WAVELAND GOLF COURSE AND GLENDALE CEMETERY

STORMWATER MANAGEMENT MASTER PLAN

OCTOBER 2014

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MASTER PLAN SUMMARY

01

Master Plan Summary

Waveland Golf Course and Glendale Cemetery are used and cherished by thousands of Des Moines area residents. The former has great historical significance, and the latter is a beautiful place of repose and contemplation. With changes in regional precipitation patterns since the 1980s, however, erosion and flooding have created problems for the course and cemetery users as well as for operations and maintenance staff. Conditions are exacerbated by dense urban development surrounding the golf course and cemetery, a situation which accelerates the movement of water through the system, increasing erosion rates and flooding frequency. This 515-acre green island in urban Des Moines can become more ecologically and operationally sustainable, while preserving the history and character of the course and cemetery.

In early 2013, the Des Moines Parks and Recreation Department retained a team of experts in ecology, stormwater management, water engineering, landscape architecture, and golf course design, and charged the team with finding a unified and holistic solution to the following issues:

- Control erosion in watercourses and at pond edges
- Manage flooding of low areas
- Create improved and stable playing conditions at Hole 3
- Reduce flooding in the vicinity of burial sites
- Improve the quality of water entering Waveland Creek
- Create connected and improved conditions in oak woodland and other natural systems

In 2013 and 2014, the consulting team worked to address these issues with City staff and an advisory committee. The advisory committee represented stakeholders and provided expertise relevant to the issues facing the consulting team. Two public meetings were held to solicit information about the golf course and cemetery and to gauge support for the solutions proposed by the consulting team and advisory committee.

The consulting team used the following framework to complete its work.

- Gather information on current conditions
- Summarize and discuss current conditions and potential solutions with advisory committee and public
- Analyze the rate of stormwater runoff in subwatersheds of the site
- Identify candidate stormwater management projects and estimate costs
- Prioritize candidate projects with the advisory committee
- Develop concept plans for the highest priority candidate projects and estimate costs
- Summarize and discuss concept plans with the advisory committee and public
- Present the findings and recommendations in a stormwater management master plan

Waveland Golf Course

Glendale Cemetery

The advisory committee and City staff also toured and critiqued the highest priority projects in the field. The highest priority projects together will reduce the runoff flows after storms by 18-23% (depending on the type of storm), and will reduce the amount of sediment and phosphorus entering Waveland Creek by 61% and 29%, respectively. The priority projects address the serious problem of poor playability and repeated failure to contain erosion at Hole 3, and the issue of standing water at burial sites. They improve water quality in Waveland Creek by reducing erosion by controlling the rate and quantity of stormwater runoff moving through the site. Lastly these projects, together with an ecological restoration concept, propose a more integrated system of natural lands in the golf course and cemetery.

MASTER PLAN OVERVIEW

02

Master Plan Overview

Rather than address the cemetery and golf course separately, this stormwater master plan examines the watershed and streams of the entire area, takes a natural systems approach, and finds comprehensive solutions to persistent problems caused by land and stormwater management. Years of excessive stormwater runoff, stream and pond shore erosion, and poor drainage have compromised the use, enjoyment and maintenance of the cemetery and golf course. This master plan delivers a holistic solution to address these problems and, at the same time, identifies opportunities to reduce maintenance and improve the functionality, aesthetics, and natural resources of the area.

Waveland Golf Course and Glendale Cemetery (hereafter referred to as the "site") are located in western Des Moines. The cemetery is north of, and drains to, the golf course (Figure 1). The site is located at the headwaters of the Waveland Creek watershed, which flows southwest into Walnut Creek and eventually the Raccoon River (Figure 2). The upper Waveland Creek watershed, like drainage basins in many urban areas, collects and releases unconstrained stormwater runoff from neighborhoods into and through the course and cemetery, frequently flooding the site and causing erosion. Extensive turf and pavement in the site, combined with moderately steep slopes, promote rapid drainage as well. The large runoff volume from even small storms quickly raises water levels in Waveland Creek. The most polluted "first flush" of runoff—generally the first quarter to half inch of rainfall in Des Moines—flows directly into ponds and Waveland Creek. A solution comprised of volume and rate control[(1)], sediment and phosphorus removal, and ecological restoration is required. This is challenging to implement because space is limited and the aesthetics and character of the historic golf course and cemetery must be preserved.

Several localized problems also exist. Shallow "perched" groundwater in the northern cemetery creates drainage problems for burials. Flocks of waterfowl add nutrients to waterbodies, especially the cemetery pond, reducing water clarity. Both overland and piped runoff have contributed to significant erosion and damage in the golf course, especially along the fairway of Hole 3. Minor drainage problems exist throughout the course in depressions and where runoff becomes concentrated.

These conditions not only pollute ponds and erode banks on site, they affect Waveland Creek and downstream waters. The result is unattractive in public parks and damaging to the ecology of both Waveland and Walnut Creeks. Some undeveloped portions of the course and cemetery, however, have moderately good biodiversity. Although Parks staff is actively restoring these areas, more could be done to improve and connect these areas for the benefit of water quality and wildlife.

The City of Des Moines asked the consulting team to take a holistic, ecological approach to runoff management, water quality improvement, ecological restoration, and the needs of golf course and cemetery users. The result is this master plan, which is designed to be practical and cost-effective. The consulting team had expertise in ecology, engineering, landscape architecture, and golf course design. Early discussions among these professionals resulted in the holistic assessment of existing conditions which laid the foundation for a realistic range of potential solutions.

The City formed an Advisory Committee to share information with the consulting team, generate ideas, and critique the planning outcomes and documents. The Advisory Committee

(1) Volume control means, reducing the total amount of runoff flowing into rivers, lakes and streams. In natural landscapes, less than 15 percent of rainfall reaches water bodies by flowing across the land. In cities, up to half of the rain falling on the ground flows directly to water bodies, usually via gutter, pipes, and ditches. This extra water—this extra volume of runoff—destroys aquatic habitat. By contrast, rate control simply means slowing the water down as it flows over the land and through natural or engineered drainage systems. This helps reduce flooding by spreading out the flow of runoff—it doesn't all hit an area at one time and cause flooding.

Wet area in cemetery

Golf course pond

was made up of representatives of the City's Parks, Public Works, and Engineering Departments, the City's Sustainability Coordinator, the City's Cemeteries Manager, the Waveland Golf Course Contractor, and members of the cemetery and golf course advisory committees. Three Advisory Committee meetings were held. At two open houses, the public provided the consulting team with feedback on the concepts.

Cemetery pond bank erosion

Hole 3 erosion

Consulting team conducts field assessment of site

Advisory committee meeting

PROJECT GOALS, CONSIDERATIONS, AND DESIGN PRINCIPLES

03

Project Goals, Considerations, and Design Principles

Project Goals

1. Identify and prioritize opportunities to improve stormwater management in cemetery, golf course, and neighborhoods.
2. Reduce the rate and volume of stormwater runoff entering Waveland Creek, and improve water quality for Waveland and Walnut Creeks and the Raccoon River.
3. Maintain and improve the aesthetic character and function of cemetery and golf course.
4. Preserve and enhance the unique historical character of the golf course.
5. Improve wildlife habitat.
6. Reduce maintenance effort and cost.

Project Considerations

Aesthetics are an important consideration in parks and are of paramount importance at the Waveland-Glendale site. The cemetery must present a sense of beauty, order, and peace as a way to respect those buried there and to attract future purchases of burial lots. To remain a viable business, the golf course must respect its historical character and attract golfers of all abilities. For these reasons, more specific goals were established.

Glendale Cemetery Design Principles

- Adopt a sustainable ("triple bottom line") approach by considering the social, environmental, and economic implications of all decisions.
- Improve the health and "look" of the landscape.
- Preserve desirable and long-lived vegetation.
- Enhance the groundlayer and understory of woodland and savanna by removing invasive species; creating an open, layered understory; and defining edges.
- Reduce landscape maintenance.

Waveland Golf Course Design Principles

- Adopt a sustainable ("triple bottom line") approach by considering the social, environmental, and economic implications of all decisions.
- Preserve desirable and long-lived vegetation.
- Enhance the groundlayer and understory of woodland and savanna by removing invasive species; creating an open, layered understory; and defining edges.
- Enhance playability and reduce landscape maintenance.
- Enhance the historical character of golf course by preserving and restoring turn-of-the-last-century styling, and by considering product lifecycle and annual maintenance costs.

Pond concept

Restored stream

OPPORTUNITIES & CONSTRAINTS

04

Opportunities & Constraints

Identifying the opportunities and constraints at the site took place in numerous meetings, conversations, and reviews of data. The consulting team compiled City-provided map data in a series of base maps. The team and Richard Brown of City Parks toured the cemetery and golf course, then met with the Advisory Committee to discuss observations, share information, and discuss goals and priorities.

In its assessment of site data, the consulting team delineated drainage areas, conducted preliminary runoff and water quality modeling, and identified opportunities for stormwater Best Management Practices (BMPs). The team conceptualized in maps those opportunities, while also looking for locations to improve the connectivity and quality of plant communities and wildlife habitat. This analysis was followed by an internal design charette with Richard Brown to refine potential BMPs and design criteria.

Regional Context

The site is nearly completely surrounded by urban development (Figure 1). This intensive development leaves little opportunity for meaningful habitat connections. The site's southwest corner, however, drains to Waveland Creek, which is connected by a greenway to Walnut Creek and the Raccoon River (Figure 1). Significant obstacles to connectivity exist here, such as Interstate 235, making this habitat corridor unusable for many species. Enhancing this greenway should be part of future planning in this area. A regional trail spur (Waveland Trail), consisting of an asphalt trail and sidewalk, already runs along the west side of the cemetery and golf course from Franklin Avenue south to the Walnut Creek Trail. At its north end, Waveland Trail passes through the cemetery's northwest corner, which has been designated by the City as a public recreation area. This area is envisioned to become a restored natural area that would provide opportunities for passive recreation, nature appreciation, and use by birds, butterflies, and other wildlife.

In 2011, the Parks and Recreation Department retained Dr. Tom Rosburg of Drake University to inventory all 3,800 acres of the city's park lands and open space. Dr. Rosburg found that the parks system harbors 459 native plant species--nearly one-third of all of Iowa's plant species. He also noted that several areas, including Waveland Golf Course, supported uncommon oak-dominated ecosystems, which have the potential, if managed properly, to become excellent savanna and woodland communities. This important natural resource was recognized and incorporated in the master planning process for the golf course.

Habitat

The consulting team reviewed and used the vegetation mapping created by Dr. Rosburg for the natural resource inventory. The cemetery and golf course landscapes are primarily manicured turf grass, and natural and semi-natural habitats are limited (Figures 3 and 4). A variety of native trees and other native vegetation exist in the cemetery and even more so in the golf course. The cemetery's existing native habitats include a planted prairie in the cemetery's northwest corner and a woodland/

Mature oak trees in a savanna and woodland setting

Native groundlayer vegetation in oak woodlands

Drake Municipal Observatory at Waveland Golf Course prairie/wetland complex in the southeast corner. The golf course's existing native habitats consist primarily of oak woodlands and denser forests scattered throughout the course. Despite constraints, connectivity and native diversity could be enhanced to benefit wildlife.

Site Uses

As an active cemetery and golf course, significant programmatic requirements must be met. The cemetery is nearly all existing or proposed burial sites, with only small, scattered outlots available for significant modification for stormwater management practices. The drainage and aesthetic problems facing the cemetery must be solved largely in these small areas.

Any improvements in Waveland Golf Course need to respect and preserve the historical character of the course as well as the historical order of play or "routing." Changes to the hole and fairway layout must be minimal, while ideally increasing the efficiency of play, and at the same time addressing drainage issues and erosion.

Cemetery pond assessment

Hydrology

Analysis

Analysis of existing LiDAR topographic data resulted in the delineation of 19 subwatersheds in the headwater watershed of Waveland Creek (Figure 5). Contour data, land cover data, and soils data were input to an XPSWMM model, and the runoff volume and rate were estimated for each subwatershed (Table 1 - Figure 6). This helped identify subwatersheds with the greatest potential need for runoff control. As expected, higher runoff volumes and rates were in subwatersheds with a higher percent

Table 1. Existing Subwatershed Information

		Outflows (cfs)*			Outflow per Acres (cfs/acre)		
Subwatershed	Area (ac)	2-Year	10-Year	100-Year	2-Year	10-Year	100-Year
C_NW	17.9	5.7	21.6	55.5	0.3	1.2	3.1
C_N	38.2	23.0	63.8	169.9	0.6	1.7	4.4
C_SW	70.4	45.6	116.0	287.9	0.6	1.6	4.1
C_Center	40.0	39.3	113.6	241.7	1.0	2.8	6.0
C_SE	85.9	45.6	55.3	54.5	0.5	0.6	0.6
C_Pond	22.8	50.0	82.7	116.0	2.2	3.6	5.1
GC_Pond	26.5	68.1	183.5	449.1	2.6	6.9	17.0
GC_Center	9.5	68.5	168.1	430.4	7.2	17.7	45.2
GC_NW	20.5	52.5	136.5	343.9	2.6	6.7	16.8
GC_E	54.2	92.8	201.4	488.0	1.7	3.7	9.0
Res_E	64.2	65.9	143.8	306.4	1.0	2.2	4.8
GC_SW	33.0	83.4	236.9	718.2	2.5	7.2	21.7
GC_SE_W	7.0	0.9	4.7	18.1	0.1	0.7	2.6
GC_SE_C	5.9	3.1	9.1	25.2	0.5	1.6	4.3
GC_SE_E	23.9	19.6	41.8	91.8	0.8	1.7	3.8
Res_S	56.3	61.7	110.2	134.3	1.1	2.0	2.4
Res_SE	46.3	103.0	226.8	390.1	2.2	4.9	8.4
GC_S	30.9	114.6	254.8	472.2	3.7	8.3	15.3
To Creek	653.4	198.0	491.7	1190.4	0.3	0.8	1.8

** This value denotes flow exiting the subwatershed, not flow generated by the subwatershed.*

of connected impervious cover—roofs, driveways, streets—and storm sewer infrastructure. But the size and location of a subwatershed was also important. For example, high in the watershed in the cemetery, and in small, isolated subwatersheds in the golf course, runoff rates were the least. Meanwhile, subwatersheds farther downstream received combined runoff from higher in the watershed, with larger flow volumes and runoff rates.

Results

To simplify prioritization of BMPs, the 19 subwatersheds were combined into four drainage areas. The drainage areas were defined by their obvious receiving water—a pond or a stream (Figure 6). Goals were developed for each drainage area.

Swale east of Hole 3

Poor water quality in pond west of Hole 3

Waveland Creek bank erosion

Cemetery Pond Drainage Area

- Reduce wet conditions in north burial area
- Reduce sediment and nutrient inputs to pond
- Improve ability of pond to handle sediment inputs
- Improve pond aesthetics – water clarity, eroding shoreline

Hole 3 East Drainage Area

- Increase pond volume storage and create new pond(s)
- Stabilize creek at Hole 3
- Reduce neighborhood runoff with BMPs
- Remove more sediment, phosphorus, and nitrogen from runoff

Hole 3 West Drainage Area

- Increase volume storage by constructing pond
- Capture worst eroding flows (caused by multiple small storms)
- Reduce sediment, phosphorus, and nitrogen entering golf course waters

Waveland Creek Drainage Area

- Control runoff from high school watershed using BMPs
- Because most runoff bypasses the south edge of golf course, improvements will primarily benefit Waveland Creek downstream of the site

RUNOFF MANAGEMENT

05

Runoff Management

Glendale Cemetery and Waveland Golf Course have experienced years of drainage and erosion problems, but there are many opportunities to improve runoff management. A goal of this project is to reduce by 50% the annual runoff volume leaving the site. With properly chosen and designed stormwater BMPs, this goal should be achievable.

Opportunities for runoff management considered:

- Programmatic needs, which include drainage and erosion issues that currently impair cemetery and golf course operations;
- Available space for BMPs;
- Need for runoff management in a particular area;
- Amount of rate and volume control that might be achieved;
- Amount of sediment and nutrient removal that might be achieved;
- Effect on playability and safety at the golf course; and
- Aesthetics.

The consulting team employed the Stormwater Treatment Train (STT) approach to conceptually design projects and BMPs at the site. The STT is a holistic, ecological approach to guide the design of stormwater management systems. It uses a variety of natural elements, such as prairies, rain gardens, vegetated swales, and treatment wetlands. It also incorporates engineered components, such as hydrodynamic separators and infiltration chambers.

Potential BMPs identified for the site ranged from small, surface conveyance and storage features (e.g., bioswale, rain garden), to highly engineered solutions (e.g., dry detention basin, subsurface infiltration chamber). We evaluated opportunities to store and infiltrate runoff in the adjacent neighborhoods. We also assessed the value and feasibility of day-lighting portions of the storm sewer system, such as in the valley below the golf course parking lot and clubhouse.

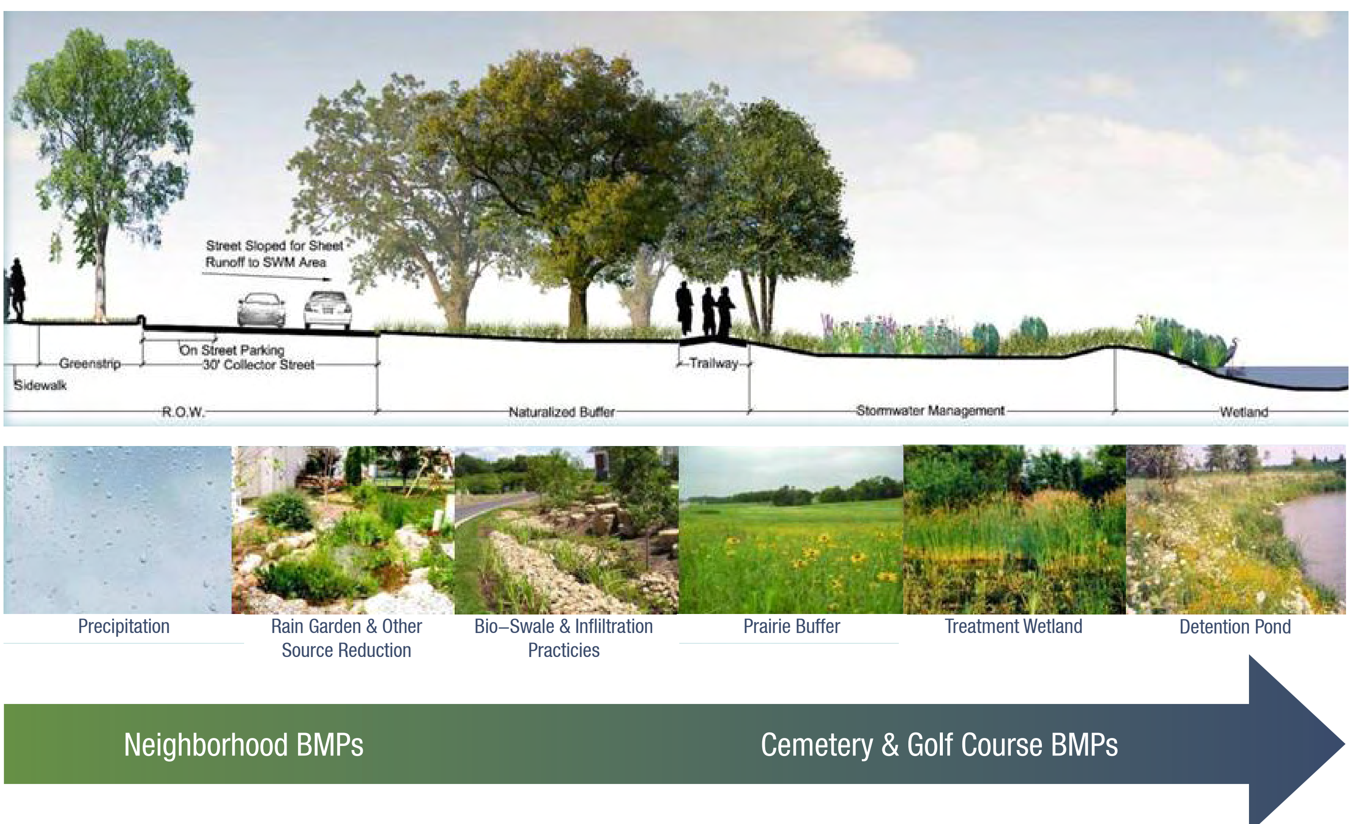
The potential projects and BMPs (Figures 7 and 8) were designed conceptually and a simple model was used to estimate volume reduction, runoff rate reduction, and sediment and nutrient reduction (Table 2). Discussions with the City and Advisory Committee led to the following potential projects.

Programmatic Projects

Three projects were identified as "programmatic" since they address drainage and erosion issues that currently interfere with cemetery and golf course operations. These projects by themselves do not address runoff volume issues, although they may address water quality and rate issues.

Cemetery North Wet Area (C-2)

In recent years, the northern portion of the cemetery has increasingly experienced drainage problems, particularly in the north-central portion of property. This area experiences intermittent surface water, which appears to be related to



Stormwater Treatment Train concept

Table 2. Estimated Reductions by BMP															
	Existing Outflows (cfs)			Proposed Outflows (cfs)			Flow Reductions (cfs)			Load Reductions (lbs/event)		Load Reductions (%)			
BMP ID	2-Year	10-Year	100-Year	2-Year	10-Year	100-Year	2-Year	10-Year	100-Year	TSS	TP	TSS	TP	Volume Reductions (cu-ft.)†	Comments
G-1	68.1	183.5	449.1	37.0	132.1	310.4	31.1	51.5	138.7	529	1.30	67	34	NA	This pond is already providing some runoff management
G-2	10.2	36.2	106.5	10.2	36.2	106.5	0.0	0.0	0.0	88	0.10	20	4	NA	
G-3	92.7	201.4	487.9	60.0	114.7	424.9	32.7	86.7	63.0	342	0.60	41	16	NA	
G-4	66.3	143.9	306.4	70.0	143.4	304.5	0.0	0.5	1.9	198	0.20	42	11	NA	
G-5	26.6	67.1	139.4	21.8	49.5	66.3	4.8	17.6	73.0	104	0.18	61	27	NA	
G-6	19.6	41.8	91.8	NA	NA	NA	N*	N*	N*	94	0.16	61	27	NA	
G-7	3.1	9.1	25.2	NA	NA	NA	N*	N*	N*	7	0.03	100	95	NA	
G-8	0.9	4.7	18.1	NA	NA	NA	N*	N*	N*	6	0.02	100	95	NA	
G-9	17.9	50.5	131.3	16.9	47.9	128.6	1.0	2.6	2.7	52	0.10	71	37	NA	
C-1	45.6	116.0	287.8	30.1	77.8	166.0	15.5	38.2	121.8	60	0.10	89	57	NA	
C-2	2.2	4.4	12.0	1.7	3.9	11.5	0.5	0.5	0.5	1	0.01	80	48	NA	
C-3	45.6	116.0	287.8	45.6	116.0	287.8	0.0	0.0	0.0	343	0.90	89	58	NA	This pond is already providing some runoff management
C-4	23.0	63.8	169.8	22.8	63.5	169.3	0.2	0.3	0.5	102.4	0.12	34.8	10.7	NA	
N-1	29.7	64.2	89.6	29.5	63.9	89.5	0.2	0.3	0.1	40	0.03	22	4	3200	Infiltration chamber
N-2	1.6	2.5	4.5	1.1	2.0	4.0	0.5	0.5	0.5	3	0.01	83	57	1040	Rain garden
N-3	2.3	3.4	5.4	1.2	1.8	3.3	1.1	1.6	2.1	16	0.06	100	94	908	Permeable paver parking lot
N-4	30.7	61.9	72.0	30.1	59.0	71.2	0.6	2.9	0.8	37	0.03	18	3	750	Rock infiltra-tion trench
N-5	10.8	22.6	48.8	10.2	17.2	20.8	0.6	5.4	28.1	26	0.03	47	16	0	Dry detention
N-6	31.5	65.7	90.0	30.9	64.5	89.5	0.6	1.2	0.5	41	0.02	22	3	2550	Infiltration chamber
N-7	2.9	6.1	13.1	1.9	4.5	8.9	1.1	1.6	4.2	11	0.03	78	52	0	Dry detention
N-8	NA	NA	NA	NA	NA	NA	NA	NA	NA	27	0.04	48	18	0	Bioswales

†Volume reductions are for each 1.25” storm. Based on 36” average rainfall, there would be approximately 29 storms per year.
NA = not analyzed
N = Negligible*

Cemetery north wet area

shallow "perched" groundwater. These conditions may be exacerbated by increasing precipitation and other factors. The wet area creates problems for cemetery use and maintenance.

The City previously developed a conceptual plan to install tile to drain shallow groundwater into a constructed pond near a proposed cemetery scattering area. While this solution may be effective, there are many outstanding questions regarding its feasibility and effect on the cemetery. The consulting team proposes an interim measure to eliminate surface water. A long-term solution requires a feasibility study to fill data gaps, explore alternatives, and devise the most cost-effective solution to address the drainage issue.

Cemetery Existing Pond (C-3)
The cemetery's existing pond is a significant landmark, amenity, and gathering place for visitors. However, the bare, concrete-strewn, and eroding shoreline is unattractive, and the turf around the perimeter is tainted by goose droppings, which adds nutrients to the pond water, leading to poor water quality and clarity.

A design involving re-grading and installation of attractive plantings along the pond perimeter would help stop erosion and reduce sediment entering the pond. Installation of a tasteful, native vegetated buffer will discourage geese from using the pond edge, thus reducing contamination from droppings. Constructing an in-pond sediment forebay where piped stormwater enters the pond would also improve pond water quality and clarity by intercepting sediment and phosphorus. This small forebay would allow easy sediment clean-out. Improvements to the pond and its surroundings should complement the site's history and aesthetics. This should entail using stone hardscaping and bench or wall materials like those in the golf course.

Golf Course Hole 3 (G-2)
For many years, the fairway of Hole 3 has been plagued by drainage problems and severe erosion. More recently, vegetation growth has narrowed the fairway. As a result, Hole 3 has become an unnecessarily difficult golf hole, with unsightly erosion, failed stabilization efforts, and hazardous conditions for players due to steep slopes and sinkholes filled with rock. These problems are largely due to runoff coming from the upper Waveland Creek watershed above this point, which is collected and routed to Hole 3 with limited volume management or rate control.

The City previously developed a stormwater routing and stabilization plan to address some of these issues; however, the estimated construction cost was prohibitive, and the City also realized that by improving management of runoff upstream, a more affordable and sustainable approach to stabilizing Hole 3 could be accomplished. With the STT approach and upstream BMPs in place, the stormwater stress placed on Hole 3 would decrease, and drainage for the fairway could be redesigned in a more cost-effective manner. This redesign would involve conveyance pipes, small ponds, and naturalized channels. Simultaneously, selective vegetation could be removed to improve the playability of the hole. Clearing of vegetation will emphasize removal of invasive, undesirable, short-lived or unhealthy trees and shrubs. Longer-lived and desirable species such as oak and hackberry will be preserved to the greatest extent possible.

Tier 1 BMPs

BMPs were grouped into three tiers. Tier 1 BMPs provide the greatest rate reduction and pollutant removal.

Cemetery Proposed SW Pond (C-1)
A small ravine, which receives runoff from the western portion of the cemetery, lies in the southwest corner of the cemetery. With the exception of a few large trees, most of the vegetation is pioneer bottomland forest trees, invasive honeysuckles (Lonicera morrowii, L. tatarica), brush, and weeds. Runoff is piped southward under University Avenue to Hole 3, entering Waveland Creek on the west side of the fairway. Pollution is evident here, and the banks are eroding. The runoff from this tributary contributes to the poor playing conditions at Hole 3.

Designing the cemetery's southwest ravine to function as a pond would allow runoff to be stored, the rate to be controlled, and pollutants to be removed. This proposed pond would not only manage cemetery runoff, but help solve problems in the Hole 3 fairway. It is also possible to redirect a small portion of the adjacent neighborhood runoff to this pond. Its design has the potential to affect the vegetation around the ravine by raising the local water table, and this effect will be taken into account in the pond design.

Golf Course Existing Pond (G-1)

The golf course's existing pond near Hole 1 is a significant landmark and amenity. However, sediment has filled much of pond, cattails now obscure the views into it, plant diversity is poor, and the outlet and spillway were constructed with unattractive gabions.

By dredging the existing basin, enlarging the pond, and re-designing the outlet, this pond would function more effectively to store runoff, manage runoff rate, and remove pollutants. Careful design will be required to protect mature oak trees near the pond and to control excavation costs. Historically appropriate stone would be used at the outlet and spillway to match stone used elsewhere in the golf course. The enlarged pond would store more water than currently, which could serve as a source for irrigation water at the golf course. Using the pond to manage stormwater and provide irrigation water has multiple benefits.

- Reduces potable water use (currently obtained from the City at no cost; however, the City anticipates needing to pay for water in the near future).
- Increases storage capacity of pond to hold runoff from upstream and to control rate downstream.
- Removes nutrients.
- Improves water quality in Waveland Creek.

Golf Course Hole 13 Proposed Ponds (G-3)

The swale south of Hole 13's tee has optimal topography to direct and manage runoff with the creation of two small stormwater ponds. The proposed ponds would intercept piped runoff from the clubhouse and from the residential neighborhood east of the golf course, collect sheet runoff from the golf course turf, control the rate of runoff entering the existing golf course pond, and remove pollutants. The pond design will need to consider the impact on play and vegetation of potentially raising the local water table.

Tier 2 BMPs

Compared with Tier 1, Tier 2 BMPs provide moderate and/or more localized runoff management.

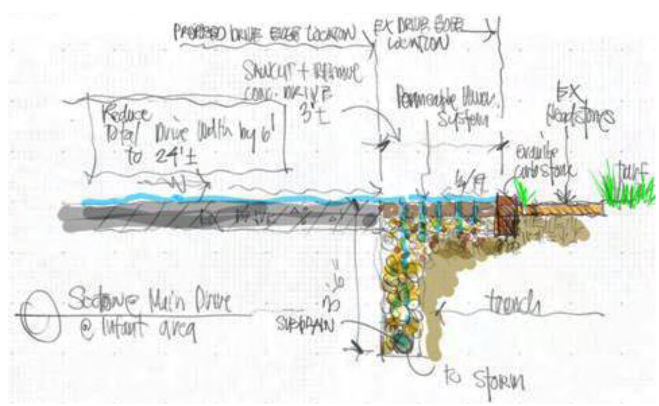
Cemetery Main Drive (C-4)

A significant portion of Glendale Cemetery's runoff flows overland to Main Drive (Figure 5). Storm debris lines in the adjacent turf, and anecdotal reports indicate that this central

Golf course existing pond

Cemetery Main Drive assessment

Unattractive gabions



Cemetery Main Drive permeable paver sketch "spine" road carries heavy runoff flows, which likely wash significant amounts of sediment and pollutants to the cemetery pond. If runoff volume could be reduced, fewer pollutants would enter the cemetery pond.

Burial plots near the road limit what can be done here. A narrow band of infiltration pavers is proposed to replace 5 feet of existing road at its edge. Runoff, especially in low flows, would infiltrate down between the pavers, accumulate in the infiltration soil, and excess water would flow into an underdrain. This underdrain could be routed to the existing stormwater pipe (beneath Main Road) or into another stormwater management BMP, such as a subsurface storage and infiltration chamber.

Golf Course NW Proposed Pond (G-5)
Constructing a pond at this location would store runoff, control runoff rate, and remove pollutants. Like the cemetery's southwest pond (C-1), this pond would not only manage upstream runoff, but help alleviate pressure on the waterway and pipes in the lower fairway of Hole 3.

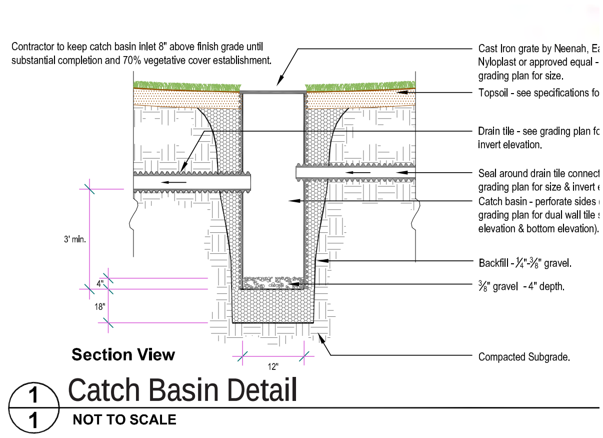
Golf Course E Proposed Pond (G-9)
Construction of a pond at this location would store runoff, control rate, and remove pollutants from runoff originating east of the golf course. Like projects C-1 and G-5, this pond would not only manage upstream runoff, but also help alleviate pressure on the Hole 3 fairway.

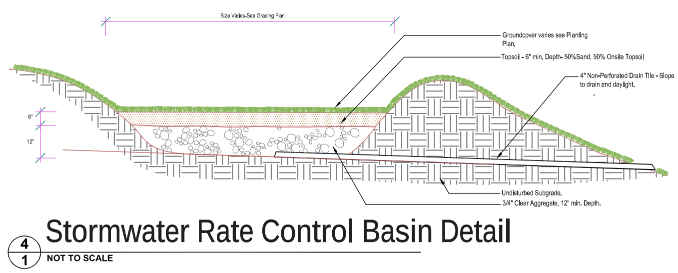
Small BMPs for Golf Course (some Tier 2 and all Tier 3 BMPs)

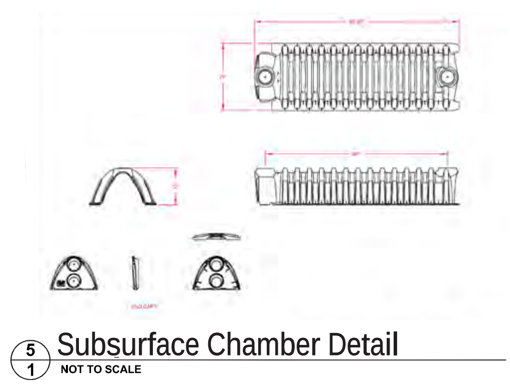
A number of small BMPs are appropriate and effective at addressing the unique needs and limitations of golf courses. These smaller BMPs have been installed at golf courses around the country and have proven to be effective if designed, installed, and maintained properly. They typically have a somewhat minimal impact on stormwater treatment, but their cost is also low compared to large scale projects. They are effective at managing runoff at small scales, particularly by helping to dry out fairways and improve playability.

Catch Basin & Tile System
Catch basin and tile systems are designed to move water from one side of the fairway to the other via underground drainage. Water sheet-flows into a shallow depression (18"-24" deep), which is typically vegetated with Kentucky bluegrass or another turf grass. The depression is usually very close to the fairway edge (and very much in play); therefore, it needs to be dry to accommodate traffic from carts and mowers. The depression is typically drained via a 12"-18" HDPE catch basin with a 4-inch drain tile. The tile runs under the cart path or fairway

Catch basin in subtle depression in rough







Small BMPs for golf course

to daylight or to another collection area or rate control basin. Dozens of opportunities exist for catch basin and tiles systems at Waveland Golf Course, and they are inexpensive to construct and maintain.

Rate Control Basin

Rate control basins are moderate-sized depressions of 1,000 to 5,000 sq ft that are placed on hillsides and in areas at the edge of play. They are typically vegetated with turf that is maintained at 2” to 4” height. These basins are often constructed in two tiers with a drain tile inlet at the bottom, which is covered with a porous material and a well-drained planting medium. These basins hold water for a brief period after rain and then dry out. This means they can be maintained with mowers. Possible locations for rate control basins at the golf course include:

- In ravine, left of Hole 3
- Right of Hole 7
- In swale left of Hole 10 green
- In swale left of Hole 15 green
- Right of Hole 14 tees

Step Pool (G-4, G-6, G-7, G-8, and others)

Eroding or poorly vegetated drainageways that experience perennial or intermittent flow can be stabilized by installing step pools. These can be built on slopes ranging from moderately steep to relatively flat, and can be integrated with other small BMPs. Several moderate-slope drainageways at the golf course could be stabilized with step pools, including:

- Left of Hole 14 fairway
- At the pond outlet right of Hole 2 fairway (this drainageway is not noticeably eroding, but step pools could be considered, if warranted and economically feasible, in combination with the re-design of the main golf course pond outlet (project G-1)

Subsurface Chambers

Subsurface chambers typically provide both storage and infiltration of runoff. These are used when an area receives significant runoff volume, but space is not enough to construct a pond or rate control basin. Possible locations at the golf course include:

- Left side of Hole 3 fairway where ravine meets the fairway edge or cart path
- Left side of Hole 9 fairway
- Right side of Hole 16 fairway

Neighborhood BMPs

The hydrologic analysis of surrounding residential neighborhoods identified numerous locations that lend themselves to effective runoff management. Neighborhood BMPs will be implemented over time by private landowners (possibly through cost-share programs) and through the City’s public works department, but only as opportunities arise. Opportunities range from obtaining a grant to install a specific BMP at a location that consistently floods, to a BMP that can be installed in collaboration with a private landowner, or as part of a road or utility upgrade.

Several stormwater BMPs appropriate for neighborhoods were identified and evaluated (indicated by orange stars in Figures 7 and 8).

- Small rain gardens (e.g., N-2)
- Permeable paver parking lot (N-3)
- Infiltration rock trench (N-4)
- Dry detention basin (N-5 and N-7)
- Bioinfiltration swales (N-8)
- Subsurface storage/infiltration chambers (N-1 and N-6)

Permeable pavers

Rain garden / street planter

ECOLOGICAL RESTORATION & MANAGEMENT

06

Ecological Restoration & Management

Benefits

Ecological conditions at Glendale Cemetery and Waveland Golf Course are like those at many public parks in the Midwest. The landscape is dominated by manicured turf, planted with scattered horticultural trees and shrubs, and harbors scattered patches of natural vegetation (Figures 3 and 4). The ecological restoration plan proposed here would yield many benefits.

- Stabilize erosion
- Enlarge and improve the condition of woodlands, wetlands, and other habitats
- Create ponds to protect water quality and improve aquatic habitat
- Improve aesthetics
- Reduce the per-acre cost of maintaining turf and grounds

Opportunities

The golf program and cemetery traditions determine where land can be restored to a more natural, lower maintenance landscape. There are, nevertheless, many locations that can be converted to native ecosystems; specifically woodland, savanna, prairie, and pond (Figures 9 and 10).

In the cemetery, restoration could enhance several degraded woodlands and savannas. Some areas not designated as burial sites could become "naturalized" plantings with shorter grasses and plantings of native wildflowers. In the golf course, areas outside the playable corridor could be converted to prairie or short grasses. Larger areas that could be naturalized are:

- Right of Hole 5
- Left of Hole 5
- South of Hole 11 green and Hole 12 tee

Existing and proposed pond shorelines could be stabilized and enhanced by ecological restoration techniques. The golf course's streams (Waveland Creek along the north side of I-235, and the tributary at the south end of Hole 3) also provide opportunities for stabilization and enhancement. Invasives removal, minor grading, erosion control techniques (e.g., soil lifts, coir blanket), installation of habitat enhancements (e.g., cross vanes in stream), and establishment of more diverse native vegetation would improve shoreline, bank, and channel stability and riparian and aquatic habitats.

Process

Ecological restoration and enhancement often entail grading, soil preparation, removal of invasive and weedy vegetation, and installation of native plants. Invasive species of central Iowa are well known, and effective management techniques have been developed for various site conditions. Species of native trees, shrubs, and herbaceous plants (i.e., grasses, sedges, wildflowers) appropriate for planting in the Des Moines region are provided in Appendix A.

While ecological restoration requires up-front investment, native landscapes are typically much less expensive to manage than turf grass and formal landscaping beds. Therefore, conversion to native landscapes can reduce maintenance costs over the long-term. For instance, three to four years after planting, the cumulative maintenance cost (plus installation) for a medium-diversity prairie is less than the maintenance costs for standard turf grass (excluding establishment costs). Over several years, the cost savings become significant. Appendix B provides general unit costs for a variety of ecological restoration and management tasks.

Stewardship

A commitment to perpetual stewardship is essential to protecting the investments made in ecological restoration and to achieving conservation goals. Stewardship requires monitoring to assess how the site is responding to management, and this information then allows for "adaptive management" to ensure efficient and effective use of City resources.

ALTERNATIVES ANALYSIS

07

Alternatives Analysis

After potential projects and BMPs were identified, the consulting team compared and ranked them in consultation with the City and the Advisory Committee. Due to the large number of potential projects, it was decided to focus the alternatives analysis on: a) programmatic projects, b) Tier I BMPs, c) select Tier II projects, and d) select neighborhood projects. Because potential neighborhood BMPs are located in the headwaters of the Waveland Creek Watershed, volume control—removing some of the water running off roofs and pavement—was the primary criterion for selecting a neighborhood project. The cemetery and golf course have more space for rate control—spreading the runoff over a longer time period—which is essential for flood and erosion control. Hence potential cemetery and golf course projects focused on rate control. Programmatic projects were also very important. All projects were analyzed for water quality performance.

Criteria for the alternatives analysis were:

- **Operational**
  - o Program Benefits - Does the proposed project improve the playability of the golf course or provide a direct economic or aesthetic benefit to the cemetery?
  - o Operations & Maintenance Cost Savings - Does the project decrease management or operational costs?
- **Hydrological**
  - o Impact - Does the proposed project result in stormwater improvements of a substantial magnitude?
  - o Opportunity - Does the proposed project represent a unique stormwater management opportunity based on its location?
  - o Priority Headwater - Does the proposed project manage runoff in a headwater sub-watershed that is in the greatest need of improvement?
- **Habitat**
  - o Habitat Benefit - Does the project improve or enlarge habitat for native plants and animals?
- **Hydrologic & Water Quality Benefit**
  - o Small Storm Protection – Degree of 2-yr flow reduction (cfs)
  - o Neighborhood Volume Control – Degree of volume reduction (cu ft)
  - o Sediment Reduction Amount – Quantity of Total Suspended Solid (TSS) load reduction (lbs/event)
  - o Nutrient Reduction Amount – Quantity of Total Phosphorus (TP) load reduction (lbs/event)
- **Cost**
  - o Opinion of Probable Cost – Calculated separately for each project
- **Cost: Benefit**
  - o Small Storm Protection – Cost of 2-yr flow reduction ($/cfs)
  - o Neighborhood Volume Control – Cost of volume reduction ($/cu ft)
  - o Sediment Reduction Amount – Cost of TSS load reduction ($/lbs/event)
  - o Nutrient Reduction Amount – Cost of TP load reduction ($/lbs/event)

The results of the November 2013 alternatives analysis are summarized in Figure 11.

WAVELAND GOLF COURSE & GLENDALE CEMETERY STORMWATER MANAGEMENT MASTER PLAN
FIGURE 11
ALTERNATIVES ANALYSIS
(based on November 2013 BMPs and OPCs)

	Operational		Hydrological			Habitat	Hydrolog	
	Program Benefits	O&M Savings	Impact	Opportunity	Priority Headwater	Habitat Benefit	Small Storm Protection	Neighl Volume
Project/ BMP	Does the proposed project improve the playability of the golf course or provide a direct economic or aesthetic benefit to the cemetery?	Does the project decrease management or operational costs?	Does the proposed project result in stormwater improvements of a substantial magnitude?	Does the proposed project represent a unique stormwater management opportunity based on its location?	Does the proposed project manage runoff in a headwater sub-watershed that is in the greatest need of improvement?	Does the project result in improved/enlarged habitat for native plants and animals?	2-yr flow reduction (cfs)	volume (c
G-1*		X	X	X		X	31.14	
G-2	X	X	X	X		X	0	
G-3			X	X		X	32.71	
G-4					X	X	0	
G-5					X	X	4.75	
G-6						X	Negligible	
G-7						X	Negligible	
G-8						X	Negligible	
G-9						X	1	
C-1	X		X	X	X	X	15.45	
C-2	X	X		X		X	0.5	
C-3*	X	X		X		X	0	
C-4	X			X			0.2	
N-1			X					
N-2						X		
N-3					X			
N-4					X			
N-5					X	X		
N-6			X		X			
N-7					X	X		
N-8					X	X		

Alternatives Analysis Matrix (only a portion shown here; complete matrix in Figure 11).

PRIORITY PROJECTS

08

Priority Projects

The alternatives analysis and discussions with City staff and the Advisory Committee led to the identification of five priority projects. Each priority project is described briefly below, and the projects are ordered based on their location in the watershed (i.e., from upstream to downstream). The consulting team prepared concept designs for the five priority projects. The concept designs consist of plan view layouts which identify major design elements and features through illustrations and text (Appendix C).

In August 2014, City staff, the Advisory Committee and consulting team visited the five priority projects. The group reviewed the projects in the field and offered suggestions for improvements. The group's opinion was that the intent and design of these projects were appropriate to their settings and the programmatic and natural resource goals that were stated at the beginning of the master planning process.

1. Cemetery Bioswales (C-2)
The historical and ongoing drainage concerns here made this project the top priority. While the impetus behind this project is effective drainage, not runoff control, it will be integrated with the other cemetery runoff management projects. As a long-term solution, the City proposed installing subsurface drainage tiles to convey water to a pond, which would be designed as a part of the cemetery's aesthetic features. Uncertainty about the surface water table elevation, its seasonal and annual fluctuations, the depth of confining layers, the hydraulic transmissivity of the soils, and the adequacy of the grades to convey water prevent this concept from being implemented in the short term. This long term solution requires a feasibility study with additional data to ensure that the solution achieves its goals at reasonable cost.

As an immediate solution to address surface water only, standing water near the Islamic cemetery will be drained by a vegetated swale. In large storms, the swale may overflow, but for 95 percent of all storms, water will drain to the swale and away from grave sites.

Maintenance of the bioswales will consist of occasional weeding or spot-spraying to remove invasive plants, and of annual haying (i.e., mowing and removal of cut vegetation). Haying should be conducted before spring green-up, usually March or April, which will allow insect eggs in dead stems to hatch and the young to disperse.

2. Cemetery Proposed Pond (C-1)
This project would achieve significant rate control for small storm runoff events. It also is highly cost-effective and reduces the volume of water reaching the lower fairway of Hole 3, where erosion is severe.

Maintenance of the proposed cemetery pond will include occasional weeding or spot-spraying of invasive plants, mostly near pond edges, and the clean-out every 5-10 years of accumulated sediment in the forebays.

3. Hole 13 Proposed Ponds (G-3)
Operating in concert with the enlarged/enhanced existing golf course pond, these two ponds will also provide significant rate control and reductions in sediment and nutrient loading. This project will also reduce runoff to the downstream Hole 3 fairway.

Maintenance near Hole 13 will require occasional weeding or spot-spraying of invasive plants, mostly near pond edges, and clean-out every 5-10 years of accumulated sediment in the forebays. Depending on how well the ponds retain water after construction, "top-off" water may need to be added to maintain the desired aesthetic look.

4. Hole 1 Pond Enlargement (G-1)
The aesthetic importance of the existing golf course pond, the opportunity for significant runoff management, and overall cost-effectiveness made this project a high priority. Enlarging and redesigning the existing golf course pond will provide significant rate control and reductions in sediment and nutrient loading, which will also reduce runoff to the downstream Hole 3 fairway.

Maintenance near Hole 1 will include occasional weeding or spot spraying of invasive plants, mostly near pond edges, and clean-out every 10-15 years of accumulated sediment. Depending on how well the enlarged pond retains water, "top-off" water may need to be added to maintain the desired aesthetic look.

5. Hole 3 Erosion Stabilization (G-2)
The significant erosion and playability issues at this location made this project the second most important to address. A combination of solutions was proposed for Hole 3: a) redesigned conveyance pipes, b) small ponds, and c) naturalized channels. The moderately steep slope and narrow width of

the fairway does not offer an opportunity for significant rate control, volume control, or water quality improvement, but it addresses the most urgent safety and playability issue at the golf course. It will require a substantial financial investment, but that investment will result in a more sustainable solution than those proposed previously, and it will significantly benefit water quality, course playability, and wildlife habitat. At the same time, this project will improve the ecological conditions in Waveland Creek and in the golf course.

Maintenance of BMPs at Hole 3 will include occasional weeding or spot-spraying of invasive plants, mostly near pond and creek banks, and the clean-out every 5-10 years of sediment accumulating in the ponds.

Estimated Peak Flow and Loading Reduction

Of the five priority projects, the two programmatic projects (C-2 and G-2) would have a negligible influence on flow rates. The three Tier 1 projects would reduce peak flow rates by an estimated 18 to 23 percent (Table 3). Implementation of the five priority projects would significantly reduce sediment and nutrient loadings to Waveland Creek (Table 4).

Neighborhood BMPs

Runoff management projects in the neighborhoods may be cost-effective and help reduce pressure on Waveland Creek, but they would not be as effective at addressing problems in the cemetery and golf course as the priority projects discussed above. Of the eight neighborhood BMP projects, two had the greatest opportunity to reduce volume:

- 48th Street subsurface storage/infiltration chamber (N-1)
- Pleasant Street subsurface storage/infiltration chamber (N-6)

Opinions of Probable Cost

Opinions of probable cost (OPCs) were developed for each of the five priority projects (Appendix D). These costs were based on the November 2013 OPCs developed as part of the alternatives analysis. Additional detail was added and the costs revised after the priority projects were finalized. Appendix E provides OPCs for other potential projects identified within the watershed. Note that all OPCs (Appendices D and E) represent preliminary costs and are based only on concept plans. OPCs do not account for major contingencies, such as disposal of contaminated soils.

Table 3. Estimated Peak Flow Reduction from 3 Tier 1 Projects

		Existing Outflows (cfs)			Proposed Outflows (cfs)			Flow Reductions		
Subwatershed	Area (ac)	2-Year	10-Year	100-Year	2-Year	10-Year	100-Year	2-Year	10-Year	100-Year
To Creek	653.4	198.0	491.7	1190.4	161.6	383.4	911.5	36.4	108.3	278.9
							Percent Reduction:	18.4%	22.0%	23.4%

Table 4. Estimated Load Reductions to Waveland Creek from 5 Priority Projects

	Proposed Load Reductions (lbs/event)		Proposed Load Reductions (%)		Increase Over Existing Removals	
Subwatershed	TSS	TP	TSS	TP	TSS	TP
To Creek	1683	3.21	61.4%	29.4%	49.8%	121.1%

Grass filter strip between road and rain garden

Prescribed burning for cost-effective management

Design for Reduced Maintenance

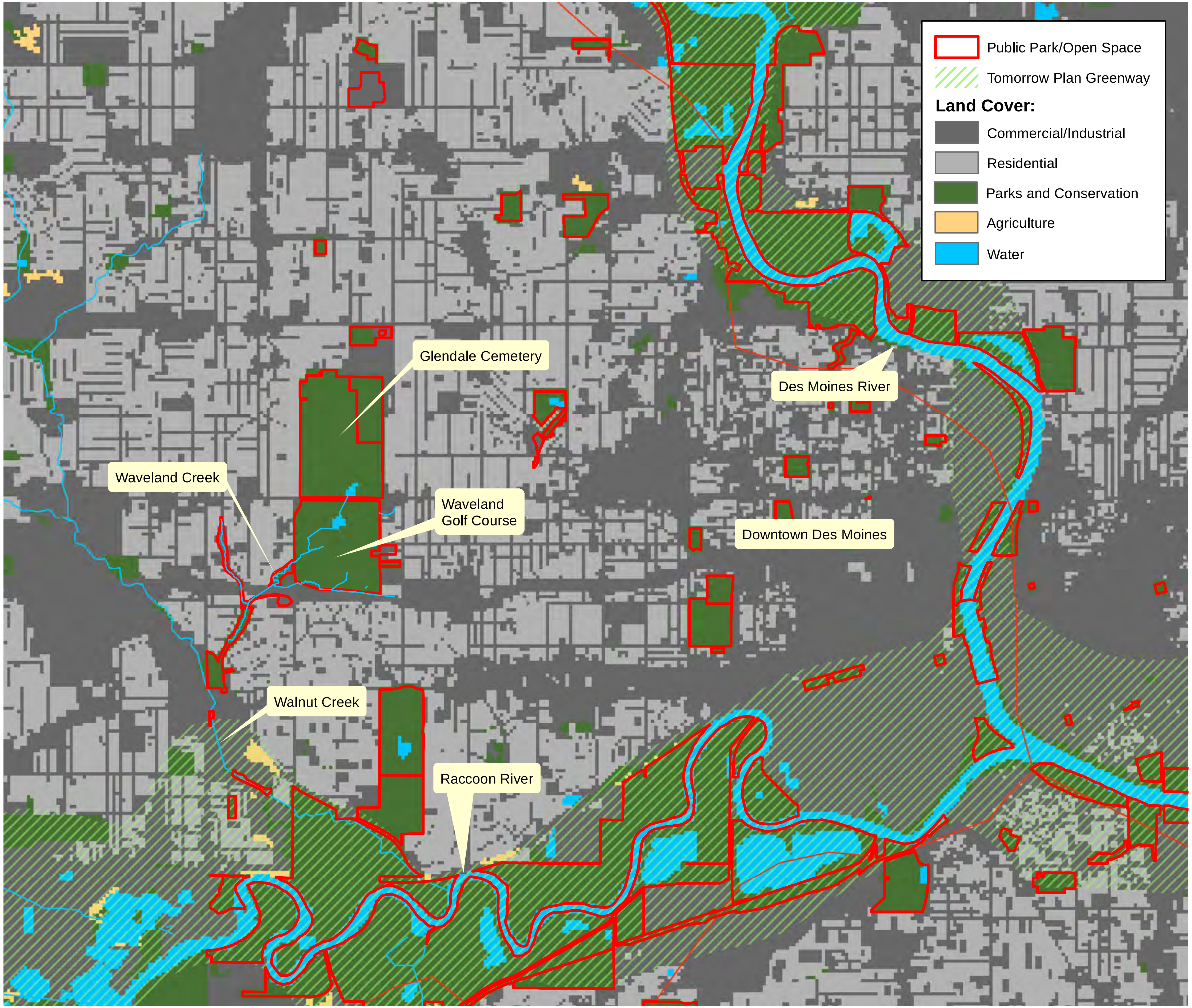
The greatest return on investment—cost to benefit—will be achieved if the above projects are designed with equal attention to ecology, hydrological engineering, and landscape architecture. By considering all these perspectives, projects will achieve multiple positive outcomes: a) improvements for users of the site, b) better runoff management, c) enhanced aesthetics, and c) better wildlife habitat.

Just as importantly, project designs should strive to reduce maintenance costs over the next 10 years below current maintenance costs. The projects themselves will help achieve that, but other actions can also reduce maintenance.

- Use forebays for efficient sediment removal from ponds
- Install filter strips between pavement or turf and the adjacent water bodies
- Install filter strips around BMPs
- Use native, drought-tolerant vegetation at locations where turf is not needed
- Reduce or eliminate mowing where taller vegetation is acceptable
- Use prescribed burning to manage vegetation in appropriate locations
- Design pond edges with narrow safety shelf followed by moderately steep underwater slopes; plant aggressive native emergent vegetation to discourage invasion/takeover by cattails

By the third or fourth year after planting native vegetation, the cumulative year-to-year cost of installing and maintaining it is less than the cumulative year-to-year cost of installing and maintaining turf. An argument against native plantings is its unkempt look. Designers deal with this by tailoring the native planting to the local situation. In developments this often means creating planting plans that are simple, uniform in height and texture, and colorful throughout the seasons. At the same time, the strength and longevity of native plantings lies in diversity—one study demonstrated that at least sixteen species from different groups of plants are needed for native plantings to withstand drought and adapt to environmental change.

FIGURES



WAVELAND GOLF COURSE & GLENDALE CEMETERY STORMWATER MANAGEMENT MASTER PLAN

FIGURE 1

SITE LOCATION MAP

AES Job Number: 12-0415
Date: 9/16/2014
File Name: Fig1_SiteLocation_2014-09-16.mxd

Data Sources:
- City of Des Moines
- USDA/NRCS National Land Cover Database (2011)

CITY OF DES MOINES

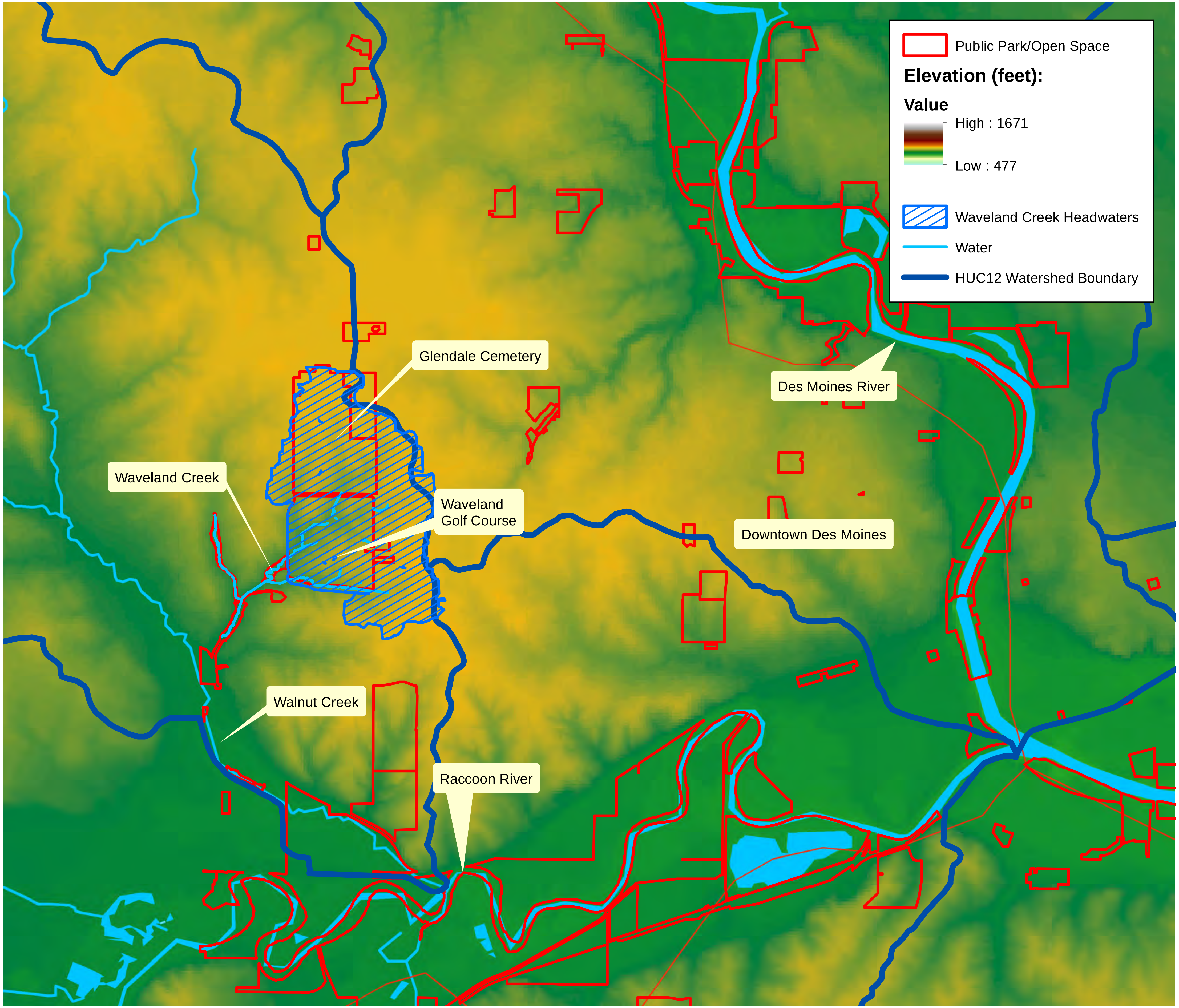
APPLIED ECOLOGICAL SERVICES

HRGreen

RDG PLANNING • DESIGN

HERFORT NORBY GOLF COURSE ARCHITECTS

0 0.25 0.5 1 Miles



WAVELAND GOLF COURSE
& GLENDALE CEMETERY
STORMWATER MANAGEMENT
MASTER PLAN

FIGURE 2

REGIONAL WATERSHEDS

AES Job Number: 12-0415
Date: 9/16/2014
File Name: Fig2_RegWtsds_2014-09-16.mxd

Data Sources:
- City of Des Moines
- USGS National Elevation Dataset (NED)
- USGS Watershed Boundary Dataset (WBD)

CITY OF DES MOINES

APPLIED ECOLOGICAL SERVICES

HRGreen

RDG PLANNING • DESIGN

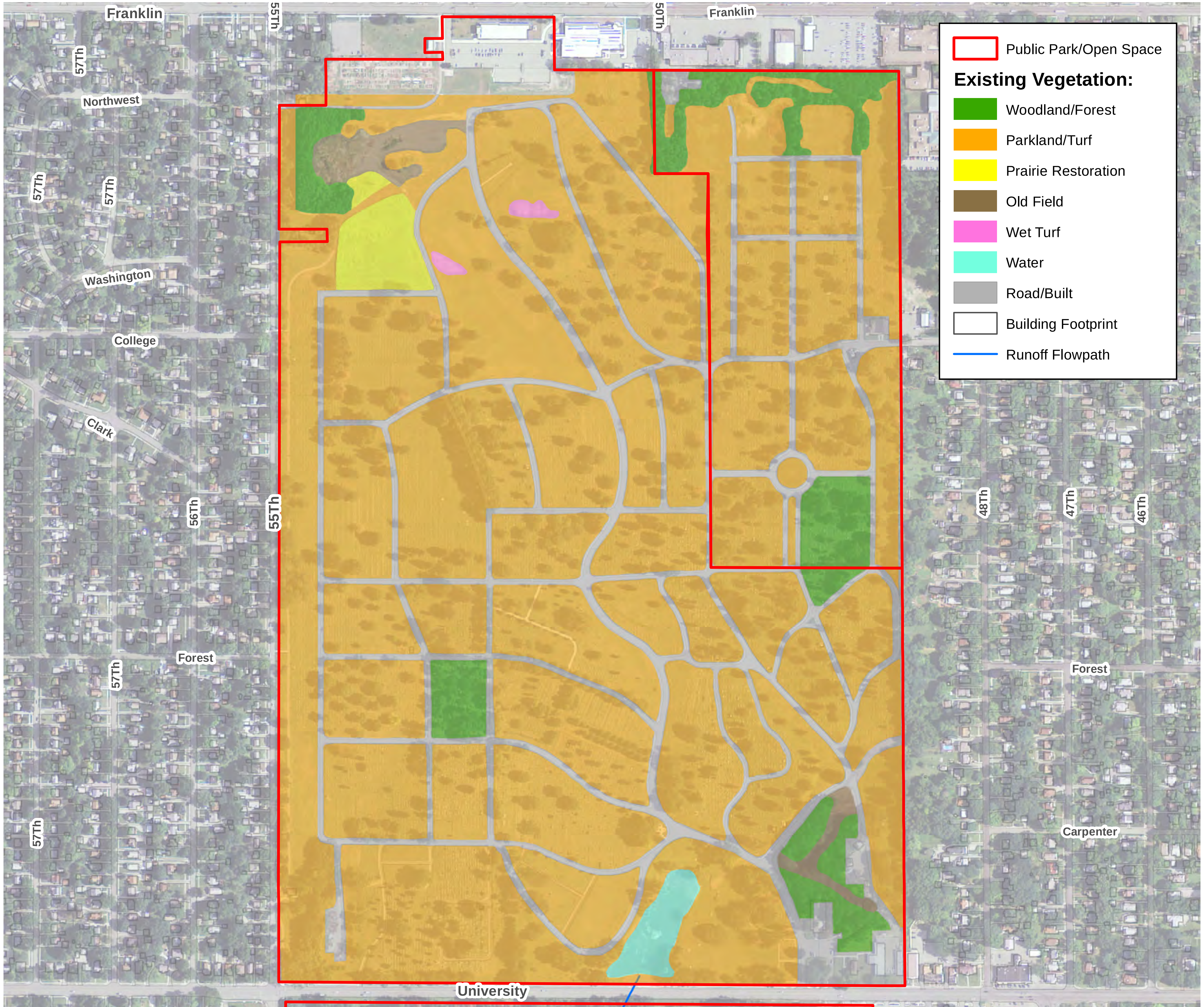
HERFORT NORBY GOLF COURSE ARCHITECTS

0 0.25 0.5 1 Miles

WAVELAND GOLF COURSE & GLENDALE CEMETERY STORMWATER MANAGEMENT MASTER PLAN

FIGURE 3

EXISTING VEGETATION – GLENDALE CEMETERY



AES Job Number: 12-0415
Date: 9/16/2014
File Name: Fig3_ExistVeg_Glendale_2014-09-16.mxd

Data Sources:
- City of Des Moines
- NAIP orthophoto (2011)
- StreetMap USA

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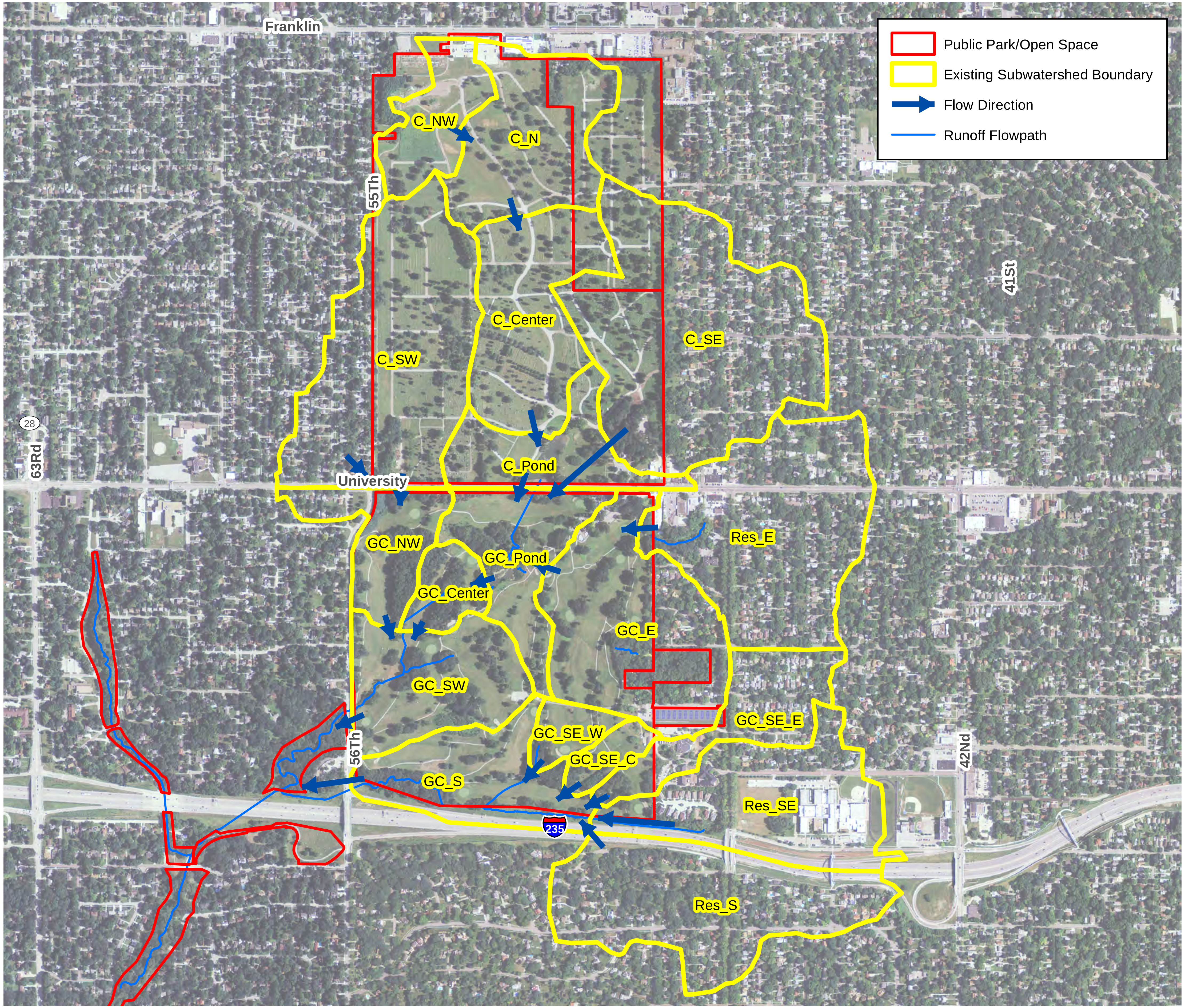
STORMWATER MANAGEMENT
MASTER PLAN

FIGURE 4

EXISTING VEGETATION –
WAVELAND GOLF COURSE

AES Job Number: 12-0415
Date: 9/16/2014
File Name: Fig4_ExistVeg_Waveland_
2014-09-16.mxd

Data Sources:
- City of Des Moines
- NAIP orthophoto (2011)
- StreetMap USA



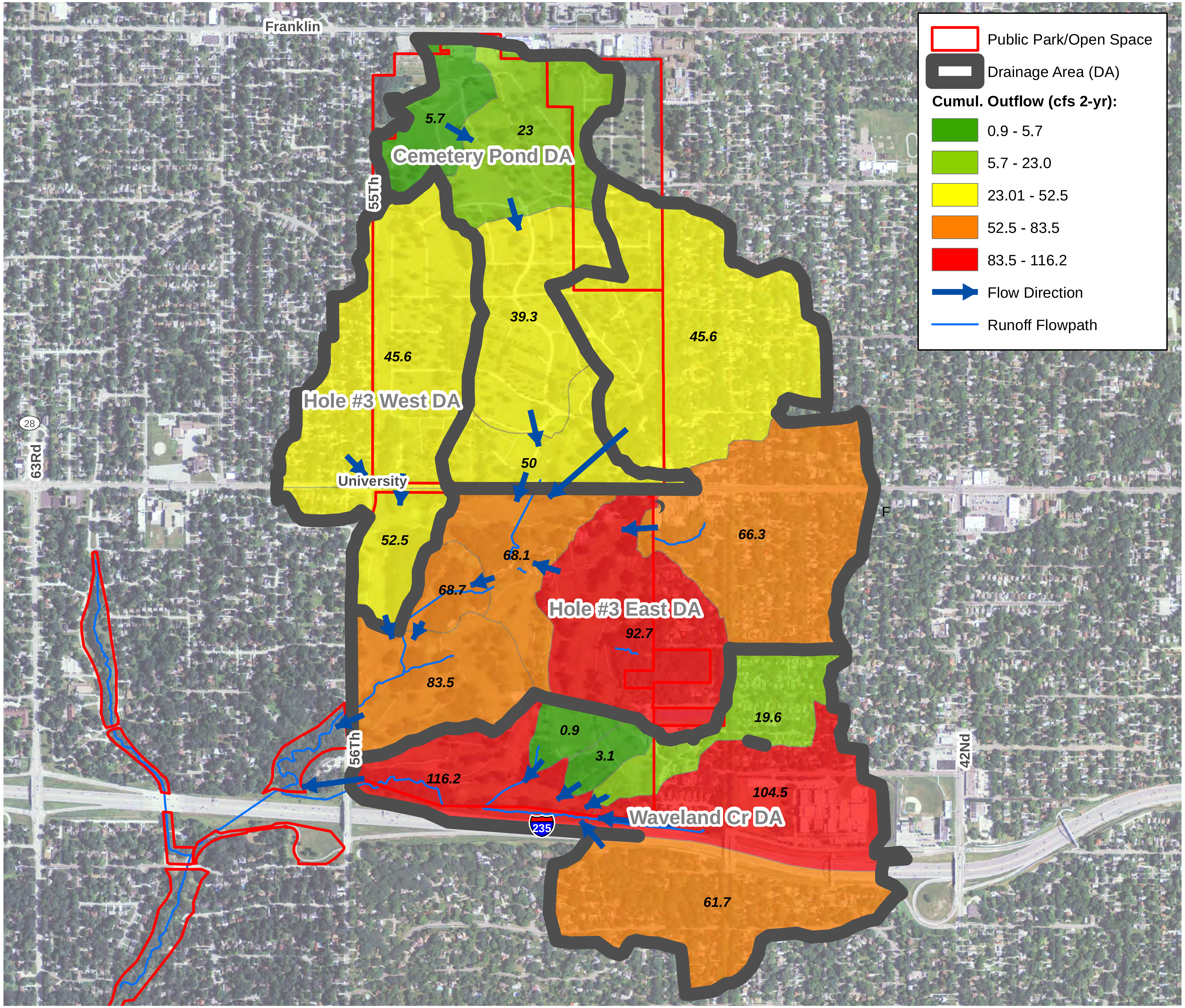
WAVELAND GOLF COURSE
& GLENDALE CEMETERY
STORMWATER MANAGEMENT
MASTER PLAN

FIGURE 5

EXISTING SITE SUBWATERSHEDS

AES Job Number: 12-0415
Date: 9/16/2014
File Name: Fig5_ExistSiteSubwtsds_
2014-09-16.mxd

Data Sources:
- City of Des Moines
- NAIP orthophoto (2011)
- StreetMap USA



WAVELAND GOLF COURSE
& GLENDALE CEMETERY
STORMWATER MANAGEMENT
MASTER PLAN

FIGURE 6

DRAINAGE AREAS AND RUNOFF RATES

AES Job Number: 12-0415
Date: 9/16/2014
File Name: Fig6_DrainageAreas_2014-09-16.mxd

Data Sources:
- City of Des Moines
- NAIP orthophoto (2011)
- StreetMap USA

CITY OF DES MOINES

APPLIED ECOLOGICAL SERVICES

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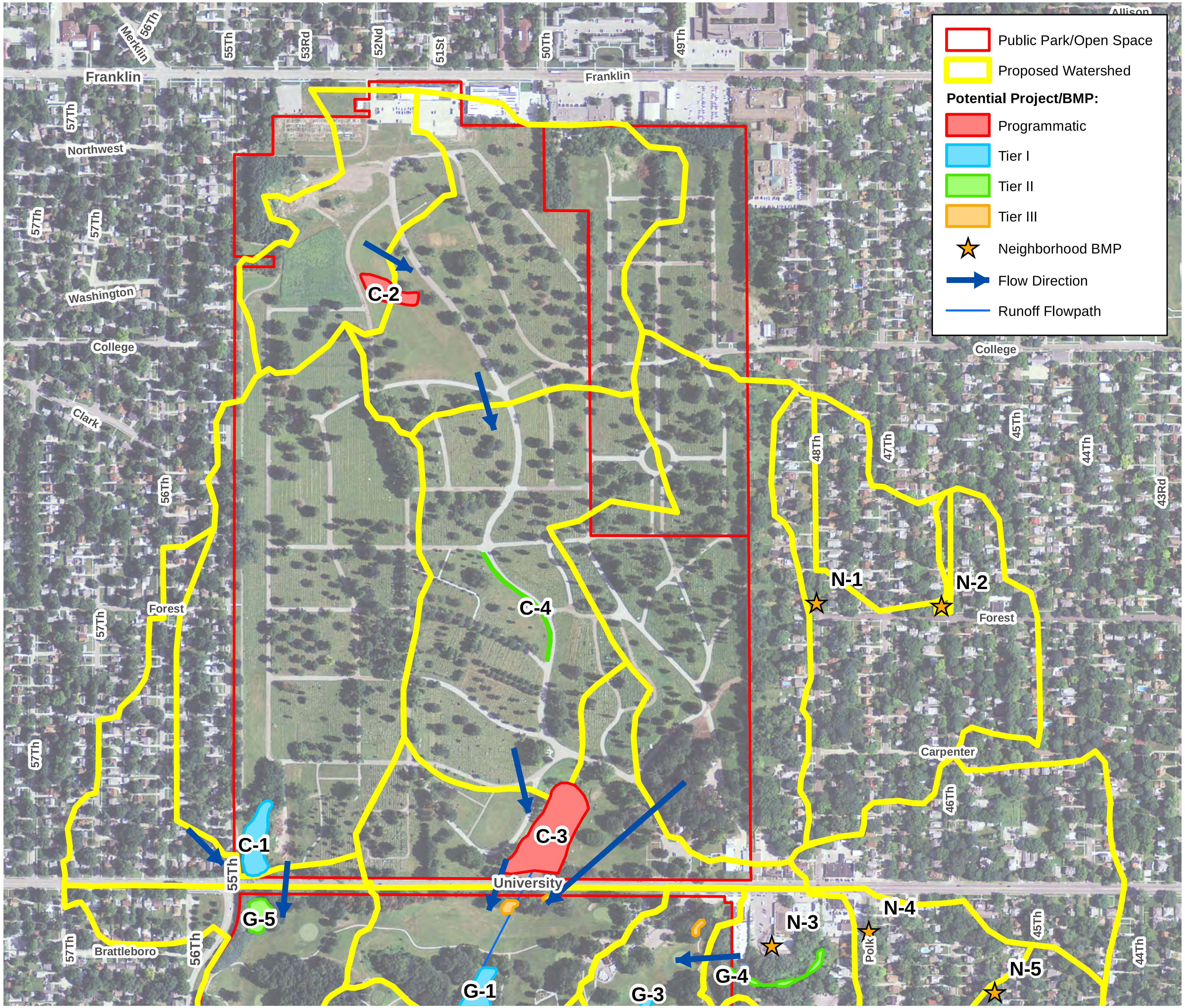


WAVELAND GOLF COURSE & GLENDALE CEMETERY STORMWATER MANAGEMENT MASTER PLAN

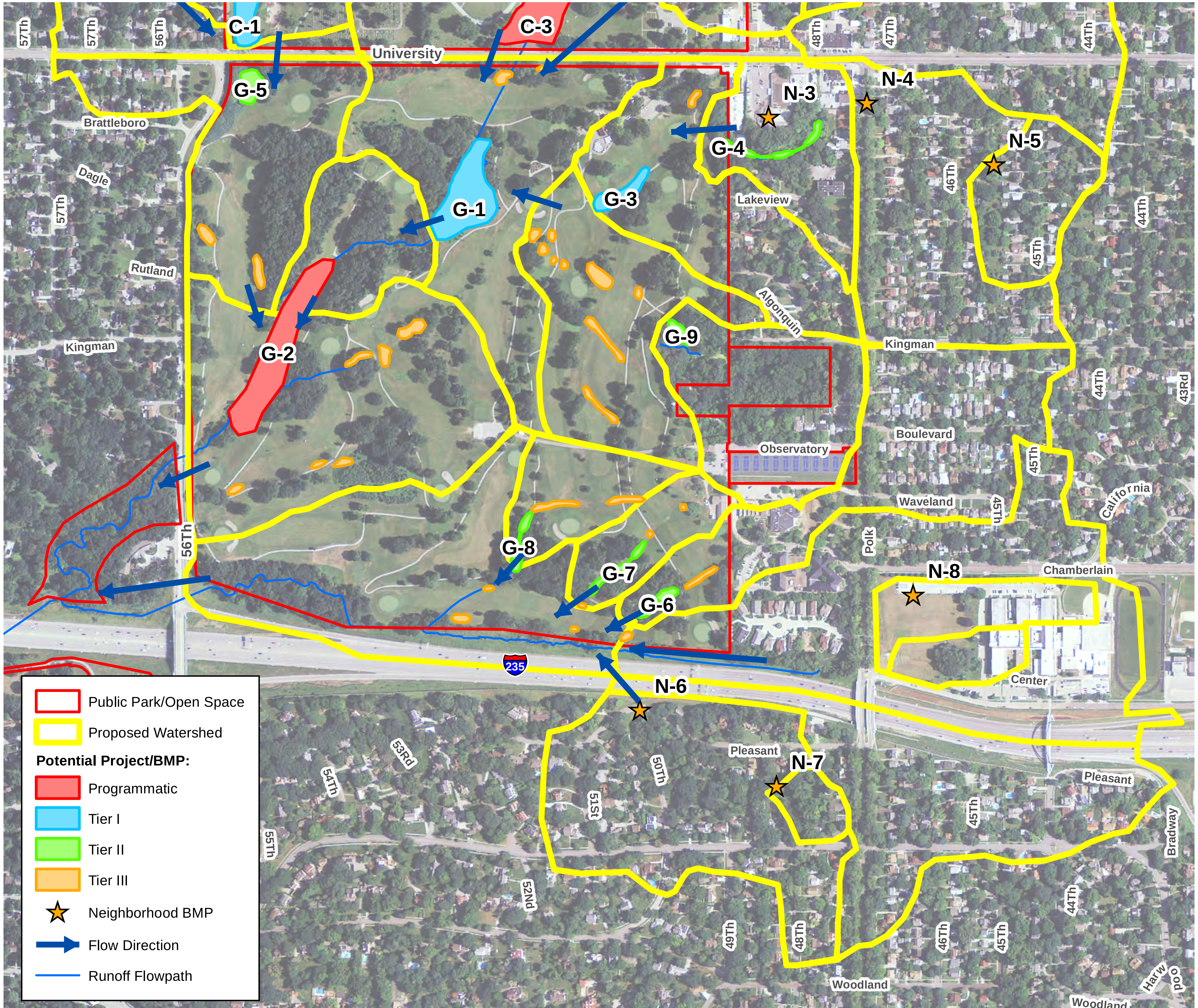
FIGURE 7

POTENTIAL PROJECT & BMP LOCATIONS – GLENDALE CEMETERY

AES Job Number: 12-0415
Date: 9/16/2014
File Name: Fig7_PotBMPs_Glendale_2014-09-16.mxd

Data Sources:
- City of Des Moines
- NAIP orthophoto (2011)
- StreetMap USA

0 245 490 980 Feet



WAVELAND GOLF COURSE & GLENDALE CEMETERY STORMWATER MANAGEMENT MASTER PLAN

FIGURE 8

POTENTIAL PROJECT & BMP LOCATIONS – WAVELAND GOLF COURSE

AES Job Number: 12-0415
Date: 9/16/2014
File Name: Fig8_PotBMPs_Waveland_2014-09-16.mxd

Data Sources:
- City of Des Moines
- NAIP orthophoto (2011)
- StreetMap USA

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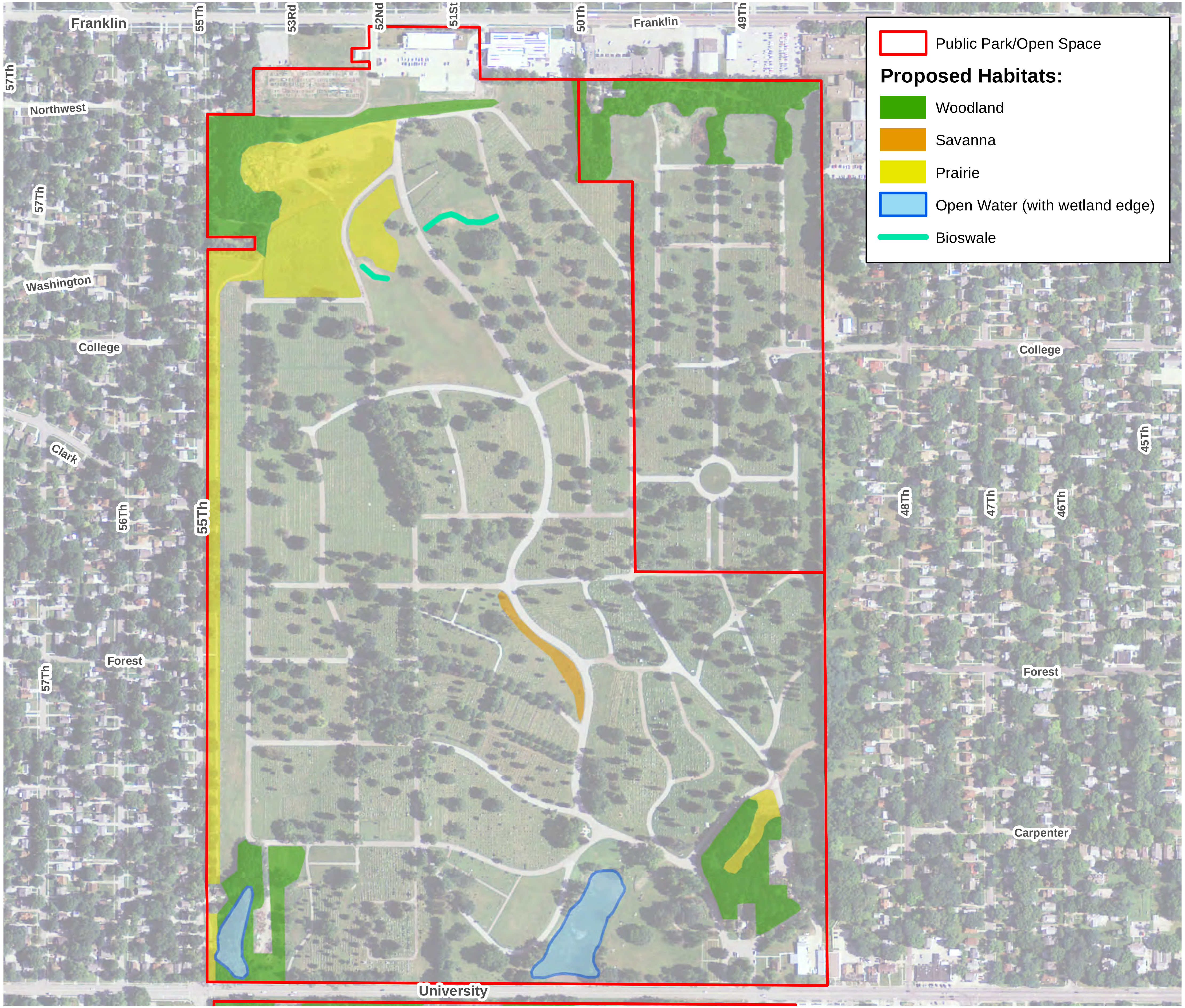
0 245 490 980
Feet



WAVELAND GOLF COURSE & GLENDALE CEMETERY STORMWATER MANAGEMENT MASTER PLAN

FIGURE 9

PROPOSED HABITATS – GLENDALE CEMETERY

AES Job Number: 12-0415
Date: 9/16/2014
File Name: Fig9_PropHabitats_Glendale_2014-09-16.mxd

Data Sources:
- City of Des Moines
- NAIP orthophoto (2011)
- StreetMap USA

CITY OF DES MOINES

APPLIED ECOLOGICAL SERVICES

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HERFORT NORBY GOLF COURSE ARCHITECTS

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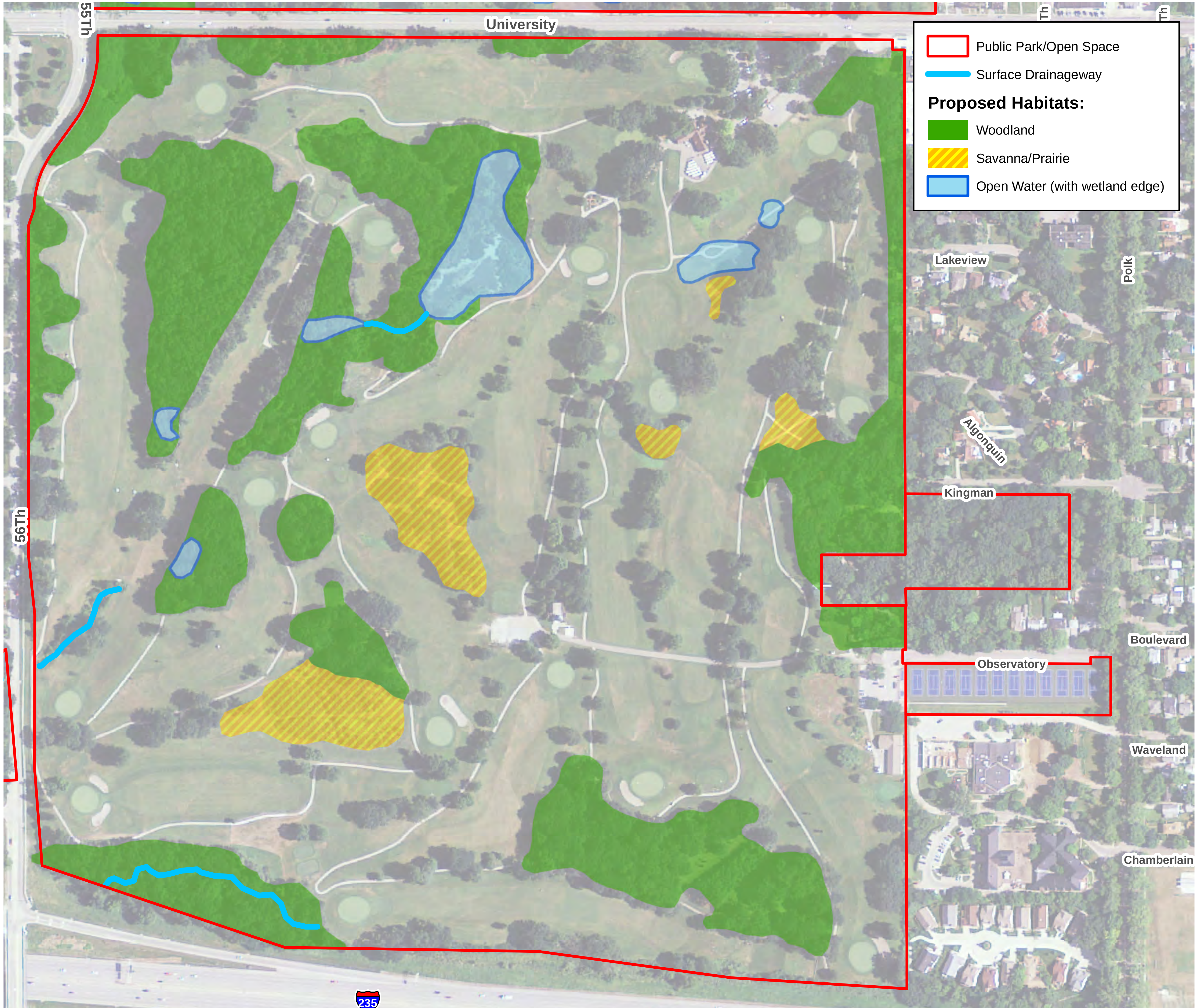


WAVELAND GOLF COURSE
& GLENDALE CEMETERY
STORMWATER MANAGEMENT
MASTER PLAN

FIGURE 10

PROPOSED HABITATS –
WAVELAND GOLF COURSE

AES Job Number: 12-0415
Date: 9/16/2014
File Name: Fig10_PropHabitats_Waveland_2014-09-16.mxd

Data Sources:
- City of Des Moines
- NAIP orthophoto (2011)
- StreetMap USA

0 150 300 600
Feet

WAVELAND GOLF COURSE & GLENDALE CEMETERY STORMWATER MANAGEMENT MASTER PLAN
FIGURE 11
ALTERNATIVES ANALYSIS
(based on November 2013 BMPs and OPCs)

	Operational		Hydrological			Habitat	Hydrologic & Water Quality Benefit				Cost	Cost:Benefit (lower $ better)			
	Program Benefits	O&M Savings	Impact	Opportunity	Priority Headwater	Habitat Benefit	Small Storm Protection	Neighborhood Volume Control	Sediment Reduction Amount	Nutrient Reduction Amount	Cost	Small Storm Protection	Neighborhood Volume Control	Sediment Reduction Amount	Nutrient Reduction Amount
Project/ BMP	Does the proposed project improve the playability of the golf course or provide a direct economic or aesthetic benefit to the cemetery?	Does the project decrease management or operational costs?	Does the proposed project result in stormwater improvements of a substantial magnitude?	Does the proposed project represent a unique stormwater management opportunity based on its location?	Does the proposed project manage runoff in a headwater sub-watershed that is in the greatest need of improvement?	Does the project result in improved/enlarged habitat for native plants and animals?	2-yr flow reduction (cfs)	volume reduction (cu ft)	TSS load reduction (lbs/event)	TP load reduction (lbs/event)	Construction Opinion of Probable Cost	2-yr flow reduction ($/cfs)	volume reduction ($/cu ft)	TSS load reduction ($/lbs/event)	TP load reduction ($/lbs/event)
G-1*		X	X	X		X	31.14		529	1.30	$ 510,700	$ 16,400		$ 970	$ 392,800
G-2	X	X	X	X		X	0		88	0.10	$ 220,100			$ 2,500	$ 2,201,000
G-3			X	X		X	32.71		342	0.60	$ 225,600	$ 6,900		$ 660	$ 376,000
G-4					X	X	0		198	0.20	$ 52,100			$ 260	$ 260,500
G-5					X	X	4.75		104	0.18	$ 105,800	$ 22,300		$ 1,020	$ 587,800
G-6						X	Negligible		94	0.16	$ 44,200			$ 470	$ 276,300
G-7						X	Negligible		7	0.03	$ 44,800			$ 6,280	$ 1,493,300
G-8						X	Negligible		6	0.02	$ 49,100			$ 8,050	$ 2,455,000
G-9						X	1		52	0.10	$ 43,300	$ 43,300		$ 830	$ 433,000
C-1	X		X	X	X	X	15.45		60	0.10	$ 140,500	$ 9,100		$ 2,330	$ 1,405,000
C-2	X	X		X		X	0.5		1	0.01	$ 151,000	$ 302,000		$ 188,800	$ 21,571,400
C-3*	X	X		X		X	0		343	0.90	$ 185,900			$ 540	$ 206,600
C-4	X			X			0.2		102	0.12	$ 92,500	$ 462,500		$ 900	$ 770,800
N-1			X					3200	40	0.03	$ 48,600		$ 15	$ 1,220	$ 1,620,000
N-2						X		1040	3	0.01	$ 11,800		$ 11	$ 3,520	$ 1,180,000
N-3					X			908	16	0.06	$ 333,700		$ 368	$ 21,250	$ 5,561,700
N-4					X			750	37	0.03	$ 36,480		$ 49	$ 1,000	$ 1,216,000
N-5					X	X		0	26	0.03	$ 22,100			$ 850	$ 736,700
N-6			X		X			2550	41	0.02	$ 42,100		$ 17	$ 1,030	$ 2,105,000
N-7					X	X		0	11	0.03	$ 36,000			$ 3,280	$ 1,200,000
N-8					X	X			27	0.04	$ 31,700			$ 1,180	$ 792,500

* The existing golf course pond (G-1) and cemetery pond (C-3) are already providing some stormwater management functions; however, significant enlargement is proposed for the golf course pond, and both ponds are proposed for enhancement.

= best results for the column's criteria

APPENDIX A

Native Species for Ecological Restoration

Native Canopy Trees		
Common Name	Scientific Name	Notes
Black Maple	*Acer nigrum*	
Red Maple	*Acer rubrum*	
Sugar Maple	*Acer saccharum*	
Ohio Buckeye	*Aesculus glabra*	
River Birch	*Betula nigra*	
Shagbark Hickory	*Carya ovata*	
Hackberry	*Celtis occidentalis*	
Honeylocust	*Gleditsia triacanthos*	
Kentucky Coffee-tree	*Gymnocladus dioica*	use male species if desired
Black Walnut	*Juglans nigra*	
Eastern Red Cedar	*Juniperus virginiana*	evergreen
Eastern White Pine	*Pinus strobus*	evergreen
Eastern Cottonwood	*Populus deltoides*	use male species if desired
Quaking Aspen	*Populus tremuloides*	
Black Cherry	*Prunus serotina*	
White Oak	*Quercus alba*	
Swamp White Oak	*Quercus bicolor*	
Bur Oak	*Quercus macrocarpa*	
Black Willow	*Salix nigra*	wet areas
Eastern White Cedar	*Thuja occidentalis*	evergreen
Basswood	*Tilia americana*	

Native Understory Trees and Shrubs			
Common Name	Scientific Name	Form	Notes
Low Serviceberry	*Amelanchier humilis*	Shrub	
Black Chokeberry	*Aronia melanocarpa*	Shrub	
American Hornbeam	*Carpinus caroliniana*	Short Tree	
Pagoda Dogwood	*Cornus alternifolia*	Shrub	
Gray Dogwood	*Cornus racemosa*	Shrub	
Red-twig Dogwood	*Cornus sericea*	Shrub	
American Hazelnut	*Corylus americana*	Shrub	
Fireberry Hawthorn	*Crataegus chrysocarpa*	Short Tree	
Witch Hazel	*Hamamelis virginiana*	Shrub	
Ironwood	*Ostrya virginiana*	Short Tree	
Ninebark	*Physocarpus opulifolius*	Shrub	
Wild Plum	*Prunus americana*	Shrub	
Chokecherry	*Prunus virginiana*	Shrub	
Smooth Sumac	*Rhus glabra*	Shrub	
Smooth Rose	*Rosa blanda*	Shrub	
Pussy willow	*Salix discolor*	Shrub	wet areas
Prairie Willow	*Salix humilis*	Shrub	
American Black Elderberry	*Sambucus nigra ssp canadensis*	Shrub	
Nannyberry	*Viburnum lentago*	Shrub	
Highbush Cranberry	*Viburnum opulus var. americanum (trilobum)*	Shrub	

Native Mesic Prairie Seed Mix *(based on Grays Lake Outlet "Sloped Edges" mix)*			
Common Name	Scientific Name	oz/ac	Notes
Big Bluestem	*Andropogon gerardii*	4	tall
Drummond's Aster	*Aster drummondii*	2	
Smooth Blue Aster	*Aster laevis*	2	
Calico Aster	*Aster lateriflorus*	0.5	
New England Aster	*Aster novae-angliae*	1	
Canadian Milk Vetch	*Astragalus canadensis*	8	
Tall Bellflower	*Campanula americana*	0.5	
Plains Oval Sedge	*Carex brevior*	3	
Brown Fox Sedge	*Carex vulpinoidea*	2	wet areas
Partridge Pea	*Cassia fasciculata*	16	nitrogen-fixing annual
Tall Coreopsis	*Coreopsis tripteris*	2	
Canada Wild Rye	*Elymus canadensis*	16	
Rattlesnake Master	*Eryngium yuccifolium*	4	
Cream Gentian	*Gentiana flavida*	2	
Early Sunflower	*Heliopsis helianthoides*	16	
Prairie Alumroot	*Heuchera richardsonii*	0.1	
Wild Bergamot	*Monarda fistulosa*	2	
Common Evening Primrose	*Oenothera biennis*	2	
Switch Grass	*Panicum virgatum*	8	
Slender Mountain Mint	*Pycnanthemum tenuifolium*	0.5	
Yellow Coneflower	*Ratibida pinnata*	4	
Black-eyed Susan	*Rudbeckia hirta*	4	
Sweet Black-eyed Susan	*Rudbeckia subtomentosa*	4	
Brown-eyed Susan	*Rudbeckia triloba*	4	tall
Early Figwort	*Scrophularia lanceolata*	0.5	
Late Figwort	*Scrophularia marilandica*	1	
Rosin Weed	*Silphium integrifolium*	8	
Stiff Goldenrod	*Solidago rigida*	1	
Germander	*Teucrium canadense*	4	
Ohio spiderwort	*Tradescantia ohiensis*	4	
Culver's Root	*Veronicastrum virginicum*	0.25	
Golden Alexanders	*Zizia aurea*	8	

Native Wet Prairie/Wet Meadow Seed Mix *(based on Grays Lake Outlet "Bottom" mix)*			
Common Name	Scientific Name	oz/ac	Notes
Swamp Milkweed	*Asclepias incarnata*	8	
New England Aster	*Aster novae-angliae*	0	
American Slough Grass	*Beckmannia syzigachne*	1	
Blue Joint Grass	*Calamagrostis canadensis*	0.5	
Small Yellow Fox Sedge	*Carex annectens xanthocarpa*	1	
Crested Oval Sedge	*Carex cristatella*	1	
Lance-fruited Oval Sedge	*Carex scoparia*	2	
Common Fox Sedge	*Carex stipata*	2	
Brown Fox Sedge	*Carex vulpinoidea*	2	
Virginia Wild Rye	*Elymus virginicus*	16	
Cinnamon Willow Herb	*Epilobium coloratum*	0.5	
Joe Pye Weed	*Eupatorium maculatum*	1	tall
Boneset	*Eupatorium perfoliatum*	0.5	
Fowl Manna Grass	*Glyceria striata*	1	
Sneezeweed	*Helenium autumnale*	1	
Torrey's Rush	*Juncus torreyi*	0.1	
Prairie Blazing Star	*Liatris pycnostachya*	8	
Cardinal Flower	*Lobelia cardinalis*	0.25	short-lived perennial
Great Blue Lobelia	*Lobelia siphilitica*	0.5	
Water Horehound	*Lycopus americanus*	1	
Prairie Loosestrife	*Lysimachia quadriflora*	1	
Winged Loosestrife	*Lythrum alatum*	0.05	
Wild Mint	*Mentha arvensis*	0.25	
Obedient Plant	*Physostegia virginiana*	2	
Fowl Bluegrass	*Poa palustris*	1	
Mountain Mint	*Pycnanthemum virginianum*	1	
Dark-green Bulrush	*Scirpus atrovirens*	0.5	
Great Bulrush	*Scirpus validus*	1	very wet areas
Grass-leaved Goldenrod	*Solidago graminifolia*	0.5	
Ohio Goldenrod	*Solidago ohioensis*	1	
Cord Grass	*Spartina pectinata*	8	
Culver's Root	*Veronicastrum virginicum*	0.1	

Native Bioswale Seed Mix			
Common Name	Scientific Name	Height (in)	lbs/acre
Graminoids			
Fringed Brome	*Bromus ciliatus*	24-48	1.21
Bluejoint	*Calamagrostis canadensis*	24-60	0.16
Fox Sedge	*Carex vulpinoidea*	36	0.61
Virginia Wild Rye	*Elymus virginicus*	48	5.45
Tall Manna Grass	*Glyceria grandis*	48-60	0.18
Fowl Manna Grass	*Glyceria striata*	36	0.16
Dark Green Bulrush	*Scirpus atrovirens*	60	0.12
Prairie Cordgrass	*Spartina pectinata*	48-120	1.44
		Total Graminoids	9.32

Forbs			
Canada Anemone	*Anemone canadensis*	12-24	0.95
Swamp Milkweed	*Asclepias incarnata*	21-48	1.27
Flat-Topped Aster	*Aster umbellatus*	40-72	0.27
Common Boneset	*Eupatorium perfoliatum*	36-60	0.17
Grass-Leaved Goldenrod	*Euthamia graminifolia*	24	0.10
Autumn Sneezeweed	*Helenium autumnale*	24-36	0.20
Great Blazing Star	*Liatris pycnostachya*	24-48	0.97
Great Lobelia	*Lobelia siphilitica*	12-48	0.09
Virginia Mountain Mint	*Pycnanthemum virginianum*	12-36	0.15
Red-Stemmed Aster	*Aster puniceus*	60	0.27
Blue Vervain	*Verbena hastata*	24-72	0.31
Golden Alexanders	*Zizia aurea*	12-36	1.21
		Total Forbs	5.97

APPENDIX

B

General Ecological Restoration and Management Unit Costs

Generalized Ecological Restoration and Management Unit Costs

Planning and implementing ecological restoration and management projects requires an understanding of cost. While there are many variables that can significantly influence unit costs (e.g., size of area being addressed, existing site conditions, slopes), the following generalized costs are provided for early planning purposes.

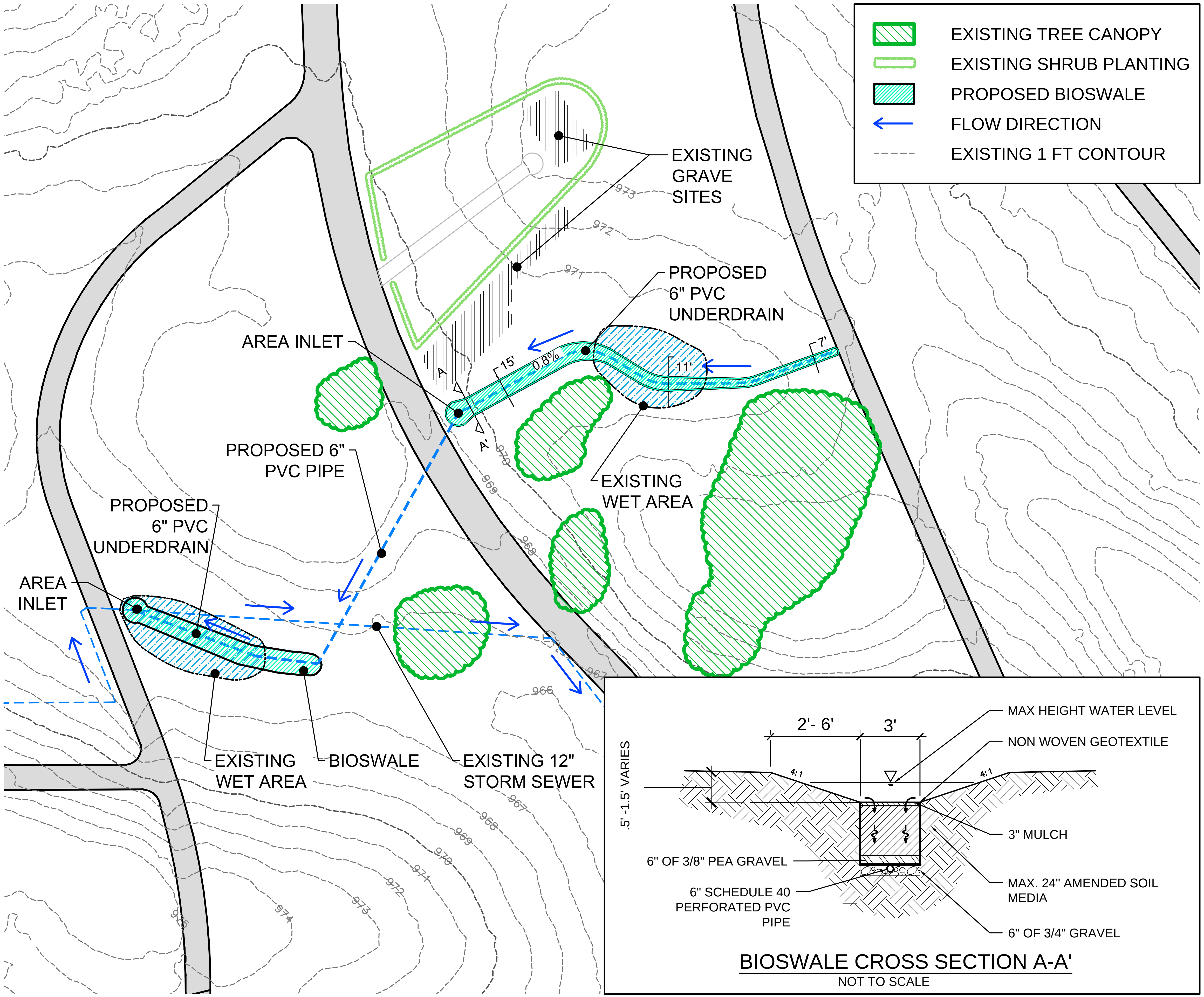
Generalized Ecological Restoration and Management Unit Costs		
Task	Unit	Unit Cost Range
Brushing (cut and stump treat)	acre	$1,500-$3,500
Foliar spray young woody brush	acre	$200-400
Broadcast herbicide	acre/trip	$175-300
Spot herbicide	acre/trip	$200-400
Mowing	acre/trip	$150-350
Prescribed burn (min. 3 ac)	acre	$300-700
Tilling	acre	$150-350
Native seed (material only)	acre	$200-$1,100
Native seeding (no-till drill, labor only)	acre	$200-500
Native seeding (hand-broadcast, labor only)	acre	$300-600
Straw mulch (spread and crimp)	acre	$600-900
Installed live herbaceous plant plug	each	$3-7
Installed shrub (#2)	each	$25-40
Installed tree (#10, 2" B&B)	each	$150-250, $300-600
Ecological monitoring & reporting	year	$2,500-$6,000

Restoring native plant communities typically requires a moderate initial investment – more than simply seeding with cool-season grasses. However, proper installation and management of native plant communities can actually reduce considerably the long-term maintenance costs. Many variables influence the return on investment, but many native landscapes can begin to save landowners money within approximately 2 to 5 years.

APPENDIX

C

Concept Plans for Priority Projects



WAVELAND GOLF COURSE & GLENDALE CEMETERY STORMWATER MANAGEMENT MASTER PLAN

CONCEPT PLAN

CEMETERY BIOSWALES

September 2014

CITY OF DES MOINES

APPLIED ECOLOGICAL SERVICES

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HERFORT NORBY GOLF COURSE ARCHITECTS

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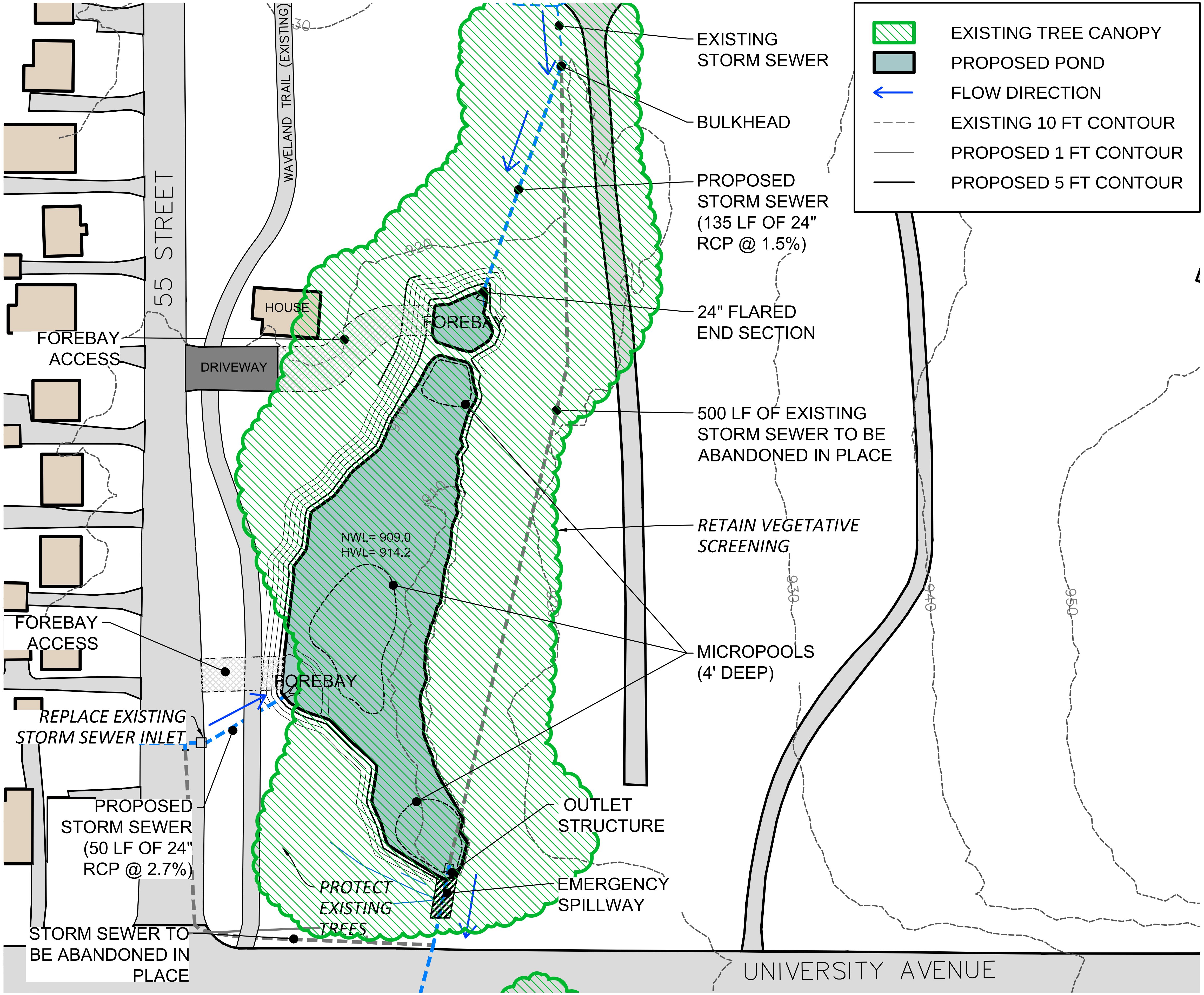

WAVELAND GOLF COURSE
& GLENDALE CEMETERY
STORMWATER MANAGEMENT
MASTER PLAN

CONCEPT PLAN

CEMETERY PROPOSED POND

September 2014

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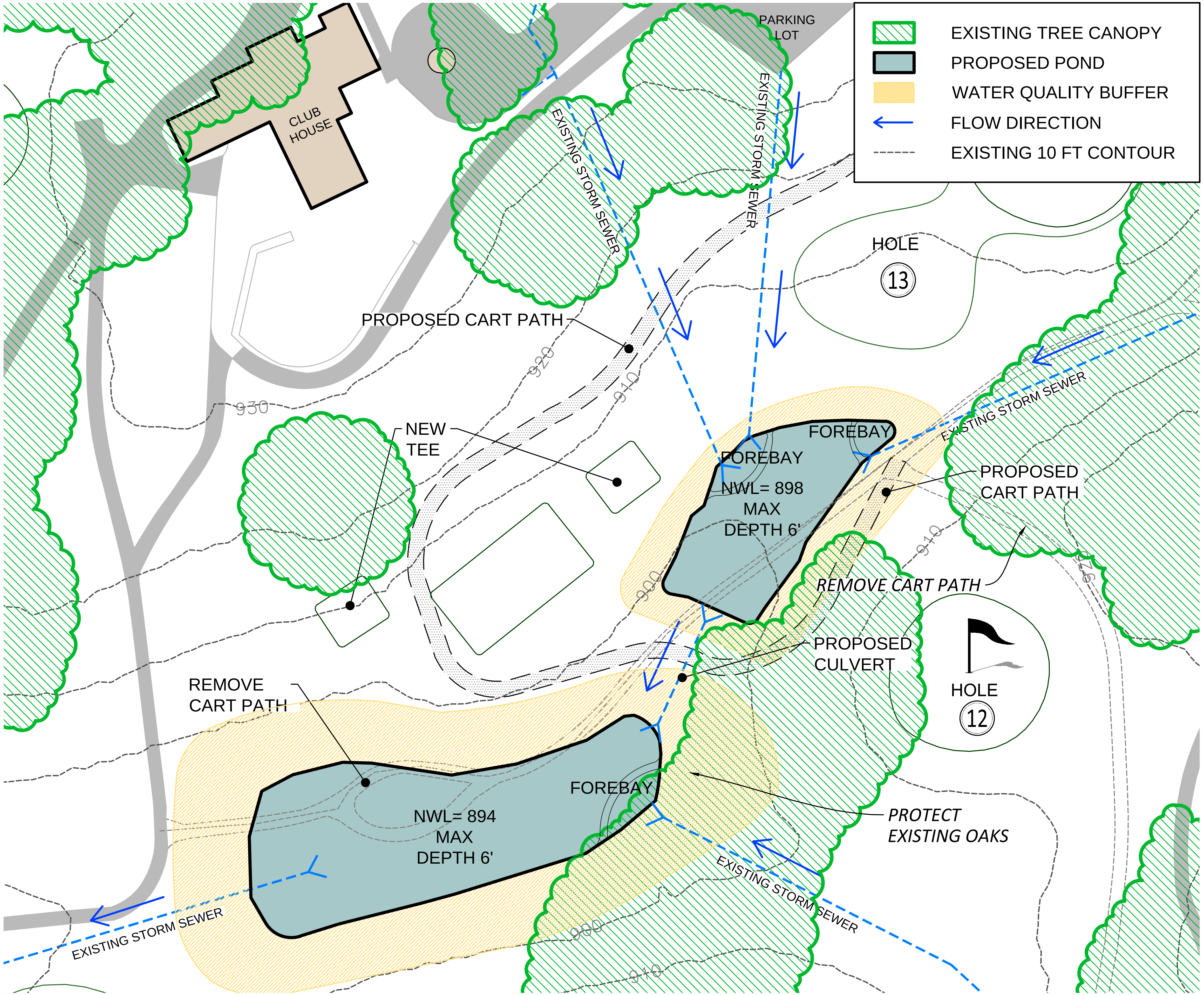
HERFORT NORBY GOLF COURSE ARCHITECTS



WAVELAND GOLF COURSE
& GLENDALE CEMETERY
STORMWATER MANAGEMENT
MASTER PLAN

CONCEPT PLAN

HOLE 13
PROPOSED PONDS

September 2014

CITY OF DES MOINES

APPLIED ECOLOGICAL SERVICES

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HERFORT NORBY GOLF COURSE ARCHITECTS

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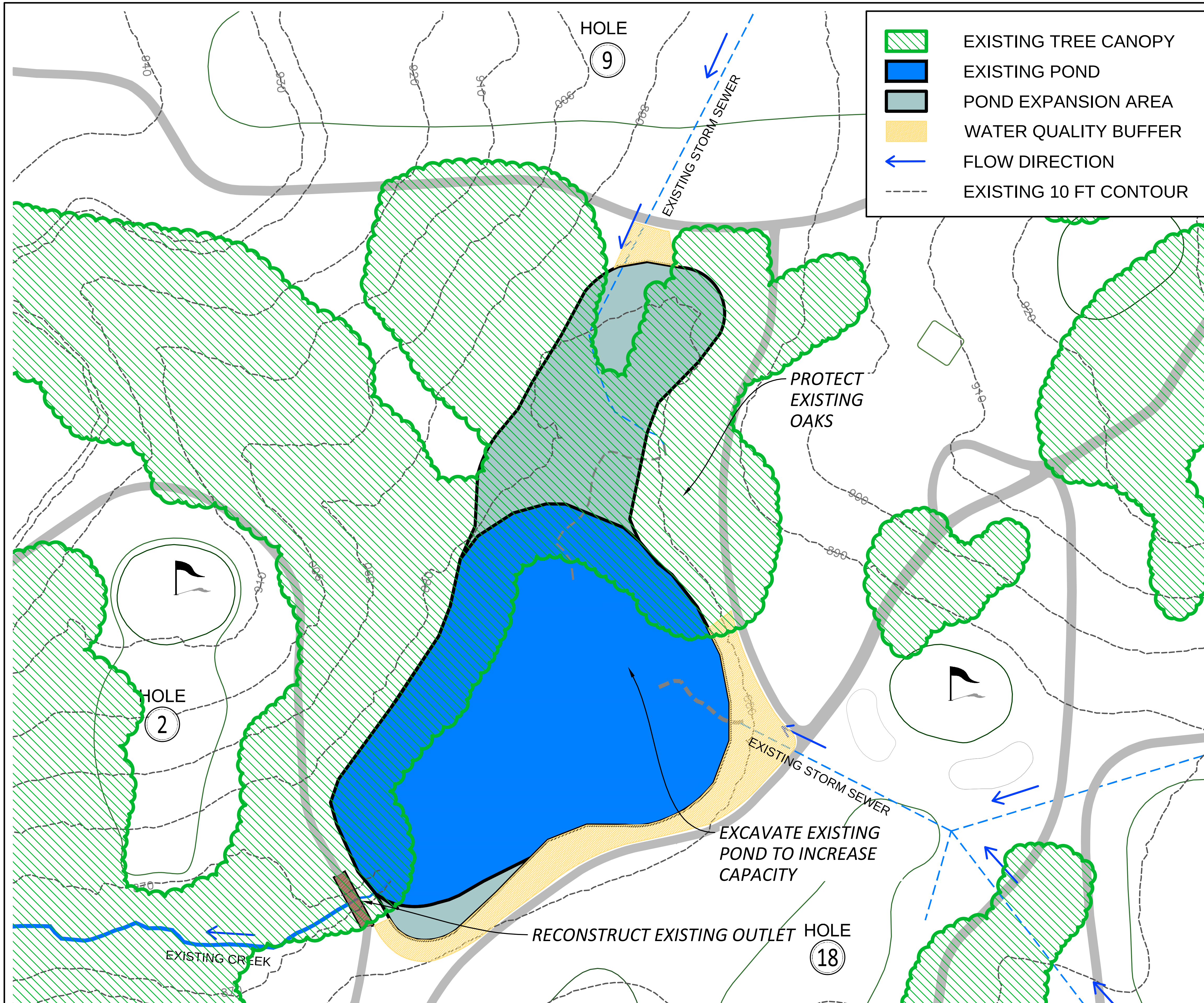
1" =50'



WAVELAND GOLF COURSE
& GLENDALE CEMETERY
STORMWATER MANAGEMENT
MASTER PLAN

CONCEPT PLAN

HOLE 1
POND ENLARGEMENT

September 2014

CITY OF DES MOINES

APPLIED ECOLOGICAL SERVICES

HRGreen

RDG PLANNING • DESIGN

HERFORT NORBY GOLF COURSE ARCHITECTS

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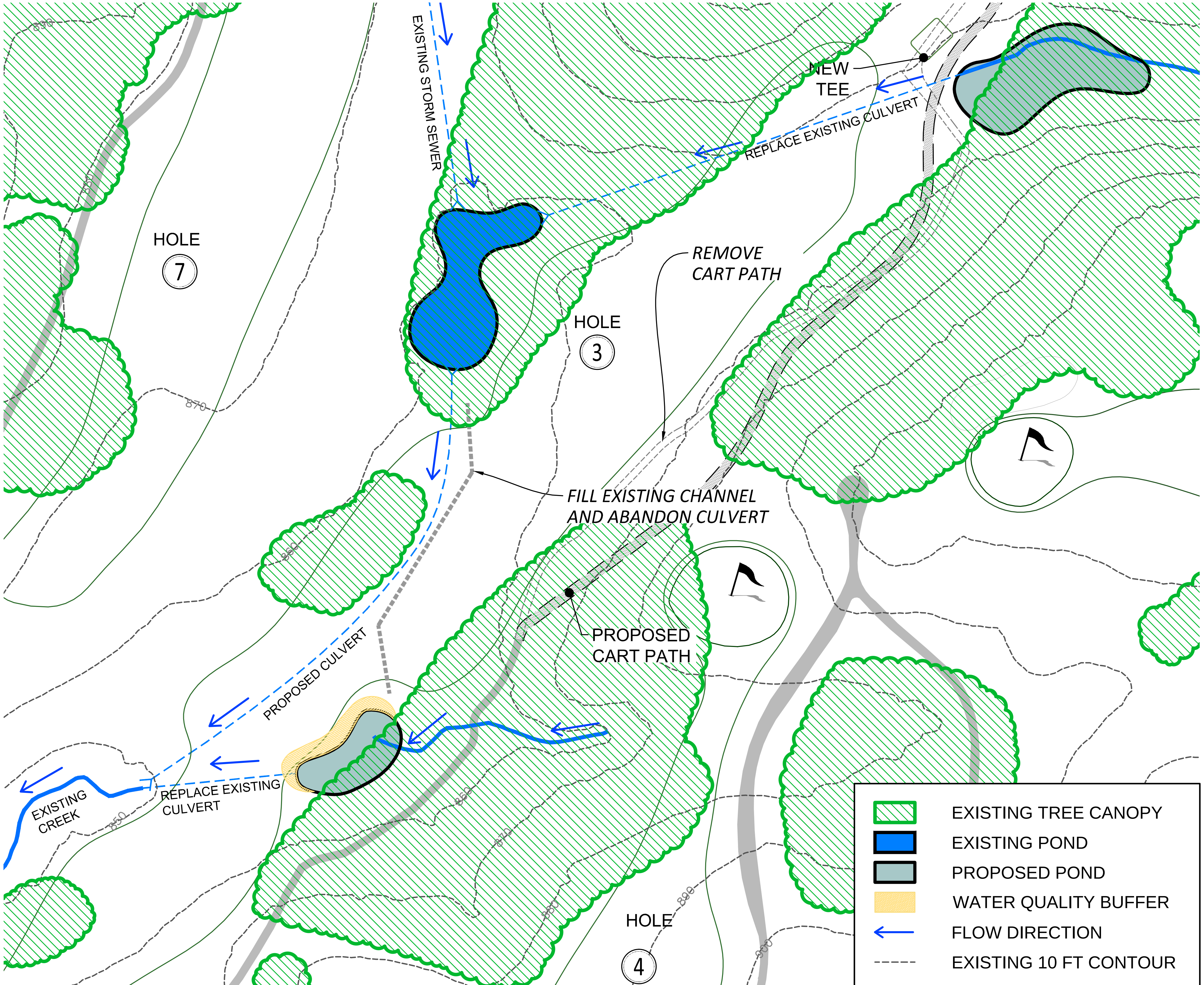

WAVELAND GOLF COURSE
& GLENDALE CEMETERY
STORMWATER MANAGEMENT
MASTER PLAN

CONCEPT PLAN

HOLE 3
EROSION STABILIZATION

September 2014

0 50 100 200 FEET
1:80

APPENDIX

D

Opinions of Probable Cost for Priority Projects

APPENDIX D

Opinions of Probable Cost for Priority Projects

Cemetery Bioswales (C-2)				
Estimated Construction & Initial Management Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
Overall				
mobilization	1	LS	$ 6,000	$ 6,000
erosion control	1	LS	$ 900	$ 900
common excavation/grading	371	CY	$ 15	$ 5,600
native seeding	0.12	AC	$ 8,000	$ 1,000
Bioswale/Hydrology				
connection to exiting inlet	1	EA	$ 1,200	$ 1,200
amended soil media	98	CY	$ 55	$ 5,400
area inlet	2	EA	$ 500	$ 1,000
6" gravel	49	CY	$ 50	$ 2,400
6" PVC underdrain pipe	439	LF	$ 10	$ 4,400
6" PVC pipe	273	LF	$ 10	$ 2,700
Vegetation Establishment				
watering & weeding (first 3 growing seasons)	6	EA	$ 300	$ 1,800
			Subtotal	$ 32,400
			Contingency (20%)	$ 6,500
			Total Estimated Construction & Initial Management Cost	**$ 38,900**
			Estimated Other Project Costs* (30%)	**$ 11,700**
			Total Estimated Cost	**$ 50,600**

* Other project costs include final design, construction documents, bid package, permitting, permit fees, construction management and oversight, and monitoring of performance standards.

Estimated Annual O&M Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
weeding/invasive control	2	EA	$ 75	$ 150
mow & remove clippings	1	EA	$ 150	$ 150
inspect/repair	1	EA	$ 50	$ 50
			Subtotal	$ 350
			Contingency (20%)	$ 70
			Total Estimated Annual O&M Costs	**$ 420**

APPENDIX D
Opinions of Probable Cost for Priority Projects

Cemetery Proposed Pond (C-1)				
Estimated Construction & Initial Management Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
Overall				
mobilization	1	LS	$ 20,000	$ 20,000
erosion control	1	LS	$ 3,200	$ 3,200
common excavation/grading	2557	CY	$ 15	$ 38,400
remove trees/stumps	1	LS	$ 8,000	$ 8,000
remove storm sewer	500	LF	$ 15	$ 7,500
native seeding (edges & shallows)	0.50	AC	$ 4,000	$ 2,000
native plant plugs (emergent)	300	EA	$ 5	$ 1,500
Pond/Hydrology				
flared outlet	2	EA	$ 1,500	$ 3,000
outlet structure	1	EA	$ 10,000	$ 10,000
new storm sewer	200	LF	$ 80	$ 16,000
Vegetation Establishment				
watering & weeding (first 3 growing seasons)	6	EA	$ 800	$ 4,800
			Subtotal	$ 114,400
			Contingency (20%)	$ 22,900
			Total Estimated Construction & Initial Management Cost	**$ 137,300**
			Estimated Other Project Costs* (30%)	**$ 41,200**
			Total Estimated Cost	**$ 178,500**

* Other project costs include final design, construction documents, bid package, permitting, permit fees, construction management and oversight, and monitoring of performance standards.

Estimated Annual O&M Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
weeding/invasive control	1	EA	$ 300	$ 300
mowing edge	1	EA	$ 200	$ 200
inspect/repair	1	EA	$ 50	$ 50
clean inlet/outlet structures	6	EA	$ 50	$ 300
dredging (every 5-10 years; cost averaged)	1	LS	$ 1,000	$ 1,000
			Subtotal	$ 1,850
			Contingency (20%)	$ 400
			Total Estimated Annual O&M Costs	**$ 2,250**

APPENDIX D

Opinions of Probable Cost for Priority Projects

Hole 13 Proposed Ponds (G-3)

Estimated Construction & Initial Management Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
Overall				
mobilization	1	LS	$ 15,000	$ 15,000
erosion control	1	LS	$ 10,300	$ 10,300
common excavation/grading	10400	CY	$ 15	$ 156,000
remove trees/stumps	2	EA	$ 825	$ 1,700
remove storm sewer	800	LF	$ 25	$ 20,000
buffer seeding	0.60	AC	$ 6,000	$ 3,600
native seeding (pond edges)	0.20	AC	$ 6,000	$ 1,200
native plant plugs (emergent)	1500	EA	$ 5	$ 7,500
Pond/Hydrology				
flared outlet	5	EA	$ 1,500	$ 7,500
outlet structure	2	EA	$ 10,000	$ 20,000
new storm sewer	100	LF	$ 80	$ 8,000
Golf Course Features				
remove cart path	1	EA	$ 6,750	$ 6,800
reconstruct/level tees	5500	SF	$ 6	$ 30,300
drain tile (4" non-perforated)	400	LF	$ 11	$ 4,400
drain tile (6" non-perforated)	100	LF	$ 12	$ 1,200
catch basins	2	EA	$ 600	$ 1,200
collection areas	2	EA	$ 1,000	$ 2,000
new cart path (8')	525	LF	$ 24	$ 12,600
cart path curbing	400	LF	$ 11	$ 4,400
irrigation (pipe, wire & heads)	20	EA	$ 1,000	$ 20,000
bluegrass sod	5500	SY	$ 4	$ 19,300
Vegetation Establishment				
watering & weeding (first 3 growing seasons)	6	EA	$ 1,500	$ 9,000
			Subtotal	$ 362,000
			Contingency (20%)	$ 72,400
			Total Estimated Construction & Initial Management Cost	**$ 434,400**
			Estimated Other Project Costs* (30%)	**$ 130,300**
			Total Estimated Cost	**$ 564,700**

* Other project costs include final design, construction documents, bid package, permitting, permit fees, construction management and oversight, and monitoring of performance standards.

Estimated Annual O&M Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
weeding/invasive control	2	EA	$ 150	$ 300
mowing buffer	2	EA	$ 200	$ 400
inspect/repair	2	EA	$ 100	$ 200
clean inlet/outlet structures	6	EA	$ 100	$ 600
dredging (every 5-10 years; cost averaged)	1	LS	$ 1,500	$ 1,500
			Subtotal	$ 3,000
			Contingency (20%)	$ 600
			Total Estimated Annual O&M Costs	**$ 3,600**

APPENDIX D

Opinions of Probable Cost for Priority Projects

Hole 1 Pond Enlargement (G-1)				
Estimated Construction & Initial Management Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
Overall				
mobilization/hauling	1	LS	$ 37,400	$ 37,400
erosion control	1	LS	$ 12,300	$ 12,300
common excavation/grading (pond enlargement)	10000	CY	$ 15	$ 150,000
haul road	1	LS	$ 9,000	$ 9,000
remove trees/stumps	1	LS	$ 5,000	$ 5,000
buffer seeding	0.45	AC	$ 6,000	$ 2,700
native seeding (pond edges)	0.50	AC	$ 4,000	$ 2,000
native plant plugs (emergent)	1000	EA	$ 5	$ 5,000
restoration (e.g., repair of damaged sod or pavement)	1	LS	$ 25,000	$ 25,000
Pond/Hydrology				
modify existing outlet structure	1	EA	$ 25,000	$ 25,000
dredging (of existing sediment)	10000	CY	$ 15	$ 150,000
Vegetation Establishment				
watering & weeding (first 3 growing seasons)	6	EA	$ 1,000	$ 6,000
			Subtotal	$ 429,400
			Contingency (20%)	$ 85,900
			Total Estimated Construction & Initial Management Cost	**$ 515,300**
			Estimated Other Project Costs* (30%)	**$ 154,600**
			Total Estimated Cost	**$ 669,900**

* Other project costs include final design, construction documents, bid package, permitting, permit fees, construction management and oversight, and monitoring of performance standards.

Estimated Annual O&M Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
weeding/invasive control	2	EA	$ 75	$ 150
mowing buffer	2	EA	$ 50	$ 100
inspect/repair	1	EA	$ 150	$ 150
clean inlet/outlet structures	6	EA	$ 50	$ 300
dredging (every 5-10 years; cost averaged)	1	LS	$ 1,500	$ 1,500
			Subtotal	$ 2,200
			Contingency (20%)	$ 400
			Total Estimated Annual O&M Costs	**$ 2,600**

APPENDIX D

Opinions of Probable Cost for Priority Projects

Hole 3 Erosion Stabilization (G-2)

Estimated Construction & Initial Management Costs

Item	Quantity	Unit	Unit Cost	Cost
Overall				
mobilization	1	LS	$ 33,400	$ 33,400
erosion control	1	LS	$ 15,300	$ 15,300
common excavation/grading	5000	CY	$ 15	$ 75,000
remove trees/stumps	1	LS	$ 10,000	$ 10,000
remove storm sewer	580	LF	$ 25	$ 14,500
buffer seeding	0.8	AC	$ 6,000	$ 4,800
native seeding	2.5	AC	$ 3,000	$ 7,500
native plant plugs (emergent)	1000	EA	$ 5	$ 5,000
Ponds/Storm Sewer/Hydrology				
storm sewer structures	6	EA	$ 6,000	$ 36,000
storm sewer (48")	500	LF	$ 120	$ 60,000
storm sewer (42")	400	LF	$ 100	$ 40,000
storm sewer (18")	180	LF	$ 40	$ 7,200
Golf Course Features				
remove cart path	1	EA	$ 7,750	$ 7,800
reconstruct/level tees	5000	SF	$ 6	$ 27,500
drain tile (4" non-perforated)	1000	LF	$ 11	$ 11,000
drain tile (6" non-perforated)	1000	LF	$ 12	$ 11,500
catch basins	5	EA	$ 700	$ 3,500
collection areas	5	EA	$ 1,250	$ 6,300
new cart path (8')	840	LF	$ 24	$ 20,200
cart path curbing	350	LF	$ 11	$ 3,900
sand bunkers	4000	SF	$ 8	$ 32,000
irrigation (pipe, wire & heads)	40	EA	$ 1,000	$ 40,000
bluegrass sod	13500	SY	$ 4	$ 54,000
Vegetation Establishment				
watering & weeding (first 3 growing seasons)	6	EA	$ 1,500	$ 9,000
			Subtotal	$ 535,400
			Contingency (20%)	$ 107,100
			Total Estimated Construction & Initial Management Cost	**$ 642,500**
			Estimated Other Project Costs* (30%)	**$ 192,800**
			Total Estimated Cost	**$ 835,300**

* Other project costs include final design, construction documents, bid package, permitting, permit fees, construction management and oversight, and monitoring of performance standards.

Estimated Annual O&M Costs

Item	Quantity	Unit	Unit Cost	Cost
weeding/invasive control	2	EA	$ 150	$ 300
mowing buffer	2	EA	$ 50	$ 100
inspect/repair	2	EA	$ 100	$ 200
clean inlet/outlet structures	6	EA	$ 100	$ 600
dredging (every 5-10 years; cost averaged)	1	LS	$ 1,000	$ 1,000
			Subtotal	$ 2,200
			Contingency (20%)	$ 400
			Total Estimated Annual O&M Costs	**$ 2,600**

APPENDIX

E

Opinions of Probable Cost for Other Potential Projects

APPENDIX E

Opinions of Probable Cost for Other Potential Projects

Cemetery Main Drive (C-4)						
Estimated Construction & Initial Management Costs						
Item	**Quantity**	**Unit**	**Unit Cost**		**Cost**	
Overall						
mobilization	1	LS	$	9,000	$	9,000
erosion control	1	LS	$	2,400	$	2,400
common excavation/grading	267	CY	$	10	$	2,667
demo of pavement	400	SY	$	15	$	6,000
demo of ribbon curb	1200	LF	$	10	$	12,000
Infiltration/Hydrology						
permeable pavers	3600	SF	$	11	$	39,600
subbase	200	CY	$	25	$	5,000
drain tile	1200	LF	$	6	$	7,200
Subtotal					$	83,867
Contingency (20%)					$	16,800
Total Estimated Construction & Initial Management Cost					**$**	**100,667**
Estimated Other Project Costs* (30%)					**$**	**30,200**
Total Estimated Cost					**$**	**130,867**

* Other project costs include final design, construction documents, bid package, permitting, permit fees, construction management and oversight, and monitoring of performance standards.

Estimated Annual O&M Costs						
Item	**Quantity**	**Unit**	**Unit Cost**		**Cost**	
vacuuming (semi-annual)	2	EA	$	400	$	800
Subtotal					$	800
Contingency (20%)					$	200
Total Estimated Annual O&M Costs					**$**	**1,000**

APPENDIX E

Opinions of Probable Cost for Other Potential Projects

Cemetery Existing Pond (C-3)				
Estimated Construction Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
Overall				
mobilization	1	LS	$ 20,000	$ 20,000
erosion control	1	LS	$ 5,000	$ 5,000
common excavation/grading	682	CY	$ 15	$ 10,200
install limestone-lined access	150	TONS	$ 500	$ 75,000
restore construction damage	1	LS	$ 10,000	$ 10,000
native seeding (buffer and shoreline)	2.0	AC	$ 3,000	$ 6,000
native plant plugs (emergent)	3000	EA	$ 5	$ 15,000
Pond/Hydrology				
dredging (of existing sediment)	1556	CY	$ 20	$ 31,100
Vegetation Establishment				
watering & weeding (first 3 growing seasons)	6	EA	$ 1,500	$ 9,000
			Subtotal	$ 181,300
			Contingency (20%)	$ 36,300
			Total Estimated Construction Cost *	**$ 217,600**
			Estimated Other Project Costs* (30%)	**$ 65,300**
			Total Estimated Cost	**$ 282,900**

* Other project costs include final design, construction documents, bid package, permitting, permit fees, construction management and oversight, and monitoring of performance standards.

Estimated Annual O&M Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
weeding/invasive control (buffer and shoreline)	2	EA	$ 100	$ 200
inspect/repair	2	EA	$ 50	$ 100
clean inlet/outlet structures	6	EA	$ 50	$ 300
dredging (every 5-10 years; cost averaged)	1	LS	$ 3,000	$ 3,000
			Subtotal	$ 3,600
			Contingency (20%)	$ 700
			Total Estimated Annual O&M Costs	**$ 4,300**

APPENDIX E

Opinions of Probable Cost for Other Potential Projects

Golf Course Step Pools (G-4)						
Estimated Construction Costs						
Item	**Quantity**	**Unit**	**Unit Cost**		**Cost**	
Overall						
mobilization	1	LS	$	10,000	$	10,000
erosion control	1	LS	$	1,200	$	1,200
common excavation/grading	815	CY	$	25	$	20,400
restore construction damage	1	LS	$	2,500	$	2,500
native seeding	0.25	AC	$	5,000	$	1,300
Step Pools/Hydrology						
rock structures	1	LS	$	6,500	$	6,500
Vegetation Establishment						
watering & weeding (first 3 growing seasons)	6	EA	$	800	$	4,800
				Subtotal	$	46,700
				Contingency (20%)	$	9,300
				Total Estimated Construction Cost *	**$**	**56,000**
				Estimated Other Project Costs* (30%)	**$**	**16,800**
				Total Estimated Cost	**$**	**72,800**

* Other project costs include final design, construction documents, bid package, permitting, permit fees, construction management and oversight, and monitoring of performance standards.

Estimated Annual O&M Costs						
Item	**Quantity**	**Unit**	**Unit Cost**		**Cost**	
weeding/invasive control	1	EA	$	200	$	200
inspect/repair	1	LS	$	100	$	100
silt removal (every 5 years; cost averaged)	1	LS	$	500	$	500
				Subtotal	$	800
				Contingency (20%)	$	200
				Total Estimated Annual O&M Costs	**$**	**1,000**

APPENDIX E

Opinions of Probable Cost for Other Potential Projects

Golf Course Wet Pond (G-5)				
Estimated Construction Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
Overall				
mobilization	1	LS	$ 10,000	$ 10,000
erosion control	1	LS	$ 2,100	$ 2,100
common excavation/grading	2365	CY	$ 15	$ 35,500
remove storm sewer	160	LF	$ 25	$ 4,000
restore construction damage	1	LS	$ 2,500	$ 2,500
native seeding (buffer and shoreline)	0.25	AC	$ 5,000	$ 1,300
native plant plugs (emergent)	500	EA	$ 5	$ 2,500
Pond/Hydrology				
outlet structure	1	EA	$ 10,000	$ 10,000
new storm sewer	50	LF	$ 80	$ 4,000
Vegetation Establishment				
watering & weeding (first 3 growing seasons)	6	EA	$ 500	$ 3,000
			Subtotal	$ 74,900
			Contingency (20%)	$ 15,000
			Total Estimated Construction Cost *	**$ 89,900**
			Estimated Other Project Costs* (30%)	**$ 27,000**
			Total Estimated Cost	**$ 116,900**

* Other project costs include final design, construction documents, bid package, permitting, permit fees, construction management and oversight, and monitoring of performance standards.

Estimated Annual O&M Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
weeding/invasive control	2	EA	$ 100	$ 200
mowing buffer	2	EA	$ 50	$ 100
inspect/repair	2	EA	$ 50	$ 100
clean inlet/outlet structures	6	EA	$ 25	$ 200
dredging (every 5-10 years; cost averaged)	1	LS	$ 1,000	$ 1,000
			Subtotal	$ 1,600
			Contingency (20%)	$ 300
			Total Estimated Annual O&M Costs	**$ 1,900**

APPENDIX E
Opinions of Probable Cost for Other Potential Projects

Golf Course Step Pools (G-6)				
Estimated Construction Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
Overall				
mobilization	1	LS	$ 10,000	$ 10,000
erosion control	1	LS	$ 900	$ 900
common excavation/grading	622	CY	$ 15	$ 9,300
restore construction damage	1	LS	$ 5,000	$ 5,000
native seeding	0.25	AC	$ 5,000	$ 1,300
Step Pools/Hydrology				
rock structures	1	LS	$ 5,000	$ 5,000
Vegetation Establishment				
watering & weeding (first 3 growing seasons)	6	EA	$ 500	$ 3,000
			Subtotal	$ 34,500
			Contingency (20%)	$ 6,900
			Total Estimated Construction Cost *	**$ 41,400**
			Estimated Other Project Costs* (30%)	**$ 12,400**
			Total Estimated Cost	**$ 53,800**

* Other project costs include final design, construction documents, bid package, permitting, permit fees, construction management and oversight, and monitoring of performance standards.

Estimated Annual O&M Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
weeding/invasive control	1	EA	$ 100	$ 100
inspect/repair	1	LS	$ 100	$ 100
silt removal (every 5 years; cost averaged)	1	LS	$ 500	$ 500
			Subtotal	$ 700
			Contingency (20%)	$ 100
			Total Estimated Annual O&M Costs	**$ 800**

APPENDIX E

Opinions of Probable Cost for Other Potential Projects

Golf Course Step Pools (G-7)				
Estimated Construction Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
Overall				
mobilization	1	LS	$ 10,000	$ 10,000
erosion control	1	LS	$ 900	$ 900
common excavation/grading	644	CY	$ 15	$ 9,700
restore construction damage	1	LS	$ 5,000	$ 5,000
native seeding	0.25	AC	$ 5,000	$ 1,300
Step Pools/Hydrology				
rock structures	1	LS	$ 5,000	$ 5,000
Vegetation Establishment				
watering & weeding (first 3 growing seasons)	6	EA	$ 500	$ 3,000
			Subtotal	$ 34,900
			Contingency (20%)	$ 7,000
			Total Estimated Construction Cost *	**$ 41,900**
			Estimated Other Project Costs* (30%)	**$ 12,600**
			Total Estimated Cost	**$ 54,500**

* Other project costs include final design, construction documents, bid package, permitting, permit fees, construction management and oversight, and monitoring of performance standards.

Estimated Annual O&M Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
weeding/invasive control	1	EA	$ 100	$ 100
inspect/repair	1	LS	$ 100	$ 100
silt removal (every 5 years; cost averaged)	1	LS	$ 500	$ 500
			Subtotal	$ 700
			Contingency (20%)	$ 100
			Total Estimated Annual O&M Costs	**$ 800**

APPENDIX E

Opinions of Probable Cost for Other Potential Projects

Golf Course Step Pools (G-8)				
Estimated Construction Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
Overall				
mobilization	1	LS	$ 10,000	$ 10,000
erosion control	1	LS	$ 1,100	$ 1,100
common excavation/grading	741	CY	$ 15	$ 11,100
restore construction damage	1	LS	$ 5,000	$ 5,000
native seeding	0.25	AC	$ 5,000	$ 1,300
Step Pools/Hydrology				
rock structures	1	LS	$ 6,000	$ 6,000
Vegetation Establishment				
watering & weeding (first 3 growing seasons)	6	EA	$ 500	$ 3,000
			Subtotal	$ 37,500
			Contingency (20%)	$ 7,500
			Total Estimated Construction Cost *	**$ 45,000**
			Estimated Other Project Costs* (30%)	**$ 13,500**
			Total Estimated Cost	**$ 58,500**

* Other project costs include final design, construction documents, bid package, permitting, permit fees, construction management and oversight, and monitoring of performance standards.

Estimated Annual O&M Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
weeding/invasive control	1	EA	$ 100	$ 100
inspect/repair	1	LS	$ 100	$ 100
silt removal (every 5 years; cost averaged)	1	LS	$ 500	$ 500
			Subtotal	$ 700
			Contingency (20%)	$ 100
			Total Estimated Annual O&M Costs	**$ 800**

APPENDIX E
Opinions of Probable Cost for Other Potential Projects

Golf Course Wet Pond (G-9)

Estimated Construction Costs

Item	Quantity	Unit	Unit Cost	Cost
Overall				
mobilization	1	LS	$ 5,000	$ 5,000
erosion control	1	LS	$ 1,000	$ 1,000
common excavation/grading	887	CY	$ 20	$ 17,700
remove storm sewer	40	LF	$ 25	$ 1,000
restore construction damage	1	LS	$ 2,000	$ 2,000
native seeding	0.25	AC	$ 5,000	$ 1,300
Pond/Hydrology				
outlet structure	1	EA	$ 5,000	$ 5,000
new storm sewer	30	LF	$ 80	$ 2,400
Vegetation Establishment				
watering & weeding (first 3 growing seasons)	6	EA	$ 500	$ 3,000
			Subtotal	$ 38,400
			Contingency (20%)	$ 7,700
			Total Estimated Construction Cost *	**$ 46,100**
			Estimated Other Project Costs* (30%)	**$ 13,800**
			Total Estimated Cost	**$ 59,900**

* Other project costs include final design, construction documents, bid package, permitting, permit fees, construction management and oversight, and monitoring of performance standards.

Estimated Annual O&M Costs

Item	Quantity	Unit	Unit Cost	Cost
weeding/invasive control	1	EA	$ 100	$ 100
inspect/repair	2	EA	$ 50	$ 100
clean inlet/outlet structures	6	EA	$ 25	$ 200
dredging (every 5-10 years; cost averaged)	1	LS	$ 1,500	$ 1,500
			Subtotal	$ 1,900
			Contingency (20%)	$ 400
			Total Estimated Annual O&M Costs	**$ 2,300**

APPENDIX E

Opinions of Probable Cost for Other Potential Projects

Neighborhood Infiltration Chamber (N-1)				
Estimated Construction Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
Overall				
mobilization	1	LS	$ 5,000	$ 5,000
erosion control	1	LS	$ 1,100	$ 1,100
common excavation/grading	214	CY	$ 10	$ 2,100
structure reconstruction	2	EA	$ 6,000	$ 12,000
restore construction damage	1	LS	$ 500	$ 500
Infiltration Chamber/Hydrology				
infiltration chamber	1,492	CF	$ 8	$ 11,900
coarse filter aggregate	159	CY	$ 40	$ 6,300
			Subtotal	$ 38,900
			Contingency (20%)	$ 7,800
			Total Estimated Construction Cost *	**$ 46,700**
			Estimated Other Project Costs* (30%)	**$ 14,000**
			Total Estimated Cost	**$ 60,700**

* Other project costs include final design, construction documents, bid package, permitting, permit fees, construction management and oversight, and monitoring of performance standards.

Estimated Annual O&M Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
inspect/repair	3	EA	$ 30	$ 100
clean-out (every 5 years; cost averaged)	1	LS	$ 500	$ 500
			Subtotal	$ 600
			Contingency (20%)	$ 100
			Total Estimated Annual O&M Costs	**$ 700**

APPENDIX E
Opinions of Probable Cost for Other Potential Projects

Neighborhood Rain Garden (N-2)				
Estimated Construction Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
Overall				
mobilization	1	LS	$ 2,000	$ 2,000
erosion control	1	LS	$ 200	$ 200
common excavation/grading	57	CY	$ 10	$ 600
subgrade excavation	58	CY	$ 15	$ 900
curb cut	1	EA	$ 200	$ 200
restore construction damage	1	LS	$ 500	$ 500
Rain Garden/Hydrology				
amended soil media	18	CY	$ 75	$ 1,400
native plant plugs (emergent)	500	EA	$ 5	$ 2,500
Vegetation Establishment				
watering & weeding (first 3 growing seasons)	6	EA	$ 250	$ 1,500
			Subtotal	$ 9,800
			Contingency (20%)	$ 2,000
			Total Estimated Construction Cost *	**$ 11,800**
			Estimated Other Project Costs* (30%)	**$ 3,500**
			Total Estimated Cost	**$ 15,300**

* Other project costs include final design, construction documents, bid package, permitting, permit fees, construction management and oversight, and monitoring of performance standards.

Estimated Annual O&M Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
weeding/invasive control	2	EA	$ 100	$ 200
inspect/repair	2	EA	$ 50	$ 100
mow & remove clippings	1	EA	$ 100	$ 100
			Subtotal	$ 400
			Contingency (20%)	$ 100
			Total Estimated Annual O&M Costs	**$ 500**

APPENDIX E

Opinions of Probable Cost for Other Potential Projects

Neighborhood Permeable Concrete Parking Lot (N-3)

Estimated Construction Costs

Item	Quantity	Unit	Unit Cost	Cost
Overall				
mobilization	1	LS	$ 22,500	$ 22,500
erosion control	1	LS	$ 7,400	$ 7,400
pavement removal	2822	SY	$ 5	$ 14,100
excavation	1881	CY	$ 10	$ 18,800
Permeable Concrete/Hydrology				
subbase	1881	CY	$ 25	$ 47,000
drain tile	450	LF	$ 8	$ 3,600
permeable concrete	2822	SY	$ 50	$ 141,100
			Subtotal	$ 254,500
			Contingency (20%)	$ 50,900
			Total Estimated Construction Cost *	**$ 305,400**
			Estimated Other Project Costs* (30%)	**$ 91,600**
			Total Estimated Cost	**$ 397,000**

* Other project costs include final design, construction documents, bid package, permitting, permit fees, construction management and oversight, and monitoring of performance standards.

Estimated Annual O&M Costs

Item	Quantity	Unit	Unit Cost	Cost
vacuuming (semi-annual)	2	EA	$ 500	$ 1,000
			Subtotal	$ 1,000
			Contingency (20%)	$ 200
			Total Estimated Annual O&M Costs	**$ 1,200**

APPENDIX E

Opinions of Probable Cost for Other Potential Projects

Neighborhood Rock Trench (N-4)				
Estimated Construction Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
Overall				
mobilization	1	LS	$ 5,000	$ 5,000
erosion control	1	LS	$ 900	$ 900
pavement removal	21	SY	$ 5	$ 100
common excavation/grading	134	CY	$ 10	$ 1,300
subgrade excavation	21	CY	$ 15	$ 300
restore construction damage	1	LS	$ 500	$ 500
Rock Trench/Hydrology				
manhole	2	EA	$ 6,000	$ 12,000
HDPE perforated pipe (48")	145	LF	$ 45	$ 6,500
coarse filter aggregate	70	CY	$ 40	$ 2,800
			Subtotal	$ 29,400
			Contingency (20%)	$ 5,880
			Total Estimated Construction Cost *	**$ 35,300**
			Estimated Other Project Costs* (30%)	**$ 10,600**
			Total Estimated Cost	**$ 45,900**

* Other project costs include final design, construction documents, bid package, permitting, permit fees, construction management and oversight, and monitoring of performance standards.

Estimated Annual O&M Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
inspect/repair	3	EA	$ 30	$ 100
clean-out (every 5 years; cost averaged)	1	LS	$ 500	$ 500
			Subtotal	$ 600
			Contingency (20%)	$ 100
			Total Estimated Annual O&M Costs	**$ 700**

APPENDIX E

Opinions of Probable Cost for Other Potential Projects

Neighborhood Dry Detention (N-5)				
Estimated Construction Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
Overall				
mobilization	1	LS	$ 5,000	$ 5,000
erosion control	1	LS	$ 500	$ 500
common excavation/grading	248	CY	$ 10	$ 2,500
remove storm sewer	60	LF	$ 15	$ 900
native seeding	0.10	AC	$ 6,000	$ 600
restore construction damage	1	LS	$ 500	$ 500
Detention Area/Hydrology				
outlet structure	1	EA	$ 6,000	$ 6,000
Vegetation Establishment				
watering & weeding (first 3 growing seasons)	6	EA	$ 500	$ 3,000
			Subtotal	$ 19,000
			Contingency (20%)	$ 3,800
			Total Estimated Construction Cost *	**$ 22,800**
			Estimated Other Project Costs* (30%)	**$ 6,800**
			Total Estimated Cost	**$ 29,600**

* Other project costs include final design, construction documents, bid package, permitting, permit fees, construction management and oversight, and monitoring of performance standards.

Estimated Annual O&M Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
weeding/invasive control	2	EA	$ 100	$ 200
inspect/repair	1	EA	$ 100	$ 100
silt removal (every 5-10 years; cost averaged)	1	LS	$ 200	$ 200
			Subtotal	$ 500
			Contingency (20%)	$ 100
			Total Estimated Annual O&M Costs	**$ 600**

APPENDIX E

Opinions of Probable Cost for Other Potential Projects

Neighborhood Infiltration Chamber (N-6)				
Estimated Construction Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
Overall				
mobilization	1	LS	$ 5,000	$ 5,000
erosion control	1	LS	$ 1,000	$ 1,000
common excavation/grading	183	CY	$ 10	$ 1,800
structure reconstruction	2	LS	$ 6,000	$ 12,000
restore construction damage	1	LS	$ 500	$ 500
Infiltration Chamber/Hydrology				$ -
infiltration chamber	955	CF	$ 8	$ 7,600
coarse filter aggregate	148	CY	$ 40	$ 5,900
			Subtotal	$ 33,800
			Contingency (20%)	$ 6,800
			Total Estimated Construction Cost *	**$ 40,600**
			Estimated Other Project Costs* (30%)	**$ 12,200**
			Total Estimated Cost	**$ 52,800**

* Other project costs include final design, construction documents, bid package, permitting, permit fees, construction management and oversight, and monitoring of performance standards.

Estimated Annual O&M Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
inspect/repair	3	EA	$ 30	$ 100
clean-out (every 5 years; cost averaged)	1	LS	$ 500	$ 500
			Subtotal	$ 600
			Contingency (20%)	$ 100
			Total Estimated Annual O&M Costs	**$ 700**

APPENDIX E

Opinions of Probable Cost for Other Potential Projects

Neighborhood Dry Detention (N-7)				
Estimated Construction Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
Overall				
mobilization	1	LS	$ 5,000	$ 5,000
erosion control	1	LS	$ 600	$ 600
common excavation/grading	722	CY	$ 10	$ 7,200
native seeding	0.15	AC	$ 6,000	$ 900
restore construction damage	1	LS	$ 500	$ 500
Detention Area/Hydrology				
outlet structure	1	EA	$ 6,000	$ 6,000
Vegetation Establishment				
watering & weeding (first 3 growing seasons)	6	EA	$ 500	$ 3,000
			Subtotal	$ 23,200
			Contingency (20%)	$ 4,600
			Total Estimated Construction Cost *	**$ 27,800**
			Estimated Other Project Costs* (30%)	**$ 8,300**
			Total Estimated Cost	**$ 36,100**

* Other project costs include final design, construction documents, bid package, permitting, permit fees, construction management and oversight, and monitoring of performance standards.

Estimated Annual O&M Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
weeding/invasive control	2	EA	$ 100	$ 200
inspect/repair	1	EA	$ 100	$ 100
silt removal (every 5-10 years; cost averaged)	1	LS	$ 300	$ 500
			Subtotal	$ 800
			Contingency (20%)	$ 200
			Total Estimated Annual O&M Costs	**$ 1,000**

APPENDIX E

Opinions of Probable Cost for Other Potential Projects

Neighborhood School Bioswales (N-8)

Estimated Construction Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
Overall				
mobilization	1	LS	$ 3,000	$ 3,000
erosion control	1	LS	$ 400	$ 400
common excavation/grading	696	CY	$ 10	$ 7,000
native seeding	0.33	AC	$ 6,000	$ 2,000
restore construction damage	1	LS	$ 1,000	$ 1,000
Vegetation Establishment				
watering & weeding (first 3 growing seasons)	6	EA	$ 500	$ 3,000
			Subtotal	$ 13,400
			Contingency (20%)	$ 2,700
			Total Estimated Construction Cost *	**$ 16,100**
			Estimated Other Project Costs* (30%)	**$ 4,800**
			Total Estimated Cost	**$ 20,900**

* Other project costs include final design, construction documents, bid package, permitting, permit fees, construction management and oversight, and monitoring of performance standards.

Estimated Annual O&M Costs				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
weeding/invasive control	2	EA	$ 100	$ 200
inspect/repair	2	EA	$ 50	$ 100
mow & remove clippings	1	EA	$ 100	$ 100
			Subtotal	$ 400
			Contingency (20%)	$ 100
			Total Estimated Annual O&M Costs	**$ 500**