



Erie, Pa

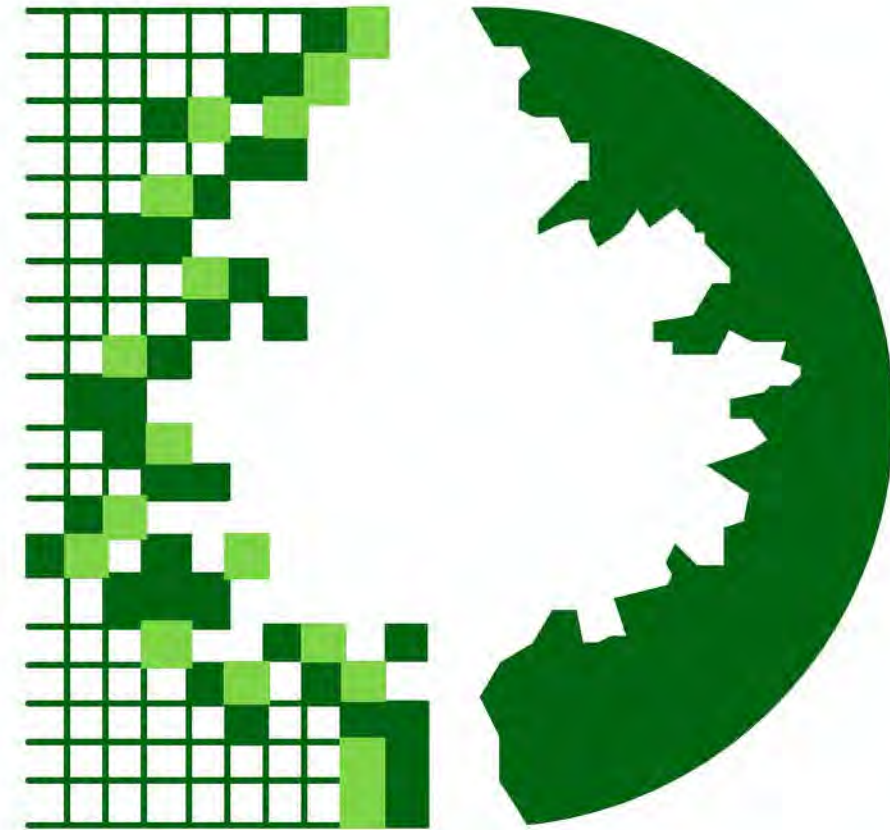
Bluff & Ravine Evaluation

February 26, 2020

Dahlkemper Landscape Architects & Contractors

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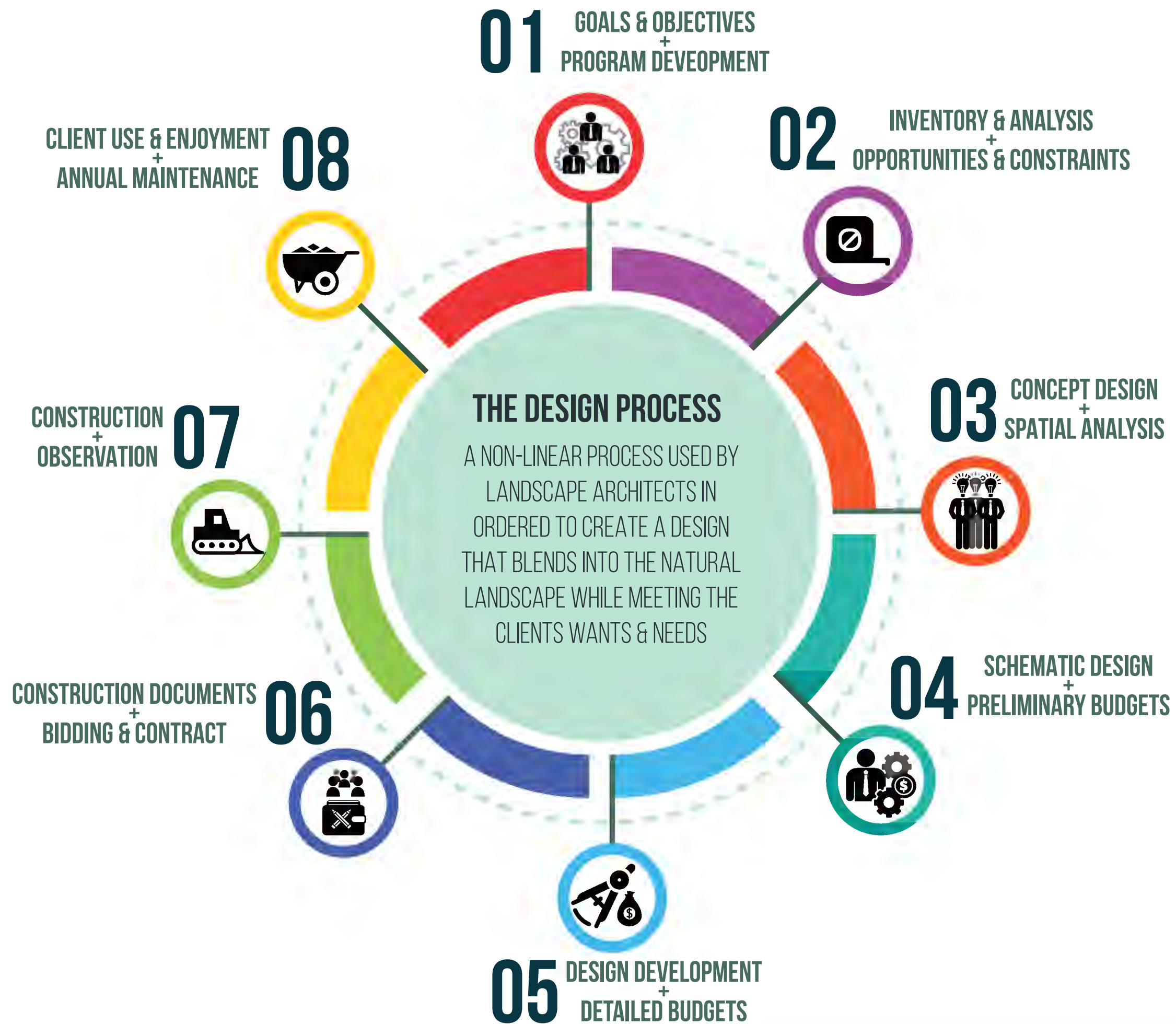


David N. Marino

Landscape Architect & Certified Arborist

Alexander W. Luddy

Landscape Architect



Acknowledgements

The Erie Western Pennsylvania Port Authority in collaboration with Dahlkemper Landscape Architects & Contractors.



**Dahlkemper
Landscape
Architects &
Contractors**
(814) 825-3253
1650 Norcross Road



The information presented in this package is part of an evaluation and recommendation study conducted on the Port Authority owned ravine and bluff properties located in Erie, Pa. The first part of the study was to evaluate the existing conditions at the following properties:

- 1.) Bayfront Bluffs: West - Cascade Street to Walnut Street
- 2.) Bayfront Bluffs: Central - Walnut Street to Peach Street
- 3.) Bayfront Bluffs: East - Holland Street to Parade Street
- 4.) Cascade Creek Bluff & Wetlands
- 5.) Ravine Park: Overall Top & Bottom along Yacht Club Road
- 6.) Ravine Park: Enlarged Area - Entrance to Yacht Club Road
- 7.) Ravine Park: Enlarged Area - Bayview Park

The evaluation focused on reviewing the Port Authority properties along the bluff and ravine areas to assess existing conditions and how the current maintenance practices are addressing the areas. Mainly the bluff stability concerns, regarding tree trimming, and soil, and water erosion: We also looked at identifying any encroachments and hazards in those areas. The second part of the program was to prioritize the concerns and provide recommendations and best management practices for handling those issues.

This information will be utilized by the Port Authority as a guide to properly maintain and manage their ravine & bluff properties so that they can be enjoyed by all users for generations to come.

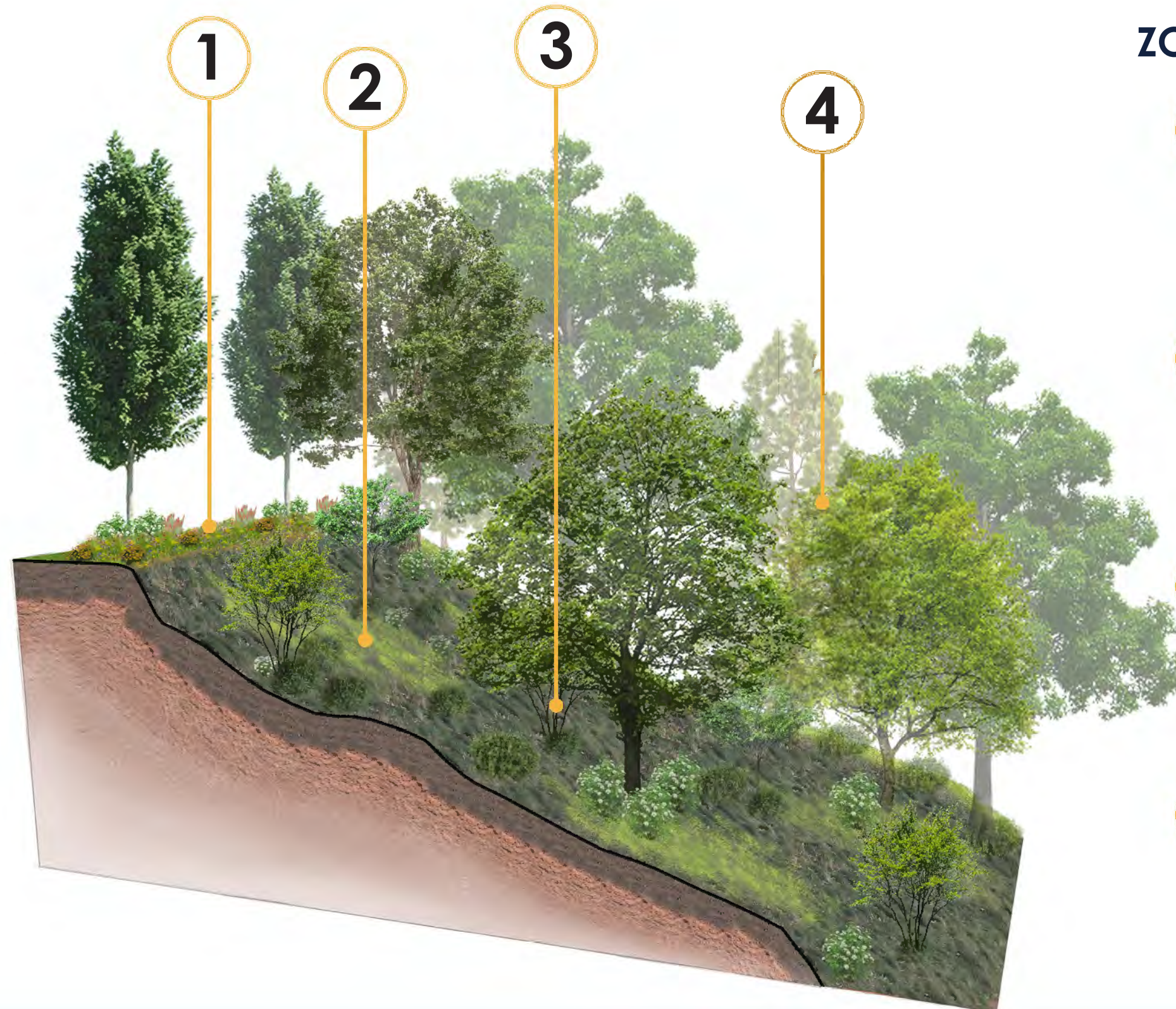


Ravines and bluff properties can vary from one site to the next. The ecosystems that make up these areas are highly variable. Factors such as steepness, aspect (the way the slope faces), how much sunlight they receive, how much moisture they receive, their soil profile, and the lands that surround them can create differences at each space. Generally, these areas were formed over many and many years by the natural process of erosion. As lands around these natural features continued to be developed thus increasing the amount of stormwater shedding off of impervious surfaces and loss of vegetation, the natural process of erosion has been accelerated. A healthy ravine and bluff has some of the following characteristics:

- Diverse native trees, shrubs, and herbaceous plants
- Healthy, properly maintained mature trees
- Stable soils and slopes

- Native buffer zones on the flat top lands
- Established ground vegetation with woody debris
- Structures setback from the slopes edge

- Diverse animal habitats
- Proper drainage (natural and/or man-made)
- No dumping including yard waste



ZONES OF A NATURAL RAVINE & BLUFF

1

The Buffer Zone

This zone is an important zone to help slow and filter stormwater before going down the slope face. This zone should be a minimum 10-feet from the bluffs edge and should include a diverse native planting

2

The Ground (lowest) Zone

This zone includes herbaceous and grass like plants that help stabilize the surface soil. This zone also helps to slow water for infiltration and trap sediment from moving down the slope face. Establishing this zone is important so that minimal bare soil is exposed.

3

The Middle Zone

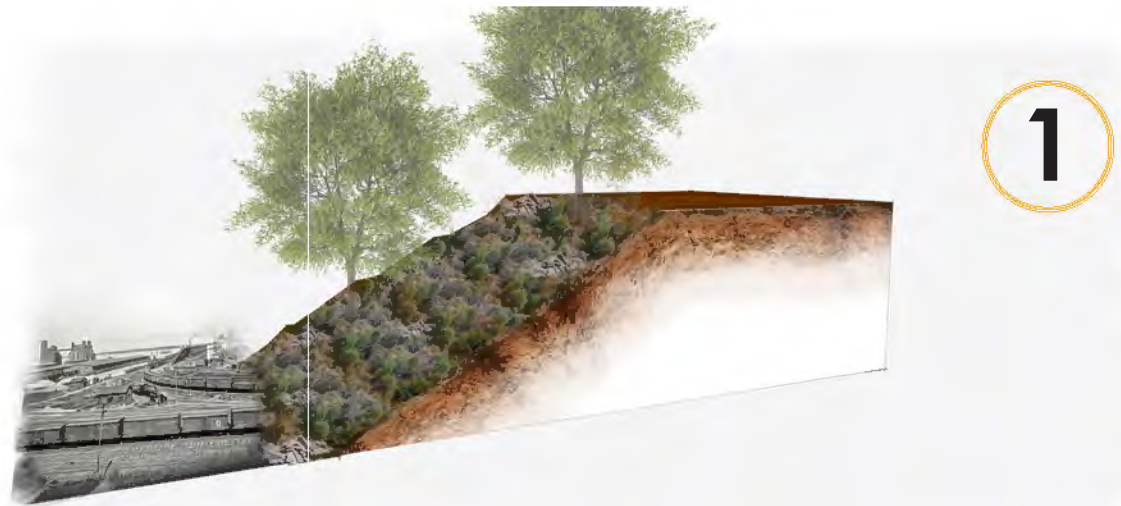
This includes shrubs and smaller understory trees. The vegetation in this zone produces larger roots than the ground zone which helps to stabilize the soil. This zone provides habitat and food sources for animals and birds.

4

The Upper Zone

This zone includes large deciduous and coniferous canopy trees that help protect the lower zones from too much sunlight and rain. The roots produced by this zone go deep and provide the most stability to the soil. Maintaining a proper density is key in this zone to allow enough sunlight to establish the other zones.

The Bayfront Bluffs were formed by natural processes but what we know today as the Bayfront Bluffs are not natural. The bluffs have been altered and modified significantly over the years by industry, railways, and man intervention. The land has been stripped, cleared, dumped, and revitalized at various stages over the deep rich history of Erie, Pa. The bluffs therefor are not a natural system as most of the land surrounding them has stormwater systems that captures and handles the majority of the stormwater. The bluffs therefor do not face some of the same natural threats that a natural ravine or bluff will face over its lifetime and thus is maintained differently than a natural system.



1

EVOLUTION OF THE BAYFRONT BLUFFS

1

Industrial Divide

Early on industry dominated the waterfront and the bluffs separated this industry from the town. Active coal and other industry rail lines ran along the base of the bluffs dumping material onto its slopes for decades. This industrial time modified the natural makeup of the soil and vegetation giving way to harsh conditions.

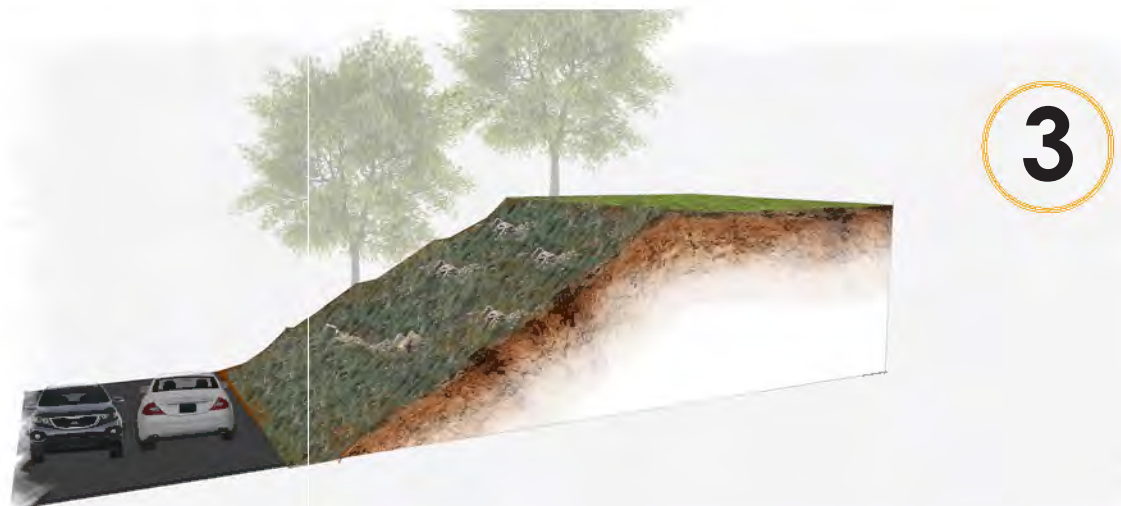


2

2

Dumping & Invasive Takeover

Prior to and as the Bayfront Highway was being developed the bluffs were used as a dumping location for decades. Anything from construction debris to private residential material. This created poor growing conditions that killed off most of the native vegetation and allowed invasive species to thrive. These invasive species took over the bluffs for decades created a green mass on the outside, but hid trash, debris, and other unsightly items for decades.



3

3

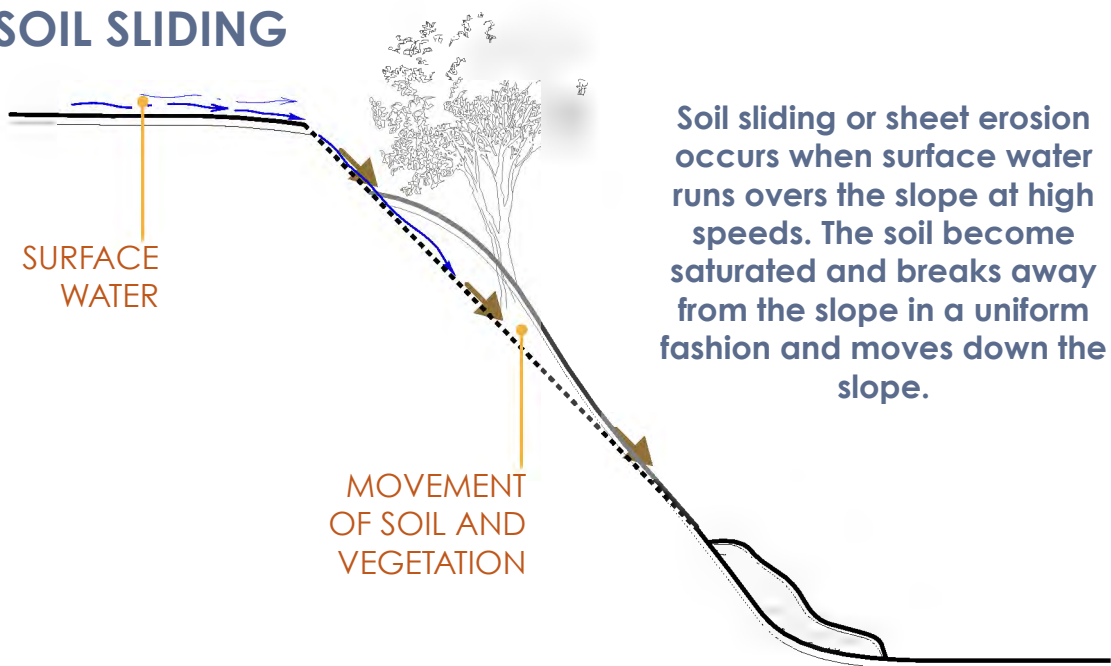
Clearing & Revitalization

In 2011 there was a joint community effort put together to take back the bluffs. This involved intensive clearing and debris removal. Due to the severity of the invasive species the entire area including most trees and vegetation had to be removed. This created a clean slate to plant native slope stabilizing grasses that soon thrived leaving what we now see today as we drive along the bayfront highway. The invasive species control is still an on-going battle.

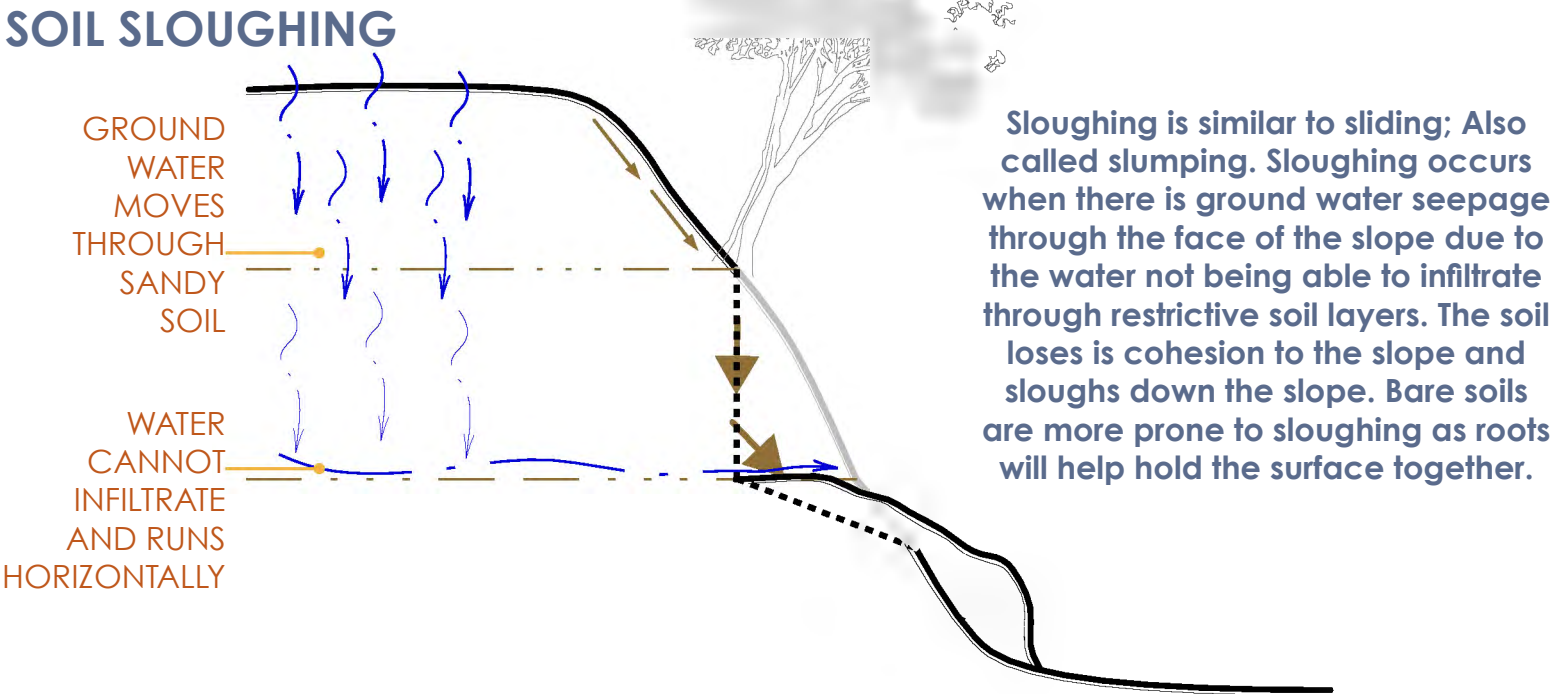
Erosion - A Natural Process

The process of erosion, over many years, is natural and ultimately what created the ravine and bluff properties in Erie, Pa. That same process, however, is also the biggest threat to the survival of these properties. The process is affected by many variables, however, the two most significant are the speed (and volume) of storm water runoff and the soil characteristics. While the soil and geology were established many years ago, the speed and volume of stormwater runoff is constantly affected by human intervention and development. As humans continue to develop land around ravines and bluffs the amount of impervious surface increases which in turn increases the amount of stormwater that cannot infiltrate and thus the volume (and speed) of stormwater runoff is increased. This increased volume and speed of stormwater causes erosion in ravines and bluffs in a variety of ways. Below are some of the common erosion threats ravine and bluff properties face due to this increase in stormwater runoff.

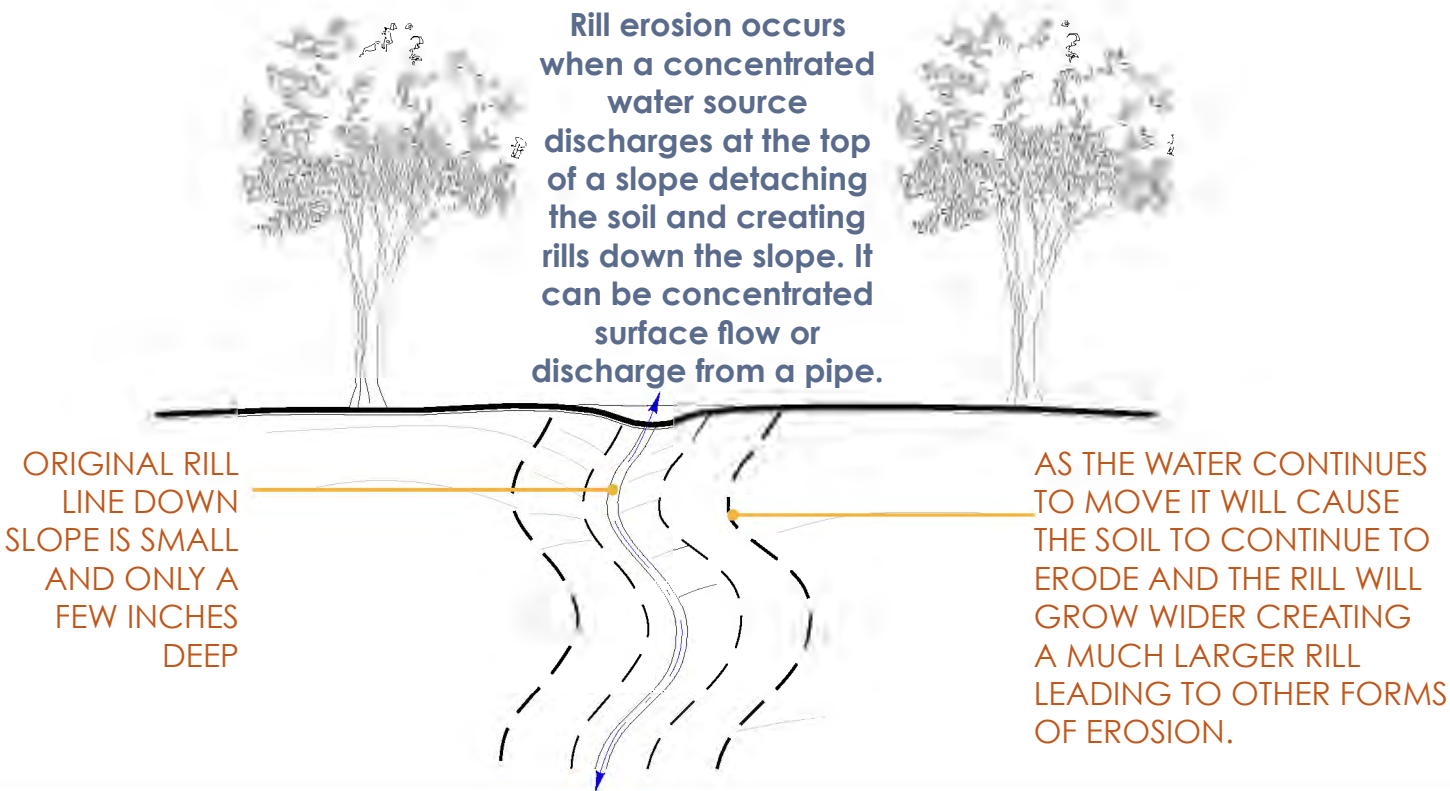
SOIL SLIDING



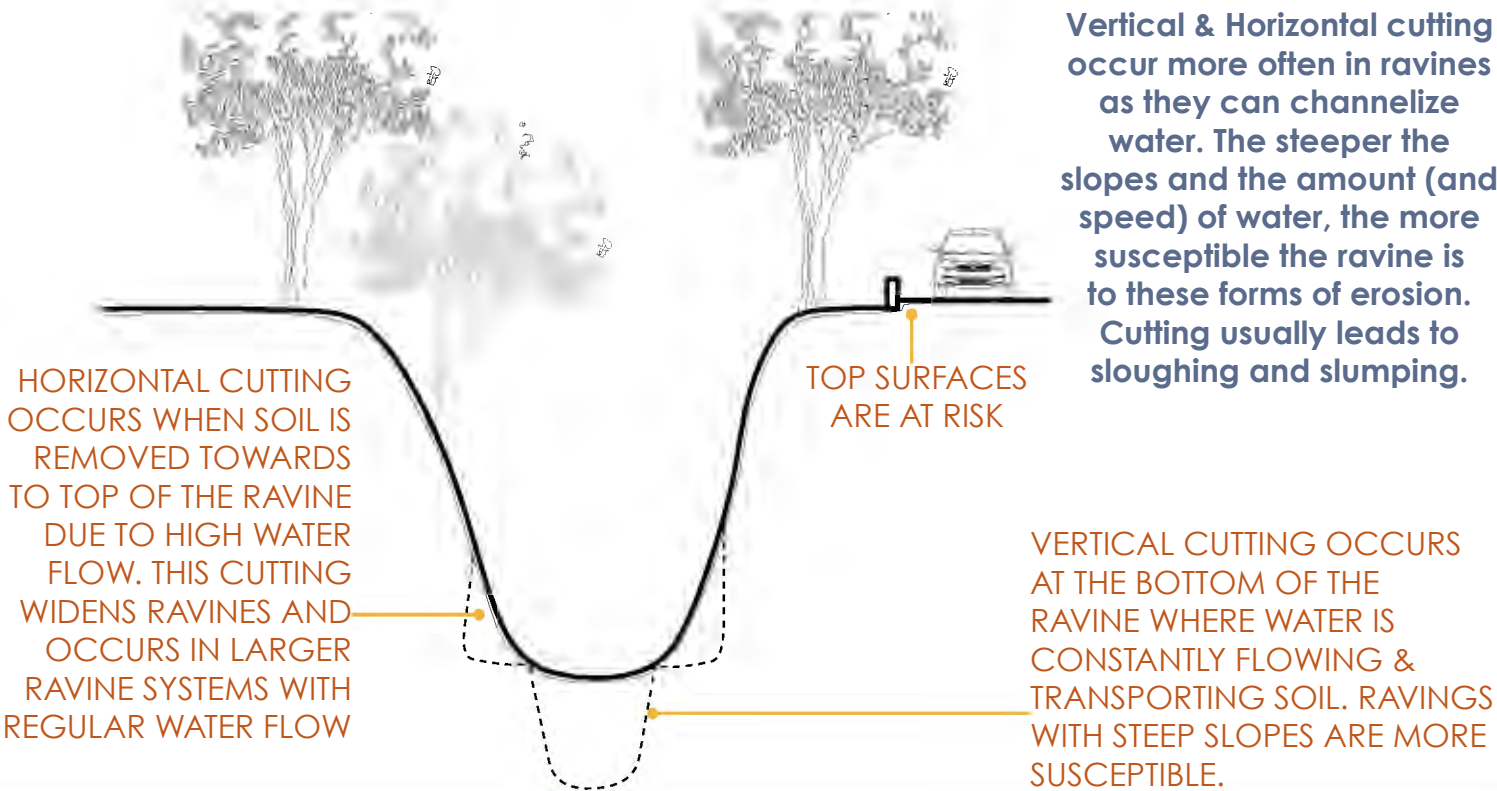
SOIL SLOUGHING



RILL EROSION



VERTICAL & HORIZONTAL CUTTING

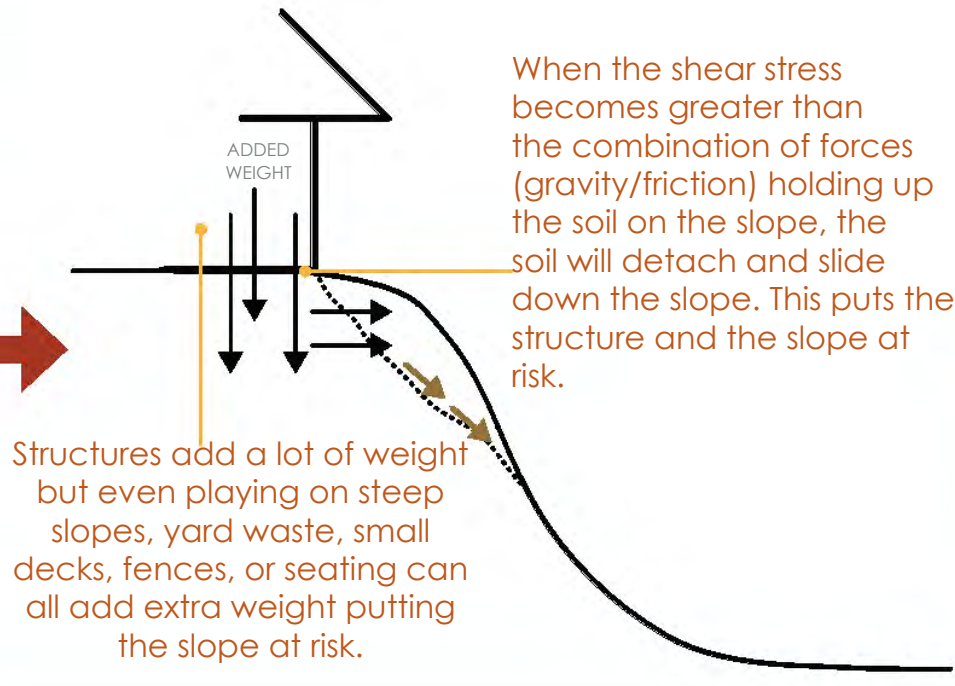


Dumping and Encroachment

Encroachment is when one property owners crosses his neighboring property line with a structure, surface, tree, or even waste. Encroaching onto public or private property is not only illegal, but even minor infractions can cause major issues for a bluff and ravine property as well as the owners of the property being encroached upon. Dumping yard waste (lawn clippings, leaves, branches, etc.) and other inorganic trash seems minor. Residents may even try to argue that it's the same as the leaves falling from the trees on the slope. Dumping creates a dense pile of debris (typically) at the top of a slope. This pile smothers any underlying vegetation, does not allow water to infiltrate, and adds extra weight to the top of the slope. Doing this hundreds or thousands of times across decades can cause catastrophic issues. Not allowing vegetation to grow leaves the slope bare which creates an unstable surface susceptible to sliding and sloughing. The extra weight on steep slopes will cause the waste along with the underlying soil to detach from the surface and slide down the slope.



In addition to leaving soil bare and susceptible to erosion, yard waste adds extra weight to the top of slopes. Along with yard waste, the encroachment of structures, buildings, play sets, and other activities at the top of slopes threatens the slopes leading to eventual failure. If an unauthorized structure is built on public land and causes failure there can be significant health and financial issues as a result.



Bulk Vegetation Removal

The removal of vegetation from a slope leaves bare soil vulnerable to erosion. In addition, vegetation provides valuable roots for soil stabilization and soaking up of water from the soil - removing these threatens the health of the slope.



Invasive Vegetation

Invasive species threaten the native plant communities by out competing and taking over large areas choking out anything from growing. If not controlled they can kill out important slope stabilizing vegetation leaving them at risk of erosion.



Improper Tree Trimming

Residents living near ravine and bluff properties want to enjoy their views leading to tree topping & poor trimming practices. This creates unhealthy diseased trees as well as dense canopies that will choke out any understory vegetation



Poor Stormwater Control

Water is one of the biggest threats to ravine and bluff properties. Improper discharging or controlling of stormwater on the surface can lead to major erosion and slope failure.



Existing Conditions

A

BAYFRONT BLUFFS

West: cascade st. to walnut st.
Central: walnut st. to peach st.
East: holland st. to parade st.

B

CASCADE CREEK

bluffs + natural wetland area

C

RAVINE PARK

overall ravine park drive
yacht club entrance
bayview ave lookout



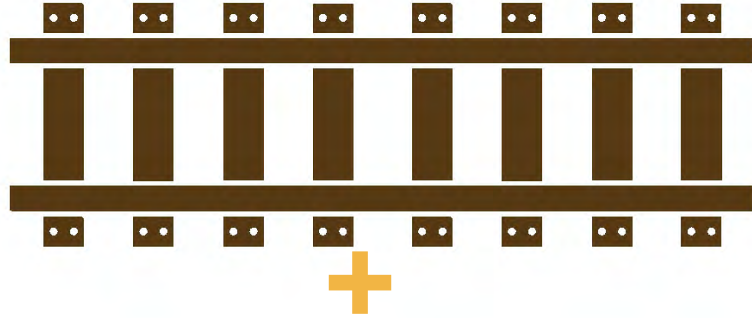


Well Established Ground Vegetation with Minimal Understory & Canopy Trees

BAYFRONT BLUFF ECOSYSTEM

Not a 'natural' system due to centuries of industry, development and man-made alterations.

The bluffs were separated from the water front by a rail system and industry for years. This was not conducive to healthy vegetation growth



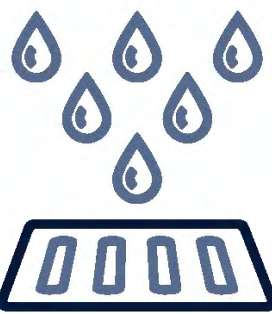
The bluffs were used as a dump for construction debris and residents trash for decades effectively altering any native soils to 'urban land'



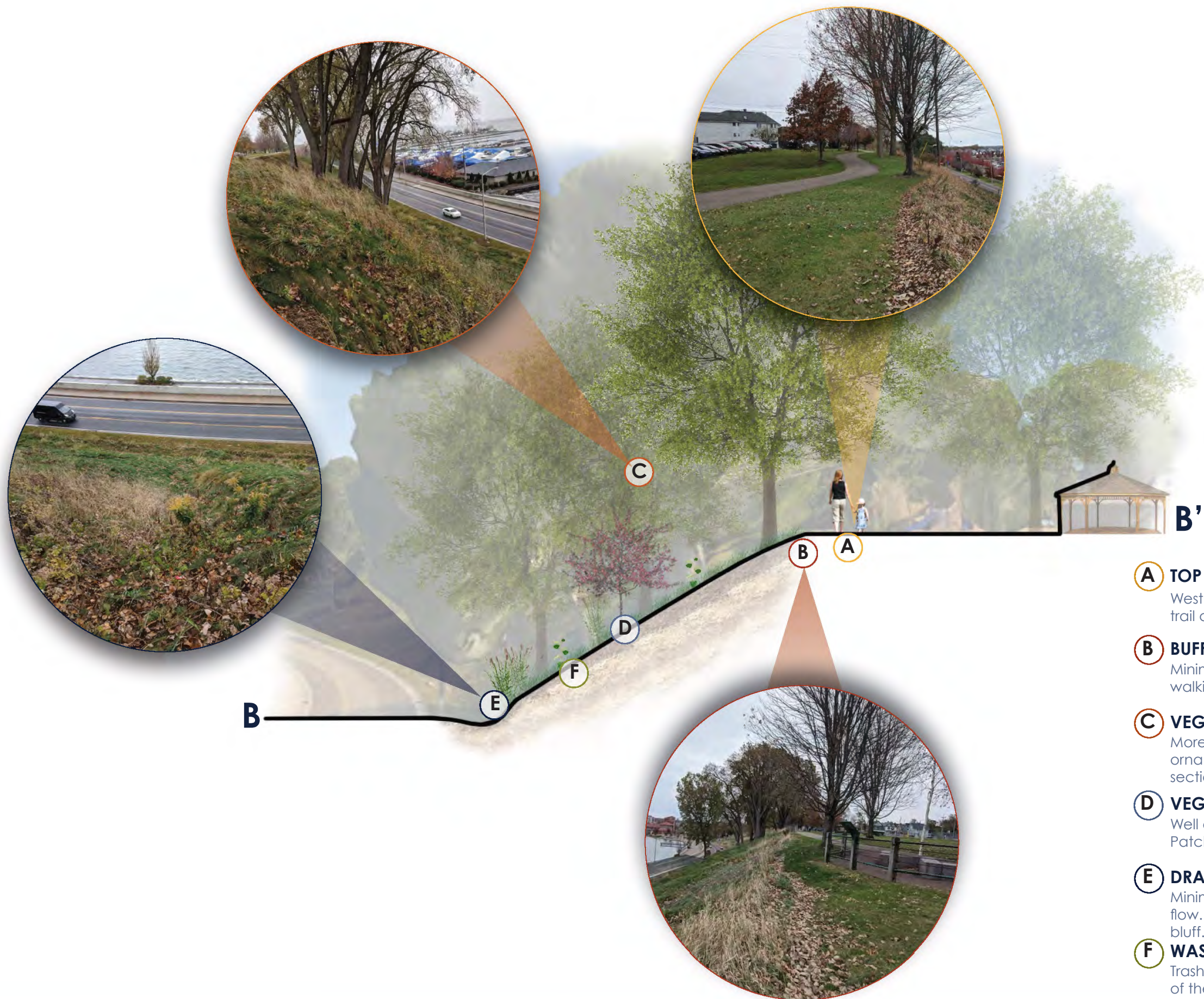
The harsh environment created allowed hardy aggressive invasive species to out compete any native vegetation. This lead to bulk vegetative clearing in 2011 which allowed the establishment of a slope stabilizing grass across all of the bluffs.



The constant development surrounding the bluffs includes excessive impervious surface that controls stormwater in an extensive drainage system removing the threat of natural ground water seepage and surface runoff



- A TOP SURFACE CONDITIONS**
West Bluffs has 10' wide asphalt trail with asphalt roadway and no curb along roadway.
- B BUFFER**
Wide green space but mowed to the edge of the slope - no vegetated buffers.
- C VEGETATION: TREES**
Minimal to no mature trees. A handful of small ornamental flowering trees scattered throughout bluff section.
- D VEGETATION: UNDERSTORY/GROUND**
Well establish low mow grass has stabilized the soil very well. Patches of invasive species throughout bluff section.
- E DRAINAGE/WATER**
Minimal rills created down hillside from channelized water flow.
- F WASTE/DEBRIS**
Trash & non-organic debris scattered throughout this section of the bluffs. Minimal yard waste discovered.



- A TOP SURFACE CONDITIONS**
West Bluffs between Cherry & Walnut has 10' wide asphalt trail at the top of the slope and green space on other side.
- B BUFFER**
Minimal green space as slope goes directly or close to walking trail leaving minimal space for a buffer.
- C VEGETATION: TREES**
More established mature trees and handful of small ornamental flowering trees scattered throughout bluff section.
- D VEGETATION: UNDERSTORY/GROUND**
Well establish low mow grass has stabilized the soil very well. Patches of invasive species throughout bluff section.
- E DRAINAGE/WATER**
Minimal rills created down hillside from channelized water flow. There is a swale with drainage along the toe of the bluff.
- F WASTE/DEBRIS**
Trash & non-organic debris scattered throughout this section of the bluffs. Minimal yard waste discovered.

Existing Conditions

Inventory & Analysis: Bayfront West - Cascade St. to Walnut St.

SOIL: Gageville Silt Loam (GaF); 18-50% slopes; 0-10" -silt loam, 10-22" -silt loam, 22-56" -clay loam, 56-80" -clay loam; moderately well drained
K-Factor: .43 - one of six factors used to predict the average annual rate of soil loss by sheet and rill erosion - ranges from .02 to .69 - the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

SOLAR/ASPECT: North facing slope; moist, shaded and cooler for longer periods of time.

No vegetated buffer at top of bluff. It is mowed to the edge. There is no curb along this stretch of road allowing all surface water to free flow over top of bluff

Drainage pipe discharges at mid-slope face and at top of slope sloughing is occurring

Rill created. Minor at top of slope currently, but is larger towards bottom of slope.

Polygonum cuspidatum
Japanese Knotweed

Phragmites australis
Common Reed

Water is beginning to undercut walkway through erosion at top of concrete sluice

Rill created. Large channel, but has established ground cover. Could increase in size if water flow increases

Wall is in poor condition with undermining occurring and crumbling concrete on both ends

RESILIENCE
Overall, the Bayfront Bluffs West has proved to be resilient to the adapting bayfront in Erie. Continuing to monitor and control invasives, addressing drainage issues, installing vegetated buffers and implementing green infrastructure to handle the increasing stormwater will allow the property to continue to be resilient for years to come.

OPPORTUNITIES:

- 1.) Well established grass/ground cover will allow the introduction of more canopy trees as well as understory shrubs and trees to further stabilize the slopes.
- 2.) Minimal established trees and flat table top areas at top of slopes allow for look-out/viewing stations.
- 3.) Flat open table top areas and no curbs along the road at top of slopes allow for potential rain gardens and native vegetated buffers to handle surface water flow.

CONSTRAINTS:

- 1.) Broken up parcels without single ownership doesn't allow for a cohesive maintenance and management plan across the entire bluffs.
- 2.) Steep slopes do not allow for any walking trail or recreation opportunities.

GENERAL SHEET NOTES:

- 1.) Control invasive species regularly across the bluffs as per established maintenance specifications.
- 2.) Maintain 10-15' vegetated buffer at top of slopes - do not mow to the edge of the slopes.
- 3.) Soil is overall stable with no immediate slumping or sliding.
- 4.) Minimal trees established across this section of bluffs.
- 5.) Dumping of trash and organic waste will need to be controlled and reduced.

LEGEND KEY



INVASIVE SPECIES



STRONG VIEWS



WATER/DRAINAGE CONCERNS



MATURE TREES



EROSION CONCERNS



NOT PORT AUTHORITY PROPERTY

Existing Conditions

Inventory & Analysis: Bayfront Context Plan





Existing trees can be thinned/pruned to improve view through them. Maintain vines so as not to choke out and kill healthy trees.

Well established grass covered slopes. Not very steep with ornamental tress planted. Mow down 1-2 times a year.



Polygonum cuspidatum
Japanese Knotweed



Phragmites australis
Common Reed

SOLAR/ASPECT: North facing slope; moist, shaded and cooler for longer periods of time.

SOIL: [Mostly] Gageville Silt Loam (GaF); 18-50% slopes; 0-10" -silt loam, 10-22" -silt loam, 22-56" -clay loam, 56-80" -clay loam; moderately well drained
K-Factor: .43 - one of six factors used to predict the average annual rate of soil loss by sheet and rill erosion - ranges from .02 to .69 - the higher the value, the more susceptible the soil is to sheet and rill erosion by water.
Urban Land makes up rest.



LEGEND KEY



RESILIENCE
Overall, the Bayfront Bluffs Central has proved to be resilient to the adapting bayfront in Erie. Properly maintaining the existing trees will increase the health of the trees allowing them to thrive and continue to provide important slope stabilizing roots. In addition, continuing to monitor and control invasives and implementing green infrastructure to handle the increasing stormwater will allow the property to continue to be resilient for years to come.



Stable ravine channel with established grass/ground cover. Could use canopy trees, understory trees and shrubs to maintain stabilization.

OPPORTUNITIES:

- 1.) Well established grass/ground cover will allow the introduction of more canopy trees as well as understory shrubs and trees to further stabilize the slopes.
- 2.) Least steep slopes of all Bayfront and established walkways in place opens up options for additional seating, lookouts, and other passive recreational opportunities.
- 3.) Stable and shallow slopes allow option to connect across Bayfront with pedestrian bridge.

CONSTRAINTS:

- 1.) Short table top where Bluffs are steeper goes directly to walkways - minimal area for any buffers.
- 2.) Surrounded by a lot of Urban/private land.

GENERAL SHEET NOTES:

- 1.) Control invasive species regularly across the bluffs as per established maintenance specifications.
- 2.) Soil is overall stable with no immediate slumping or sliding.
- 3.) Minimal trees established across this section of bluffs.
- 4.) Mow down low mow grass between Sassafra and State Street one to two times a year.

Existing Conditions

Inventory & Analysis: Bayfront Context Plan



Steep Slope Well Established Ground Vegetation with Minimal Understory & Few Canopy Trees



- A TOP SURFACE CONDITIONS**
East Bluffs has 10' wide asphalt trail with asphalt roadway and with concrete curb along roadway.
- B BUFFER**
Green space varies in width, but no established buffer along entire length - mowed directly to edge.
- C VEGETATION: TREES**
Mature trees exist on the top of the bluff with a few understory/small ornamental trees on the slope.
- D VEGETATION: UNDERSTORY/GROUND**
Well establish low mow grass has stabilized the soil very well. Large patches of invasive species throughout bluff section.
- E DRAINAGE/WATER**
Minimal rills created down hillside from channelized water flow with swale & standing water at toe of slope.
- F WASTE/DEBRIS**
Trash & non-organic debris scattered throughout this section of the bluffs. Yard waste discovered near tops of bluffs.

Existing Conditions

Inventory & Analysis: Bayfront East - Holland St. to Parade St.



Steep bluff slope crests right at the edge of the walkway. Erosion is undermining the walk and causing it to tip down the slope. Wood retaining wall measures have been put in place at locations.



A swale holds water and debris along the majority of the bluff at the toe.



A rill is forming from the discharge of a drainage pipe at the top of the slope. Moving the pipe down the slope and discharging at the toe is preferred.



Polygonum cuspidatum
Japanese Knotweed



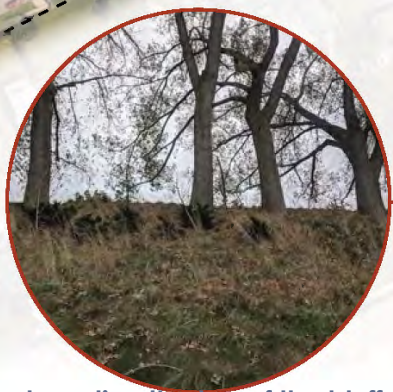
Phragmites australis
Common Reed

SOLAR/ASPECT: North facing slope; moist, shaded and cooler for longer periods of time.

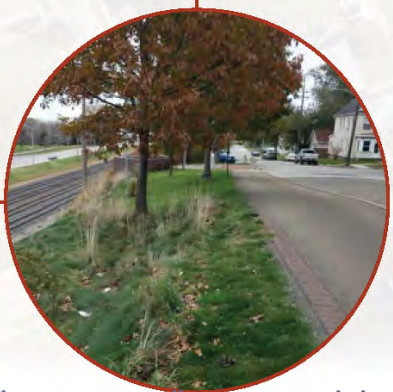
SOIL: Gageville Silt Loam (GaF); 18-50% slopes; 0-10" -silt loam, 10-22" -silt loam, 22-56" -clay loam, 56-80" -clay loam; moderately well drained
K-Factor: .43 - one of six factors used to predict the average annual rate of soil loss by sheet and rill erosion - ranges from .02 to .69 - the higher the value, the more susceptible the soil is to sheet and rill erosion by water.



No buffer at top of slope. Mowed right to the edge.



Mature trees line the top of the bluff. There are smaller ornamental trees along the majority of this stretch as well.



LEGEND KEY



INVASIVE SPECIES



STRONG VIEWS



WATER/DRAINAGE CONCERNS



MATURE TREES



EROSION CONCERNS



BUILDING/STRUCTURE



NOT PORT AUTHORITY PROPERTY



OPPORTUNITIES:

- 1.) Well established grass/ground cover will allow the introduction of more canopy trees as well as understory shrubs and trees to further stabilize the slopes.

CONSTRAINTS:

- 1.) Steepest slopes along Bayfront and do not allow for any walking trail or recreation opportunities.
- 2.) Tight space between walks/roadway at top of bluff makes buffer space limited.
- 3.) Large community of Japanese Knotweed to the East that will be a constant threat to the cleared areas.

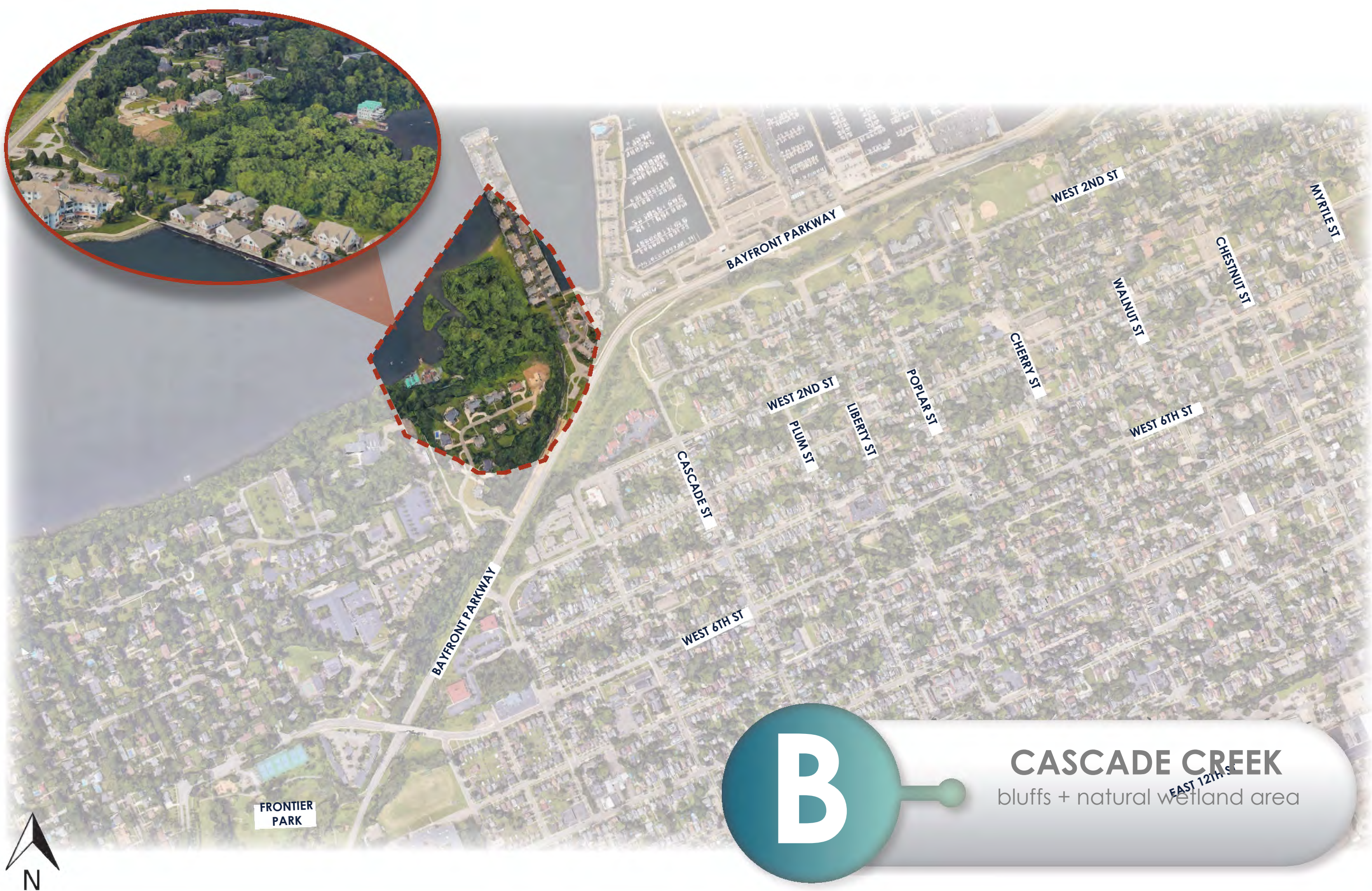
GENERAL SHEET NOTES:

- 1.) Control invasive species regularly across the bluffs as per established maintenance specifications.
- 2.) Maintain 10-15' vegetated buffer at top of slopes - do not mow to the edge of the slopes.
- 3.) Soil is overall stable with no immediate slumping or sliding.
- 4.) Dumping of trash and organic waste will need to be controlled and reduced.



RESILIENCE

Overall, the Bayfront Bluffs East has proved to be resilient to the adapting bayfront in Erie. Controlling the invasive species that are trying to take back over, installing vegetated buffers and implementing green infrastructure to handle the increasing stormwater will allow the property to continue to be resilient for years to come.





CASCADE CREEK ECOSYSTEM

The majority of the land owned by the Port Authority is a delta wetland at the mouth of Cascade Creek. The bluff slope is private property. The delta wetland is saturated by surface and/or ground water at frequent times through the seasons and there indicator plants throughout.

The vegetation that is found at the mouth of Cascade Creek are able to tolerate wet/saturated soil conditions as well as dry periods. This fluctuation in the water makes it a challenge to establish a dense ground cover and understory.

In addition, the area is flat so erosion is not as much of a concern throughout this area as it is on a slope face.

A TOP SURFACE CONDITIONS

Cascade Creek has large residential homes with roof surfaces, patios, decks, & expansive lawns

B BUFFER

Majority of home owners mow to the edge leaving no buffer but some vegetated buffers found along top of slope.

C VEGETATION: TREES

Mature trees exist but clear cutting and topping is happening regularly.

D VEGETATION: UNDERSTORY/GROUND

Dense canopy (where not clear cut) is not allowing an established ground cover. Dense thick brush in low land.

E DRAINAGE/WATER

Low land is wet and showing signs of wetland indicators.

F WASTE/DEBRIS

Yard waste and cut/cleared trees along slope. Low lands have cut & cleared trees along with trash and debris.



Existing Conditions

Inventory & Analysis: Cascade Creek

B



RESILIENCE

The Cascade Creek Wetland area is facing continued threats to its resiliency from the rising water levels due various factors. In addition, the invasive species thriving in the area are a threat to the native species. Implementing green infrastructure and Low Impact Development will help improve the areas resiliency to threats.

SOLAR/ ASPECT: North/Northwest facing slope; moist, shaded and cooler for longer periods of time.

SOIL: ON SLOPE:
Gageville Silt Loam (GaF); 18-50% slopes; 0-10" -silt loam, 10-22" -silt loam, 22-56" -clay loam, 56-80" -clay loam; moderately well drained
K-Factor: .43 - one of six factors used to predict the average annual rate of soil loss by sheet and rill erosion - ranges from .02 to .69 - the higher the value, the more susceptible the soil is to sheet and rill erosion by water.
ON FLAT LAND/BOTTOM SLOPE:
Udorthents sandy (UbC); 0-15% slopes; 0-4" very gravelly sandy loam, 4-28" very gravelly loamy coarse sand, 28-80" extremely gravelly loamy sand; Somewhat excessively drained
K-Factor: .05 - one of six factors used to predict the average annual rate of soil loss by sheet and rill erosion - ranges from .02 to .69 - the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Wetland plant indicators and other marks of high water indicate water levels can rise quickly

Tree topping and dropping of trees is happening in low land as well. Debris is left on site.

Clear cutting and in addition leaving the heavy debris on the hillside is adding extra weight to the already unstable soil as well as choking out any understory from establishing.

While not Port Authority property, tree topping and clear cutting is occurring on slopes leaving them susceptible to major erosion, sliding & slumping.

OPPORTUNITIES:

- 1.) Low land/bottom of slope has potential for a natural area with the use of minimal disturbance boardwalks to deal with water levels.
- 2.) We established trees will allow for selective clearing to establish a healthy understory.

CONSTRAINTS:

- 1.) Steepest slopes are private property so establishing a maintenance plan and upholding it will be difficult.
- 2.) High water levels at lower lands limit use during parts of the year.
- 3.) Dense vegetation/brush creates visibility issues and possible security concerns.

GENERAL SHEET NOTES:

- 1.) Steep banks are being clear cut and have no established ground cover or understory making them more susceptible to rill and sheet erosion.
- 2.) Low land/bottom of slope is susceptible to high water during periods of high lake levels - collects a lot of debris.
- 3.) Dumping of trash and organic waste will need to be controlled and reduced.

LEGEND KEY



INVASIVE SPECIES



ORGANIC DEBRIS



WATER/DRAINAGE CONCERNS



MATURE TREES



EROSION CONCERNS



TREES CUT/ CLEAR CUT



NOT PORT AUTHORITY PROPERTY



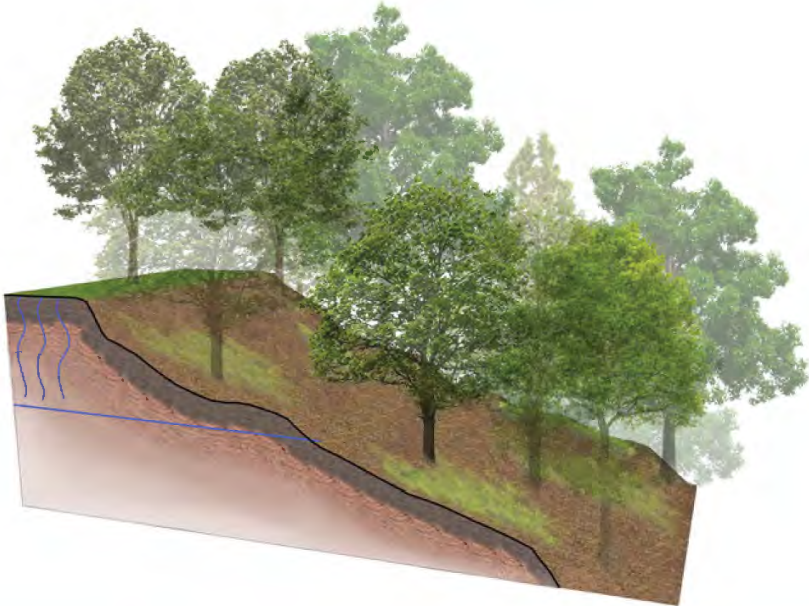
RAVINE PARK
overall ravine park drive
yacht club entrance
bayview ave lookout



RAVINE PARK ECOSYSTEM

A natural ravine system with natural dense vegetation growing including old growth trees. The ravine is surrounded by a lot of green space that is a constant ground water re-charge creating ground seepage & surface water runoff

The vegetation along Ravine Park needs maintenance, however, it's overall a natural ecosystem that has survived for centuries and is being threatened by man-made development.



- A TOP SURFACE CONDITIONS**
Ravine drive has green space at the top of slopes with residential homes. Any roadways has curbed edge
- B BUFFER**
No buffers along majority of ravine slopes. Residential owners and Port Property mow to edge.
- C VEGETATION: TREES**
Dense mature trees line the ravine slopes at top, bottom, and middle.
- D VEGETATION: UNDERSTORY/GROUND**
Minimal to no understory & ground cover due to dense canopy coverage from mature trees. Few invasives found.
- E DRAINAGE/WATER**
Swale runs along the east side of the ravine drive at the foot of the slopes with stormwater basins.
- F WASTE/DEBRIS**
A lot of yard waste, leaf litter, and other organic waste found all along Ravine slopes. In addition, trash & other debris found.

Existing Conditions

Inventory & Analysis: Ravine Park - Overall Yacht Club Road

SOIL: Gageville Silt Loam (GaF); 18-50% slopes; 0-10" - silt loam, 10-22" - silt loam, 22-56" - clay loam, 56-80" - clay loam; moderately well drained

K-Factor: .32 - one of six factors used to predict the average annual rate of soil loss by sheet and rill erosion - ranges from .02 to .69 - the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

SOLAR/ ASPECT: Yacht Club Road is mostly east & west facing; bayview is a north facing slope



There is a swale with storm drains located along the yacht club road on the east side of the road.



Solid concrete check dams with small pipe in place.



Organic yard waste including leaves, clippings, branches, and other material is being dumped at the top and on the ravine slopes.



Along the drive there are steep slopes susceptible to sliding/under cutting. Minimal understory/ground vegetation



RESILIENCE

Overall, Ravine Park is face numerous threats to it's resiliency. The consistent dumping, ground water seepage due to increase stormwater, and thick tree canopies has created slopes vulnerable to sliding, sloughing and eroding potentially creating hazards. Implementing low impact development and green infrastructure will be necessary in order to maintain it's resiliency.



Private sheds, shelters, tree houses, and other amenities are encroaching on Port Authority Property.

OPPORTUNITIES:

- 1.) Flat open areas at top of slopes can become small pocket parks: off of Bayview, Rosemont Ave and Off of Crescent Drive.
- 2.) Well established mature trees along entire Ravine Park site.

CONSTRAINTS:

- 1.) Steep slopes along entire Yacht Club road minimize opportunities.
- 2.) A lot of private owners dumping organic waste over slopes.
- 3.) Active two lane road (Ravine Dr) runs through park.
- 4.) Mature trees have created too dense of a canopy not allowing an understory or ground cover to properly establish.

GENERAL SHEET NOTES:

- 1.) Steep banks minimize a lot of recreational opportunities.
- 2.) Private owners are encroaching on Port Authority Property and have been for years.
- 3.) The massive amount of dumping of trash and organic waste will need to be controlled and reduced.

LEGEND KEY



STRONG VIEWS



ORGANIC DEBRIS



WATER/DRAINAGE CONCERNS



MATURE TREES



EROSION CONCERNS



TREES CUT/ CLEAR CUT



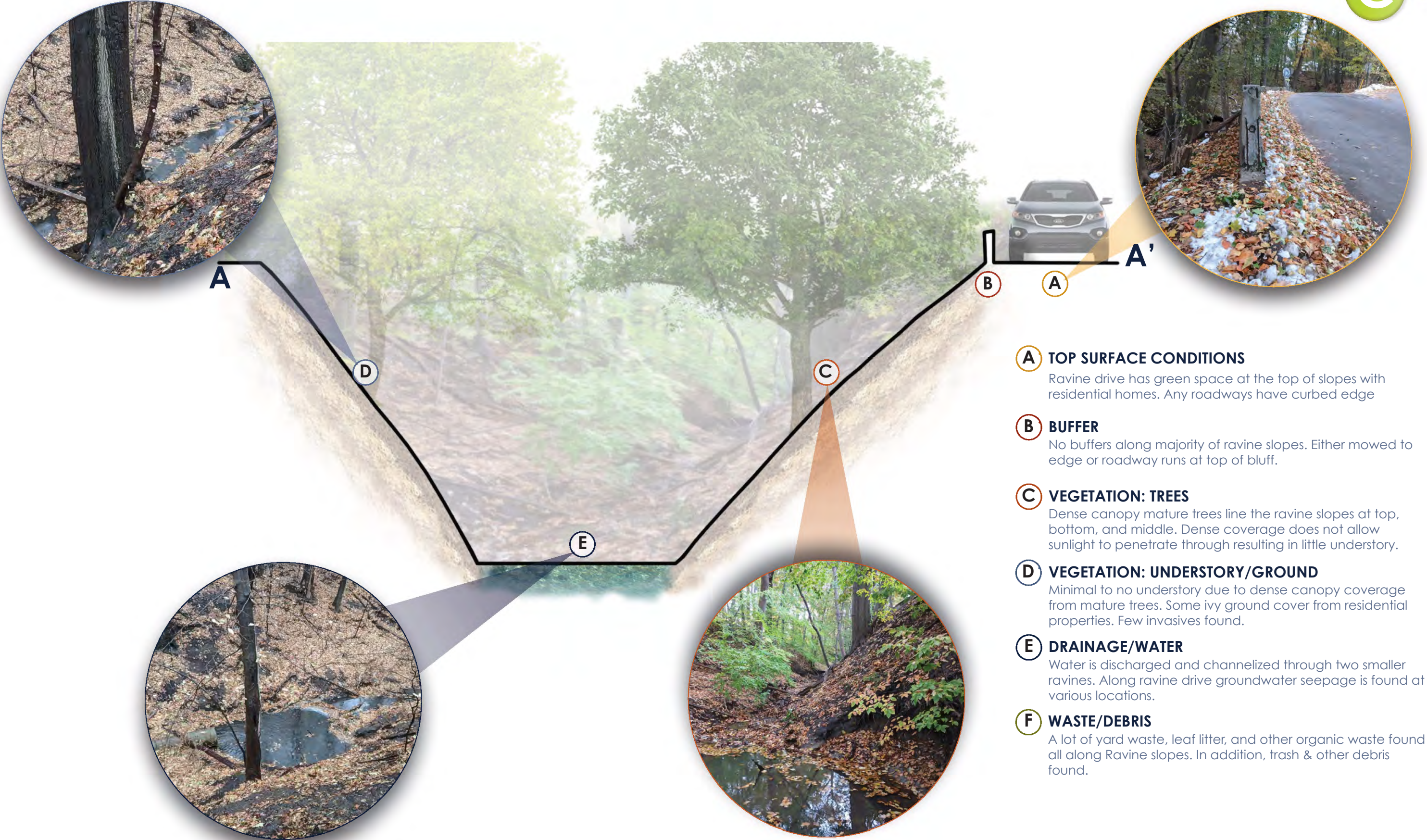
BUILDING/ STRUCTURE



NOT PORT AUTHORITY PROPERTY



Steep Slope Minimal Ground Cover with Minimal Understory & Dense Canopy Trees



- A TOP SURFACE CONDITIONS**
Ravine drive has green space at the top of slopes with residential homes. Any roadways have curbed edge
- B BUFFER**
No buffers along majority of ravine slopes. Either mowed to edge or roadway runs at top of bluff.
- C VEGETATION: TREES**
Dense canopy mature trees line the ravine slopes at top, bottom, and middle. Dense coverage does not allow sunlight to penetrate through resulting in little understory.
- D VEGETATION: UNDERSTORY/GROUND**
Minimal to no understory due to dense canopy coverage from mature trees. Some ivy ground cover from residential properties. Few invasives found.
- E DRAINAGE/WATER**
Water is discharged and channelized through two smaller ravines. Along ravine drive groundwater seepage is found at various locations.
- F WASTE/DEBRIS**
A lot of yard waste, leaf litter, and other organic waste found all along Ravine slopes. In addition, trash & other debris found.

Existing Conditions

Inventory & Analysis: Ravine Park -RP1- Entrance



SOLAR/ ASPECT: East & West facing slopes
SOIL:

Gageville Silt Loam (GaF); 18-50% slopes; 0-10" -silt loam, 10-22" -silt loam, 22-56" -clay loam, 56-80" -clay loam; moderately well drained
K-Factor: .32 - one of six factors used to predict the average annual rate of soil loss by sheet and rill erosion - ranges from .02 to .69 - the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

LEGEND KEY



BUILDING/
STRUCTURE



ORGANIC
DEBRIS



WATER/DRAINAGE
CONCERNS



MATURE
TREES



EROSION
CONCERNS



NOT PORT
AUTHORITY
PROPERTY



A shallow ravine funnels water towards a single storm drain and check dam.



Home owners are encroaching on Port Authority property with various structures.



Slope crests at road and concrete wall at bottom has failed. Heavy erosion/sliding is susceptible in this area on both sides. Minimal erosion control in places makes the rich organic soil susceptible to moving.



Shallow slopes filled with organic and trash debris, overgrown vines & understory.



Flat areas at top of slopes have potential for pocket parks. Private residents need to stop dumping yard litter.



Water discharges from a concrete tube directly at the toe of two steep slopes. Causing severe undercutting of the slope which will eventually undermines walls and the road. A lot of debris/fallen logs lay in path of water could cause blockage with large enough storm.



RESILIENCE

The entrance to Ravine Drive is seeing the effects of the increased stormwater and the current system in place is not adequate enough to handle this increase. Implementing green infrastructure will help improve the resiliency of this space.

OPPORTUNITIES:

1.) Natural area with established mature trees, water flowing, and lightly traffic area. Flat area at top of crescent drive provides seating opportunities.

CONSTRAINTS:

1.) Steep slopes right to impervious surfaces creating steep areas with minimal erosion protection.
2.) Water flows through this area undercutting some of the steep slopes.

GENERAL SHEET NOTES:

1.) Steep banks minimize a lot of recreational opportunities.
2.) Private owners are encroaching on Port Authority Property and have been for years.
3.) The massive amount of dumping of trash and organic waste will need to be controlled and reduced.
4.) Minimal to no erosion control measures in place where water discharges & flows.

Steep Slope Minimal Ground Cover with Minimal Understory & Dense Canopy Trees



A TOP SURFACE CONDITIONS

Bayview area has greenspace including residential backyards and a curbed roadway.

B BUFFER

No buffers along bayview slopes. Residential and Port Authority mow to edge of bluff.

C VEGETATION: TREES

Dense mature trees found in the middle and lower part of the slope. They have dense irregular branching patters as a result from topping & trimming for sightlines. The dense canopy does not allow light to penetrate through to the ground.

D VEGETATION: UNDERSTORY/GROUND

Woody shrubs found towards the upper portion of the slopes where sunlight is ample. Minimal to no understory in the middle and lower part of the slope due to dense canopy coverage from mature trees. Some ivy ground cover from residential properties. Few invasives found.

E DRAINAGE/WATER

Slopes are wet with ground water seeps at various locations.

F WASTE/DEBRIS

A lot of yard waste, leaf litter, and other organic waste found all along Ravine slopes. In addition, trash & other debris found.

GENERAL SHEET NOTES:

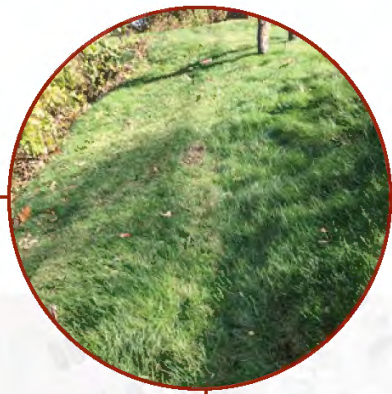
- 1.) Sloughing is occurring at various locations due to ground water seepage discharging at the slope face resulting in steep and bare slope faces. In addition, wet & soft areas are left unstable.
- 2.) Dry and firm surface soils with small clusters of large trees and more stable slope conditions are present between the slough areas.

Existing Conditions

Inventory & Analysis: Ravine Park - RP2- Bayview



Erosion is occurring down the slop and at the top of the slope where the lawn is mowed directly to the edge of the slope. Slumping is evident in the lawn area as its starting to erode down the hill.



Bare steep slopes with a lot of added organic matter and clear cutting of trees is making slope susceptible to sliding.



A snake grass/horsetail is spreading rapidly along the east side of the ravine. Most likely established through dumping.



SOLAR/ ASPECT: North/Northwest facing slope; moist, shaded and cooler for longer periods of time.

SOIL: Gageville Silt Loam (GaF); 18-50% slopes; 0-10" -silt loam, 10-22" -silt loam, 22-56" -clay loam, 56-80" -clay loam; moderately well drained
K-Factor: .32 - one of six factors used to predict the average annual rate of soil loss by sheet and rill erosion - ranges from .02 to .69 - the higher the value, the more susceptible the soil is to sheet and rill erosion by water.



Plant, shrub, and grass clippings dumped in heavy piles.



Structure encroached on the Port Authority Property

LEGEND KEY



INVASIVE SPECIES



ORGANIC DEBRIS



WATER/DRAINAGE CONCERNS



MATURE TREES



EROSION CONCERNS



TREES CUT/ CLEAR CUT



BUILDING/ STRUCTURE



STRONG VIEWS



NOT PORT AUTHORITY PROPERTY



RESILIENCE

The north end of Ravine Park & off of Bayview Ave has seen catastrophic events take place due to the increased stormwater causing major sliding to occur. Green infrastructure has been implemented on a portion of the slopes, but addressing similar issues across all of the slopes will help the area maintain its resiliency for years to come.

OPPORTUNITIES:

1.) Flat area at top of slope can provide connection from Bayview lookout to Rosemont Ave potential park.

CONSTRAINTS:

- 1.) Steep slopes along entire Yacht Club road minimize opportunities.
- 2.) A lot of private owners dumping organic waste over slopes.
- 3.) Slopes have a lot of ground water discharge and rich organic soil making them unstable.

GENERAL SHEET NOTES:

- 1.) Steep banks minimize a lot of recreational opportunities.
- 2.) Private owners are encroaching on Port Authority Property and have been for years.
- 3.) The massive amount of dumping of trash and organic waste will need to be controlled and reduced.
- 4.) No buffer at the top of slopes.



Existing Conditions

Conclusion: Overall Observations

Through inventory & analysis of all areas the overall maintenance has been found to be adequate and effective in protecting the ravine & bluff properties. Areas of concern were identified as specific areas that need to be addressed. As mentioned previously, ravine & bluff properties will constantly be changing as the land surrounding them continue to be developed by human activity. These evaluation reports should happen every 5-10 years in order to re-visit these areas and identify any areas that are concerning.

The existing maintenance and management of the Port Authority properties has been successful in fighting the various threats these fragile properties face each year. In addition, the practices implemented have proved to be effective as seen through the minimal invasive species found across all areas, the minimal drainage issues, minimal waste at most areas, and healthy vegetation at most areas.



INVASIVE SPECIES CONTROL

In 2011 the Bayfront Bluffs were completely covered in invasive species, trash, and overgrown trees. Not only was it an eye sore it was becoming a threat to the health of the bluffs. The sites were cleared and have been properly maintained since that time creating stable slopes with minimal invasive species. Continued monitoring and control will need to be done annually to ensure the invasive species does not return. Similar monitoring and control methods should be introduced at Ravine Park & Cascade Creek to make sure the minimal amount of invasives found do not grow any larger.



DRAINAGE & STORMWATER

There are a few areas of concern regarding drainage, but overall the drainage & stormwater has been handled sufficiently across all areas. Reviewing the areas through these evaluations is helpful for drainage & stormwater because as more impervious surfaces are added the more stormwater is running off. Addressing any areas of concern will help continue to protect these properties.



ORGANIC & INORGANIC WASTE

The Port Authority's maintenance has including picking up waste as well as provide trash receptacles for waste. This has helped keep trash & organic waste out of these properties, but the major issue comes from home owners and private residents. Increased monitoring and education will help fight this on going issues across all areas.



VEGETATION MANAGEMENT

Through an annual maintenance contract, the Port Authority has effectively been able to manage the vegetation along the Bayfront Bluffs for years. Increased monitoring will help further improve this maintenance and developing a similar strategy for the Ravine Park & Cascade Creek areas may be beneficial to maintaining these properties. Implementing the recommendations proposed from this study will also help maintain the health of these properties.

Existing Conditions



Priority: LEVEL 1

The **priority level 1** issues should be addressed as soon as possible as they put the public at risk and can cause significant economic & health/safety risks.



Priority: LEVEL 2

The **priority level 2** are issues that need immediate attention. These issues don't pose threats to health, safety and welfare, but need to be addressed.



Priority: LEVEL 3

The **priority level 3** are issues that need to be addressed in a timely manner and should be handled as they could progress to a level 1 or 2.



Priority: LEVEL 4

The **priority level 4** are issues that will require attention to review, assess, and work towards fixing, but are not an immediate threat.



Priority: LEVEL 5

The **priority level 5** are issues that might not need immediate attention, but acknowledgement & monitoring will be needed.

Areas of Concern: Priority Areas

Sloughing, Undercutting & Erosion due to Water Discharge from Pipe

Located at the entrance to the Erie Yacht Club at the beginning of Ravine Drive there is a concrete tube that discharges water into the ravine. This water has carved out a steeper ravine and is continuing to carve & undercut the already steep slopes causing sloughing to actively occur. This has caused a concrete wall along the roadway to begin to tip, the roadway is beginning to tip, and if not dealt with will cause more major issues. The water will need to be controlled, slowed, and the slopes will need to be reinforced.

Current Conditions at Ravine Park Entrance



Solutions to Protect the Slope & Reduce Undercutting/erosion:

Step one will be to clean up and clear away debris from the ravine and re-use on site if possible

Reinforcing the point of discharge will be required as this is where the largest amount of undercutting is taking place. Using larger stones to create a pool to disperse & slow down the water, trap sediment and reinforce and build up the edge.

Slowing & narrowing the channel will be useful in protecting the slope from additional erosion. Using large wood debris found on site or bringing in stone/wood to create veins to direct the water away from the edges to smaller pools along the flow.

Concern & Priority Level

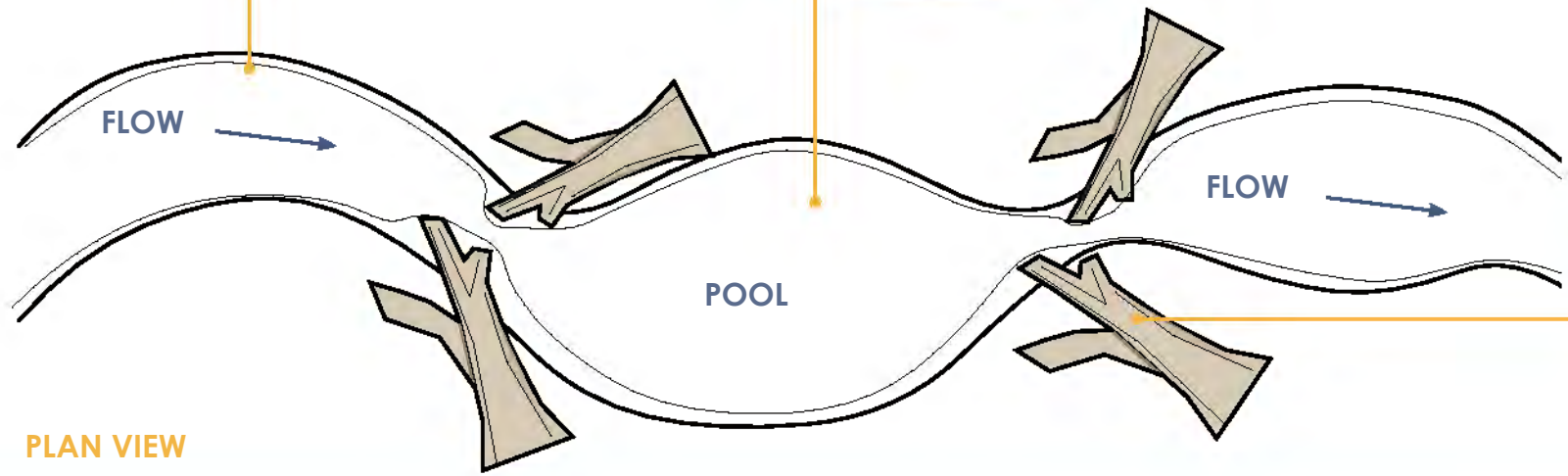
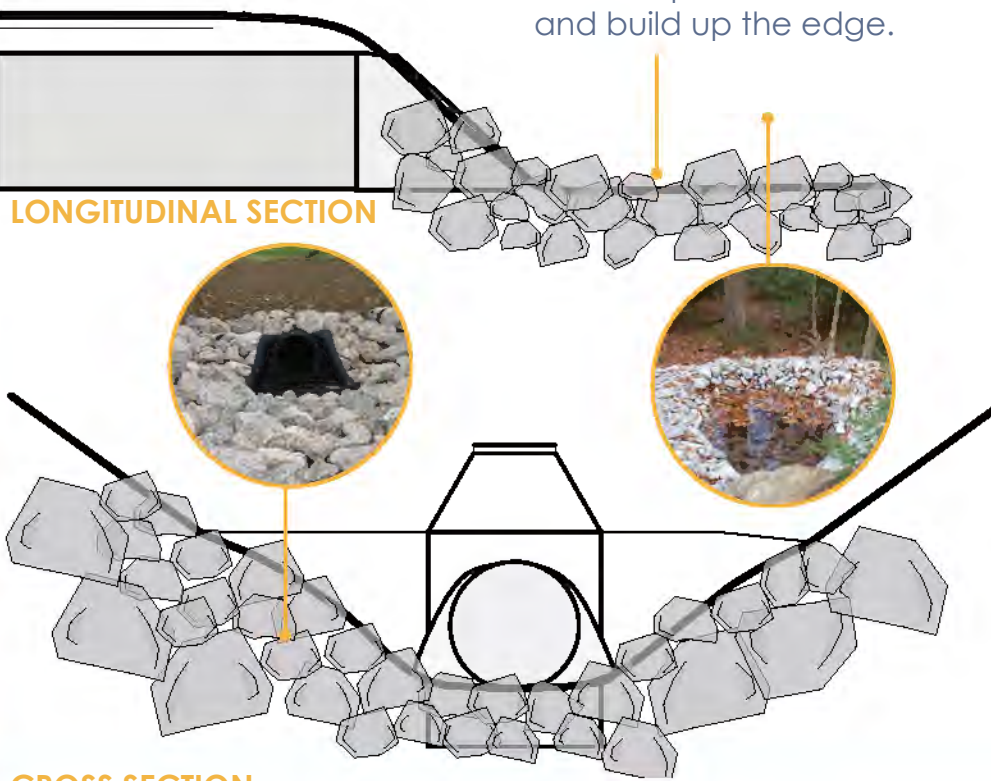
Concern: LONG TERM

This area of concern is a long term issue that if not dealt with now will create future financial and health issues.



Priority: LEVEL 1

The sloughing & undercutting ranks as a **priority level 1** because there is sever undercutting of Ravine Park Road happening due to the uncontrolled flow of water. The slopes are extremely steep and unstable causing active erosions with every rain storm. If and when the wall at the top of the slope fails, the roadway will fail, and there could be a major erosion of the roadway. Further investigation of the roadway conditions should happen as well.



CROSS SECTION

PLAN VIEW

Roadway, Wall & Swale Restoration

This provides a cost estimate to engineer and replace the roadway & concrete wall that is falling into the ravine. In addition, this is to restore the drainage swale in its current condition. This includes reinforcing the discharge point, clearing the area of debris, stabilizing the slopes, adding veins, creating pools, and seeding the slopes.

There needs to be a full project assigned to this going through the entire design process to determine the best solution for this area. The estimate provided here gives a range of what could be expected.



RESILIENCE

The increased stormwater, both on the surface and through groundwater seepage, has exceeded the limits of the current system in place causing the ravine to erode which is causing road & wall failure. In order to maintain resiliency, a full design implementing low impact development (LID) and green infrastructure will be necessary to make sure this natural ravine sustains future threats.

complete project costs

This includes full engineering services as well as removal of the existing materials and installation of new walls, drainage structures, and asphalt roadway. In addition, this includes restoring the swale to be more natural and avoid this issue happening in the future.

\$400,000 - 475,000
ESTIMATED



Encroachment onto Port Authority Property

Using Erie County Tax Maps and other survey plans obtained from the Port Authority, it has been determined there are various locations where adjacent property owners are encroaching onto the Port Authority owned property. All of the locations would need to be field verified with physical pins & a professional survey team.

Encroachment Locations Discovered on Ravine Park - Entrance



Concern & Priority Level

Concern: LONG TERM

Encroachment is an issue that will need to be monitored, verified, and discussed with adjacent property owners to determine to best course of action.



Priority: LEVEL 1

The encroachment locations found along Ravine Park ranks as a **priority level 1** because there are structures built on the slopes of ravine park that if fail could cause harm to the users. These types of encroachments pose threats to the health and welfare of the general public and because they are on Port Authority property it puts the Port Authority at risk for liability.

Options to Handle Encroachment:

Professional Land Survey with Physical Stakes

Getting physical stakes in the ground will take away any dispute of line locations drawn on a plan. With this information a conversation should be started with the violators.

Work out Agreement Amongst Parties Involved

There can be written agreements worked out between the parties involved which allow everyone to get what they desire with certain terms.

Legal Action & Removal of Items

A last resort, but possibly necessary action, is to get legal court orders for the adjacent owner to remove all items of encroachment.

Encroachment onto Port Authority Property

Using Erie County Tax Maps and other survey plans obtained from the Port Authority, it has been determined there are various locations where adjacent property owners are encroaching onto the Port Authority owned property. All of the locations would need to be field verified with physical pins & a professional survey team.

Encroachment Locations Discovered on Bayfront Bluffs - West



Concern & Priority Level

Concern: LONG TERM

Encroachment is an issue that will need to be monitored, verified, and discussed with adjacent property owners to determine to best course of action.



Priority: LEVEL 1-2

The encroachment locations found along the west Bayfront ranks as a **priority level 1-2** because although the majority of the locations are minor amenities that are not posing any threats, causing any damage or putting anyone in harms way, they become a legal matter and need to be addressed. There is, however, one item that is creating a health & safety risk - the play equipment at Bayview park. In addition, there is an entire garage sitting on Port Authority property that could become a financial and legal issue.

Options to Handle Encroachment:

Professional Land Survey with Physical Stakes

Getting physical stakes in the ground will take away any dispute of line locations drawn on a plan. With this information a conversation should be started with the violators.

Work out Agreement Amongst Parties Involved

There can be written agreements worked out between the parties involved which allow everyone to get what they desire with certain terms.

Legal Action & Removal of Items

A last resort, but possibly necessary action, is to get legal court orders for the adjacent owner to remove all items of encroachment.

Encroachment onto Port Authority Property

Using Erie County Tax Maps and other survey plans obtained from the Port Authority, it has been determined there are various locations where adjacent property owners are encroaching onto the Port Authority owned property. All of the locations would need to be field verified with physical pins & a professional survey team.

Encroachment Locations Discovered on Ravine Park - Bayview

- A** Planting Beds
- B** Playground
- C** Storage Shed & Seating
- D** Small building



Options to Handle Encroachment:

Professional Land Survey with Physical Stakes

Getting physical stakes in the ground will take away any dispute of line locations drawn on a plan. With this information a conversation should be started with the violators.

Work out Agreement Amongst Parties Involved

There can be written agreements worked out between the parties involved which allow everyone to get what they desire with certain terms.

Legal Action & Removal of Items

A last resort, but possibly necessary action, is to get legal court orders for the adjacent owner to remove all items of encroachment.

Concern & Priority Level

Concern: LONG TERM

Encroachment is an issue that will need to be monitored, verified, and discussed with adjacent property owners to determine to best course of action.



Priority: LEVEL 2

The encroachment locations found along Ravine Park - Bayview ranks as a **priority level 2** because there are amenities such as sheds, planting beds, and playgrounds encroaching on Port Authority land creating a legal issue, but they are stable & not causing threats to the health and welfare of the public.

Encroachment Resolution

This provides estimates per unit for the next steps to handle encroachment conflicts discovered through this evaluation study.

Encroachment has been an issue for some time and the Port Authority has been proactive in the past through the sending of letters. It becomes a legal issue and overall a liability issue moving forward.

I
field survey
& property
line confirmation

This would include a two man field survey crew to properly locate and identify property stakes in the field. This information will be the first thing needed in order to confirm any areas of potential encroachment.

\$185-
200/HR
ESTIMATED

II
legal
services

This includes the average cost for legal services to handle the confirmed encroachment issues discovered.

\$250-
300/HR
ESTIMATED

Organic & Inorganic Waste Dumping

The dumping of yard waste and inorganic waste over the bluffs & ravines is a concern across all areas. Yard waste and trash, in addition to adding extra weight to the upper portion of the slope eventually causing failure, will smother any underlying vegetation. This does not allow any ground cover or understory vegetation to become established leaving unstabilized bare loose soil open to erosion, sliding, and sloughing. The organic waste eventually breaks down leaving behind unstable loose material susceptible to sliding. In addition, dumping waste spreads invasives and prevents rain water from soaking into the ground.

Examples of Waste Found in Areas of Concern



Concern & Priority Level

Concern: LONG TERM

The dumping of wastes poses a long-term concern that will require monitoring and annual maintenance.



Priority: LEVEL 2

The dumping of waste threat across all areas on average ranks as a **priority level 2** because there is a large amount of waste discovered in certain areas, but all areas have signs of dumping. It doesn't create an immediate threat, but the continuation and build up of waste over time can cause major damage to the slope stability. It also reduces the aesthetic appeal of the natural areas.

General Control Methods and Potential Solutions:

Increased Signage with Heavier Fines

Increase the size and number of signs across location prone to dumping and increase the amount of the fine deter people. Include educational information as to why it's dangerous.

Composting & Proper Disposal

Creating a compost pile or bin away from the slopes edge allows the material to be used in gardens. Alternatively, placing waste in proper bags or containers will be removed by the city during weekly pick-up.

Trail Cameras and/or Citizen Monitoring

Installing trail cameras to catch people dumping and follow up with fines. In addition, neighbors & community members need to be monitoring and reporting to protect their own community lands.



The edge of this slope will slide down & be gone over time. This is happening due to years and years of organic dumping creating loose unstable soil conditions at the top of the slope.

Sloughing & Erosion due to Ground Water Seepage and Surface Water

Sloughing is when soil slides or moves down a slope due to loss in cohesion. Water and/or wet soil conditions are the number one factor for sloughing to occur on a slope face. Across all areas of Concern areas of various localized sloughing has been observed with larger sections occurring in years past. Due to the loose sandy soil and low shear strength, these slope faces are high susceptible to sloughing. In addition, due to the dense canopies bare soil is present and much more susceptible to sloughing. Ground & Surface water are the main causes.

Current Conditions along Entire Ravine Park Area



Solutions to Sloughing:

Ground water and (more minor) surface water play the biggest role in causing sloughing. Handling this water and directing it to discharge in a safe location will be key. There are various methods, but some of the simplest and causing the least disturbance will be:

- **Surface Drains:** The simplest method for reducing any erosion & sloughing caused by groundwater discharge is to capture the water where it discharges from the face of the slope.
- **Sub-surface Drains:** Taking the surface drain a step further and placing the drain into the slope face to capture water before it discharges from the slope face. The best method to drill the pipe into the slope will need to be investigated.
- **Improved Vegetation:** establishing healthy vegetation zones will help reduce erosion and stability across the entire slope.

Concern & Priority Level

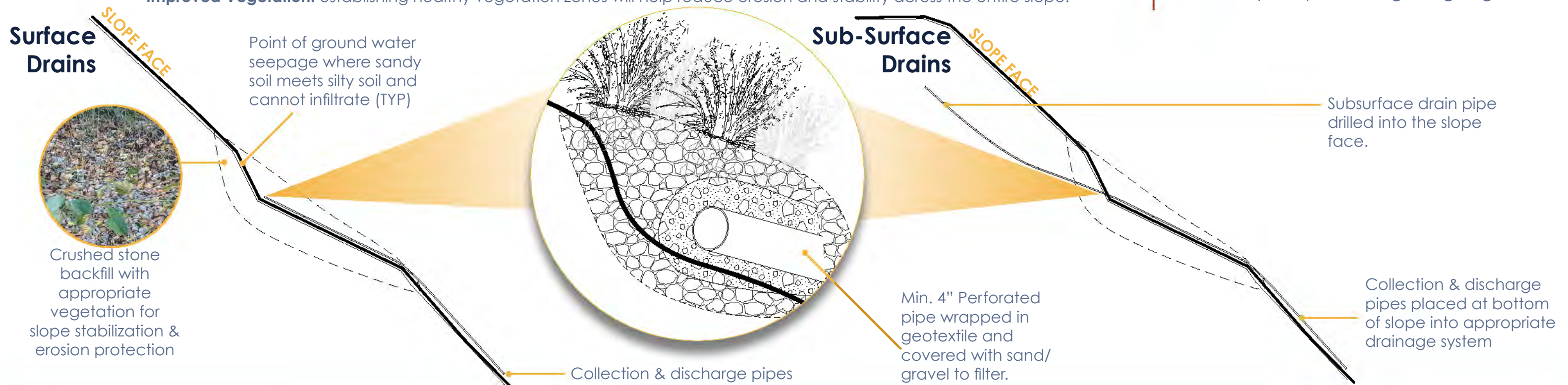
Concern: LONG TERM

This area of concern is a long term issue that if not dealt with now will create future financial and health issues.



Priority: LEVEL 3

The sloughing ranks as a **priority level 3** because there are various areas where this is occurring which can lead to a large scale event happening. Simple steps such as establishing healthy vegetation layers will be steps to preventing sloughing.



Ground water drainage relief

This provides estimates for surface drainage pipes, crushed stone reinforcement, and slope stabilizing vegetation at various locations along Ravine Park.

The estimates provided in this section used numbers & research from a 2004 study titled, "Lake Erie Cliff Erosion Protection Demonstration Project: Ferncliff Park, Erie, Pennsylvania". Numbers have been adjusted to account for inflation.



RESILIENCE

Increased storm events has led to the increase in ground water, as well as surface water runoff, in this area. When the already vulnerable slopes become saturated the soil loses cohesion and slide causing significant damage.

A portion of the slopes south of Ferncliff Cottages has seen green infrastructures installed and in turn they have become resilient to this increase in ground & surface water. Other slopes across Ravine Park will need similar action taken to ensure they maintain resilient to future threats.

I
surface
drains
location #1

This includes adding perforated pipes at the points of discharge on the slope face to intercept the water, transport it through a pipe down the slope, and discharge it at the bottom of the slope. The pipes should be wrapped in geotextile fabric and bedded in filter sand & gravel. In addition, the pipes should be anchored to the slope. Lastly, this includes backfilling the slough area using a crushed stone as well as planting the slope with appropriate vegetation to further stabilize the slope & establish vegetative cover.

\$41,000-
45,000
ESTIMATED

II
surface
drains
location #2

This includes adding perforated pipes at the eight points of discharge on the slope face to intercept the water, transport it through a pipe down the slope, and discharge it at the bottom of the slope. The pipes should be wrapped in geotextile fabric and bedded in filter sand & gravel. In addition, the pipes should be anchored to the slope. Lastly, this includes backfilling the slough area using a crushed stone as well as planting the slope with appropriate vegetation to further stabilize the slope & establish vegetative cover.

\$328,000-
360,000
ESTIMATED



Surface Drains Location #1



Surface Drains Location #2

Tree Topping & Bulk Tree Clearing

The upper canopy layer is the first line of defense for a ravine or bluff slope. This layer acts as a protective umbrella shading the floor and capturing rain drops before falling directly on the ground. The trees that make up the canopy layer also provide deep stabilizing roots, habitats for birds & other animals, and they provide aesthetic values. There is evidence of tree topping/bulk clearing at Ravine Park and Cascade Creek. At Cascade Creek there is a lot of evidence of tree topping in addition to bulk tree clearing. Topping and bulk clearing pose significant threats to the health of ravine & bluff slopes.

Tree Topping & Clearing Found at Cascade Creek



Why Tree Topping Hurts Trees: Stresses Trees

It removes the tree leaf bearing crown and the leaves are the food factories for trees. Removing them starves a tree and triggers survival mechanisms will seriously weaken or kill the tree.

Leads to Decay

Cuts across a limb at multiple points leaves open stubs vulnerable to decay. Too many and the tree won't be able to close them off which allows the decay to move down the tree.

Risk to Health & Safety

Survival mechanisms produce multiple shoots that are weak and anchored only to the outermost layers. These limbs will break off easily in a storm and will grow [sometimes] higher than the original.

Ugly & Poor Growth

Multiple cut stubs at the same length is not how a tree grows naturally. In addition, it forces a tree to grow horizontally which create dense canopies blocking sunlight from penetrating.

Bulk Clearing Makes Slopes Vulnerable

A healthy ravine & bluff slope has an upper canopy layer, middle understory layer, and a ground layer. All three of these layers create a healthy & stable slope. At Ravine Park & Cascade Creek there is a strong canopy layer, a weak middle understory layer, and an almost non-existent ground cover layer. When the main canopy layer is cleared in mass it exposes bare loose soil that is open to heavy rain and wind. Rain and wind on bare soil is a recipe for erosion & soil sliding which will lead to more significant slope erosion & setback.

Concern & Priority Level

Concern: LONG TERM

Tree topping & clearing is a long term issue due to having to re-establish mature trees that take years and years to grow. Stopping the issue now will prevent further damage.



Priority: LEVEL 3

The topping & bulk clearing of trees ranks as a **priority level 3** because of the risks involved with removing trees from an at risk slope which can lead to massive erosion. Tree topping creates unhealthy & irregular branching patters as well as leaves trees open to disease. This issue will need to be addressed in order to begin restoration.

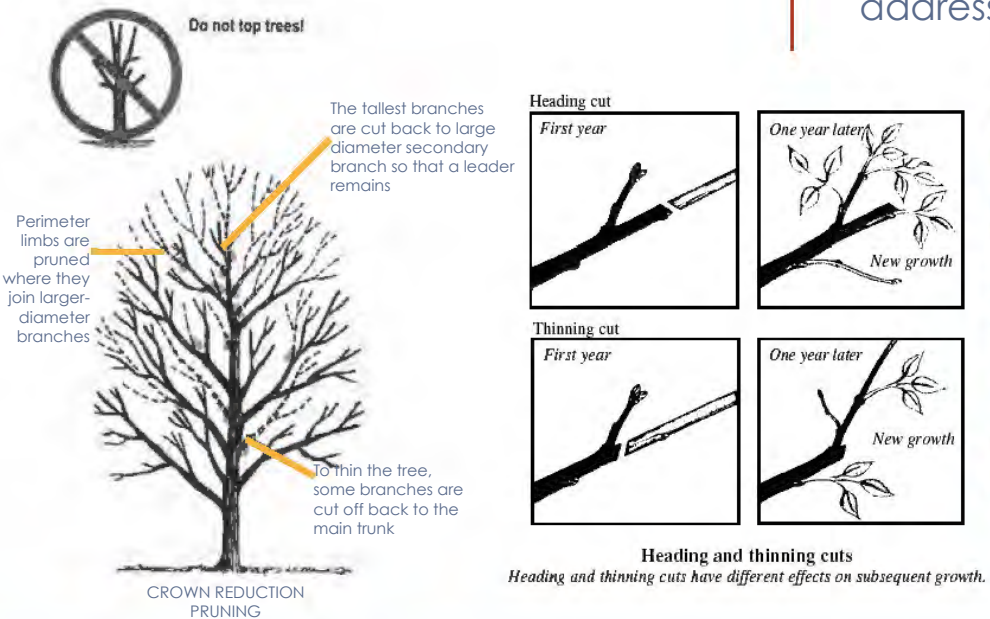
Alternatives to Tree Topping & Bulk Clearing:

Sometimes trees must be reduced in height or spread, such as for providing utility line clearance, and sometimes for aesthetic reasons such as wanting a certain view opened up. In either case, there are methods to use.

- Small branches should be removed back to their point of origin.
- If a larger limb must be shortened, it should be pruned back to a lateral branch that is large enough (1/3 the diameter of the limb being removed) to assume the terminal role.

These methods will help maintain the tree natural form and accomplish your goal for reducing the size and/or spread.

An alternative to bulk clearing would be selective clearing beginning with any invasive or low grade trees to begin framing views. Framing a view accomplishes the desired view while allow select larger trees to remain and create a framed view.

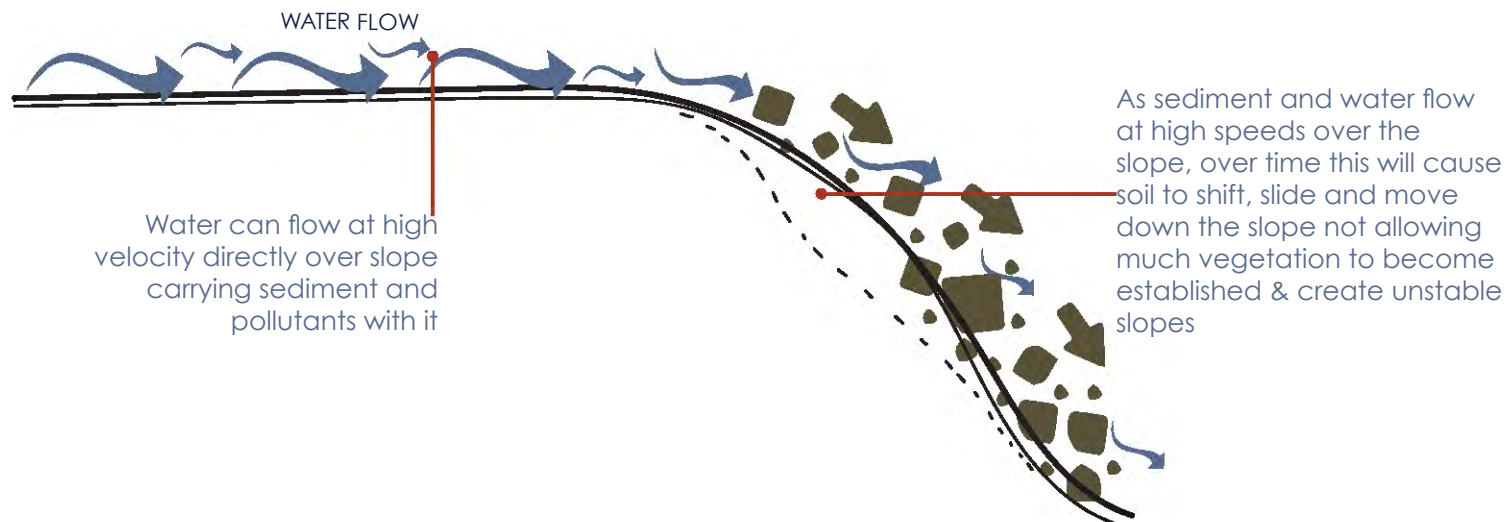


FRAMING A VIEW

No Vegetated Buffer at the Top of the Slope

One of the most basic and easy ways to manage stormwater runoff at the top of slopes is to create a vegetated buffer. Vegetated buffers can be accomplished simply by creating a “no mow” zone along the top 10-feet of flat land at the top of the slope and can get more involved with the implementation of native herbaceous plants, shrubs, and trees. These buffers can help stabilize the soil as well as absorb excess water and sediments before going over the edge. Buffers can be maintained through selective pulling, herbicides, and even mowed down one to two times a year as needed.

Current Conditions without Vegetated Buffers



Issue Summarized:
Having not buffer will allow water & sediment to flow freely over the slope causing erosion and soil displacement. In addition, necessary roots from the vegetated buffer that help further stabilize the soil are missing further putting the slope at risk for sliding, sloughing, and erosion.

Concern & Priority Level

Concern: LONG TERM

Mowing directly to the edge and leaving no buffer will add to the bank erosion over time causing long term effects.



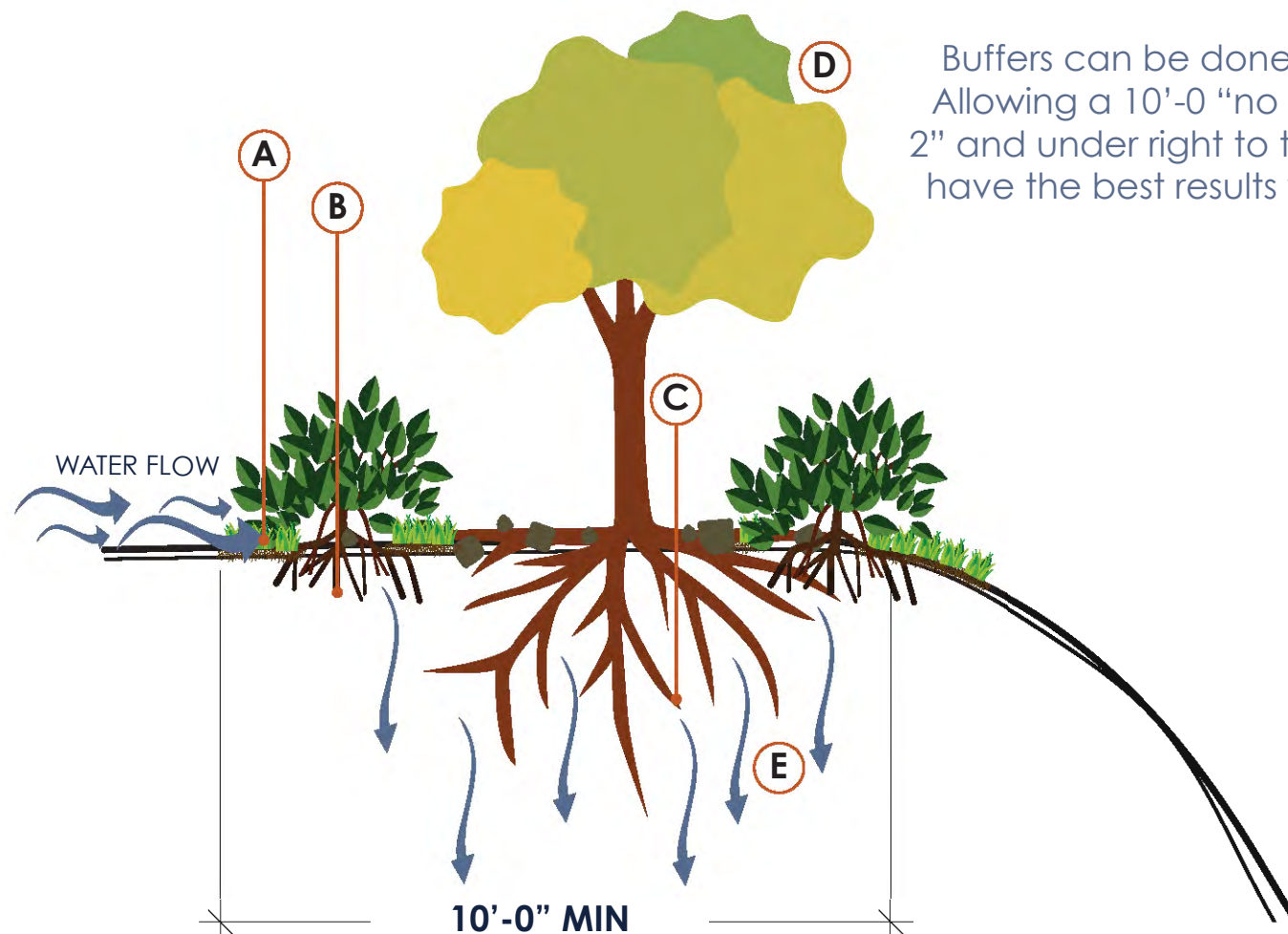
Priority: LEVEL 3

No vegetated buffers along on average rank as a **priority level 3** because when there are no curbs along the roadway to control the stormwater, it flows freely over the edge. There is not a large amount of surface water running over the slope, however, it is good practice to have buffers for extra stabilization, water absorption and aesthetics.

General Recommendations for Vegetated Buffers:

Vegetated Buffers:

Buffers can be done at different scales and to various extents. Allowing a 10'-0" “no mow” strip will do better than cutting lawn 2" and under right to the edge. A mixed native planted buffer will have the best results with an open canopy for strong understory growth.



- A Herbaceous & Ground covers**
Herbaceous plant material and ground covers, on the surface, will help slow the water & trap sediment. Their roots will help stabilize the surface soil as well as protect the surface soil from rain.
- B Shrubs & Woody Plant Material**
Shrubs and woody plant material will help absorb water and use their deeper roots to increase soil cohesion and reduce mass soil erosion.
- C Tree Roots**
Tree roots offer the most soil stabilization as they can penetrate deeper to help hold and stabilize the soil by keeping it together. In addition, tree roots can absorb a lot of ground water.
- D Tree Canopy & Vegetation Surfaces**
Trees can absorb ground water and through evapotranspiration remove the water from the soil. In addition the vegetation absorbs the energy of falling rain minimizing any displacement.
- E Allows for Infiltration**
Vegetated buffers slow the velocity of water which will allow the water to infiltrate into the ground as well as act as a filter to catch & trap sediment before going over the slope.



RESILIENCE

While storm events continue to grow the amount of stormwater runoff will continue to grow. Managing this increase, even at a small scale, will help the ravine & bluff properties adapt to these increased threats. Simple vegetated buffers will slow down the speed of the water, trap sediment, and promote infiltration. These buffers are a simple piece of green infrastructure with a big impact.

Native vegetated buffers

This provides estimated costs for a no mow zone through three different sized native vegetated buffers. A complex buffer including all three layers of vegetation (tree, shrub & herbaceous). A mid-range buffer including two layers of vegetation (shrubs & herbaceous). A simple buffer including just herbaceous plants.



**COMPLEX NATIVE
VEGETATED BUFFER**



**MID-RANGE NATIVE
VEGETATED BUFFER**



**SIMPLE NATIVE
VEGETATED BUFFER**

I
ravine park
buffer #1:
5,000 SF

This includes a range to install a linear 10'-0" buffer strip as shown on the conceptual plan. The low end of the budget would be a basic herbaceous planted buffer and the high end would be a fully planted buffer strip with all of the recommended layers of vegetation. This cost includes design and installation.

**\$10,000-
69,000**
ESTIMATED

II
ravine park
buffer #2:
2,700 SF

This includes a range to install a linear 10'-0" buffer strip as shown on the conceptual plan. The low end of the budget would be a basic herbaceous planted buffer and the high end would be a fully planted buffer strip with all of the recommended layers of vegetation. This cost includes design and installation.

**\$6,000-
37,000**
ESTIMATED

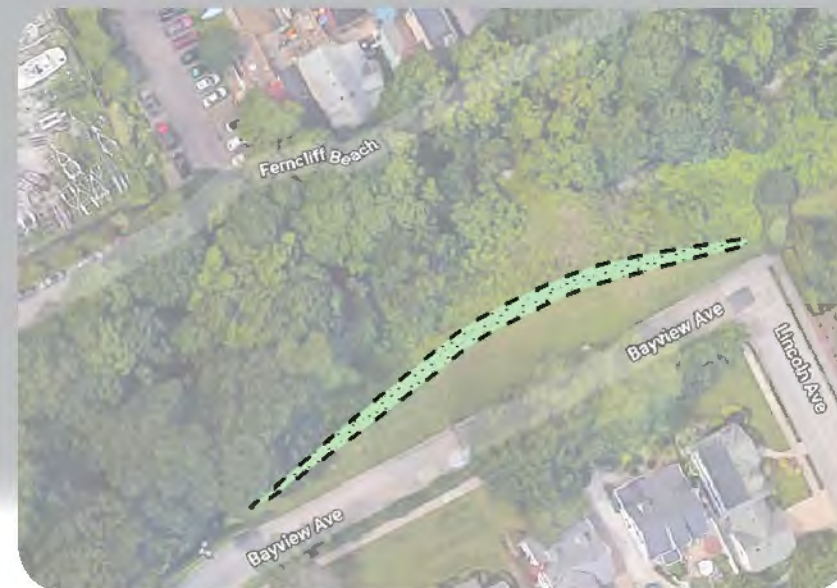
III
bayfront
bluff buffer:
5,000 SF

This includes a range to install a linear 10'-0" buffer strip as shown on the conceptual plan. The low end of the budget would be a basic herbaceous planted buffer and the high end would be a fully planted buffer strip with all of the recommended layers of vegetation. This cost includes design and installation.

**\$10,000-
69,000**
ESTIMATED



Ravine Park Buffer #1: 5,000 SF



Ravine Park Buffer #2: 2,700 SF



Bayfront Bluff Buffer: 5,000 SF

Rills and Rill Erosion Running Down Slope

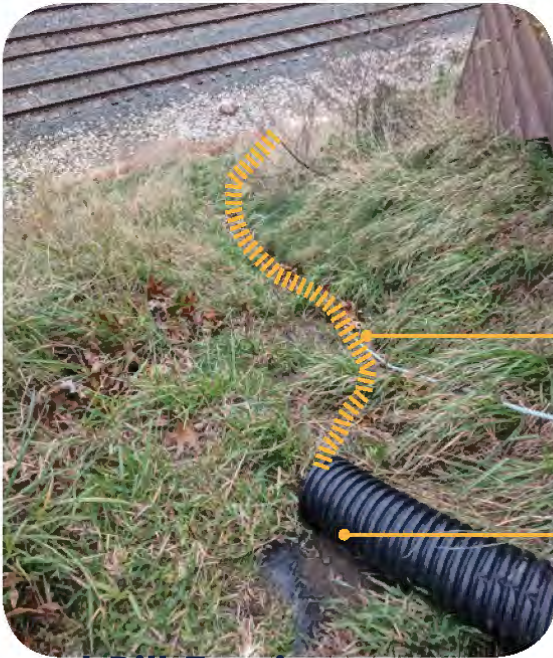
A rill is a shallow channel cut into soil by the erosive action of flowing water - small rills are known as channels and larger rills become gullies. Rill erosion occurs by the removal of soil along a particular path due to concentrated water running along the same path. The development of rills is usually the first sign of an enduring erosion problem. A rill has formed along the slope at the foot of Plum Street likely due to a large amount of concentrated water flowing over impervious surfaces down the slope.

Examples of Issue Discovered



Near the bottom of the slope the rill has gotten much wider with areas of bare soil showing signs of undercutting. A large amount of debris & trash is collected in this area which is added weight to the soil making it more unstable.

Near the top of the slope the rill is narrow and shallow. The dense grass ground cover is helping to stabilize the soil, but some areas of bare soil are showing when pushed down grass is pulled back. This particular rill leads directly to a catch basin at the bottom of the slope.



In addition to the pipe being discharged, there is a rope tied to the top of the hill that is being used by pedestrians to walk up and down the slope in the rill being formed from the water being discharged. This foot traffic is increasing the potential for erosion by not allowing vegetation to grow and leaving the soil bare & vulnerable.

A corrugated pipe is discharging water at the top of the slope just below Parade Street. It is unknown where this pipe comes from or what amount of water it's discharging. Small rills are forming at the discharge location and will continue to grow over time.

Solutions to Control, Prevent & Avoid Rills and Rill Erosion:



Capturing the water at the top of the slope and directing it down the slope through a pipe and discharging at the bottom of the slope is the best way to remove the water source. The rill can be used for the pipe and backfilled with free draining material.



The implementation of a vegetated buffer and/or rain garden at the point of discharge will help capture and slow the water as well as disperse it so that a single concentrated flow is not consistently eroding away the soil.



Gravel strips or other methods of water dispersal will help slow and capture water. These methods will accomplish an important role in reducing rills and that is dispersing the water so as not to create concentrated flows.

Concern & Priority Level

Concern: SHORT TERM

The rill in this area is currently minor and stable due to vegetation. Capturing and redirecting any water will minimize it from increasing.



Priority: LEVEL 3

The rill erosions found at various locations rank on average as a **priority level 3** because as it is minor currently it could become an issue in the long run if it's not dealt with now. The larger the rill becomes the more difficult it will be to stabilize and fix on the slope.



RESILIENCE

While storm events continue to grow the amount of stormwater runoff will continue to grow. Managing this increase, even at a small scale, will help the ravine & bluff properties adapt to these increased threats. Capturing stormwater at a point source or sheet flow source will direct this water, through a pipe, down the slope and into an existing stormwater system which will minimize any threats of erosion or rill formation on the slopes.

Simple Drainage Solutions

This provides estimated costs for two simple drainage solutions to handle surface water flowing over the slope creating rills. These two solutions focus on capturing water at a single point source or capturing water that is sheet flowing over the slope. Both solutions take the water down the slope via a pipe.

Capturing surface water at the top of the slope and transporting it down the slope via a pipe and discharging it is good practice to reduce sheet and rill erosion caused by water freely flowing over the slopes edge.



CATCH BASIN WITH DRAIN PIPE DOWN SLOPE



GRAVEL STRIP WITH DRAIN PIPE DOWN SLOPE

I
catch basin
& solid pipe

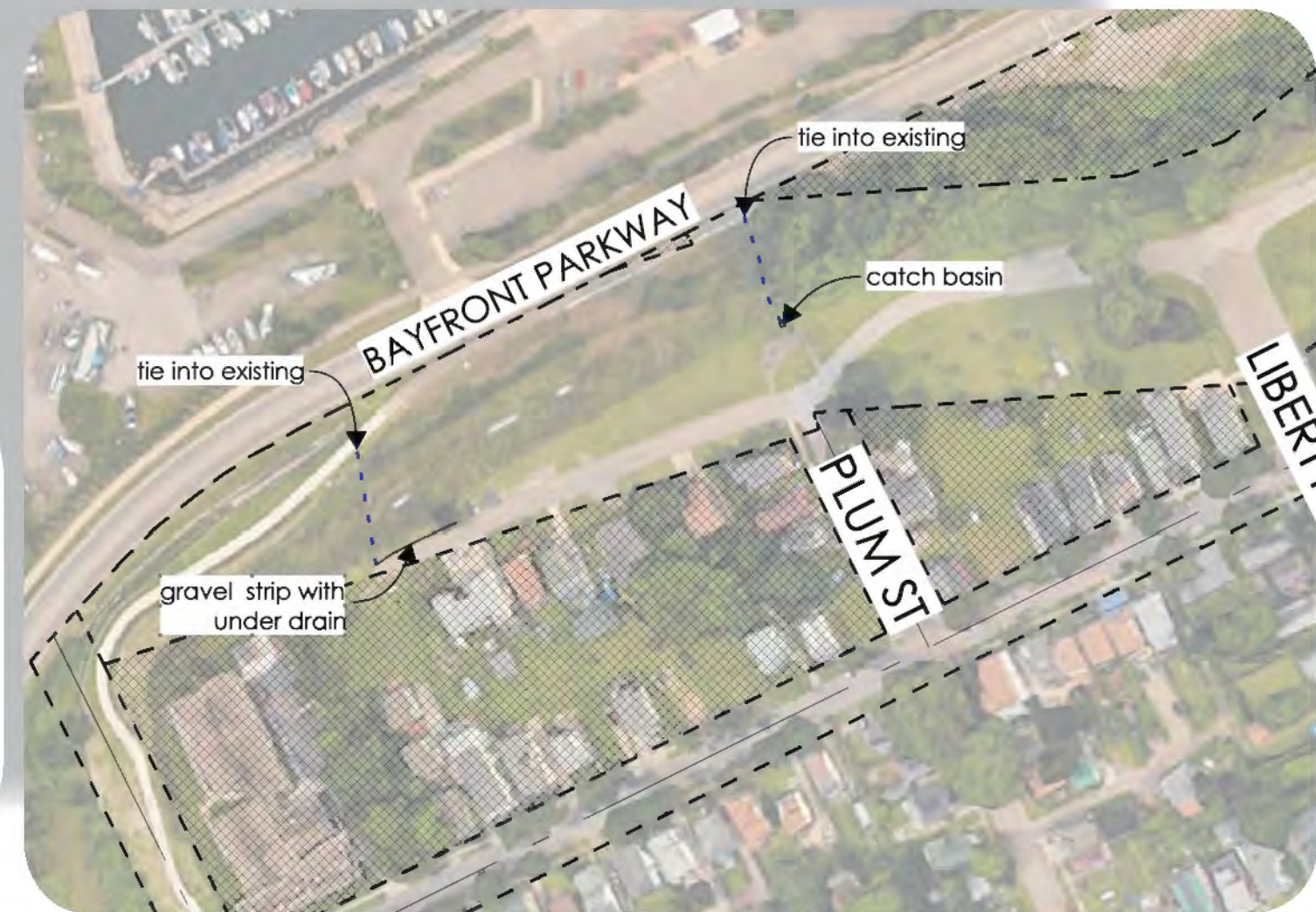
This includes installing an 18" x 18" plastic catch basin and installing 60 linear feet (avg length of slopes evaluated) into a trench down the slope and discharging at the bottom or tying into an existing storm system. This would be used to capture water concentrating over the slope at a specific area.

\$4,500-
5,500
ESTIMATED

II
gravel strip
with
under drain

This includes installing 85 linear feet of a 12" wide x 12" deep gravel strip with an underdrain connected to 60 linear feet of solid pipe (avg length of slopes evaluated) in a trench down the slope and discharging at the bottom or tying into an existing storm system. This would be used to capture water that is sheet flowing over the slope and cannot be done at a single location.

\$3,400-
3,700
ESTIMATED



Invasive Plant Control

Invasive Plant Species are defined as non-native (or alien) to the ecosystem or particular area and whose introduction causes harm to the environment, local species, or human interests. These species can be introduced on purpose or by accident. Once a new species is introduced, it can be difficult to control and even more difficult to eradicate. Local plants and even local animals species can get displaced by being choked out by the invasive species. Invasive species control takes years and must occur annually to begin eradicating them from our local environments.

Species Discovered in Areas of Concern

Japanese Knotweed
Polygonum cuspidatum



Common Reed
Phragmites australis



Concern & Priority Level

Concern: LONG TERM

The invasive species threat poses a long-term concern that will require monitoring and annual maintenance.



Priority: LEVEL 3

The invasive species threat ranks as a **priority level 3** because the area has been mostly controlled but these two species have been found in swaths that are getting larger and larger each year. Due to the aggressive spreading nature of these species they should be controlled regularly so they do not take over a particular area.

General Control Methods and Potential Solutions:

Herbicide Treatment

Use this to spray and kill individual plants or small patches of the plant. When dead, cut down and dispose of properly.

Cut Stem Treatment

This method works well with larger or isolated stands. Cut the plants around waist height and immediately apply a herbicide (such as Glyphosate) to the hollow stems.

Long-Term Management and Monitoring

Due to the ability for these species to spread through seed and rhizomes, long-term management and monitoring are necessary.



Invasive Species Control

This provides estimated costs for invasive species control at three distinct areas. The control would include cutting the invasive species, treating the cuts with chemical treatments and repeating this process.



RESILIENCE

Invasive species threaten native habitats and native plant communities. Monitoring and controlling them is an ongoing struggle as they spread & grow aggressively over time.

Controlling these invasive species will help maintain the ravine & bluff properties's resilience to allow native species to thrive which will help with stormwater control, slope stabilization and provide native habitats for animals.

I
invasive species
control ravine
park #1: 1200 SF

This includes treating the bamboo found at the foot of Lincoln Ave and Bayview Ave using the cut & treat method. This is for one year worth of treatments. Invasive species control needs to be maintained annually to be most effective.

\$4,500-
5,000
ESTIMATED

II
invasive species
control ravine
park #2: 3200 SF

This includes treating the bamboo and horestail near the entrance to the Yacht Club. This is for one year worth of treatments. Invasive species control needs to be maintained annually to be most effective.

\$10,500-
12,000
ESTIMATED

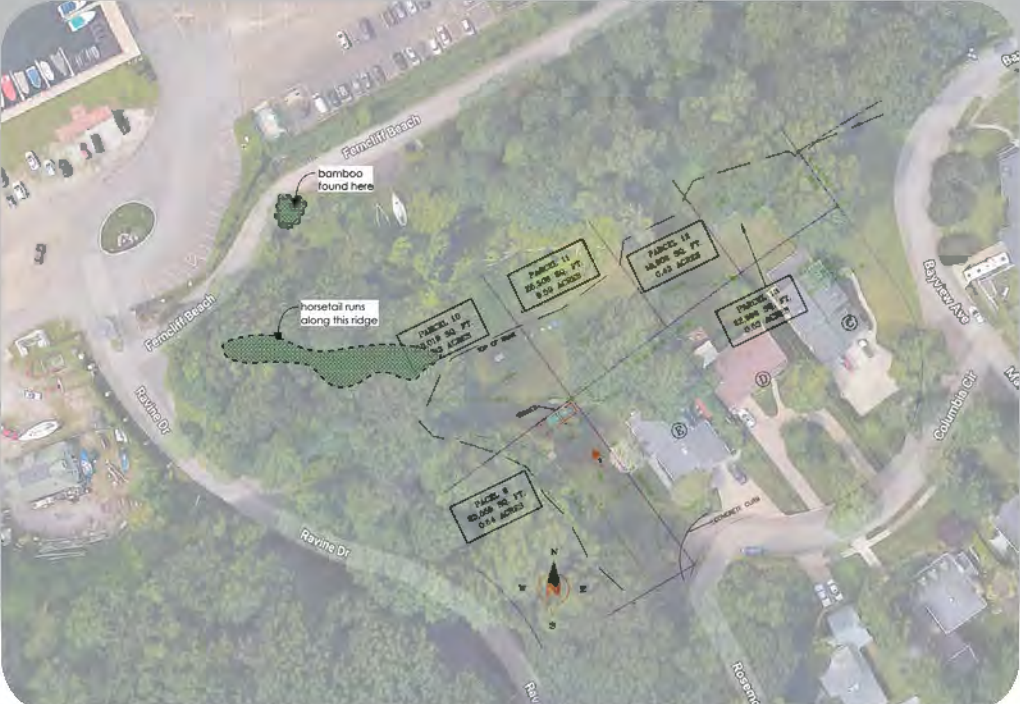
III
invasive species
cascade creek
whole area

This includes treating the various invasive species found throughout the Cascade Creek Wetland Area. The invasive species have never been controlled here and the first year would take a major effort This is for one year worth of treatments. Invasive species control needs to be maintained annually to be most effective.

\$70,000-
80,000
ESTIMATED



Ravine Park Invasive Control #1: 1200 SF



Ravine Park Invasive Control #1: 3200 SF

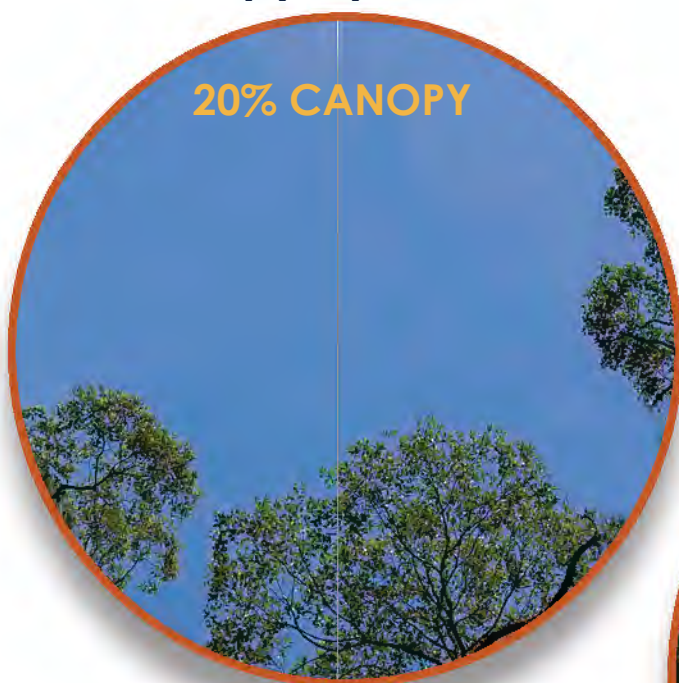


Cascade Creek Wetland: Whole Area

Tree Canopy Coverage - Too Dense

Thinking about ravines & bluffs we often think of shady, cool places covered with trees. Our ravine and bluff properties either have minimal to no trees or too many trees from beech, oak and maples dominating. However, a healthy ravine & bluff ecosystem has a middle understory layer and a groundcover layer with wildflowers & herbaceous plants. Each layer plays an important role in protecting soil, water, and habitats. Middle understory and ground cover plants are especially important to hold & stabilize soil in place. These layers need the sun to thrive. We found at Ravine Park and Cascade Creek that the canopy layer to be so dense that sunlight cannot penetrate to allow the other layers to establish.

Tree Canopy by Percent - Ideal Coverage is 40-60% Canopy



Primary Targets

Begin removing dead, dying, diseased, hazardous, and invasive species first.

40-60% Coverage

Adequate sunlight levels to support flowering plants and grasses

Obtaining Tree Canopy Coverage

Protect Natives

Special care should be put in place to avoid removing key and native species.

Leave the Stumps!

Trees should be cut flush with the soil leaving the stumps & roots in place for stabilization



Concern & Priority Level

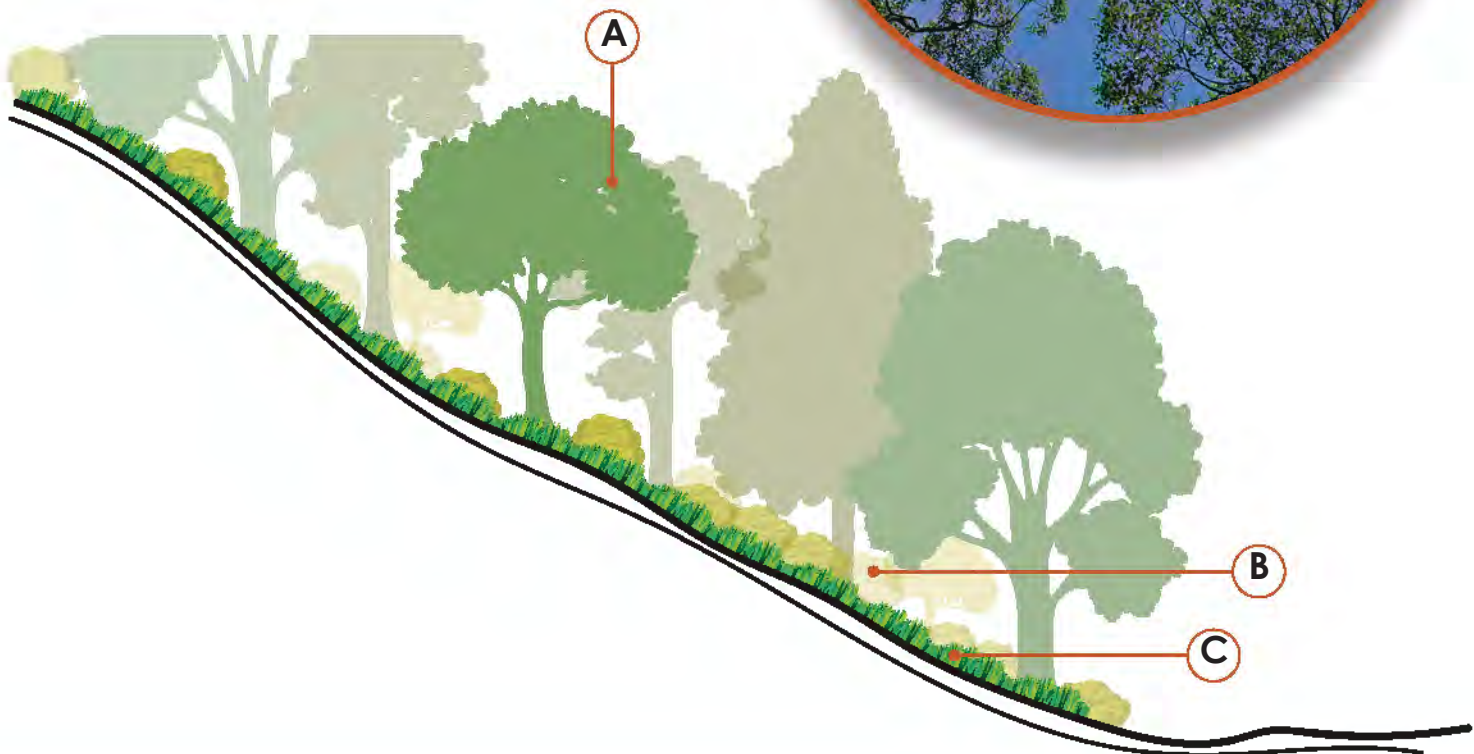
Concern: SHORT TERM

Canopy coverage can be obtained through selective trimming & removal. If done properly, ideal coverage can be obtained and maintained in a short period of time.



Priority: LEVEL 4

Obtaining ideal tree canopy coverage ranks as a **priority level 4** because it's something that will need to occur before any middle understory and ground cover plant communities can become established. These layers will help stabilize the soil which ultimately leads to the improved health of our slopes.



Vegetation Zones of a Healthy Ravine & Bluff Ecosystem

- A Tree Canopy Zone**
The upper most zone should consist of deciduous & coniferous trees of varying sizes, ages and types. This zone protects the floor from too much sun & precipitation as well as provides deep roots for soil stabilization.
- B Shrub & Tree Understory Zone**
The middle zone includes smaller native trees and shrubs. This layer provides even more coverage for the floor as well as acts as a cohesive layer to help further maintain slope & soil stability.
- C Groundcover & Herbaceous Plant Zone**
The lower zone has native herbaceous plants, grasses, and sedges. This zone of vegetation helps stabilize surface soils as well as acts as a filter to slow down water for increased infiltration and trap sediment.

Tree Canopy Coverage Overall - Ravine Park

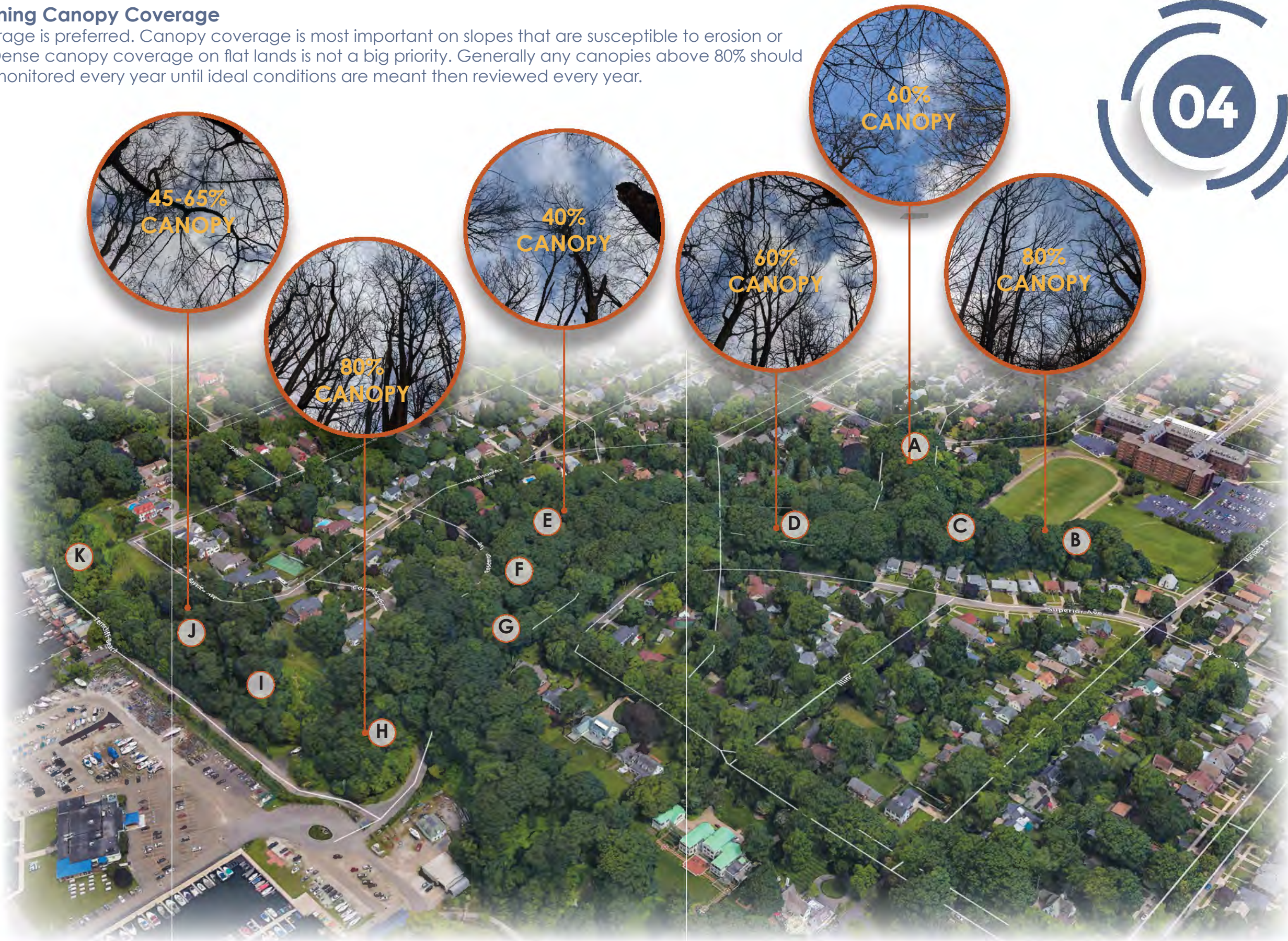
Ravine Park has a lot of mature trees that populate the area. This is a plan noting the various densities found in the area and a general rule about maintaining these densities.

Maintenance Plan for Thinning Canopy Coverage

Ideally a 40-60% canopy coverage is preferred. Canopy coverage is most important on slopes that are susceptible to erosion or have erosion issues currently. Dense canopy coverage on flat lands is not a big priority. Generally any canopies above 80% should be thinned, maintained, and monitored every year until ideal conditions are meant then reviewed every year.

CANOPY COVERAGE AREAS

- A 60% Canopy**
 - Thin larger trees
 - Clear debris
- B 80% Canopy**
 - Thin larger trees
 - Selectively remove trees
- C 60% Canopy**
 - Thin larger trees
 - Selectively remove trees
- D 60% Canopy**
 - Selectively remove trees
 - Clear Debris
- E 40% Canopy**
 - Remove debris
 - Thin larger trees
 - Overall good canopy coverage
- F 80% Canopy**
 - Selectively remove trees
 - Thin larger trees
- G 60% Canopy**
 - Thin larger trees
 - Clear Debris
- H 80% Canopy**
 - Selectively remove trees
 - Thin larger trees
 - Dense stand of trees
- I 40% Canopy**
 - Remove debris
 - Thin larger trees
- J 40% Canopy**
 - Remove debris
 - Thin larger trees
- K 20% Canopy**
 - Restore Trees
 - Selectively remove trees towards top of slope



Ravine Park Tree Maintenance Budget

This provides a per area estimate for a three-man tree crew to trim/prune/thin an area equivalent to approximately 11,000 SF. This is an average approximate area and would vary from site to site depending on density, access, and other conditions.

The three-man tree crew can trim/thin approximately 11,000 SF per day. Factors such as density, access and other conditions would effect this but the map to the right gives an idea of square footage covered per day. According to this plan to completely trim this area would take approximately 35 days.



RESILIENCE

Trees are one of nature's natural cooling elements. Trees release moisture, provide shade, and create micro-climates. In addition, trees provide deep slope stabilizing roots that help maintain the integrity of the ravine & bluff slopes across all areas.

Dense canopies become a threat to a resilient landscape when there are other underlying issues, such as active erosion, taking place. Reducing canopies in the areas of concern will allow light to penetrate through which will help establish an understory & ground cover layer to further stabilize the slopes to help battle the increased stormwater and the treats that this brings.

tree maintenance
per 11,000 SF

This includes trimming, thinning, and pruning of existing trees. In addition, this includes removing the debris off site and/or chipping material on site. This is an average approximate cost.

**\$3,000/
11,000 SF**
ESTIMATED



Tree Canopy Coverage Overall - Cascade Creek

Cascade Creek Area has a lot of mature trees that populate the area. This is a plan noting the various densities found in the area and which areas should be thinned/managed first.

Maintenance Plan for Thinning Canopy Coverage

Ideally a 40-60% canopy coverage is preferred. Canopy coverage is most important on slopes that are susceptible to erosion or have erosion issues currently. Dense canopy coverage on flat lands is not a big priority. Generally any canopies above 80% should be thinned, maintained, and monitored every year until ideal conditions are meant then reviewed every year.



Improper Pipe Discharge Location on Slope

When water is concentrated and discharged through a pipe, if not properly located, the discharge location can become a serious threat to any hillside, slope or bluff face. Good practice is to capture any water and direct it downhill to a discharge location at the bottom of the hill. The discharge location needs to be reinforced with a material to disperse the water and not erode away. Discharging pipes at the top of a slope or the middle of a slope is poor practice as it puts a high concentrated water flow down a slope creating rills & erosion that will eventually compromise the slope.

Current Conditions found at Bayfront Bluffs - West



A 4" PVC pipe is discharging water in the middle of the slope just below Cascade Street. It is unknown where this pipe comes from or what amount of water it's discharging. Small rills are forming at the discharge location and will continue to grow over time.

Concern & Priority Level

Concern: SHORT TERM

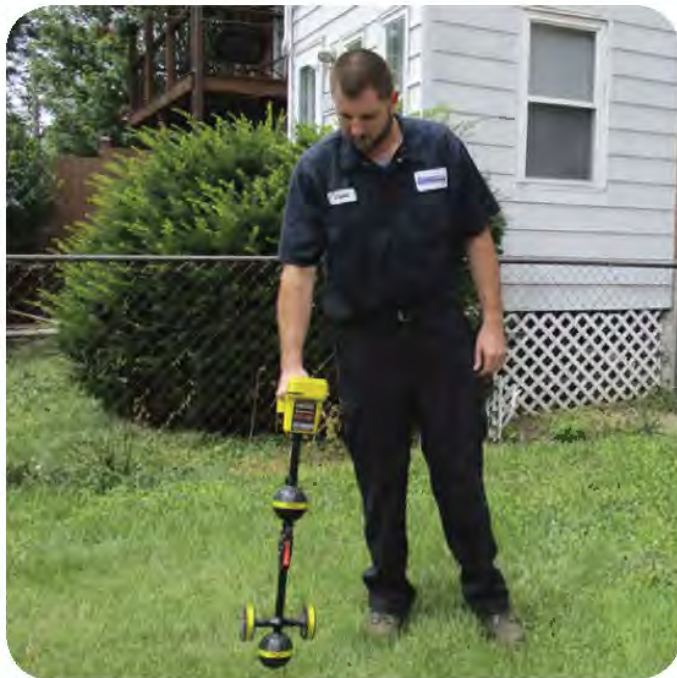
The discharge of this pipe on the slope in this area is currently minor and stable due to vegetation. Moving the pipe discharge to the bottom of the slope will solve the potential future issue.



Priority: LEVEL 4

The discharge of this pipe found along the west Bayfront ranks as a **priority level 4** because as it is minor currently it could become an issue in the long run if it's not dealt with now. There are minor rills being created from the water being discharged which can come larger over time and cause sloughing in this area.

Solutions to Prevent Further Erosion & Rill Creation:



The first step will be to locate the pipe and find out where it's connected, how much water it's moving, and if it's a permitted pipe to be discharging onto Port Authority property.



If it's permitted to be discharged and carrying significant amounts of water then using flexible pipe and running it down the slope to discharge at the bottom into the existing drainage system will stop water from discharging mid-slope.



The flexible pipe will allow it to bend to the contours of the slope and reduce the risk of breaking from any pressure on the surface. The pipe can be left on the surface or buried to visually hide it. Burying it will require more soil disturbance - the necessary precautions will be required.

Edge Protection Along Path at top of Slope

Along the tops of slope where the trail sits directly at the top of the slope there can be increased undercutting of the road due to a lack of protection. The edges along the trails are beginning to erode/under cut and will want to be monitored and reinforced as needed. Due to the amount of water directed to these locations and no reinforcement currently in the place, the water is carrying material away from this area causing erosion and undercutting. This has been observed along the multi-use trail along the bayfront at various spots.

Current Conditions Found in Areas of Concern



We can see the asphalt path beginning to be undercut as the material is continually carried away with every rain storm. This will eventually lead to the failure of this walkway.



We can see the asphalt path beginning to tip & crack towards the slope. This could be an early indication that the soil is beginning to erode away causing the base to move.

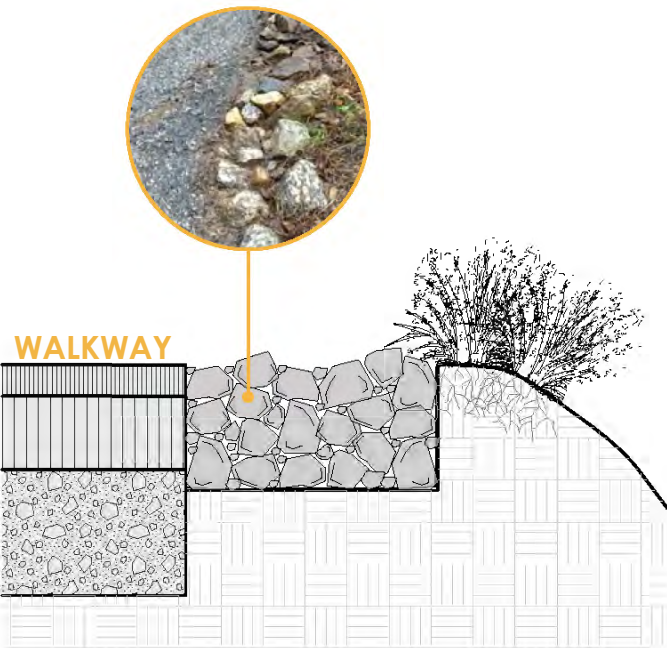
Concern & Priority Level

Concern: SHORT TERM

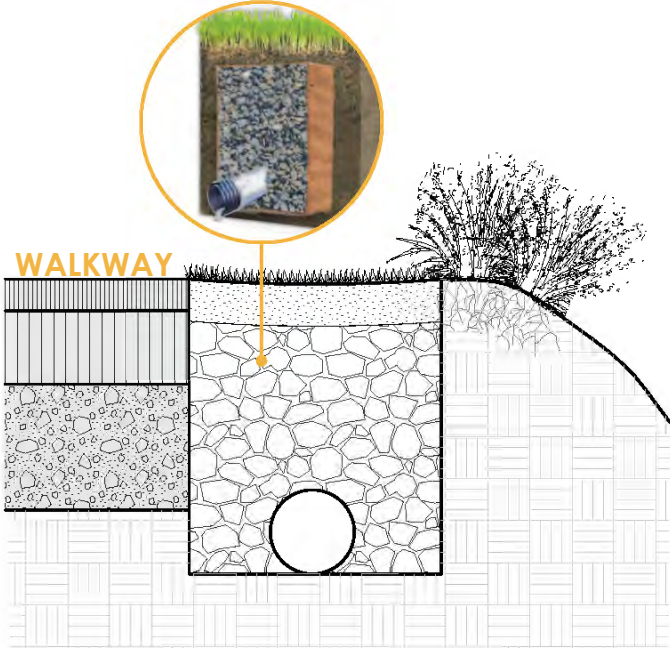
These areas of concern are a short term concern where implementing simple solutions will help stabilize and minimize or stop the erosion concern.



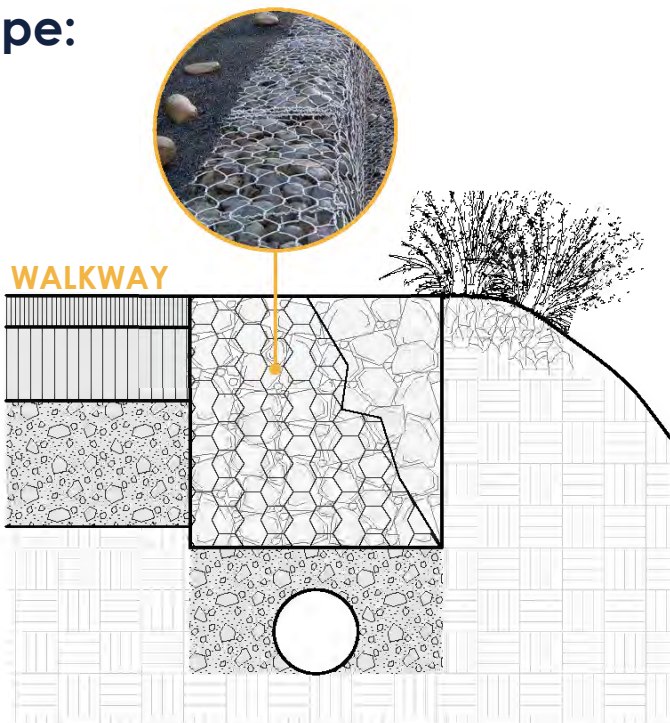
Solutions to Protect the Walkway Edge & Help Stabilize the Slope:



Placing a filter fabric in a trench and fill it with 3" + size angular stone will help reinforce the edge of the asphalt. In addition the stone will slow and disperse water as well as capture additional sediment. Planting vegetation on the edge will further help stabilize slope.



Installing a french drain with reinforced turf on top will help capture any water and discharge it at the bottom of the slope or tie into any existing drainage. This solution will help to keep water from washing soil away from the edge and undercutting the walkway



Installing a gabion basket or other form of retaining wall will reinforce the edge of the walkway and provide stabilization to the top of the slope. This solution can vary in costs and would require further investigations.

Priority: LEVEL 4

The undercutting edges on average rank as a **priority level 4** because there is not major undercutting and does not pose a serious threat in its current state. In addition there are not signs of rapid erosion or undercutting, but it's an issue that if let go could grow into a large issue with greater costs such as complete walkway replacement.

Reinforced Edge Protection

This provides four options for the edge reinforcement at the top of slopes where there is a hard surface close to the edge of the slope that is being undercut at the foot of German Street.



I
oversized
gravel
reinforcement

This includes installing a 18" wide oversized gravel strip along the edge of the hardscape surface for edge reinforcement. The oversized stone should be between 3-6" angular stone with fines in between to allow the stone to lock together further strengthening the edge.

\$1,000-
1,500
ESTIMATED

II
french
drain with
gravel

This includes installing an 18" wide french drain system backfilled with gravel. The french drain would then be tied into the existing drainage system or discharged at the bottom of the slope through a solid drain pipe. This application would be suitable if there was heavy sheet flow off of the hard surface.

\$3,300-
4,000
ESTIMATED

III
gabion
basket
retainage

This includes installing a 2'-wide by 2'-high gabion basket retaining curb along the hard surface needing reinforcement. The gabion would be set into the slope so that the top sits flush with the edge of the hard surface. The baskets would be filled with a natural stone that matched the surrounding aesthetics.

\$5,700-
6,700
ESTIMATED

IV
timber
wall
retainage

This includes installing an 18" timber curb similar to what exists off of German Street. There would need to be three horizontal rows of 6" timber set into the slope and vertical timbers spaced appropriately holding the horizontal rows in place. This application would be useful in limited space or if there is sever undercutting happening.

\$7,000-
8,000
ESTIMATED

Tree/Vegetation Maintenance - Overall

Maintaining established trees across all of the areas should always be a priority as they offer a lot of soil stabilization through their deep root structure, they absorb water and remove it from the soil, they help protect the ground from rainwater causing soil displacement and they are aesthetically pleasing. Trees provide food and habitats for local birds. The views to the bay are important along the Bayfront, however, using best management practices trees can be trimmed to keep the tree health and maintain views.

Poorly Maintained Trees Found Across all Areas



Concern & Priority Level

Concern: SHORT TERM

Vines in growing in trees, suckers, and over grown trees are mostly an eye sore and the issue is solved with proper pruning.



Priority: LEVEL 5

The vines in growing in trees, suckers, and over grown trees issue ranks as a **priority level 5** because it's mostly for aesthetic purposes, however, if not addressed the trees could be choked out by the vines and perish. The trees help add a lot of stabilization and need to be maintained annually.

General Control Methods and Potential Solutions:

Proper Cutting Basics

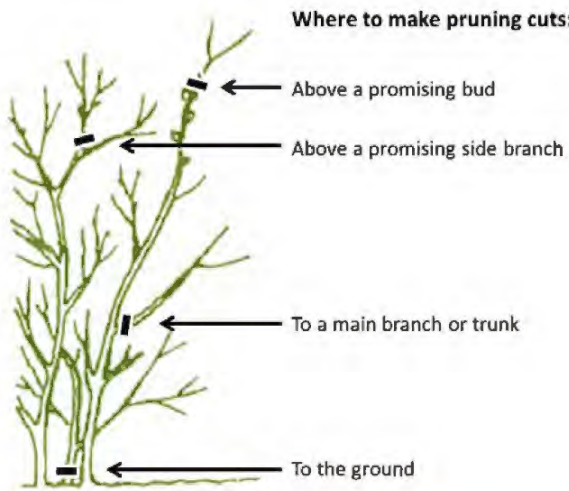
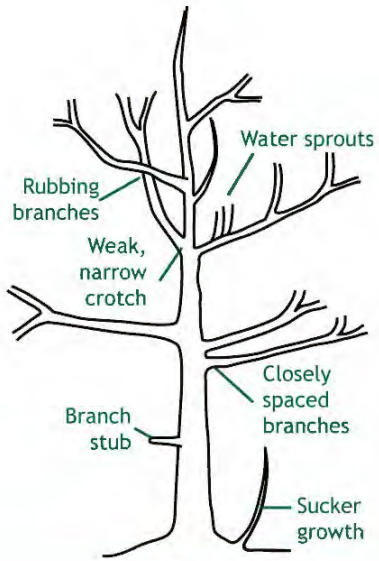
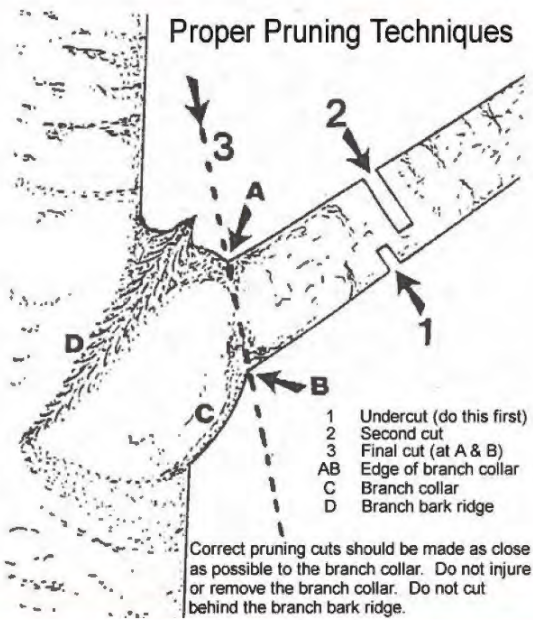
Always cut to a node or bud at an angle. Never cut perpendicular to the branches. When removing a branch at the trunk cut in line with the branch collar without cutting into the collar.

What to Cut First

Remove all dead branches and remove crossover branches. Always look twice before making a live cut, if in doubt, pull branch back and look at it.

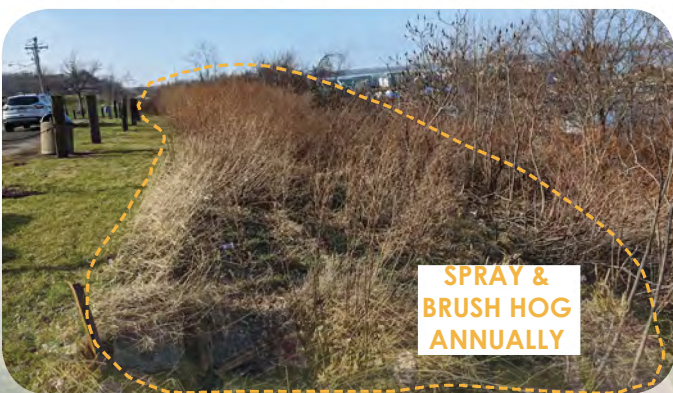
Cutting Large Branches

When cutting large branches make three cuts to remove the limb. This keeps the removed branch from stripping the bark below the cut.



Tree/Vegetation Maintenance - Bayfront: Poplar to Plum

Along Front Street between Poplar and Plum there are numerous multi-stem trees on the Port Authority property that are not healthy trees and could grow to become hazardous. Multi-stemmed trees can break and create issues. Selecting one lead and removing the rest will help the health of the tree and views out. In addition, tall herbaceous plant material has been let go for years and has created an additional screen. These herbaceous materials can be selectively sprayed and brush hogged annually to maintain.



The issue along this stretch is aesthetic views to the bay. One major obstacle is the majority of the land is privately owned. The top of the bluffs can be maintained through selective trimming, invasive species removal, selective herbicide spraying, and brush hogging annually.



Tree/Vegetation Maintenance - Bayview Ave

At the foot of Lincoln Ave and Bayview Ave there are numerous multi-stem Sumac trees on the Port Authority property that can be thinned and removed to create healthier trees as well as increase visibility. Anything removed should be replaced to provide the stabilization and done in phases to make sure no open bare areas are created.



The issue along this stretch is aesthetic views to the bay. The Sumacs are a valuable native tree that provide stabilization to the hillside. Selective thinning can be done in line with selective restoration to phase in native replacements.



Tree/Vegetation Maintenance - Land Lighthouse

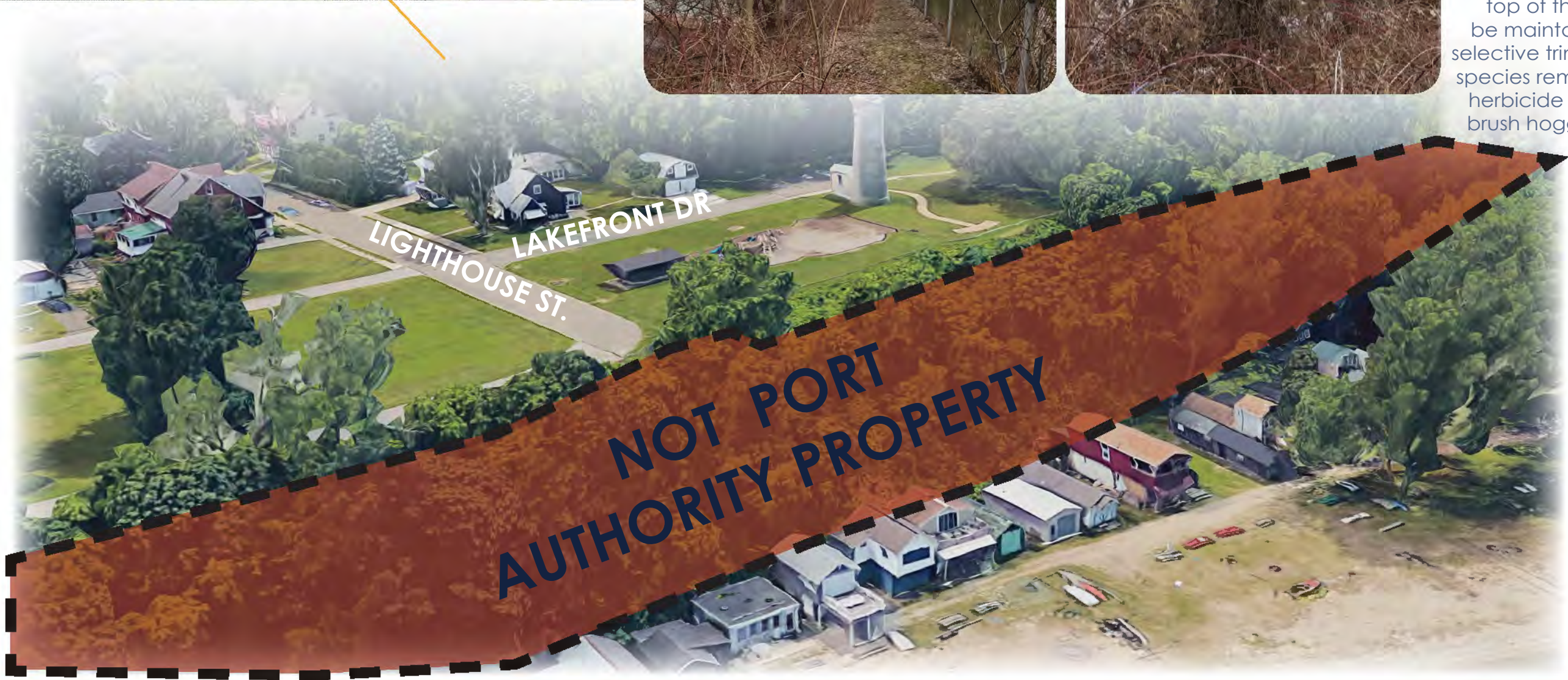
Bordering the Land Lighthouse property the Port Authority owns a small parcel of the bluff that is overgrown and will benefit from selective clearing. There are numerous trees that can be limbed up for views. Selecting one lead and removing the rest will help the health of the tree and views out. In addition, tall herbaceous plant material has been let go for years and has created an additional screen. These herbaceous materials can be selectively sprayed and brush hogged annually to maintain.



The issue along this stretch is aesthetic views to the bay and invasive species.

One major obstacle is the majority of the land is privately owned. The

top of the bluffs can be maintained through selective trimming, invasive species removal, selective herbicide spraying, and brush hogging annually.



Selective trimming & restoration

This provides estimates to selectively trim & clear two specific areas: Bayfront West between Plum & Poplar Street and Ravine Park at the foot of Lincoln Ave.

I
bayfront
west
selective
trimming

This includes selectively trimming existing trees, applying a selective herbicide to control woody material, and brush sawing any hazardous material along the edge of the slope. In addition, general cleanup & debris removal would be included. This work would take roughly 2-3 days to complete.

\$3,800-
4,500
ESTIMATED

II
ravine park
selective
trimming

This includes selectively trimming existing trees, applying a selective herbicide to control woody material, and brush sawing any hazardous material along the edge of the slope. In addition, general cleanup & debris removal would be included. This work would take roughly 1-2 days to complete.

\$2,000-
2,800
ESTIMATED

III
native tree
restoration
ravine park

This includes furnishing and installing (4) four 1-2" native trees to replace vegetation removed from the slope. Included are tree stakes, compost, and slow drip tree irrigation bag.

\$4,000-
5,000
ESTIMATED

IV
land
lighthouse
selective
trimming

This includes selectively trimming existing trees, applying a selective herbicide to control woody material, and brush sawing any hazardous material along the edge of the slope. In addition, general cleanup & debris removal would be included. In addition, this include invasive species control.

\$6,500-
7,500
ESTIMATED

Bluff & Ravine Evaluation: Don't Create Tomorrow's Crisis Today!

Ravine & Bluff ecosystems are beautiful as well as unique, but they are also extremely fragile and vulnerable if not taken care of properly. Routine maintenance and being knowledgeable about ways to prevent issues are important to ensure their longevity.

Ravine & Bluff slopes are susceptible to erosion and slippage - especially during periods of above-average rainfall. Excessive water that flows directly or indirectly over a slope during major storm events can accelerate erosion as well as over saturate the soil which makes the slope susceptible to slippage - the sliding of soil and surface material - which leaves bare earth even more susceptible to further erosion.

Ravine & Bluff slopes, in their natural state, are susceptible to erosion and are unstable so it is extremely important that precautions are taken to reduce poor practices which cause to increased erosion and instability.

The Ravine and Bluff properties located in Erie County have high ecological and aesthetic value if taken care of properly. Poor practices listed in this manual will lead to the decline and failure of these beautiful areas. Prior to undertaking any maintenance & management of any Port Authority owned property please reach out to the Port Authority for guidance and approval:

John Mulligan • Director of Operations/Harbormaster • Erie-Western PA Port Authority • 1 Holland St. • Erie PA, 16507 • 814-455-7557 ext. 228 • www.porterie.org

Every property (public or private) is unique, but following a simple process will allow you to make sure your property is managed & maintained properly.

1 Inventory Existing Site Resources and Create a Site Specific Management Plan

- Depending on your site, your capabilities, and the tools available to you - this could vary in detail, but your inventory should include all of the existing vegetation (herbaceous, woody shrubs, and trees), any water found in or around the property that could effect your property, and a general idea about the topography of the site.
- Identify and record your site specific management goals as well as think about how those goals are going to be accomplished. Your management goals should ask these questions:
 - a.) What plants do you want to remove and for what reason? What category - invasive, protected, key - do they fall under?
 - b.) Are there any Key Species found on site or near the plants wanting to be removed?
 - c.) Is there a suitable native plant to replace the removed plants?
 - d.) How will the site be accessed to perform the work?
 - e.) Is there a timeline for when these plants need to be removed?

2 Gather Required Approval & Permits from Local Agencies

- If the scope and scale of the work is minimal, with proper approval, a management plan can be developed rather easily. Larger and more complex properties will require a consultation with a professional such as a Landscape Architect, Arborist, Ecologist and/or a land management specialist.
- Vegetation trimming, pruning, modification and removal will require written approval from the Erie Western Pennsylvania Port Authority as well as a consultation with the City of Erie arborist.

3 Remove Hazardous Plant Material First and Remove and/or Control Aggressive Plants

- Any invasive, dead, dying, and/or material posing a healthy/safety risk should be removed. If there are large swaths of this type of material or an entire area has this type of material, there will need to be phases of removal to avoid exposing the slope to bare, loose soil that is susceptible to erosion. Consultation with an arborist or landscape architect will be required.
- Any trees/shrubs/woody material removed from the slopes should be cut flush with the surface and the stump/roots should be left in place.
- Prune trees according to ANSI A300 standards for proper practice. Consult with an arborist to ensure proper trimming & pruning occurs.
- Maintain 40-60% canopy coverage to allow enough sunlight to reach the understory layers; Maintain 10-15% understory coverage (small trees & shrubs).
- Herbaceous plants help further stabilize the soil. Removal of these species should be done manually when possible. If herbicides are used make sure to follow the written instructions and application rates. Avoid pulling/spraying large areas at once.
- Any debris created from the removal process including logs, limbs, brush, etc. that can be removed from the property needs to be completely removed. Instances where a log is too large to move or heavy machines are required - consult with an arborist or landscape architect for the best method to minimize disturbance.

4 Restore Utilizing Native Plants

- After vegetation has been removed a restoration plan should be developed. Depending on the size and scope a consultation with an arborist or landscape architect may be helpful.
- Refer to the Native Plants for Vegetation Restoration list in this manual for native plants recommended for restoration. A wide variety of species, varying heights, and various aesthetic values should be chosen for any given site.
- Minimize site disturbance by choosing smaller grade species and make sure to remove any excess soil from the slope. Mulch over fresh topsoil when completed.
- When using native seeds on a slope consider using erosion control blankets until the site has an established 70% coverage.
- Water all material by hand - avoid over watering or sprinklers as they can increase the risk of soil erosion.

5 Monitor and Maintain Annually

- Reviewing your property regularly and performing maintenance as required will ensure the long-term health of the ravine & bluff property.
- Remove invasive species as they are discovered to avoid spreading and out competing of native plants.

MAINTENANCE MANAGEMENT STANDARDS

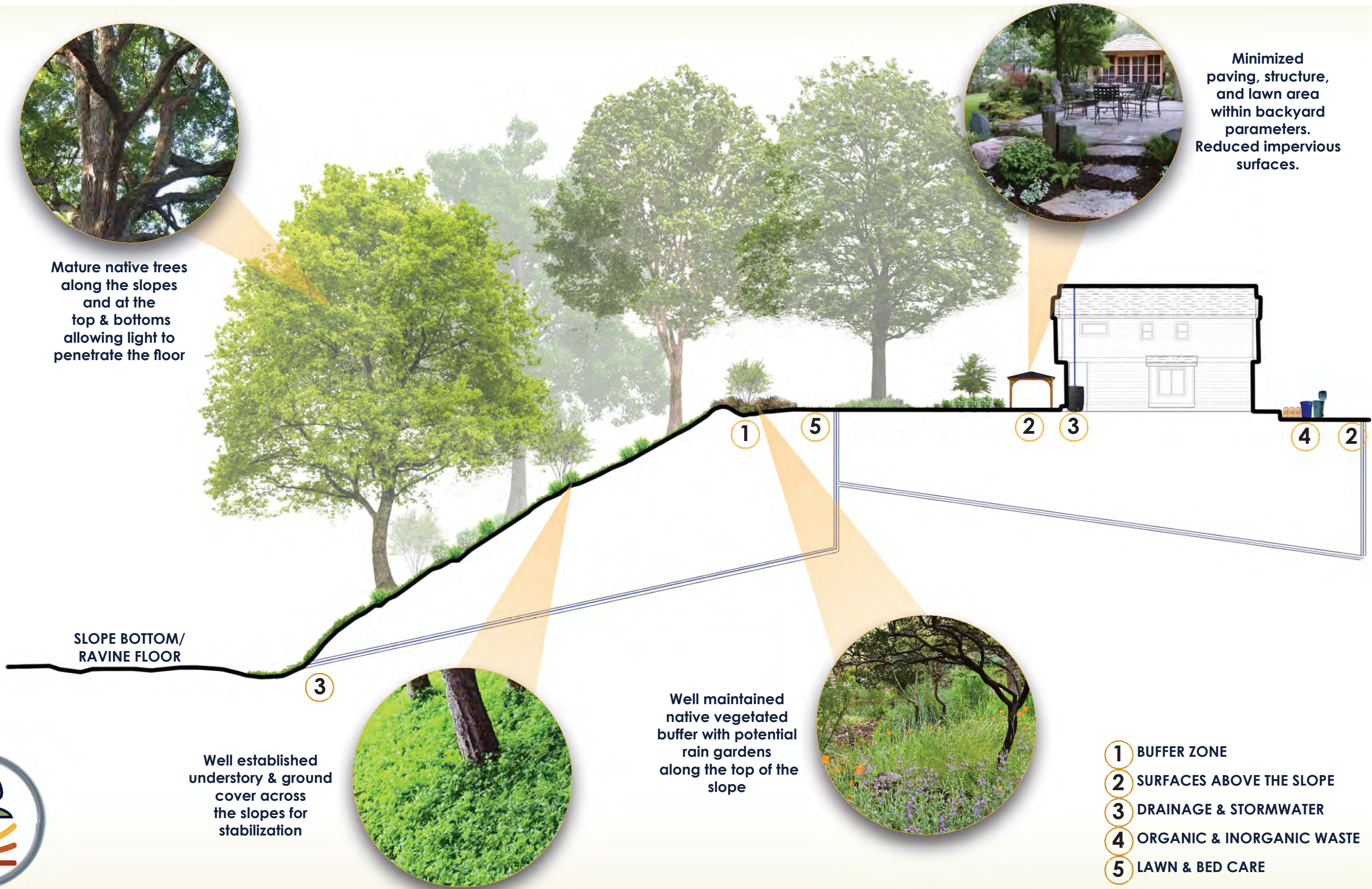
Below are the standards that need to be followed for key areas of the bluff & ravine properties. These areas include the buffer/no mow zone as well as all Tree Trimming and potential removals.

1 BUFFER ZONE/NO-MOW ZONE

- The Buffer Zone is an important element of ravine & bluff properties. Space is the most limiting factor to implementing a buffer zone. The standard to be used to establish a the minimum buffer zone has the following guidelines:
 - The Zones along the Bayfront Bluffs: **the Buffer Zone should be 5'-0" minimum (where space allows)**
 - The Zones along Cascade Creek & Ravine Park: **the Buffer Zone should be 10'-0" minimum (larger is encouraged)**
- Areas designated as the buffer zone or no-mow zones will not be regularly mowed. Specific selective herbicides can be used to control broad-leaf or woody plant material and brush-hogging can be done once to twice a year, but maintaining a no-mow zone is required in all areas.

2 TREE TRIMMING AND REMOVALS

- Trees are one of the best stabilizers for a slope and provide numerous other benefits that improve the health of the slope. Instances where a tree needs to be trimmed or thinned for a specific reason, the following guidelines must be followed:
 - What category is the tree: Invasive, Protected, or Key: **If invasive - removal & replacement should be an option; If Protected or Key Species, as per policy found in this manual**
 - All trimming **MUST FOLLOW** the **ANSI A300 Standards** for industry standards tree care practices
 - All work is to be done by a certified company with **minimum 5-years experience** trimming/thinning/pruning trees in our area
 - All debris generated by the work is to be completely removed from the site and disposed of properly
 - Tree topping, bulk clearing, or complete removal (without approval) is not allowed under any circumstance
- Trees can be removed if diseased, dead, dying, and/or they pose a health & safety risk to the general public.
- If any trees located on the Port Authority Property poses any health & safety risks it should be brought to the Port Authority's attention immediately by calling 814-455-7557



Mature native trees
along the slopes
and at the
top & bottoms
allowing light to
penetrate the floor

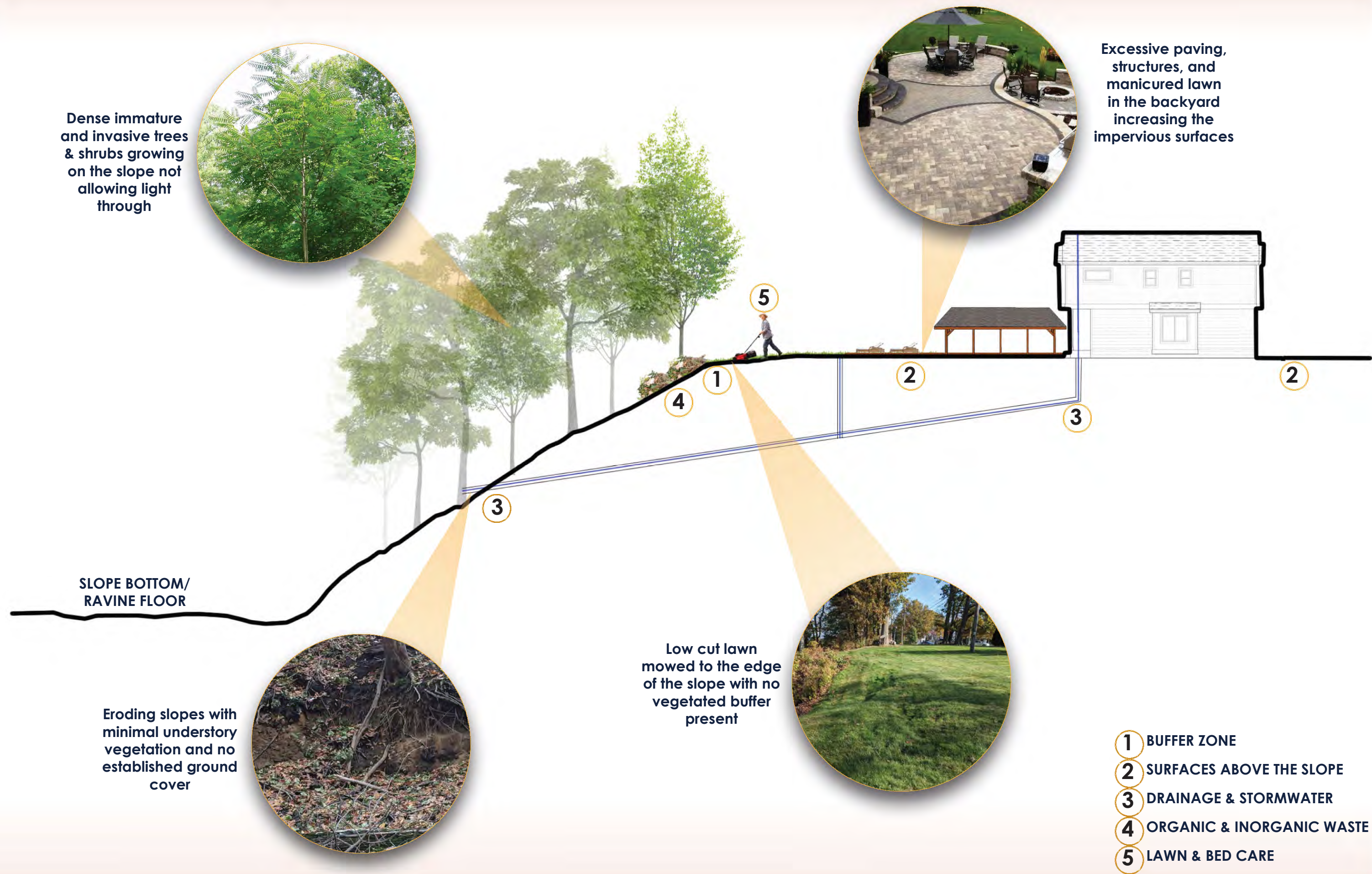
Minimized
paving, structure,
and lawn area
within backyard
parameters.
Reduced impervious
surfaces.

SLOPE BOTTOM/
RAVINE FLOOR

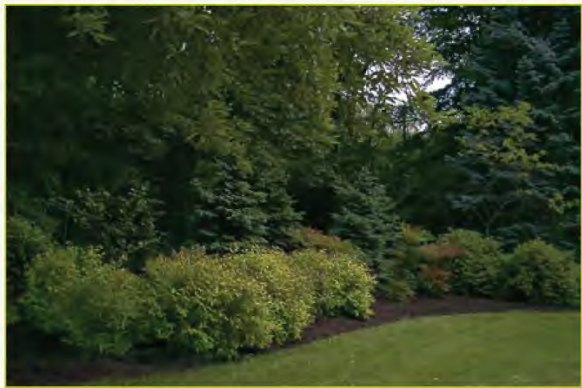
Well established
understory & ground
cover across the
slopes for
stabilization

Well maintained
native vegetated
buffer with potential
rain gardens
along the top of the
slope

- 1 BUFFER ZONE
- 2 SURFACES ABOVE THE SLOPE
- 3 DRAINAGE & STORMWATER
- 4 ORGANIC & INORGANIC WASTE
- 5 LAWN & BED CARE



Good Practice: These will improve your ravine/bluff property



- **Minimum 10' width from top of slope**
This is a minimum width (as space allows) however the wider the buffer the more beneficial it will be to the slope's health
- **Along entire length of property adjacent to slope**
This is a minimum width (as space allows) however the wider the buffer the more beneficial it will be to the slope's health



- **Plant Native Plants**
Use native plants from the recommended restoration list provided in this manual to create a diverse selection of native species



- **Minimal Irrigation**
If irrigation is going to be installed in the buffer zone - use drip irrigation.



Poor Practice: These will put your ravine/bluff property at risk for issues



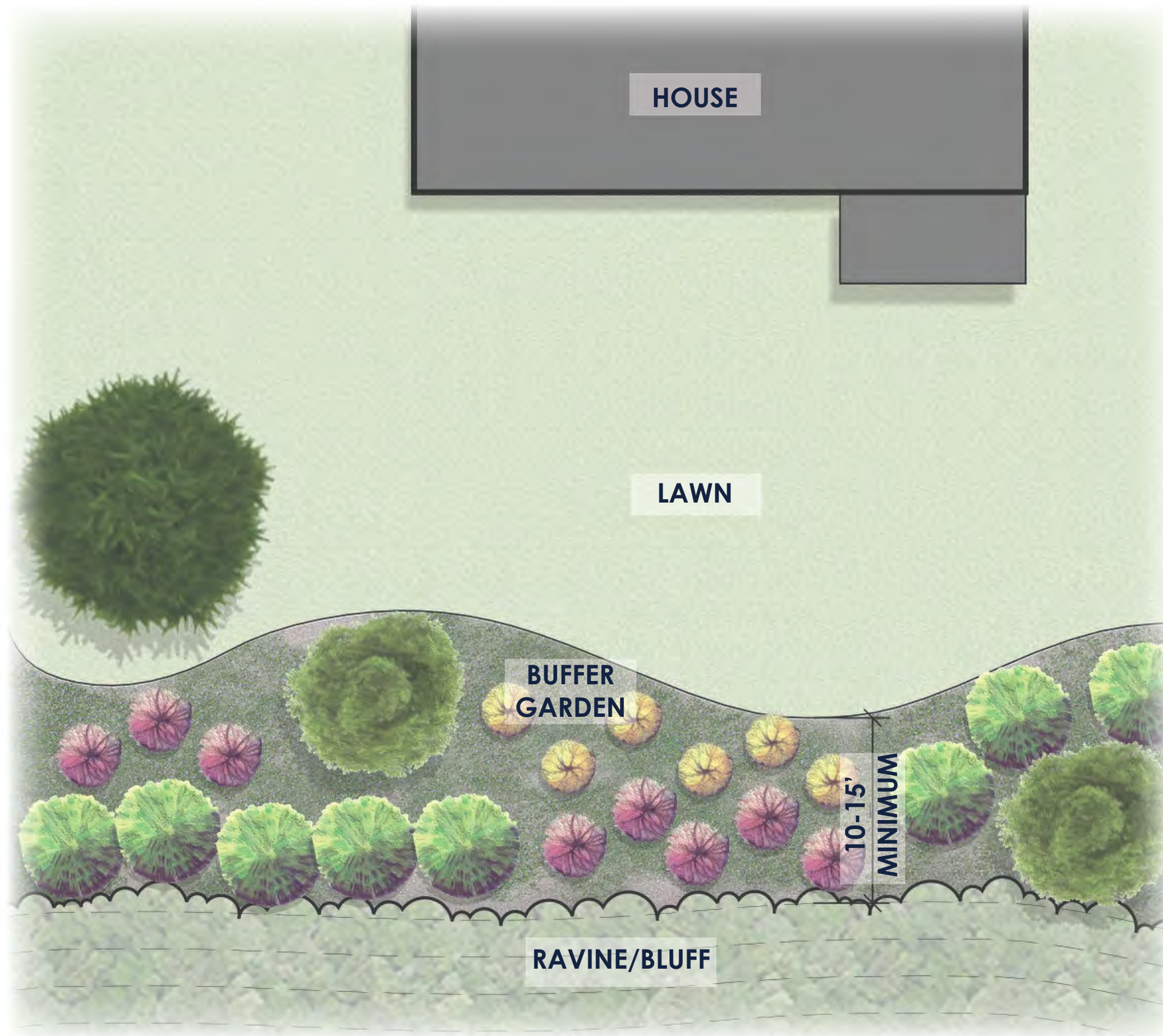
- **Encroach within 10' of top of slope with following:**
 - Mowed lawn
 - Paving/hardscape,
 - Pool/pond,
 - Outdoor furniture
 - Play equipment
 - Sheds & structures.

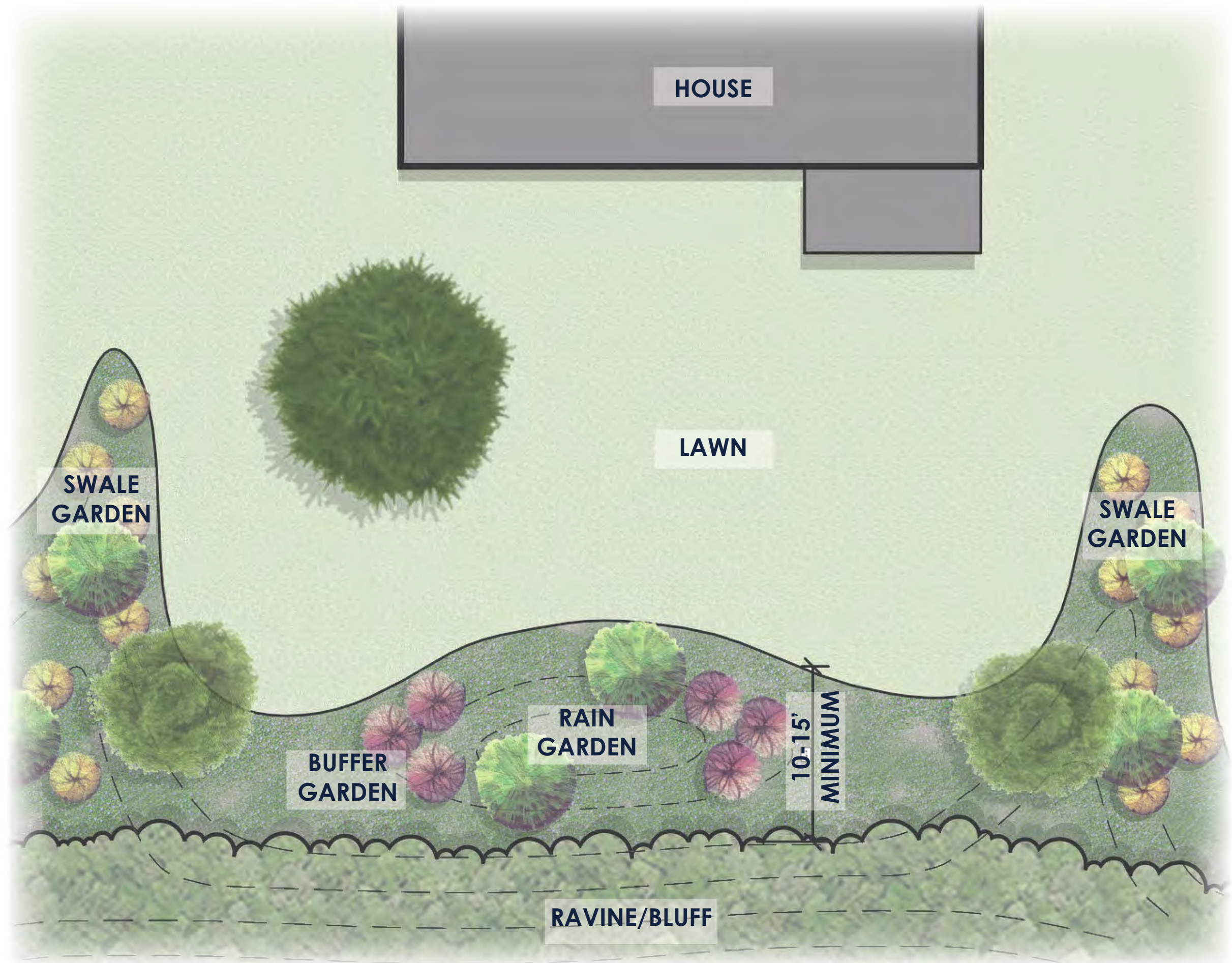


- **Plant Non-Native Plants**
Non-native plantings can have adverse effects to the slope and introduce invasive species that can out compete native plant communities.



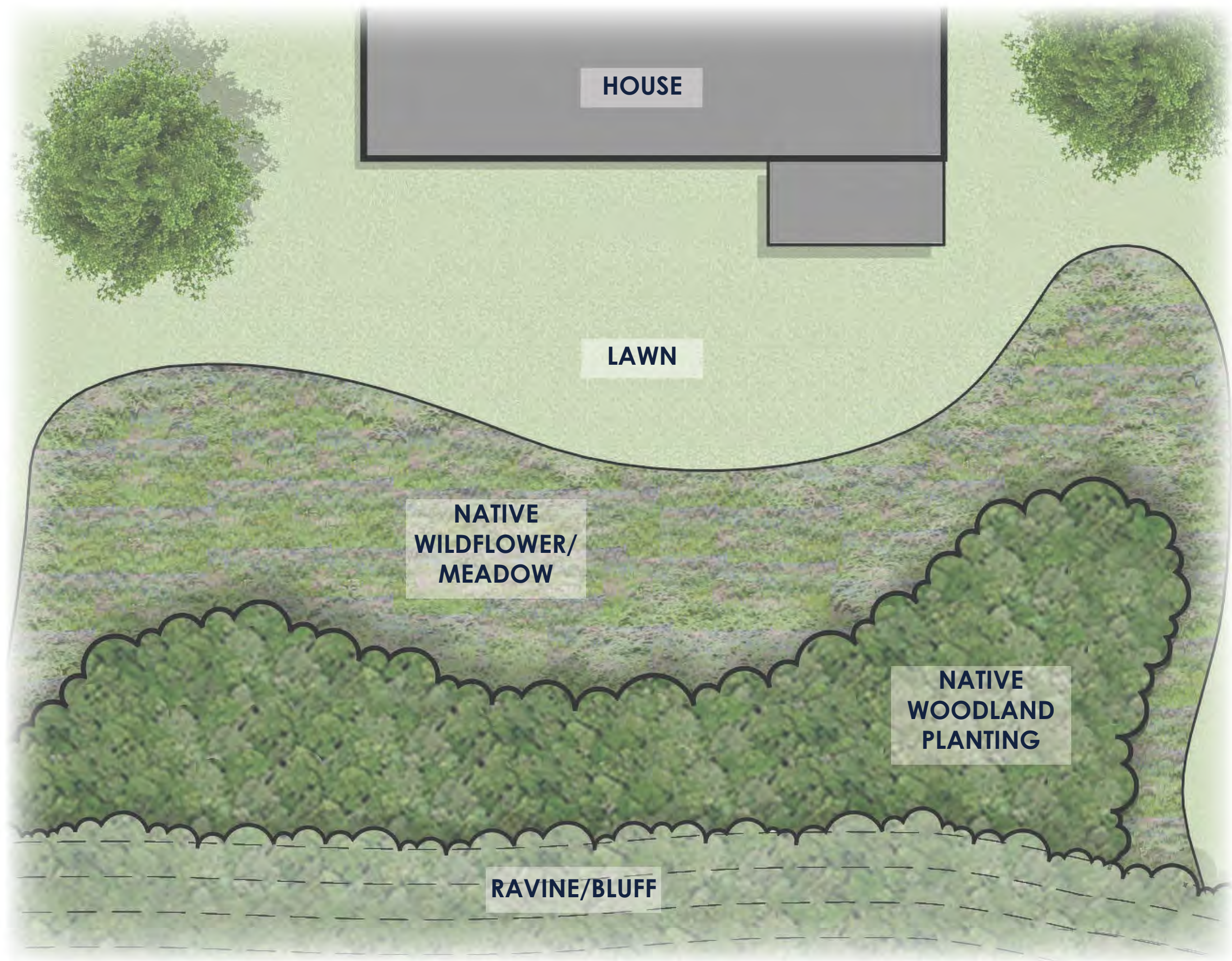
- **Activity & Play Along Slopes**
Reduce or remove any play by children or activity by walking and/or machinery along the slopes.





Policies & Standards

Ravine & Bluff Elements: **Buffer Zone** - Natural Wildflower Meadow



Good Practice: These will improve your ravine/bluff property



- **Minimize Amount of Impervious Surface**
 - Reduce the size of patios and/or decks to reduce amount of surface for water to runoff.
 - Surround patio/hardscape with vegetation to capture and/or slow down water runoff.



- **Curbed Roadway**

Areas where roads and walkways are at the top of slopes installing curbs will reduce the amount of water running off from the roadway over the slope.



- **Porous Paving**

If a hard surface is needed, try using a porous material with proper drainage connections. Some examples include:

 - Permeable pavers
 - Porous concrete/asphalt
 - Gravel
 - Reinforced grass pavers

- Slope patios and driveways toward the street, away from the slope
- Construct structures and/or swimming pools a minimum 20' from the edge of the slope



Poor Practice: These will put your ravine/bluff property at risk for issues



- **Overbuild with Hardscape**

Overbuild backyards with excessive patios, walls, roofs, and manicured lawns.



- **Excessive Impervious Surfaces**

Large continuous pieces of impervious surfaces with no areas for stormwater infiltration



- **Directing Stormwater**

Hardscape flowing stormwater directly towards and over the slopes edge with no control for reduction in velocity or quantity.

- Locate impervious surfaces next to slopes/slope edges

Good Practice: These will improve your ravine/bluff property



- **Direct Stormpipes to Bottom of Slope**
Capturing stormwater from roofs, yards, and other surfaces and directing that water through a pipe to the bottom of the slope will avoid causing erosion from letting the water discharge at the top or middle of the slope.



- **Native Vegetated Swales & Rain Gardens**
Planting native vegetated swales and rain gardens will help capture, infiltrated, and slow down water before going over the slope.



- **Rain Barrels & other devices**
Capture water from downspouts into cisterns and/or rain barrels to be re-used on the planting beds.

- Regularly inspect and maintain existing drainage
- Regularly inspect swimming pools for possible leaks



Poor Practice: These will put your ravine/bluff property at risk for issues



- **Direct Stormpipes to top & middle of Slope**
Directing stormwater through a pipe to the top or middle of the slope will create erosions from uncontrolled high velocity water wearing away at the slope face.



- **Excessive Runoff over Slope**
Allowing water to flow freely over the slope with no vegetation to buffer it will begin the process of erosion and continue to get worse over time.



- **Using Spray Sprinklers**
Using excessive water through spray sprinklers at the top of the slope, use when ground is already saturated or leave them on for long periods of time thus adding more water to the surface and groundwater.

- Drain pools near slopes or directly into the ravine or bluff
- Direct stormwater runoff to the top of slopes

Good Practice: These will improve your ravine/bluff property



- **Yard Waste**
Dispose of yard waste in trash or local landfill. Use leaf bags required by the city/township.



- **Composting**
Composting organic matter will reduce waste and also provide a useful product to be used around the yard.



- **Pick up Trash as Seen**
Pick up trash and debris as it is seen - do not let it pile up or become excessive.

- **Regularly inspect slopes and remove debris jams that may be blocking any channels or natural water flows.**



Poor Practice: These will put your ravine/bluff property at risk for issues



- **Dump Yard Waste over Slope**
Disposing of yard waste including leaves, clippings, branches, etc. in large heavy piles at the top of the slopes.

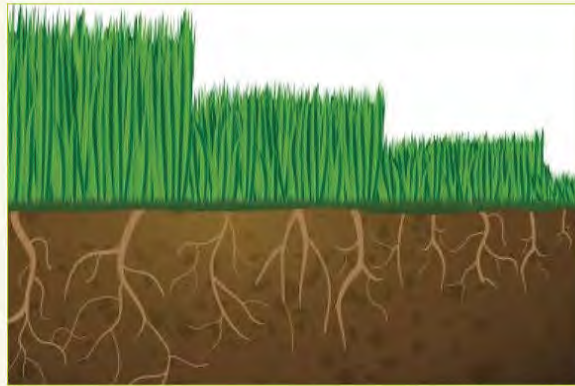


- **Dumping of Trash**
Dumping cans, bottles, and other inorganic trash over the slopes edge.



- **Leaving Trash for the Next Person to Pickup**
If we pick up trash and waste as we see it, we reduce the amounts able to build up over time and create a healthier outdoor environment.

Good Practice: These will improve your ravine/bluff property



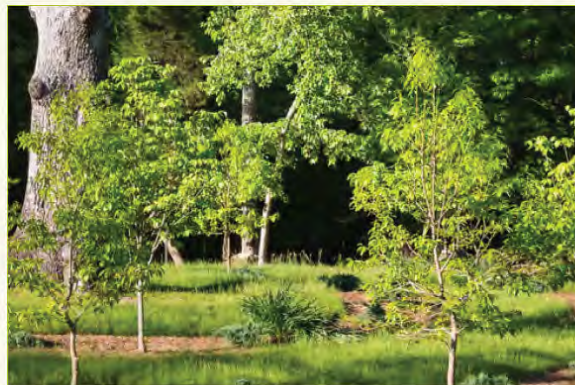
● Minimal Mowings & Brush Hogging

- The grass blade is where photosynthesis takes place and where the plant produces food for root and shoot growth
- Longer grass keeps the ground cooler and won't dry out as quickly - this reduces the amount of additional water needed
- Taller grass allows the roots to establish and become stronger helping to stabilize the soil further
- Mowing or brush hogging 1-2 times a year allows roots to establish, minimizes disturbance on sloped areas, and reduces amount of maintenance.



● Manually Remove Weeds & Aerate

- Use organic fertilizers and pesticides as required using selective methods such as wicking - avoid broadcasting
- Pull shallow rooted species in stages
- Aeration improves air exchange between the soil and the atmosphere
- Aeration will enhance soil water uptake
- Aeration will reduce water runoff and puddling
- Aeration will create stronger roots in your lawn



● Diverse Native Plantings with Minimal Disturbance

- Maintaining diverse native plantings in large groupings near the top of the slopes act as buffers to slow/infiltrate water before free flowing over the edge.
- Groupings create a more natural look around the property and are less maintenance than individual plants surrounded by lawn.
- Choose deep rooted, native plants - smaller sizes when planted will do better in the long term and cause less disturbance



Poor Practice: These will put your ravine/bluff property at risk for issues



● Excessive & Low Mowing

- Lawn that is mowed often and low focuses all of it's energy to producing blades thus creating weak root systems.
- Requires more supplemental water as it tends to dry out faster



● Large Plants & Trees with Heavy Machines

- Large trees and shrubs require more soil disturbance and excess soil left behind and often require large machines to install all increasing the risk of soil movement

Good Practice: These will improve your ravine/bluff property



- **Selective Trimming & Removal - Trees**
 - Primary targets for removal should be dead, dying, diseased, hazardous and invasive trees
 - Tree canopy Coverage should be between 40-60% which will allow enough light to support understory & ground cover plants.
 - Promote locally appropriate native trees
 - Practice alternative trimming & pruning methods such as framing to create desirable views
 - Prune trees according to ANSI A300 standards to ensure long-term tree health



- **Remove Invasives**
 - It's a general rule of thumb that the removal of invasives is always encouraged and recommended



- **Leave Stumps & Roots**
 - When trees & shrubs need to be removed make sure to cut flush at the ground leaving the stump & roots in tact. The stump and roots will continue to stabilize the soil while new vegetation is established



Poor Practice: These will put your ravine/bluff property at risk for issues



- **Clear Cutting & Topping**
 - Clear cutting and topping of trees for views or other reasons is never permitted.
 - Removal of key species (see list) is not permitted
 - Topping forces the tree to grow outward rather than upward creating a dense irregular branching pattern that does not allow sunlight to penetrate through to the ground.



- **Letting Invasives Takeover**
 - Invasive species will out-compete the native vegetation and threaten the biodiversity of ecosystems



- **Excessive Soil Disturbance**
 - Removing stumps & roots causes a lot of soil disturbance as well as severely weakens the stability of the soil.

VEGETATION REMOVAL GUIDELINES

The trimming and/or removal of trees, shrubs, & herbaceous plants is the first step toward managing vegetation on ravine & bluff slopes. Any trimming and/or removal on Port Authority Property will require a permit to be issued and all guidelines laid out in this manual must be followed.

Mature trees on the ravine and bluff slopes are desirable, however, the desired canopy coverage is approximately 40-60%. Therefore, trimming, pruning, and removal of trees may be necessary to achieve this coverage to allow for adequate sunlight levels to support herbaceous vegetation at the ground plane. This increased light at the ground plane will support robust growth of native understory plants as well as native grasses and wildflowers that will prevent soil erosion, stabilize slopes, and provide habitats for wildlife.

The following pages will present a variety of trees, shrubs, and herbaceous species listed under three categories:

INVASIVE: *These species can and should be completely removed when found in the landscape. A permit is still required, but the removal is required to decrease competition and promote native plants.*

PROTECTED: *These species can be considered for removal under certain conditions & circumstances. These species may include certain species such as Maples and Sumac which can become too aggressive and/or prone to diseases such as Emerald Ash borer or Dutch Elm Disease. It may be recommended that selective thinning is done first prior to complete removal.*

KEY: *These species should be completely preserved on all sites. There may be circumstances where one of these species will need to be removed, but it will be handled on a case by case basis.*

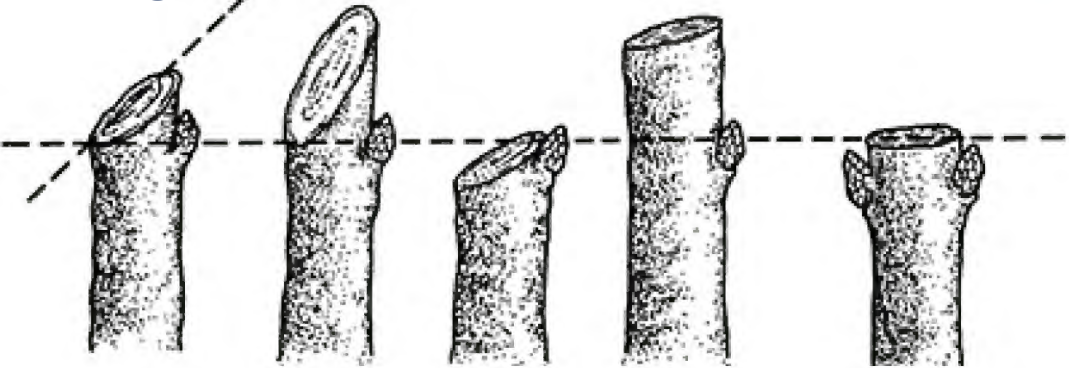
Any vegetation removal needs to be approved by the Port Authority prior to any removal taking place. Any removal done without approval from the Port Authority will be required to be restored with equal or improved vegetation.

PRUNING AND TRIMMING STANDARDS

Pruning/Trimming Basics

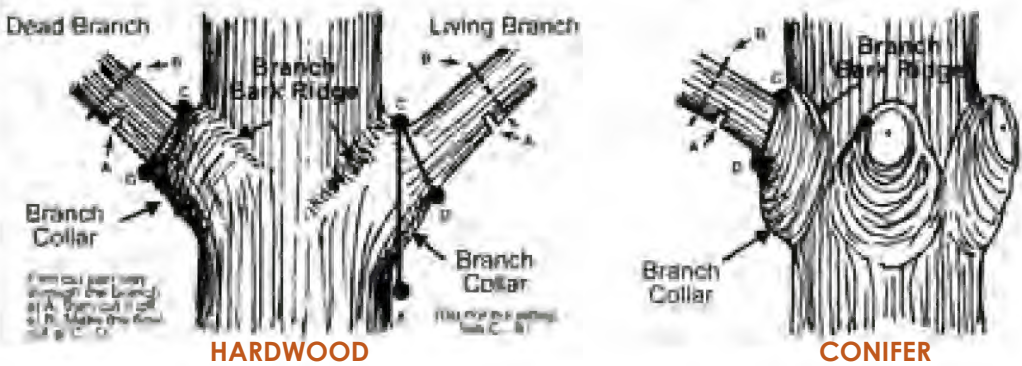
- Understand the plants you're pruning and why you're pruning them a certain way
- Always have sharp and clean pruning instruments (pruners, saws, loppers, etc.)
- Always practice safety when pruning by wearing proper safety equipment
- General Rule - if the plant flowers before June 1st, prune it during or shortly after flowering. If it blooms after June 1st prune it in the late winter or early spring before flower buds are visible.
- Prune trees and shrubs annually to maintain a well-shaped plant and avoid temptations to over-prune a neglected plant. Remove no more than 30% of the plant during a single pruning event.

Pruning in Relation to Stem Buds



45° Angle Good Cut **Too Angular** **Too Low** **Too High** **Opposite Good Cut.**

- Cut on an angle near a node or bud 1/4 to 1/2" away
- Always cut in line with but not in the branch collar



- Remove all dead branches
- Remove crossover branches
- Selectively remove branches to shape/thin
- Look twice before making a live cut - pull branch back and look at it

Deciduous Trees & Shrubs:
shedding its leaves annually



Evergreen Trees & Shrubs:
retains green leaves throughout the year



Perennials:
herbaceous plants returning annually

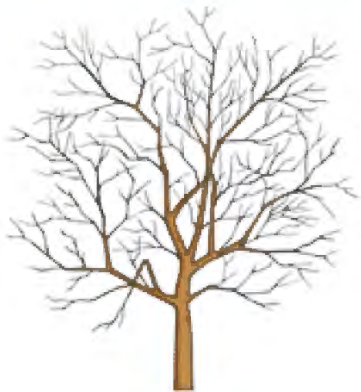
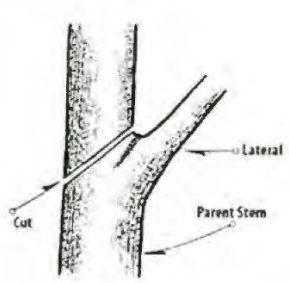


Tree & Shrub Thinning

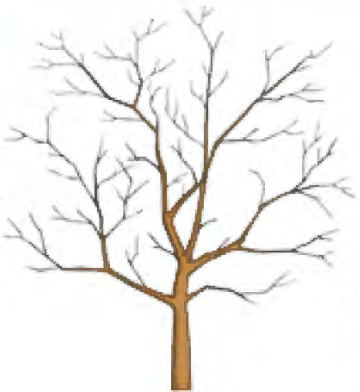
- Open up tree (think being able to throw a ball through it)
- Cut to bud allowing growth
- Do not sub or cross-cut
- Avoid witches brooms and lion tailing
- DO NOT top a tree
- Focus on keeping the natural shape of the tree/shrub
- If a tree must be reduced in height or spread:

- Small branches should be removed back to their point of origin.
- A larger limb should be pruned back to a lateral branch that is large enough (at least 1/3 the diameter of the limb being removed) to assume the terminal role.

CROWN REDUCTION



Before Pruning



Well pruned, open head



NOT GOOD

Topping produces clumps of uncontrolled growth



Before



After

THINNING



Before



After

GRADUAL RENEWAL

INVASIVE TREES



Amur Maple
Acer ginnala



Siberian Elm
Ulmus pumila



Tree-of-Heaven
Ailanthus altissima



White Mulberry
Morus alba



Norway Maple
Acer platanoides



Sycamore Maple
Acer pseudoplatanus

INVASIVE TREES



European Black Alder
Alnus glutinosa



Mimosa
Albizia julibrissin



Callery or Bradford Pear
Pyrus calleryana

PROTECTED TREES



American Elm
Ulmus americana



Basswood
Tilia americana



Black Cherry
Prunus serotina



Black Locust
Robinia pseudoacacia



Black Willow
Salix nigra



Box Elder
Acer negundo

PROTECTED TREES



Eastern Cottonwood
Populus deltoides



Eastern Redcedar
Juniperus virginiana



Green Ash
Fraxinus pennsylvanica



Quaking Aspen
Populus tremuloides



Sugar Maple
Acer saccharum



White Ash
Fraxinus americana

KEY TREES



American Beech
Fagus grandifolia



Black Walnut
Juglans nigra



Hackberry
Celtis occidentalis

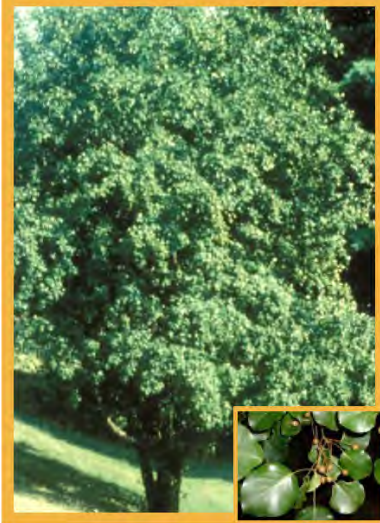


Hickory Species
Carya spp.



Oak Species
Quercus spp.

INVASIVE TREES



Buckthorn Species
Rhamnus spp.



Paper mulberry
Broussonetia papyrifera

PROTECTED TREES



Hawthorn species
Crataegus spp.



Smooth Sumac
Rhus glabra Smooth Sumac



Staghorn Sumac
Rhus typhina Staghorn

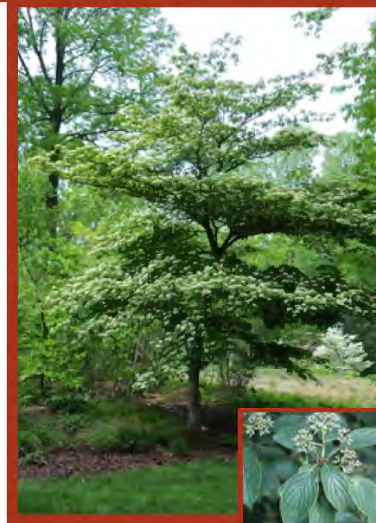
KEY TREES



American Hornbeam
Carpinus caroliniana



Hop Hornbeam
Ostrya virginiana



Pagoda Dogwood
Cornus alternifolia



Paper Birch
Betula papyrifera



Redbud
Cercis canadensis



Serviceberry
Amelanchier arborea



Witch Hazel
Hamamelis virginiana

INVASIVE SHRUBS & VINES



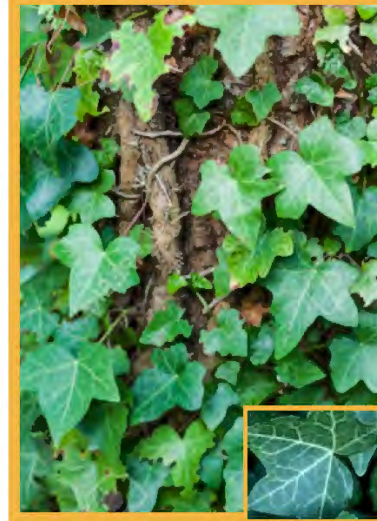
Asian Bittersweet
Celastrus orbiculatus



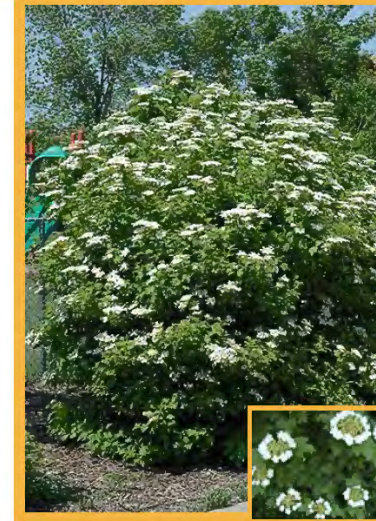
Boston Ivy
Parthenocissus tricuspidata



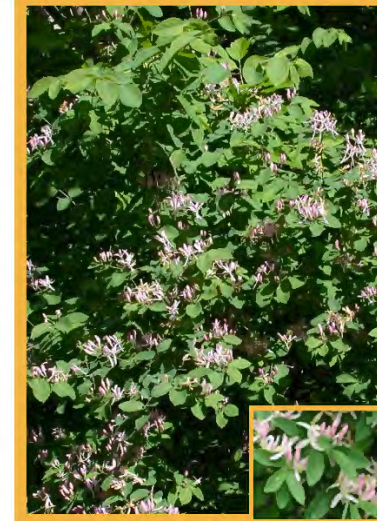
Burning Bush
Euonymus alatus



English Ivy
Hedera helix



European Highbush Cranberry
Viburnum opulus

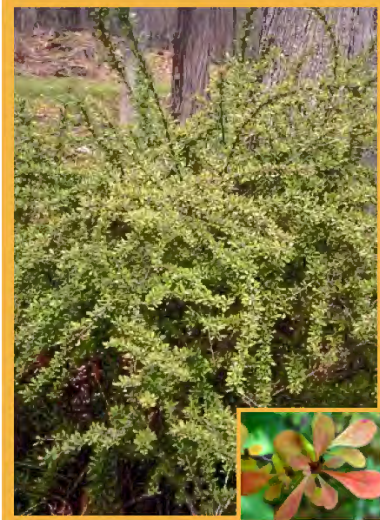


Honeysuckle species
Lonicera x bella



Wineberry
Rubus phoenicolasius

INVASIVE SHRUBS & VINES



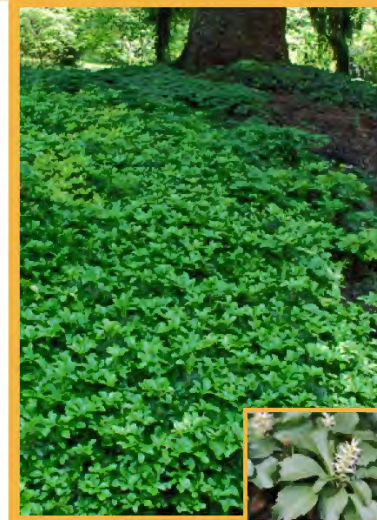
Japanese Barberry
Berberis thunbergii



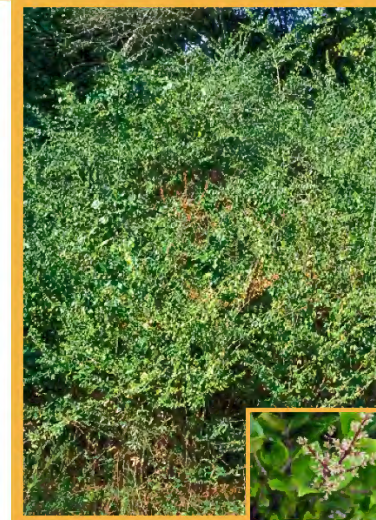
Paper mulberry
Broussonetia papyfera



Multiflora Rose
Rosa multiflora



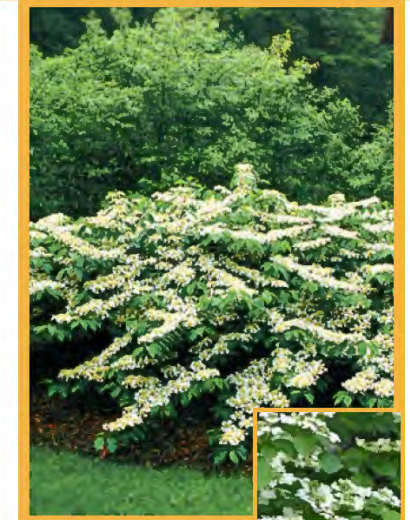
Pachysandra
Pachysandra terminalis



Privet Species
Ligustrum spp.



Japanese spiraea
Spiraea japonica



Doublefile Viburnum
Viburnum plicatum

INVASIVE SHRUBS & VINES



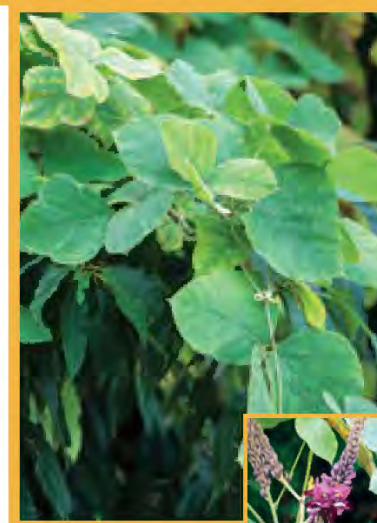
Linden Viburnum
Viburnum dilatum



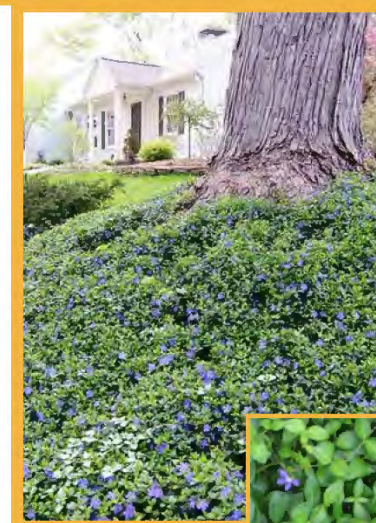
Wintercreeper
Euonymus fortunei



Mile-a-minute weed
Persicaria perfoliata



Kudzu
Pueraria lobata



Common periwinkle
Vinca minor



Japanese wisteria
Wisteria floribunda

PROTECTED SHRUBS & VINES



Chokecherry
Prunus virginiana



Gray Dogwood
Cornus racemosa



Peach-leaved Willow
Salix amygdaloides

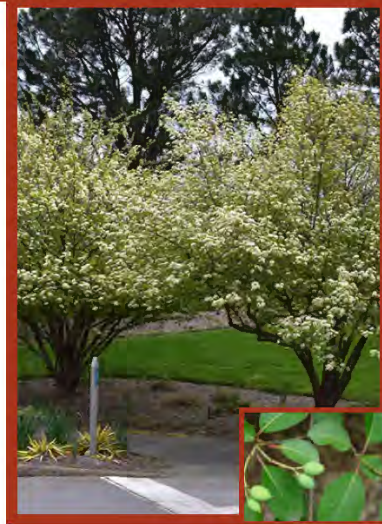


Raspberry Species
Rubus spp.

KEY SHRUBS & VINES



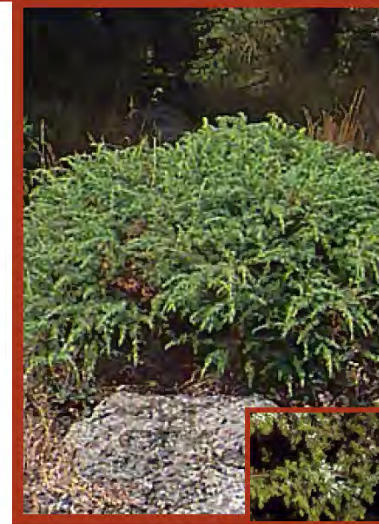
American Hazelnut
Corylus americana



Blackhaw Viburnum
Viburnum prunifolium



Buffalo Berry
Shepherdia canadensis



Common Juniper
Juniperus communis



Downy Arrowwood
Viburnum rafinesquianum



Summer Grape
Vitis aestivalis

KEY SHRUBS & VINES



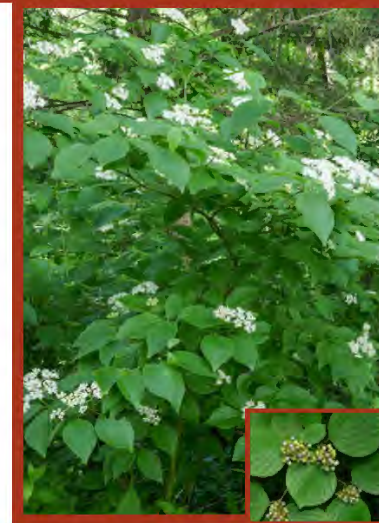
Elderberry
Sambucus canadensis



Maple-leaved Viburnum
Viburnum acerifolium



Red-Twig Dogwood
Cornus stolonifera



Round leaved dogwood
Cornus rugosa

PROTECTED EVERGREENS



Black Pine
Pinus nigra



Blue Spruce
Picea pungens glauca



Serbian Spruce
Picea omorika



Colorado Spruce
Picea pungens



Douglas Fir
Pseudotsuga menziesii



Eastern Red Cedar
Juniperus virginiana

PROTECTED EVERGREENS



False Cypress
Chamaecyparis sp.



Northern White Cedar
Thuja occidentalis



Norway Spruce
Picea abies

KEY SHRUBS & VINES



Canadian Hemlock
Tsuga Canadensis



White Pine
Pinus strobus

INVASIVE GRASSES & SEDGES



Common Reed
Phragmites australis



Lyme Grass
Leymus arenarius



Reed Canary Grass
Phalaris arundinacea



Small Carpetgrass
Anthraxon hispidus



Cheatgrass
Bromus tectorum



Common Velvet Grass
Holcus lanatus

INVASIVE GRASSES & SEDGES



Japanese stiltgrass
Microstegium vimineum



Chinese silvergrass
Miscanthus sinensis



Golden bamboo
Phyllostachys aurea



Rough bluegrass
Poa trivialis



Racenna grass
Saccharum ravennae



Tall Fescue
Schedonorus arundinaceus

INVASIVE GRASSES & SEDGES



Johnsongrass
Sorghum halepense



Horsetail
Equisetum hyemale

PROTECTED GRASSES & SEDGES



Brome species
Bromus spp.



Cattail species
Typha spp.



Fescue Species
Festuca spp.

KEY GRASSES & SEDGES



Bluestem Species
Andropogon spp.



Bottlebrush Grass
Hystrix patula



Fowl Manna Grass
Glyceria striata



Poverty Oatgrass
Danthonia spicata



Sedge Species
Carex spp.



Switchgrass
Panicum virgatum



Wildrye Species
Elymus spp.

INVASIVE HERBACEOUS PLANTS



Bishop's Goutweed
Aegopodium podagraria



Canada Thistle
Cirsium arvense



Common Burdock
Arctium minus



Common Mugwort
Artemisia vulgaris



Crown vetch
Securigera varia



Orange Daylily
Hemerocallis fulva



Birds Foot Trefoil
Lotus corniculatus

INVASIVE HERBACEOUS PLANTS



Garlic mustard
Alliaria petiolata



Japanese Knotweed
Polygonum Cuspidatum



Japanese Hop
Humulus japonicus



Moneywort
Lysimachia nummularia



Purple Loosestrife
Lythrum salicaria



Seaside Goldenrod
Solidago sempervirens

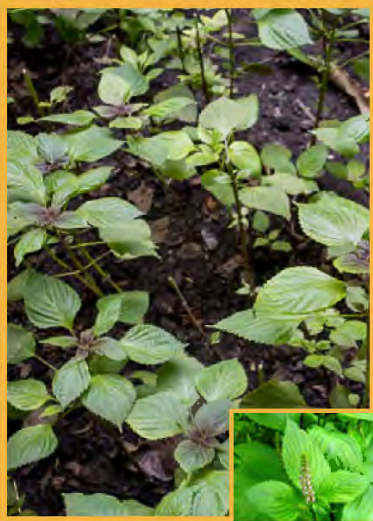


Sweet Clover
Melilotus spp.

INVASIVE HERBACEOUS PLANTS



Teasel Species
Dipsacus spp.



Beefsteak Plant
Perilla frutescens



Wild Parsnip
Pastinaca sativa



Giant Hogweed
Heracleum mantegazzianum

PROTECTED HERBACEOUS PLANTS



Canada Goldenrod
Solidago canadensis



Sunflowers
Helianthus spp.



Tall Goldenrod
Solidago altissima

KEY HERBACEOUS PLANTS



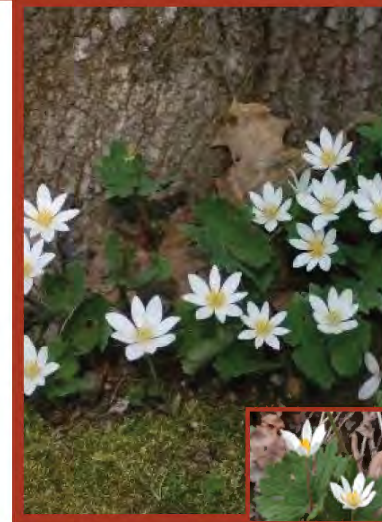
Aster Species
Aster spp.



Bellwort
Uvularia grandiflora



Black-Eyed Susan
Rudbeckia spp.



Bloodroot
Sanguinaria canadensis



Blue Phlox
Phlox divaricata



Broad-leaved Goldenrod
Solidago flexicaulis

KEY HERBACEOUS PLANTS



Columbine
Aquilegia canadensis



Elm-leaved Goldenrod
Solidago ulmifolia



False Solomon's Seal
Smilacina racemosa



Golden Alexander
Zizia aurea



Lead Plant
Amorpha canescens



Marsh Marigold
Caltha palustris

KEY HERBACEOUS PLANTS



May Apple
Podophyllum peltatum



Sharp-lobed Hepatica
Hepatica acutiloba



Shooting Star
Dodecatheon meadia



Wild Geranium
Geranium maculatum



Solomon's Seal
Polygonatum spp.



Trillium Species
Trillium spp.

KEY HERBACEOUS PLANTS



Wild Bergamot
Monarda fistulosa

NATIVE PLANTS FOR VEGETATION RESTORATION

According to DCNR, a native plant is one which occurred within the state before settlement by Europeans. Native plants include herbaceous plants (flowers, grasses, sedges, ferns and groundcovers), large trees, intermediate trees, small trees, and shrubs (also known as woody plants). Native plants help create beautiful landscapes that provide wildlife habitat and reduce maintenance costs.

This section will provide recommended [mostly] native plants that should be planted to restore ravine and bluff properties. This is not intended to be an exclusive or comprehensive list and it is strongly encourage to consult with a landscape architect or arborist to determine the best plants for a particular area.

The following pages will present a variety of trees, shrubs, and herbaceous species listed with sufficient information to choose the right combination of native plantings:

HERBACEOUS PLANTS:

Wild Flowers

Grasses & Sedges

Ferns & Groundcovers

WOODY PLANTS:

Medium to Large Trees

Small Trees & Shrubs

WILDFLOWERS												
COMMON NAME	SCIENTIFIC NAME	ZONE	BLOOM PERIOD	BLOOM COLOR	LIGHT PREFERENCE SUN / MED / SHADE			MOISTURE WET/ MOIST / DRY			HEIGHT (FT)	NOTES
Doll's Eyes	Actaea pachypoda	5	Apr-Jun	White	-	-	X	-	X	-	1-3	Interesting berries
Wild Columbine	Aquilegia canadensis	5-6	Apr-Jun	Red & Yellow	-	X	X	-	X	X	1-3	Deer -resistant; slopes; spread by seed
Jack-in-the-pulpit	Arisaema triphyllum	5-6	Apr-Jun	Green-purple	-	X	X	X	X	-	1-3	Unusual flower; bright red berries
Wild Ginger	Asarum canadense	5-6	Apr-May	Maroon	-	-	X	-	X	-	<1	Edible/Herbal use; slopes
Swamp milkweed	Asclepias incarnata	6	Jul-Aug	Rose	X	X	-	X	X	-	2-4	Butterfly plant; raingardens
Common Milkweed	Asclepias syriaca	5-6	Jun-Aug	Pink	X	X	-	-	X	X	2-6	Butterfly plant; raingardens
Butterfly Weed	Asclepias tuberosa	6	May-Sept	Orange	X	X	X	-	X	X	1-3	Butterfly plant; taproot; raingardens
New England Aster	Aster novae-angliae	6	Aug-Oct	Purple	X	X	-	-	X	-	2-6	showy; cultivated often
Turtlehead	Chelone glabra	5-6	Jul-Sept	White-ish	X	X	X	X	X	-	1-3	Strong grower; hummingbirds; Herbal
Joe-Pye Weed	Eupatorium fistulosum	6	Aug-Sept	Purple	X	X	-	X	X	-	3-6	Good for insects; raingardens; Herbal
White Snakeroot	Eupatorium rugosum	6	Jul-Oct	White	X	X	X	-	X	X	2-3	Tough plant;
Gaura	Gaura biennis	6	Jul-Sept	White	X	X	-	-	X	-	1-6	Attractive flowers
Wood Geranium	Geranium maculatum	5-6	Apr-Jul	Rose	X	X	X	-	X	-	1-2	Adaptable plant; spreader; Herbal
Common Sneezeweed	Helenium autumnale	6	Aug-Oct	Yellow	X	X	X	X	X	-	2-6	Tolerates wet areas
Sunflowers	Helianthus sp.	6	Jul-Sept	Yellow	X	X	X	X	X	X	4-6	Aggressive; good for birds
Oxeye sunflower	Heliopsis helianthoides	6	Jul-Sept	Yellow	X	X	X	-	X	-	1-5	Butterfly plant
Alum-root	Heuchera americana	6	May-Aug	Green-ish	X	X	X	-	X	-	1-2	Long bloom time; many cultivars
Cardinal Flower	Lobelia cardinalis	6	July-Sept	Scarlet	X	X	X	X	X	-	2-5	Long bloom time; butterfly
Great blue lobelia	Lobelia siphilitica	6	Jul-Oct	Blue	X	X	X	X	X	-	1-3	Long bloom time; butterfly
Monkey Flower	Mimulus ringens	5-6	Jul-Sept	Violet	X	X	-	X	X	-	2-3	Grows in moist places;
Partridge-berry	Mitchella repens	5-6	Jun-Jul	White	-	X	X	-	X	X	1-3	Evergreen; edible berry
Bee-Balm	Monarda didyma	5	Jul-Aug	Red	X	X	X	-	X	-	2-5	Showy; butterfly plant
Sundrops	Monarda fistulosa	5	Jul-Aug	Violet	X	X	-	-	X	X	2-5	Showy; butterfly plant; tolerates dry
Sundrops	Oenothera perennis	5-6	Jun-Sept	Yellow	X	-	-	-	X	X	1-2	Bright Flowers;
Sundrops	Oenothera fruticosa	6	Jun-Sept	Yellow	X	X	-	-	X	-	1-3	Bright Flowers;
Beard-tongue	Penstemon digitalis	6	May-Jul	White	X	-	-	-	X	X	2-5	Colored cultivars; hummingbirds
Phlox	Phlox divaricata	6	May-Jun	Lilac	X	X	X	X	X	-	1-2	Aromatic; Butterflies; Deer resistant
Phlox	Phlox maculata	6	Jun-Sept	Purple	X	X	X	X	X	-	1-3	Aromatic; Butterflies
Phlox	Phlox paniculata	6	Jul-Oct	Pink	X	X	X	X	X	-	2-5	Aromatic; Butterflies
May-Apple	Podophyllum peltatum	6	May	White	-	X	X	-	X	-	1-2	Edible fruit; mottled foliage
Spreading Jacobs Ladder	Polemonium reptans	3-8	Apr-Jun	Blue	X	X	X	-	X	-	1-2	Attractive; herbal
Solomon's Seal	Polygonatum pubescens	6	Apr-Jun	Yellow	X	X	X	-	X	-	1-3	Not fussy; deer resistant;edible uses
Black-eyed Susan	Rudbeckia hirta	5-6	May-Sept	Orange	X	X	X	-	X	X	2-3	Daisy like flower; long bloom
Cutleaf coneflower	Rudbeckia lacianata	5-6	Jul-Sept	Yellow	X	X	-	X	X	-	2-6	Tall daisy like flowers; herbal
Bloodroot	Sanguinaria canadensis	6	Mar-May	White	-	X	X	-	X	-	<1	Herbal uses;
Golden ragwort	Senecio aureus	6	May-Jul	Yellow	X	X	X	X	X	-	1-2	Wet conditions;
False Solomon's seal	Smilacina racemosa	5-6	May-Jul	White	-	X	X	-	X	X	1-2	Plume like flower; Deer resistant
Wrinkle-leaf goldenrod	Solidago rugosa	5-6	Jul-Nov	Yellow	X	X	X	-	X	-	2-6	tough plant; butterflies
Nodding ladies-tresses	Spiranthes cernua	5-9	Aug-Oct	White	X	X	-	X	X	-	1-2	Moist soil conditions; herbal
Tall meadow-rue	Thalictrum pubescens	5-6	May-June	White	X	X	X	X	X	-	2-8	Tall plant; delicate flowers
Foamflower	Tiarella cordifolia	5	Apr-Jul	White	-	X	X	-	X	-	<1	Attractive; many cultivars
Trillium	Trillium grandiflorum	4-8	Apr-Jun	White	-	-	X	-	X	-	1-2	Showy flowers; Common to PA
Blue vervain	Verbena hastata	5-6	Jun-Sept	Blue	X	X	-	X	X	-	2-5	Moist soils; herbal
New York Ironweed	Vernonia noveboracensis	6	Jul-Sept	Purple	X	X	-	X	X	-	3-6	Tall plant; bright flowers

WILDFLOWERS												
COMMON NAME	SCIENTIFIC NAME	ZONE	BLOOM PERIOD	BLOOM COLOR	LIGHT PREFERENCE			MOISTURE			HEIGHT (FT)	NOTES
American Dog Violet	Viola conspersa	6	Apr-May	Violet	X	X	X	X	X	-	<1	Delicate plant & flower; Edible
Common blue violet	Viola sororia	6	Apr-May	Violet	X	X	X	-	X	-	<1	Delicate plant & flower; Edible
Golden Alexander	Zizia aurea	3-8	Apr-Jun	Gold	X	X	X	-	X	-	1-2	Attracts good insects; slopes
Lead Plant	Amorpha canescens	2-9	Jul-Sept	Purple & Blue	X	-	-	-	-	X	2-3	Deep roots for slope stability
GRASSES & SEDGES												
Big Bluestem	Andropogon gerardii	4-9	Jun-Sept	N/A	X	X	-	-	X	X	3-5	Deep roots for slope stability
Lurid Sedge	Carex lurida	5-6	Jun-Oct	N/A	X	X	X	X	-	-	1-2	Wet soils; Interesting seeds
Bottlebrush Grass	Elymus hystrix	6	Jun-Aug	N/A	-	X	X	-	X	-	2-4	Grows well in shade
Riverbank Wild-rye	Elymus riparius	5-6	Jul-Sept	N/A	X	X	-	X	X	-	3-5	Good along stream banks
Virginia Wild-rye	Elymus virginicus	5-6	Jul-Sept	N/A	X	X	X	X	X	-	2-4	Tolerates a lot of conditions
Switch Grass	Panicum virgatum	5-9	Aug-Sept	N/A	X	-	-	-	X	X	3-6	Deep roots for slope stability
Little Bluestem	Schizachyrium scoparium	6	Jul-Sept	N/A	X	-	-	-	-	X	2-4	Deep roots for slope stability
Indian Grass	Sorghastrum nutans	5	Aug-Sept	N/A	X	-	-	-	X	X	3-6	Clump grass; slope stability
FERNS & GROUNDCOVERS												
Maidenhair Fern	Adiantum pedatum	5-6	N/A	N/A	-	-	X	-	X	-	1-2	Grows in clumps; herbal
Evergreen Shield Fern	Dryopteris marginalis	5-6	N/A	N/A	-	X	X	-	X	X	1-3	Evergreen; Clumps; Attractive
Interrupted Fern	Osmunda claytoniana	5-6	N/A	N/A	-	X	X	-	X	-	2-4	Clump former; distinctive fronds
Christmas Fern	Polystichum achrostichoides	5-6	N/A	N/A	-	X	X	-	X	-	1-2	Evergreen; Clumps
Early Meadow Rue	Thalictrum dioicum	4-7	Apr-May	Green & Purple	X	X	X	-	X	X	1-2	Groundcover; deer resistant
Trout Lily	Erythronium albidum	3-8	April	White & Yellow	-	X	X	-	X	X	<1	Does well on slopes; moist conditions
Virginia Creeper	Parthenocissus quinquefolia	3-9	May-Aug	N/A	-	X	X	-	X	-	30-50	Deer resistant

MEDIUM TO LARGE TREES

COMMON NAME	SCIENTIFIC NAME	ZONE	BLOOM PERIOD	WILDLIFE VALUE	LIGHT PREFERENCE			MOISTURE			HEIGHT (FT)	NOTES
					SUN	MED	SHADE	WET	MOIST	DRY		
Red Maple	Acer rubrum	5-6	Mar-Apr	Very High	X	X	X	X	X	X	40-60	Beautiful red fall color
Sugar Maple	Acer saccharum	5-6	Apr-May	Very High	-	X	X	-	X	-	60-75	Yellow flower; Fall Color; Maple Syrup
Yellow Birch	Betula alleghaniensis	4-9	Apr-May	Very high	-	X	X	-	X	-	60-80	Catkins in winter
Black Birch	Betula lenta	4-9	Apr-May	Very high	-	X	X	-	X	X	45-55	Catkins in winter
River Birch	Betula nigra	4-9	Apr-May	Very High	X	X	X	X	X	-	60-80	Catkins; beautiful bark
American Beech	Fagus grandifolia	5-6	Apr-May	High	X	X	X	-	X	-	50-70	Beautiful tree; edible nuts
Tulip Poplar	Liriodendron tulipifera	6	May-June	Intermediate	X	X	X	-	X	X	75-100	Green flowers in early summer;
Black Gum	Nyssa sylvatica	6	Apr-May	High	X	X	X	X	X	-	30-60	Outstanding fall color`
Eastern White Pine	Pinus strobus	5-6	N/A	Very High	X	X	X	-	X	X	50-80	Evergreen conifer
Sycamore	Platanus occidentalis	5	Apr-May	Low	X	X	X	-	X	-	75-100	Showy bark; drops fruits
White Oak	Quercus alba	6	Mar-May	Very High	X	X	X	-	X	X	50-100	Edible nuts; majestic
Chestnut Oak	Quercus montana	6	May-Jun	Very High	-	X	X	-	-	X	40-75	Fall color; attracts wildlife
Pin Oak	Quercus palustris	6	Apr-May	Very High	X	X	-	X	X	-	60-70	Fall color
Red Oak	Quercus rubra	5-6	Apr-May	Very High	X	X	-	-	X	X	60-80	Hardy long lived; fall color
Sassafras	Sassafras albidum	6	Apr	High	X	X	X	-	X	-	30-50	Edible & herbal uses; fall color
Basswood	Tilia americana	5-6	May-Jun	Ver Low	X	X	-	-	X	-	60-80	Aromatic flower; multiple trunks
Canada Hemlock	Tsuga canadensis	5-6	N/A	High	-	X	X	-	X	-	40-70	Evergreen; PA State Tree
Hop Hornbeam, Ironwood	Ostrya virginiana	3-9	April	Low	X	X	-	-	-	X	25-40	Unique wood texture;Deer resistant

SMALL TREES AND SHRUBS

Smooth Alder	Alnus serrulata	6	Mar-April	High	X	X	X	X	-	-	6-10	Yellow catkins; multi-stemmed
Serviceberry	Amelanchier arborea	6	Mar-May	High	X	X	X	-	X	X	15-25	White flowers;edible berries;fall color
Black chokeberry	Aronia melanocarpa	3-8	Mar-Jul	Intermediate	X	X	X	X	X	X	3-6	White flowers;multi-stemmed;fall color
New Jersey Tea	Ceanothus americanus	6	May-Sep	Intermediate	X	X	X	-	X	X	< 3	White flowers; Fixes nitrogen; Tough
Buttonbush	Cephalanthus occidentalis	6	Jun-Sep	Intermediate	X	X	X	X	X	-	6-15	White flowers;multi-stemmed;
Redbud	Cercis canadensis	4-8	April	Very Low	-	X	X	-	X	X	20-35	Purple flowers in spring; Fixes nitrogen
Alt-Leaved Dogwood	Cornus alternifolia	5-6	May-Jun	Very High	-	X	X	-	X	-	15-25	White flowers; blue berries
Silky Dogwood	Cornus amomum	6	May-Jul	Very High	X	X	-	X	X	-	6-12	White flowers; blue berries; Multi-stem
Flowering Dogwood	Cornus florida	6	Apr-Jun	Very High	-	X	X	-	X	-	10-30	White bracts in spring; red berries;
Witch-hazel	Hamamelis virginiana	5-6	Sep-Nov	Low	-	X	X	-	X	-	20-30	yellow flowers; deer resistant
Wild Hydrangea	Hydrangea arborescens	6	Jun-Jul	Low	-	X	X	-	X	-	3-5	white bloods in summer;multi-stem
Winterberry	Ilex verticillata	6	May-Jun	High	X	X	X	X	X	-	6-10	Showy berries in winter;
Mountain Laurel	Kalmia latifolia	6	May-July	Very Low	X	X	X	X	X	X	7-15	Evergreen; multistem; PA State Flower
Spicebush	Lindera benzoin	6	Mar-May	High	-	X	X	X	X	-	6-12	Berries and foilage in fall;multistem
Ninebark	Physocarpus opulifolius	6	May-Jul	Intermediate	X	X	X	X	X	-	5-10	Pink flowers; papery bark; multistem
Wild Plum	Prunus americana	6	Apr-May	High	X	X	X	-	X	X	15-25	White flowers; edible fruit;
Rosebay	Rhododendron maximum	5	Jun-Jul	Very low	-	-	X	X	X	-	10-30	Rose flowers; evergreen
Staghorn Sumac	Rhus Typhina	3-8	Jun-Jul	Very High	X	X	X	-	X	X	15-25	Stabilizes slopes;fall color; edible fruit
Black Willow	Salix nigra	6	Apr-May	Intermediate	X	X	X	X	X	-	30-50	Catkins in spring; wet to moist soil
Silky Willow	Salix sericea	5-6	May	Intermediate	X	X	X	X	-	-	<12	Catkins;wet conditions
Elderberry	Sambucus canadensis	5-6	Jun-Jul	Very High	X	X	X	X	X	-	1-3	White flowers; edible berries & flowers
Lowbush Blueberry	Vaccinium angustifolium	5	May-June	Very High	X	X	-	-	X	X	1-2	White flowers; edible berries
Highbush Blueberry	Vaccinium corymbosum	5	Apr-Jun	Very High	X	X	X	X	X	-	6-12	White flowers; edible berries; Fall color
Maple-Leaved Viburnum	Viburnum acerifolium	5-6	May-Jun	Intermediate	-	X	X	X	X	X	4-6	White flowers; edible berries; Fall color
Arrow-wood	Virburnum recognitum	5	May-June	Very High	X	X	X	X	X	-	3-15	White flowers in late spring;

Potential Opportunities

Bluff & Ravine Evaluation: Design Recommendations

The information provided will present potential areas for various design installations. The information will be conceptual to present the possibilities for these areas but is not to serve as final design documents. All of the potential opportunities would need to become individual projects taken through the full design process.

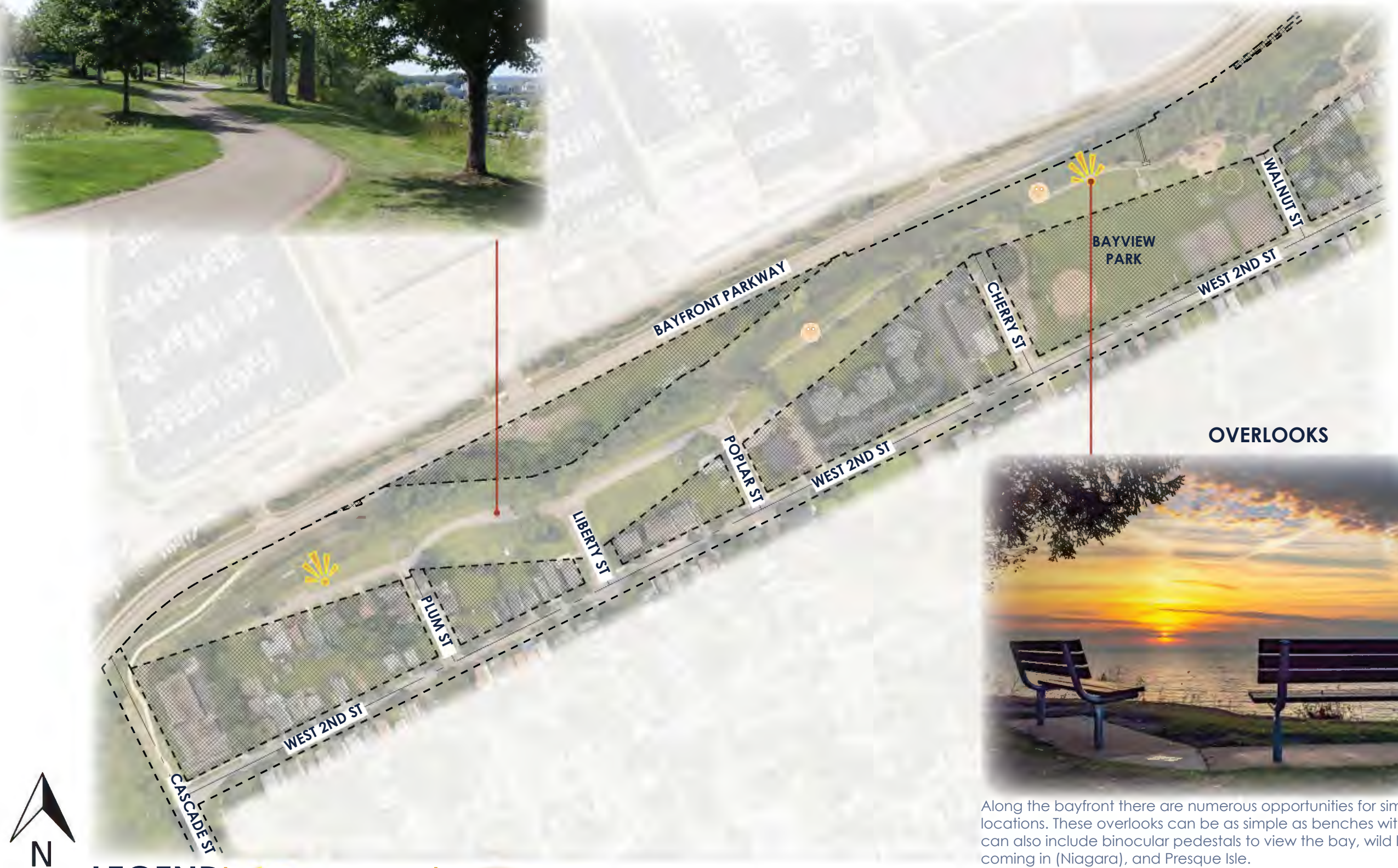
Potential Opportunities

Bluff & Ravine Evaluation: Design Recommendations - Bayfront





Extending the Bayfront Promenade where it ends at Poplar Street will carry pedestrians across Front Street extending the walking and biking trail.



OVERLOOKS



Along the bayfront there are numerous opportunities for simple overlook locations. These overlooks can be as simple as benches with a foundation and can also include binocular pedestals to view the bay, wild life, various ships coming in (Niagara), and Presque Isle. The overlooks will also provide seating opportunities for walkers, runners, and bikers using the multi-use trail running along the top of the Bayfront Bluffs.

LEGEND
KEY

 OVERLOOK

 BINOCULAR
PEDESTAL

Promenade Extension

This provides an estimate to extend the promenade from Poplar Street to Plum Street. The work includes extending the 10'-0" wide multi-use asphalt trail, removal of the existing asphalt drive, and green space restoration

This portion of roadway is not needed as it does not serve any driveways or properties north of Second Street. This can be eliminated and the promenade can be extended to provide more access to this area with views, lookouts, and plantings.



RESILIENCE

Extending the promenade will reduce the amount of impervious surface in this area significantly as well as add back green space. The greenspace can be simple lawn to vegetated buffers all of which will help manage the increased stormwater runoff this area is experiencing. Any opportunity to reduce impervious surface and increase green space is a step towards creating a resilient landscape for years to come.

promenade extension with overlook

This includes an estimated budget to remove the existing roadway and extend the existing promenade to Plum Street. This includes installing an overlook with benches and a binocular viewport as well as revitalizing the greenspace surrounding the promenade. Including in this cost are estimated design fees.

\$310,000-325,000
ESTIMATED



Potential Opportunities

Bluff & Ravine Evaluation: Design Recommendations - Bayfront

Along the bayfront there are numerous opportunities for simple overlook locations. These overlooks can be as simple as benches with a foundation and can also include binocular pedestals to view the bay, wild life, various ships coming in (Niagara), and Presque Isle. The overlooks will also provide seating opportunities for walkers, runners, and bikers using the multi-use trail running along the top of the Bayfront Bluffs.



OVERLOOKS



LEGEND
KEY



OVERLOOK



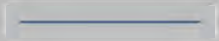
BINOCULAR
PEDESTAL



Binoculars will allow pedestrians to get a closer view out to the Bay during events like the Tall Ships Festival

Overlooks & amenities

This provides estimates to install an overlook with railing at various locations. In addition, estimates for binocular view ports are also provided.



I
overlook
with
benches

This would include design, layout, and installation of one (1) concrete overlook point with a decorative railing along the slope side and three benches per overlook. This includes design time estimated into it.

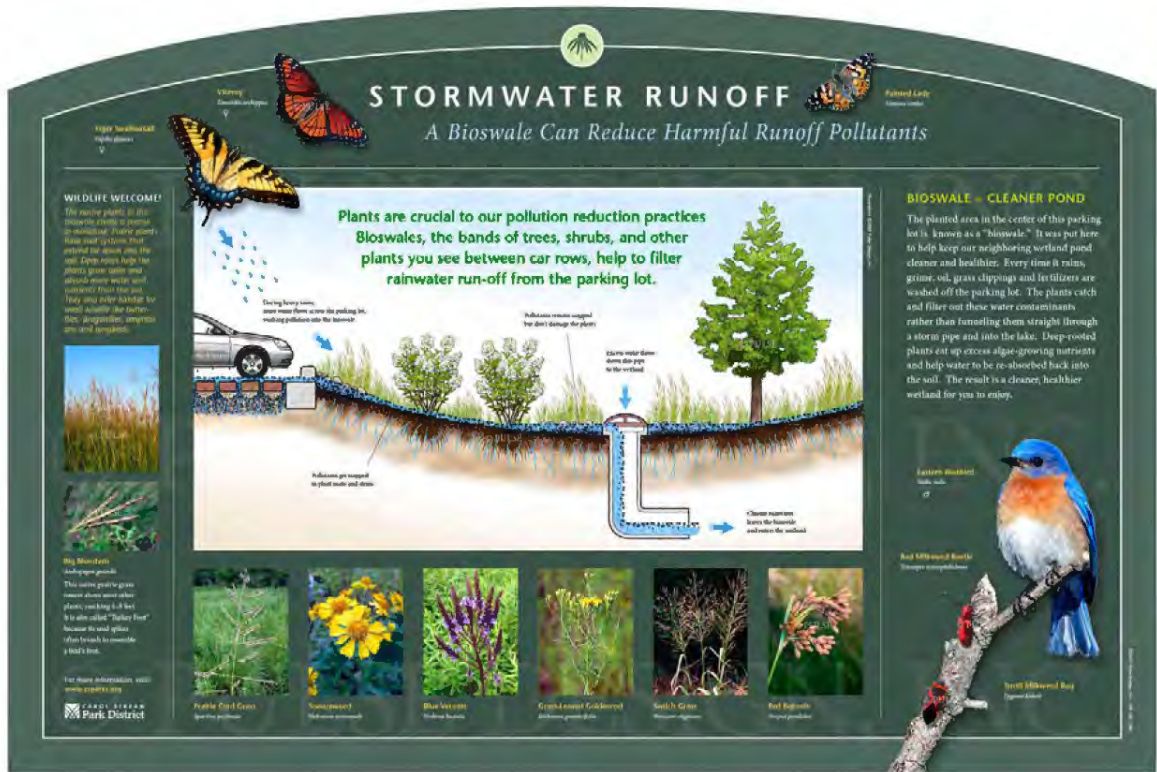
\$43,000-
45,000
ESTIMATED

II
binocular
viewports:
three total

This includes furnishing and installing two pedestal binocular viewers (non-coin operated) with a concrete foundations.

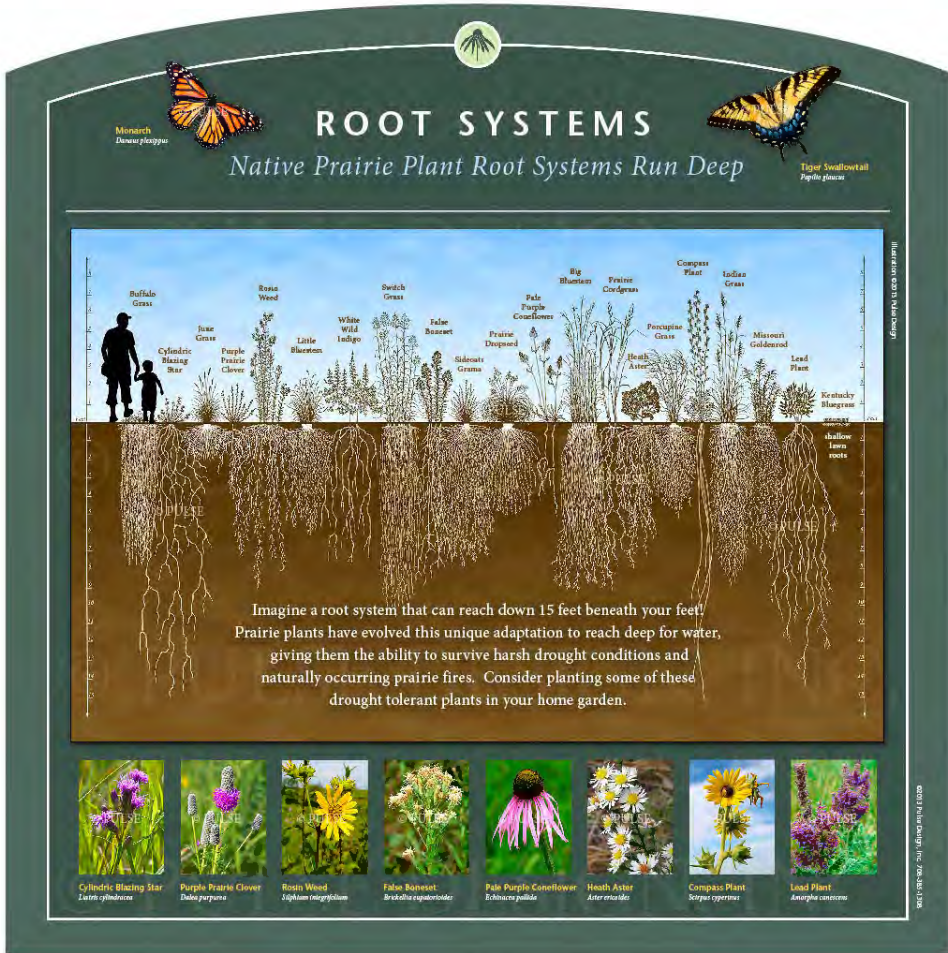
\$13,000-
15,000
ESTIMATED





Educational Interactive Graphic Signage is a good way to educate citizens about various areas and why an area looks the way that it looks and what function it performs. In addition, the signs can educate about why certain practices are happening and why certain practices need to be avoided. Examples of topics include:

- What is a Ravine/Bluff & Why they are important
- Stormwater Runoff & Effects on Slopes
- How Plants Help Stabilize
- No Dumping & Why its bad
- No Mow Zones & Why
- Native plants and why they work
- Threats to Slopes
- What is a Buffer Zone



Signage Initiative: Educating the public

This provides an overall estimated cost to provide various educational signs and potential educational information for the public.

Some of the biggest threats to the health of the bluff & ravine properties are caused by human intervention. Educating the public about these threats and how to prevent them will be key to protecting the properties for years to come.



LARGE
SIGN



MEDIUM
SIGN



SMALL
SIGN

signage
initiative
overall
budget

This includes signage placed around all Port Authority Properties. There are three sized signs - large, medium, and small - that will portray various information to the public. In addition, this budget includes producing pamphlets for the public.

\$46,000-
50,000
ESTIMATED

Estimated Initiatives

Bayfront Bluff Area

- (1) Large Educational Sign (i.e. bluff system & threats)
- (3) Small Educational Signs (i.e. no mow zones)
- (3) Small Educational Signs (i.e. no dumping)

Cascade Creek Wetland Area

- (1) Large Educational Sign (i.e. wetland system & threats)
- (1) Medium Educational Signs (i.e. invasive species threat)
- (2) Small Educational Signs (i.e. no dumping)

Ravine Park Area

- (1) Large Educational Sign (i.e. bluff system & threats)
- (2) Small Educational Signs (i.e. no mow zones)
- (2) Medium Educational Signs (i.e. why dumping hurts)
- (4) Small Educational Signs (i.e. no dumping)

Overall Miscellaneous

- Hard copy educational brochures printed & distributed
- Educational Workshops done by Professionals



RESILIENCE

Human intervention is a serious threat towards maintaining a resilient landscape. Through a signage & education initiative the public can learn about why mowing to the edge of a slope is poor practice and why dumping organic waste are all threats to our ravines & bluffs. This education should minimize these poor practices thus helping maintain resiliency across all areas.

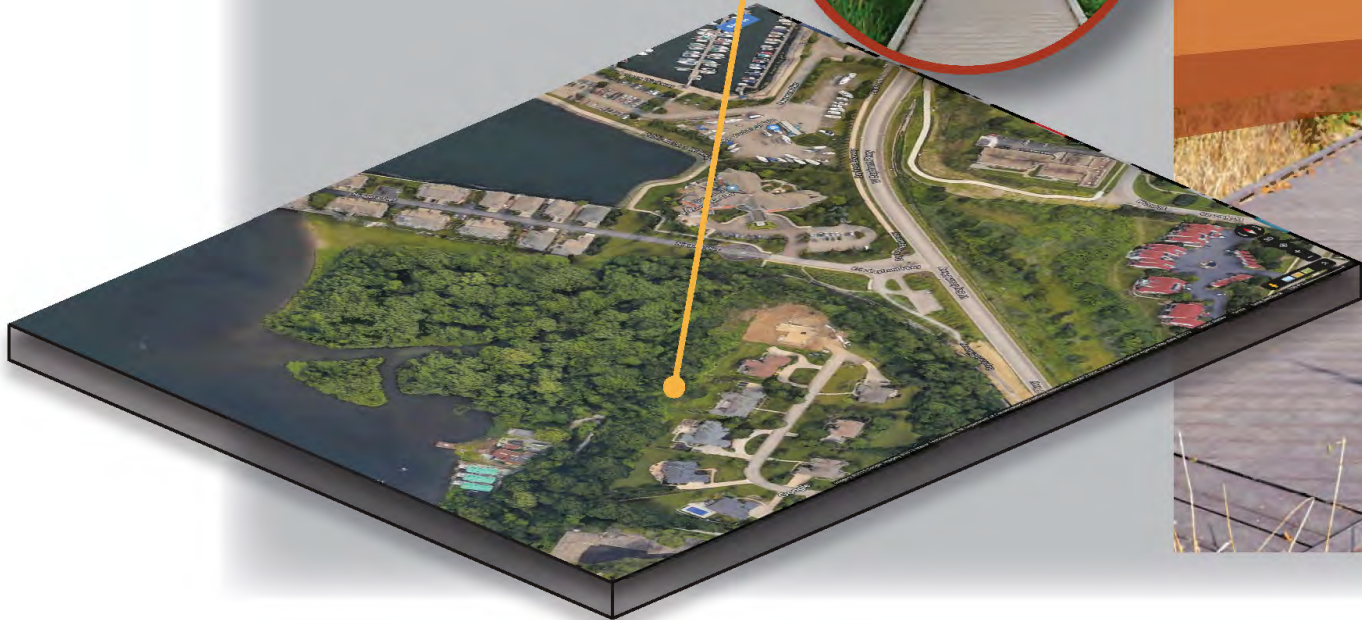
Potential Opportunities

Bluff & Ravine Evaluation: Design Recommendations - Cascade Creek



Raised boardwalk at Cascade Creek

This provides an estimated for a designed and installed 515 linear foot raised boardwalk system by Modular Trail Structures. This boardwalk system is minimal disturbance and easy installation.



modular
trail
structure
boardwalk

This estimate includes the design of the boardwalk as well as the furnishing and installment of the boardwalk system on site. The price varies due to factors that can effect the price such as type of wood and width of the boardwalk.

\$225,000-
230,000
ESTIMATED

The MTS Difference

What sets us apart is our understanding of the delicate balance you are trying to maintain between providing access to nature while improving the stewardship of the land.

Each project we work on is unique, but our approach is consistent:

- Custom solutions to meet any need
- A focus on minimizing the environmental footprint
- On-site delivery of pre-fabricated materials with proprietary features to speed up installation and minimize on-site construction time
- 10,000 pound load capacities to allow maintenance vehicle access
- Designs that meet the Army Corp of Engineers guidelines for construction in wetland environments
- ADA (Americans with Disabilities Act) compliant designs to ensure access for all
- One-year warranty on all products

The MTS Elements



FOOTING

You can't build a solid building on a weak foundation. The same is true when building a boardwalk. To properly secure your project, MTS has developed two proprietary solutions. Our bearing plate is ideal when permanent footings aren't required. Our saddle brackets provide a permanent way to marry our system to foundations made of concrete, timber, or helical piles. Your footing selection will depend on your specifications and the soil-bearing capacity.



FRAME

MTS can design and pre-fabricate to your specifications for easy installation. We offer frames made of steel (galvanized, epoxy-coated or powdered-coated) or pressure-treated lumber. Your frame selection will depend on the application and environment.



DECKING

At MTS we don't want your boardwalk to just be functional, we want it feel like a part of the environment. We offer decks built of pressure treated lumber, exotic hardwoods, plastic lumber or composite. If you can imagine it, we can build it.

The MTS Applications

Poerio Park, Kenosha, WI
Hiking and Biking Trail



Length: 120 feet
Footing: Bearing Plate Design (w/ adjustable leg)
Frame: Pre-fabricated Pressure Treated Lumber
Decking: 2" x 6" Plastic Lumber

Liberty Park, Summit County, OH
Hiking and Biking Trail



Length: Two 36 foot Boardwalks
Footing: Bearing Plate Design (w/ adjustable leg)
Frame: Galvanized Steel
Decking: 2" x 6" Pressure Treated South Yellow Pine

Frohring Meadows, Chardon, OH
Wildlife Viewing and Group Education Platform



Length: 40 feet
Footing: Bearing Plate Design (w/ adjustable leg)
Frame: Galvanized Steel
Decking: 2" x 6" Pressure Treated South Yellow Pine

Potential Opportunities

Bluff & Ravine Evaluation: Design Recommendations - Ravine Park

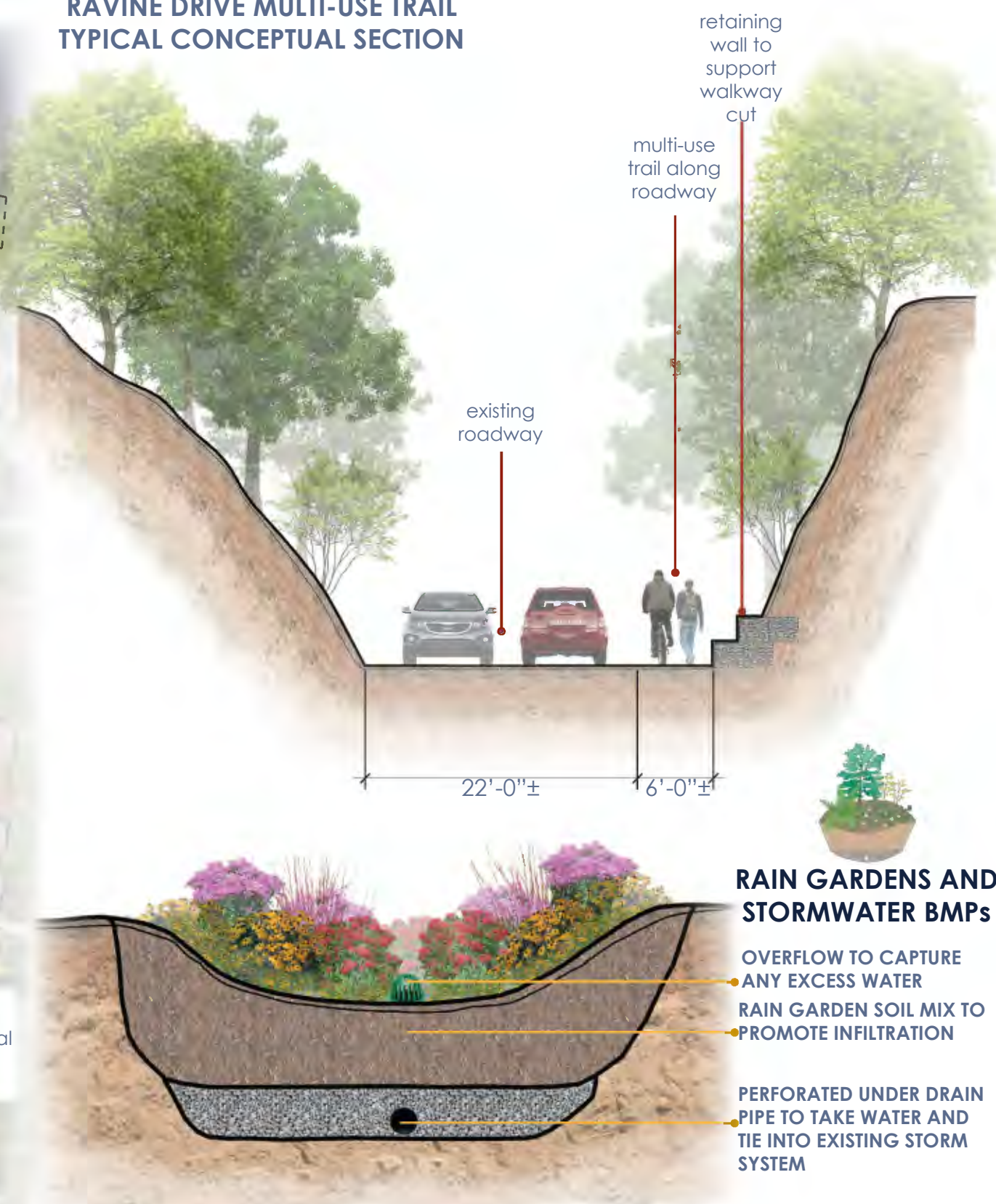


Potential Opportunities

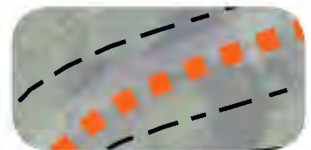
Bluff & Ravine Evaluation: Design Recommendations - Ravine Park



RAVINE DRIVE MULTI-USE TRAIL TYPICAL CONCEPTUAL SECTION



LEGEND KEY



RAVINE DRIVE
MULTI-USE
TRAIL



RAVINE PARK
CANOPY
WALK



BAYVIEW
OVERLOOK
TRAIL



POTENTIAL
TRAILHEAD
PARKING

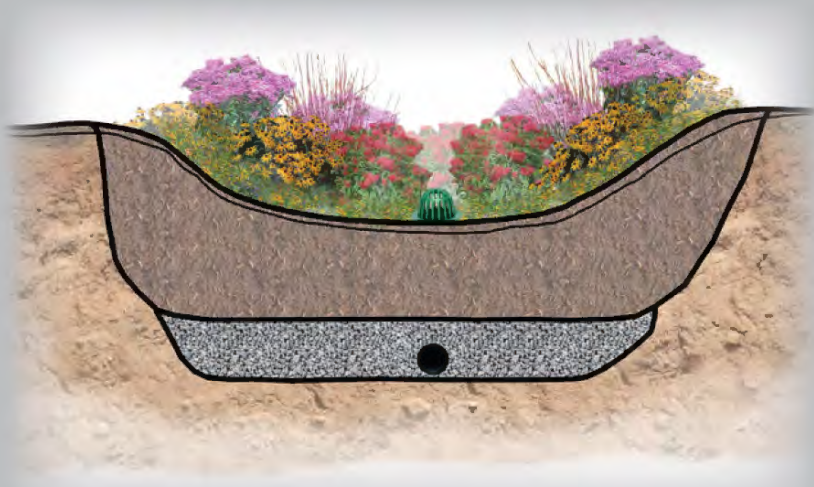


RAIN GARDEN/
STORMWATER
BMP

Slowing down and capturing stormwater at the bottom of the ravine can be improved with the addition of rain gardens and other stormwater BMPs to help infiltrate water, capture sediment, and slow the velocity of the water.

Multi-use trail Ravine Park Drive

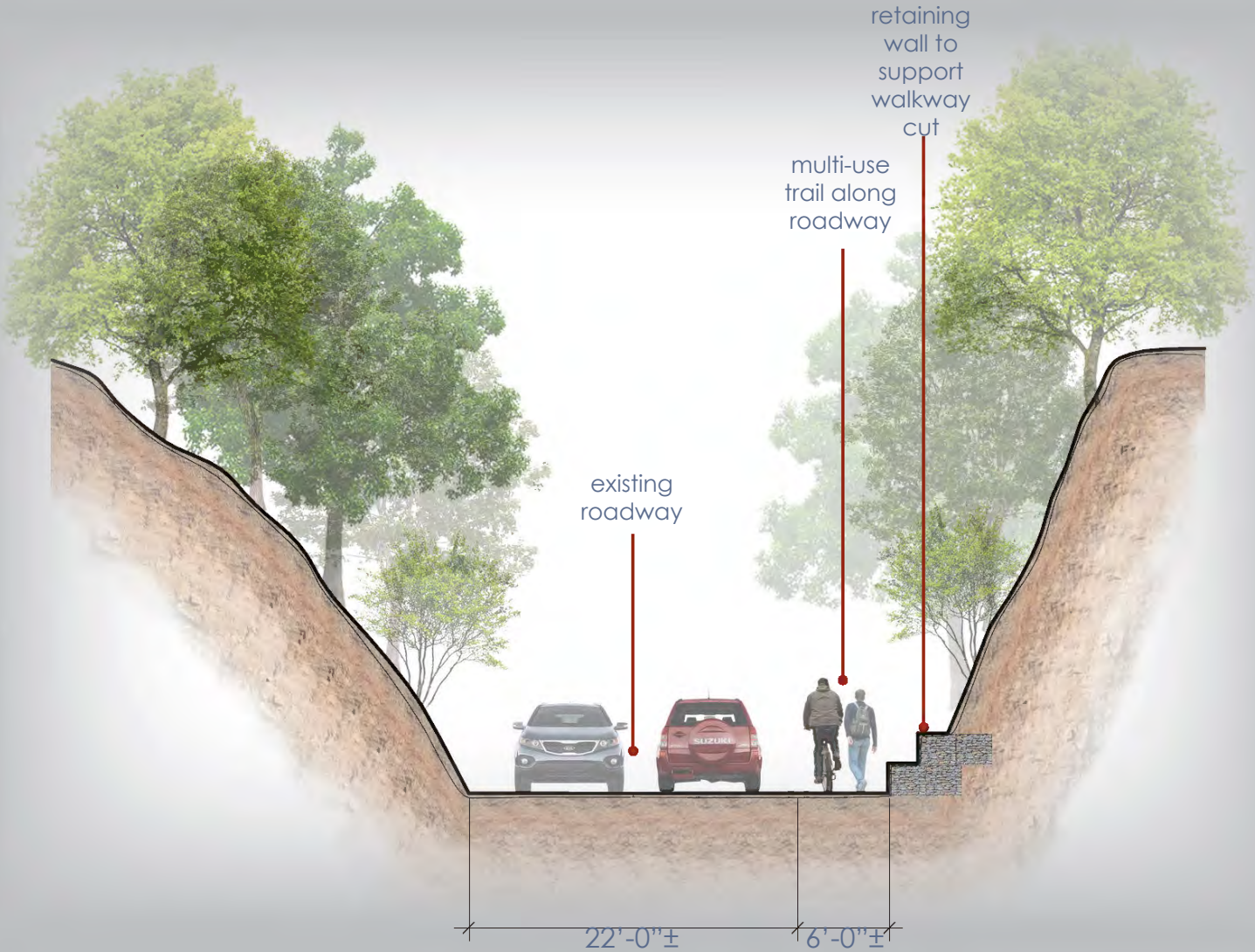
This provides estimates to design and install an asphalt multi-use trail along the existing Ravine Drive. This includes, due to the slopes, an estimate for natural stone retaining walls along the trail as well as native rain gardens.



multi-use
asphalt
trail w/ walls
and rain gardens

This includes the design and installation of a multi-use asphalt trail along the east side of Ravine Drive. A feasibility study would need to take place prior to any work occurring. This includes design estimates as well.

\$400,000-
500,000
ESTIMATED





An opportunity to design and implement a walking trail from Rosemont Ave to Bayview Ave connection to the sidewalk along Lincoln Ave. This trail could have various overlook points and two potential small trail head parking locations. In addition, the mature trees along Bayview overlook and Ravine Drive present an opportunity to explore a canopy walk.



A TRAILHEAD PARKING OPTIONS



B ADA GRAVEL WALKING TRAIL WITH OVERLOOK LOCATIONS



C CANOPY WALKING TRAIL



Overlook Trail Ravine Park

This provides estimates to install an overlook trail, potential trail head parking, stair access connecting the top of the ravine to the bottom, and a potential canopy walk.



I
overlook
trail &
site work

This would include design, layout, and installation of an 8'-0" wide gravel ADA trail along the top of the ravine connecting Rosemont Ave to Bayview Ave.

\$80,000-
90,000
ESTIMATED

II
gravel
trailhead
parking

This would include the design, layout and install of 2 gravel parking lots with a minimum of one concrete ADA parking pad with associated isle. This includes an estimated cost for line painting and signage.

\$60,000-
68,000
ESTIMATED

III
aluminum
steps &
walkway

This would include the design, layout, and installation of 275 linear feet of a 4'-0" aluminium stair and walkway system to allow people to get from the top of the ravine at Rosemont Ave to the bottom of the ravine at Ravine Drive.

\$124,000-
134,000
ESTIMATED

IV
canopy
walkway

This is an approximate idea for construction costs of a 300 foot canopy walk at Ravine Park. The construction costs are based off of numbers from the United States longest canopy walk located in Midland, MI in the Whiting Forest. This canopy walk is roughly 1,140 LF and took four years to complete.

\$4,290,000-
4,340,000
ESTIMATED

Overall Conclusions

How can we stay resilient?



What is resiliency?

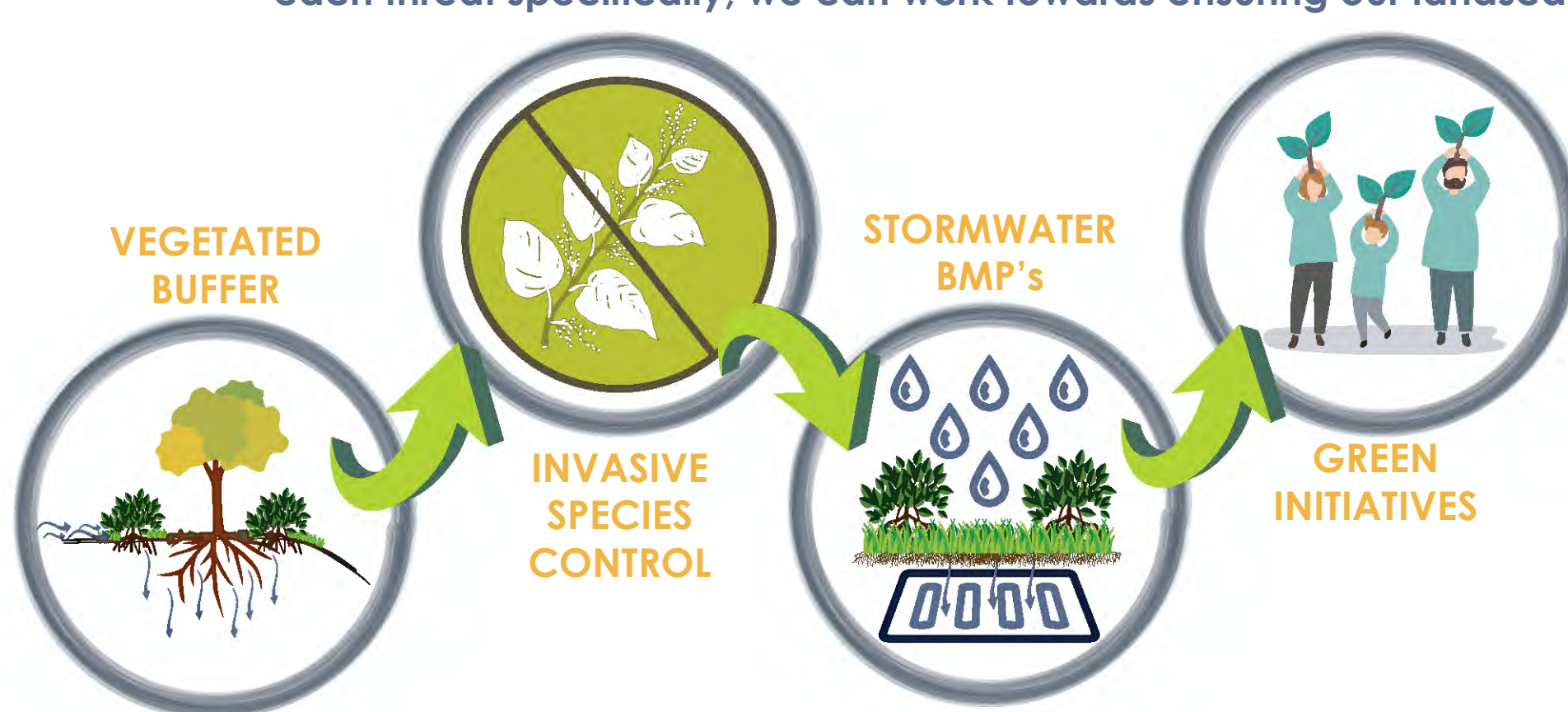
According to the Resilient Design Institute, resilience is the capacity to adapt to changing conditions and to maintain or regain functionality and vitality in the face of stress or disturbance. It is the capacity to bounce back after a disturbance or interruption. Relative to climate change, resilience involves adaptation to the wide range of regional and localized impacts that are expected with a warming planet: more intense storms, greater precipitation, longer and more severe droughts in some areas, wildfires, warmer temperatures, and power outages (resilientdesign.org). The ravine and bluff properties are experiencing increased stormwater runoff, groundwater discharge, higher lake levels, and higher temperatures. These threats are increased by the constant development and increase in impervious surfaces surrounding these properties. This evaluation has identified areas of concern and prioritized them in an effort to highlight areas that need immediate attention in order to keep these spaces resilient.

The U.S. Environmental Protection Agency (EPA) has supported the integration of green infrastructure into stormwater regulatory frameworks since 2007 and now actively promotes green solutions as a way to improve climate resilience.

Review of Resiliency Threats Directly Affecting the Bluff & Ravine Properties:

- Increased Stormwater Runoff
- Landslides/Erosion
- Increased Groundwater Seepage
- Increased Urban Heat Effects
- Invasive Species
- Poor Human Practices
- High Lake/Bay Water Levels

Designing for resilience is very site specific and in order to address each challenge we need to look at each site specifically. In this case, we are dealing with a natural ravine system, a “man altered” bluff system, and a natural wetland system. Each system poses different challenges & threats towards a resilient landscape, but taking each site individually and addressing each threat specifically, we can work towards ensuring our landscape is resilient to future threats for years to come.



Even small, decentralized projects & stormwater management practices, like vegetated buffers, can make a major cumulative difference to the resiliency of an area.

