CROSS KEYS CONDOMINIUM NO. 1 DRAINAGE AND STORMWATER ASSESSMENT AND RECOMMENDATIONS

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1. Executive Summary

Cross Keys Condominium No. 1 seeks to improve their stormwater management practices through a comprehensive Stormwater Assessment to prioritize future programmatic and structural improvements to their property. The Drainage and Stormwater Assessment and Recommendations report was commissioned by Cross Keys Condo No. 1 to develop an overall stormwater plan for the campus in advance of preparing full construction drawings for priority stormwater practices and to identify funding opportunities.

CityScape Engineering, LLC and Grow Landscape Designs, LLC completed the following feasibility study and evaluation of options, leading to an overall master plan for improving storm water management for the Condo No. 1 area of Cross Keys. Upstream drainage areas leading into the study boundary were evaluated as part of the master plan; however, stormwater interventions were limited to projects within the Condo No. 1 boundary.

A combination of record rainfall in recent years, poorly draining soils and land grading, overgrazing by deer, and landscape management practices has led to nuisance flooding and polluted stormwater quality runoff on campus. Six programmatic practices and four structural practices were identified by the study team to alleviate the quantity of runoff from rainfall, improve the quality of stormwater, and enhance the landscaping using more sustainable and environmentally-friendly management practices. The specific action strategies are described in Section 4. Sections 5 and 6 describe a Recommended Action Plan for implementation of the proposed strategies and Resources for technical assistance in design and construction funding.

2. Project Background and Description

The Cross Keys property is located just south of Northern Parkway between Falls Road and the Jones Falls stream on the site of the former Baltimore Country Club Golf Course. The property is comprised of hilly terrain and steep slopes. Several of the hill slopes are forested, but deer have denuded much the understory and groundcover vegetation. Other areas of open space are characterized by mowed grass cover with some areas of ornamental landscaping adjacent home properties.

According to the USGS soil survey information, the site soils are mapped as Legore-Urban land complex, 8 to 15 percent slopes. This soil type is characterized as a well-draining loam type soil. However, soil borings performed by the project team within the top 3-4 feet of soil found uniform site soils comprised of fill material with high clay-content. Measured infiltration rates were minimal, indicating that the soils are poorly draining. It is suspected that fill soils were imported during construction of the current homes or previous golf course, resulting in the mapped versus assessed discrepancies.

Excess stormwater runoff is resulting in flooding conditions at numerous locations throughout the Condo No. 1 properties. 2018 was the wettest year on record in Baltimore City. Historically, the average annual rainfall for the region is around 42 inches per year with 110 precipitation days per year. In 2018, the annual rainfall total measured 71.82 inches at BWI airport with approximately 145 precipitation days. The region experienced an unusually wet summer with July 2018 being the second rainiest month ever on record (Baltimore Sun Report, 2019-01-02). It is unknown whether 2018 was an extreme outlier or is an indicator of changing rainfall patterns. However, the 2018 National Climate Assessment predicts wetter weather and increasing rainfall intensity across much of the Northeast, so it can be assumed that stormwater runoff challenges will continue. The strategies presented in this report are intended to help mitigate flooding and create resiliency by slowing, reducing and filtering stormwater runoff to more closely mimic natural watershed conditions.

3. Project Scope and Findings

CityScape Engineering, LLC and Grow Landscape Designs, LLC were hired in November 2018 to perform a site assessment and develop recommendations to improve runoff and flooding conditions within the Condo No. 1 area. In addition, opportunities to improve water quality and promote sustainable water management practices were explored.

A meeting was held with Condo No. 1 residents on 11/28/2018 to discuss the project objectives and collect input on problem areas.

Available site mapping information was requested from the Client, Baltimore City and BGE. This information was compiled into an overall site map showing topography, drainage patterns, impervious areas, and known utility locations.

Field investigations were then conducted to verify mapped conditions and assess site soils. Site investigations revealed steep slopes with different vegetated cover. Most slopes were characterized by manicured turf grass and individual tree plantings. Other slopes were forested but lacked robust understory and groundcover vegetation, likely the result of overgrazing by a large deer population. Figure 1 shows the locations of areas where flooding or erosion problems were noted and observed. The existing site drainage patterns are also shown.

Soil borings were performed with a hand-held soil augur and infiltration tests were conducted to measure the permeability of the soils. Figure 2 shows the location and depth of the soil borings. All locations revealed fill soils with high clay content and minimal to no infiltration.

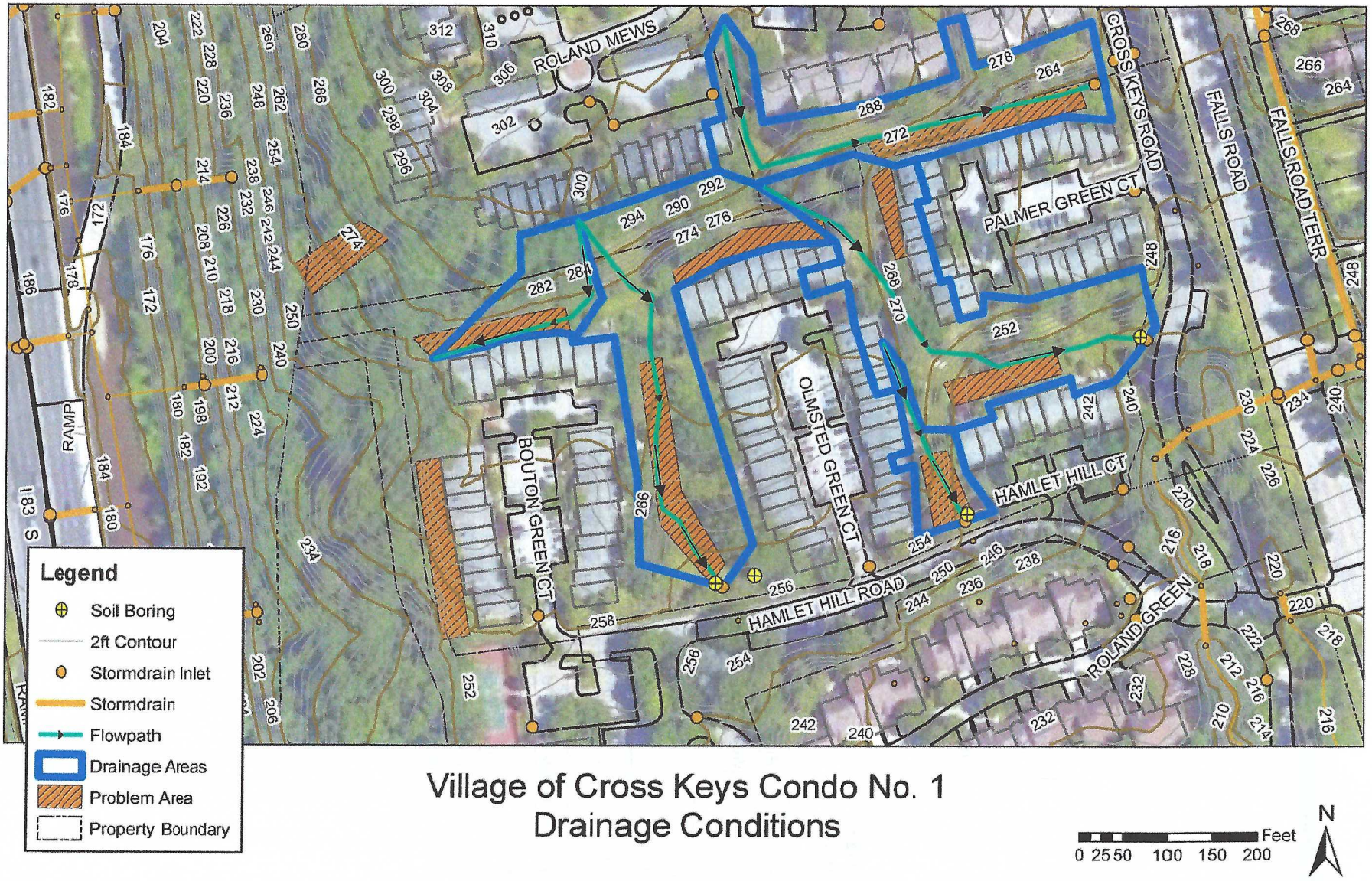

Figure 1. Map of problem areas and drainage patterns

4. Project Strategies and Recommendations

Given the observed site soil characteristics, it is not feasible to promote significant stormwater infiltration on site. Rather, selective grading and plantings can be used to slow, filter, and absorb runoff prior to entering the stormdrain inlets. The landscape requires more deer-resistant vegetation to stabilize site soils and absorb stormwater runoff. Earthen berms and grassed swales can direct water away from properties and into open spaces where it will be less of a nuisance to homeowners. Rain gardens and planted swales can capture water for uptake by existing and proposed additional trees and shrubs. The creation of large native meadow areas can improve slope stability and decrease the amount of lawn mowing. Further, a refined turf management plan comprised of less frequent mowing, fertilizer and pesticide use can improve water quality and the ecosystem services provided by the property green space. These strategies will also improve soil quality and infiltration over time. Project strategies are organized into two types: (1) Programmatic Actions, which involve low impact techniques such as native plantings, maintenance, and behavioral changes and (2) Structural Actions, that involve constructed interventions to redirect and control stormwater runoff through environmental site design strategies. Each action is described below and summarized in Table 1. Figure 2 illustrates the proposed strategy locations.

Table 1. List of Recommended Strategies

Strategy Number	Description	Runoff Reduction and Flooding Impact*	Water Quality Impact	Cost
P1	Plant Shaded Hillsides	M	M	$$
P2	Meadow Establishment	M	M	$$$
P3	Tree Planting	L [1]	L	$$
P4	Reduced Mowing	M	L	$
P5	Turf Management	L	H	$
P6	Rain Barrels	L	L	$
S1	Berms	H	L	$$
S2	Bioswales and Dry Creek Beds	H	H	$$$
S3	Rain Gardens	M	H	$$
S4	Outfall Stabilization	L [2]	H	$$$$

* Describes impact on Condo No. 1 area in short term (2-3 years)

[1] Low immediate impact, but will improve over time as trees establish and grow.

[2] Low impact on property, but will have a moderate impact downstream

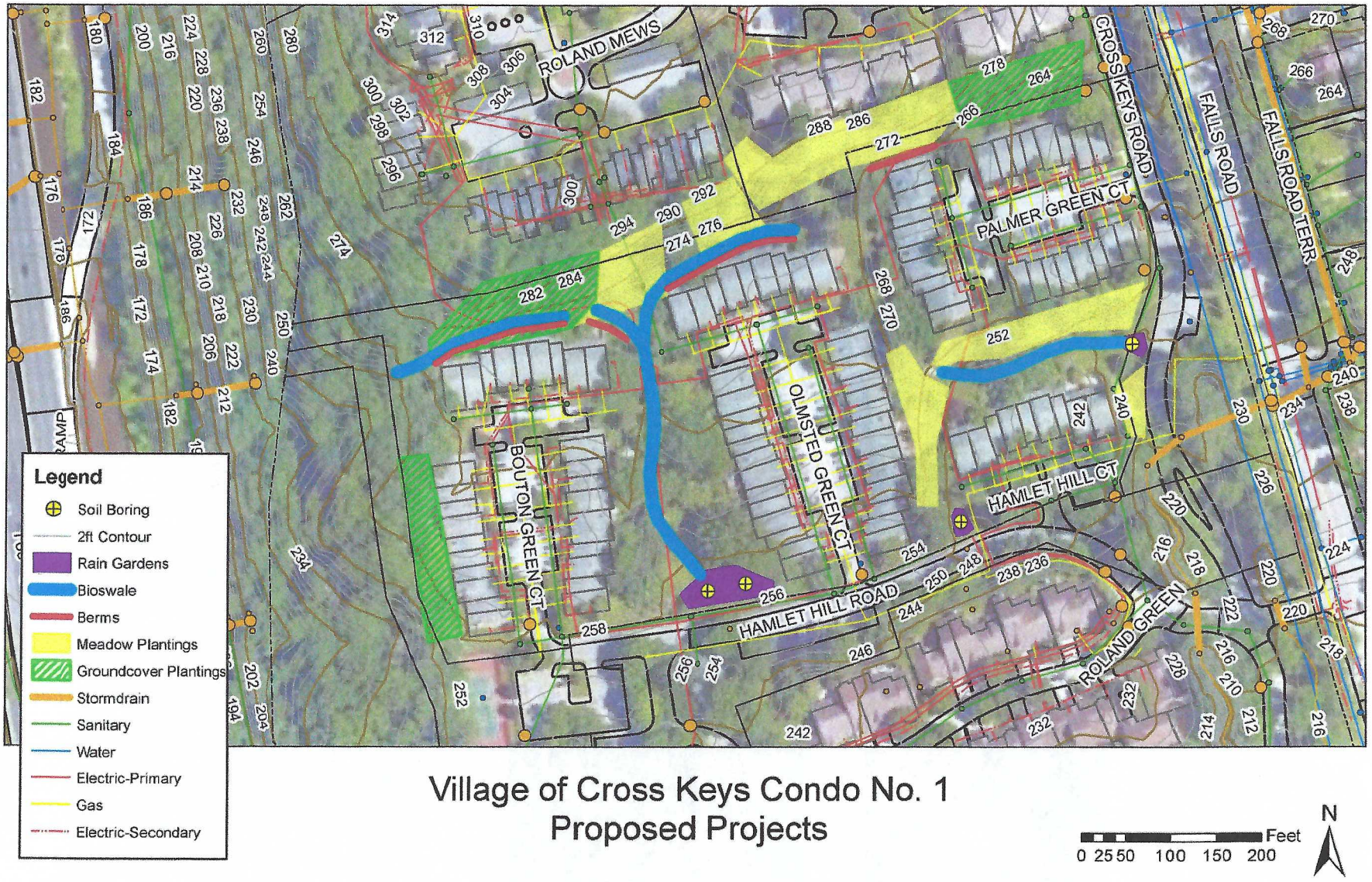

Figure 2. Proposed projects.

PROGRAMMATIC ACTIONS

P1. Establish dense groundcover and understory plantings on shaded hillsides. There are approximately 30,000 sf of shaded hillside that lack robust understory and groundcover. Planting these areas with dense groundcover plants and shrubs will help stabilize the slope and reduce soil erosion, allow for uptake and evapo-transpiration of water, and slow down runoff flowing from the slope. Deer resistant plantings must be selected to ensure plant viability. Due to the steep slopes, it is recommended that coir logs or natural fiber nets be installed to keep soil secure during plant establishment. Mulching should be done at planting and for the first 2 years to reduce weed growth. A list of recommended plants is included in Section 6 of this report.

Figure 3. (a) Existing shaded slope lacking groundcover. (b) and (c) Examples of healthy groundcover and understory.

Figure 4. Existing properties along west Bouton Green Ct. with (a) lack of groundcover and (b) established native groundcover.

P2. Meadow establishment on sunny hillsides. Roughly 1 acre of steep hillside that is currently mowed turf can be converted to native meadow. Meadow grasses and flowers grow long and deep roots that hold soils in place and soak up greater volumes of water than turf. Comparatively, the roots of common turf grasses only grow a couple inches deep as shown in the illustration below. Meadows can be an attractive site amenity that provide critical habitat for birds and pollinators. A meadow should be carefully planned to select site-appropriate species and will require a few years of close hands-on maintenance to get fully established. However, after these first few years the maintenance requirement will be far less costly and intensive than standard turf. The following is an excerpt from the North America Permaculture magazine,

> *"There are several ways to create a meadow in urban/suburban landscapes. No matter which you choose, be aware that a new meadow will probably take several years to become a relatively stable ecosystem. Establishing a meadow takes a bit more care than lawn. And meadow maintenance, while much less intensive than lawn care in terms of time, energy, and fossil fuels, requires a bit more knowledge and attention, a small price for the great pleasure of having a vibrant meadow in the landscape."*

Meadow areas are not intended for frequent foot traffic. If walking routes are desired through the meadow areas, a pathway can be periodically mowed or a designated path can be creating using mulch, gravel, or even pavement. A list of recommended plants is included in Section 6 of this report.

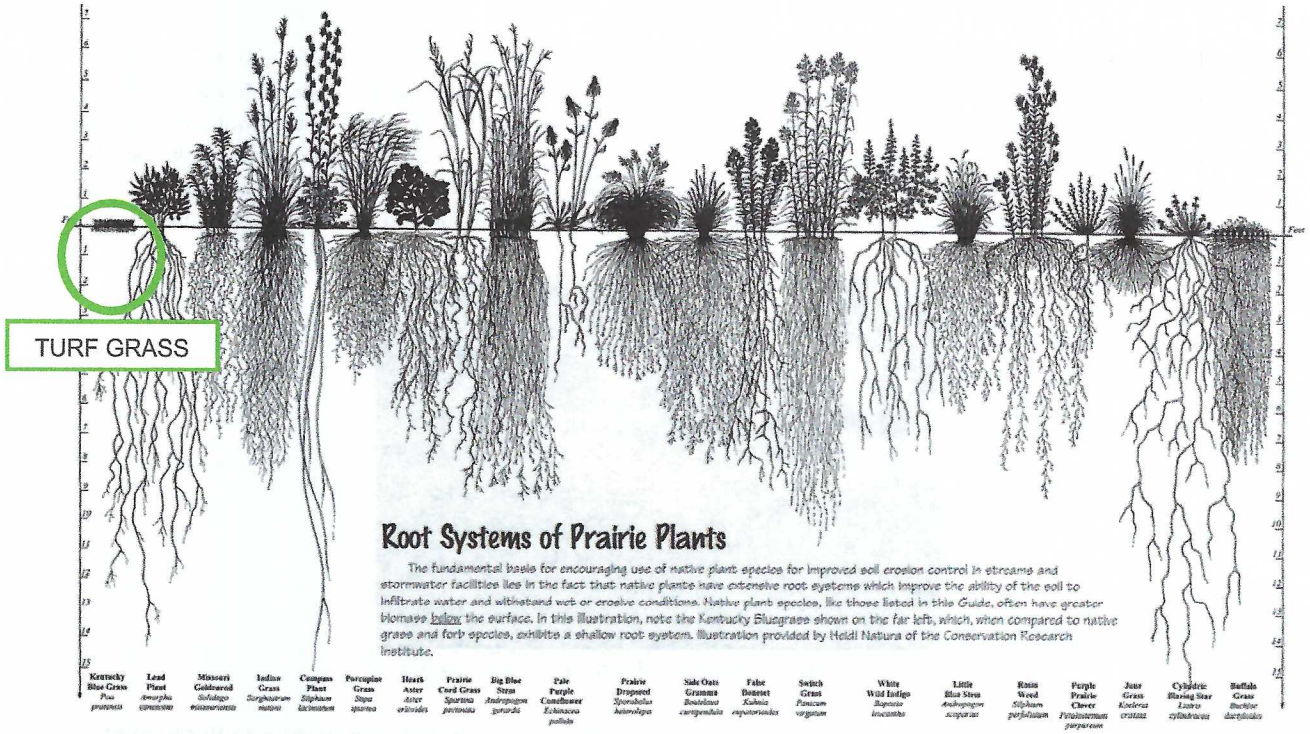

Figure 5. Root systems of meadow plants compared to turf grass. Illustration by Heidi Natura of the Conservation Research Institute.

Figure 6. (Top Row) Existing grassed slopes at Cross Keys Condo No. 1 area. (Bottom Row) Examples of urban meadow plantings.

P3. Plant more trees. A robust tree canopy helps intercept rainfall and can reduce runoff through evapotranspiration. Water loving trees can be planted in low lying areas to soak up ponded water. Contact Blue Water Baltimore (BWB) to engage residents to identify potential locations. There are numerous organizations, such as Baltimore Tree Trust, that BWB can partner with to install native trees at little or no cost to the community. A list of recommended water-loving native trees is included in Section 6.

P4. Aerate turf-area-soils and reduce mowing frequency. Turf groundcover functions poorly to absorb or slow stormwater runoff and provides minimal ecosystem benefits. Mowing of damp soils causes compaction and can result in tire rutting that causes bare spots and exacerbates erosion. Aerating the soils and allowing turf to reach 6, 8 or even 12 inches will promote denser plant cover, encourage growth of deeper roots, and discourage weed germination. When cut, the grass should be left 3-4 inches or longer to maintain a healthy plant base. Decreasing the frequency of mowing will reduce maintenance costs and result in reduced emissions from mowing equipment.

Figure 7. Examples of reduced mowing area.

P5. Evaluate turf management plan to decrease use of pesticides and fertilizers and promote tolerance of clover in lawn. Lawns are typically maintained using fertilizer and pesticides, a portion of which can be picked up by stormwater runoff and washed downstream. Pesticides can harm beneficial insects and earthworms, which are important for soil aeration and health. Uniform turfgrass provides no benefit to pollinators. Allowing clover to establish in a lawn presents numerous advantages. Clover attracts beneficial insects, does not require fertilizer or herbicides, out-competes other weeds, and grows well in poor soils. Clover is a member of the legume family and fixes nitrogen in the soil, beneficial to remaining turf grass. The specific lawn-care routine for Cross Keys Condo No. 1 area was not evaluated as part of this effort, so this report does not contain specific recommendations for improvement. However, we highly recommend an assessment of the existing routine to identify areas where sustainable turf management can be incorporated.

P6. Consider allowing rain barrels and encourage use by residents who garden. If not currently permitted, the Condo Association should consider allowing the use of rain barrels as part of their rules and regulations. Rain barrels can be installed on roof downspouts to collect water and reduce flow downstream. Collected water can be used to irrigate outdoor gardens or water houseplants. Rain barrels come in a variety of shapes and sizes and can be prominent or disguised in a landscape. They require simple installation and can be done by a handy homeowner or by service providers such as Blue Water Baltimore. Residents should be educated on water reuse options and simple rain barrel maintenance needs.

Figure 7. Examples of rain barrels, which typically hold 50 gallons, each.

STRUCTURAL ACTIONS

S1. Design and construct earthen, planted, or stacked stone berms and swales, re-grading to direct water away from structures. Along the north side of the property, rainfall runoff flows rapidly down the steep hillslope and into the back portions of several properties. The authors suspect that historically, drainage swales directed water from behind the homes around to the sides and eventually to receiving stormdrain inlets. Over time these swales have likely filled in due to accumulation of sediment from eroding slope soils, lack of adequate maintenance, and possibly other site improvement activities (i.e. utility work with unintended regrading). Improving groundcover and plantings on the upstream slopes can help to reduce the volume of water flowing downhill, but it will not entirely eliminate runoff, particularly during high-intensity rainfall events. This runoff can be directed around the properties by re-grading swales and constructing berms to keep water away from properties. Berms can be sodded, planted, or even constructed from stone to create a barrier to hold back water. Figure 7 illustrates a simple berm and swale design. A drainage engineer can determine the required height and dimensions of the berm. The recent grading improvement at Hamlett Hill demonstrates how soil can be mounded to redirect water along an intended drainage swale. Figure 2 shows the specific locations where additional berm structures are proposed.

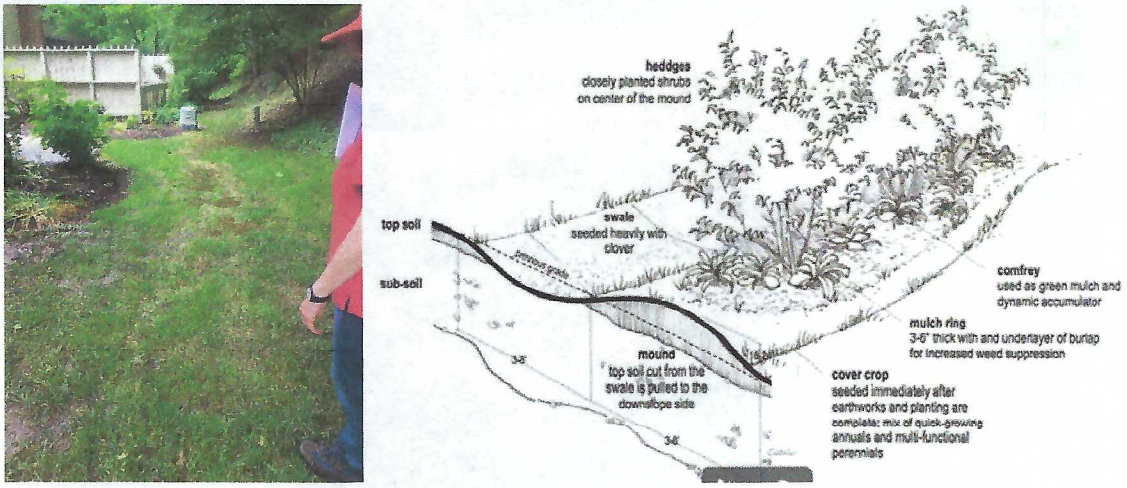

Figure 8. (a) Existing conditions along back of homes. (b) Illustration of a berm and swale design.

S2. Design and construct planted bioswales or dry creek beds to slow runoff and convey water to desired locations. There are several large, wide areas of maintained turf grass in the Condo No. 1 area. In particular, the spaces between Bouton Green and Olmsted Courts and Palmer Green and Hamlett Hill Courts. Stormwater runoff from upslope is conveyed directly through these areas to the downstream stormdrain inlets. At the time of site inspection, the soil in these areas was soggy and contained shallow ponded water, despite 3 days of dry weather. These areas are well suited for construction of stormwater

bioswales- vegetated channels that serve to slow, filter, and convey stormwater runoff. Creation of defined bioswales can direct water along an intended flow path and reduce nuisance ponding from perimeter areas. Due to the poor draining quality of the site soils, underdrains should be considered to further alleviate surface ponding. Underdrains are perforated drain pipes installed just beneath the soil surface and connected to the downstream stormdrain to more quickly drain ponded water It is understood that these areas are used by residents mainly for dog walking purposes. Depending on the desired use for these spaces, walking trails, landscape bridges, and other features can be integrated into the design to accommodate resident interest. There is an underground electrical utility is present in the space between Bouton Green and Olmsted Courts that must be considered and avoided during project design.

Figure 9. (a and b) Existing open spaces for potential bioswale construction. (c and d) Example bioswale construction at the Deering Woods Condominium Association in Columbia, MD. (e) Additional example of a bioswale.

S3. Design and construct rain gardens with underdrains near stormwater inlets to manage and filter stormwater runoff. Similar to bioswales, rain gardens help slow and filter stormwater runoff. Rather than convey runoff, they capture and hold water and allow it to percolate through enhanced topsoil, evaporate or transpire through vegetation, and eventually drain through an engineered underdrain system. Since the soils are not well draining, the use of underdrains is recommended. The underdrains can be connected to stormdrain inlets located in proximity to the proposed rain gardens. Rain gardens are typically densely planted with native plants that provide aesthetic and habitat benefits.

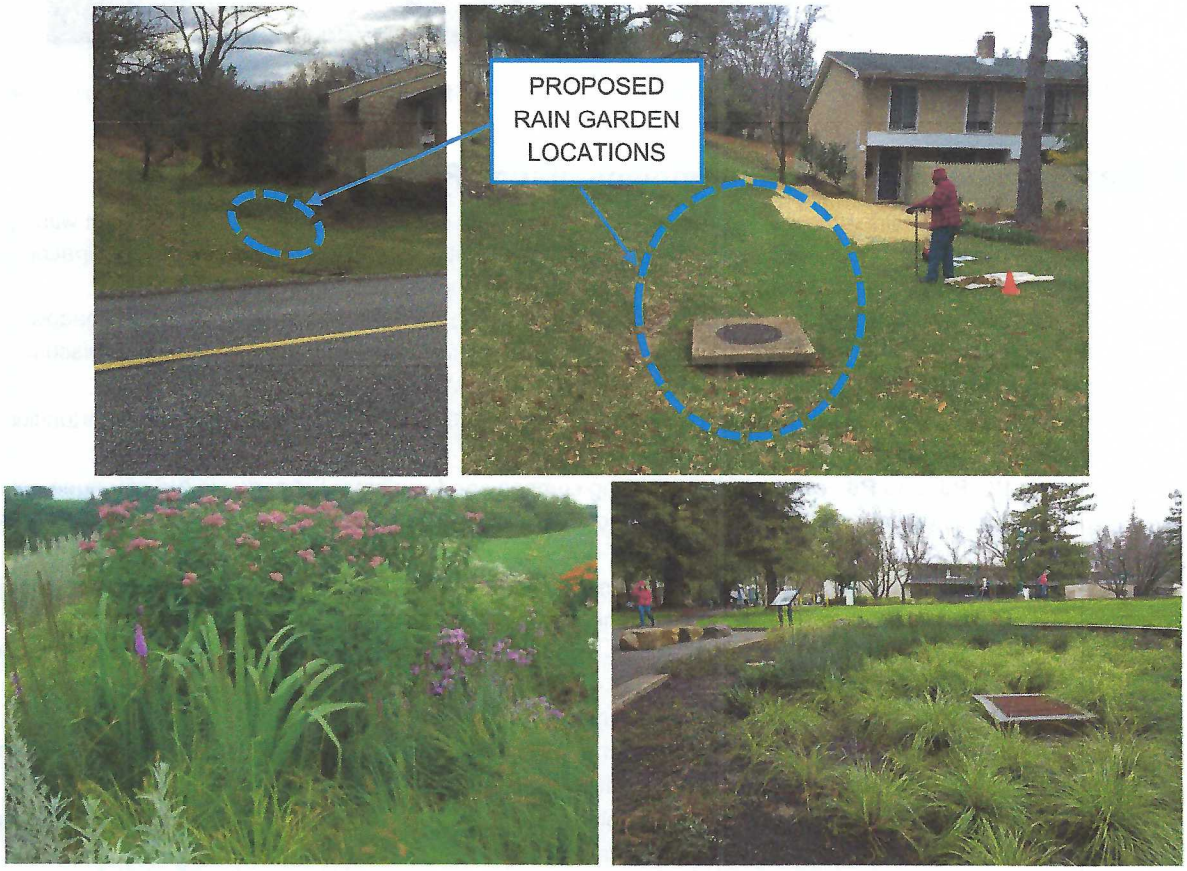

Figure 10. (Top row) Proposed locations for rain gardens. (Bottom Row) Examples of rain gardens.

S4. Outfall stabilization. Stabilization of pipe outfalls in the woods along the Jones Falls will help prevent further erosion and silting downstream. Significant erosion was noted at an outfall pipe just north of Condo No. 1 area and is outside the scope of this report. The main outfall from the Condo. No. 1 area was not mapped or located, but scour was observed at a smaller, 4-5" pipe handling the downspouts from the top group Condo No. 1 properties. The site should be fully assessed for outfall locations to evaluate the extent and severity of erosion. For areas of minor outfall erosion, rock or plants can be placed to hold soil in place. At more severely eroded outfalls, step pool stormwater conveyance systems (SPSCs) can be considered to stabilize the channel in an environmentally friendly manner. SPSCs can slow down the conveyance of water down the hillslope and improve water quality through similar mechanisms as bioswales and raingardens.

Figure 11. (a) Existing outfall in need of stabilization, and (b) Example step pool stormwater conveyance system.

5. Recommended Actions and Implementation Plan

1. Present plan to residents and gather feedback. Solicit input on how residents currently interact with open space property and their vision for improvements. Gauge interest in rain barrel program participation and locations for individual tree planting. Re-prioritize options if needed. (Winter 2019).
2. Review the existing site landscape maintenance plan and costs. Identify possible areas for meadow establishment, reduced mowing, and more environmentally focused maintenance strategies. Discuss potential strategies with property managers and residents. (Winter/Spring 2019)
3. Consider applying for grant funding to support Actions P1, S2, S3, and P2. A list of grant opportunities is included in Section 6.
4. **Action P5, P3, and P6.** Meet with landscaping company and implement changes in turf management protocols. Coordinate with Blue Water Baltimore and residents to plant trees and install rain barrels. (Spring 2019)
5. **Action S4 (Part 1).** Perform follow up assessment of outfall conditions (Winter 2019). Document conditions and perform minor stabilization of outfalls as needed.
6. **Action S1.** Construct berms below hillslopes. Consult with civil engineer for sizing and to develop design drawings. It is anticipated that this project will disturb less than 5,000 square feet of area, and thus a simplified grading permit will be required. (Spring 2019)
7. **Action P4.** Implement areas of reduced mowing. This could begin as a trial run on test areas to see how residents respond, and later expanded to the full areas shown in Figure 2. (Spring/Summer 2019)
8. **Action P1.** Plant the shaded hillsides to establish groundcover and understory. Consult with a landscape architect to develop a sustainable planting plan and maintenance schedule. (Fall 2019)
9. **Action S2.** Design and install bioswales in locations shown. Consult with civil engineer for sizing and to develop design drawings. This project may exceed 5,000 square feet of disturbance which would require full City plan review and permitting. This effort is anticipated to take 1-2 years for design and construction and could be funded through several grant opportunities. (Design Fall 2019-Fall 2020. Construction Spring/Summer 2021)
10. **Action S3.** Design and install rain gardens. Consult with civil engineer for sizing and to develop design drawings. It is anticipated that this project will be less than 5,000 square feet of disturbance and a simplified grading permit will be required. Ideally, these practices should be installed following construction of upstream bioswales to prevent damage and ensure drainage area is stabilized. (Fall 2021)
11. **Action P2.** Plant the sunny hillsides to establish meadow. Consult a landscape architect with native meadow experience to develop a sustainable planting plan, establishment period, and maintenance schedule. Ensure that a robust meadow establishment plan is in place. Consider expanding no-mow zones based on feedback from action P4. (Winter/Spring 2022)
12. **Action S4 (Part 2, as needed).** Stabilization of significantly eroded outfalls will require significant design and permitting to implement. (Year 2022)

Table 2. Implementation Plan

Priority	Strategy Number	Description	Timeline
1		Review Plan with residents	Winter 2019
2		Review existing site maintenance	Winter/Spring 2019
3		Review Grant Opportunities	Winter/Spring 2019
4	P5	Turf Management	Spring 2019
4	P3	Tree Planting	Spring 2019
4	P6	Rain Barrels	Spring 2019
5	S1	Berms	Spring 2019
6	P4	Reduced Mowing	Spring/Summer 2019
7	P1	Plant Shaded Hillsides	Fall 2019
8	S2	Bioswales and Dry Creek Beds	Fall 2019-Summer 2021
9	S3	Rain Gardens	Fall 2021
10	P2	Meadow Establishment	Winter/Spring 2022
11	S4	Outfall Stabilization	2022+

6. Resources and References

A. GRANT OPPORTUNITIES

Several environmental improvement grants are available through national and local foundations for funding. Typically, these grants are only available to Not-for-profit entities, such as BWB and Parks and People Foundation (PPF). However, the strategies identified in this report closely align with the missions of these local non-profits, and we recommend that the Cross Keys Condo No. 1 consider partnership with BWB or PPF to apply for funding. Table 3 outlines the recommended grant opportunities, approximate due dates based on previous grant announcements, and typical funding amount.

Table 3. Potential Funding Mechanisms

Historic Due Dates	Funder[1]	Program Name	Funding Amount
January	NFWF	5 Star and Urban Waters Restoration Grant	$20-50k
March	MDDNR	Community Resiliency	$75-100K
March	CBT	Green Streets, Green Jobs, Green Towns	$30K design, $75K Implementation
March	MDDNR	Chesapeake and Coastal Bay Trust Fund	$500k
September	CBT	Outreach and Restoration	$5-75K
September	CBT	Watershed Assistance	$5-75K
September	NFWF	Innovative Nutrient and Sediment Removal	$200K
September	NFWF	Small Watershed Grant	$75K
September	NFWF	Technical Assistance	$50K
Ongoing	PPF	Community Greening Grant	$5K?
Ongoing	CBT	Small Watershed Grant	$5K

[1]CBT = Chesapeake Bay Trust, MDDNR = Maryland Department of Natural Resource, and NFWF = National Fish and Wildlife Foundation

B. SUGGESTED PLANT LISTS FOR THE CROSS KEYS CONDO NO. 1 AREA

DENSE PLANTINGS (SHADED HILLSIDES)

Suckering shrubs:

- *Itea virginica*
- *Leucothoe axillaris*
- *Clethra alnifolia*
- *Ilex glabra*
- *Rhus aromatica*

Ferns:

- *Christmas ferns*
- *Hay scented ferns*
- *Eastern wood ferns*
- *Ostrich ferns*

Sedges:

- *Carex appalachica*
- *Carex laxiculmus 'Bunny Blue'*

WATER-LOVING TREES

- American Hornbeam
- Bald Cypress
- Black Gum
- Pin Oak
- Red Maple
- River Birch
- Sweet Bay Magnolia
- Sweet Gum
- Willow
- Willow Oak

DENSE MEADOW PLANTINGS (SUNNY HILLSIDES)

30-70% native grasses and sedges (examples)

- *Andropogon spp.*
- *Panicum spp.*
- *Schizachyrium spp.*

Perennials (examples)

- *Coneflowers*
- *Black-eyed Susans*
- *Liatris spp*
- *Rattlesnake Master*
- *Garden Phlox*
- *Sweet Fern*
- *Asters*
- *Perennial Sunflowers*

C. REFERENCES

Baltimore Sun Article, January 2, 2019. "2018 was Baltimore's wettest year on record. Here are the final numbers." https://www.baltimoresun.com/news/weather/bs-md-rain-record-numbers-20181115-story.html

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