Utah State University Botanical Center Stream Master Plan

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UTAH STATE UNIVERSITY BOTANICAL CENTER STREAM

MASTER PLAN

By

Daniel Willard Schults

A report submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF LANDSCAPE ARCHITECTURE

(PLAN B)

Department of Landscape Architecture and Environmental Planning

Approved:

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May 2012
ABSTRACT

Utah State University Botanical Center Stream Master Plan

By

Daniel Willard Schults, Master of Landscape Architecture

Utah State University, 2012

Major Professor: Phillip S. Waite
Department: Landscape Architecture and Environmental Planning

The Utah State University Botanical Center Stream Master Plan is a design to assist Utah State University Botanical Center (USUBC) administration in fulfilling their goals of community outreach and education, implementing sustainable practices and creating aesthetically beautiful areas for public enjoyment. These goals are met through updating the USUBC master plan to account for the newly built man-made stream as well as other future buildings. Trails, overlooks and information nodes are part of the new master plan. The planting plan includes representations of six natural plant communities found in Northern Utah. Additionally, the stream design improves the water quality of USUBC ponds on site. All of these designs will contribute to USUBC goals. The Utah State University Botanical Center Master Plan and Planting Plan is a plan B thesis project.

(52 pages)
ACKNOWLEDGEMENTS

I would like to thank my family and friends for their support and encouragement, especially Jillian and Norah. Thanks to Phil, Dave and Larry for pushing me to be better.

I appreciate the expert input from Jon Rice, Richard Anderson and Jeff Turley.
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INTRODUCTION

Utah State University Botanical Center History

The Utah State University Botanical Center (USUBC) is one of the few botanical centers in the Intermountain West and is a leader in issues critical to this region. Located near Kaysville, UT, the USUBC includes the Utah House, a plant nursery and greenhouse facilities, educational buildings, an arboretum, ponds which are used for recreation, storm water management and educational purposes, demonstration gardens and much more on over 100 acres. Some of the issues the USUBC focuses on include diminishing open space, efficient water use and promoting native and sustainable plants of the Intermountain West.

Figure 1: Aerial photo of the USUBC project site; including retention ponds, stream and various buildings. (Google Earth image)
The USUBC is owned and operated by Utah State University. Through community workshops, Utah State University Regional Campus and Distance Education courses, community events and public gardens, the USUBC is a leader in education and inspiration for those living in the Intermountain West region. The Utah State University Botanical Center supports research on sustainable practices and raises community awareness of the challenges facing residents in this region. The USUBC’s mission statement is “To guide the conservation and wise use of plant, water, and energy resources through research-based educational experiences, demonstrations, and technologies.” (http://usubotanicalcenter.org/)

Figure 2: Reference map of USUBC (Jeff Turley)
Utah State University Botanical Center Physical Layout

The Utah State University Botanical Center houses the Kaysville Education Center, the Wetland Discovery Point building, the Utah House (which focuses on sustainable practices on a residential scale), greenhouse/nursery facilities and demonstration gardens. According to the Conceptual Plan of the Utah State University Botanical Center Vision Document, a café, visitor center, viewing tower, gift store, theater and children’s house are also long term building goals on site (Anderson, 2005).

The project site covers an area of nearly 35 acres. It is located in the middle of the USUBC. To the west of the project site are the ponds and Wetland Discovery Point facility. The USUBC greenhouse and offices are east of the project site. The stream is nearly a half-mile long on the project site and runs another quarter mile underground off the site. The stream runs east to west on the project site and bisects the site into a northern area and a southern area.

Utah Climate History

Utah has a wide variety of climate conditions. One example is variation in precipitation. According to the Western Regional Climate Center (2011) in the western portion of the state, average precipitation amounts can be as little as five inches per year. In the Wasatch Mountains to the east, annual precipitation can reach 40 inches. Along the bench of the Wasatch Mountains, where the USUBC is located, average precipitation varies from 15 to 20 inches each year. Much of the precipitation in Northern Utah comes
as snow during the winter. It can snow up to 30 feet each year and can remain well into summer in the mountains. Summers often are hot and dry, with precipitation less than one inch in many areas.

Temperature varies greatly in Utah as well. In Southern Utah, temperatures often reach over 100°F. Northern Utah can drop well below freezing in winter, with temperatures falling below -50°F in extreme cases. The USDA climate zones across the state range from two to nine, depending on the latitude and elevation (USDA, 2012).

Due to the large fluctuations in temperature and precipitation, Utah has diverse ecological variety. The cold deserts and salt flats in the west, red rock canyons in the south and broadleaf and coniferous forests at higher elevations make Utah a unique place.

The climate along the Wasatch Front is classified as continental sub-humid or semi-arid. The intermountain region where the USUBC is located is specified as a semi-arid desert (Meyer et al, 2009). As mentioned, this region receives moderate precipitation between 15-20 inches each year. Summers tend to be hot and dry. The average maximum summer temperatures reach 93°F. Large amounts of snowfall and sub freezing temperatures occur in winter, with average lows around 20°F.

**Value of Riparian Zones**

**Scarcity in Utah.** With precipitation levels as low as a few inches per year in some areas, water is a valuable resource. Much of the moisture received is during winter in the form of snow. Wetland and riparian areas in Utah are, therefore, rare and valuable.
The term riparian refers to the terrestrial zone directly adjacent to water. Some experts include the aquatic ecosystem with the adjacent lands as part of the riparian zone (Gardner et al., 1999). For the purpose of this thesis, the immediately adjacent land and the stream will both be included in the riparian zone.

**Wildlife and Habitat.** There are many benefits of riparian zones to wildlife. There is a large diversity of habitat types in a riparian zone, which results in some of the most productive and intricate food webs of any ecosystem type (Johnson et al., 1993). Organisms of all trophic levels occupy riparian areas. Undisturbed riparian zones offer food, cover, water and often special habitat needs required by wildlife. Studies show that wildlife use of riparian zones is disproportionately more than any other habitat type (Johnson et al., 1993).

Figure 3: Section illustration of a typical riparian zone. (NCRS)
Water Quality. Riparian zones are not only very beneficial to local wildlife, but these zones also serve as stream buffers and filters. Nutrients from runoff, such as nitrogen and phosphorous, cause excessive algae growth and act as pollutants for fish and wildlife populations using the water source. Multiple studies show that riparian vegetation significantly improves water quality absorbing excess nutrients and chemicals (Tabacchi et al., 2000).

Often, riparian zones can be prone to flooding. Overflow zones and stream channels without the reinforcement of plant roots and above ground plant mass can undergo massive erosion during floods as well as regular water flow. Riparian vegetation significantly reduces erosion or water channels in riparian zones by holding the stream bank secure with plant roots. Riparian vegetation also traps sediment carried in the water (Tabacchi et al., 2000). By reducing the nutrient and sediment loads in the water, riparian vegetation acts as a filter for streams.

Other Related Plant Communities and Vanishing Open Space. Many plant communities contribute to the wildlife habitat and environmental well-being of Utah. There are as many different plant communities as there are climates and geologic regions in Utah. Alpine forests, Great Basin deserts, the Colorado Plateau and semi-arid grasslands are just some of the valuable plant communities that make Utah unique. However, Utah’s population is booming. The 2010 United States Census reports that Utah’s population grew nearly 24% from 2000 to 2010. That is roughly 15% higher than the US average. Open space and water are two resources that are in threatened with
increasing population (Meyer et al, 2009). Many of Utah’s unique habitats are threatened because of the expanding human populations. Water sources are being over-subscribed as the demand for water increases. Community education regarding water conservation efforts and increased sustainable design—for example, using native and well-adapted plants—are ways to mitigate the effects associated with population growth.
DESIGN NEEDS

Master Plan Update

The existing USUBC Master Plan was last updated five years ago (Jones et al, 2007). Since that time, the Kaysville Education Center and Wetland Discovery Point buildings, stream route, pump, arboretum and an ornamental grass garden have been built or expanded. The conceptual master plan foresaw many of the buildings and other features on site. However, as is typical, actual building and stream footprints are somewhat different than those proposed by the existing master plan. As with any dynamic design process, new ideas have been introduced by USUBC leaders. All of which maintain the USUBC’s core mission to promote conservation and wise use of natural resources. These new additions as well as future needs necessitate a revision of the USUBC master plan as proposed by this project.

Design Details

Trail Systems. One of the great opportunities generated by the introduction of the stream and other new features on the site is the expansion of the trail system. Currently a trail system exists on the project site. This existing trail system primarily runs around the periphery of the site with limited access to the heart of the property. The existing master plan calls for extensive trails throughout the site. However, additional trail design is
needed to further develop the conceptual trail network as well as tie into the existing trail system.

**Amphitheater.** One of the USUBC’s goals is to reach out to the local community. An opportunity seen by USUBC leaders is the installation of an amphitheater at the upper part of the project site between the two forks of the stream. An amphitheater would draw more of the public in to the USUBC and also provide the USUBC with more opportunities to educate and entertain. Currently, the amphitheater site is little more than a grassy slope. Space making, shade, and access all need to be addressed as part of the amphitheater design.

**Retention Ponds.** One large project already completed on the USUBC property involves stormwater management through renovation and rehabilitation of the four retention ponds on the west edge of USUBC property. These ponds, once filled with large deposits of runoff sediment, were cleaned out, rebuilt and revegetated.

Figure 4: Reference map of water circulation (Jeff Turley)
They now function as retention ponds for Kaysville city storm water. The pond project focused on the sustainable use of water. The storm water from Kaysville does not go through a filtering process and enters the ponds carrying the pollutants and sediment acquired along the path to the ponds. Each pond has one outlet. The outlets are V-notch and horizontal weirs found at the inlet, outlet and in between each pond. There is a 1.5 foot elevation change between each pond that causes water to flow from pond to pond. While the water quality is good enough to support wildlife, on site studies have shown high levels of nitrogen and phosphorous. The stream represents an opportunity to further improve water quality before it enters the pond.

Because the flow rate is low, problems common with stagnant or slow-flowing water have arisen. These include excessive algae growth, lower oxygen in the water and general water pollution. A stream that can oxygenate the water and provide bio-filtration through plant material was identified as a partial but viable solution to the problem. A variable speed pump was installed to circulate the pond water to two outlet points of higher elevation. The terrain was regraded between the pump outlets and the pond to represent a natural stream. This man-made stream circulates the stagnant pond water to elevated outlets. The water then runs down to a small retention basin and back to Blood’s pond.

The ponds serve many other purposes as well. Trails provide the public with places to exercise and bird watch. Piers offer areas to fish. The Wetland Discovery Point is a destination for school fieldtrips and community education classes.
Dave Anderson, Director of the USUBC, says ‘We can teach about stormwater, water quality, fishing, wildlife, birds and ecology, all right here. Everyone acknowledges the value of an on-site experience. Kids will remember these experiences.’ Anderson continues, ‘This will let them experience a little of natural wildlife, and also learn more about the (Great Salt) Lake,’ he said (http://usubotanicalcenter.org/). Other topics that are emphasized are wise water use, beneficial insects, air quality and sustainable horticulture.

Additionally, the vegetation and high standard of design quality improves not only the aesthetics on-site, but also improves views from nearby freeways and neighboring residential areas.

The flow of water between ponds varies throughout the year. In the spring, the water flow is typically at its highest. During the summer, the flow decreases. However, at night during the summer, the flow is greater due to upstream irrigation. During the fall, flow is minimal.

**Transition from Building Clusters.** The current master plan proposes a building cluster south of the stream area. These buildings include a café, visitors’ center, gift shop and more. There is an existing educational building on the north side of the stream. The plan calls for additional educational buildings and potentially a building cluster for Extension use. There is a need to develop connectivity between these building clusters. The stream and circulation plans can be part of the solution to tie the buildings together.
Utah State University Botanical Center Stream Design

The USUBC stream is roughly three quarters of a mile long. It drops over 20 feet in elevation, with variable slopes. On the eastern side—at the highest elevation, before the two upper stream branches converge, there is an 11% slope. This section of the stream does not receive any pond water from the pump. Each arm of the stream has different sources of water. The north branch is connected to the pressurized irrigation system and can be turned on during the irrigation season from April 15th to October 15th. The south branch is intended to be intermittent. It is connected to a large city storm drain pipe and will channel water from that storm pipe. Water will not flow constantly through these branches. Rather, this will be dictated by the USUBC staff and storm events. The USUBC staff will also be able to control the amount of water that flows along these branches. As the branches converge, the slope lessens to approximately 3-5%. After the two arms join, the stream flattens out with large meanders and a slope of 1-2%. This is the longest section of stream and receives the most water. In this section, there are two outlets for the pump to introduce pond water into the stream. The water is pumped from Barton’s Pond to these outlets.
With the pump running at full capacity, there is an expected flow of nearly 3 cubic feet per second. The water then flows to a small retention basin. From there, the water drains into a piping system that carries the water in a northwesterly direction to the southwest corner of Blood’s pond.

**Next Steps for the Man-Made Stream.** The approach to development of the planting plan is to create an abstraction of natural plant communities found in Northern Utah. For the purposes of this section, the term “stream” includes the stream channel and the immediate surrounding lands up to approximately 60 feet on either side. The development of a planting and circulation plan will allow for future fund-raising and planting of the stream corridor.

The USUBC offers opportunities for wildlife viewing and places to learn about horticulture and sustainability. Visitors can learn about wetlands, xeriscaping and landscaping for wildlife in various areas of the facility. However, at the current phase of the project, the undeveloped stream does little to contribute to these opportunities without a designed planting plan. The updated master plan and planting plan will assist in introducing educational components as part of the next phase in the stream development.

![Figure 6: Aerial photo of the USUBC stream channel after grading the channel and pump installation. (USUBC, April 2009)](image)
DESIGN PROPOSAL

Revisiting the Master Plan

The USUBC serves many functions. The 35 acres that houses the stream also contains classroom buildings, an arboretum, and a grass collection. Additionally, future plans include an amphitheater, visitor’s center, reception area and more. Stream design, including trail systems, lookout points, screens, and focal points will need to be designed with these future developments in mind.

Create a Buffer Between the Two Building Clusters. According to the master plan of the project site, the stream will separate two sets of buildings. A portion of the stream will act as a visual divide between the two building clusters. The dividing portion of the stream will be planted as a valley plant community. Higher concentrations of trees and shrubbery will be planted that will function as the screen.

Improve Trails. School and public tours are part of the USUBC program. The stream will also be a focus of tours. It is estimated that in the coming years upwards of 10,000 students will visit the USUBC annually. The USUBC also strives to encourage community use of the USUBC. Trails provide opportunities for joggers and walkers. Extensive pathways along the stream, highlighting points of interest and connecting to other areas will be necessary to accomplish these goals.

Conceptualize Amphitheater. The amphitheater will be situated between the fork of the upper two branches. The steep slope and natural framing from the streams creates an excellent space for the amphitheater. However, due to the westerly aspect of
the slope, the setting sun during evening events will cause problems for spectators. Trees to screen the evening sun and to create some separation between the amphitheater space and the surrounding area are required.

**Improve Habitat.** In the design, patches of planted area are left inaccessible by pedestrians to create wildlife habitat. This is designed to maintain some areas strictly for wildlife. The stream provides a habitat for birds, insect and other wildlife. By keeping some areas off-limits to humans, those areas will better support the wildlife. Additionally, one of the attractions of the USUBC is bird watching. Strategic viewpoints are designed to allow for observation of these less disturbed areas. Also, the addition of three layers of vegetation (canopy, understory and groundcover) will maximize the habitat value for wildlife (Maderik et al., 2006).

**Clean Water.** The cycling water does undergo some oxygenation, thereby improving the water quality of the ponds. However, added vegetation and microhabitats that create waterfalls would greatly increase the effectiveness of the stream. The vegetation will filter out much of the pollution in the stream and the falls will increase oxygenation of the water.

Additionally, by adding trees and other vegetation, the water will be shaded. This, in turn, cools the water to a temperature more similar to streams found in nature. This is especially applicable to the mountain and foothill streams, but is important to the valley stream as well. Cooler water enhances aquatic habitat and creates a more natural environment.
**Plant Materials Education.** One of the goals of the USUBC is to show visitors new and improved ways to lower human impact and be more sustainable. One way to accomplish this is by educating the public on the benefits of native and drought tolerant plants. Many such varieties go unused in everyday landscapes simply due to ignorance. The much of the vegetation used in the planting design will be valuable in educating visitors about native and drought tolerant landscaping.
DESIGN PROCESS

Utah State University Botanical Center Goals and Standards

The first step in creating the plan is to identify some general design ideas that will serve as the backbone of the design. Plant communities should be represented by the stream, but creating a biologically and ecologically accurate replica of nature is not feasible for the scale of the stream. There are multiple reasons for this. The actual riparian area is rather small and to accurately replicate nature would not address all of the purposes identified above. Also, as will be explained later on, not all plant communities designed to be represented will thrive naturally. Instead, a representation or abstraction of the plant communities is a better choice for the planting design. This allows for a more extensive horticultural education and provides an adequate buffer while still fulfilling the other purposes of the stream.

After identifying and addressing the opportunities and constraints on the stream site, the objectives of the USUBC are to be incorporated in the design process. The USUBC has five major objectives:

1. Conservation and Preservation
2. Sustainability
3. Education and Extension
4. Community and Economic Development
5. Research
Thesis Contributions to the Utah State University Botanical Center Goals

**Conservation and Preservation.** The stream planting plan calls for extensive use of native plants and a select small number of well adapted non-native species. This plan will offer the opportunity to create native plant communities in a developed area along the Wasatch Front. While this is not the same as preserving existing native plant communities, the creation of new native plant communities offers many benefits to humans and wildlife that will be explained below.

**Sustainability.** By representing an abstraction of nature, the planting plan for the USUBC stream also creates habitat for Utah wildlife. Many of the plant selections provide shelter, food and other resources for wildlife. The design accounts for the importance of canopy, understory and groundcover vegetation layers. Building upon the habitat created by the ponds, the riparian and upland communities of the stream will offer both wildlife viewing and habitat areas designated for small mammals, song birds and other creatures. This increases habitat in the Kaysville area and encourages visitors to build wildlife habitat in their own backyards.

Using the storm water from the USUBC ponds for stream flow is an example of adapting to inherited circumstances in a sustainable manner. However, as mentioned before, sedimentation, pollutants and low water flow have created problems for the pond wildlife and USUBC visitors. The stream vegetation will contribute to a sustainable solution by reducing chemical and sediment loads in the water. The elevation change and
water movement also mitigate alga buildup and reoxygenates the water. Cooling the water through shade from vegetation enhances habitat.

**Education and Extension.** As was mentioned earlier, the planting plan for the stream is not designed to replicate nature directly. Instead, the planting plan will be an abstraction or representation of nature. By an abstraction, it is meant that plants commonly found in the natural habitat represented by the stream will be found on the planting plan. Companion plants will be grouped together as they occur in nature. However, due to the limited space, the quantities of certain species may not be consistent with natural habitats. For example, to exhibit more plant species found in a natural habitat, stream sections will house smaller plant quantities but higher species diversity. This is designed to increase educational value by exposing the public to more plant diversity without compromising the integrity of the habitat representation.

In conjunction with planting native species for public education, USUBC leaders have identified the opportunity to show different plant communities found in Northern Utah. Six communities were chosen to be demonstrated along the stream site based on the slope of the site, water availability and natural plant habitat progressions found in Northern Utah. These six communities can be grouped in pairs: Mountain Upland and Mountain Riparian, Foothill Upland and Foothill Riparian, Valley Upland and Valley Riparian. Each community will be discussed in detail later. The purpose for the different communities is to provide a more comprehensive educational experience for visitors. A wider variety of plants will be showcased. Demonstrating different communities gives
visitors a better understanding of natural habitats in Utah. Visitors will also have more opportunities to explore planting possibilities in their own yards.

Additionally, emphasis will be placed on native species that have application in residential landscapes. This will be accomplished through identification signs and prominent placement of these plant species. By incorporating such species into a natural setting, visitors will be able to connect with the plants in nature and be taught how to use them in residential settings.

The USUBC is committed to creating beautiful as well as sustainable landscapes. By creating a natural planting design with trails and signage to unify the site, the stream site offers the chance to experience the tranquility of nature. Plant species specified in the planting plan offer year round interest in the form of flowers, autumn colors, foliar effects and shade.

Additionally, public and semi-public spaces will be created for visitor use. These spaces give form and meaning to the site and will invite visitors to enjoy the details of the stream.

**Research.** The USUBC is a leading research facility for new and innovative plant species for many purposes from residential use to food production to increased viability in Utah climate. Many of the research species are also native to Utah. Species used along the stream will be observed and studied as they become established. This will provide valuable practical information about the species such as water needs, disease susceptibility, root growth patterns and more.
Case Studies

**Lady Bird Johnson Wildflower Center.** The USUBC draws inspiration from the Lady Bird Johnson Wildflower Center (LBJWC). The LBJWC is dedicated to the protection and restoration of Texas wildflowers and America’s native plant species (LBJWC website, 2012). One way the LBJWC does this is through demonstration gardens. Many of the gardens open to the public showcase regionally native plants. These gardens offer native plant solutions for ornamental purposes in landscapes. The demonstration gardens are part of a focus on public education and outreach programs. These hands-on display gardens inspire visitors and show how native plants can be used in residential landscapes. This helps home owners break out of the traditional landscapes that usually require more resources to maintain. The use of native plants to inspire the public and provide ideas for residential landscapes is also practiced at the USUBC.

The LBJWC also devotes patches of land to wildlife habitat. Through habitat restoration and by creating areas of low or no human traffic, the LBJWC is now home to many species of birds and other wildlife. This pattern of directing visitor traffic will also be used at a smaller scale for the USUBC stream.

By using building materials that are indigenous to the area, the LBJWC creates a unique and inviting character for visitors. This also is another opportunity to educate the public about using sustainable and local materials. The USUBC also focuses on using sustainable and local building materials. By using materials from local sources as well as
materials that reflect the natural surrounding beauty, public can be further educated on the benefits and importance of sustainable practices.

**Missouri Botanical Garden.** Another facility that has been used as a pattern for the USUBC is the Missouri Botanical Garden (MBG). The MBG provides visitors access to an extensive library and other horticultural resources through the University of Missouri Extension Service (MBG website 2012). The horticultural education does not stop at books and libraries. Many courses are taught that the MBG through the Extension service. This is a strong parallel to the USUBC. Abstractions from natural plant communities are incorporated into the landscape. This provides each landscape with additional educational value as well as aesthetic value. This is also one of the goals of the USUBC stream plan.

Additionally, the Kemper Center for Home Gardening on the MBG contains 23 different demonstration gardens. While the stream site won’t contain nearly that many demonstration gardens, many of the gardens at the Kemper Center offer ideas for display areas in the USUBC stream site. Kemper Center gardens include a native shade garden, a rock garden that focuses on native plants for rocky areas, and a restored meadow garden containing native plants. There will be many demonstration gardens adjacent to the stream site on the USUBC grounds. The stream site will help to unify and enhance these demonstration gardens.

The USUBC draws inspiration from and parallels many of its functions with the LBJWC and MBG. The USUBC acts as a regional resource for horticulture and
sustainability. By providing educational courses, demonstration gardens, and community functions, the USUBC has used many of the successful systems from these two facilities in forming its own vision and conceptual plans.

**Red Butte Gardens.** Red Butte Gardens (RBG) is located in Salt Lake City, UT and operated by the University of Utah. RBG focuses on community outreach, botanical and gardening education and preservation (RBG website, 2012). One way this is accomplished is through incorporating plant collections into the display landscapes. By doing this, native Utah plants are preserved, used to educate visitors and provide aesthetic value to the landscape. RBG also incorporates research plants into landscapes. By partnering with the Center for Plant Conservation, RBG helps protect over 250 plant species. The USUBC is also involved in preserving Utah’s native plant species. RBG provides a good example of combining preservation and research species into the public gardens. While the USUBC stream planting plan doesn’t focus on preservation of rare or endangered plant species, there will be research species incorporated into the design.

The use of local building material, effective trail systems and informative garden displays also make RBG successful. Much of the hardscape and built environment blends in with the surroundings, creating an aesthetically unified design. The trail systems weave through native habitat and designed display gardens, giving variety and interest for visitors. Many of the display gardens transition into the natural habitat. All of these aspects of RBG unify the site with the surroundings. Visitors feel a sense of
connectedness with nature and, perhaps, an escape from the bustle of the city. These are all aspirations that also drive the USUBC master plan and stream planting plan.

**Opportunities and Constraints**

**Slopes.** As was mentioned earlier, the slope of the stream varies dramatically from one end to the other. Near the genesis of the stream, where the two smaller streams begin, the slope is roughly 11%. This is representative of a mountain stream found in nature. The resulting riparian zone is smaller and the saturation zone is even smaller due in part to the rapid flow of water caused by the steep slopes. After roughly 150 feet, the slope lessens to 5%. The meanders in the stream enlarge with the lesser slope. At this point, the community transitions to foothill vegetation. The final two-thirds of the stream fluctuate between 1% and 2%. This area will be the valley community due, in large part, to the flattened slope.

**Soils.** One of the limiting factors in plant choice is the soil on site. Typically, soil types vary greatly from mountain to valley settings. However, because the stream is approximately ¾ mile long, there is little room for soil variation. This especially affects the smaller herbaceous vegetation and riparian plants. Thus, there is less variation among herbaceous vegetation, especially in the riparian communities. According to USUBC staff experts, the soils have a high clay content and relatively poor drainage.
Climate. A challenge with creating a representation of three different plant communities in such a small space is the large variety of water needs for each community. Mountain habitats in Utah can experience over 40 inches of precipitation a year. Valley habitats in Utah can receive 5-7 inches of moisture each year. Foothill habitats receive moisture levels anywhere in between. It would be nearly impossible to create the various communities with the accurate, representative vegetation without manipulating naturally occurring moisture levels.

Additionally, portions of the riparian zones, especially mountain and foothill communities, are so narrow, that any plants larger than the sedges, rushes and perhaps a small shrub or two wouldn’t be able to survive. Measures such as supplementary watering must be taken to allow for moisture-loving riparian plants to survive.
Plant Communities

After deciding that the vegetation plan are designed to represent enhanced natural plant communities, determining the actual plant communities and plant palette for each was the following step. Three upland plant communities and three riparian communities are represented on the stream site. The communities are defined primarily by the elevation where they naturally occur and the natural procession from valley to mountain ecology. Plant choices are driven by iconic plants of the respective communities, educational value, habitat value, commercial/production availability and maintenance issues. There are three riparian communities with a corresponding upland community. They are designated as Mountain, Foothill and Valley communities. Each plant community will be discussed in detail. Additionally, a table can be found as an appendix that lists the species to be planted categorized by community.
Mountain Communities

Mountain Upland Community. This community is commonly found between 8,000’ and 9,500’ and is largely impacted by slope, aspect, latitude and elevation (Meyer, et al). Due to significantly higher precipitation, trees in this community grow densely together and obtain taller heights than trees in other communities. Douglas fir (Pseudotsuga menziesii) and Quaking aspen (Populus tremuloides) are the dominant tree species in the Utah Mountain Upland Community. The understory vegetation consists of low growing shrubs such as serviceberry (Amelanchier utahensis), ninebark (Physocarpus malvaceus) and Snowberry (Symphicarpos oreophilus). The Bureau of Land Management (BLM) conducted a study to quantify the percentage of tree, shrub, grass and forb cover in Utah plant communities (DEIS, no date). In the Douglas fir plant community, tree coverage can make up 60% of vegetation cover, with shrubs taking up to 40%. Due to the high tree density and accompanying heavy shade, grass species are less numerous in the Mountain Upland community than in other communities.

After consulting with horticultural experts and USUBC staff, it was determined that grass species for the site should be chosen based on viability, maintenance and availability rather than ecological accuracy. The grasses chosen are native, but perhaps not commonly found in the Upland Mountain regions naturally. Species such as western wheatgrass (Elymus smithii) and basin wildrye (Leymus cinereus) will perform reliably and still provide a reasonable representation of the grassy understory found in Mountain
Upland communities. Mountain Community wildflowers and forbs include Sticky geranium (*Geranium viscosissimum*), Stream hollyhock (*Iliamna rivularis*), Western columbine (*Aquilegia formosa*) and Wasatch beardtongue (*Penstemon cyananthus*).

**Mountain Riparian Community.** The existing steep slopes and less water flow of the mountain riparian community on the USUBC site allow for only a narrow area for riparian plants. Broad-leaf trees such as grey alder (*Alnus incana*), western water birch (*Betula occidentalis*) and Rocky Mountain maple (*Acer glabrum*) form a dense canopy over the Mountain Riparian Community. Willows (*Salix spp.*) and ninebark, among other water-loving shrubs, form a dense thicket of understory vegetation. The bank and toe zones are colonized by herbaceous rushes and sedges. In narrow, fast flowing mountain stream, these zones are relatively narrow. Nebraska sedge (*Carex nebrascensis*), Sierra rush (*Juncus nevadensis*) and swordleaf rush (*Juncus ensifolius*), while not naturally found in the mountain riparian community, will adequately represent the natural vegetation found along the bank and toe zones.

**Foothill Communities**

**Foothill Upland Community.** This community represents plants commonly found from 5,500’ to 8,000’. This can be described as a transition community between the dense forests of the Mountain communities and the grassy Valley communities. Vegetation composition percentages of the BLM study reflect this transition. Tree vegetation comprises up to 20% of the mosaic, with shrub species making up to 50%.
Common tree species found here are Gambel oak (*Quercus gambelii*), bigtooth maple, and Rocky Mountain juniper (*Juniperus scopulorum*). With less rain, the overstory species tend to be smaller and more sparsely distributed than the Mountain community. Thickets of Gambel oak often intermingle with sagebrush (*Artemesia spp.*) and little-leaf mountain mahogany (*Cersocarpus intricatus*). On wetter sites, big tooth maple provide a canopy for understory shrubs. Grasses become more common. Wildryes and Indian ricegrass (*Sporobolus cryptandrus*) fill in where shrubs and trees have not. While foothill communities may receive more moisture than valley communities, many of the foothill vegetation species are highly adaptable and can tolerate drought. Foothill Community wildflowers and forbs include Common yarrow (*Achillea millifolium*), Sulphurflower buckwheat (*Eriogonum umbellatum*), Low beardtongue (*Penstemon humilis*), and Northern sweetvetch (*Hedysarum boreale*).

**Foothill Riparian Community.** The foothill riparian community, much like the foothill upland community, consists of slopes less steep than the mountain communities and a more open canopy than mountain riparian communities. Broad-leaf trees such as the western water birch and narrowleaf cottonwood (*Populus angustifolia*) make up the canopy trees. Understory vegetation is more varied than the mountain riparian community. On the USUBC site, this is due to the shallower slopes and resulting larger riparian zones. Red-twig dogwood (*Cornus sericea*), currants (*Ribes spp.*) and willows compose a dense understory. Again, the bank and toe zones will consist primarily of Nebraska sedge and rushes.
Valley Communities

**Valley Upland Community.** Valley Upland communities range from valley floors up to 5,500’. Drier and warmer conditions favor grasses. The BLM study shows that tree populations make up 15% of the percent cover, shrub vegetation is variable based on the age of the rangeland. Trees such as netleaf hackberry (*Celtis reticulata*) and western chokecherry (*Prunus virginiana*) dot the landscape. Sagebrush and rabbitbrush (*Ericameria nauseosa*) are commonly found. However, grasses dominate the landscape. Wheatgrasses, wildryes and ricegrass thrive in the often sandier soil. Many useful drought tolerant plants originate in this community. Valley Community wildflowers and forbs include Gooseberryleaf globemallow (*Sphaeralcea grossulariifolia*), Fragrant evening primrose (*Oenothera caespitosa*), Beebalm (*Cleome serrulata*), and Butterfly milkweed (*Asclepias tuberosa*).

**Valley Riparian Community.** Unlike the valley upland community, the valley riparian community offers enough moisture for large trees to grow. Cottonwoods are iconic in a valley riparian community, often reaching over 60 feet tall. Douglas hawthorns (*Crataegus douglasii*) and occasionally western water birches are also found in the valley riparian community. Dogwood and willow make up the understory, which now can be several times wider than a mountain riparian community. This is also the case
with the USUBC site. Nebraska sedge and clustered field sedge (*Carex praegracilis*) are common herbaceous plants that colonize the bank and toe zones.

**Design Details**

In a traditional design process, once the problems have been identified and goals established, a schematic design follows. This includes design suggestions that respond to the goals and program already created. The schematic design addresses how the design will incorporate potential solutions to challenges on the site. Design standards and even some details start to form as the final product begins to take shape. Plans and drawings effectively illustrate schematic designs. For the purposes of this thesis, a written explanation will provide further insight into the schematic design process. Each solution to the challenges identified previously will be addressed in further detail.

**Create a Buffer Between the Two Building Clusters.** The desire for a buffer to separate the educational and commercial uses was identified as a need that could be solved by the stream vegetation. The main stretch of stream that will act as the buffer is primarily Valley Plant Communities. Natural valley plant communities have fewer and, in the case of the Valley Upland Community, smaller trees than foothill and mountain communities. However, through careful placement of cottonwoods as well as other riparian and upland tree species, the integrity of the represented plant communities will be preserved while creating a buffer. This is accomplished by staggering trees in such a way that, when viewed on the north-south axis, minimal site lines pass from the
educational facilities on the north side through the stream vegetation to the south, where the commercial facilities will be located. However, adequate plant densities along the trail still represent the valley upland plant community character found in nature.

**Improve Trails.** The trail system around the retention ponds and wetland areas to the west are well developed. Several piers for wildlife viewing and fishing dot the landscape. Trails lead to and from the Utah House, Wetland Discovery Point and parking lots, creating anchors and easy access to the ponds. However, once visitors cross the road to the east of the project site, trails exist only on the perimeter of the stream site. Visitors need more trail options, shorter distances between destinations and greater variety in trail experiences on the stream site.

Trails will be added to run the length of the stream. The trail system will be a series of short loops. This gives users options for different experiences. For example, if a couple wants to enjoy a quiet walk along the stream but there is a field trip of 25 students touring the stream site at the same time, the couple can use the opposite loop arms of the

Figure 8: Concept detail of trail and bridge.
trail than the students. Additionally, the loop system allows for sections of the trail to be closed without completely cutting off the trail. As long as one arm of the trail is open, the whole stream can be accessed. Finally, visitors won’t have to retrace their steps. By choosing one loop arm when traveling one direction and the opposite arm coming back, new areas can be explored without walking on the same trail section twice.

The trails will be different widths. One section will be eight feet wide to accommodate maintenance vehicular traffic. The companion trail section on the opposite side will be six feet wide to accommodate two to three people across. The wider trail will also allow larger school groups to use the trail without the confinement of the six foot wide.

Additionally, the trail surface will be composed of gravel. This is a cost-effective and sustainable material that reduces hardscape, allows for light vehicular traffic, storm water penetration and is also American Disability Association compliant. In higher traffic areas around the nodes and trail entries, curbing will be used to define the trail and keep the gravel in place.
**Trail Nodes.** Trails nodes will be positioned throughout the stream site. The purpose of the nodes is to offer wildlife viewing points, areas for directional and educational signage, resting opportunities and areas for teaching. They will be built using natural materials such as local stone and wood. The simple design will compliment nature and not detract from it. These nodes are circular with a ten foot radius. Typically, each node will have two to four trails entering the circle. It is suggested that the remaining space around the perimeter will be bordered by benches or seat walls. This node design allows a teacher to stand in the middle and speak to the class sitting on the surrounding benches. Depending on the number of trails connecting to the node, two to four bench sections will be present at each node, allowing multiple small groups or individuals to use the same node without compromising privacy.

Each node will have a special educational emphasis based on the surrounding plant community or a unique stream feature. For example, there will be a node for each
plant community with information regarding the respective community. Additional nodes will be found at waterfalls, oxbows and other points along the stream.

**Signage.** Signage will be required throughout the site for directional and educational purposes. The USUBC already has begun creating a naturalistic hardscape style that the stream signage will compliment. Sign design will be simple. Materials will consist of local stone and weathered metal. These materials are appropriate due to their durability, rustic nature and low maintenance.

![Figure 11: Concept detail of signage and trail.](image)

The signs will display three types of information. Plant community markers will identify transitions between plant community zones as well as show riparian and upland boundaries. Signs will also provide educational information regarding plant species and habitat. Signage will be added to indicate direction to points of interest such as information nodes and lookout areas along the trail and throughout the USUBC.

**Amphitheater.** The amphitheater will be used for outdoor concerts, community classes and other public functions. Situated between the forks in the stream, the slope and location create a natural amphitheater. Visitors for concerts could exceed 500 at a given event. Thus, access to the amphitheater must be able to accommodate large quantities of
people in a short time. As with much of the site currently, the area that will house the amphitheater lacks defined edges and, therefore, a defined space. Additionally, many of these events will occur in the evening and, due to the aspect of the amphitheater slope, low-angle sunlight will be a problem for attendees. All of these factors influence the stream planting and trail designs. While the actual amphitheater design is not in the scope of this thesis, the needs listed above can be mitigated through design elements of the USUBC stream and master plan.

Trail access from four points around the periphery of the site will avoid a bottleneck that can occur when large crowds have only one or two entries to a venue. Wider and more direct trails into the amphitheater area will enable crowds to move more quickly. These elements of the trail design address the concerns of accommodating large crowds during amphitheater events.

Vegetation surrounding the amphitheater will define edges by providing vertical planes. The height of the trees and density of vegetation massings will create a sense of enclosure, separating the amphitheater space from the remainder of the site. The junction where the two streams converge is the critical point for sunsets. Audiences will be looking to the stage area directly in front of the stream junction, which also is due west from the amphitheater. It is imperative that some screening is provided to block the setting sun. Large cottonwood trees have been massed in locations surrounding the stage area to aid in blocking the sun. Shrub massings will also contribute to blocking the sun as well as create a visual buffer, acting as a backdrop to stage performers.
**Improve Habitat.** The master plan and stream vegetation plan is not just for human visitors. The USUBC boasts of a large variety and quantity of birds and other wildlife. Drawing from examples like the Lady Bird Johnson Wildflower Center and Red Butte Gardens, the USUBC strives to provide habitat for wildlife. The stream design does this through many different design aspects.

The stream and master plan draws a balance between site access and habitat preservation. While much of the site is visible to visitors on the trails, the loop system creates patches that won’t be entered by the general public. Shrubbery will be added in certain places to discourage visitors from going off the trail into wildlife habitat.

Additionally, many of the selected native plant species provide several habitat benefits. Serviceberry, hawthorn, and other trees and shrubs as well as many of the grasses and perennials provide food for insects, birds and even mammals. Canopy, understory and groundcover landscape, when combined together, improve wildlife habitat dramatically over simple canopy and groundcover landscapes (Graham 2002). The USUBC stream planting plan accomplishes the three levels of vegetation throughout the site. Also, by planting species that require little maintenance and fertilizer, habitat will be left undisturbed and less contaminated.

**Clean Water.** One of the primary goals of the stream is to clean and oxygenate the water. The stream planting plan accomplished this through a variety of design aspects. Excess nitrogen and phosphorus, common pollutants in fertilizers and chemical compounds are a primary cause of excess algae growth (Environmental Protection
Division, 2008). Of particular concern is blue-green algae, which grows in slow moving water containing high nutrient levels. Studies show that riparian vegetation absorbs excess nutrients and pollutants in water (Osbourne et al., 1993). By creating a natural succession of riparian plants, the nutrient filtering effect by the plants will be maximized. Thus, excessive algae growth will be, in part, mitigated through the addition of the riparian vegetation along the stream.

Oxygenation is another important aspect of clean water. The pump outlets for pond water discharge the water in the valley community areas of the stream. Much of the stream slope is at 3% or less where pond water circulates. Therefore, while some oxygenation will occur along the gradual 3% slope, greater elevation drops will improve water oxygenation greatly. Small dam-waterfall systems will be designed in the stream to increase oxygenation.

**Vegetation for Education.** One goal of the USUBC is community education. An important role of the USUBC is education regarding home landscapes. Master Gardener classes, display gardens, plant research and local plant retail events all contribute to this area of emphasis. This goal is also incorporated into the stream planting plan.

The plant choices for the site are not only native or well adapted species, but they have undergone multiple reviews from horticultural professionals from the USUBC, Utah State University and Utah Division of Wildlife Resources. Standards for plant choices not only correspond with the native plant communities, but many are commercially available and appropriate for residential use. Signage and learning areas along the trail system will
educate visitors about potential plants for residential use and those not suited for residential use. Learning areas will include appropriate species arranged so that visitors will be able to view the plants up close and study them in a way that they may not be able to along other stretches of the trail system. Habitat creation will also be a focus of the learning areas. Effective habitat creation through plant succession from groundcover to canopy will be exemplified. Plant species for particular effects such as attracting butterflies or birds will be highlighted.

Additionally, education about the general effects of the stream vegetation will be made available through signage. Water filtering, urban cooling effect and habitat creation will all be explained throughout the site. This will provide further learning opportunities for visitors, especially school groups.
IMPLEMENTATION

It is not the primary focus of this thesis to explore the implementation of the master plan and planting plans. It is understood that the projects designed in this thesis will be constructed in phases. However, during the production of this thesis, suggestions have been gathered specifically for the planting plan. While these are merely suggestions, to exclude them from the thesis would be irresponsible as they can guide future implementation and represent knowledge from qualified professionals.

Weed mitigation is a primary concern of the USUBC for the stream site. Efforts are currently made to discourage weed reseeding. However, an intensive effort to clear the site of weeds is needed. A cycle of chemical applications coupled with controlled burns is a common practice for large sites where total redesign is desired. This is also recommended for the stream site. Perennial and annual weeds can be greatly reduced through this method.

There are two basic classifications of chemical herbicides: pre-emergent and post-emergent. Pre-emergent herbicides prevent weed seeds from germinating whereas post-emergent herbicides attack existing weeds. Pre-emergent herbicides may be effective in the initial weed mitigation phase. However, once the project site is seeded with grass, pre-emergent herbicides should not be used.

The use of post-emergent herbicides is most effective if used when weeds are in the growing phase. Warm-season weeds sprout and do most of their growing in the spring
and early summer. This is the time to apply a post-emergent herbicide. Cool-season weeds sprout and grow in the fall and set seed the following spring. A fall application of post-emergent herbicide should be applied to mitigate cool-season weeds. It is not uncommon to need multiple herbicide applications to kill weeds, especially perennial and biennial species. There should be multiple applications for both in the spring and fall seasons. Additionally, consistent use of a single herbicide can create resistant strains of weed species. Instead, multiple herbicides should be used.

While the chemical cycling and burning efforts will be effective, not all weeds will be eliminated. The second phase for weed mitigation coincides with the initial planting phase. Plant competition is an effective way to deter weeds from entering a site. A general broadcast of the native and well-adapted grasses specified in the planting plan will provide competition against weeds that remain or that may enter the site. This will also be the first phase of the plant installation. Additional spot weed treatment will be necessary for certain weed types such as broad-leaf weeds.

Once the grasses have effectively been established on the site, tree, shrub and perennial installation is the next step in plant installation. Because the grasses will be established, new plants will be installed as containerized plants. This means that the introduced shrubs, trees and perennials will be able to compete with the established grasses and not be dominated for resources such as light and water. Irrigation measures will be addressed during this phase and is beyond the scope of this thesis. Additional
maintenance in the form of plant replacement, plant pruning, weeding, etc. will be necessary as the site develops.
CONCLUSION

Evaluation

The effectiveness of the master plan and planting plans can be measured through at least five metrics: plant survival, wildlife counts, maintenance requirements, visitor counts and water quality.

**Plant survival.** Landscapes are dynamic. Some plants are more aggressive than others. On sites as large as the project site, intensive maintenance would be needed to maintain the site as originally planned. That is not the purpose of a natural landscape and certainly not the goal of the project site. It is expected that certain species will thrive better than others. However, a diverse collection of plant species is desired. One way to monitor the success of plant choices and the effectiveness of plant community representation is through plant survival. Counts can be made to identify weaknesses in plant choice and plant groupings which will improve the knowledge of horticultural and landscape design fields.

**Wildlife counts.** The USUBC already hosts myriad of wildlife species. However, the stream site represents a new habitat and greatly increases the habitat footprint on USUBC grounds. As explained above, the stream site represents food and shelter sources. It will be valuable to record new species as well as any increases in general wildlife numbers that use the USUBC upon completion of the stream site.
**Maintenance requirements.** In the interest of similar projects in the future as well as community education for residential projects, maintenance issues should be explored. Information regarding weed mitigation, watering and fertilizer requirements as well as plant survival and the effectiveness of installation techniques will be invaluable. Successes will be powerful tools for public education about the benefits of practices used in the stream project. Failures will provide opportunities for further research.

**Visitor counts and experiences.** Much can be learned from how and how often a site is used. Certain aspects of the design are focused toward specific user groups. The loop trail system, plant learning areas, sun screening for the amphitheater and visual buffering between the commercial and educational spaces all affect the visitor experience. Like the maintenance evaluations, evaluations of the visitor related aspects of this design can be used to improve future projects as well as provide opportunities for further research.

**Water quality.** One of the major reasons for the stream project is to improve water quality. Measurements of water pollution levels before and after project completion must be made in order to accurately evaluate the effectiveness of the stream filtering process. Oxygen levels should likewise be measured before and after to evaluate the falls and general water cycling process for effectiveness in oxygenating the water. Additional measurements regarding algae levels, fish counts, water temperature, and general aesthetic value would also provide valuable information regarding water quality before and after project completion.
Further projects and research

In addition to research opportunities and potential projects identified above, there are numerous projects and research available through the general master plan and stream site. Amphitheater design, further refinement of the master plan—including building design and placement, and additional research plant implementation are just some of the many opportunities generated in conjunction with this thesis.
Works Cited


areas in Utah. Logan, Utah: Environmental Field Service Program, Dept. of Landscape Architecture and Environmental Planning, Utah State University.


Appendix I

Maps
PROPOSED CAFE
PROPOSED VISITOR CENTER
PROPOSED GIFT STORE
PROPOSED THEATER

FUTURE ADDITION

PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT
Mountain Trail Node

Trail Access to Varga Arboretum

Western River Birch
Betula occidentalis

Grey Alder
Alnus incana

Rocky Mountain Maple
Acer glabrum

Alpine Currant
Ribes alpinum

Mallowleaf Ninebark
Physocarpus malvaceus

Coyote Willow
Salix exigua

Rocky Mountain Juniper
Juniperus scopulorum

Douglas Fir
Pseudotsuga menziesii

Quaking Aspen
Populus tremuloides

Dwarf Rubber Rabbitbrush
Ericameria naseosa

Silver Sagebrush
Artemisia cana

Shrubby Cinquefoil
Potentilla fruticosa

Foothill/Mountain Riparian: Nebraska Sedge, Sierra Rush, Swordleaf Rush

Upland Grasses: Western Wheatgrass, Basin Wildrye, Indian Ricegrass
Foothill Trail Node
Amphitheater
Western River Birch
Betula occidentalis
Grey Alder
Alnus incana
Rocky Mountain Maple
Acer glabrum
Alpine Currant
Ribes alpinum
Mallowleaf Ninebark
Physocarpus malvaceus
Coyote Willow
Salix exigua
Rocky Mountain Juniper
Juniperus scopulorum
Douglas Fir
Pseudotsuga menziesii
Quaking Aspen
Populus tremuloides
Dwarf Rubber Rabbitbrush
Ericameria nauseosa
Silver Sagebrush
Artemisia cana
Shrubby Cinquefoil
Potentilla fruticosa

Foothill/Mountain Riparian: Nebraska Sedge, Sierra Rush, Swordleaf Rush
Upland Grasses: Western Wheatgrass, Basin Wildrye, Indian Ricegrass

Amphitheater
rail Node
Foothill Plant Schedule

- *Fagus grandifolia* (American beech)
- *Quercus gambelii* (Gambel oak)
- *Acer grandidentatum* (Bigtooth maple)
- *Juniperus scopulorum* (Rocky Mountain juniper)
- *Salix rigida* (MacKenzie's willow)
- *Cornus sericea* (Red-twig dogwood)
- *Ribes alpinum* (Alpine currant)
- *Amelanchier utahensis* (Utah serviceberry)
- *Cercocarpus intricatus* (Littleleaf mountain mahogany)
- *Quercus gambelii* (Gambel oak)
- *Populus angustifolia* (Narrowleaf cottonwood)
- *Potentilla fruticosa* (Shrubby cinquefoil)
- *Alnus incana* (Grey alder)
- *Acer glabrum* (Rocky Mountain maple)
- *Betula occidentalis* (Western river birch)

Foothill Trail Node

Amphitheater

Mountain

Trail Acc
PROPOSED CAFE

Maintenance Vehicle Accessible Trail

Pedestrian Only Trail

Narrowleaf Cottonwood
Populus angustifolia

Western River Birch
Betula occidentalis

Douglas Hawthorn
Crataegus douglasii

MacKenzie's Willow
Salix rigida

Red-twig Dogwood
Cornus sericea

Netleaf Hackberry
Celtis laevigata

Western Chokecherry
Prunus virginiana

Dwarf Rubber Rabbitbrush
Ericameria naseosa

Silver Sagebrush
Artemisia cana

Upland Grasses: Western Wheatgrass, Basin Wildrye, Indian Ricegrass

Valley Riparian: Nebraska Sedge, Claretfield Sedge

VALLEY PLANT SCHEDULE

Scale: 0' 5' 10' 15' 20' 25' North

Page #4

ROPOSED CAFE

Utah State University
Planting Plan
Dan Schults Masters Thesis, Department of Landscape Architecture and Environmental Planning, Utah State University
Valley Trail Node
Utility Access Road
Maintenance Accessible

Narrowleaf Cottonwood
Populus angustifolia
Western River Birch
Betula occidentalis
Douglas Hawthorn
Crataegus douglasii
MacKenzie's Willow
Salix rigida
Red-twig Dogwood
Cornus sericea
Netleaf Hackberry
Celtis laevigata
Western Chokecherry
Prunus virginiana
Dwarf Rubber Rabbitbrush
Ericameria naseosa
Silver Sagebrush
Artemisia cana
Porcupine Grass
Elymus canadensis
Shrubby Cinquefoil
Potentilla fruticosa
Upland Grasses: Western Wheatgrass, Basin Wildrye, Indian Ricegrass

Valley Riparian: Nebraska Sedge, Clustered Field Sedge

VALLEY PLANT SCHEDULE
Appendix II

Plant List
Narrowleaf Cottonwood  
*Populus angustifolia*

Western River Birch  
*Betula occidentalis*

Douglas Hawthorn  
*Crataegus douglasii*

Grey Alder  
*Alnus incana*

Rocky Mountain Maple  
*Acer glabrum*

MacKenzie's Willow  
*Salix rigida*

Red-twig Dogwood  
*Cornus sericea*

Alpine Currant  
*Ribes alpinum*

Mallowleaf Ninebark  
*Physocarpus malvaceus*

Coyote Willow  
*Salix exigua*

Netleaf Hackberry  
*Celtis laevigata*

Western Chokecherry  
*Prunus virginiana*

Gambel Oak  
*Quercus gambelii*

Bigtooth Maple  
*Acer grandidentatum*

Rocky Mountain Juniper  
*Juniperus scopulorum*

Douglas Fir  
*Pseudotsuga menziesii*

Quaking Aspen  
*Populus tremuloides*

Dwarf Rubber Rabbitbrush  
*Ericameria naseosa*  
spp. naseosus var. speciosa

Silver Sagebrush  
*Artemisia cana*

Shrubby Cinquefoil  
*Potentilla fruticosa*

Utah Serviceberry  
*Amelanchier utahensis*

Littleleaf Mountain Mahogany  
*Cercocarpus intricatus*

Mountain Snowberry  
*Symphoricarpos oreophilus*

Mountain Lover  
*Pachystima myrsinites*

Grasses

Valley Riparian: Nebraska Sedge, Clustered Field Sedge

Foothill/Mountain Riparian: Nebraska Sedge, Sierra Rush, Swordleaf Rush

Upland Grasses: Western Wheatgrass, Basin Wildrye, Indian Ricegrass
Appendix III

Bibliography


AUTHOR’S BIOGRAPHY

Dan was born in Providence, Rhode Island in September, 1983. Shortly thereafter, his family moved to Salt Lake City, Utah. Dan graduated from Olympus High School in 2002. Immediately after, Dan served a mission in Germany and Austria for two years. Dan graduated from Brigham Young University in 2009 with a bachelor’s degree with honors in Physiology and Developmental Biology and a minor in German. He will graduate from Utah State University in 2012 with a master’s degree in Landscape Architecture.

Dan and his wife, Jillian, welcomed their first child, Norah, in July 2011. Dan looks forward to pursuing a career in landscape architecture. He loves horticulture and teaching. Dan hopes to combine his passions and build a career that he enjoys.