TRILLIUM SITE
TROUT BROOK GREENWAY
NATURAL RESOURCE MANAGEMENT PLAN

EMMONS & OLIVIER RESOURCES

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TRILLIUM SITE – TROUT BROOK GREENWAY
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Introduction

This Natural Resource Management Plan (NRMP) encompasses that section of the Trout Brook Greenway extending from just north of Maryland Avenue, south to the proposed I-35E interchange at Cayuga Street. The site is generally bordered on the east by a railroad alignment and on the west by various manufacturing business along Agate Street. The entire site is owned by the City of St. Paul with approximately 7-acres of the site placed into a Minnesota Department of Natural Resources (MNDNR) conservation easement. At the time of the NRMP writing, the conservation easement had not been finalized. Generally, it is assumed to cover the eastern, lower portion of the site.

The purpose of the NRMP is to provide an implementation framework consistent with the *Trout Brook Greenways Plan,* as adopted by the City of St. Paul on October 24, 2001. The NRMP also defines resource management practices and implementation with respect to the MNDNR conservation easement. An overview of all aspects of the NRMP is depicted in Figure 1 – Conceptual Site Plan.

Project Vision: Goals and Objectives

The overriding vision for the Trillium Site is to create a nature preserve in the heart of a heavily urbanized area. The Trillium Site borders a residential area of the City that, at one time, was on a bluff overlooking the Trout Brook Valley. Many residents still remember walking along the creek down to the Mississippi River or up to Lake McCarrons to go swimming. With the tunnelization and filling of the creek, the valley slowly transformed into a heavily industrial area and severed the neighborhood's connection with the natural environment. The goal of the Trillium Natural Resource Management Plan is to re-connect this neighborhood with the environment through creation of a nature sanctuary.

The following are specific objectives of the Natural Resource Management Plan:

Visitor Use and Access

- The area will consist of a local and regional trail. The regional trail will serve as the primary trail through the site and will be a multi-use surface built to ADA standards. This trail will connect to the existing Gateway Trail and serve as the beginning of an eventual regional trail heading to the Northwest. The main entrance for this trail will be at the north end of the site along the old railroad bed. Additional access points will be provided along the western edge of the site to allow local access to the trail. The local trail will be a spur off the regional trail that will allow access through the nature preserve. This trail will be a non-paved surface intended for walking or cross country skiing.
- The portion of the site held under DNR Easement will be designed as a "nature sanctuary." Structural elements shall be excluded and access shall be limited.
- The rail line along the eastern edge of the site and it's associated hazard, noise and dust will minimized through combined designed elements of: topography, vegetation, stream and fence.
- Environmental Education and/or Cultural History will be interpreted onsite
- The nature sanctuary will be designed and managed to serve as a "Wayside Rest" to provide users of the regional trail the opportunity to stop, picnic and hike though the site.

Natural Areas Restoration and Habitat Development

- The ecological restoration will be based on reestablishing key elements of the "Big Woods", "Prairie" and "Oak Openings and Barrens" ecosystems. These were the pre-settlement ecosystems present in this area.
- The existing higher quality vegetation found throughout the site will be incorporated into restoration efforts rather than completely clearing all vegetation from the site. As an example,

the large cottonwood trees on the site will remain and serve as a canopy for establishing the Big Woods ecosystem.
- Connectivity, especially for migratory birds, will be enhanced within the site. The site is located within a significant fly-way for migratory birds and will be designed to provide a roosting area.
- The restoration plan will provide framework for long-term maintenance. The maintenance phase of the project will be vital to long-term success of the restoration.

Water - Features, Quality and Aesthetics

- The site will include a meandering stream designed to accommodate a constant base flow of 1-2 cfs with an associated floodplain sized to handle flows generated from a 5 year storm event.
- Local stormwater runoff (from about 150 acres drainage area) will be harvested, naturally filtrated (cleaned) and slow-released into the meandering stream.
- An additional design element such as a gravity stormsewer pipe from an upstream pond or pumping from the nearby Trout Brook interceptor will be evaluated in an attempt to provide baseflow in the stream during dry periods.
- The local stormwater harvesting system will be designed with an overflow to allow larger stormevents to be diverted into the Sims/Agate storm pond through the existing storm pipe system.

Pre-European-Settlement Plant Communities

The area that comprises the Trillium Site looked quite different (compared to today) prior to European settlement. While it is probably not possible to fully restore the Trillium Site to the plant communities that existed prior to European settlement, understanding what plant communities might have been present and why, provides considerable guidance for what plant communities can realistically be established today.

According to Marchner's map of Pre-Settlement Vegetation (Marschner 1974), the Trillium Site contained a mixture of "oak openings and barrens", and "big woods" vegetation types. In general, oak openings and barrens were located on south-southwest slopes and terraces with well-drained soils. The big woods vegetation type occurred on the more shaded north-northeast slopes and more finely textured soils that provided more moist conditions. The site is located within the broad valley that once contained the Trout Brook. Parts of the site, particularly the south end, were likely floodplain areas adjacent to the creek. This theory is consistent with the soil borings conducted on the site.

The pre-settlement plant community types depicted on Marchner's Presettlement Vegetation Map were based on the public land survey, which started in 1847; however physical disturbances to this site had started to occur before the time of investigation. Therefore, the information contained may reflect site conditions after a time when original vegetation had been altered. Based on slope, aspect, hydrology, and substrate, and comparing these conditions to similar settings in the area; one might paint a slightly different picture of pre-settlement plant communities. The following paragraphs describe the Trillium Site's potential pre-settlement plant communities in more detail.

Note! Information for this section is adapted from Minnesota's Native Vegetation: A Key to Natural Communities. Version 1.5. 1993.) and Natural Resource Inventories completed by EOR for similar landscape settings in Washington County, Minnesota

Dry Sand-Gravel Prairie: Dry Prairies (Sand-Gravel subtype) typically occurred on sandy, well-drained soils of outwash plains and river terraces. These prairies were often located on south-southwest

facing slopes. Sand-Gravel Prairies in this area were often dominated by relatively short, sparse grasses and sedges, with a good diversity of forb species. Typical grasses included little bluestem, side-oats grama and hairy grama, prairie junegrass, needle grass, plains muhly, prairie dropseed, Wilcox's panic grass, blue grama, and sand reedgrass. Some widespread, characteristic forbs included dotted blazing star, pasque flower, prairie golden-aster, stiff sunflower, silky aster, stiff goldenrod, gray goldenrod, Missouri goldenrod and narrow-leaved puccoon, as well as rough blazing star, buffalo-bean, silverleaf, Louisiana sagewort, prairie larkspur, hoary puccoon, prairie smoke, and wood lily. Three sub-shrubs - leadplant, prairie rose, and wolfberry - were also generally present.

Dry/Mesic Prairie: Dry/Mesic Prairies existed in pre-European settlement times on broad terraces along the Mississippi River on deep outwash sands. In depressional settings with more mesic conditions, typical grass species included big bluestem, Indiangrass, prairie dropseed, little bluestem, and porcupine grass. A high diversity of forb species in these wetter areas may have included purple and white prairie-clovers, ground-plum, rough blazing-star, Canada and stiff goldenrods, prairie thistle, and smooth aster to name a few.

Dry Oak Savanna: Dry Oak Savanna communities were intermediate between prairie habitats and woodland, and were characterized by widely spaced to clumped stands of large, spreading bur oak over a ground layer dominated by prairie species similar to those listed in previous paragraphs. Dry Oak Savanna communities existed on topography such as moderately sloping south-southwest facing slopes.

Oak Woodland: Oak Woodlands occurred on dry to mesic sites in this area, similar to the areas of moderately to well drained substrates found on this site. Typical oak woodlands contained a patchy tree canopy and an understory dominated by shrubs and tree saplings. The canopy was typically dominated by bur oak, with occasional pin oak, white oak, aspen, or paper birch. Canopy species were relatively short, with a wide, spreading canopy and heavy, low branches. The shrub layer ranged in density from sparse occurrences, to thicker pockets. Understory forbs and grasses occurred in moderate abundance, and sometimes scattered prairie openings occur with high plant diversity.

Floodplain Forest: Floodplain Forests occurred along the floodplain terraces of the Mississippi River and large streams, such as the Trout Brook, in areas which experience heavy spring flooding. The plant species present tolerated the erosion, sedimentation, and abrasion that occurred during the spring floods. The forest canopy was generally dominated by large, mature silver maple, with cottonwood and black willow sometimes co-dominant. Other mesic forest species, such as green ash, hackberry, basswood, and boxelder may have been present as well. The understory and shrub layers were usually quite sparse, lending a spacious feel to the forest. Vines including wild grape, Virginia creeper, wild cucumber, and moonseed, and may have covered supporting vegetation especially along sunny, exposed riverbanks. The common grasses were those adapted to disturbance, including Virginia wild-rye and rice cut-grass. Similarly, typical forb species were those that are well adapted to disturbance. Many were annual species that produced abundant seed and could colonize quickly after flooding, including wood nettle and clearweed. The ground layer may have also included dense patches of canopy species seedlings.

Wet Meadow: Wet meadows occurred on wet mineral soils or shallow peat where standing water is usually present only in the spring and after heavy rains. These communities existed in scattered sections along the Trout Brook floodplain in depressions and shallow basins too wet for woody vegetation to persist. Sedge species generally dominated wet meadow communities, especially broad leaf species such as *Carex lacustris*, *C. stricta*, *C. rostrata*, and other, accompanied by a relatively high cover and diversity of herbaceous species. Other species included giant sunflower, Joe-pye weed, giant

goldenrod, redstem and New England asters, hedge nettle, jewelweed/spotted touch-me-not, tall meadow rue, stinging nettle, and dogbane. The forbs and grasses of these meadows tend to be less competitive and relatively high in their nutrient demands (Eggers and Reed 1987).

Mixed Emergent Marsh: Most Mixed Emergent Marshes within the Trillium Site area were likely large shallow-basin wetlands that had standing water most of the year. Some marshes may have been ephemeral, with little to no standing water late in the season and significant amount of exposed mud flat, or perennial, with shallow water persisting on the site throughout the season. Graminoids formed the dominant cover, and fowl manna grass, giant manna grass, rice cut-grass, bottlebrush sedge, 3-way sedge, wooly bulrush, and green bulrush are typical, and prairie cord grass may have occurred. Forb species such as marsh milkweed, boneset, arrowhead, and mud plantain were common, as were fringed loosestrife and bulb-bearing water hemlock. Beggar-ticks and jewelweed often colonized mudflat areas. Giant bur-reed occurred sporadically. Depending on topography, a narrow fringe of woody species tolerant of wet conditions may have occurred around the marsh perimeter. Raspberry and blackberry brambles were common, with occasional winterberry, steeplebush, or red-osier dogwood.

Wet Prairie: Wet Prairies occurred mainly in broad, shallow basins where bedrock was relatively near the surface, or where impermeable soils prevented drainage. In these areas, the water table remained within the plant-rooting zone for several weeks during the growing season, but inundation occurred only infrequently and briefly. Grasses typically dominated this community, with such species as prairie cordgrass and blue-joint grass, with occasional patches of fringed brome and/or big bluestem. Sedges were also often present, with and abundance of forbs including panicled aster, New England aster, giant goldenrod, Riddell's goldenrod, giant sunflower, sawtooth sunflower, sneezeweed, gay-feather, blazing-star, grass-leaved goldenrod, golden Alexander, closed gentian, and prairie loosestrife. Small willows and meadowsweet were common, with willow and aspen trees often growing either singly or scattered in small clumps along wetland margins.

Mesic Oak Forest: At least 30% of the tree canopy in a Mesic Oak Forest was made up of oak trees; typically northern red oaks, white oaks, and/or bur oaks. On these mesic, less fire-prone sites basswood, green ash, bitternut hickory, big-toothed aspen, and butternut made up the remainder of the canopy. The actual composition of the community varies considerably in response to differences in soil moisture, soil type, fire history, and climate. Canopy species were typically tall (> 20 meters), straight, single-stemmed trees that lacked spreading lower branches.

Maple-Basswood Forest: Basswood, sugar maple, and (formerly) American elm, dominated the canopy of Maple-Basswood Forest. Other mesic trees, including northern red oak, bur oak, and green ash were sometimes dominant locally. The canopy was typically dense, with tall, straight, relatively narrow-crowned trees. The understory was multi-layered and patchy. It was composed of saplings and seedlings of the canopy species (especially sugar maple), along with ironwood, bitternut hickory, pagoda dogwood and occasionally butternut and black cherry.

Existing Conditions

Existing conditions for the Trillium Site are a composite of soils, topography, hydrology and the plant and animal communities that associate with these features. This section describes conditions as they exist today within the context of ecological restoration and development of the site as part of the Trout Brook Greenway.

Geologic Landforms

The Trillium Site occurs within a shallow bedrock valley that was subsequently filled with meltwater sediments associated with the Grantsburg sublobe glaciation (*Geologic Atlas of Ramsey County, Minnesota,* Minnesota Geological Survey, 1992). This landform, referred to as the "St. Paul Sand Flats" is characterized by a broad, sandy, outwash plain with incised tributary channels outletting to the former channel (bedrock valley) of the Mississippi River. The former channel of the Mississippi River is located approximately two miles east and corresponds roughly with the Phalen Corridor. The edge of this post-glacial tributary channel is defined by the prominent ridge running along the west edge of the Trillium Site and by a similar ridge located just east of Interstate 35E. Trout Brook, which outletted lakes and wetlands to the north, drained south though this post-glacial channel to the Mississippi River. Within this broad, shallow valley, Trout Brook was but a small remnant of the much larger post-glacial stream.

Soils

Soils on the Trillium Site reflect the sandy outwash plain parent material. The native soils are often covered by several feet of fine to medium-grained sand or silty sand fill material with other materials including asphalt, concrete and wood debris. In many places, deep deposits of cinders, presumably disposed of as a byproduct of the coal-powered trains, is present.

The 1980 soil survey indicates these three soil types within the Trillium Site boundaries:

- 454D, Mahtomedi loamy sand, 12 to 18 percent slopes. This soil is excessively drained and occurs along the boundary of a glacial moraine ridge and outwash plains. This soil type is present along the western boundary of the site, upslope of the abandoned CPSL rail grade. Although this soil unit has been altered though excavation, placement of fill and hillslope erosion, it is the only native soil present on the Trillium Site.

- 1027, Udorthents are basically urban fill on top of poorly to very poorly drained soils. According to soil borings (Phase II Environmental Site Assessment, Braun Intertec, 2003), the fill material generally consists of from one to sixteen feet of silty sand, often mixed with cinders, over peat or sand within the former Trout Brook floodplain. This soil type is present within the majority of the site lying east of the CPSL rail grade.

- 85C B, Urban Land-Chetek Complex on 3-15 % slopes. This level to gently undulating soil is associated with outwash plains and is somewhat excessively well drained. Locally, the majority of this soil is altered by residential land uses. This soil is located along the west side of the site where slopes are not as steep.

Because most of the soils on the site are fill material of unknown origin, it is difficult to generalize with respect to such soil characteristics as degree of compaction, bulk density, organic content and macro and micro nutrient content. Soils investigations have been limited to analysis of contaminants and do not include analysis of soils with respect to their ability to support biological communities. Because most soils on the site are not fine-textured clay soils, which are more prone to compaction, compaction should not be difficult to correct and should mostly be limited to roadways and rail alignments within the Site.

A final consideration is soil development. Most of the Trillium Site is covered by sandy fill material that has not had an opportunity to accumulate organic material or develop structural characteristics conducive to retention of water, oxygen and nutrients. Even with the addition of nutrients (fertilizer applications), there are limitations on soil capacity to retain nutrients for plant uptake. Soil development is a long-term process that can best be achieved though establishment of native plant

communities, and their associated fungi, bacteria and invertebrates. Below there is a discussion on potential soil remediation techniques.

Slope and Aspect

Elevation on the Trillium Site ranges from 847 feet at the top of the ridge where Agate Street dead ends in the northwest corner of the site to 780 feet within the Simms-Agate Wetland. The slopes along the western portion of the site generally rises 20 to 30 feet above the abandoned CPSL rail grade. Elevation changes between this railroad grade and the more level portions of the site adjacent to the BNSF Rail range from about 15-feet just south of Maryland to just a few feet at Jenks Avenue. Overall, with the exception of the two slopes described above, the site is gently sloping. Slope aspects are predominantly east to northeast with a few short slope sections, associated with small ravines, facing to the southeast.

Physical Disturbances

The Trillium Site was historically used as a coach yard for the Northern Pacific Railroad and as a major route of the Canadian Pacific/Soo Line Railroad (CPSL) and the Burlington Northern – Santa Fe Railroad (BNSF). In order to construct these rail lines, the floodplain valley was filled and a terrace graded into the west slope of the valley to accommodate the CPSL rail, which is now abandoned. Associated with these rail lines, the site also contained a coach yard for the CPSL and later, industrial facilities dependent on rail transportation services became established. Today, the coach yard is no longer in operation; however the BNSF rail and many of the industrial facilities remain.

More recent physical disturbances include the Trout Brook Sanitary Sewer Interceptor, and a roadway that runs though the site. To the south of the site, a large stormwater treatment pond was constructed to treat stormwater runoff from approximately 150-acres of mostly residential neighborhoods to the west. This pond is largely filled with sediment and is dominated by reed canary grass. The City of St. Paul plans to excavate the sediment from the basin in 2004.

Existing Vegetation

To describe the existing vegetation on the Trillium Site a field inventory was conducted in December 2003. The inventory resulted in subdividing the site into eleven distinct areas as shown in Figure 2 – Existing Conditions. These areas provide a framework to describe current conditions on the site and, where possible, are designated in accordance with *Minnesota's Native Vegetation: A Key to Natural Communities, Version 1.5* (Minnesota Department of Natural Resources, 1993). Where disturbances are substantial, such that little in the way of native plant community species composition or structure remains, descriptive titles are assigned, consistent with the *Minnesota Land Cover Classification System, Version 4.0* (Minnesota Department of Natural Resources, 2000). Following is a brief description of each area. A summary of plant species within each area is provided in Table 1.

Area 1. Lowland Hardwood Forest: This area occurs in a low-lying depression between the abandoned CPSL railroad grade and the parking lot of the Harmony Nursing Home. The tree canopy is dominated by 20-inch diameter eastern cottonwood with a subcanopy of American elm, boxelder and green ash. The shrub layer is generally sparse with regeneration of boxelder and green ash. Invasive woody species are present in low to moderate densities in the shrub layer and include Chinese elm saplings, common buckthorn and tatarian honeysuckle. It was too late in the season to observe what groundcover species are present; however, garlic mustard is likely the dominant species.

Area 2. Disturbed Deciduous Woodland: Area 2 includes two separate areas, one along a slope north a Maryland and the other off Agate Street. Both of these woodlands occur along moderately steep, northeast-facing slopes. Within the woodland, the tree canopy is patchy and dominated by eastern

cottonwood trees of variable size. The subcanopy includes occasional boxelder, Chinese elm and butternut. The shrub layer includes green ash, common buckthorn, hawthorne and tatarian honeysuckle, with smooth sumac present around the edges. Groundcover species visible in less shaded areas include smooth brome, blue grass and Canada goldenrod. In more shaded areas, garlic mustard and white snake root are the dominant groundcover species.

Area 3. Old Field/Abandoned Railroad Grade*:* Area 3 encompasses open areas along the abandoned railroad grade that have succeeded to old field and will eventually succeed to brushland in a few years. This area is dominated by mostly nonnative annual and perennial grasses and forbs, many of which could be considered highly invasive. Cool season grasses including smooth brome and Kentucky blue grass dominate this area. Other grasses present include yellow foxtail, occasional big blue stem and orchard grass. Forbs present include horseweed, stiff goldenrod, hoary vervain, common mullein, spotted knapweed, Canada goldenrod, beard tongue foxglove, queen anne's lace and ragweed. Shrub and sapling-size tree species occur in patches and include Chinese elm, eastern red cedar, smooth sumac and occasional pin oak and butternut.

Area 4. Disturbed Deciduous Woodland: Area 4 occurs along a moderate to steep, east-facing slope between residential homes along Agate Street and the abandoned railroad grade. The canopy is patchy and dominated by eastern cottonwood trees of variable size. The subcanopy includes occasional boxelder, Chinese elm and butternut. The shrub layer is dominated by common buckthorn, and occasional tatarian honeysuckle. The groundcover layer includes mostly invasive native and nonnative herbs such as garlic mustard and white snakeroot.

Area 5. Lowland Hardwood Forest: This area is mostly off site within a fenced-in area located south of the Modernistic Die Cutting Facility. This forest area is within a level, flood-prone area that appears to receive stormwater runoff. The canopy is dominated by young (less than 12-inch DBH) eastern cottonwood along with box elder and Chinese elm. The shrub layer is dominated by boxelder regeneration. Groundcover species present include white snakeroot, ragweed, motherwort, smooth brome and yellow foxtail. Soils in this area appear to be significantly compacted from past uses of this site.

Area 6. Cattail Marsh: This cattail marsh, referred to as the Sims Agate Pond, is dominated by cattail and forb species including *Epolobium coloratum*, beggerstick, water dock and blue vervain. The north boundary of the wetland has recently been planted to switch grass, hawthorne and white spruce. This cattail marsh did not contain any standing water at the time of the survey; however, soils were saturated to the surface. Stormwater discharges to this cattail marsh from the residential areas to the west. A weir/skimmer structure outlets the pond into the Trout Brook storm sewer. Also included under this designation is a small cattail swale just north of Maryland near the BNSF rail.

Area 7. Soil Stockpile Site: Area 7 is a recently graded/seeded area just north of the Sims Agate Pond. This site was previously used by Frattalone Excavation to stockpile soil and construction debris. Since this site has only recently been seeded (during the past growing season) it is unclear what vegetation will become established on this site. It is anticipated that at least some of this area will be utilized for the MNDOT / Sims Agate Pond, which is expected to be partially relocated as part of the new Cuyuga/35E interchange.

Area 8. Old Field: Area 8 is an old field with scattered pockets of shrub and young tree growth. This area contains numerous piles of concrete, asphalt, wood and other debris scattered about in small piles. The vegetation is dominated by weedy annual and perennial grasses and forbs including smooth brome, Kentucky blue grass, reed canary grass, yellow foxtail, orchard grass, Canada goldenrod, prairie dock, ragweed, cocklebur, blue vervain, spotted knapweed, stiff goldenrod, and queen anne's lace. Shrubs

present include red raspberry, willow sp. and Chinese elm, boxelder and eastern cottonwood saplings. This area contains occasional pockets of potential wetland within shallow depressions that are dominated by reed canary grass and willow. If wetlands are present, it is likely that proposed improvements will more than offset any impacts. Prior to grading or other alterations, a formal wetland determination should be conducted.

Area 9. Woodland/Old Field: Area 9 encompasses a short section of steep slope that separates the lower (easterly) portion of the site from the upper (westerly) portion of the site. At least some portions of this slope were created as part of the upper railroad grade, which appears to have been cut out of the natural slope along the western boundary of the site. The elevation difference between the lower and upper portions of the site increases from south to north with relief on the northernmost portion of the site reaching a maximum of 20 to 25 feet. Because much of the Trillium Site is relatively flat, this slope constitutes one of the more distinctive land form features. Vegetation within Area 9 is similar to adjacent areas with the groundcover dominated by smooth brome, Kentucky bluegrass and Canada goldenrod. Common shrubs include smooth sumac and Chinese elm saplings. Scattered patches of Chinese elm, boxelder, green ash and eastern cottonwood are present along the slope. The northerly portion of this area contains occasional northern pin oak seedlings.

Area 10. Oak Woodland: This area is the least disturbed portion of the site and contains the best overall diversity of native species, although invasive woody and herbaceous species are common. The canopy is dominated by northern pin oak, eastern cottonwood, American elm and butternut trees, most of which are probably 50-years or less in age. Native shrubs and tree seedlings include red-berried elder, red osier dogwood, northern pin oak, bur oak, green ash and butternut are present in the shrub layer. Nonnative shrubs include tatarian honeysuckle, common buckthorn, Chinese elm and Russian olive. At the time of the survey, groundcover species were dormant; therefore, it was difficult to assess the true diversity of this area; however, it is likely that at least some additional native herbs are present in this area. Groundcover species visible at the time of the survey include white snakeroot, *Solidago speciosa*, Virginia stickseed and smooth brome.

Area 11 Old Field-Brushland: Area 11 includes the brushy, old field areas both north and south of Maryland. These two areas are similar to many of the other old fields on the site, but have nearly succeeded to brushland. As a result, some of the forbs common on other portions of the site have been crowded out by shrubs. Common grasses and forbs include smooth brome, Kentucky bluegrass and Canada goldenrod. Shrub and sapling-size tree species include eastern cottonwood, Chinese elm, tatarian honeysuckle, boxelder, and red osier dogwood.

Table 1. Existing Plant Species				**Existing Condition Areas**										
Species	**Common name**	**Invasive Native**	**Invasive Exotic**	1	2	3	4	5	6	7	8	9	10	11
Acer negundo	Boxelder			X	X		X	X			X	X		X
Ageratina altissima	White Snakeroot							X					X	
Alliaria petiolata	Garlic Mustard		yes	X			X							
Ambrosia artemisiifolia	Common Ragweed	yes						X			X			
Ambrosia trifida	Giant Ragweed	yes												
Andropogon gerardii	Big Bluestem					X								
Arctium minus	Common Burdock		yes											
Bidens cernua	Beggartick								X					
Bromus inermis	Smooth Brome		yes		X	X		X			X	X	X	X

Table 1. Existing Plant Species (cont)				**Vegetation/Site Preparation Areas**										
Species	**Common name**	**Invasive Native**	**Invasive Exotic**	1	2	3	4	5	6	7	8	9	10	11
Centaurea biebersteinii	Spotted Knapweed		yes			X					X			
Cirsium arvense	Canada Thistle		yes											
Conyza canadensis	Horseweed					X								
Cornus sericea	Redosier Dogwood												X	X
Coronilla varia	Crown Vetch		yes											
Crataegus sp.	Hawthorne				X				X					
Dactylis glomerata	Orchard Grass					X								
Daucus carota	Queen Anne's Lace		yes			X								
Elaeagnus angustifolia	Russian Olive		yes										X	
Epilobium coloratum	Purpleleaf Willowherb								X					
Fraxinus pennsylvanica	Green Ash			X	X		X					X	X	
Hackelia virginiana	Virginia Stickseed												X	
Juglans cinerea	Butternut					X							X	
Juniperus virginiana	Eastern Redcedar					X							X	
Leonurus cardiaca	Common Motherwort		yes					X						
Linaria vulgaris	Butter and Eggs		yes											
Lonicera tatarica	Tartarian Honeysuckle		yes	X	X		X						X	X
Panicum virgatum	Switch Grass								X					
Pennisetum glaucum	Yellow Foxtail		yes			X		X			X			
Penstemon digitalis	Foxglove Beard-tongue					X								
Phalaris arundinacea	Reed Canary Grass	yes												X
Picea glauca	White Spruce								X					
Poa pratensis	Kentucky Bluegrass	yes	yes											X
Poa spp.	Grasses				X	X					X	X		
Populus deltoides	Cottonwood			X	X		X	X			X	X	X	X
Quercus ellipsoidalis	Northern Pin Oak					X						X	X	
Quercus macrocarpa	Bur Oak												X	
Rhamnus cathartica	European Buckthorn		yes	X	X		X						X	
Rhus glabra	Smooth Sumac					X						X		
Rubus idaeus. ssp. strigosus	Red Raspberry										X			
Rumex crispus	Curled Dock		yes						X					
Rumex orbiculatus	Greater Water Dock										X			
Sambucus pubens	Red-berried Elder												X	
Solidago canadensis	Canada Goldenrod					X						X		X
Solidago gigantea	Giant Goldenrod										X			
Solidago rigida	Stiff Goldenrod					X					X			
Solidago speciosa	Showy Goldenrod												X	
Typha latifolia	Broadleaf Cattail								X					
Ulmus americana	American Elm			X			X						X	
Ulmus parviflora	Chinese Elm		yes	X	X	X		X			X	X	X	X
Verbascum thapsus	Common Mullein		yes			X								
Verbena hastata	Blue Vervain								X		X			
Verbena stricta	Hoary Vervain					X								
Xanthium strumarium	Cocklebur		yes								X			

Wildlife Habitat

Wildlife habitat associated with the Trillium Site can be described using the plant community designations for existing conditions. These plant communities (already described) include deciduous woodland, oak woodland, lowland hardwood forest, old field and cattail marsh. The species lists shown in **Appendix A** lists mammal, bird and herpitile occurrences associated with three major habitat types; forest/woodland, prairie, and wetland. These habitat types collectively describe the existing vegetative cover types of the site and also encompass the mosaic of natural communities proposed to be restored to the Trillium Site. These lists include species documented for Ramsey and Washington County, Minnesota, and encompass most of the species that may potentially occur locally. The forest/woodland designation would best represent existing deciduous woodland, oak woodland and lowland hardwood forest. The prairie designation would best represent old field and old field-brushland. The wetland designation would represent cattail marsh.

Species that have been documented within the Trillium Site, or which are generally assumed to occur in urban areas are denoted by a "confirmed" occurrence. Species that are undocumented and not necessarily associated with urban areas, yet are likely to be present during at least some time of the year are denoted by a "likely" occurrence. Species that are undocumented and where habitat specific to their needs is thought to be present are denoted by a "possible" occurrence. Finally, species that are undocumented and where no habitat is thought to exist are denoted by an "unlikely" occurrence.

Habitat Generalist Species

Most wildlife species that would currently be present on the Trillium Site are species that would be characterized as *habitat-generalist* species. Habitat generalist species are capable of exploiting a wide range of conditions, especially where human disturbance is present. Habitat-generalist species are also capable of thriving within a wide range of different plant communities, often utilizing a mosaic of forest, grassland and wetland habitats intermixed with a broad range of urban land uses. Habitat-generalist species are also capable of adapting to plant communities of lower ecological quality that are fragmented and poorly buffered. Examples of habitat-generalist species either documented or likely to be present in the Trillium Site include raccoon *Procyon lotor*, red fox *Vulpes vulpes*, and white-tail deer *Odocoileus virginianus.*

Habitat Specialist Species

Habitat specialists, which can be thought of as indicator species, have unique habitat requirements and are usually associated with higher quality natural communities. Some of these species may also require large breeding or home range territories that are well buffered from human disturbance. Examples of habitat specialist species would include the Red Shouldered Hawk (*Buteo* lineatus), which requires large, undisturbed floodplain or lowland hardwood forest areas. Because this species is known to occur along the Mississippi River, it is possible that this hawk could move through the Trillium Site, if suitable habitat was present, or if traveling between the Mississippi River and natural areas to the north.

Endangered Species

Minnesota's Endangered Flora and Fauna (Coffin & Pfannmuller, 1988) lists a number of species for Ramsey County that could potentially occur under existing conditions, or more likely, might be found following reclamation of the TRILLIUM SITE. **Table 2** summarizes these species.

Table 2 Endangered Animal Species		**State Status***	**Key Habitat**
American Bittern	*Botaurus lentiginosus*	SC	Wetlands
Bald Eagle	*Haliaeetus leucocephalus*	TH	Large trees near water for nesting
Red-Shouldered Hawk	*Buteo lineatus*	SC	Floodplain Forests
Osprey	*Pandiod haliaetus*	SC	Large trees/snags near water for nesting
Forster's Tern	*Sterna forsteri*	SC	Emergent Marshes
Northern Myotis	*Myotis septentrionalis*	SC	Natural caves
Eastern Pipistrelle	*Pipistrellus subflavus*	SC	Natural caves
Snapping Turtle	*Chelydra serpentina*	SC	Marshes
Fox Snake	*Elaphe vulpina*	SC	Wooded bluffs with rock outcrops near floodplains
Eastern Hognose Snake	*Heterodon platyrhinos*	SC	Sandy soils-oak woodland savanna, prairie, floodplain
Gopher Snake	*Pituophis melanoleucus*	SC	Dry-mesic prairie, oak savanna and woodlands

SC-Special Concern, TH-Threatened

All of these species are recorded in Ramsey County and most are known to occur within the Twin Cities Area, including areas near the urban cores of St. Paul and Minneapolis. Where these species occur near heavily urbanized areas, they are generally associated with the Mississippi and Minnesota River Valleys.

Key Wildlife Habitat Features

Following is a summary of some of the key habitat features associated with the Trillium Site

Wildlife Travel Corridor

The BNSF and CPSL rail corridors have the potential to provide excellent connections between the Mississippi River and areas to the north and east. In particular, the CPSL rail provides a connection to the mosaic of lakes, wetlands and forests associated with Snail Lake Regional Park. The BNSF rail provides an additional connection to Como Regional Park. Although these corridors lack continuous habitat and are often quite narrow, a long term effort to restore existing gaps could result in a viable travel corridor for waterfowl, shorebirds, raptors and songbirds. As these corridors are improved, terrestrial species including mammals and herpetiles should also benefit.

Emergent Marsh

The Simms-Agate Pond, which functions as a stormwater pond for a 150-acre drainage area, nonetheless provides important habitat for waterfowl and shorebirds. This pond also may provide habitat for herpitiles such as turtles and frogs. The size of the pond, with its dense growth of cattails serves as a refuge for mammals, especially during the winter and provides habitat for fur-bearing species such as mink, muskrat and raccoon.

Large, old Cottonwood Trees

Along the west slope of the Trillium Site, the deciduous forest includes occasional, large-diameter eastern cottonwood trees. These trees provide a "super canopy" that adds structural diversity to the forest and provides valuable nesting habitat for cavity nesting birds and mammals as well as roosting and feeding sites for raptors.

Water Resources

The Trillium project site is located within a north-south running valley that once confined the original Trout Brook surface channel. Progressive development of Saint Paul and surrounding areas eventually resulted in all portions of the Trout Brook channel being shifted to underground confinement within what is referred to as the Trout Brook Interceptor. The interceptor originally contained combined sanitary and stormsewer flow, but has since been separated. Today the Trout Brook sanitary interceptor runs in a north-south orientation just west of the Soo Line RR under the Trillium project site and the 11' x 12' stormsewer runs north-south just east of the project site.

The Trillium site drainage area, shown in Figure 3 – Hydrologic Evaluation and Base-flow Alternatives, is approximately bound by Hawthorn Avenue (just north of Maryland) on the north, Sylvan Street on the west, Sims Avenue on the south and the Soo Line RR on the east of the project site. The drainage area is composed of St. Paul residential development, cemetery, and the valley corridor itself housing two railroad lines, a dirt access road, poor quality open space and a large soil stockpile site. Trillium site surface flows and stormsewer flows all enter a storm sewer pipe running along the western site boundary into the Sims/Agate Pond. There are five main entry points into the stormsewer pipe; one entry point each at the eastern end of Rose, Magnolia, Cook, Jenks, and Case Avenues. The total site drainage area is approximately 210 acres.

Key Natural Resource Issues and Concerns

There are numerous natural resource issues and concerns that must be addressed as part of the Trillium Site NRMP. The purpose of this section is to describe these natural resource issues and concerns within the context of the goals and vision for the Trillium Site. The key issues include:

Day-lighting of Trout Brook

One of the Specific Recommendations of the Trout Brook Greenway Plan is to "restore a portion of Trout Brook and Wetlands on the Trillium Site". A number of design issues must be addressed to determine the feasibility of this plan, but in particular, the cost of various options. A secondary issue relates to local stormwater management, by both the City and MNDOT, and the proposed enlargement and relocation of the Simms-Agate Pond. Our approach is to provide a stream that not only enhances the aesthetics of Trillium Site, but also provides a broad range additional functions such as wildlife habitat, water quality protection and flood control.

Wildlife Corridor – Connectivity

The BNSF and CPRL rail lines provide a potentially viable link between the Mississippi River and areas to the north including Snail Lake Regional Park. Although these rail lines provide excellent opportunities to connect existing and proposed natural areas, many challenges remain. In particular, many sections of these rail corridors offer little or no habitat, and thus serve as barriers to wildlife movement. While some wildlife species are quite mobile and capable of moving though narrow areas of poor cover, many other species, such as small mammals and reptiles, may not be able to safely traverse these gaps. A key element of this NRMP will be to insure that connections to the north and south are maximized.

Invasive Species

Invasive plant species are widespread and abundant across the entire Trillium Site. Of 53 plant species recorded on the site, 18 are listed as invasive exotic species. Invasive plants occur in tree, shrub and herbaceous form, and in most areas are more common than native species. The competitive strategies of invasive plants include rapid growth rates, abundant seed production, thick rhizome and root expansion, and ability to thrive in poor soils of low nutrient status. Some species such as spotted

knapweed, garlic mustard, and European buckthorn have been shown to contain chemicals that inhibit the growth of other plants. Once brought under control, ongoing maintenance activities, such as mowing or controlled burning will be necessary to suppress newly established invasive plants as they attempt to repopulate the Trillium Site. Control of invasive plants is proposed as a key element of this NRMP.

Definition of Site Boundaries (Legal/Administrative vs. Ecological)

Substantial portions of existing natural features associated with the Trillium Site cross onto various private parcels. This is especially true of residential homes that border the west side of the Site. Many of these residential homes have back yards extending into wooded areas that provide an excellent foundation from which to establish native plant communities. Several natural areas also cross over onto adjoining commercial/industrial parcels. A key element of this NRMP will be to identify opportunities for the City to partner with local residents willing to actively manage and improve their natural resources.

Site Remediation and Soil Reclamation

Site remediation and soil reclamation are two different processes. In site remediation, contaminants are removed or their risks reduced to an acceptable level by some means such as capping off with clean material. Soil reclamation implies restoration of physical and biological attributes including soil structure, organic content, fertility and soil microorganisms. All of these parameters function in providing a living matrix of material that enables plant communities to thrive. Soils in the Twin Cities area have generally had about 8000 to 10,000-years to form since the end of the last glaciation. Soils on the Trillium Site are largely composed of varying qualities of fill material. In some areas of the site, old road beds, rail alignments and other activities have resulted in severe soil compaction, poorly suited to plant community reestablishment. These areas will be identified and addressed as part of the NRMP.

Compatibility of Existing/Future Human Use

Future recreational uses of the Trillium Site will include construction of a regional trail along the abandoned CPRL rail. A soft-surface foot path is also desired so that users can walk though restored areas of the site. Placement of trails will need to be carefully planned to avoid steep slopes, sensitive plant communities and wildlife habitat.

Erosion/Sedimentation

The west portion of the site is generally bordered by a steep slope with residential streets ending as short “stubs” projecting out into the site. These short stubs provide an excellent path for stormwater runoff to flow into and across the site. In several locations, a plume of sediment arising from local runoff is visible. A key element of this project will be to evaluate where stormwater and sediment is coming from and how stormwater can be treated to improve conditions on the site.

Recommendations

Hydrologic Evaluation

As a project amenity it was proposed that a portion of the Trout Brook be resurfaced and allowed to run in an open channel through the Trillium project site. Because all portions of the original brook have been enclosed in a storm sewer, the main challenge to creation of this feature becomes supplying a reliable and constant source of water for base flows in the channel. In order to supply a recommended base flow of 1 to 2 cfs in the proposed channel, four alternative water sources were investigated

The four base flow alternatives presented and shown in Figure 3 – Hydrologic Evaluation and Base-flow Alternatives include:

1. Construction of a stormsewer pipe from the Arlington Pond to the Trillium Site following the alignment of the large Trout Brook Storm Sewer Pipe.
2. Installation of a pump and force main to bring flows from the nearby Trout Brook Storm Sewer to the Trillium Site.
3. Interception and harvest of local stormwater which currently flows in a pipe through the Trillium Site.
4. Combination of alternatives 2 and 3 (Trout Brook pump & local runoff harvest).

Economic Evaluation

In order to properly compare the alternatives, the total cost over a 20-year cycle was evaluated. The cost of initial construction, operation and maintenance, equipment replacement and/or other reconstruction was identified and estimated. Mechanical equipment, such as pumps, was assumed to need replacement at some stage within the 20-year analysis. A moderate inflation rate of 3% was applied to the annual costs.

All future costs were brought forward to an equivalent value termed Present Worth. Present Worth can be defined as the equivalent amount of current value funds needed to pay for a future expense. The interest rate assumed for this computation was 3%. Cost estimates of each alternative are discussed below and detailed in Appendix A.

Alternatives

Alternative 1 – Arlington Pond Pipe

This alternative investigated the possibility of tapping into the Arlington Pond, located north of the project site, to bring a base flow by pipe to the proposed open channel. The pipe alignment and configuration of this alternative was, for the most part, as presented in the Trout Brook Greenways Plan (2001). A detailed review of the pipe alignment (for generation of the cost estimate) resulted in only minor re-alignment changes from that previously presented. The proposed alignment for the 15" RCP is shown in Figure 3 – Hydrologic Evaluation and Base-flow Alternatives.

The estimated total cost of this alternative is shown in the following summary table (Table 3) and broken down by bid item in Appendix A. Using Arlington pond as a base flow water source turned out to be the most costly of the alternatives presented. In addition to the higher cost associated with this alternative, other potential difficulties and disadvantages of this alternative included:

- minimal pipe clearance at the Trout Brook interceptor crossing
- additional construction and permanent easement acquisitions,
- disturbance of developed areas, existing utilities, and alignment issues
- low flood prone areas at Arlington Avenue
- minimal design flexibility due to the low gradient between Arlington Pond and the project site.

Key assumptions made when generating a cost-estimate for this alternative included:

- Flap gate necessary to prevent Arlington Avenue flooding
- Adequate cover is available to cross the Trout Brook sanitary sewer near Trout Brook Circle
- No soil correction in the RR swale
- Excess soils disposed on site
- Permanent easement is adequate through the impound lot and behind K-Mart
- No additional cost for temporary easement through industrial property

- Vegetation restoration costs are computed for the disturbed area between the pump station and the railroad crossing.
- The cost of restoration of the disturbed area within the limits of the project site are included in the overall project restoration costs.

The cost estimate included an annual cost that equals the cost of a bi-annual inspection over the 20-year cycle of the analysis. The life of the storm sewer is estimated to be 50^{+} years, therefore no replacement or major rehabilitation costs were included in the estimate.

Also as a result of the flat gradient of the long pipe and necessary pipe elevations due to alignment restrictions, the proposed channel length would be significantly shortened. Site grade and project restrictions would require that the pipe daylight approximately half way into the project site. An alternative not explored would be to use and in-line pump to allow base-flow delivery at a higher elevation.

Alternative 2 – Trout Brook Pump

Multiple pump station locations were investigated for this alternative. The final alignment proposed (Figure 3) recommends that a pump station be located adjacent to the section of the Trout Brook storm sewer that is proposed to be reconstructed at Lorient Street. This location takes advantage of near-future proposed Trout Brook repairs as well as proximity to the site. The new stormsewer should incorporate a bypass manhole with a stub outlet designed to allow low flows to divert to a future pump station.

Components of the pump alternative include:

- The pump station would contain 2 submersible pumps designed to lift 1 cfs of flow a total height of 30 feet.
- A manufactured device designed to remove heavy sediment and floatables would be located between the Trout Brook storm sewer and the pump station.
- Approximately 1000’ of 6” d.i.p. forcemain would deliver the water to the upper segment of the Trillium site. The pipe would be augered under the railroad.
- A gravel access pad would be constructed between the adjacent parking lot and the pump station.
- Vegetation restoration costs are computed for the disturbed area between the pump station and the railroad crossing.
- The cost of restoration of the disturbed area wihin the limits of the project site are included in the overall project restoration costs.

The estimated total cost of this alternative is shown in the following summary table (Table 3) and broken down by bid item in Appendix A.

Pumping base flow from the Trout Brook stormsewer is a viable alternative, however, dependable dry period flow rates achievable are limited to approximately 1cfs. Dry period flows within the Trout Brook, and therefore flow available to be pumped, will be limited to discharge from the St. Paul Water Utility facility located upstream of the project site. The St. Paul Water Utility delivers a constant discharge of about 1.5 cfs clean water to the Trout Brook. Investigation of a storage feature to capture the St. Paul Utility discharge was not included in this design analysis.

Key assumptions made when generating an estimate of the annual operation costs included:

- Continuous pump operation from April through October for 12 hours per day.
- 1 cfs constant Trout Brook base flow available.

- Pumps replaced two times during 20-year life cycle.
- Electrical panel would be replaced once during the 20-year cycle.
- Pumps would be inspected and maintained weekly during the annual pump operation period.
- Sediment removal device would be cleaned once per year.

Alternative 3 – Local Runoff Harvesting

This alternative taps into runoff captured by the local stormsewer drainage system serving the St. Paul neighborhood directly west of the project site. Currently, stormwater captured in this drainage system is delivered to a large north-south stormsewer which brings stormwater to the Sims/Agate Mn/DOT pond (which is slated for reconstruction). The harvesting alternative taps into manholes along the main laterals at Rose, Magnolia, Cook, and Jenks Avenues and delivers runoff water to a series of terraced water quality garden features. The engineered gardens are designed specifically to filter and clean the stormwater as well as attenuate peak flow rates to allow for extended base flow augmentation to the proposed channel. In addition to capturing the local stormsewer flows, the garden features will capture and treat additional surface flows that run-bys the stormsewer system (catch basin bypass) and bluff runoff. The main features of this alternative are shown in Figure 3 – Hydrologic Evaluation and Base-flow Alternatives.

The estimated total cost of this alternative is shown in the following summary table (Table 3) and broken down by bid item in Appendix A. Key components and assumptions made when generating the cost-estimate for this alternative included:

- 12" and 24" bypass lines constructed between existing manholes and new basins.
- Creation of three terraced stormwater basins
- Each basin is underlaid with 6" perforated HDPE for collection of filtered stormwater.
- Bentonite liner not necessary under water quality filter features
- Water collected in underdrains discharged to channel.
- Excess water delivered to basins during large rain/snowmelt events would overflow basins rather than submerge local drainage system.

The annual cost assumes that the site would be inspected yearly, and that a minor amount of accumulated sediment and/or litter would need to be removed.

This alternative provides a storm-based source of channel base flow, as well as improved water quality treatment of St. Paul stormwater. An additional potential benefit of harvesting local stormwater on the site would be the addition of water quality treatment facilities upstream of the Sims/Agate pond. The Mn/DOT pond currently receives water from both St. Paul streets and I-35E. This alternative will provide separate water treatment of St. Paul runoff reducing or eliminating the need for additional water quality treatment in the existing pond. It is possible that St. Paul and Mn/Dot could take advantage of the gained treatment potential of the pond or could reduce its need and size as a result of the water quality benefits realized from this alternative. By treating the runoff in a new system, the St. Paul runoff would not need the additional treatment in the pond, allowing St. Paul and Mn/DOT flexibility in determining how to use the existing pond as I-35E is reconstructed.

Alternative 4 – Combination Pump and Local Runoff Harvest

This alternative combines the features presented under alternatives 2 (Trout Brook pump) and 3 (local runoff harvesting) to provide onsite water quality treatment of local stormwater in combination with an assured minimal channel base flow (provided by the pump). Total hours of pump operation are significantly reduced under this combined alternative as a result of base flow augmentation from the

water quality garden features. Cost savings are realized from reduction of pump operation and maintenance and potentially as a result of negotiations regarding the future reconstruction of the Sims/Agate pond.

The estimated total cost of this alternative is shown in the following summary table (Table 3) and broken down by bid item in Appendix A. The basin design and cost do not change in this alternative. Minor changes in the pump station design and operation include:

- Number of pumps reduced to one.
- Single pump allows elimination of manifold and valve manhole.
- Pump operation time reduced 50%, by turning off pumps during rain events.
- Two mobilization costs combined into one lower mobilization cost.

Combining alternatives 2 and 3 is an attractive alternative because it provides the water quality benefits described under alternative 3, and ensures a constant minimum channel base flow (to be provided by the Trout Brook pump). To fully appreciate the benefits and cost savings possible by combining alternatives 2 and 3 it is necessary to consider the operation and maintenance of the alternatives over a 20 year life span. Additional potential cost savings resulting from the combined alternative include:

- reduced pump operation (less wear and tear)
- reduce pump maintenance needs
- increased pump lifespan (fewer replacements needed)
- Reduced need for Mn/Dot treatment pond.

Recommendation

Alternative 4, combination of local runoff capture and the Trout Brook pump, provides the best combination of site features and long-term benefits for the City of Saint Paul and the Capitol Region Watershed District. Benefits provided are described above. Key benefits include:

- on-site water quality treatment
- ensured minimal channel base flow during dry periods
- reduced pump operation and maintenance need and cost
- future negotiations regarding reconstruction of Mn/DOT Pond

Table 3 Hydrologic Evaluation - Cost Summary	Total Estimated Construction Cost	Annual Operation and Maintenance Cost	One-Time Replacement Cost	20-Year Present Worth
Alternative 1 Arlington-Jackson Pond Storm Drain	$1,318,000	$2,000		$1,348,000
Alternative 2 Trout Brook Pump Station	$337,000	$15,000	$40,000	$590,000
Alternative 3 Harvest Neighborhood Drainage	$544,000	$3,000	$5,000	$592,000
Alternative 4 Merge Alternative #1 and #2	$787,000	$7,000	$10,000	$899,000

Trout Brook Stream Channel

Using applied stream morphology, natural streambed substrate and native vegetation, the created stream has been design to mimic a natural river system. This modest perennial flowage has been design to receive locally treated stormwater. During dry periods the stream will be supplied with a 1 cfs baseflow from one of the two offsite delivery options to insure a constant flow.

In order to retain flows within this stream course, which resides over a highly porous and potentially contaminated substrate, the stream has been lined with a Bentonite Liner. As illustrated in Figure 5 - Typical Stream Cross-Section, this liner requires a 15" subcut and associated 15" ballast import of sand, topsoil borrow and clean gravel.

Table 4: Trillium Stream morphology Parameters		
Design Discharge		
	Baseflow:	1 cfs
	Bankfull:	
	@ Rose	3 cfs
	@ Magnolia	8 cfs
	@ Jenks	14 cfs
Design Channel Cross-Section Morphology		
	Entrenchment Ratio:	6.25-1.88
	Width / Depth Ratio:	7.1
	Sinuosity:	1.55
	Gradient:	.0085
	Channel Material:	Sand/Silt/Clay
	Rosgen Stream Type:	E 5/6
Design Channel Alignment Morphology		
	Meander Belt Width:	40'- 10'
	Pool – Riffle Ratio:	60' +/-
	Meander Wavelength:	110'
	Radius of Curvature:	18.4' +/-

Site Preparation and Plant Community Pre-Establishment

Note that a summary of some of the common control practices for invasive species is listed in Appendix C. Site preparation and plant community pre-establishment areas are the same areas defined in the Figure 1.

Area 1. Lowland Hardwood Forest

- *Invasive Species – First Year*: Hand cut or girdle buckthorn and other woody invasive species during early to mid-summer, but prior to fruit/seed production. Retain native trees including Eastern cottonwood, hackberry, boxelder and native elms. All slash should be removed from the slope and disposed of or piled onsite and burned. Apply basal application of Garlon-4 or other approved herbicide within twenty-four hours of cutting/girdling. Larger trees (DBH>6"), should be girdled rather than cut and left standing. Spot treat garlic mustard and other invasive herbs as needed.

- *Invasive Species - Second Year:* Provide spot control of invasive species with either herbicide treatments or hand pulling. Clip buckthorn sprouts as they occur. Conduct controlled burn during fall of first year or spring of second year.

- Divert stormwater runoff away from area and into rain garden/infiltration swale system as specified under the stormwater management discussion of this report.

- Remove debris from site, post signs prohibiting dumping.

Area 2. Disturbed Deciduous Woodland

- *Invasive Species – First Year*: Hand cut or girdle buckthorn and other woody invasive species during early to mid-summer, but prior to fruit/seed production. Retain native trees including Eastern cottonwood, hackberry, boxelder and native elms. All slash should be removed from the slope and disposed of or piled onsite and burned. Apply basal application of Garlon-4 or other approved herbicide within twenty-four hours of cutting/girdling. Spot treat garlic mustard and other invasive herbs as needed.

- *Invasive Species - Second Year:* Provide spot control of invasive species with either herbicide treatments or hand pulling. Clip buckthorn sprouts as they occur. Conduct controlled burn during fall of first year or spring of second year.

- During mid-summer, girdle Chinese elm 6-inches DBH and larger, and apply (within the cut) garlon-4 herbicide. These trees should not be removed unless they pose a safety concern to adjoining properties or the public.

- Divert stormwater runoff away from area and into rain garden/infiltration swale system.

- Remove debris from site and post signs prohibiting dumping where residential streets dead end into site.

- Designate 2-3 large cottonwood trees/acre as "wildlife snag trees". Large cottonwood trees should be located, so that when dead, do not pose safety concerns to adjacent residential property or to the public. These trees should be girdled and treated with Garlon-4 herbicide during midsummer. Large Chinese elm may be substituted where appropriate.

- A meeting should be held, on-site, with local landowners to discuss the NRMP and more specifically, how local residents can work with the City to restore the forest communities that border the Trillium Site.

Area 3. Old Field/Abandoned Railroad Grade

(Note that the following activities should be closely coordinated with the RAP) These site preparation recommendations should be implemented in the order given below, and where a preceding step adequately addresses site preparation requirements, subsequent steps may not be necessary.

- Remove all junk and debris piles from site. Where debris are buried, or encountered during excavation, debris should be removed to minimum depth of one-foot and covered with clean fill, consistent with the RAP.

- Where soil is compacted along the abandoned CPSL rail or on roadways within the site, remove any unnatural surface material and rip soil to minimum depth of one foot. Make two passes over site with a disk. This work should be done prior to planting and incorporate erosion control measures as needed.

- *Soil Reclamation and Seedbed Preparation - Soils Analysis:* Soils should be evaluated to determine suitability for plant community establishment before initiation of soil restoration, seeding or planting activities For each soil-mapping unit, composite soil samples should be evaluated for macronutrients, micronutrients, pH, organic content, bulk density and soil

microorganism populations. This analysis can be carried out by the University of Minnesota Soils Department for a nominal fee.

- *Soil Reclamation and Seedbed Preparation - Soil Amendments:* Based on results of the soils analysis, the application rate and composition of the soil amendments should be established to improve soil structure and fertility, consistent with target plant communities.

- Remove (if possible, clear and grub as part of overall site development) invasive woody trees and shrubs. Stumps not grubbed out should be treated with basal application of garlon-4 herbicide. Removal should ideally occur during mid-summer, but before target species have fruited.

- Treat entire site during early summer (while cool season grasses still growing, but before grasses/forbs go to seed) with roundup. Monitor for re-sprouting or germination of weedy grasses and forbs, and if necessary, reapply roundup during mid-September.

- Conduct fall burn (to extent that fuel is adequate) over entire site from late-September to mid-October.

Area 4. Disturbed Deciduous Woodland (See Site Preparation recommendations for Area 2)

Area 5. Lowland Hardwood Forest

- If possible, remove (or move back) chain-link fence that separates Trillium site from private land to west. Work with landowner to manage as part of lowland hardwood forest restoration.

- *Invasive Species – First Year*: Hand cut or girdle buckthorn and other woody invasive species during early to mid-summer, but prior to fruit/seed production. Retain native trees including Eastern cottonwood, hackberry, boxelder and native elms. All slash should be removed from the slope and disposed of or piled onsite and burned. Apply basal application of Garlon-4 or other approved herbicide within twenty-four hours of cutting/girdling. Larger trees (DBH>6”), should be girdled rather than cut and left standing. Spot treat garlic mustard and other invasive herbs as needed.

- *Invasive Species - Second Year:* Provide spot control of invasive species with either herbicide treatments or hand pulling. Clip buckthorn sprouts as they occur. Conduct controlled burn during fall of first year or spring of second year.

Area 6. Cattail Marsh

- The reconstructed wetland should be designed (to the extent possible) to minimize stormwater bounce for smaller storm events. Side slopes should be reduced to a maximum of 10:1 and preferably to 20:1 (horizontal:vertical elevation in feet) to promote greater diversity of wetland vegetation. If primary stormwater treatment is needed on this site, a separate cell to remove sediments should be incorporated into the design so that the remaining portion of the wetland

- Control reed canary grass around margins of wetland with early summer application of glyphosphate, followed by a mid-fall glyphosphate application. Follow with a controlled burn.

- For portions of cattail marsh not graded or excavated, remove cattails by drawing down water level during mid-summer, mowing, and then re-flooding so that water level is maintained over cut cattails.

- *Invasive Species Control in Excavated Areas:* Most invasive species will be removed as part of wetland construction. Invasive species not removed should be treated as described previously for Site Preparation Area III. Care should be taken when excavating soils near the surface to keep separate from deeper soils. Shallow soils containing invasive species, including vegetative material or seeds, should be placed at the bottom holes excavated for contaminated soil removal and covered with weed-free soil.

Area 7. Soil Stockpile Site

- Areas not excavated should be treated with an appropriate herbicide and burned (if fuel conditions are suitable) prior to seeding/planting

Area 8. Old Field:

- Remove all junk and debris piles from site. Where debris are buried, or encountered during excavation, debris should be removed to minimum depth of one-foot and covered with clean fill, consistent with the RAP.

- On roads to be abandoned, remove any unnatural surface material and rip soil to minimum depth of one foot. Make two passes over site with a disk. This work should be done prior to planting and incorporate erosion control measures as needed.

- *Soil Reclamation and Seedbed Preparation - Soils Analysis:* Soils should be evaluated to determine suitability for plant community establishment before initiation of soil restoration, seeding or planting activities For each soil-mapping unit, composite soil samples should be evaluated for macronutrients, micronutrients, pH, organic content, bulk density and soil microorganism populations. This analysis can be carried out by the University of Minnesota Soils Department for a nominal fee.

- *Soil Reclamation and Seedbed Preparation - Soil Amendments:* Based on results of the soils analysis, the application rate and composition of the soil amendments should be established to improve soil structure and fertility, consistent with target plant communities.

- Remove (if possible, clear and grub as part of overall site development) invasive woody trees and shrubs. Stumps not grubbed out should be treated with basal application of garlon-4 herbicide. Removal should ideally occur during mid-summer, but before target species have fruited.

- Treat entire site during early summer (while cool season grasses still growing, but before grasses/forbs go to seed) with roundup. Monitor for re-sprouting or germination of weedy grasses and forbs, and if necessary, reapply roundup during mid-September.

- Conduct fall burn (to extent that fuel is adequate) over entire site from late-September to mid-October.

Area 9. Woodland/Old Field

- Due to the steepness of grade in this area, care should be taken to minimize disturbance and soil exposure in this area. Standard erosion control practices including silt fence, erosion blankets and mulching should be applied where needed or where problems are anticipated.

- Remove all junk and debris piles from site. Where debris are buried, or encountered during excavation, debris should be removed to minimum depth of one-foot and covered with clean fill, consistent with the RAP.

- Remove (if possible, clear and grub as part of overall site development) invasive woody trees and shrubs. Stumps not grubbed out should be treated with basal application of garlon-4 herbicide. Removal should ideally occur during mid-summer, but before target species have fruited.

- Treat entire site during early summer (while cool season grasses still growing, but before grasses/forbs go to seed) with roundup. Monitor for re-sprouting or germination of weedy grasses and forbs, and if necessary, reapply roundup during mid-September.

- Conduct fall burn (to extent that fuel is adequate) over entire site from late-September to mid-October.

Area 10. Oak Woodland

- This area contains significant natural regeneration of oak species. Before cutting or applying herbicide to invasive woody species, first locate and mark all native trees and shrubs to avoid accidentally damaging or killing young tree seedlings or saplings.

- *Invasive Species – First Year*: Hand cut or girdle buckthorn and other woody invasive species during early to mid-summer, but prior to fruit/seed production. Retain native trees including Eastern cottonwood, hackberry, boxelder and native elms. All slash should be removed from the slope and disposed of or piled onsite and burned. Apply basal application of Garlon-4 or other approved herbicide within twenty-four hours of cutting/girdling. Spot treat garlic mustard and other invasive herbs as needed.

- *Invasive Species - Second Year:* Provide spot control of invasive species with either herbicide treatments or hand pulling. Clip buckthorn sprouts as they occur. Conduct controlled burn during fall of first year or spring of second year.

- During mid-summer, girdle Chinese elm 6-inches DBH and larger, and apply (within the cut) garlon-4 herbicide. These trees should not be removed unless they pose a safety concern to adjoining properties or the public.

Area 11 Old Field-Brushland

- Prior to initiating invasive species control, identify and mark all desirable native shrubs and tree seedlings. These trees and shrubs should be carefully protected during site restoration activities.
- *Invasive Species Control - Woody Species:* Cut species targeted for **immediate removal.** Larger trees (DBH > 8") shall be girdled or treated with a hypo-hatchet and left standing.

Cutting should be conducted during mid-summer, but prior to fruit/seed production on buckthorn. All woody material should be inspected to insure that seed material (primarily buckthorn fruits) are not attached and should be piled for chipping and mulching. Dead snags should be left standing provided that they do not present a safety problem or restrict future management activities.

- *Invasive Species Control - Herbaceous Species:* Prior to initiation of herbaceous species control efforts, survey site to locate any areas of the Old Field dominated by native species and if found, delineate native species areas with flagging. Delineate remaining areas dominated by cool season grasses with flagging from areas that are predominantly forbs (e.g., spotted knapweed, thistle). Apply mid to late May application of glyphosate herbicide to cool season grass dominated areas. Apply glyphosate or appropriate selective herbicide during middle to late summer (but before target species go to seed) to control annual weeds.

- *Invasive Species Control – Controlled Burns:* Once vegetation has died back and dried out sufficiently, conduct a controlled burn of all treated areas. If conditions are too wet or if density of vegetation is not sufficient to carry a burn, mow in place of the controlled burn. ***Note! For areas where soil remediation requires removal of soil or placement of clean soil over existing soil, this step should be omitted.***

- *Invasive Species Control – Second Year Efforts:* Following removal of woody and herbaceous invasive species and controlled burn, allow invasive grass, forb or woody species to resprout or germinate (mid-late summer) and grow to a height of approximately eight inches. At this time, apply a second treatment of glyphosate and possibly other selective broadleaf herbicides to control annual weeds. Monitor site, and follow up with additional herbicide applications at intervals of three to four weeks. After first hard frost, conduct final controlled burn if conditions allow.

- *Soil Reclamation and Seedbed Preparation - Soils Analysis:* Soils should be evaluated to determine suitability for plant community establishment before initiation of soil restoration, seeding or planting activities. Prior to collecting soil samples, existing soil testing information and soil surveys should be reviewed to determine soil-mapping units. For each soil-mapping unit, composite soil samples should be evaluated for macronutrients, micronutrients, pH, organic content, bulk density and soil microorganism populations. This analysis can be carried out by the University of Minnesota Soils Department for a nominal fee.

- *Soil Reclamation and Seedbed Preparation - Soil Amendments:* Based on results of the soils analysis, soil reclamation objectives should be developed that will achieve long-term stability of soil conditions conducive to plant community health. Reclamation objectives should be defined for each soil mapping unit and appropriate soil amendments prescribed accordingly**.** It is important to note that most prairie grasses and forbs are adapted to low-nutrient soils and that fertilizer may encourage invasive weeds. For this reason, it may be preferable to minimize the use of organic fertilizers, especially those high in nitrogen. The use of wood chips, or other material, is used to enhance soil structure while tying up available nitrogen to reduce weed competition. All soil amendment approaches assume that soil remediation has first been completed. Soil remediation includes removal and offsite disposal and covering contaminated soils with clean soil.

Proposed Natural Communities: Descriptions and Restoration Strategies

Natural communities proposed for the Trillium Site include a mosaic of woods, savanna, prairie and streambed. The proposed natural communities were selected on the basis of specific physical site characteristics and the ecoregion. Soil classification, relief, and aspect were the prevalent physical characteristics used to establish natural community units.

The existing cover types on the Trillium Site consist of areas with significantly disturbed remnants of natural woodland and forest communities to wholesale vegetation and soil alteration. For the disturbed remnant sites, the restoration strategy is to do partial vegetation restoration, retaining as much of the existing vegetative structure as possible, remove invasive species, and replant with native species. Thus, the proposed wooded community types are consistent with the canopy cover to be retained in existing disturbed woodlands. For disturbed soil sites the strategy is to begin with soil reclamation and then move to complete vegetation restoration.

Existing site preparation strategies include invasive species removal followed by controlled burn in complete restoration areas. Sites will then be planted and/or seeded depending on the community type. This plan does not include detailed site design and restoration specifications.

Figure 4 – Proposed Plant Communities depicts the location of proposed natural communities. Restoration activities are based upon the need for partial and completion restoration in different units of each proposed community. Appendix C provides species lists for each natural community. For a summary of restoration activities, please refer to the Detailed Cost Estimate for Natural Community Restoration in Appendix A. A summary of the acreages of each proposed Natural Community type is in table 5.

Table 5 – Proposed Plant Community Composite Acreages

Plant Community	**Acres**
Big Woods	4.3
Oak Woodland	2.9
Oak Savanna	7.9
Mesic Prairie	9.9
Lowland Hardwood Forest	4.3
Mixed Emergent Marsh	3.1
Wet Prairie	9.2

Big Woods

Big Woods is a complex of Central Minnesota forest community types determined by variation in soil, relief, and aspect. A big woods natural community is proposed for the Trillium Site which would consist of maple-basswood and mesic/dry oak forest communities.

Maple-basswood forest communities have a dense canopy of mostly basswoods, sugar maples, and (formerly) American elms. Other mesic trees, such as slippery elms, northern red oaks, bur oaks, white ashes, and green ashes, are sometimes dominant locally. The understory is multi-layered and patchy. It is composed of saplings and seedlings of the canopy species (especially sugar maple), along with American hornbeam, ironwood, bitternut hickory, pagoda dogwood and leatherwood. The spring ephemerals and winter annuals, a suite of forb species that bloom, produce seeds, and die back in May and early June before tree leaves are fully developed, includes spring beauties (Claytonia spp.), Dutchman's breeches (Dicentra cucullaria), trout-lilies (Erythronium spp.), and cleavers (Galium aparine). Other herbs, such as the sedge Carex pedunculata, bottlebrush grass (Hystrix patula), and

bearded short-husk (Brachyelytrum erectum), are commonly present in the groundlayer but usually not abundant.

Northern red oaks, white oaks, or bur oaks dominate the more mesic stands of Oak Forest. Historically these stands occurred on sites with fewer severe fires compared to the sites on which dry Mixed Oak Forest occurred. Commonly, mesic fire-sensitive tree species are present with the oaks in these stands, especially in the understory. These species include basswood, green ash, bitternut hickory, big-toothed aspen, and butternut. The shrub layer in mesic stands is sparser than in dry stands and, correspondingly, the forb layer is denser and more diverse and there are more graminoid species.

The Trillium site characteristics are feasible for a restoration trajectory towards mesic or dry oak forest. The restoration strategy is a planting of combined mesic and dry oak forest species to ensure a broader competitive advantage over invasive species during the establishment phase. Controlled burns will be used at sites within the oak forest unit to favor future dry oak forest establishment. First and second year site monitoring data will be analyzed to select controlled burn sites to favor a dry oak forest type.

Tree and Shrub Planting: Trees and shrubs should be planted randomly at a rate of 50 trees/acre and 50 shrubs/acre. Shrubs should be distributed across the site according to individual species preference with respect to dryness of soil and/or position on slope. All trees and shrubs should be protected with hardware mesh enclosures to a height of five feet to protect against deer browsing and rodent damage. Tubes may also be used for tree seedlings without branches.

Seeding and Mulching: Following tree and shrub planting, apply mixed shade/sun woodland seed and cover crop mix. Hand broadcast seed with spreader after mid-October (dormant seed), but before snow covers ground. Apply and roll mulch.

Oak Woodland

Oak Woodland is floristically and structurally intermediate between Oak Savanna and Oak Forest, with a patchy tree canopy and an understory dominated by shrubs and tree saplings. The principal species in the tree canopy are bur oak, northern pin oak, white oak, and northern red oak. Aspens may form up to 70% of the tree canopy cover. The brush layer ranges in density from sparse (with 10-30% cover), to an impenetrable thicket. It is often especially dense in openings between clumps or groves of trees. Most of the floristic diversity in the community exists in the brush layer, which most commonly is composed of blackberries, raspberries, gooseberries, dogwoods, cherries, hazelnuts, prickly ashes, and sprouts of oak and quaking aspen. Prairie vegetation, if present, occurs only in small openings in the tree or shrub canopy. Except in these scattered prairie openings, the herbaceous layer is sparse and floristically poor. It is usually composed of woodland species capable of surviving in the dense shade beneath the brush layer.

Oak Woodland is proposed for an east-facing sloping area intermediate between big woods and prairie.

Tree and Shrub Planting: Trees and shrubs should be planted randomly at a rate of 50 trees/acre and 50 shrubs/acre. Shrubs should be distributed across site according to individual species preference with respect to dryness of soil and/or position on slope. All trees and shrubs should be protected with hardware mesh enclosures to a height of five feet to protect against deer browsing and rodent damage. Tubes may also be used for tree seedlings without branches.

Seeding and Planting - Grasses and Forbs: Following site preparation and tree and shrub planting, apply herbaceous seed mix using broadcast spreader. Do not seed areas marked for acorn planting.

Seeding – Acorn Seeding: Follow directions for establishment of oak seeding areas described for Oak Savanna. Oak should be seeded in patches and marked to make relocation possible.

Oak Savanna

The principal trees are bur oaks and northern pin oaks, but black oaks are also common in the southeast. Northwards, quaking aspens become more frequent in the community. Small, gnarly, open-grown trees are most common, although in moister spots, or in heavier soils, larger trees are sometimes more common. Tree spacing ranges from sparsely and evenly distributed to strongly clumped in moderately dense patches. Shrub cover is variable as well. The species composition of the shrub layer depends somewhat upon soil characteristics. Oak grubs and chokecherries are common on all soil types. On sandier soils, prairie willows (Salix humilis), New Jersey tea (Ceanothus americanus), American hazelnuts (Corylus americana), sand cherries (Prunus pumila), and juneberries (Amelanchier spp.) are usually present. Wolfberries (Symphoricarpos occidentalis) are commoner on heavier soils. Substrates range from excessively-drained to well-drained sand to loam soils. The presence of savanna rather than prairie indicates a lower fire frequency or intensity (or both) than in prairie. In the complete absence of fire woodland will eventually replace Oak Savanna.

Oak Savanna is proposed for upper slope portions of what is now old field on the east side of the site. The lower elevation of this community will be transitional to the wet prairie at the base of the slope. Oak Savanna is also proposed as an east-facing cover type which is transitional to Oak Woodland.

Seeding - Grasses and Forbs: Install mesic prairie seed and cover crop mix with a Truax Drill or Trillium Seeder. Seeding may be completed as either a dormant seeding or spring seeding. Apply mulch and anchor with a straw crimper. Areas marked for seeding oak acorns should not be planted to prairie grasses and forbs until oak seedlings have had several years to grow.

Seeding - Acorns: Planting acorns provides a cost-effective alternative to seedlings and helps to establish a more "authentic look" to the oak savanna by creating scattered patches of dense oak grubs, as opposed to single trees or small groups of trees established from seedlings. Acorns can be collected locally from groves in the City of St. Paul with the help of volunteers. Bur oak and pin oak acorns should be gathered in the fall. Collected acorns should be soaked in water with those floating to the surface discarded (they are usually unviable). Plant acorns two-inches deep, with nuts randomly spaced, one to two feet apart. Bur oak, which require cold stratification, will germinate in the spring, while pin oak will germinate immediately, given proper soil conditions. Oak acorns should be planted in small, scattered patches and at high densities to allow for predation. The boundaries of each patch should be permanently marked with fire-proof stakes so that patches can be relocated. For the first two to three years, competing grasses and forbs should be weeded to enable the oak seedlings to become established. Once oak seedlings are established, interseed low-growing oak savanna grasses and forbs into oak seeding area. After a few more years, oak seeding areas can be managed with the rest of the site using controlled burns.

Tree and Shrub Planting: Oak trees should be planted at a rate of 25 trees/acre with an equal number of bur and northern pin oak of local genotype planted. Shrub species should be planted at a rate of 25 shrubs/acre with shrub planting divided equally among the shrub species planted. Trees and shrubs should be planted randomly as both individuals and as small groups. The density of trees and shrubs should be higher adjacent to edges abutting oak woodland and lower adjacent to edges abutting prairie. All trees and shrubs should be protected with hardware mesh enclosures to a height of five feet to protect against deer browsing and rodent damage. Tubes may also be used for tree seedlings without branches.

Mesic Prairie
Mesic prairie is proposed for lower slope areas transitional to wet prairie. Parts can be subject to occasional flood events. Most of the floods that have historically occurred are spring floods resulting from snowmelt runoff and precipitation. The mesic prairie mix is designed to accommodate wetness during some flood events and contains a mixture of warm season grasses that are generally dormant during spring floods and species adapted to more dry conditions.

Seeding and Planting: For areas above the 100-year floodplain, apply cover crop and grass/forb seed mix with Truax Drill or Trillium Seeder as a dormant fall seeding after soil temperature fall below 54° F. For areas below the 100-year floodplain, apply cover crop and grass/forb seed mix with a Truax Drill in late-spring, after flooding threat is gone. Apply mulch and anchor with a straw crimper.

Lowland Hardwood Forest
It is transitional between the terrestrial and palustrine systems, occurring on sites with seasonally high water tables (within the tree-rooting zone) but that do not flood regularly and that have mineral rather than peat soils. In accord with the poorly drained sites on which the Lowland Hardwood Forests occur, species tolerant of periodic soil saturation dominate the tree canopy. American elms and black ashes are common canopy dominants, but most sands are mixed, with slippery elms, rock elms, basswoods, bur oaks, hackberries, yellow birches, green ashes, black ashes, quaking aspens, balsam poplars, and paper birches as important species. The tall-shrub layer is usually discontinuous and is composed of a mixture of upland and lowland shrubs. The groundlayer is composed mostly of upland herbs that do not root to the water-table.

Tree and Shrub Planting: Trees and shrubs should be planted randomly at a rate of 100 trees/acre and 50 shrubs/acre. All trees and shrubs should be protected with hardware mesh enclosures to a height of five feet to protect against deer browsing and rodent damage. Tubes may also be used for tree seedlings without branches. Wet prairie seed mix will be distributed with a hand spreader and mulched with prairie hay.

Mixed Emergent Marsh
Mixed emergent marsh is dominated by wetland species other than cattails. Bulrushes are the most common dominants, especially hard-stemmed bulrush (Scirpus acutus), river bulrush (Scirpus fluviatilis), softstem bulrush (Scirpus validis), Scirpus Americanus, and Scirpus heterochetus. Common reed grass (Phragmites australis), spike rushes (Eleocharis spp.) and (in some river backwaters) prairie cordgrass (Spartina pectinata) are less common dominants. In general, Mixed Emergent Marsh tends to occur on harder pond, lake, or river bottoms than Cattail Marsh and is less likely to contain the forbs that grow on the floating peat mats present in many cattail marshes. Broad-leaved arrowhead (Sagittaria latifolia) and aquatic macrophytes are the most common non-graminoid associates. Many Mixed Emergent Marsh species are sensitive to fertilizer run-off and other artificial disturbances, and disturbed Mixed Emergent Marshes (especially in the Prairie Zone) tend to convert to Cattail Marshes or become strongly dominated by reed canary grass (Phalaris arundinacea) or common reed grass (Phragmites australis), species that increase in abundance with disturbance.

Mixed emergent marsh may be restored to the cattail marsh occupying the MnDOT pond at the southern end of the site. This goal is contingent on future site use and surface runoff chemistry. Seeding along the margins of open water will be repeated for two or three years, depending on the cover and diversity of initial seeding. Planting may be proposed for the permanent pool if seeding is successful. Natural recruitment and reestablishment of cattail may occur after three years. For the first three years cattail will be reduced by suphocation.

Seeding and Planting - Grasses and Forbs: Apply cover crop and grass/forb seed mix (broadcast) in late-spring, after flooding threat is gone. Apply mulch and anchor with a straw crimper.

Wet Prairie

Wet Prairie is dominated by grasses, but sedges are also important in the community. The major cover-forming grasses in wet prairies in eastern Minnesota are prairie cordgrass (Spartina pectinata) and blue-joint (Calamagrostis canadensis). Forbs are abundant in Wet Prairies, but on the whole fewer forb species occur in Wet Prairie than in Mesic Prairie. Wet Prairie occurs in low areas (such as depressions and drainageways) where the water table remains within the plant rooting zone for several weeks during the growing season, but where inundation occurs only infrequently and briefly.

Wet prairie will dominate the stream course area. Restoration will consist of seeding and planting. Planting will be relied upon in areas with frequent water flow. Following normal spring flood conditions planting and seeding will be performed.

Seeding and Planting - Grasses and Forbs: Apply cover crop and grass/forb seed mix (broadcast or Truax Drill) in late-spring, after flooding threat is gone. Apply mulch and anchor with straw crimper. Planting will consist of installing seedlings into coir roll or mat substrate for anchoring in frequent flow areas.

Soil Reclamation

Soil reclamation will need to be a key element in those areas of the site with existing road base and excavation activities. This discussion focuses on key parameters important to soil reclamation and techniques that may be applied to this site.

Soil Development

Soil development refers to the physical and biological changes that occur to soil though time. The context of time for soil development is generally on the order of hundreds to thousands of years and results from the interaction of weathering, leaching, soil fungi and bacteria, animal activity and vegetative influences. These factors combined with origin and type of parent material and climate determine the path that soil formation will take. In the case of undisturbed soils in the Twin Cities, soil development has been in progress for about 10,000 years, or since the last glaciation.

Some of the key parameters that are influenced by soil formation include:

- *Macro/Micro Nutrients:* Nutrients are derived from a variety of sources including physical weathering (e.g., freezing, erosion), atmospheric deposition, microbial fixation and anthropogenic sources.

- *Bulk Density:* Bulk density, which is a measure of mass of a unit volume of soil is influenced greatly by organic content and compaction. High bulk densities of greater than 1.6 gm/cm^3 indicate significant compaction and low organic content. Lower bulk densities promote oxygen, water holding capacity, root development and diversity and abundance of soil microbes.

- *Organic Content:* Organic content includes plant and animal matter in various stages of decomposition. Accumulation of organic matter occurs when the rate of organic matter production exceeds losses though decomposition, leaching and mineralization.

- *Microbial Populations (Mycorrhizae):* Mycorrhizal fungi and bacteria occur within the soil/root interface of most terrestrial plants including trees, shrubs, grasses and forbs. Plants benefit from the mycorrhizae by greatly enhanced water and nutrient uptake. Mycorrhizae in healthy soil also constitute a significant portion of the organic matter and nutrients. Soil fungi and bacteria can populate disturbed areas from donor sites located hundreds of miles distant. Spore dispersal mechanisms include rainfall, wind-blown dust, floodwaters or through transport of donor soil.

Approaches to Soil Reclamation

Soil reclamation generally involves "jump starting" the soil development process by physically and biologically altering soil though mechanical means, introduction of soil amendments and establishment of soil biotic communities. Table 6 summarizes treatments to address some of the more common soil reclamation problems.

Table 6. - Strategies for Soil Reclamation

Category	**Problem**	**Immediate Treatment**	**Long-term treatment**
Physical Parameters of Soil			
Texture	Coarse textured sand or gravel	Incorporate organic matter and/or fines	Vegetation
Structure	Soil compaction Loose, friable	Rip or scarify Add fines/compact	Vegetation Vegetation
Bulk Density	Above 1.6	Incorporate organic material/nitrogen fertilizer	Vegetation
Stability	Unstable/erodible	Stabilizer, erosion control blankets, mulch, cover crop	Regrade and/or establishment of vegetative cover
Moisture	Wet Dry	Drain Mulch	Hydrophytic vegetation Xerophytic vegetation or increase water-holding capacity of soil
Nutritional Needs of Soil			
Macronutrients	Deficient	Fertilizer Fertilizer and Lime	N-fixing species Fertilizer and Lime
Micronutrients	Deficient	Fertilizer	-----
Toxicity			
PH	Low High	Lime Organic matter	Establish appropriate vegetation based on soil pH -----
Heavy Metals	High	Organic matter or tolerant plants	Inert covering

Adapted from Bradshaw, 1987

The primary soil characteristics that limit reclamation are related to soil bulk density, soil structure (compaction), and soil fertility (topsoil removal in the stockpile area).

Five major soil reclamation approaches are suggested. These approaches include the use of donor soils, mulching, organic fertilizer, and green manure. It is anticipated that two or more of these approaches may be implemented in combination and that several combinations or variations of these approaches may be used. Preliminary discussions with MNDOT and the U of M Soils Department indicate that there may be interest in research-related efforts to test and monitor different soil reclamation approaches.

Following is a brief overview of suggested soil reclamation techniques:

Donor Soils

Depending on timing of nearby development projects, donor topsoil may be available to place on the site. Donor topsoil will only be used from sites such as public transportation projects that may generate the quality and quantity of material sufficient to make use of donor soil economically feasible. Ideally, donor soils will be from sites that previously were occupied by plant communities similar to those proposed for establishment. For example, peat from sedge meadow or fen type wetlands would be preferred over cattail marsh peat, since the proposed wet prairie and emergent marsh communities more closely resemble wet meadow and sedge meadow conditions. Donor soil will only be used from sites where sequencing to avoid environmental impacts has been followed. It is not the intent of this NRMP to in any way encourage or promote large-scale conversion of undisturbed vegetation and soils for purposes of supplying donor soils.

Wood Chips/Mulch

The addition of wood chips/mulch to brownfield sites and highway road cuts is increasingly being used to "jump start" the soil restoration process. Woodchips serve both structural and nutritional functions. Addition of wood chips can be used to lower bulk density, increase soil-water holding capacity, and increase soil pore space for exchange of gases. Addition of wood chips also provides a substrate and food source for soil organisms. As a general rule, soil carbon:nitrogen ratios must be maintained at about 30:1 to maximize the benefits of wood chip amendments; therefore, the addition of wood chips (or other high carbon amendments), will likely require concurrent additions of nitrogen via applications of sludge, manure or other sources.

Organic Fertilizer

Organic fertilizer includes manure, composted lawn waste, sewage sludge and other agricultural or wood industry byproducts. Depending on type of material, these amendments may also enhance soil structural characteristics and serve as a source of carbon. Both mulch and fertilizer should preferably be incorporated into the upper six inches of soil with a light disk. Soil amendments may also be spread or broadcast evenly across the soil surface and left in place. Incorporation, however, will accelerate soil restoration and reduce the transport of soil amendments off site via surface runoff, flooding, or as wind-borne dust. *It should be noted, that many of the plant communities proposed do quite well on soils with low fertility; therefore, the goal of fertilizer amendments should be to achieve nutrient conditions that promote target plant communities, without bringing about over-enriched conditions that may favor high-nutrient invasive species.*

Green Manure

Green manure involves establishment of a cover crop (usually an annual) that is plowed into the soil or left standing, with the target plant community then seeded in. The purpose of green manure is to add organic material and nutrients to the soil while providing protection against erosion. Nitrogen-fixing legumes such as annual alfalfa are commonly used. The primary drawback of green manure on

brownfield sites is that existing soil conditions (e.g., moisture, nutrients), may be unsuitable for green manure establishment. A compromise may be to include native, nitrogen-fixing species such as *Amorpha spp.* shrubs in the seeding and planting mixes.

Site Amenities

As a nature sanctuary, the future use of the Trillium Site as a local passive-recreation park precludes the need for intensive program inputs. The focus of this park is the restored native plant communities and the passive recreational opportunities associated with this enhancement.

Trail Network

To make these natural areas accessible to bikers, birders, hikers and the like, a network of interconnecting trails have been proposed. This trail system consists of two trail types, which provide different levels of use. A segment of the Trout Brook Regional Trail has been sited along the former westerly North-South rail line; this 10' paved trail connects to the existing Gateway Trail at the south portion of the park and will expand northward towards Lake McCarrons in the future. The remainder of the trail network is to be exclusively used by hikers and walkers. This 6' wide, soft-surface trail permits visitors to have a more intimate experience and will be less disturbing to the restored natural areas and associated wildlife.

Parking & Access

This park will be heavily utilized by local residents and regional users. Access to the regional trail and the park will draw users from around the Twin Cities. These users may merely pass through the site or access the regional trail here. In addition, it is envisioned that school groups will be visiting the site by bus for environmental education opportunities. To accommodate this need for parking and alleviate local on-street parking, a parking facility has been sited off of Jackson Street. This facility would accommodate 12-16 vehicles and allow for bus drop off. Local visitors to the site will have multiple convenient points at which to access the park, along the west-east streets that intersect the park.

Project Implementation

Phasing

The implementation schedule for implementing this plan is highly contingent upon the City securing funding. It is likely that various components of the project will have different funding mechanisms. There is a logical order in which the components should be developed and several aspects of the plan must be closely coordinated with the work of other agencies. The following is a discussion of the phasing issues affecting various aspects of the plan.

Site Cleanup

Prior to implementation of this Natural Resource Management Plan, there are some basic site cleanup activities that need to be done. There are several piles of garden/yard waste throughout the site as well as miscellaneous garbage.

Southern MnDOT Parcel

The southern portion of the site, south of the extension of Jenks Avenue, was sold to the Minnesota Department of Transportation for a future interchange at Cuyuga Avenue (currently scheduled for 2009). A City owned regional stormwater pond, the Sims Agate Pond, is located on the southern end of this parcel. MnDOT will need to move the pond to the northern end of the parcel to make room for the interchange. The pond will be expanded to mitigate for the additional impervious surface developed for the interchange. The exact location and size of the pond is not known at this time (the size of the pond may be significantly reduced by the stormwater management facilities proposed in this plan).

Basically all aspects of the project are affected by the interchange construction. The proposed regional trail connects to the existing Gateway Trail directly in the corridor for the interchange. If constructed

prior to the interchange work, it is likely that a portion of the trail would need to be reconstructed as a result of MnDOT's work. The Gateway Trail currently is routed across the Burlington Northern Railroad tracks via a large bridge immediately adjacent to the Highway. This bridge will need to be moved as part of the interchange project. The proposed regional trail through the Trillium Site could serve as a detour for users of the Gateway Trail during the course of the MNDOT interchange project.

The Trout Brook stream channel is currently designed to flow through the City property and outlet into the Sims Agate Pond. Since the ultimate location of the pond is not known at this time, a generalized connection has been shown. If the stream channel work is done in conjunction with the interchange project, coordination will be needed with MNDOT, who has expressed a willingness to include the channel on their parcel. If the stream channel work is conducted prior to the interchange work, the recommendation is to construct a temporary channel to convey stream flows into the existing stormsewer system on the west of the site, immediately upstream of the MNDOT parcel.

The overall plant community restoration is intended to be continued into the MNDOT parcel. The timing issues described above apply this restoration work as well. Generally, no final plant community establishment work should be conducted on the MNDOT parcel prior to the interchange construction to avoid having to replace plant material.

Capitol Region Watershed District / Met Council – Trout Brook Stormsewer
The Capitol Region Watershed District and the Metropolitan Council Environmental Services have identified the need to repair or replace a large segment of the Trout Brook Stormsewer pipe. The segment to be repaired or replaced is located to the northeast of the Trillium Site, within the Kmart parking lot. Close coordination with the repair/replacement project will be needed if the pumping option for water delivery to the site is chosen. The coordination will result in cost savings for the project.

Budget

Table 7 - Project Budget	Total Estimated Construction Cost	Annual Operation and Maintenance Cost	One-Time Replacement Cost	20-Year Present Worth
Alternative 1	$1,318,000	$2,000		$1,348,000
Arlington-Jackson Pond Storm Drain Alternative 2	$337,000	$15,000	$40,000	$590,000
Trout Brook Pump Station Alternative 3	$544,000	$3,000	$5,000	$592,000
Harvest Neighborhood Drainage Alternative 4	$787,000	$7,000	$10,000	$899,000
Merge Alternative #2 and #3				
Site Development	$524,000	$5,000	$25,000	$617,000
Trout Brook Stream Channel	$170,000			$170,000
Vegetation Restoration	$458,000	$10,000		$607,000

Appendix A: Cost Estimates

Project Title	**Trillium Site**
Owner	**St. Paul Public Works**
Location	**St. Paul, Minnesota**

Project Description	**Gravity Storm Drain from Arlington Pond to Trillium Site**
Alternative #	**1: Construction**
Date	**22-Sep-10**

Item	Description	Units	Quantity	Unit Cost	Total Estimated Cost
	Arlington/Jackson Wetland				
	Modify existing outlet structure	each	1	$25,000.00	$25,000.00
	Install flap gate	each	1	$5,000.00	$5,000.00
	Construct 15" RCP				
	Average depth < 10 feet	LF	3400	$40.00	$136,000.00
	Average depth 10-20 feet	LF	1000	$50.00	$50,000.00
	Pipe Jacking under Jackson St. and RR	LF	450	$215.00	$96,750.00
	Construct Manholes				
	Average depth < 10 vertical feet	each	12	$2,000.00	$24,000.00
	Average depth 10-15 vertical feet	each	1	$2,500.00	$2,500.00
	Average depth 15-20 vertical feet	each	4	$3,000.00	$12,000.00
	Jacking Pit (at Jackson and RR)				
	Excavation	CY	160	$2.50	$400.00
	Backfill pit	CY	160	$2.50	$400.00
	Removals				
	Saw cut pavement	LF	6000	$2.25	$13,500.00
	Remove pavement	SY	6200	$6.50	$40,300.00
	Remove curb	LF	36	$7.00	$252.00
	Replacements				
	Repave	SY	6200	$50.00	$310,000.00
	Replace curb	LF	36	$15.00	$540.00
	Restore Vegetation/Mulch				
	Arlington pond outlet reconfiguration	AC	0.10	$2,500.00	$250.00
	700' open cut along RR	AC	0.20	$2,500.00	$500.00
	Jacking pit at RR	AC	0.10	$2,500.00	$250.00
	Mobilization/Demobilization	lump sum	1	$50,000.00	$50,000.00
	Erosion control	lump sum	1	$10,000.00	$10,000.00
	Traffic control	lump sum	1	$3,500.00	$3,500.00
				Subtotal	$781,142.00
				35% Contingencies	$273,399.70
				Subtotal	$1,054,541.70
				25% Design & Construction Engineering	$263,635.43
				TOTAL CONSTRUCTION COST	$1,318,177.13

Project Title	**Trillium Site**
Owner	**St. Paul Public Works**
Location	**St. Paul, Minnesota**

Project Description	**Pump Station at Trout Brook Storm Drain**
Alternative #	**2**
Date	**22-Sep-10**

Item	Description	Units	Quantity	Unit Cost	Total Estimated Cost
	Pump Station Vehicle Access				
	Remove curb	lf	10	$7.00	$70.00
	Construct drive opening	each	1	$4,000.00	$4,000.00
	Grading	cy	25	$7.50	$187.50
	Class V aggregate surface	cy	50	$35.00	$1,750.00
	Pump Station				
	12" RCP	lf	40	$35.00	$1,400.00
	Sump/sediment removal device	each	1	$25,000.00	$25,000.00
	Pump manhole	each	1	$9,000.00	$9,000.00
	Manifold manhole	each	1	$5,400.00	$5,400.00
	1 cfs submersible pumps	each	2	$10,000.00	$20,000.00
	Pump control panel	each	1	$9,000.00	$9,000.00
	Misc valves and components	lump sum	1	$7,500.00	$7,500.00
	Electrical hook-up	lump sum	1	$15,000.00	$15,000.00
	6" D.I.P. forcemain	lf	325	$100.00	$32,500.00
	Bike Trail/RR Crossing				
	Auger pit excavation	cy	160	$2.50	$400.00
	Auger pit backfill	cy	160	$2.50	$400.00
	Auger 6" D.I.P.	lf	200	$135.00	$27,000.00
	Forcemain: RR crossing to Trillium Site				
	6" D.I.P.	lf	600	$28.00	$16,800.00
	Surge basin	each	1	$1,000.00	$1,000.00
	Flared end section	each	1	$1,000.00	$1,000.00
	RipRap	cy	15	$75.00	$1,125.00
	Restore Vegetation				
	Pump station	acre	0.1	$2,500.00	$250.00
	Auger pit	acre	0.1	$2,500.00	$250.00
	Mobilization	lump sum	1	$30,000.00	$30,000.00
	Erosion control	lump sum	1	$4,000.00	$4,000.00
	Traffic control	lump sum	1	$2,500.00	$2,500.00
				Subtotal	$215,532.50
				25% Contingencies	$53,883.13
				Subtotal	$269,415.63
				25% Design and Construction Engineering	$67,353.91
				TOTAL CONSTRUCTION COST	$336,769.53

Project Title	**Trillium Site**
Owner	**St. Paul Public Works**
Location	**St. Paul, Minnesota**

Project Description	**Stormwater harvest from local drainage areas - Rose Avenue Subwatershed**
Alternative #	**3a**
Date	**22-Sep-10**

Item	Description	Units	Quantity	Unit Cost	Total Estimated Cost
	Rose Avenue Gardens				
	Pipe Construction				
	6" Perforated HDPE (ave. depth <10 ft.)	LF	500	$20.00	$10,000.00
	8" HDPE (ave. depth < 10 ft.)	LF	250	$20.00	$5,000.00
	8" HDPE (ave. depth < 10 ft.)	LF	150	$20.00	$3,000.00
	24" HDPE (ave. depth < 10 ft.)	LF	325	$30.00	$9,750.00
	Adjust Manhole	each	1	$3,500.00	$3,500.00
	24" cut				
	Internal weir (poured concrete)				
	grouting				
	Earthwork (for garden feature construction)				
	Excavation	CY	7500	$2.50	$18,750.00
	Gravel bed (12" depth)	CY	1700	$24.00	$40,800.00
	Sand filter (6" depth for filter bed)	CY	850	$10.00	$8,500.00
	Organic/sand topsoil mix (12" depth)	CY	1700	$25.00	$42,500.00
	Emergency Overflow				
	42" to 24" Drop Structure	each	1	$2,500.00	$2,500.00
	Pipe connections & End treatments				
	Flared End Section (FES)	each	3	$2,500.00	$7,500.00
	Connections and fittings	lump sum	1	$1,000.00	$1,000.00
	Rip-rap				
	At FES's	CY	25	$75.00	$1,875.00
	At terrace berm	CY	30	$75.00	$2,250.00
	Removals				
	Sawcut pavement	LF	65	$2.25	$146.25
	Remove pavement	SY	30	$6.50	$195.00
	Remove curb	LF	15	$7.00	$105.00
	Replacements				
	Repave	SY	30	$50.00	$1,500.00
	Replace curb	LF	15	$15.00	$225.00
	Traffic control	lump sum	1	$500.00	$500.00
				Subtotal	$159,596.25
				20% Contingencies	$31,919.25
				Subtotal	$191,515.50
				20% Design & Construction Engineering	$38,303.10
				TOTAL CONSTRUCTION COST	$229,818.60

Project Title	**Trillium Site**
Owner	**St. Paul Public Works**
Location	**St. Paul, Minnesota**

Project Description	**Stormwater harvest from local drainage areas - Magnolia & Cook Avenue Subwatersheds**
Alternative #	**3b**
Date	**22-Sep-10**

Item	Description	Units	Quantity	Unit Cost	Total Estimated Cost
	Magnolia/Cook Avenue Gardens				
	Pipe Construction				
	6" Perforated HDPE (ave. depth <10 ft.)	LF	800	$20.00	$16,000.00
	8" HDPE (ave. depth < 10 ft.)	LF	200	$20.00	$4,000.00
	10" HDPE (ave. depth < 10 ft.)	LF	120	$20.00	$2,400.00
	24" HDPE (ave. depth = 10 ft.)	LF	145	$30.00	$4,350.00
	Adjust Manhole (at Magnolia) 24" cut Internal weir (poured concrete) grouting	each	1	$3,500.00	$3,500.00
	Adjust Manhole (at Cook) 10" cut Internal weir (poured concrete) grouting	each	1	$2,500.00	$2,500.00
	Earthwork (for garden feature construction)				
	Excavation	CY	3590	$2.50	$8,975.00
	Gravel bed (12" depth)	CY	1020	$24.00	$24,480.00
	Sand filter (6" depth for filter bed)	CY	510	$10.00	$5,100.00
	Organic/sand topsoil mix (12" depth)	CY	1020	$25.00	$25,500.00
	Emergency Overflow				
	48" to 24" Drop Structure	each	1	$2,500.00	$2,500.00
	Pipe connections & End treatments				
	Flared End Section (FES)	each	5	$2,500.00	$12,500.00
	Connections and fittings	lump sum	1	$1,000.00	$1,000.00
	Rip-rap				$0.00
	At FES's	CY	51	$75.00	$3,825.00
	At terrace berm	CY	30	$75.00	$2,250.00
	Removals				
	Sawcut pavement	LF	175	$2.25	$393.75
	Remove pavement	SY	110	$6.50	$715.00
	Remove curb	LF	50	$7.50	$375.00
	Replacements				
	Repave	SY	110	$50.00	$5,500.00
	Replace curb	LF	50	$15.00	$750.00
	Traffic control	lump sum	1	$1,500.00	$1,500.00
				Subtotal	$128,113.75
				20% Contingencies	$25,622.75
				Subtotal	$153,736.50
				20% Design & Construction Engineering	$30,747.30
				TOTAL CONSTRUCTION COST	$184,483.80

Project Title	**Trillium Site**
Owner	**St. Paul Public Works**
Location	**St. Paul, Minnesota**

Project Description	**Stormwater harvest from local drainage areas - Lawson & Jenks Avenue Subwatersheds**
Alternative #	**3c**
Date	**22-Sep-10**

Item	Description	Units	Quantity	Unit Cost	Total Estimated Cost
	Lawson/Jenks Avenue Gardens				
	Pipe Construction				
	6" Perforated HDPE (ave. depth <10 ft.)	LF	700	$20.00	$14,000.00
	8" HDPE (ave. depth < 10 ft.)	LF	100	$20.00	$2,000.00
	24" HDPE (ave. depth < 10 ft.)	LF	145	$30.00	$4,350.00
	Adjust Manhole (at Jenks)	each	1	$3,500.00	$3,500.00
	24" cut				
	Internal weir (poured concrete)				
	grouting				
	Earthwork (for garden feature construction)				
	Excavation	CY	2775	$2.50	$6,937.50
	Gravel bed (12" depth)	CY	750	$24.00	$18,000.00
	Sand filter (6" depth for filter bed)	CY	375	$10.00	$3,750.00
	Organic/sand topsoil mix (12" depth)	CY	750	$25.00	$18,750.00
	Emergency Overflow				
	48" to 24" Drop Structure	each	1	$2,500.00	$2,500.00
	Pipe connections & End treatments				
	Flared End Section (FES)	each	3	$2,500.00	$7,500.00
	Connections and fittings	lump sum	1	$1,000.00	$1,000.00
	Rip-rap				
	At FES's	CY	30	$75.00	$2,250.00
	At terrace berm	CY	30	$75.00	$2,250.00
	Removals				
	Sawcut pavement	LF	75	$2.25	$168.75
	Remove pavement	SY	40	$6.50	$260.00
	Remove curb	LF	20	$7.00	$140.00
	Replacements				
	Repave	SY	40	$50.00	$2,000.00
	Replace curb	LF	20	$15.00	$300.00
	Traffic control	lump sum	1	$750.00	$750.00
				Subtotal	$90,406.25
				20% Contingencies	$18,081.25
				Subtotal	$108,487.50
				20% Design & Construction Engineering	$21,697.50
				TOTAL CONSTRUCTION COST	$130,185.00

Project Title	**Trillium Site**
Owner	**St. Paul Public Works**
Location	**St. Paul, Minnesota**

Project Description	**Pump Station combined with Neighborhood Drainage**
Alternative #	**4**
Date	**22-Sep-10**

Item	Description	Units	Quantity	Unit Cost	Total Estimated Price
	Pump Station Vehicle Access				
	Remove curb	lf	10	$7.00	$70.00
	Construct drive opening	each	1	$4,000.00	$4,000.00
	Grading	cy	25	$7.50	$187.50
	Class V aggregate surface	cy	50	$35.00	$1,750.00
	Pump Station				
	12" RCP	lf	40	$35.00	$1,400.00
	Sump/sediment removal device	each	1	$25,000.00	$25,000.00
	Pump manhole	each	1	$6,500.00	$6,500.00
	1 cfs submersible pumps	each	1	$10,000.00	$10,000.00
	Pump control panel	each	1	$6,000.00	$6,000.00
	Misc valves and components	lump sum	1	$3,000.00	$3,000.00
	Electrical hook-up	lump sum	1	$15,000.00	$15,000.00
	6" D.I.P. forcemain	lf	325	$100.00	$32,500.00
	Bike Trail/RR Crossing				
	Auger pit excavation	cy	160	$2.50	$400.00
	Auger pit backfill	cy	160	$2.50	$400.00
	Auger 6" D.I.P.	lf	200	$135.00	$27,000.00
	Forcemain: RR crossing to Trillium Site				
	6" D.I.P.	lf	600	$28.00	$16,800.00
	Surge basin	each	1	$1,000.00	$1,000.00
	Flared end section	each	1	$1,000.00	$1,000.00
	RipRap	cy	15	$75.00	$1,125.00
	Restore Vegetation				
	Pump station	acre	0.1	$2,500.00	$250.00
	Auger pit	acre	0.1	$2,500.00	$250.00
	Rose Avenue Gardens	lump sum	1	$159,596.25	$159,596.25
	Magnolia/Cook Avenue Gardens	lump sum	1	$128,113.75	$128,113.75
	Lawson/Jenks Avenue Gardens	lump sum	1	$90,406.25	$90,406.25
	Mobilization	lump sum	1	$8,000.00	$8,000.00
	Erosion control	lump sum	1	$4,000.00	$4,000.00
	Traffic control	lump sum	1	$2,500.00	$2,500.00
				Subtotal	$546,248.75
				20% Contingencies	$109,249.75
				Subtotal	$655,498.50
				20% Design and Construction Engineering	$131,099.70
				TOTAL	$786,598.20

Project Title	**Trillium Site**
Owner	**St. Paul Public Works**
Location	**St. Paul, Minnesota**

Project Description	**Trillium Program Amenities**
Date	**22-Sep-10**

Item	Description	Units	Quantity	Unit Cost	Total Estimated Price
	Regional Trail (10' wide paved)	LF	4,800	$15.00	$72,000.00
	Regional Trail Signage and Painting	lump sum	1	$9,500.00	$9,500.00
	Entrance Trail (6' paved)	LF	1,100	$12.60	$13,860.00
	Local Trail (5' wide wood-chip)	LF	3,300	$3.75	$12,375.00
	4' X 20' span pedestrian bridge	each	2	$25,000.00	$50,000.00
	Interpretive signage	each	2	$2,200.00	$4,400.00
	Entrance signage	each	3	$1,000.00	$3,000.00
	6' colored chain-link fence (cost to be shared with R&R)	LF	3,600	$7.80	$28,080.00
	Park bench	each	8	$1,500.00	$12,000.00
	Bike rack	each	3	$800.00	$2,400.00
	Parking Lot & Jackson St Entry (lighting, no curb)	lump sum	1	$127,500.00	$127,500.00
	Mobilization	lump sum	1	$10,000.00	$10,000.00
	Erosion Control	lump sum	1	$4,000.00	$4,000.00
				Subtotal	$349,115.00
				20% Contingencies	$69,823.00
				Subtotal	$418,938.00
				25% Design and Construction Engineering	$104,734.50
				TOTAL	$523,672.50

Project Title	**Trillium Site**
Owner	**St. Paul Public Works**
Location	**St. Paul, Minnesota**

Project Description	**Trillium Stream Channel Construction**
Date	**22-Sep-10**

Item	Description	Units	Quantity	Unit Cost	Total Estimated Price
	Stream & Subcut Excavation	CY	2,050	$2.50	$5,125.00
	Stream Floodplain Excavation	CY	3,650	$2.50	$9,125.00
	Bentonite Liner	SY	3,900	$5.00	$19,500.00
	3" Sand Bed	CY	260	$20.00	$5,200.00
	Category 3 Erosion Control Blanket	SY	7,500	$1.75	$13,125.00
	Rock Cross Vane (Class IV Field Stone Rip-rap)	Each	15	$1,750.00	$26,250.00
	Mobilization	lump sum	1	$30,000.00	$30,000.00
	Erosion Control	lump sum	1	$5,000.00	$5,000.00
				Subtotal	$113,325.00
				20% Contingencies	$22,665.00
				Subtotal	$135,990.00
				25% Design and Construction Engineering	$33,997.50
				TOTAL	$169,987.50

Appendix B: Mammal, Bird, and Reptile/Amphibian Occurrences

Trillium Site NRMP
Amphibian and Reptile List

	Common Name	*Scientific Name*	Current Occurrence	Future Occurrence	Prairie	Deciduous Forest	Water/ Wetland
Turtles	Snapping Turtle	*Cheldyra serpentina*	u	p			●
	Painted Turtle	*Chrysemys picta*	p	l			●
	Blanding's Turtle	*Emydoidea blandingii*	u	u			●
Lizards	Six-lined Racerunner	*Cnemidophorus sexlineatus*	u	u	●	1	
	Prairie Skink	*Eumeces septentrionalis*	p	l	●		
Snakes	Racer	*Coluber constrictor*	u	p	●	2,3	
	Fox Snake	*Elaphe vulpina*	p	p		1	
	Eastern Hognose Snake	*Heterodon platirhinos*	u	u		3	
	Milk Snake	*Lampropeltis triangulum*	u	u		3,4	
	Northern Water Snake	*Nerodia sipedon*	u	u		1	●
	Smooth Green Snake	*Ophedrys vernalis*	u	u		3	
	Gopher Snake	*Pitophis catenifer*	u	u	●		
	Brown Snake	*Storeria dekayi*	u	u		1,3	
	Redbelly Snake	*Soreria occipitomaculata*	u	u	●	4	
	Common Garter Snake	*Thamnophis sirtalis*	l	l	●	●	●
Salamanders	Blue-spotted Salamander	*Ambystoma laterale*	u	u		1	●
	Tiger Salamander	*Ambystoma tigrinum*	p	l	●	1	●
Toads and Frogs	American Toad	*Bufo americanus*	l	l	●	●	●
	Gray Treefrog	*Hyla versicolor*	p	p	●		●
	Spring Peeper	*Pseudacris crucifer*	u	u	●		●
	Western Chorus Frog	*Pseudacris triseriata*	u	u	●	●	●
	Green Frog	*Rana clamitans*	u	u		●	●
	Northern Leopard Frog	*Rana pipiens*	l	l	●	●	●
	Wood Frog	*Rana sylvatica*	c	l		1	●

u =Unlikely
p = Possible
l = Likely
c = Confirmed

1 = Moist-mesic
2 = Dry/ savanna
3 = Woodland edges/ partially open areas
4 = Wooded/ bushy

	Common Name	*Scientific Name*	Current Occurrence	Future Occurrence	Status	Prairie	Deciduous Forest	Water/ Wetland
Loons and Grebes	Pacific Loon	*Gavia pacifica*	u	u	m			
	Common Loon	*Gavia immer*	u	u	mn			●
	Pied-billed Grebe	*Podilymbus podiceps*	u	u	nm			●
	Horned Grebe	*Podiceps auritus*	u	u	m			●
	Red-necked Grebe	*Podiceps grisegena*	u	u	nm			●
	Eared Grebe	*Podiceps nigricollis*	u	u	m			●
	Western Grebe	*Aechmophrus occidentalis*	u	u	m			●
	Clark's Grebe	*Aechmophrus clarkii*	u	u	m			
Pelicans and Cormorants	American White Pelican	*Pelecanus erythrorhynchos*	u	u	m			●
	Double-crested Cormorant	*Phalacrocorax auritus*	p	p	nm			●
Bitterns, Herons, and Egrets	American Bittern	*Botaurus lentiginosus*	u	u	nm			●
	Least Bittern	*Ixobrychus exilis*	u	u	nm			●
	Great Blue Heron	*Ardea herodias*	p	p	nm		●	●
	Great Egret	*Casmerodius albus*	p	p	nm			●
	Snowy Egret	*Egretta thula*	u	u	m			●
	Little Blue Heron	*Egretta caerulea*	u	u	nm			●
	Cattle Egret	*Bubulcus ibis*	u	u	m	●		●
	Green Heron	*Butorides striatus*	c	l	nm		●	●
	Black-crowned Night-Heron	*Nycticorax nycticorax*	u	l	nm			●
	Yellow-crowned Night-Heron	*Nycticorax violaceus*	u	u	nm		●	●
Vultures	Turkey Vulture	*Cathartes aura*	c	p	m		●	
Swans, Geese, and Ducks	Greater White-fronted Goose	*Anser albifrons*	u	u	m			
	Snow Goose	*Chen caerulescens*	u	u	m			
	Ross's Goose	*Chen rossii*	u	u	m			
	Canada Goose	*Branta canadensis*	l	l	nm-r			●
	Mute Swan	*Cygnus olor*	u	u	m			
	Trumpeter Swan	*Cygnus buccinator*	u	u	m			●
	Tundra Swan	*Cygnus columbianus*	u	u	m			
	Wood Duck	*Aix sponsa*	p	p	nm		●	●
	Gadwall	*Anas strepera*	u	u	m			●
	American Wigeon	*Anas americana*	u	u	m			●
	American Black Duck	*Anas rubripes*	u	u	m			●
	Mallard	*Anas platyrhynchos*	l	l	nm			●
	Blue-winged Teal	*Anas discors*	p	l	nm			●
	Cinnamon Teal	*Anas cyanoptera*	u	u	m			
	Northern Shoveler	*Anas clypeata*	u	p	nm			●
	Northern Pintail	*Anas acuta*	u	u	m			●
	Green-winged Teal	*Anas crecca*	u	l	m			●
	Canvasback	*Aythya valisineria*	u	u	m			●
	Redhead	*Aythya americana*	u	u	m			●
	Ring-necked Duck	*Aythya collaris*	p	l	nm			●
	Greater Scaup	*Aythya marila*	p	p	m			
	Lesser Scaup	*Aythya affinis*	p	p	m			●
	Harlequin Duck	*Histrionicus histrionicus*	u	u	m			
	Surf Scoter	*Melanitta perspicillata*	u	u	m			

	Common Name	*Scientific Name*	Current Occurrence	Future Occurrence	Status	Prairie	Deciduous Forest	Water/ Wetland
	White-winged Scoter	*Melanitta fusca*	u	u	m			
	Black Scoter	*Melanitta nigra*	u	u	m			
	Oldsquaw	*Clangula hyemalis*	u	u	m			
	Bufflehead	*Bucephala albeola*	p	l	m			●
	Common Goldeneye	*Bucephala clangula*	p	p	m			●
	Hooded Merganser	*Lophodytes cucullatus*	u	p	nm			●
	Common Merganser	*Mergus merganser*	u	p	m			●
	Red-breasted Merganser	*Mergus serrator*	u	p	m			●
	Ruddy Duck	*Oxyura jamaicensis*	u	u	nm			●
Ospreys, Eagles, Harriers	Osprey	*Pandion haliaetus*	p	p	nm			●
and Hawks	Bald Eagle	*Haliaeetus leucocephalus*	c	l	nm			●
	Northern Harrier	*Circus cyaneus*	p	p	nm	●		
	Sharp-shinned Hawk	*Accipiter striatus*	l	l	m			
	Cooper's Hawk	*Accipiter cooperi*	p	p	nm		●	
	Northern Goshawk	*Accipiter gentilis*	u	u	m			
	Broad-winged Hawk	*Buteo playtypterus*	u	u	nm		●	
	Swainson's Hawk	*Buteo swainsoni*	u	u	nm	●		
	Red-tailed Hawk	*Buteo jamaicensis*	c	l	nm			
	Ferruginous Hawk	*Buteo regalis*	u	u	m			
	Rough-legged Hawk	*Buteo lagopus*	p	p	m			
	Golden Eagle	*Aquila chrysaetos*	u	u	m			
	American Kestrel	*Falco sparverius*	l	l	nm	●		
	Merlin	*Falco columbarius*	u	u	m			
	Gyrfalcon	*Falco rusticolus*	u	u	m			
	Peregrine Falcon	*Falco peregrinus*	p	p	nm	●		
	Prairie Falcon	*Falco mexicanus*	u	u	m			
Partriges, Pheasants,	Gray Partridge	*Peridix perdix*	u	u	r	●		
Grouse, Turkeys, and Quails	Ring-necked Pheasant	*Phaisanus colchicus*	c	l	r	●		
	Ruffed Grouse	*Bonasa umbellus*	u	u	r		●	
	Wild Turkey	*Meleagris gallopavo*	p	p	r		●	
Railes, Coots and Cranes	Yellow Rail	*Coturnicops noveboracensis*	p	p	m			●
	Virginia Rail	*Rallus limicola*	p	p	nm			●
	Sora	*Porzana carolina*	p	p	nm			●
	Common Moorhen	*Gallinula chloropus*	u	u	nm			●
	American Coot	*Fulica americana*	p	p	nm			●
	Sandhill Crane	*Grus canadensis*	u	u	m			●
Plovers and Avocets	Black-bellied Plover	*Pluvialis squatarola*	u	u	m			
	Lesser Golden-Plover	*Pluvialis dominica*	u	u	m			
	Semipalmated Plover	*Charadrius semipalmatus*	u	u	m			
	Piping Plover	*Charadrius melodus*	u	u	m			●
	Killdeer	*Charadrius vociferus*	l	l	nm	●		
	American Avocet	*Recurvirostra americana*	u	u	m			●
Sandpipers, Godwits,	Greater Yellowlegs	*Tringa melanoleuca*	u	u	m			
Snipes, Woodcocks and	Lesser Yellowlegs	*Tringa flavipes*	u	u	m			
Phalaropes	Solitary Sandpiper	*Tringa solitaria*	u	u	m			

	Common Name	*Scientific Name*	Current Occurrence	Future Occurrence	Status	Prairie	Deciduous Forest	Water/ Wetland
	Willet	*Catoptrophorus semipalmatus*	u	u	m			
	Spotted Sandpiper	*Actitis macularia*	u	u	nm			●
	Upland Sandpiper	*Bartramia longicauda*	u	u	nm	●		
	Whimbrel	*Numenius phaeopus*	u	u	m			
	Hudsonian Godwit	*Limosa haemastica*	u	u	m			
	Marbled Godwit	*Limosa fedoa*	u	u	m	●		
	Ruddy Turnstone	*Arenaria interpres*	u	u	m			
	Red Knot	*Calidris canutus*	u	u	m			
	Sanderling	*Calidris alba*	u	u	m			
	Semipalmated Sandpiper	*Calidris pusilla*	u	u	m			
	Least Sandpiper	*Calidris minutilla*	u	u	m			
	White-rumped Sandpiper	*Calidris fuscicollis*	u	u	m			
	Baird's Sandpiper	*Calidris bairdii*	u	u	m			
	Pectoral Sandpiper	*Calidris melanotos*	u	u	m			
	Dunlin	*Calidris alpina*	u	u	m			
	Stilt Sandpiper	*Calidris himantopus*	u	u	m			
	Buff-breasted Sandpiper	*Tryngites subruficollis*	u	u	m			
	Short-billed Dowitcher	*Limnodromus griseus*	u	u	m			
	Long-billed Dowitcher	*Limnodromus scolopaceus*	u	u	m			
	Common Snipe	*Gallinago gallinago*	u	u	nm			●
	American Woodcock	*Scolopax minor*	u	u	nm		●	
	Wilson's Phalarope	*Phalaropus tricolor*	u	u	m			●
	Red-necked Phalarope	*Phalaropus lobatus*	u	u	m			
	Parasitic Jaeger	*Stercorarius parasiticus*	u	u	m			
Gulls and Terns	Franklin's Gull	*Larus pipixcan*	u	u	m			●
	Little Gull	*Larus minutus*	u	u	m			
	Bonaparte's Gull	*Larus philadelphia*	u	u	m			
	Ring-billed Gull	*Larus delawarensis*	p	p	nm			●
	Herring Gull	*Larus argentatus*	u	u	m			●
	Thayer's Gull	*Larus thayeri*	u	u	m			
	Iceland Gull	*Larus glaucoides*	u	u	m			
	Lesser Black-backed Gull	*Larus fuscus*	u	u	m			
	Glaucous Gull	*Larus hyperboreus*	u	u	m			
	Great Black-backed Gull	*Larus marinus*	u	u	m			
	Caspian Tern	*Sterna caspia*	p	p	m			●
	Common Tern	*Sterna hirundo*	u	u	m			●
	Black Tern	*Childonias niger*	u	u	nm			●
Pigeons and Doves	Rock Dove	*Columbia livia*	c	l	r	●		
	Mourning Dove	*Zenaida macroura*	c	l	r	●		
Cuckoos	Black-billed Cuckoo	*Coccyzus erythropthalmus*	u	l	nm		●	
	Yellow-billed Cuckoo	*Coccyzus americanus*	u	u	nm		●	
Owls	Eastern Screech-Owl	*Ottus asio*	u	u	r		●	
	Great Horned Owl	*Bubo virginianus*	l	l	r		●	
	Snowy Owl	*Nyctea scandiaca*	u	u	m			
	Barred Owl	*Strix varia*	u	u	r		●	

	Common Name	*Scientific Name*	Current Occurrence	Future Occurrence	Status	Prairie	Deciduous Forest	Water/ Wetland
	Long-eared Owl	*Asio otus*	u	u	m		●	
Goatsuckers	Common Nighthawk	*Chordeiles minor*	p	p	nm	●		
	Whip-poor-will	*Caprimulgus vociferus*	u	u	nm		●	
Swifts and Hummingbirds	Chimney Swift	*Chaetura pelagica*	p	p	nm			
	Ruby-throated Hummingbird	*Archilochus colubris*	l	l	nm		●	
Kingfishers	Belted Kingfisher	*Ceryle alcyon*	p	p	nm			●
Woodpeckers	Red-headed Woodpecker	*Melanerpes erythrocephalus*	p	p	m		●	
	Red-bellied Woodpecker	*Melanerpes carolinus*	p	p	r		●	
	Yellow-bellied Sapsucker	*Sphytrapicus varius*	l	l	m		●	
	Downy Woodpecker	*Picoides pubescens*	c	l	r		●	
	Hairy Woodpecker	*Picoides villosus*	l	l	r		●	
	Three-toed Woodpecker	*Picoides tridactylus*	u	u	m			
	Northern Flicker	*Colaptes auratus*	c	l	nm		●	
	Pileated Woodpecker	*Dryocopus pileatus*	p	p	r		●	
Flycatchers	Olive-sided Flycatcher	*Contopus borealis*	u	u	m			
	Eastern Wood-Pewee	*Contopus virens*	l	l	nm		●	
	Acadian Flycatcher	*Empidonax virescens*	u	u	nm		●	
	Alder Flycatcher	*Empidonax alnorum*	u	u	m			●
	Willow Flycatcher	*Empidonax trailii*	p	p	nm			●
	Least Flycatcher	*Empidonax minimus*	c	l	nm		●	
	Eastern Phoebe	*Sayornis nigricans*	c	I	nm		●	
	Great Crested Flycatcher	*Myiarchus critinus*	l	l	nm			
	Western Kingbird	*Tyrannus verticalis*	u	u	nm	●		
	Eastern Kingbird	*Tyrannus tyrannus*	p	p	nm	●		
Jays, Magpies, and Crows	Blue Jay	*Cyanatta cristata*	c	l	r		●	
	Black-billed Magpie	*Pica pica*	u	u	m			
	American Crow	*Corvus brachyrhynchos*	c	l	r		●	
	Common Raven	*Corvus corax*	u	u	m			
Larks and Swallows	Horned Lark	*Eremophila alpestris*	u	u	nm	●		
	Purple Martin	*Progne subis*	p	p	nm	●		●
	Tree Swallow	*Tachycineta bicolor*	c	l	nm			●
	Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	c	l	nm	●		●
	Bank Swallow	*Riparia riparia*	p	p	nm	●		●
	Cliff Swallow	*Hirundo pyrrhonota*	p	p	nm	●		●
	Barn Swallow	*Hirundo rustica*	c	l	nm	●		●
Chickadees and Titmice	Black-capped Chickadee	*Parus artricapillus*	c	l	r		●	
	Tufted Titmouse	*Parus bicolor*	u	u	m		●	
Nuthatches and Creepers	Red-breasted Nuthatch	*Sitta canadensis*	c	l	r			
	White-breasted Nuthatch	*Sitta carolinensis*	l	l	r			
	Brown Creeper	*Certhia americana*	p	p	nm		●	
	Carolina Wren	*Thryothorus ludovicianus*	u	u	m			
	House Wren	*Troglodytes aedon*	l	u	nm		●	
	Winter Wren	*Troglodytes troglodytes*	u	u	m			
	Sedge Wren	*Cistothorus platensis*	c	l	nm			●
	Marsh Wren	*Cistothorus palustris*	l	l	nm			●

	Common Name	*Scientific Name*	Current Occurrence	Future Occurrence	Status	Prairie	Deciduous Forest	Water/ Wetland
Kinglets, Gnatcatchers,	Golden-crowned Kinglet	*Regulus satrapa*	c	u	m			
and Thrushes	Ruby-crowned Kinglet	*Regulus calendula*	c	u	m			
	Blue-gray Gnatcatcher	*Polioptila caerulea*	p	p	m		●	
	Eastern Bluebird	*Sialia sialis*	c	p	nm			
	Mountain Bluebird	*Sialia currucoides*	u	u	m			
	Townsend's Solitaire	*Myadestes townsendi*	u	u	m			
	Veery	*Catharus fuscescens*	c	l	mn		●	
	Gray-cheeked Thrush	*Catharus minimus*	u	u	m			
	Swainson's Thrush	*Catharus ustulatus*	u	u	m			
	Hermit Thrush	*Catharus guttatus*	u	u	m			
	Wood Thrush	*Hylocichla mustelina*	l	l	mn		●	
	American Robin	*Turdus migratorius*	c	l	m			
	Varied Thrush	*Ixoreus naevius*	u	u	m			
Catbirds, Mockingbirds,	Gray Catbird	*Dumetella carolinensis*	p	l	nm			
and Thrashers	Northern Mockingbird	*Mimus polyglottos*	u	u	m			
	Brown Thrasher	*Toxostoma rufum*	p	p	nm			
Starlings and Vireos	European Starling	*Sturnus vulgaris*	c	l	r			
Pipets, Waxwings,	Water Pipit	*Anthus spinoletta*	u	u	m			
and Shrikes	Bohemian Waxwing	*Bombycilla garrulus*	u	u	m			
	Loggerhead Shrike	*Lanius ludovicianus*	u	u	nm	●		
	Northern Shrike	*Lanius excubitor*	u	p	m			
	Bell's Vireo	*Vireo bellii*	u	p	mn			
	Yellow-throated Vireo	*Vireo flavifrons*	p	p	nm		●	
	Warbling Vireo	*Vireo gilvus*	p	p	nm			
	Philadelphia Vireo	*Vireo philadelphicus*	u	u	m		●	
	Red-eyed Vireo	*Vireo olivaceus*	p	p	nm		●	
	Cedar Waxwing	*Bombycilla cedrorum*	p	p	m			
Warblers and Tanagers	Blue-winged Warbler	*Vemivora pinus*	p	p	mn		●	
	Golden-winged Warbler	*Vermivora chrysoptera*	u	p	m		●	
	Tennessee Warbler	*Vermivora peregrina*	l	l	m			
	Orange-crowned Warbler	*Vermivora celata*	p	p	m			
	Nashville Warbler	*Vermivora ruficapilla*	p	p	m			
	Northern Parula	*Parula americana*	u	p	m			
	Yellow Warbler	*Dendroica petechia*	l	l	nm			
	Chestnut-sided Warbler	*Dendroica pensylvanica*	p	p	m		●	
	Magnolia Warbler	*Dendroica magnolia*	p	p	m			
	Cape May Warbler	*Dendroica tigrina*	u	p	m			
	Black-throated Blue Warbler	*Dendroica caerulescens*	u	p	m		●	
	Yellow-rumped Warbler	*Dendroica coronata*	l	l	m			
	Black-throated Green Warbler	*Dendroica virens*	u	p	m			
	Blackburnian Warbler	*Dendroica fusca*	p	p	m			
	Pine Warbler	*Dendroica pinus*	u	p	m			
	Palm Warbler	*Dendroica palmarum*	l	l	m			
	Bay-breasted Warbler	*Dendroica castanea*	u	p	m			
	Blackpoll Warbler	*Dendroica striata*	p	p	m			

	Common Name	*Scientific Name*	Current Occurrence	Future Occurrence	Status	Prairie	Deciduous Forest	Water/ Wetland
	Cerulean Warbler	*Dendroica cerulea*	l	l	mn		●	
	Black-and-white Warbler	*Mniotilta varia*	l	l	m		●	
	American Redstart	*Setophaga ruticilla*	l	l	mn		●	
	Prothonotary Warbler	*Protonotaria citrea*	u	p	mn		●	
	Worm-eating Warbler	*Helmitheros vermivorus*	u	p	m			
	Ovenbird	*Seiurus aurocapillus*	l	l	mn		●	
	Northern Waterthrush	*Seiurus noveboracensis*	u	u	m		●	
	Louisiana Waterthrush	*Seiurus motacilla*	u	u	mn		●	
	Kentucky Warbler	*Oporornis formosus*	u	p	m		●	
	Connecticut Warbler	*Oporonis agilis*	u	p	m			
	Mourning Warbler	*Oporonis philadelphia*	u	p	m		●	
	Common Yellowthroat	*Geothylpis trichas*	l	p	nm			
	Hooded Warbler	*Wilsonia citrina*	u	p	m		●	
	Wilson's Warbler	*Wilsonia pusilla*	p	p	m			
	Canada Warbler	*Wilsonia canadensis*	p	p	m		●	
	Yellow-breasted Chat	*Icteria virens*	u	p	m			
	Summer Tanager	*Piranga rubra*	u	u	m			
	Scarlet Tanager	*Pirango olivacea*	p	p	nm		●	
	Western Tanager	*Piranga ludoviciana*	u	u	m			
Towhees and Sparrows	Rufous-sided Towhee	*Pipilo erythrophtalmus*	u	u	mn			
	Green-tailed Towhee	*Pipilo chlorurus*	u	u	m			
	American Tree Sparrow	*Spizella arborea*	l	l	m			
	Chipping Sparrow	*Spizella passerina*	l	l	nm		●	
	Clay-colored Sparrow	*Spizella pallida*	l	l	nm	●		
	Field Sparrow	*Spizella pusilla*	l	l	nm	●		
	Vesper Sparrow	*Pooecetes gramineus*	l	l	nm	●		
	Lark Sparrow	*Chondestes grammacus*	u	u	mn	●		
	Savannah Sparrow	*Passerculus sandwichensis*	l	l	nm	●		
	Grasshopper Sparrow	*Ammondramus savannarum*	u	p	nm	●		
	Henslow's Sparrow	*Ammondramus henslowii*	u	u	m	●		
	Le Conte's Sparrow	*Ammodramus leconteii*	u	u	m			●
	Sharp-tailed Sparrow	*Ammodramus caudacutus*	u	u	m			
	Fox Sparrow	*Passerella iliaca*	p	p	m			
	Song Sparrow	*Melospiza melodia*	c	l	nm			
	Lincoln's Sparrow	*Melospiza lincolnii*	u	u	m			
	Swamp Sparrow	*Melospiza georgiana*	p	l	mn			●
	White-throated Sparrow	*Zonotrichia albicollis*	c	l	m			
	Harris's Sparrow	*Zonotrichia querula*	p	p	m			
	White-crowned Sparrow	*Zonotrichia albicollis*	p	p	m			
	Dark-eyed Junco	*Junco hyemalis*	c	l	m			
Grosbeaks and Buntings	Snow Bunting	*Plectrophenax nivalis*	p	p	m			
	Northern Cardinal	*Cardinalis cardinalis*	c	l	r			
	Rose-breasted Grosbeak	*Pheucticus ludovicianus*	c	l	m		●	
	Blue Grosbeak	*Guiraca caerulea*	u	u	m			
	Indigo Bunting	*Passerina cyanea*	l	l	nm		●	

	Common Name	*Scientific Name*	Current Occurrence	Future Occurrence	Status	Prairie	Deciduous Forest	Water/ Wetland
	Dickcissel	*Spiza americana*	u	u	nm	●		
Longspurs and Blackbirds	Bobolink	*Dolichonyx oryzivorus*	u	u	nm	●		
	Lapland Longspur	*Calcarius lapponicus*	u	u	m			
	Smith's Longspur	*Calcarius pictus*	u	u	m			
	Chestnut-collared Longspur	*Calcaris ornatus*	u	u	m	●		
	Red-winged Blackbird	*Agelaius phoeniceus*	c	l	nm			●
	Eastern Meadowlark	*Sturnella magna*	p	p	nm	●		
	Western Meadowlark	*Sturnella neglecta*	p	p	nm	●		
	Yellow-headed Blackbird	*Xanthocephalus xanthocephalu*	l	l	nm			●
	Rusty Blackbird	*Euphagus carolinus*	u	u	m			
	Brewer's Blackbird	*Euphagus cyanocephalus*	p	p	nm	●		
	Common Grackle	*Quiscalus quiscula*	c	l	nm			
	Brown-headed Cowbird	*Molothrus ater*	c	l	nm			
	Orchard Oriole	*Icterus spurius*	p	p	nm			
	Northern Oriole	*Icterus galbula*	c	l	nm		●	
Finches	Pine Grosbeak	*Pinicola enucleator*	u	u	m			
	Evening Grossbeak	*Carpodacus vespertinus*	u	u	m			
	Purple Finch	*Carpodacus purpureus*	p	p	m			
	Pine Siskin	*Carduelis pinus*	p	p	mn			
	House Finch	*Carpodacus mexicanus*	l	l	r	●	●	
	American Goldfinch	*Carduelis tristis*	c	l	mn			
	House Sparrow	*Passer domesticus*	c	l	r			

Occurance
u=Unlikely
p= Possible
l= Likely
c= Confirmed

Status
m= Migrant
nm= Nesting migrant
r= resident

Habitat
1 = Moist-mesic
2 = Dry/ savanna
3 = Woodland edges/ partially open ar
4 = Wooded/ bushy

	Common Name	*Scientific Name*	Current Occurrence	Future Occurrence	Prairie	Deciduous Forest	Water/ Wetland
Marsupials	Opossum	*Didelphis virginiana*	l	l		4	
Insectivores	Masked Shrew	*Sorex cinereus*	p	p		1,2	
	Short-tailed Shrew	*Blarina brevicauda*	p	p	●	1	
	Eastern Mole	*Scalopus aquaticus*	p	p	●	2	
Bats	Little Brown Bat	*Myotis lucifugus*	I	I	●	●	
	Eastern Pipistrelle	*Pipistrellus subflavus*	p	p		4	
	Big Brown Bat	*Eptesicus fuscus*	p	p	●	3	
	Siver-haired Bat	*Lasionycteris noctivagans*	p	p		●	
	Keen's Myotis	*Myotis keenii*	u	u		●	
	Hoary Bat	*Lasiurus cinereus*	p	p		3	
	Red Bat	*Lasiurus borealis*	p	p	●	3	
Lagomorphs	Eastern Cottontail	*Sylvilagus floridanus*	c	l	●	3	
Rodents	Woodchuck	*Marmota monax*	l	l	●	3,4	
	Eastern Chipmunk	*Tamias striatus*	p	p		4	
	Thirteen-lined Ground Squirrel	*Spermophilis tridecemlineatus*	c	l	●		
	Gray Squirrel	*Sciurus carolinensis*	c	l		4	
	Fox Squirrel	*Sciurus niger*	p	p	●	3	
	Red Squirrel	*Tamiasciurus hudsonicus*	p	p		4	
	Southern Flying Squirrel	*Glaucomy volans*	p	p		4	
	Plains Pocket Gopher	*Geomys bursarius*	l	l	●		
	Beaver	*Castor canadensis*	u	u	●	3,4	●
	Deer Mouse	*Peromyscus maniculatus*	l	l	●	3	
	White-footed Mouse	*Peromyscus leucopus*	p	p		4	
	Meadow Vole	*Microtus pennsylvanicus*	l	l	●	3	
	Muskrat	*Ondatra zibethica*	p	p			●
	Meadow Jumping Mouse	*Zapus hudsonius*	p	p	●	1,3	
Carnivores	Red Fox	*Vulpes vulpes*	l	l	●	3	
	Gray Fox	*Urocyon cinereoargenteus*	p	p		4	
	Coyote	*Canis latrans*	p	p	●	4	
	Raccoon	*Procyon lotor*	c	l	●	3,4	
	Ermine	*Mustela erminea*	p	p		3	
	Long-tailed Weasel	*Mustela frenata*	p	p	●	1,3,4	
	Mink	*Mustela vison*	l	l	●	3,4	●
	Striped Skunk	*Mephitis mephitis*	c	l	●	●	
Ungulates	White-tailed Deer	*Odocoileus virginianus*	c	l		3	

Occurance
u = Unlikely
p = Possible
l = Likely
c = Confirmed

Habitat
1 = Moist-mesic
2 = Dry/ savanna
3 = Woodland edges/ partially open areas
4 = Wooded/ bushy

Appendix C: Proposed Plant Community Species Lists

Big Woods – trees and shrubs

Species	Common Name
Acer saccharinum	Sugar maple
Carpinus caroliniana	Hornbeam
Ostrya virginiana	ironwood
sambucus canadensis	Common elder
Sambucus racemosa	elder
Viburnum lentago	Sweet viburnum
Eunomus atrpupureus	Winged nine-bark
Cornus alternifolia	Pagoda dogwood
Quercus alba	White oak
Quercus macrocarpa	Bur oak
Quercus rubra	Red oak
Ribes americanum	American gooseberry
Carya cordiformis	Yellow-bud kickory
Carya ovata	Shagbark hickory
Juglans cinerea	Butternut
Juglans nigra	Black walnut
Prunus serotina	Black cherry
Rubus allegheniensis	blackberry
Tilia americana	Basswood

Big Woods - herbs

Species	Common Name
Osmorhiza claytonii	Sweet cicely
Osmorhiza longistylis	Sweet cicely
Sanicula canadensis	Black snakeroot
Arisaema triphyllum	Jack-in-the-pulpit
Aralia racemosa	Spikenard
Asarum canadense	Wild ginger
Aster macrophyllus	Big-leaved aster
Eupatorium rugosum	White snakeroot
Solidago flexicaulis	Zig-zag goldenrod
Caulophyllum thalictroides	Blue cohosh
Podophyluum peltatum	May apple
Campanula rotundifolia	Round-leaved harebell
Carex blanda	
Carex pedunculata	
Carex retrorsa	
Carex rosea	
Athyrium filix-femina	Lady fern
Corydalis aurea	Golden corydalis
Dicentra cucullaria	Dutchman’s breeches
Geranium maculatum	Wild geranium
Juncos tenuis	
Allium tricoccum	Wild leek

Clintonia borealis	Blue-bead lily
Erythronium albidum	White trout lily
Maianthemum canadense	Canada mayflower
Polygonatum pubescens	Hairy solomon's seal
Smilacina racemosa	False solomon's seal
Streptopus amplexifolius	Twisted stalk
Streptopus roseus	Rose twisted stalk
Trillium grandiflorum	Large-flowered trillium
Uvularia grandiflora	Large-flowered bellwort
Uvularia sessilifolia	Wild oats
Menispermum canadense	moonseed
Botrychium virginianum	Rattlesnake fern
Osmunda cinnamomea	Cinnamon fern
Osmunda claytoniana	Interrupted fern
Sanguinaria canadensis	bloodroot
Elymus hystrix	Bottle-brush grass
Elymus villosus	Wild rye
Phlox divaricata	Woodland phlox
Polemonium reptans	Jacob's ladder
Claytonia virginica	Spring beauty
Trientalis borealis	Northern starflower
Adiantum pedatum	Maidenhair fern
Actaea alba	White baneberry
Actaea rubra	Reb baneberry
Anemone quinquefolia	Wood anemone
Anemonella thalictroides	Rue anemone
Aquilegia canadensis	Wild columbine
Clematis virginiana	Virgin's bower
Hepatica acutiloba	Sharp-lobed hepatica
Hepatica americana	Round-lobed hepatica
Isopyrum biternatum	False rue anemone
Thalictrum dioicum	Early meadow rue
Geum canadense	White avens
Gallium boreale	Northern bedstraw
Gallium triflorum	Sweet-scented bedstraw
Mitella diphylla	Bishop's cap
Tiarella cordifolia	Foam flower
Viola pubescens	Downy yellow violet

Oak Woodland – trees and shrubs

Common Name	**Latin Name**
Paper Birch	Betula papyrifera
New Jersey Tea	Ceanothus americanus
Gray-bark Dogwood	Cornus foemina
Chokecherry	Prunus virginiana
Pin Oak	Quercus ellipsoidalis
Bur Oak	Quercus macrocarpa
Red Oak	Quercus rubra

Oak Woodland – herbs

Anise Hyssop	Agastache foeniculum
Lead Plant	Amorpha canescens
Big Bluestem	Andropogon gerardii
White False Indigo	Baptisia alba
White Prairie Clover	Petalostemum candidum
Purple Prairie Clover	Dalea purpurea
Little Bluestem	Schizachyrium scoparium
Indian Grass	Sorghastrum nutans

Oak Savanna – east-facing

Species	**Common name**
Agastache foeniculum	Fragrant Giant Hyssop/Anise Hyssop
Amelanchier spp.	
Amorpha canescens	Leadplant
Andropogon gerardii	Big Bluestem
Artemesia ludoviciana	Wormwood
Asclepias tuberose	Butterfly Milkweed
Aster ericoides	
Aster oolentangiensis	Sky-Blue Aster
Aster sericeus	
Baptisia alba	White Wild Indigo
Bouteloua curtipendula	Side Oats Grama
Ceanothus americanus	New Jersey Tea
Cirsium hillii	
Coreopsis palmate	Prairie coreopsis
Cornus foemina	
Cyperus lupulinus	
Dalea purpurea	Purple Prairie Clover
Dalea purpurea	Purple Prairie Clover
Desmodium glutinosum	
Echinacea purpurea	Narrow-leaved Purple Coneflower
Euphorbia corollata	Flowering Spurge
Gentiana quinquefolia	Stiff Gentian
Helianthus hirsutus	
Koeleria cristata	June Grass
Liatris aspera	Rough Blazing Star
Liatris punctata	
Phlox pilosa	Prairie Phlox
Physalis virginiana	
Potentilla arguta	
Prunus virginiana	Choke Cherry
Quercus ellipsoidalis	Northern Pin Oak
Quercus macrocarpa	Bur Oak

Quercus rubra	Red oak
Rudbeckia hirta	Brown-eyed Susan
Schizachyrium scoparium	Little Bluestem
Smilacena stellata	
Solidago nemoralis	
Sorghastrum nutans	Indian Grass
Sporobolis heterolepis	Prairie Dropseed
Tradescantia occidentalis	Prairie Spiderwort
Vaccinium angustifolium	Low-bush blueberry
Viola pedatifida	Prairie Violet
Zizia aptera	Golden Alexanders

Oak Savanna – west-facing

Species	**Common name**
Agastache foeniculum	Fragrant Giant Hyssop/Anise Hyssop
Amelanchier spp.	
Amorpha canescens	Leadplant
Andropogon gerardii	Big Bluestem
Artemesia ludoviciana	Wormwood
Asclepias tuberose	Butterfly Milkweed
Aster ericoides	
Aster oolentangiensis	Sky-Blue Aster
Aster sericeus	
Baptisia alba	White Wild Indigo
Bouteloua curtipendula	Side Oats Grama
Ceanothus americanus	New Jersey Tea
Cirsium hillii	
Coreopsis palmate	Prairie coreopsis
Cornus foemina	
Cyperus lupulinus	
Dalea purpurea	Purple Prairie Clover
Dalea purpurea	Purple Prairie Clover
Desmodium glutinosum	
Echinacea purpurea	Narrow-leaved Purple Coneflower
Euphorbia corollata	Flowering Spurge
Gentiana quinquefolia	Stiff Gentian
Helianthus hirsutus	
Koeleria cristata	June Grass
Liatris aspera	Rough Blazing Star
Liatris punctata	
Phlox pilosa	Prairie Phlox
Physalis virginiana	
Potentilla arguta	
Prunus virginiana	Choke Cherry
Quercus ellipsoidalis	Northern Pin Oak
Quercus macrocarpa	Bur Oak
Quercus rubra	Red oak
Rudbeckia hirta	Brown-eyed Susan
Schizachyrium scoparium	Little Bluestem

Smilacena stellata	
Solidago nemoralis	
Sorghastrum nutans	Indian Grass
Sporobolis heterolepis	Prairie Dropseed
Tradescantia occidentalis	Prairie Spiderwort
Vaccinium angustifolium	Low-bush blueberry
Viola pedatifida	Prairie Violet
Zizia aptera	Golden Alexanders

Mesic Prairie

Species	**Common name**
Agastache foeniculum	Fragrant Giant Hyssop/Anise Hyssop
Amorpha canescens	Leadplant
Andropogon gerardii	Big Bluestem
Asclepias tuberose	Butterfly Milkweed
Aster oolentangiensis	Sky-Blue Aster
Aster ericoides	Heath aster
Baptisia alba	White Wild Indigo
Bouteloua curtipendula	Side Oats Grama
Bromus kalmii	Kalm's brome
Coreopsis palmata	Prairie coreopsis
Dalea candida	White Prairie Clover
Dalea purpurea	Purple Prairie Clover
Echinacea purpurea	Narrow-leaved Purple Coneflower
Elymus canadensis	Canada Wild Rye
Eryngium yuccifolium	Rattlesnake Master
Gentiana quinquefolia	Stiff Gentian
Helianthus occidentalis	Sunflower
Heliopsis helianthoides	Oxeye or False Sunflower
Lespedeza capitata	Bush-headed Prairie Clover
Liatris aspera	Rough Blazing Star
Lithospermum carolinense	
Monarda fistulosa	Wild Bergamot/ Bee Balm
Penstemon digitalis	Foxglove Beardtongue
Phlox pilosa	Prairie phlox
Physalis heterophylla	
Ratibida pinnata	Gray-headed Coneflower
Rudbeckia hirta	Brown-eyed Susan
Rudbeckia triloba	Thin Leaved Coneflower
Schizachyrium scoparium	Little Bluestem
Silphium laciniatum	Compass Plant
Solidago missouriensis	Missouri Goldenrod
Solidago speciosa	
Sorghastrum nutans	Indian Grass
Sporobolis heterolepis	Prairie Dropseed
Tradescantia occidentalis	Prairie Spiderwort
Verbena stricta	Hoary Vervain

Lowland Hardwood Forest - trees and shrubs

Species	Common Name
Celtis occidentalis	Hackberry
Ulmus americana	American elm
Ulmus rubra	Slippery elm
Parthenocissus quinquefolia	Virginia creeper
Vitis riparia	River grape
Acer rubrum	Red maple
Carpinus caroliniana	hornbeam
Ostrya virginiana	ironwood
Cornus foemina	Gray dogwood
Quercus alba	White oak
Juglans cinerea	butternut
Fraxinus pennsylvanica	Green ash
Populus tremuloides	Quaking aspen
Tilia americana	basswood

Lowland Hardwood Forest – herbs

Species	Common Name
Laportea canadensis	Wood nettle
Pilea fontant	Clearweed
Pilea pumila	Clearweed
Aralia nudicaulis	Wild sarsaparilla
Carex pedunculata	
Athyrium filix-femina	Lady fern
Matteuccia struthiopteris	Ostrich fern
Maianthemum canadense	Canada mayflower
Osmunda cinnamomea	Cinnamon fern
Osmunda claytoniana	Interrupted fern
Elymus virginicus	Virginia wild rye
Adiantum pedatum	Maidenhair fern
Geum canadense	White avens

Mixed Emergent Marsh

Common Name	Latin Name
Water-Plantain	***Alisima triviale***
Blue-joint grass	*Calamagrostis canadensis*
Slough sedge	***Carex atherodes***
Blue flag Iris	***Iris versicolor***
Pickerelweed	*Pontederia cordata*
Yellow water crowfoot	*Ranunculus flabellaris*
Broad-leaved arrowhead	***Sagittaria latifolia***
Green bulrush	*Scirpus atrovirens*
Wool-grass	*Scirpus cyperinus*
River Bulrush	*Scirpus fluviatilis*
Three-square bulrush	*Scirpus pungens*
Softstem bulrush	*Scirpus validus*

Hardstem bulrush	*Scripius acutus*
Giant Bur-Reed	*Sparganium eurycappum*

Wet Prairie

Species	Common name
Acorus calamus	Sweet Flag
Agastache foeniculum	Fragrant Giant Hyssop/Anise Hyssop
Alisma triviale	Water-Plantain
Andropogon gerardii	Big Bluestem
Asclepias incarnata	Marsh Milkweed
Aster lanceolatus	Panicled Aster
Aster novae-angliae	New England Aster
Aster puniceus	Purple Stemmed Aster
Aster umbellatus	Flat Topped Aster
Calamagrostis canadensis	Canada Bluejoint Grass
Dalea purpurea	Purple Prairie Clover
Desmodium canadense	Tick -Trefoil
Echinochloa crus-galli	Wild Millet
Elymus canadensis	Canada Wild Rye
Eupatorium maculatum	Joe-Pye Weed
Eupatorium perfoliatum	Boneset
Euthamia graminifolia	Grass Leaved Goldenrod
Helenium autumnale	Sneezeweed
Helianthus giganteus	Giant Sunflower
Hypericum pyramidatum	Great St. John's-wort
Iris versicolor	Blue Flag
Liatris ligulistylis	Blazing Star
Liatris pycnostachya	Prairie Blazing Star/ Tall Blazing Star
Monarda fistulosa	Wild Bergamot/ Bee Balm
Panicum virgatum	Switchgrass
Pycnanthemum virginianum	Mountain Mint
Rudbeckia hirta	Brown-eyed Susan
Scirpus atrovirens	Green Bulrush
Scirpus cyperinus	Wool-grass
Solidago rigida	Stiff Goldenrod
Sorghastrum nutans	Indian Grass
Sparganium eurycarpum	Giant Bur Reed
Spartina pectinata	Prairie Cordgrass
Thalictrum dasycarpum	Tall Meadow Rue
Verbena hastata	Blue Vervain
Vernonia fasciculata	Common Ironweed
Veronicastrum virginicum	Culver's Root
Zizia aurea	Golden Alexanders

Appendix D: Control of Exotic Species

Common name	Scientific name	Treatment	Time of Year
Boxelder	*Acer negundo*	repeated controlled burns; Triclopyr oil as basal bark treatment cutting followed by herbicide on cut stumps	2-3 times/growing season
Garlic mustard	*Alliaria petiolata*	pulling and removing flowering plants at ground level; Glyphosate; biological control agents	spring-summer; late fall/early spring
Ragweed	*Ambrosia artemisiifolia, A. trifida*	mowing	throughout summer
Burdock	*Arctium minus*	pulling and removing flowering plants	summer
Spotted knapweed	*Centaurea maculosa*	hand removal, carefully timed mowing; hot prescribed burn Triclopyr solution, Dicamba	 fall; fall or spring
Canada thistle	*Cirsium arvense*	mowing/selective cutting followed by removal; prescribed burn; Glyphosate; Transline	just before or during full bloom; **late** spring; early summer; pre- or early bud stage
Crown vetch	*Coronilla varia*	mow to reduce above ground growth and when regrowth is 6-8 inches high; follow by herbicide (Transline)	throughout summer
Yellow nutsedge	*Cyperus esculentus*	hand- pulling; mowing and other maintenance activities	throughout summer
Queen Anne's lace	*Daucus carota*	hand-pulling; mowing and other maintenance activities	mid-to-late summer
Barnyardgrass	*Echinochloa crus-galli*	herbicide with Clomazone; mowing and other maintenance activities	throughout summer
Russian olive	*Elaeagnus angustifolia*	Mowing followed by removal; herbicide to cut surfaces	throughout summer
Leafy spurge	*Euphorbia esula*	herbicide with Plateau and Transline; biological controls	throughout summer

White snakeroot	*Eupatorium rugosum*	prescribed burning; mowing and other maintenance activities	throughout summer
Common name	**Scientific name**	**Treatment**	**Time of Year**
Common motherwort	*Leonurus cardiaca*	hand-pulling or mowing	throughout summer
Purple loosestrife	*Lithrum salicaria*	Triclopyr and Glyphosate on young plants; biological controls	July to early September
Tartarian honeysuckle	*Lonicera tatarica*	hand removal repeated prescribed burns Triclopyr @ base of cut stems	spring; spring; winter
Birds' foot trefoil	*Lotus corniculatus*	Transline (mow first to reduce above ground growth and when regrowth is 6-8 inches high, herbicide)	summer
White sweet clover	*Melilotus alba*	prescribed burns 2 yrs in a row hand pulling	early to mid April = 1st year, early to mid May = 2nd year; just before flowering
Virginia creeper	*Parthenocissus inserta*	pulling, mowing, prescribed burning	repeatedly during growing season
Reed canary grass	*Phalaris arundinacea*	mowing; prescribed burns; Glyphosate solution	repeatedly during growing season late spring or late fall; June; October (after mid-Sept. mow)
Exotic bluegrasses	*Poa pratensis; P. compressa*	controlled burn; Glyphosate	spring (late April/early May)
Common purslane	*Portulaca oleracea*	hand-pulling; mowing and other maintenance activities	throughout summer
European buckthorn	*Rhamnus cathartica*	hand removal, repeated prescribed burns; Glyphosate or Triclopyr @ base of cut stems; Fosamine on leaves	early spring or fall; fall for chemicals
Sumac	*Rhus glabra; R. typhina*	prescribed burn; hand cutting stems; Glyphosate on stems; Triclopyr at base	spring; July and August; July and August;

Black locust	*Robinia pseudo-acacia*	Triclopyr as basal bark application; Glyphosate to cut stems	late summer/early fall/dormancy
Curly dock	*Rumex crispus*	hand-pulling; mowing and other maintenance activities	throughout summer
Common name	**Scientific name**	**Treatment**	**Time of Year**
Green foxtail	*Setaria viridis*	selective herbicides	throughout summer
Bladder campion	*Silene vulgaris*	hand-pulling; mowing and other maintenance activities	throughout summer
Siberian elm	*Ulmus pumila*	Girdling for 1-2 years; prescribed burn for seedlings/saplings	late spring-mid summer;
Common mullein	*Verbascum thapsus*	hand removal; prescribed burns Broadcast herbicide application	before flowering; fall; pre-emergence
Riverbank grape	*Vitis riparia*	hand-pulling, mowing, prescribed burning	throughout summer

Appendix E: References

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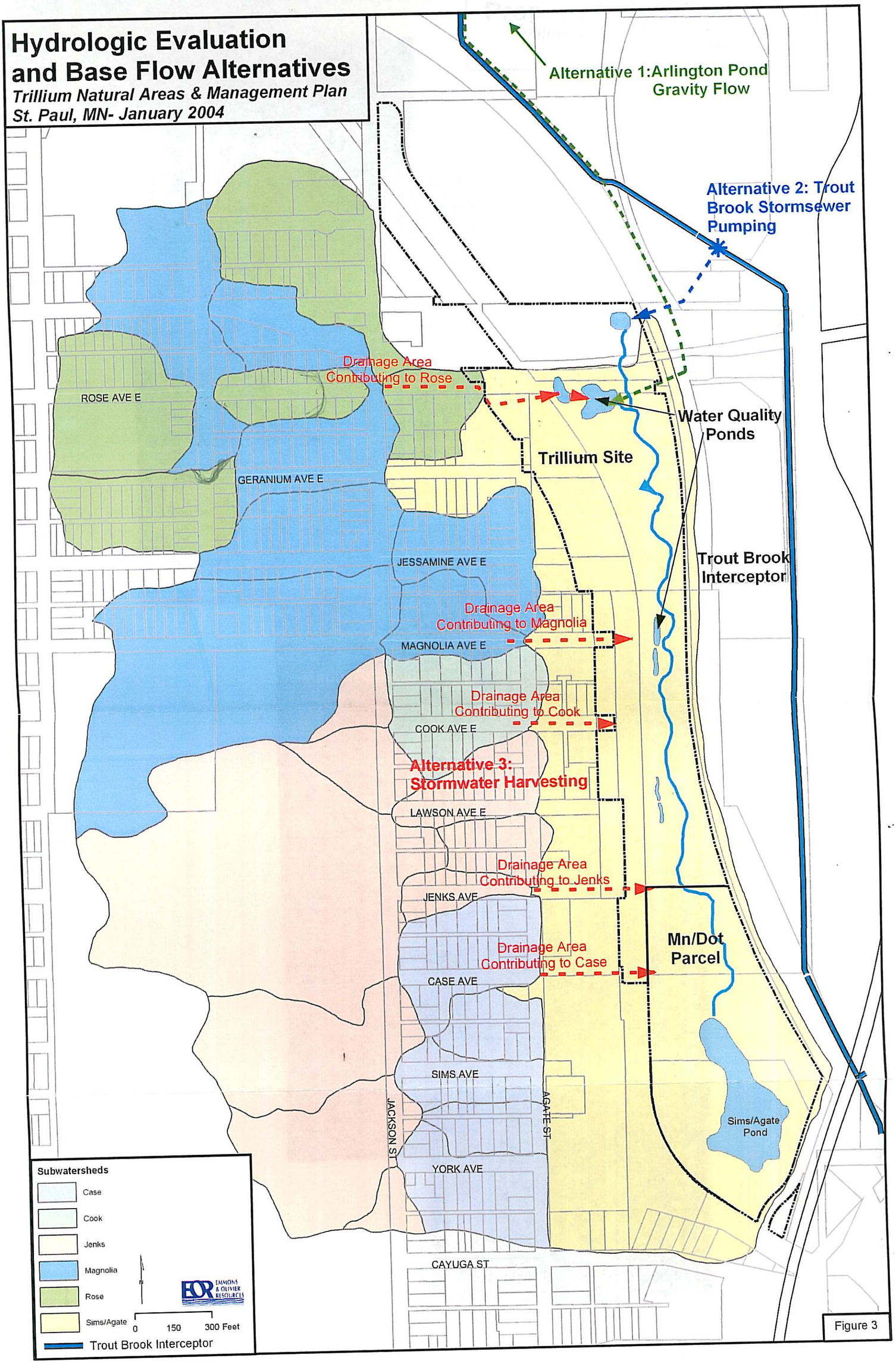
Hydrologic Evaluation and Base Flow Alternatives
Trillium Natural Areas & Management Plan
St. Paul, MN- January 2004
Alternative 1:Arlington Pond Gravity Flow
Alternative 2: Trout Brook Stormsewer Pumping
Drainage Area Contributing to Rose
ROSE AVE E
GERANIUM AVE E
Water Quality Ponds
Trillium Site
JESSAMINE AVE E
Trout Brook Interceptor
Drainage Area Contributing to Magnolia
MAGNOLIA AVE E
Drainage Area Contributing to Cook
COOK AVE E
Alternative 3: Stormwater Harvesting
LAWSON AVE E
Drainage Area Contributing to Jenks
JENKS AVE
Mn/Dot Parcel
Drainage Area Contributing to Case
CASE AVE
SIMS AVE
JACKSON ST
AGATE ST
Sims/Agate Pond
YORK AVE
CAYUGA ST
Subwatersheds
Case
Cook
Jenks
Magnolia
Rose
Sims/Agate
Trout Brook Interceptor
0
150
300 Feet
EOR
EMMONS & OLIVIER RESOURCES
Figure 3