK FROM PRELIMINARY DESIGN MEETING

b. Cons

- i. Too expensive*
- ii. Problems with property owners*
- iii. Loss of parking*
- iv. Maintenance needs*
- v. Longevity of solutions*
- vi. Estimate of water treatment volume*
- vii. Use only native species*
- viii. Didn't like the IDA parking area as much as Design 2 solution*
- ix. Concerns about one way Alley*
- x. Can't afford Dominion project as proposed*

2) Design 2

a. Pros

- i. Really love the Idea!!*
- ii. Like stage location and design a lot*
- iii. Like angled parking in lots*
- iv. Like all the green spaces, rain gardens, etc.*
- v. Like draining water off Lyric and Brewery underground- great idea*
- vi. Best Plan*
- vii. Beautiful, multi-use, family friendly, includes more aesthetic features and more stormwater controls*
- viii. Best plan- love the plantings*
- ix. Love the stage and vendor space on Broad St.*

b. Cons

- i. Too expensive*
- ii. Problems with property owners*
- iii. Loss of parking*
- iv. Maintenance needs*
- v. Longevity of solutions*
- vi. Estimate of water treatment volume*
- vii. Use only native species*
- viii. Use of private property in the Jiller & Jiller space and the Malinary Space*
- ix. No bump outs allowed by VDOT*
- x. #11 – Couldn't do parking here because of easement issue. Only against building.*
- xi. Can't afford Dominion project as proposed*

3) Comments on Both

a. Pros

- i. Like both plans but need to discuss potential costs*

STAKEHOLDERS MEETINGS

6/17/16

Conference call with Joe Morici, Cardno and Lou Wallace, town of St. Paul
CDAC Staff Present: Elizabeth Gilboy and Patricia Stroud

The 10' strip has lightly above normal amounts of lead and cadmium. It also has arsenic, but at okay levels. These are fine in the soil as long as we leave them sealed under the asphalt, but as soon as we break that protective layer there must be remediation.

Joe noted that VA DEQ (Meade Anderson) will have cleanup funds available 7/1/16. One idea would be to use the DEQ funds (up to \$50,000) for remediating the soil and then the Dominion funds (\$22,500) for construction. DEQ likely would not allow much, if any, of the funds toward the Rain Store 3 units. If this is the case, then that leaves only the \$22,250 for dealing with the 10' strip. The Dominion grant ended 6/30/16, but they got an extension to the end of October. The money/implementation would need to be completed by then.

Lou Wallace said St. Paul loves some of the elements CDAC proposed. The hotel just had a grand ceremony for renovating, so the whole area has to be worked on for aesthetics and stormwater control, but they can't afford anything! They have applied for 1/2 million dollar grant to renovate the Lyric theater, which would overflow to the market as an open air venue.

Lou spoke to the one of the construction workers from the hotel, who is LEED certified. He said the stairs from the Lyric to the Market are integral to the situation (connecting the Lyric visitors to the Market and to overcome the steep slope) and if they can't be done in concrete, they should be done in cedar wood such as in the market structure. - And to match their new boutique hotel that features a roadhouse. Lou referred to it as "elegant rustic". Also he found the old jail bars and thought he could remake them into the handrails for the stairs. They meet code for spacing guidelines.

Eventually the town would like to transform the alley into a continuous greenspace.

Also Lou said that UVA Wise was gifted the Oxbow Center, which is along the Clinch River in St. Paul. UVA Wise will consequently be looking to create a "campus" that is walkable throughout town that connects the Oxbow Center, the Lyric theater, Estonoa, etc.

The theater will be used as a lecture hall for classes, which means the outdoor area needs to be an outdoor classroom, so whatever CDAC proposes (ie Rain Store 3s, rain gardens, etc) needs to serve as an educational opportunity.

If we are recommending Rain Store 3, there must be a way to maintain them and show and prove it works.

We need to focus entirely on the runoff from the roofs of the Lyric and the Brewery. By diverting that area's runoff, the volume down the alley will roughly be cut in half. Currently there is an underground pipe that routes water from the Lyric roof to the '10 ft section'. We can instead divert the pipe water to be stored under the proposed stairs and to eventually go down to Russell St. The runoff from the brewery will be piped under the alley to rain gardens near the stage park area and allowed to flow to Russell St., which is ideal because their stormwater system is about to be upgraded. Also Lou really wants to see structured parking implemented on the IDA property next to the stage park.

STAKEHOLDERS MEETINGS

In summary, it was decided that CDAC would rework the stairs from the theater to the market and maybe some Rain Stores could be under the stairs. We will also beef up the rain gardens in the IDA lot and perhaps adjacent property. Lou will ask the owner. The idea would be to change the roof run-off direction from going down the alley to over to the rain garden. Once the rain garden fills, there would be a pipe that directs it to the storm water system on Russell St.

Cardno will do a roof run-off calculation. The gap is knowing how much rain garden is needed for how much run-off.

Joe Morici will also look at the soil test results for the IDA property to see if there was any contamination to see whether it would qualify for the DEQ funds of up to \$50,000. These funds are available for the next two years so there is time to create a proposal to utilize the money.

STAKEHOLDERS MEETINGS

06/30/2016

Community Design Assistance Center

Stormwater Management Meeting with Virginia Tech Landscape Architecture

Professors: Terry Clements and CL Bohannon

CDAC Staff Present: Elizabeth Gilboy, Amelia Hulshult, Patricia Stroud, and Daphne Williams

- Soil type on Russell St.? Can it filter? A rain garden will not work in certain soils.
- How big is the remediation area? 10 ft. strip currently beneath the asphalt. If the asphalt is removed can the \$50,000.00 grant be used for remediation?
- What are the contaminants from the roof?
- Petroleum has a low infiltration rate.
- Don't let surface stormwater mingle with other contaminants. Keep the pollutants in the soil beneath the asphalt.
- Consider that Birch and Poplar trees can bind pollutants depending upon what the specific pollutants are. These planted with secondary plants may be an option; phytoremediation.
- Consider dense plantings in 'troughs' instead of a pit.
- The structural soundness of the foundation of the building is also important as digging near it could compromise the building.
- Capacity issue: how much water do you need to detain.
- There is minimal water flowing off of the street. Most of it comes from the roof.
- A detention pit (not rain garden) where the water is sent through underground piping is a better option. A gravel filter or surface drain connected to another drain, and then sent to the street.
- You can make the pit 'pretty'. But its basic purpose is just to move the water. The quantity of water is still the issue.
- In order to hold the water from a 2 year storm the 'pit' would need to be 1700 square feet which would basically take up the whole area. If the pit were made deeper, thus taking up less space, it would become a safety issue from someone falling in.
- Cisterns are not recommended. There are multiple legal issues as well as maintenance hassle.
- The most logical option is to excavate for an underdrain, add sand and gravel, and put lawn back (or even gravel). This would allow some filtration of the particulates out of the surface water.
- Firestone is now making a permeable, subsurface filtration system using rubber tires. This has not been studied and cost may be an issue.
- Utilize design for parking and piping from the other existing drains.
- Separate area by capacity into phases. "You can't get it all, but you can get this..."
- Offer incentives to Sugar Hill Brewery and Lyric Theatre for water runoff from their roofs which is causing the problem. Let them know they will be taxed and the cost incurred. They can make improvements now instead of later.
- Phytoremediation strip on top of pipe is possible which would allow for minimal excavation. Fairly narrow strip needed for the pipe. This could also be the educational component that the town was looking for.
- Be thinking of a list of possible plants to be used to absorb the cadmium and lead that are on site.

STORMWATER REMEDIATION CASE STUDIES

Stormwater Solution Options and Case Studies for St. Paul, VA

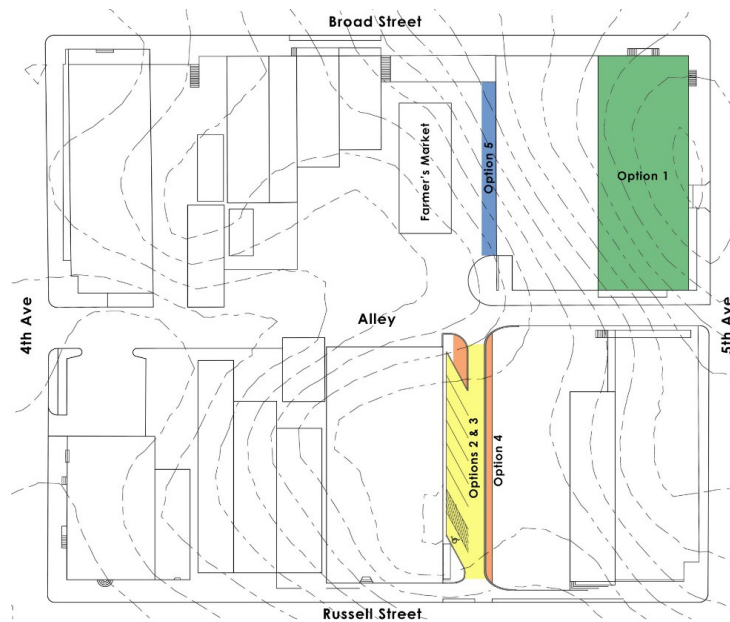
July 11, 2016

Overview

A proposal of recommended best management practices for St. Paul, VA Market Square Block focusing on filtering and diverting the stormwater from the Lyric and Sugar Hill Brewery buildings to Russell St as well as remediating the contaminated soil along the 10 ft strip neighboring the Farmer's Market and the Lyric Theater. A combination of suggested practices would be the most effective at remediating the existing issues.

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community
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assistance
center

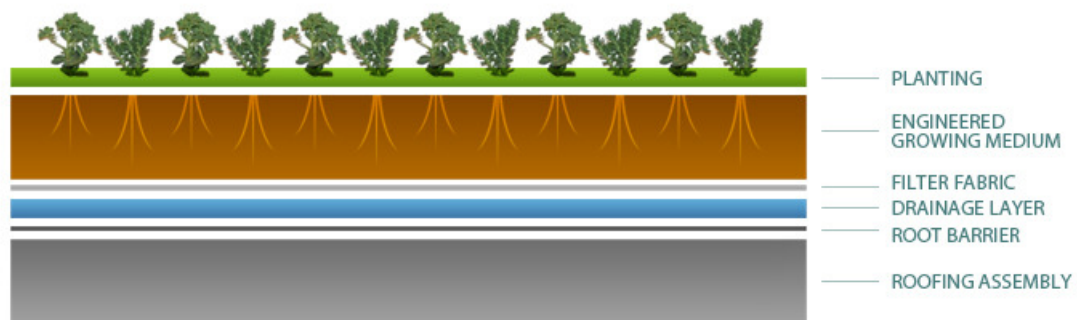


STORMWATER REMEDIATION CASE STUDIES

Solution Option 1: Green Roof on Building Containing Samson's Gym and Sugar Hill Brewery

How does it work?

Green roofs have a layer of plant material that absorbs water like a sponge. They capture water when it rains, slowly releasing it through evaporation and plant use. Green roofs can significantly reduce the amount of rain water that would otherwise run off an impervious roof surface. Green roofs can also help reduce building energy usage and noise levels while increasing the durability and lifespan of the roof compared to conventional roofs. Green roofs are being increasingly used in urban areas where space constraints limit the use of other stormwater management practices.



Section of Green Roof: Image from Greenrise Technologies - Readyville, TN

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Costs

Depends on the condition of the roof, the total surface area, and the type of green roof system to be installed. An extensive system is recommended for this project and can range from \$8-\$20 per square foot based on estimate information from Apex Green Roofs- Newberry, MA. Estimated project costs for 9,700 sq. ft. range from \$77,600-\$194,000.

Maintenance

Following construction, perform the following as needed:

- Water your roof to promote plant growth and survival.
- Inspect the vegetated roof and replace any dead or dying vegetation.

Conduct the following on a semiannual basis:

- Inspect the waterproof membrane for leaking or cracks.
- Many practitioners recommend an annual application of slow-release fertilization during the first five years of the roof garden.
- Weed the green roof to remove invasive plants.
- Inspect roof drains, scuppers, and gutters to make sure they're not overgrown or that they don't have organic matter deposits. Remove any accumulated organic matter or debris.
- Inspect the green roof for dead, dying, or invasive vegetation. Plant replacement vegetation as needed.
- Plants should be added to bare areas.

STORMWATER REMEDIATION CASE STUDIES

Recommended Plants



Marguerite daisy



Bellflower



Iceplant



Dianthus



Hawkweed



Coral Carpet



Oregano



Stonecrop



Creeping Thyme

Green Roof Case Study: Justice Center, Seattle, WA (2004)

About the Project:

The Seattle Justice Center achieved a Silver LEED™ rating from the U.S. Green Building Council. The Seattle Justice Center has two major components: the Police Headquarters and the Municipal Courts. The green roof is located on the top floor of the Municipal Courts portion of the building, adjacent to the Jury waiting rooms. This accessible roof garden provides a welcome respite for citizens serving jury duty, and includes a partially covered roof deck. The runoff overflow from the Justice Center green roof is collected in the stormwater retention system. This system has been oversized to perform both stormwater management and to store water for irrigation of landscaping in the plaza on the entry level of the building.



STORMWATER REMEDIATION CASE STUDIES

Design:

The landscape concept for the Justice Center green roof complements the water-themed design concept incorporated into the new three block downtown civic campus plaza. The landscape design for the Justice Center garden roof is naturalistic, with varying textures in the groundcover and accents of sheep fescue.

Existing Roof/ New Roof	New Roof
Green Roof Area	7,300 square feet
Green Roof Type	Extensive
Green Roof System	American Hydrotech Inc.
Accessibility	Visitors
Installation season	Jul-04
Establishment Period	One Year
Green Roof Slope	Flat
Soil Mix/ depth	6 inches
Plant Type	mostly native plants
Irrigation	Yes, establishment only
Structural Load	50 lbs/sq.ft, saturated
Cost	\$19.25 per sq.ft.

Current Status:

The green roof was installed in mid-summer 2004. The roof is green and the plants are thriving. About one third of the plants had to be replaced in the establishment period. The initial design intent was to irrigate the plants during the establishment period only. However, the system was retrofitted later for ongoing summer irrigation.

Base Specifications:

Soil Mix/ Soil Depth: Custom mixture of nitrolized pine bark*, sand, pumice, nutrients and peat. * Bark should usually be used only as mulch because the bark breaks down with time and uses up the nitrogen in the soil, competing with plant roots for existing nutrients. To correct this problem 2 to 3 inches (15 cubic yards) of compost was added on top of the soil to enrich it.

Water Retention / Drainage: Floradrain 40, lightweight panels made of 100% recycled polyethylene molded into specially designed retention cups and drainage channels

Filter Fabric: A geotextile filter sheet, Systemfilter SF, was unrolled over the entire drainage/water storage/aeration layer. The filter sheet, made of non-woven polypropylene fibers, helps prevent the loss of soil, mulch and plant debris *while allowing for the flow of moisture.*

Plants & Nutrients: Many of the plants used for the Justice Center roof are native to the area, such as Point Reyes Creeper and Barren Strawberry. Fertilizer use was specified only during installation.

References

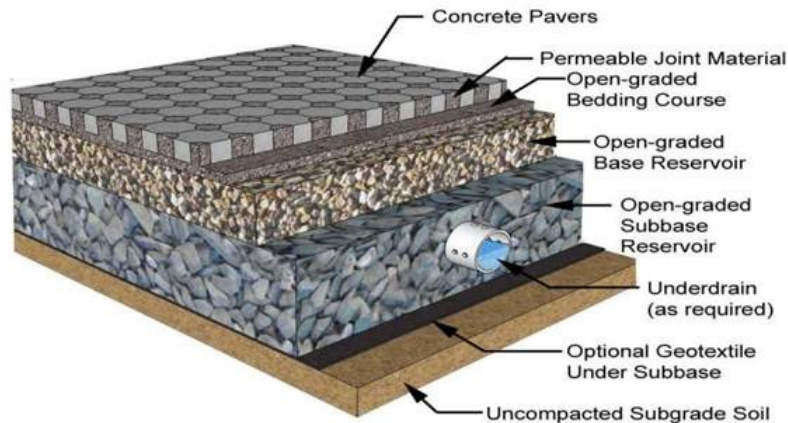
- Greenwise Technologies <http://greenrisetech.com/>
- Apex Green Roofs <http://www.apexgreenroofs.com/>
- Paladino & Company, Inc. www.paladinoandco.com/
- King County DNR Green Roof Study http://your.kingcounty.gov/solidwaste/greenbuilding/documents/KC_Green_Roof_case-study.pdf

STORMWATER REMEDIATION CASE STUDIES

Solution Option 2: Pervious / Permeable Paver Parking Lot between Alley and Russell St.

How does it work?

- Pervious pavers allow rainwater to percolate through the paver surface rather than going through void spaces between pavers. As water runs through, the pavers filter urban pollutants. Like grass, pervious pavers let the ground below breathe.
- Permeable pavers are different from pervious pavers in that rainwater passes around the paver as opposed to going through it. Void spaces are filled with aggregates between pavers to allow water to filter through.
- Average water permeability of 2 ft per day.
- Estimated longevity of 20 – 30 years.



Permeable Paver Section: Image from Interlocking Concrete Pavement Institute - Herndon, VA

Costs

General pricing from 2011 Virginia DEQ Stormwater Design Specification: Depending on existing surface conditions and paver type the costs can range from \$5.00 to \$10.00/ sq. ft. Estimated construction costs for 1,400 sq. ft. range from \$7,000-\$14,000.

Local resource pricing for Pave Drain – Charleston, WV: Depending on location in the country and project size, a conservative installed cost of PaveDrain will be approximately \$10-12/square foot. Estimated project costs for 1,400 sq. ft. from PaveDrain range from \$14,000 - \$16,800.

Maintenance

- Inspect the surface of the pavement for evidence of sediment deposition, organic debris, staining, or ponding that may indicate surface clogging.
- Vacuum sweeping / power wash regularly.
- Inspect the structural integrity of the pavement surface.
- Check inlets, pretreatment cells, and any flow diversion structures for sediment buildup.
- Inspect the condition of the observation well.

STORMWATER REMEDIATION CASE STUDIES

Pervious Paver Case Study: East Holladay Park - Portland, Oregon (2006)

Project Type:	Parking lot construction with pervious pavement—demonstration project
Technologies:	Pervious pavers
Major Benefits:	<ul style="list-style-type: none">• Stormwater is infiltrated and treated onsite, rather than entering the piped storm sewer system.• The project enhances a neighborhood park and provides a unique educational opportunity.
Cost:	\$165,000 with \$45,000 paid by EPA grant funds
Constructed:	December 2005 through May 2006

**Figure 1: East Holladay Park
Parking Lot Before**



**Figure 2: East Holladay Park
Parking Lot After**



Stormwater Management Goal:

The goal was to provide onsite stormwater infiltration for the parking lot and demonstrate a stormwater management technique for parking lots. East Holladay Park has the first Portland Parks & Recreation parking lot to use pervious pavers for stormwater management.

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By visibly demonstrating appropriate stormwater management, the project provides a unique environmental education opportunity for outer northeast Portland. An educational sign has been installed to identify the project's environmental benefits.

System Components:

Facility footprint: 5,225 square feet

Catchment area: 5,225 square feet

Pervious Pavers:

The pervious pavers allow rain to soak into the soil below the parking lot, keeping it out of storm drains. Fine rock and soil filter the rain before it recharges the groundwater.

Landscaped Areas:

Landscaped areas north of the parking lot are graded to capture overflow stormwater runoff from the parking lot and allow it to infiltrate into the soil. Curb openings at low points in the parking lot allow the runoff to enter the landscaped areas. The planting bed surface is covered with river rock instead of the usual bark mulch to slow the water and prevent erosion. The landscaped areas have drought-tolerant, low-maintenance plants that are adapted to Portland's climate, reducing watering requirements.

STORMWATER REMEDIATION CASE STUDIES

Cost Comparisons:

The installed pervious pavers, including aggregate base (which was low-cost at this site because of the site's porous soils making an additional gravel base below the pervious pavers unnecessary), cost \$10.00 per square foot. Conventional asphalt paving (including aggregate base) would cost \$3.50 to \$4.00 per square foot.

Maintenance and Monitoring:

Portland Parks & Recreation maintains this site. Weeding and mowing are incorporated into the regular maintenance schedule. The joints between pavers will be cleaned and refilled with fine crushed rock every few years to ensure long-term system infiltration. Once the drought-tolerant plants are established in about two years, irrigation will be limited to reestablishing replacement plants if needed. The pervious pavers will be monitored to determine how they handle stormwater and how they perform as a parking lot surface.

References

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- VIRGINIA DEQ STORMWATER DESIGN SPECIFICATION
<http://www.vwrrc.vt.edu/swc/NonPBMPSpecsMarch11/VASWMBMPSpec7PERMEABLEPAVEMENT.html>
- Tennessee Permanent Stormwater Management and Design Guidance Manual
<http://tnpermanentstormwater.org/manual/17%20Chapter%205.4.8%20Permeable%20Pavement.pdf>
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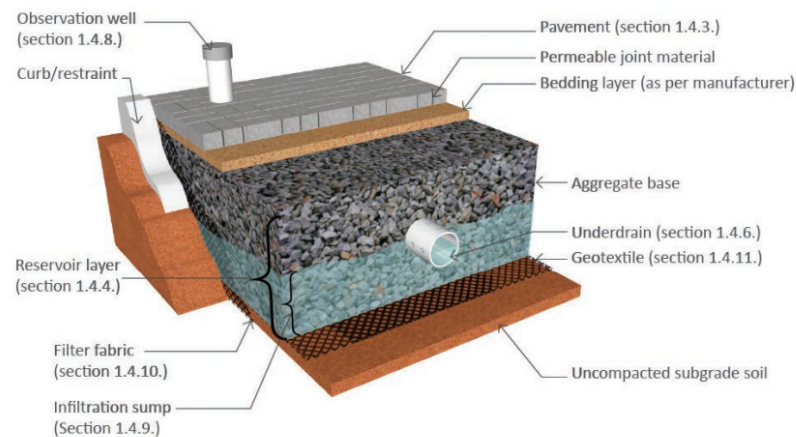
STORMWATER REMEDIATION CASE STUDIES

Solution Option 3: Pervious Concrete Pavement Parking Lot between Alley and Russell St.

How does it work?

In pervious concrete, carefully controlled amounts of water and cementitious materials are used to create a paste that forms a thick coating around aggregate particles. A pervious concrete mixture contains little or no sand, creating a substantial void content. Using sufficient paste to coat and bind the aggregate particles together creates a system of highly permeable, interconnected voids that drains quickly. Typically, between 15% and 25% voids are achieved in the hardened concrete, and flow rates for water through pervious concrete are typically around 480 in./hr (0.34 cm/s, which is 5 gal/ft²/min or 200 L/m²/min). By capturing stormwater and allowing it to seep into the ground, porous concrete is instrumental in recharging groundwater, reducing stormwater runoff, and meeting U.S. Environmental Protection Agency (EPA) stormwater regulations. This pavement technology creates more efficient land use by eliminating the need for retention ponds, swales, and other stormwater management devices.

Pavement thickness is typically 5 – 8 inches and requires to be cast in place with a seven day cure that must be covered. Estimated longevity of 20 – 30 years. - Average water permeability of 10 ft per day.



Pervious Concrete Section: Image from Tennessee Permanent Stormwater Management and Design Guidance Manual (2015)

Costs

General pricing from 2011 Virginia DEQ Stormwater Design Specification: Typically \$2.00 to \$6.50/sq. ft. with a general minimum of 500 sq. ft. Estimated project costs for 1,400 sq. ft. range from \$2,800 - \$9,100.

Maintenance

After installation:

- For the first 6 months following construction, the practice and CDA should be inspected at least twice after storm events that exceed 1/2 inch of rainfall. Conduct any needed repairs or stabilization.

As needed:

- Stabilize the CDA to prevent erosion

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- Remove any soil or sediment deposited on pavement.
- Replace or repair any necessary pavement surface areas that are degenerating

2-4 times per year (depending on use):

- Vacuum pavement with a standard street sweeper to prevent clogging

Annually:

- Conduct a maintenance inspection
- Spot weeding of grass applications

Once every 2 to 3 years:

- Remove any accumulated sediment in pre-treatment cells and inflow points
- Conduct maintenance using a regenerative street sweeper
- Replace any necessary joint material if clogged

Winter Maintenance:

- Large snow storage piles should be located in adjacent grassy areas so that sediments and pollutants in snowmelt are partially treated before they reach the Permeable Pavement.
- Sand or cinders should not be applied for winter traction over Permeable Pavement or areas of standard (impervious) pavement that drain toward Permeable Pavement, since it will quickly clog the system. If applied, the materials must be removed by vacuuming in the spring.
- When plowing plastic reinforced grid pavements, snow plow blades should be lifted 1/2 inch to 1 inch above the pavement surface to prevent damage to the paving blocks or turf. Porous asphalt, pervious concrete and permeable interlocking concrete pavers can be plowed similar to traditional pavements, using similar equipment and settings.
- Owners should be judicious when using chloride products for deicing over all permeable pavements designed for infiltration, since the salts will most assuredly be transmitted into the groundwater. Salt can be applied but environmentally sensitive deicers are recommended. Permeable Pavement applications will generally require less salt application than traditional pavements.

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Pervious Concrete Pavement Case Study: Finley Stadium - Chattanooga, TN (1997)

Scope:

This project is a municipal parking lot in which the pervious concrete was placed adjacent to conventional pavement to extend an existing parking area. The lot is in daily use, with occasional weekend use for football games and special events.



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Design:

The pervious concrete is 4" thick and has a total volume of 2,000 cubic yards. The mix design involved 400 lbs of cement, 2700 lbs of #67 stone and a w/cm of 0.43 with a retarder of 28 oz/yd³. It was placed over a #57 gravel base, which had a perforated PVC pipe in the subgrade to capture all water and divert to storage and use in watering the football field. The gravel base was placed over a geo-textile fabric, which rested on top of dirt. The location undergoes on an average about 50 cycles/year. However, the climate is not a hard freeze, as the average daily temperature does not drop below the freezing point very often. There is precipitation during winter so the location is considered a wet freeze.

Maintenance:

There is no annual maintenance and the current performance is good with minimal if any clogging, minimal raveling. The pavement is still sound and in good condition.

References

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<http://tnpermanentstormwater.org/manual/17%20Chapter%205.4.8%20Permeable%20Pavement.pdf>
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<http://www.vwrrc.vt.edu/swc/NonPBMPSpecsMarch11/VASWMBMPSpec7PERMEABLEPAVEMENT.html>
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STORMWATER REMEDIATION CASE STUDIES

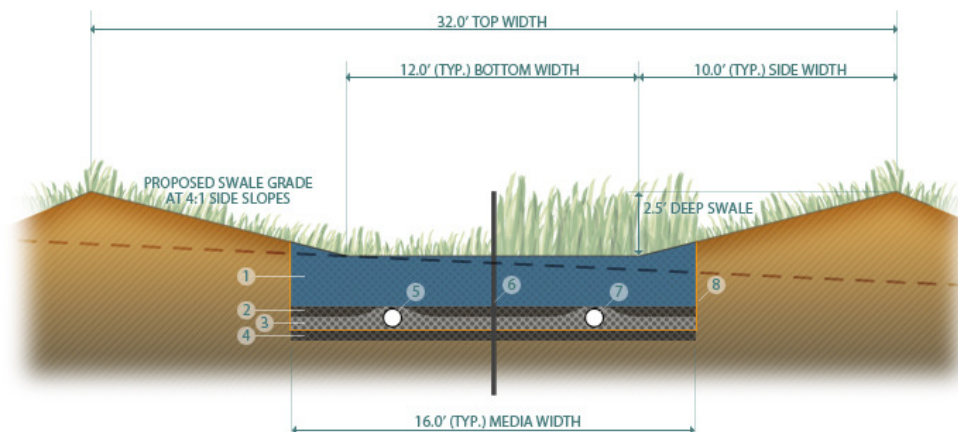
Solution Option 4: Bioretention System / Rain Garden along Alley and Parking Lot to Russell St.

How does it work?

A bioretention system or rain garden is an efficient, attractive and cost-effective way to control small-site stormwater runoff or snowmelt in urbanized areas. Basically, a bioretention system is a shallow depression that's integrated into the landscape—anywhere from parking lots to green spaces. Stormwater is diverted to the bioretention area, where vegetation and soil media capture the runoff and filter out pollutants as the water percolates back into the ground. A rain garden is not a pond but a dry planting bed between rainfalls. Rain gardens should be placed in full sun and at least 10 ft away from buildings so the infiltrating water doesn't seep into the foundation.

In addition to preventing erosion, flooding, and water contamination caused by stormwater runoff, a bioretention system offers the following advantages:

- Aesthetic enhancement – Typically featuring native plants that are resilient and attractive, a bioretention system improves property aesthetics and can even provide year-round color.
- Biodiverse habitat – The preferred use of native plants in a bioretention area creates a natural habitat for birds, butterflies, and other insects.
- New or retrofit installation – It's easy to incorporate a bioretention system into new development or as a “stormwater retrofit” to existing development.
- Lower utility costs – Maintenance of a bioretention area is routine, but typically requires less water than a similarly landscaped area.



- 1 - 2.0' DEEP (MIN.) BIORETENTION MEDIA
- 2 - 0.5' DEEP (TYP.) PEA GRAVEL LAYER
- 3 - 0.5' DEEP (MIN.) NO.3 UNDERDRAIN STONE
- 4 - PLACE IMPERMEABLE MEMBRANE ON 4" OF PEA GRAVEL (MIN.)

- 5 - COVER 8" PVC WITH 4" WIDE WOVEN GEOTEXTILE MIN AOS#30 (TYP.)
- 6 - 8" HIGH 3/4" MARINE PLYWOOD SEPARATION BARRIER TOP 2.5' FEET ABOVE SWALE
- 7 - 8" SCH.20 PERFORATED PVC @ 0.0075
- 8 - SURROUND MEDIA AND UNDERDRAIN STONE WITH 40 MIL EPDM IMPERMEABLE LINER

BIORETENTION SWALE SECTION (TYP.)

Section of Bio-swale: Image from Greenrise Technologies - Readyville, TN

STORMWATER REMEDIATION CASE STUDIES

Costs

General pricing from LID Urban Design Tools (2016): Commercial, industrial and institutional site costs can range between \$10 to \$40 per square foot, based on the need for control structures, curbing, storm drains and underdrains. Estimated costs for a 500 sq. ft. rain garden would range from \$5,000 - \$20,000.

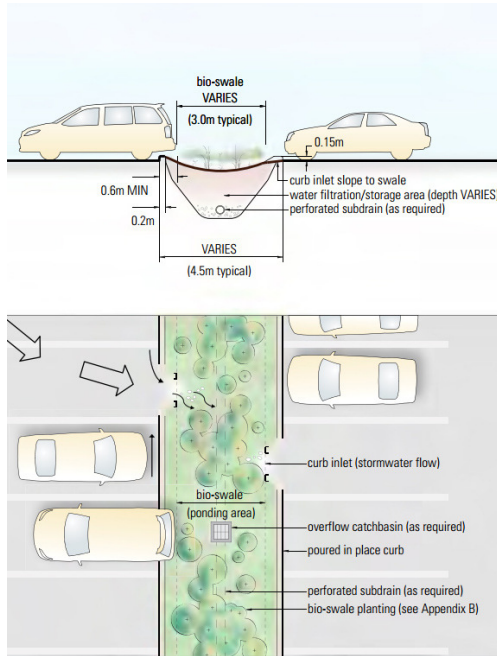


Image from Toronto City Planning (2013)



Image from American Society of Landscape Architects (2011)

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Maintenance

Rain gardens can be maintained with little effort after the plants are established. Some weeding and watering is needed during the first two years, and perhaps some thinning in later years as the plants mature.

Bioretention / Rain Garden Case Study: Proctor Town Hall – Proctor, MN (2001)

Scope:

The City of Proctor, Minnesota needed a new town hall, but the land dedicated for the building was adjacent to Kingsbury Creek, a protected trout stream.



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Design:

The City of Proctor and the building's designer, the architecture firm LHB, knew that they needed an innovative approach in order to protect the stream from the building's runoff. In order to minimize stormwater impacts, the building's parking lots were designed with 350 linear feet of sand/peat filter strips.

The filter strips consist of a two-foot-deep sand/peat mixture built on the existing clay soil. A grass buffer was placed on top at a sloping angle with riprap at the base of the slope, and all the strips were angled and fitted with drain pipes directed toward Kingsbury Creek. The objective was to slow the rate at which the water flowed off the parking lot and entered the stream, allowing it to cool. The filter strip also cools the runoff and provides a mechanism to filter out major pollutants.

Maintenance:

Since installation in January 2001, the filter strip has worked well, and has not frozen over or clogged. Maintenance has been minimal, limited to having the building's maintenance team ensure that sand used during periods of snow is removed from the grass through raking and shoveling. The strips accept all the building's roof and parking lot runoff and ensure a cleaner, healthier Kingsbury Creek.

References

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http://greenrisetech.com/stormwater_management/bioretention_systems
- Wisconsin DNR <http://dnr.wi.gov/topic/Stormwater/documents/RqManual.pdf>
- Toronto City Planning – Urban Design Department
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- Lake Superior Streams Case Study
<http://www.lakesuperiorstreams.org/stormwater/toolkit/proctor.html>
- Urban Design Tools: Low Impact Development http://www.lid-stormwater.net/bio_costs.htm

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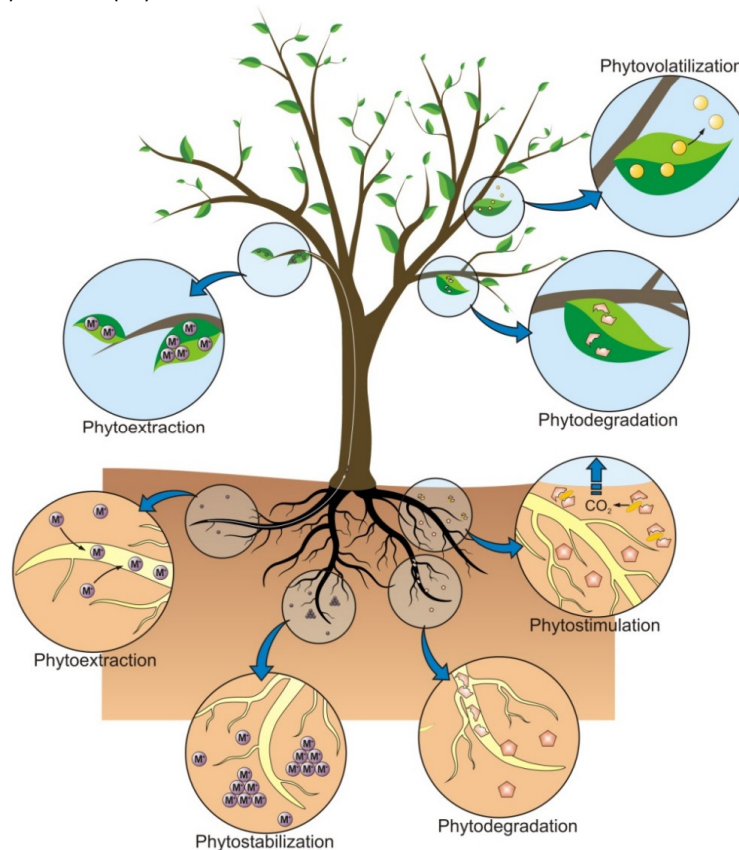
Solution Option 5: Phytoremediation along 10 ft Strip by The Lyric Theater

How does it work?

Phytoremediation is an emerging technology for remediating brownfields, landfills, and other contaminated sites. Many laboratory and field tests have demonstrated that trees and other vegetation can absorb, transform, or contain a variety of contaminants, including soft and heavy metals and volatile organics through hydraulic control, absorption, and mycorrhizal activity in the root zone.

Containment using plants either binds the contaminants to the soil, renders them nonbioavailable, or immobilizes them by removing the means of transport. Physical containment of contaminants by plants can take the form of binding the contaminants within a humic molecule (humification), physical sequestration of metals as occurs in some wetlands, or by root accumulation in nonharvestable plants. Certain trees sequester large concentrations of metals in their roots.

Phytostabilization, also referred to as in-place inactivation, is primarily used for the remediation of soil, sediment, and sludges. It is the use of plant roots to limit contaminant mobility and bioavailability in the soil. Phytostabilization can occur through the absorption, precipitation, complexation, or metal valence reduction. It is useful for the treatment of lead (Pb) as well as arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu) and zinc (Zn)



Schematic representation of phytoremediation strategies: Image from InTech (2012)

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Costs

General pricing from The Federal Remediation Technologies Roundtable (2006): Phytoremediation does not require expensive equipment or highly-specialized personnel, and it is relatively easy to implement. Estimates show a 'small site' (under 135,000 sq. ft.) with two crew members addressing metal contamination of up to 10 ft. deep to cost \$1.52 per square foot. With a much smaller site of 300 sq. ft. and additional landscaping to make an attractive planting bed by the Farmer's Market, it should be anticipated for higher square footage costs.

Maintenance

Other than typical flower bed practices, in the case of heavy metal poisoning, pull the plants up at the end of the season, and dispose of them at the landfill. The toxicity and bioavailability of biodegradation products is not always known. Products may be mobilized into ground water or bioaccumulated in animals. More research is needed to determine the fate of various compounds in the plant metabolic cycle to ensure that plant droppings and products manufactured by plants do not contribute toxic or harmful chemicals into the food chain or increase risk of exposure to the general public.

Educational signage should be posted instructing visitors of the green remediation measures and to not interact with the plants.

Recommended Plants

Lead Uptake:



Sunflowers



Violets



Honey Locust

Cadmium Uptake:



Field Chickweed



Miners Lettuce



Yarrow



Field Mustard



Foxglove



Holly

STORMWATER REMEDIATION CASE STUDIES

Phytoremediation Case Study: Ensign-Bickford Company - Simsbury, CT (1996)

Scope:

The Ensign-Bickford Company in Simsbury, Connecticut, conducted open burn/open detonation (OB/OD) activities, resulting in near surface soils in the area becoming contaminated with lead. From 1996 to 1997, Edenspace Systems Corp conducted phytoremediation treatment of a 1.5 acre area surrounding the OB/OD area. In 1998, this effort was expanded to include a total of 2.35 acres and to address not only reductions in total lead concentrations, but also stabilizing leachable lead in the soil.

Contaminants:

- Average concentration of total lead was 635 mg/kg; concentrations were higher than 1,000 mg/kg in many areas of the site, with some areas exceeding 4,000 mg/kg
- Leachable lead concentrations were higher than 0.015 mg/L using the Synthetic Precipitation Leaching Procedure (SPLP)



Design:

Phytoremediation was conducted using three treatment crops of Indian mustard and sunflower over a six month period. Total lead concentrations in a portion of the site decreased from an average of 635 mg/kg (4/98) to 478 mg/kg, with hot spots also reduced. In the area where phytostabilization also was used, the average reduction in SPLP lead concentration was 0.95 mg/L. Further treatment is planned during 1999 and 2000.

Technology:

Phytoremediation

- Combination of phytoextraction (for treatment of four areas with high lead concentrations - Areas 1-4) and phytostabilization (for treatment of one area with low lead concentrations - Area 5) to reduce total soil lead concentrations and SPLP extractable lead
- Soils were fertilized with nitrogen, phosphorus, and potassium; dolomite lime was added to adjust soil pH
- Fertilizers and lime were tilled into the soil to a depth of 15 to 20 cm; an overhead irrigation system was used to provide moisture
- Areas 1-5 were seeded with Indian mustard and sunflower; 3 treatment crops were planted
- Supplemental foliar fertilizers were added through the irrigation system
- Area 5 also treated with stabilizing amendments

STORMWATER REMEDIATION CASE STUDIES

Results:

Phytoextraction in areas 1 through 4 resulted in a decrease in total soil lead concentrations from an initial average of 635 mg/kg (April 1998) to 478 mg/kg (October 1998). After the 1998 growing season, no soil samples taken exceeded 4000 mg/kg. Before phytoremediation had been implemented, 7% of the treatment area had soil lead concentrations in excess of 2000 mg/kg and after the treatment process only 2% still exceeded that amount. The lead uptake in Indian mustard ranged from 342 mg/kg (weight) for the first crop to 3,252 mg/kg for the third crop. The average lead uptake was similar in both sunflower and Indian mustard with a value of 1000 mg/kg in the sunflower and 1,091 mg/kg (dry weight) in Indian mustard.

Cost Factors:

Not provided by Ensign-Bickford Company.

References

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- EPA National Service Center for Environmental Publications (NSCEP) <http://nepis.epa.gov/Exe/ZyNET.exe/30003T7G.TXT...>
- An Overview of the Phytoremediation of Lead and Mercury <https://clu-in.org/download/studentpapers/henry.pdf>
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