Frederick City Watershed Recreation Master Plan Phase I

Landscape Architecture
DEPARTMENT OF PLANT SCIENCE AND LANDSCAPE ARCHITECTURE

PALS

Frederick City Watershed Recreation Master Plan Phase I

Bachelor of Landscape Architecture Undergraduate Regional Design Studio
Spring 2015

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Executive Summary

Overall:

Currently, environmentally-invasive rogue trails, needless impervious roadways, and inadequate parking space present the greatest threat to the success and safety of the Frederick City Watershed. While the watershed is responsible for providing clean water, it is also deeply valued by mountain-bikers, equestrians, entomologists, hunters, and many more. In the past, the watershed has not been designed with the interests of all of its stakeholders in mind, which has led to conflict and collective dissatisfaction. The purpose of this report is to determine the most effective method by which the City of Frederick can protect its water quality while providing environmentally-sensitive recreation and utility for its many stakeholders.

Trail Assessment:

Research shows that poor design and maintenance of trails can often be the biggest contributor to erosion. Therefore, we conducted an in-depth analysis of all trails on site. Many of these trails are visitor-made and intersect environmentally sensitive areas, thereby threatening delicate ecosystems and the overall quality of water. Yet, these rogue trails provide a much richer recreational experience than the existing Blue Trail. Our goal was to create a more successful trail design, which would allow for ideal recreational experience while protecting the sensitive areas on site.

Road Assessment:

The watershed's road system was constructed according to the path of least resistance. Unfortunately, that meant placing roads right alongside streams, which effectively created easy access for pollutants to contaminate Frederick's water supply. Furthermore, the proximity of roads to streams has led to large-scale erosion and sediment build-up, which negatively affects the distribution of water throughout the watershed. This report includes substantiated recommendations to alleviate the damage caused by roads, including permanent and seasonal road closings.

Parking Locations:

Considering the volume of stakeholders involved with this site, there needs to be appropriate accommodation. Currently, the lack of designated parking spaces on site forces visitors to park illegally on the sides of the roads. The untreated pollutants that run off the cars are among the biggest contributors to the deteriorating quality of the stream. To alleviate the polluted runoff, we collaborated with the ad-hoc committee to identify the eight best areas to place parking lots. In addition to creating a more sustainable parking option, these parking lots would compensate for the road-side parking that road closures would effectively eliminate.

Figure 1. Overused, flooded guest-created parking

Visitor's Center:

Considering the importance the watershed presents to the city of Frederick, people should be made more conscious of the many ways their watershed can be harmed. If people were aware how much their actions affected the water quality, we could ensure a healthier watershed. Accordingly, we want to provide a central visitor's center, whereby students, families, and outdoor enthusiasts can learn about the watershed and their effect on it.

Figure 2. Stream by the visitors center

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Introduction:

The Frederick City Watershed, a 7,000-acre site, provides approximately 20% of the drinking water for the City of Frederick. It also provides important habitat to threatened and endangered plants and animals. Protection of the water supply and sensitive habitat areas are challenged by recreational activities. Specifically, the trail system used for hiking and mountain biking is not designed to current standards and in many cases the trails are unsanctioned.

Objectives:

-Address the city of Frederick's goals for the watershed

-Understand the watershed in terms of its opportunities and constraints

-Improve the Blue Trail for its primary stakeholders

-Reduce impact on potential sensitive areas along the trail

-Provide an analysis of the current threats from roads and trails and recommend actions to reduce these threats

-Design trailhead parking areas and a welcome center to support the recreational activities in the watershed.

Goals

-Use GIS data of the trails, streams, ponds, and contours to complete an analysis that examines the existing relationships between trails and the environmental conditions of steep slopes and wetlands.

-Analyze the Blue Trail section and make preliminary recommendations about where special care should be considered. Outline what the potential problems are and what can be done about them.

-Create buffers with a minimum width of 100 ft. around wetland areas, such as streams and ponds. The minimum should increase depending on other conditions, such as adjacent steep slopes and sensitive vegetation, which require special attention.

-Analyze the road's impact on water quality, involving erosion, proximity, and contaminated runoff. Provide recommendations for closing due to impacts, edge protection to minimize impacts and for parking areas to remove roadside impact.

-Provide precedents of signs for watershed boundary designations, vehicle navigation, trail heads, and parking areas.

-Provide precedents of visitor centers and develop a site plan for a visitor area, including the visitor center structure, grounds, and parking area.

Trail Analysis

Trail Systems

GIS Trail Analysis

Overview

Within the City of Frederick's Watershed, two forms of trail systems abide throughout it. These two trails serve a particular purpose for the visitors that come specifically to partake in outdoor activities. Whether it be as an individual or group activities, these trails lend themselves to multiple opportunities. Amongst these activities are bird watching, seasonal hunting, mountain biking, trail walking, bird watching, light running, and fishing to name a few.

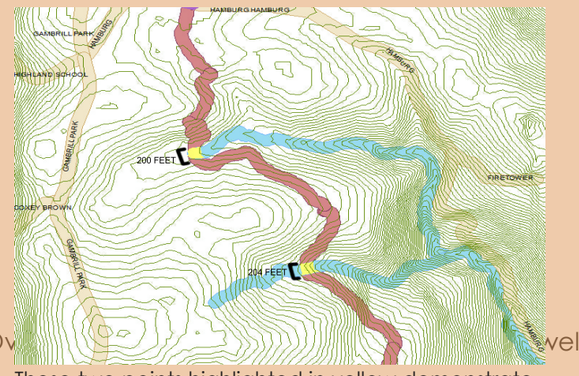
The quality of the watershed as a whole not only affects the visitors that come to it, but additionally the animals that call this watershed their home. Baring this in mind, we were mindful of our proposed solutions for the arised problem areas of the trail, in light of how it would affect the visitor and animal populations long term.

sanctioned Trail, are currently in fairly good conditions. The unsanctioned Trail does intersect with the stream and roads more often than the Blue Trail, for the reason that the unsanctioned trail is much longer. This can be seen as an issue that needs to be addressed. Another issue that we saw as a potential problem was the fact that the Blue and Sanctioned Trails run along the stream for more than 1,000 feet which can prove to be detrimental to the health of the water quality of the nearby stream.

Figure 3. Road side erosion

we were able to take it into our GIS program. Once having had all the information imported, we had a better sense as to where the streams, roads, and trails were all located. From there, we found out what the topography and change in slopes of the entire site were, and where the slopes were most steep. We made a note of where this occurred, to later remember that those particular areas would need a larger buffer to protect the water quality. Our next step was to determine how much of a buffer certain areas would need, and what those areas specifically were. The areas in which the slope was 20% and lower, we gave a 100 foot buffer, while for the areas that had a slope of greater than 20%, we gave a 200 foot buffer. Our reasoning behind this was that we considered these areas of steeper slopes more prone to contributing to the negative health quality of the water. Our last step was to assign, each feature (stream, roads, trails, slope change) a particular color that would make reading the map easier.

Figure 4. Blue Trail Traditional Crossings

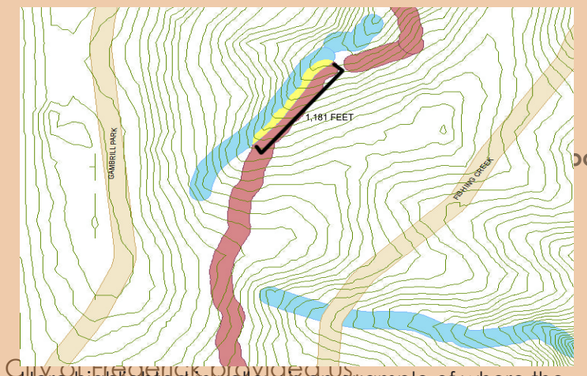


These two points highlighted in yellow demonstrate two common stream crossings for the Blue Trail.

Figure 5. Blue Trail Larger Crossings

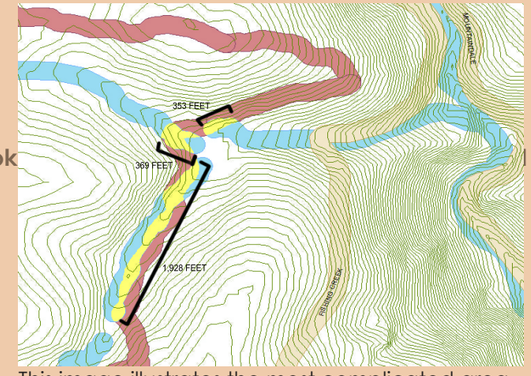
These two points now highlighted in yellow and purple demonstrate two additional areas where the stream crosses the Blue Trail, but for longer lengths.

Figure 6. Blue Trail Unconventional Crossings



Here highlighted in yellow is an example of where the Blue Trial no longer crosses, but rather runs along the stream for a much greater length.

Figure 7. Blue Trail Extreme Crossings



This image illustrates the most complicated area where the Blue Trail runs along the stream, and crosses it the multiple times nearby.

Possible Conflicts

In attempts of solving these issues that the Blue Trail and the Unsanctioned Trial both present, we have taken into consideration possible conflicts that may arise as particular concerns the people of the city of Frederick may have. The one solution that we thought would be most prominent as a concern was to close down a certain portion of the trails. Understanding how valuable these trails are to the Watershed's most frequent visitors, we stayed away from this solution and rather focused our attention to other solutions that would prove to be equally as successful. Additionally we saw built structures as areas that we had to be cautious of when rerouting trials.

Figure 8. Built structure and stream by a trail

Solution and Benefits

- Less road erosion
- Better treatment of the trails
- Water quality increases
- More appealing to visitors

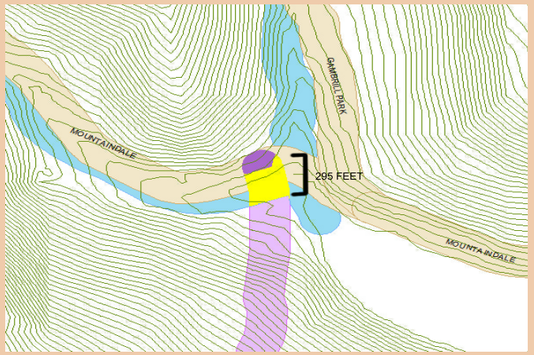
After extensive amounts of research we have found that the best solutions to the few issues present in the Watershed are: realigning, relocating, and closely monitoring trails. To start off, there would be less amounts of road erosion. Erosion has been a constantly reoccurring problem that takes away from the natural beauty that a long road can have. Additionally, the trails would be better kept, allowing for visitors to travel throughout the trails in a safer environment. Not only would the roads and trails be better maintained, but the water quality would improve. The condition of the water quality has been a constant battle, needing to be addressed and resolved. Through a combination of all of these benefits, it will attract more visitors to come visit the watershed. As of right now there are a consistent number, but if these changes were made, and these benefits taken greater advantage of, the overall number of visitors could significantly increase.

Conclusion

For the most part, the current state of both the Blue trail and the Unsanctioned trails are in fairly good conditions. As previously mentioned, the areas where the trails run right alongside the streams are not located in ideal locations. In these situations we recommend either realigning the trails, or relocating them. An additional option, is to very closely monitor these specific areas of the trail system. The reason thi s may be a better choice is because it will not require any moving or closing of the trails therefore allowing for the trial system to stay as it currently is. All in all, the current status of the Watershed is fairly good in terms of the trial systems' location in regards to steeper slopes and its close proximity to nearby streams/roads.

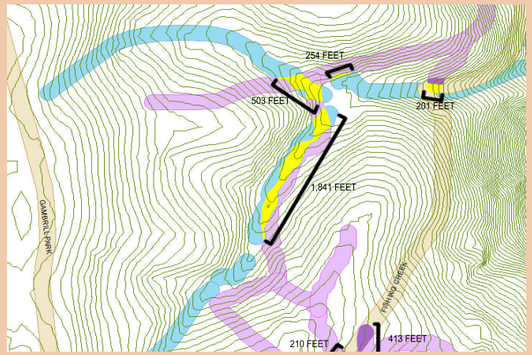
Figure 9. Built structure and stream by a

Figure 10. Unsanctioned Trail Traditional Crossings



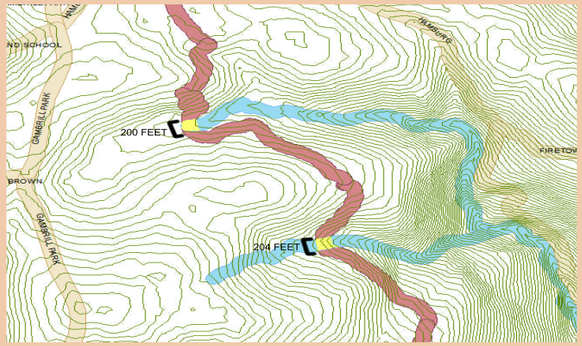
This image illustrates what a traditional crossing of the Unsanctioned trail with a road and stream look like.

Figure 11. Unsanctioned Trail Larger Crossings



Here we see how often the Unsanctioned Trail can cross a stream and a road within a small area, and for greater lengths.

Figure 12. Unsanctioned Trail Extreme Crossings



This image illustrates the most complicated area where the Unsanctioned Trail runs along the stream, showing the extreme lenghts it can go on for.

Trail Standards

Proper Grade

Avrage Grade

Grade=Rise/Run. When applied to trails, there are 3 aspects of grade to consider about:
- The average grade of the trail overall should not exceed 10% (8% is better). (Figure 1)
- Limit the maximum grade, the steepest parts, to 20% (15% is better), and only for short sections less than 50 linear feet.
- Follow The Half Rule – A trail's grade shouldn't exceed half the grade of the sideslope. (Figure 2)

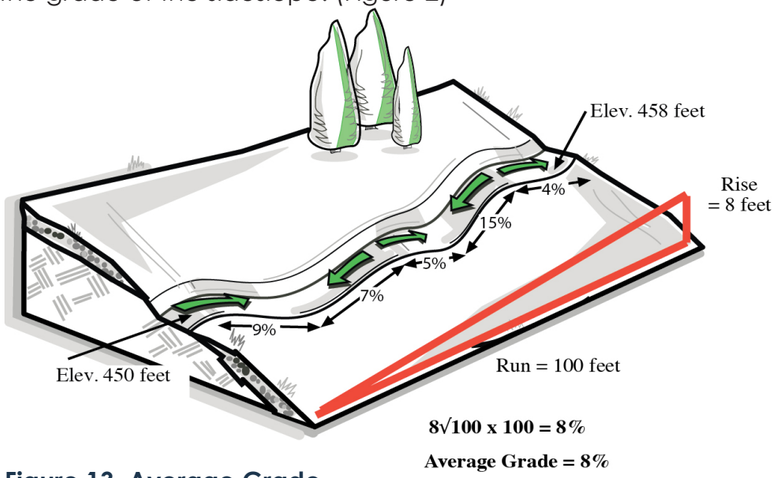
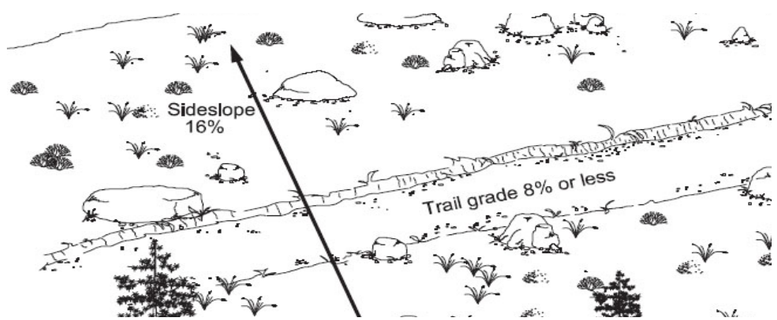


Figure 13. Average Grade



Outslope

Cross slope is how the trail is tipped to one side or the other. When the uphill side is higher than downhill side, the cross slope is called outslope. (otherwise,it is called inslope) Outslope helps water can easily drain off. A gentle outslope of at least 2%, preferably 5%, is recommended. Trails without this outslope catch, hold, and channel water, helping erode and destroy the trail. Proper outslope encourages water to sheet across and off the trail. (Figure 3)

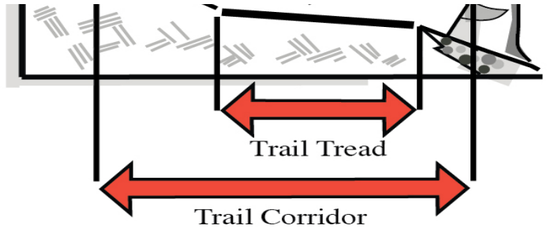


Figure 15. Outslop Diagram

Grade Reversal

"Grade Reversals," or rolling dips are little drops in a trail that forces water to drain at the low spot. Rolling dips are subtle downhills, just 10' to 50' in length, that prevent water from gaining volume, momentum, and erosive power. They also should be frequent – every 20' to 50' depending on soil and water conditions. Rolling dips replace water bars on good trails. Rolling dips also make a trail more enjoyable, providing variety and relief. (Figure 4)

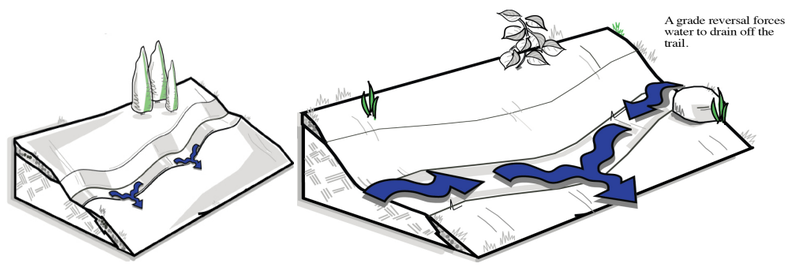


Figure 16. Grade Reversal Diagram

Climbing Turn

The sideslope is usually 15 percent or less (7 percent is best). It is necessary to keep the turning radius as wide as possible And 13 to 20 feet turning radius are easy to construct. (Figure 5). However, it's usually best not to build turns, or the connecting legs of a series of turns, on or across a ridge.

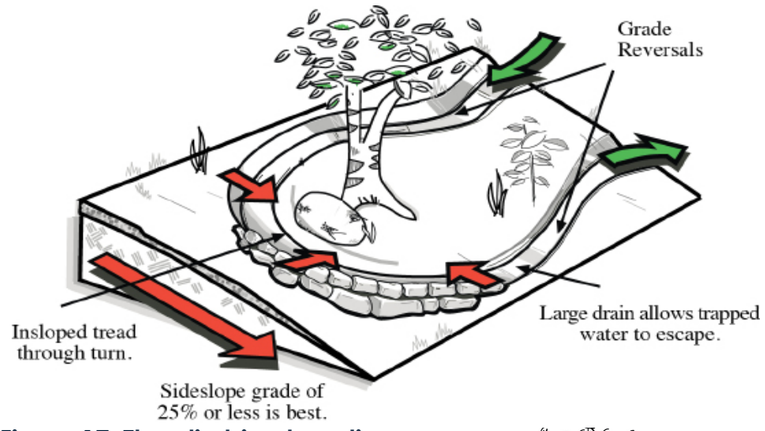


Figure 17. The climbing turn diagram

Trail Corridor

The dimensions of the corridor are determined by the needs of the arget users and the challenge of the trail (Figure 6).
- Hiker trails are cleared 6 ft wide and 8 ft high.
- The Northern Rockies, trail corridors for traditional packstock are cleared 8 ft wide and 10 ft high.

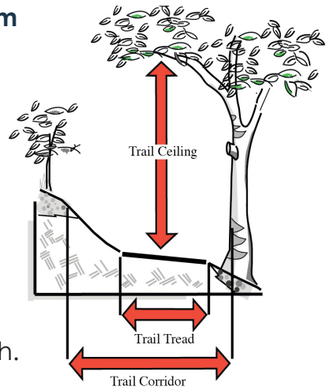


Figure 18. Trail Corridor Diagram

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Stormwater Management

Knicks

Puddles that form in flat areas on existing trails may cause several kinds of tread damage:
- Traffic going around puddles widens the trail (and eventually the puddle).
- Standing water usually weakens the tread and the backslopes.
- Water can cause a bog to develop if the soils are right.
- Traffic on the soft lower edge of a puddle can lead to step-throughs,where users step through the edge of the trail, breaking it down.
- Stepthroughs are one of the causes of tread creep.

The knick is an effective outsloped drain. Knicks are smoothand subtle and should be unnoticeable to users. To maximize the efficiency of a knick:
- the trail tread must have lower ground next to it so the water has a place to drain.
- A knick should be shaved down semicircle about 10 feet long
- A knick should be outsloped about 15 percent in the center. (Figure 6)

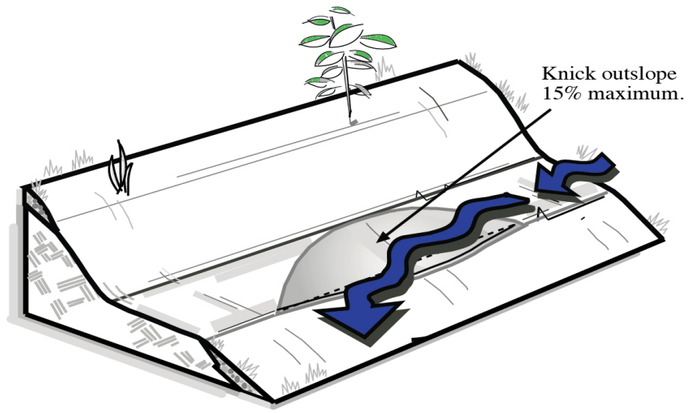


Figure 19. Storm water managment Diagram

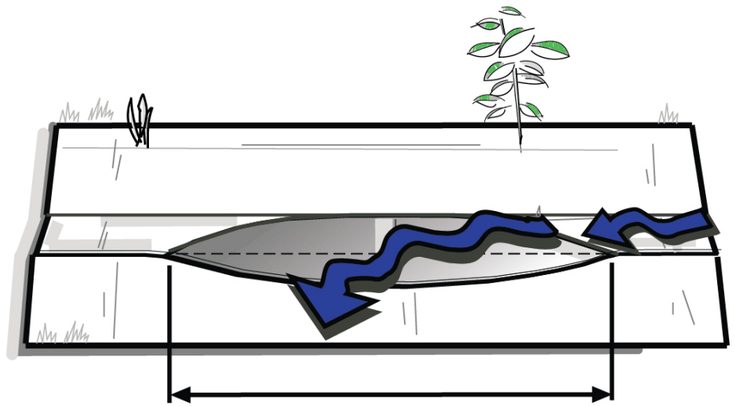


Figure 20. Road side erosion

Rolling Grade Dips

As mentioned in last page, rolling grades dips are also called grade revesal. A rolling grade dip is used on steeper sections of trail. It also works well to drain water off the lower edge of contour trails. A rolling grade dip is a knick with a long ramp about 15 feet built on its downhill side. For example, if a trail is descending at a 7-percent grade, a
rolling grade dip includes:
- A short climb of 10 to 20 feet at 3 percent
- A return to the descent (Figure 7)

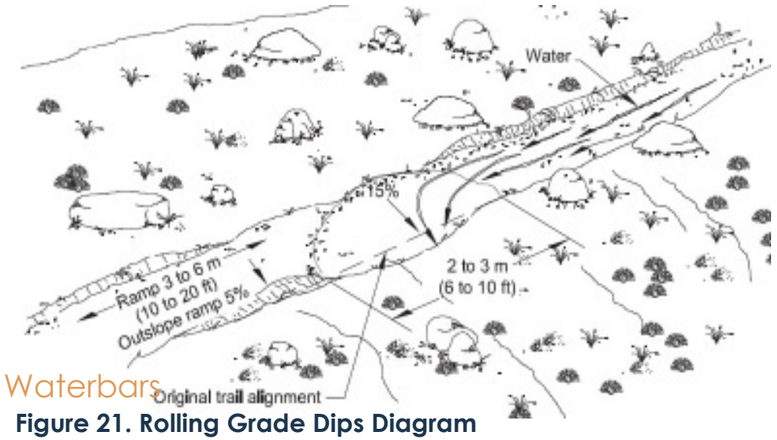


Figure 21. Rolling Grade Dips Diagram

Waterbars

Waterbars are commonly used drainage structures. Water movingdown the trail turns when it contacts the waterbar and, in theory, is directed off the lower edge of the trail. For existing trails with water problems, rolling grade dips or knicks are first choices instead of waterbars. The reasons are:
- Waterbars commonly fail when sediment fills the drain.
- If water tops the waterbar and continues down the tread, the waterbar becomes useless.
- It is easier an quicker to build a good rolling grade dip than install a waterbar, and a rolling grade dip works better.

Waterbars are less susceptible to clogging when on grades less than 5 percent. If a waterbar is on slope of 15%-20%, the angle to the trail should be greater than 45 degree.(Figure 8) Usually a rock waterbar is more durable than a wooden one.

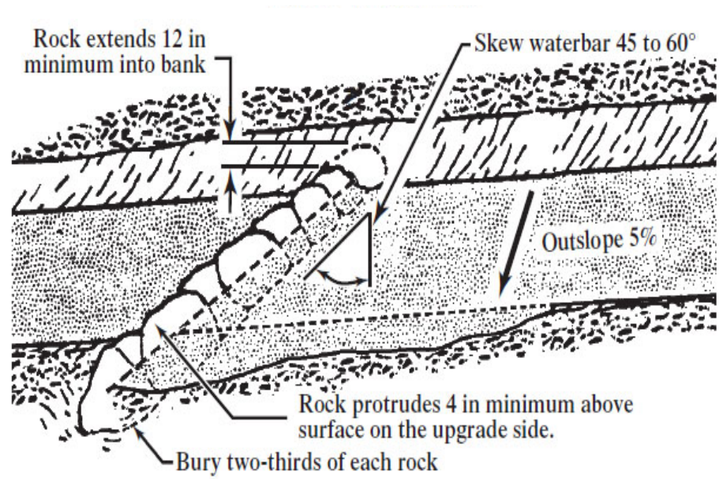


Figure 22. Waterbars need to be constructed

Trail Assessment

Assessment Tool

TRAIL ASSESSMENT TOOL

Date: 05/11/2015			Assessor: Bisheng Xu, Hanyang Liu		
Basic Information					
Trail Segment ID: Blue Trail at Frederick Watershed			Trail Color: Blue		
Trail Name or Number: Blue Trail					
Trail Status:	Open	■	Trail Classification:	Class I	
	Closed			Class II	■
	Under Construction			Class III	
				Class IV	
Managed Use					
Allowed Use: (select all that apply)	Hiker/pedestrian	■	Prohibited Use: (select all that apply)	Hiker/pedestrian	
	Pack and Saddle	■		Pack and Saddle	
	Bicycle	■		Bicycle	
	XC Ski	■		XC Ski	
	Motorcycle			Motorcycle	■
	Forest Maintenance/ Emergency Access	■		Forest Maintenance/ Emergency Access	
	Timber operations	■		Timber operations	
	ATV			ATV	■
	4WD			4WD	■
	Other:			Other:	
	Other Description:			Other Description:	
Average Trail Condition:	Good	■	Maintenance Schedule:	Annual	
	Average			Semi-annual	
	Poor			As needed	■

Primary Trail Maintainer:					
Detail Information					
Trail Segment Length:	2.54 Miles		Typical Width:	3 feet	
Typical Grade:	2/3 trail 0-10%; 1/3 trail 10-20%		Typical Cross slope:		
Is the trail part of a larger loop?	Yes		Are any portions of the trail in a flood plain?	No	
				Yes	
Structures or Obstacles present?	Bridges	■	Are there any water crossings on the trail?	No	
	Gates			Yes	■
	Kiosks		Do any segments need realignment?	No	
	Retaining walls			Yes	■
	Technical Trail Features		If YES, describe section that needs realignment:		
	Waterbars		The stream(not on GIS data) runs along the trail for at least 500 ft. The stream is 10ft away from the trail which would cause erosion problem.		
	Other:				
	Other Description:				
Average Level of Use:	Heavy		Average Trail Tread Condition:	Good	
	Moderate	■		Average	
	Light			Poor	
Special Considerations:			Additional Comments:		

Table 1. Trail Assement Tool

General Condition

- 3-4 feet wide trail in average
- In general, the trail is in good condition and only a few spaces have very serious problem.

Figure 23. Trail Width Average

- there are sections that are covered with boulders and rocks.
- Not hard to walk on and it is fun for the mountain bikers
- Some boulders are not stable so might be dangerous

Figure 24. Covered By Rocks

- There are several hills that are a bit too steep
- Erosion happened frequently in area which slope is greater than 12%

Figure 25. Erosion on Trail

Existing Problems

There are specific area in the trail that is too narrow for the national trail standard. Could get rid of one of the tree or re-route the trail

Figure 26. Trail too Narrow

Erosion protection isn't applied to all the sections that need to be protected.

Figure 27. Erosion Protection

Some areas are lack of signage which could cause confusion to hikers.
(Some places have too much signs which are right next to each other)

Figure 28. Lack of Signage

There is trees hanging above the trail which is potentially dangerous. Should be moved away from the trail

Figure 29. Dangerous Trees

The trail near the pond is very close to the stream which could cause erosion. Realignment is necessary for this section

Figure 30. Close to Stream

There is also tree fell onto the trail in the blue trail section we hiked. Should probably be moved away.

Figure 31. Trees laying across trail

Existing Problems

The outlet of the pond is too small. Because it is easy to see the erosion on each side of the channel. Solution can be simply enlarge the outlet

Figure 32. Pond outlet to small

This section of trail has serious erosion problem. The cover dirt is gone and roots are exposed to the trail. Should get this part new soil and change the cross slope to make this area well drainage.

Figure 33. Bad erosion along trial

Overall Survey

Figure 34. Trail Survey Diagram

Recommendation

- GIS data should be updated because the alignment of the trail isn't very accurate
- When the leaves are off, it's better to do a complete survey with GPS to locate the trail as it is.
- The section of trail is concave down which makes the water hard to drain from the trail. (need cross slope).
- Part of the trail have a steep slope that is more than the national trail standard.
- Signage should be placed more evenly
- Realign the trail near the pond away from the stream.
- It is better to move the trees that

Road Analysis

Road Analysis

Introduction

The water quality in the watershed is the most important issue that we need to address. We have determined that making some changes to the road system in the watershed will make a significant difference in the process of improving the water quality.

Roads are a significant contributor of pollutants to bodies of water everywhere. Contaminants from vehicles and activities associated with road and highway construction and maintenance are washed from roads and roadsides when it rains or snow melts. A large amount of this runoff pollution is carried directly into our rivers and streams.

Polluted runoff picks up a number of materials from any surface it flows over. Aside from road salts in the winter and litter from pedestrians, dirt and dust, sediment, rubber and metal deposits from tires, and engine oil is picked up with runoff and sent over the land into streams.

Sediment is often underestimated as a contributor to runoff pollution. It is produced when soil or gravel particles are eroded from the land and then transported to surface waters. Erosion happens naturally, however with any type of development comes an increase in erosion that we are trying to manage. In addition to improving water quality in the streams, preventing erosion will also keep existing roads and landforms intact.

In addition, pollutants such as heavy metals and rubber adhere to sediment as it is picked up by stormwater. Heavy metals can come from natural sources like minerals and rocks, but also from brake lining, weathered paint, and rust. Oils and grease from vehicles are leaked onto roads and are also carried by runoff into streams. All of these materials are extremely toxic to aquatic life in rivers and streams.

Given the severity of the water quality issue and the results of our site analysis, we came up with a list of changes including closing certain roads, adding barriers, and providing road edge protection that will aid in improving the water quality in the watershed.

Road Closures

After further investigating the site as a design team it was concluded that while the Frederick Steward ship plan calls for a 100 foot buffer, we have decided that the watershed would bennifit from a 200 foot buffer. This is to ensure that no sediment or runoff will be collected into the resivor.

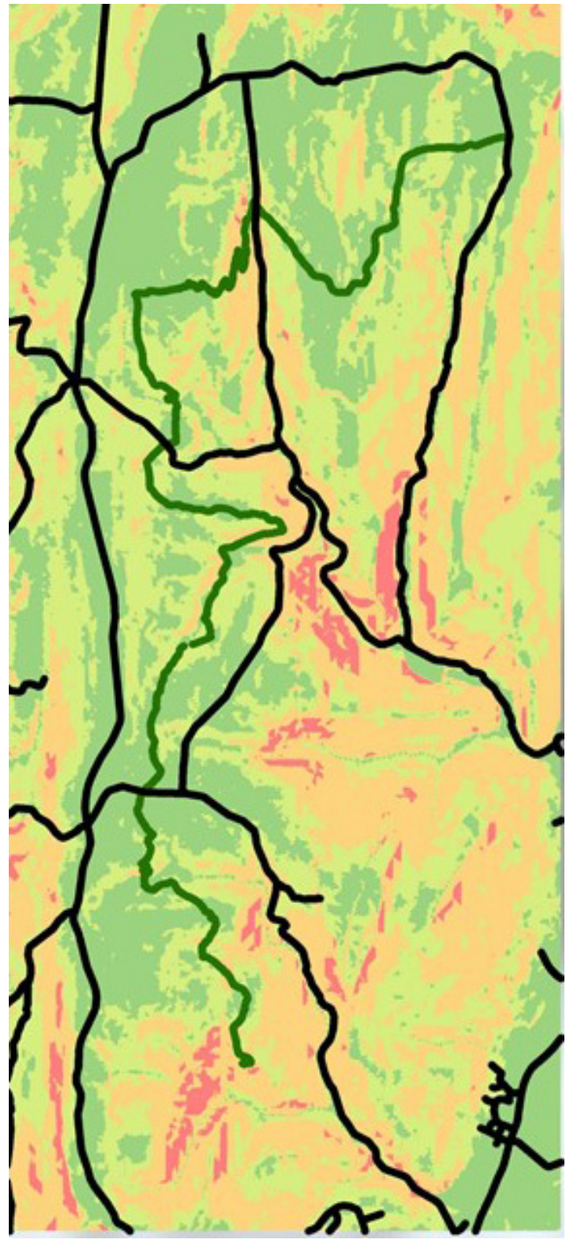
Due to this 200 foot buffer roads will need to be closed. The roads and the traveling of care along them bring the highest input of sediment runoff into the water shed. Closing the roads will stop this, and help it return to a healthy state. This is the biggest cuase of sediment runoff, so it is highly reccomened that this consideration be taken.

It must be clear that pedestrians and emergency vehivles will still be able to enter these roads. The roads will not be removed but just closed. Each one will be accesable threough a locked gate which will be covered later in this chapter for further consideration.

Slope

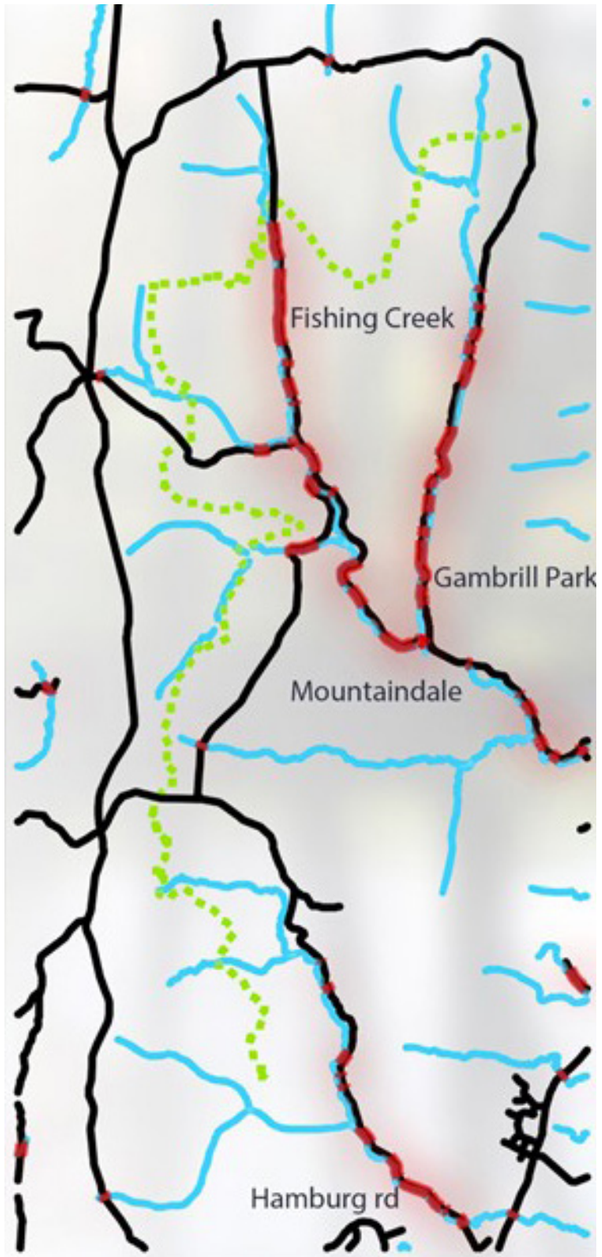
The map to the right demonstrates where the roads intersect areas of intense slope. Green representing slopes of 10% or less, yellow representing slopes of 10% to 20%. Than the red represents any slope of 20% or more.

The Frederick Stewardship plan also states that any slope over 10 percent should be considered to not have roads built on it. It also states that no roads can be built on a slope of 20% or more. Diagrams on the next page continue to display what is discussed above regarding road closures.



Slope Analysis

Figure 35: Roadway Analysis Showing Slope



Demonstrated to the left is a map detailing the 200 foot stream buffer and where it intersects with the roads in the water shed, As you can see there is quite a bit of red in the middle and at the bottom of the water shed. Parts of Fishing Creek, Gambrill Park, Mountaindale, Hamburg, and Delauter should be considered to be closed to public access within the watershed.

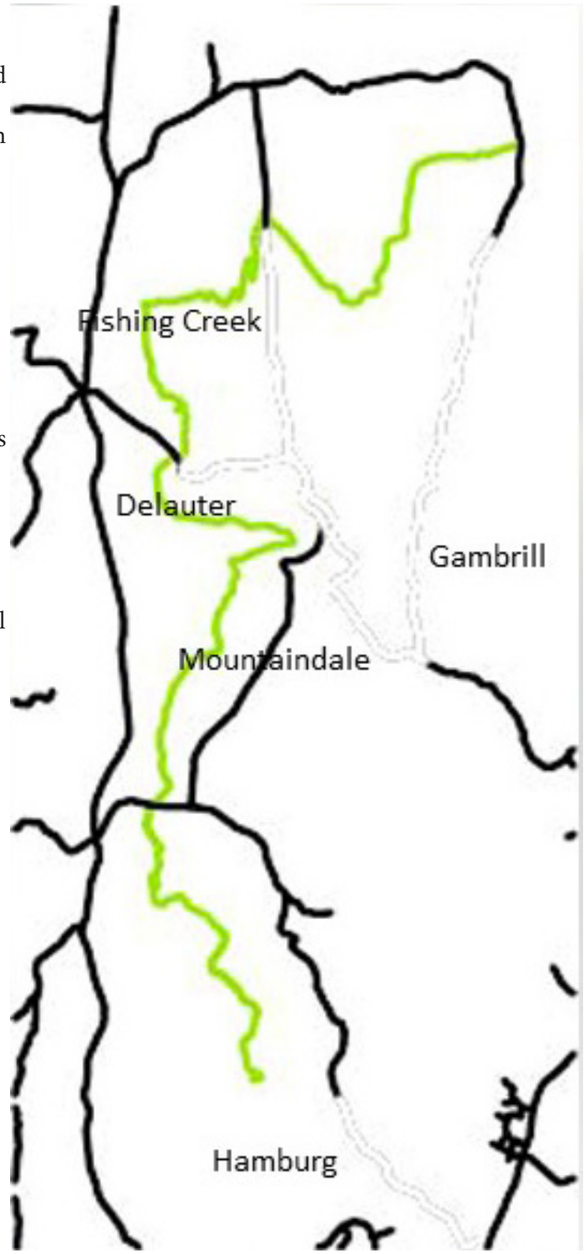
Stream Buffer Analysis

Figure 36: 200 Foot Stream Buffer Analysis

This map clealy demonstrates which roads would close and where if the recomendation were to be taken into affect. Totals would be .74 miles of Delauter, 2 miles of Fishing Creek, 1.4 miles of Mountaindale, 3.6 miles of Gambrill Park, and 2.5 miles of Hamburg. Just parts of the roads would be closed and still accesable from either side you approach until you would reach a gate which only pedestrians and emergency vehicles can pass.

Roads to Close

Figure 37: Roadways To Be Closing



This map clearly demonstrates which road systems would remain open and how they would connect as a system, while also showing the roads that would have limited access in the light white outline.

Roads to Remain Open

Figure 38: Roadways To Remain Open

Roadside Stablization

Identifying Problems & Solutions

Currently, several problems exist with the existing roadway system that pose threats to the quality of the water. These problems include, but are not limited to: roadway intersecting the stream, runoff of sediment into the stream from steep slopes, and erosion on roadsides due to cars. These problems may be hazardous to the stream quality, but can be mitigated by proper treatment of the roadways.

Existing Problems

Erosion from Parked Cars

Figure 39: Car parked in "pull-off" area along roadside.

Lack of parking on-site has created an enormous problem with cars creating their own pull-off areas along the side of the roads. This creates problems with erosion on street sides. Visitors currently use these pull-off areas for quick access to the stream for activities such as fishing. However, parking in such close proximity to the stream is detrimental for stream quality. These pull-off areas also create problems with water pooling.

Erosion from Steep Slopes

Figure 40: Deterioration of roadway due to steep slope.

Steep slopes can be found throughout the site because of the topography of the watershed. Slopes of twenty percent or higher can be classified as "steep" and pose threat to the quality of water because they allow for erosion. The photograph above shows the impact of erosion across the street due to runoff from the existing slope. This deteriorates the quality of the road as well as the quality of the stream.
Steep slopes also pose a safety threat, as rocks and other debris may fall into the roadway and threaten the safety of visitors. Furthermore, cliffs with a steep drop pose safety hazards for cars and pedestrians and need buffering.

Roadway Intersecting Wetland

Figure 41: Roadway crossing wetland.

Currently, there are several locations where the roadway actually intersects the stream. The photograph demonstrates an area on Gambrill Park Road where the road intersects an existing wetland. This threatens the quality of the water because pollution from the road immediately runs into the body of water without filtration of any sort.

Roadway Intersecting Stream

Figure 42: Roadway crossing stream.

The greatest problem currently is the proximity of the roadway to the stream in several locations. On roads such as Fishing Creek Road and Gambrill Park Road have several miles of roadway located right next to the stream. The proximity is extremely evident in the photograph provided above. Such proximity poses the greatest threat to the health of the stream and quality of the water because pollutants from cars and sediment from the gravel road goes directly into the stream without any type of filtration. Because there is no buffer between the roadway and the stream, the contact is immediate and no vegetation can filter out any of the sediment.

It is essential that the water in the stream is of the highest possible quality because it provides drinking water for the entire City of Frederick. The intersection of roadway with the stream is the greatest threat, and should be treated with great severity.

Solutions

Although several problems currently exist with the health of the roadside and stream, these problems can be mitigated by proper treatment of the road. There are several different strategies that can be employed to help the health of the stream and create safer, more sustainable roadways for the future of the watershed. Our greatest recommendation is for several roads to be closed, but the following recommendations apply to the roads that will remain open.

Roadside Protection from Parking

Figure 43: Boulder protection from cliff.

Figure 44: Boulder protection from roadside parking.

The use of boulders can be very effective in preventing cars from parking on the side of the road. Currently, some boulders exist, but many more need to be added along the roadside for maximum protection. Boulders can also be added as a safety measure where there is a great change in elevation, such as cliffs and drop-offs. Boulders can also serve to protect the roadside from erosion.

Figure 45: Vegetated protection from roadside parking.

Vegetation can also serve as a protection from roadside parking. Adding dense shrubs and trees right next to the road will prevent people from pulling off and parking. Vegetation will also provide added beauty and will help promote the health of the stream through filtering out sediment. Vegetation can be useful in blocking sediment from running directly into the stream.

Protection from Steep Slopes

Figure 46: Rail Protection for safety.

Rails can be used to provide added safety for cars on areas of steep slopes and severe grade changes. Railings can provide comfort to passangers in cars that their safety is ensured. Railings could also be used as a method for preventing cars from parking along the roadside, but will probably not be necessary for all roads.

Figure 47: Gabion Wall for Steep Slope Protection

Gabion Walls are walls or cages filled with rocks or stones and covered in wire baskets. These types of walls act as retaining walls and can be very effective in mitigating the effects of steep slopes. They are often used because their structure allows water to permeate through the wall, preventing the wall from rotting or deteriorating. For this reason, gabion walls can last a long time with little maintenance.

Gabion walls are also used for their aesthetic quality. It is possible for plant life and vegetation to grow on gabion walls, because plants can still get water and have space for their roots to grow. For this reason, gabion walls can actually look attractive. If they are vegetated, their green color allows them to fit in nicely into the existing landscape. They are often a good alternative to a standard retaining wall often used in landscaping.

Emergency Access Barriers

Manual Barriers

What is there now

As of now the watershed trails are blocked by simple swinging iron gates.

Figure 48. Picture of Current Gate in Watershed

These gates are ideal because they get the job done in a cost efficient way. The set back however is that a person must constantly open and close the gate. So in case of an emergency this could potentially slow down the rescue process.

Other Options

Figure 49 - 52. Picture of Current Gate in Watershed

When choosing a manual gate one must think of the type of material. Since the gate will be used for many years to come the chosen material must be able to withstand the natural elements. Gates must be able to last for years without rotting or rusting.

Wrought Iron is a tough, malleable and rust-resistant iron alloy that is hand-turned, hammered, bent and welded into desired shapes and forms. With this material the gates can be specially designed to match the community watershed character. However, actual wrought iron is labor intensive and expensive. It has not been commercially produced in the United States since the 1960s, according to the National Ornamental & Miscellaneous Metals Association. The ornamental fencing solid as "wrought iron" today is made from forged steel or aluminum. Regardless the material is durable and relatively rust-resistant.

Figure 53. Wrought Iron Manual Gate

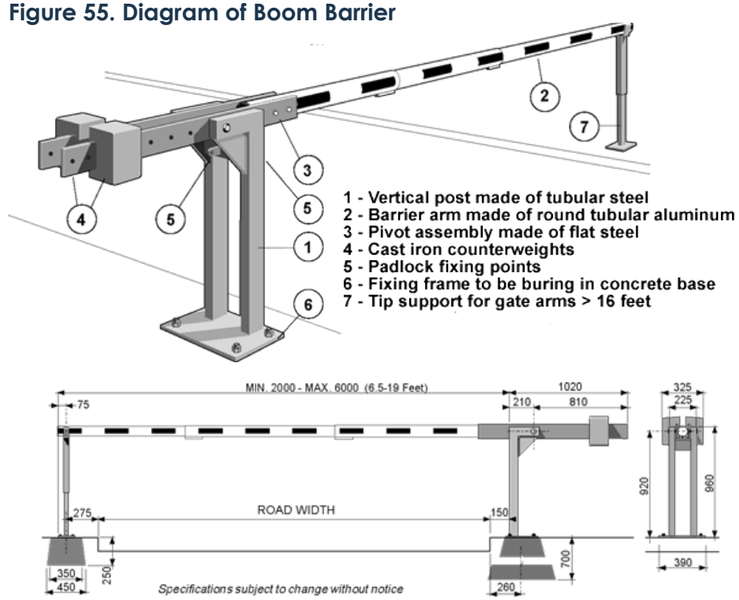
Another type of material that can be used is wood. Wood is not the ideal material because it doesn't last as long as metal. But if properly treated it can last for many years. With wood the design of the gate can be more creative than a simple swing gate. The wood pillars of the gate will add character to the site. As well as add to the aesthetics of the gate.

Figure 54. Wooden Manual Gate

Other Options

A boom barrier, also known as a boom gate, is a bar, or pole pivoted to allow the boom to block vehicular access through a controlled point. Typically the tip of a boom gate rises in a vertical position. Boom gates are often counterweighted, so the pole is easily tipped. Boom gates are often paired either end to end, or offset appropriately to block traffic in both directions. Some boom gates also have second arm which hangs 300 to 400 mm below the upper arm when lowered, to increase approach visibility, and which hangs on links so it lies flat with the main boom as the barrier is raised. Some barriers also feature a pivot roughly half way, where as the barrier is raised, the outermost half remains horizontal, with the barrier resembling an upside down 'L' when raised.

Figure 55. Diagram of Boom Barrier



Installation

Installing a manual gate is much cheaper than installing automatic gates. Manual gates do not require a company to install it. Therefore saving the individual labor cost. Manual gates cost from $300 - $1,000.

Emergency Access Barriers Continued

Automatic Barriers

Purpose

Automatic gates are used to control access into a secured area. Most commonly, automatic gates are used at the entrance to the facility, and are used to control vehicular access on and off of the site.

Components of an Automatic Gate

Automatic gates consist of two basic components:

1.Gate: The gate is the physical object that is moved to block the gate opening. Most gates used in commercial applications are made of either ornamental iron or chain-link material and are usually designed to match the fencing adjacent to where the gate is installed.

2.Gate Operator: The gate operator is the machinery that moves the gate in and out of the gate opening. Gate operators are electrically-powered and may be chain-driven, gear-driven, or hydraulic depending on the type of operator.

Types of Automatic Gates

There are six types of commonly used automatic gates. These include the slide gate, cantilever gate, swing gate, vertical lift gate, vertical pivot lift gate, bi-folding gate, and barrier arm gate. The following is a brief description of each type of gate:

The **slide gate** is probably the most commonly used type of automatic gate in light-duty commercial applications. The slide gate is mounted parallel to the inside of the fence and slides horizontally back and forth across the gate opening. The slide gate uses rollers on the bottom of the gate to support it. These rollers typically ride along a metal track that has been installed along the ground across the gate opening. Because this type of gate uses rollers that must run along the ground, there can be problems with the rollers getting blocked by snow, ice, or debris. The rollers can also be a source of friction, making the gate operator have to work harder to open and close the gate.

The **cantilever gate** is similar to the slide gate, but does not use rollers that slide along the ground to support it. Instead, the cantilever gate is supported from rails that run along the inside of the fence structure. Cantilever gates need to be much wider than slide gates in order to provide a section along the fence structure where the gate is supported. This section is called a "counterbalance" and is usually at least 1/2 the width of the gate opening itself. Cantilever gates are suspended across the gate opening from the counterbalance, with no rollers running along the ground to provide friction or to become obstructed. Because of this, cantilever gates are considered to be much more reliable than slide gates.

Swing gates are hinged on one side and swing open and closed like a door. Swing gates typically travel a 90 degree arc between their open and closed positions. Swing gates are most commonly used in residential applications because of their low cost and ease of installation. Because swing gates travel over a large arc, space must be available. The swinging arc of the gate also requires additional safety considerations to prevent people or vehicles from being hit or trapped by the moving gate.

Vertical lift gates move up and down vertically over the gate opening. The gate must be lifted high enough to allow vehicles to pass underneath of it. This type of gate requires that tall vertical support towers be installed on each side of the gate opening. Vertical lift gates are ideal when there is limited space available next to the gate opening. Vertical lift gates are also very fast and very reliable.

Vertical pivot lift gates rotate in and out of the gate opening. They are supported entirely from the gate operator itself and do not require any additional support structures. Vertical pivot lift gates provide some of the benefits of vertical lift gates, but appear less obtrusive as they do not require vertical support towers. However, the footprint of a vertical pivot lift gate operator is larger and requires additional space beside the gate. Vertical pivot lift operators typically use springs to serve as a counterweight, and in our opinion, this makes them less reliable than a standard vertical lift gate.

Bi-folding gates consist of two gate panels that are hinged together. When activated, these gate panels fold back onto themselves to allow access. Most commonly, bi-folding gates are used in pairs, with one pair being used on each side of the gate opening. Bi-folding gates require only a small footprint and are often a good choice when space is limited. Many bi-folding gates have relatively fast opening and closing speeds. Because of the many potential entrapment points possible with this type of gate, additional safety considerations are often required.

Barrier arm gates consist of a vertical barrier arm that is rotated in and out of the gate opening. Barrier arm gates are used to control vehicles, not pedestrians. As it is very easy for a person to walk beside or climb over or under the gate arm, barrier arm gates provide almost no security. Barrier arm gates are used primarily to control access in and out of parking facilities, or to control vehicular traffic at manned security entrances.

Figure 56. Automatic Boom Barrier

Gate Accessories

- Access control systems: Card Readers, digital keypads, etc...
- Intercom systems
- Video surveillance systems
- Free Exit devices
- Emergency Access

Parking Lot Designs

Hamburg Lot 1

Narrative

The overall concept of the parking lot is to create a functional and attractive area for trail users to park off Hamburg Road. The parking lot is located 200 feet away from the Blue Trail, providing a buffer necessary to preserve the quality of both the trail and stream systems. With Hamburg Road being suggested to be closed further down the road, this parking lot functions as a turn around area before the road closure further down the road. Therefore it fixes trafic congestion with instances such as parking on the side of the road and making U-Turns in the middle of the road. There has also been a path added to the bottom of the site to connect to the fishing pond just to the east of the parking lot. The trail head has an ampitheater type seating area with picnic tables. At the trail head there has been compost toilets added to accommodate needs for restroom use.

Site Features

Twenty four car parking spaces
Two horse trailer parking spaces
Waiting / rest area
Picnic tables
Ampitheater Seating Area
Side path that leads to a fishing pond.
Rain Garden
Space for Compostable Toilets

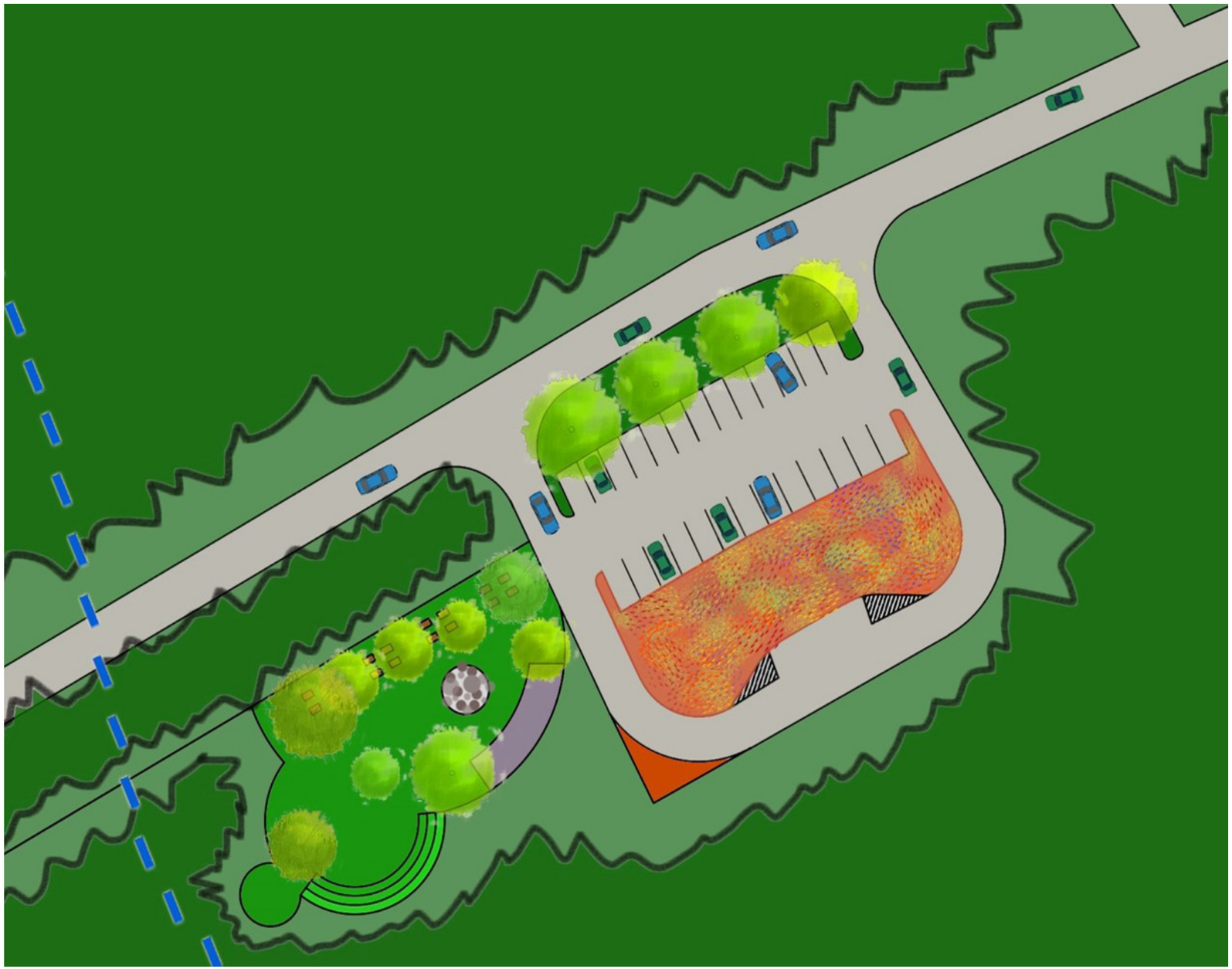


Figure 57. Concept Plan & Connection to Trail

University of Maryland College Park Department Of Plant Science and Landscape Architecture - LARC 341 Undergraduate Regional Design Studio
Instructor: Christopher D. Ellis, Ph.D. - Design Team: All Students Enrolled in the Undergradute Studio - Report Organized By: Nick Martinazzi and Brittney Wood

Gambrill Park Lot

Existing Problems and Solutions

Drivers back their cars out of the existing parking lot, and their cars go directly onto the road. This is technically illegal and doesn't match the national parking lot standard. In order to solve this problem, we proposed a two way parking lot design with the capacity of 20 cars and 2 horse trailers. The second problem with the existing parking lot is that it's close to the fishing creek but far away from the blue trail. In the new design, the parking lot is only 100 ft. away from the trail head. Although this new design constrains people who want to go fishing, it creates an easier access to the trail for a larger group of stakeholders (hikers, mountain bikers, and horse riders).

Parking Lot Design

Figure 58. Site Plan

Parking Lot Features

Figure 59. Examples of composting toilets

Composting Toilets

Some advantages of composting toilets include:

- Use of recycled human waste as fertilizers
- Reduction of water footprint
- Low power consumption
- Reduction of toilet maintenance cost
- Lack of a sewage system

Figure 60. Benches

Site furniture

We added some site furnitures to provide seating for visitors. This allows people to get picked up and dropped off at the parking lot.

Rain Garden

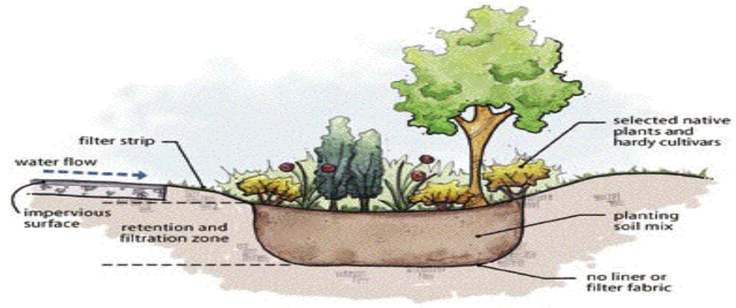


Figure 61. Rain garden diagram

Perspective of Parking Lot Entrance

Figure 62. Parking Lot Entrance Perspective

This perspective is showing the north entry point of the parking lot. Also, it shows the solar powered composting toilet with an adjacent wating area. The rain garden is located to the right.

Parking Lot

Base Map

Figure 63. Proposed Parking Plan

Key
A - Blue Trail B - Kiosk C - Rain Garden
D - Horse Trailer Parking E - Bathroom

Background

The existing parking lot consist of a rectangular shaped area filled with dirt. The parking lot is concave, which causes a large puddle of water to collect in the center of the lot when it rains.

Figure 64. Existing Parking Lot

The location of the proposed parking lot is across the street from the current parking area. The reason for this decision is because behind the current parking lot are many native mountain laurels, which are essential to the natural habitat of the site. There are also large boulders scattered throughout the area that would be hard to move.

The blue trail is located directly across the street from the current parking lot and therefor, is not build-able space. The proposed parking lot is located adjacent to the Blue Trail, which is diagonal from the original parking lot. This areas allows for the parking lot to be built with the least amount of disturbance to the watershed.

The current parking lot does not provide access to a restroom nor does it have any signage to orient people to where they are currently located. Maps such as these will help people figure out where they are along the blue trail and which routes they could take to multiple locations.

Proposed Design

Figure 65. Proposed Parking Lot

The new parking lot is filled with native vegetation and attracts a variety of animal species, such as birds and butterflies. The buffer between the road and the parking lot is a rain garden, which serves to collect and filter the polluted water that flows off the road. The proposed design also meets the requirements of a parking lot according to the Equestrian Design Guidebook, unlike the current parking lot.

Figure 66. Rain Garden Design in Existng Parking Lot

The new design includes a rain garden in place of the existing parking lot. The rain garden will prevent any flooding or damage that currently results from rainfall. This allows people crossing the road to the trail to feel connected to nature.

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Hamburg Lot 2

Context

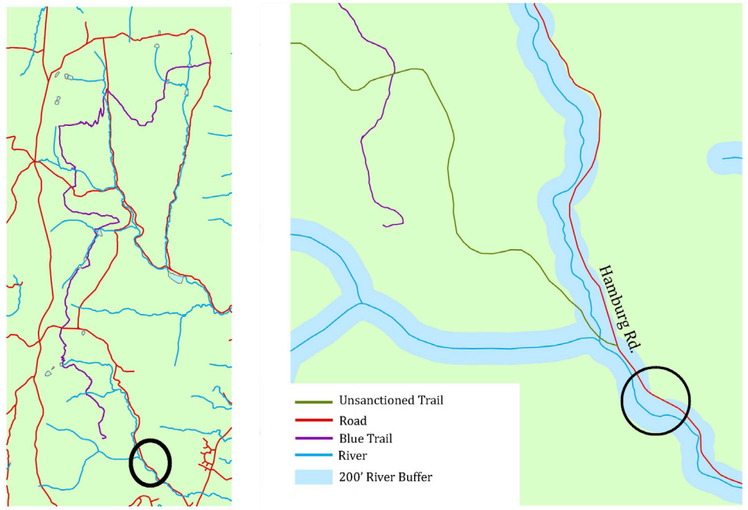


Figure 67. Context maps

Parking lot 7 is on the southern end of the watershed on Hamburg road. While the site is on an area with a slope that is less than 10%, it is within a 200 foot stream buffer. Because of its close proximity to the stream, this section of Hamburg Road is on our list of recommended closures.

There is an unsanctioned trail leading from the Blue Trail that reaches Hamburg Road a few hundred feet from the designated area for the parking lot, but the Blue Trail does not connect to or approach the parking lot.

Site Plan

Figure 68. Site Plan of Hamburg Lot 2

View of Kiosk and Bench

Figure 69. Kiosk and Bench

If built, this parking lot would include 10 parking spaces and a small kiosk and seating area. The surface would be #57 aggregate so runoff infiltration is possible. The kiosk and bench are made of wood, and there are wooden curbs and small boulders used as a barrier around the lot so people cannot drive closer to the stream.

If a parking lot is necessary in this location, there should be no more than 10 spaces and a small kiosk and seating area. Horse trailers are a large contributer to runoff pollution and there is no accessible trail connection for horses near the site. The parking lot is on the outskirts of the watershed and we do not expect it to be heavily used. For these reasons, horse trailer parking and compost restrooms were not included in the design for parking lot 7.

We do not recommend building a parking lot in this location due to its proximity to the stream and disconnection from the Blue Trail. It would benefit the water quality to prevent anyone from parking or driving in this area and to close this portion of Hamburg Road.

Fishing Creek Lot

Location Change

The original location of parking lot 6 is near the interseciton of Gambrill Park Road with Fishing Creek Road(Figure 1). By using GIS to measure the distance between the intersection and blue trail head, we found it is 0.8 miles long and too far for people to walk. Therefore, we moved it south. The new location of the parking lot is 0.25 miles to the blue trail head. To make sure that the parking lot has positive drainage and at the same time avoilds regrade as much as possible. We also put the parking lot at a slope of 0-10 percent.

Road Closure

Fishing Creek Road will not be completely closed from the intersection point. To let the cars drive into our parking lot, the road will be still open until it reaches the parking lot. To be more specific, it will have about 0.55 miles open and 0.25 miles closed.

Figure 70. Gambrill Park/Fishing Creek Intersection

Context Map

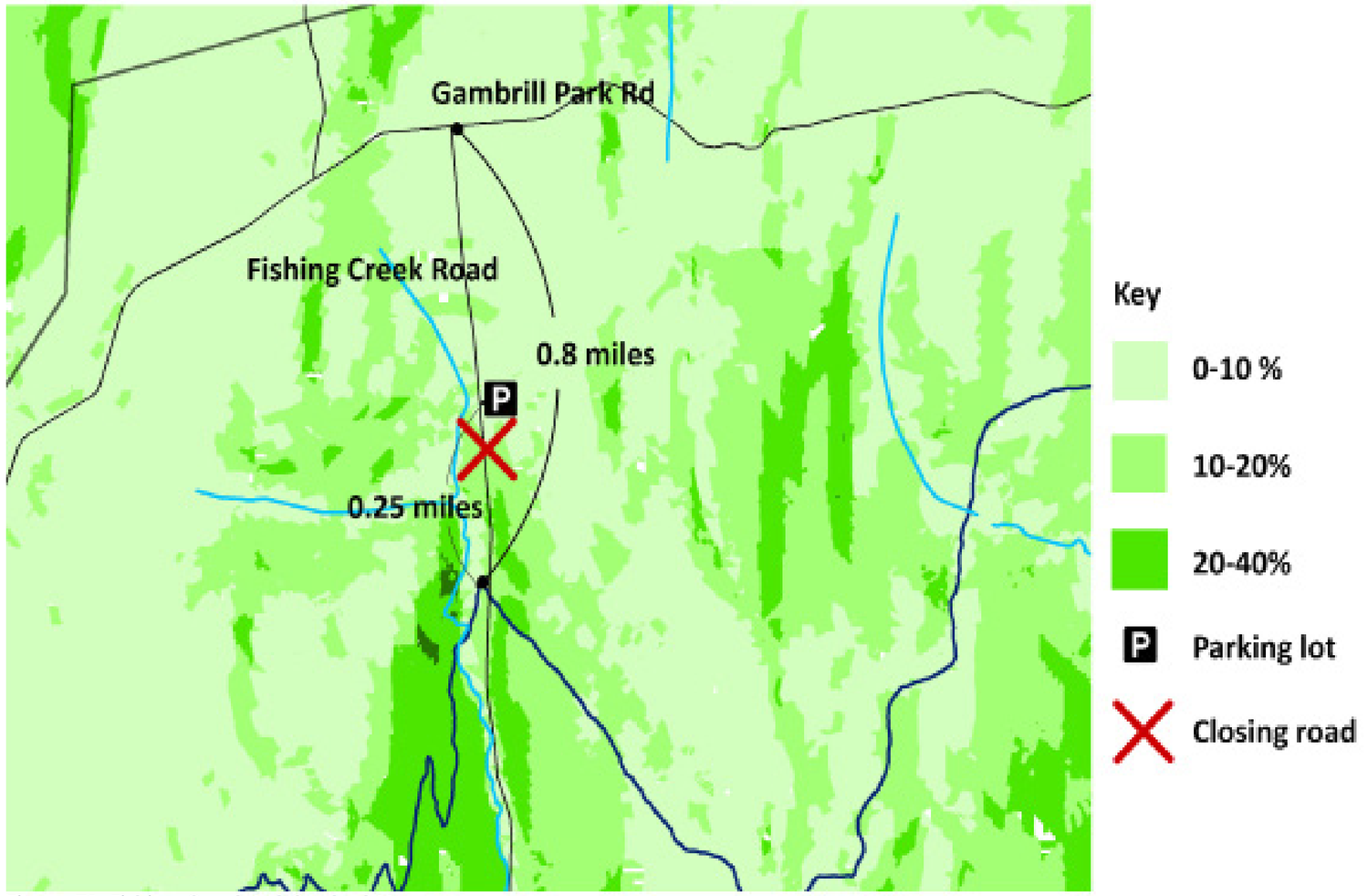


Figure 71. Fishing Creek Lot Context Map

Fishing Creek Lot

Loop/ One-way entrance and one-way exist
Bio-retention swale in the middle to infiltrate runoff
Outlet pipe on the south of the bio-retention that connects to the seating area and finally lets water drain into the forest

This parking lot is a one-way loop. Vehicles enter from the south and exist from the north. The total number of parking space is 21, including 20 regular cars and 1 horse trailer. In order to seperate the parking lot and Fishing Creek Road, a 100-foot buffer is added. The buffer will help provide privacy, and safety for drivers. In the middle of the two columns of parking, we add a bio-retention swale to help infiltrate stormwater. To provide a convience for people to have a rest, a transition area is add next to the parking lot. A restroom is also contained in the transition area.

Pespective

Figure 72. Fishing Creek Lot Perspective

Precedents

Seating Area I

Seating Area 2

Composting Toilet

Sign and Kiosk

Figure 73. Fishing Creek Lot Precedents

Site Plan

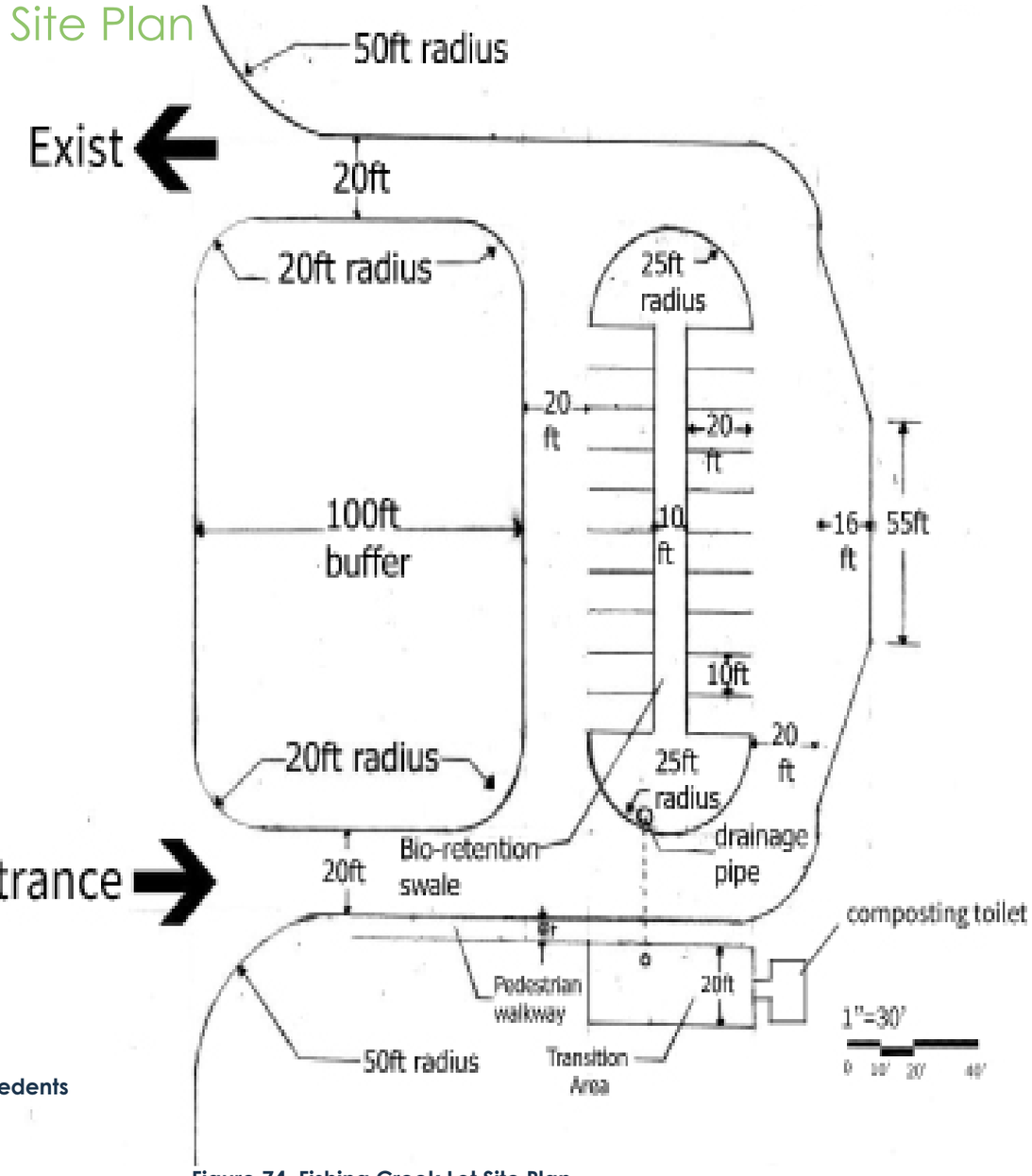


Figure 74. Fishing Creek Lot Site Plan

Delauter Lot

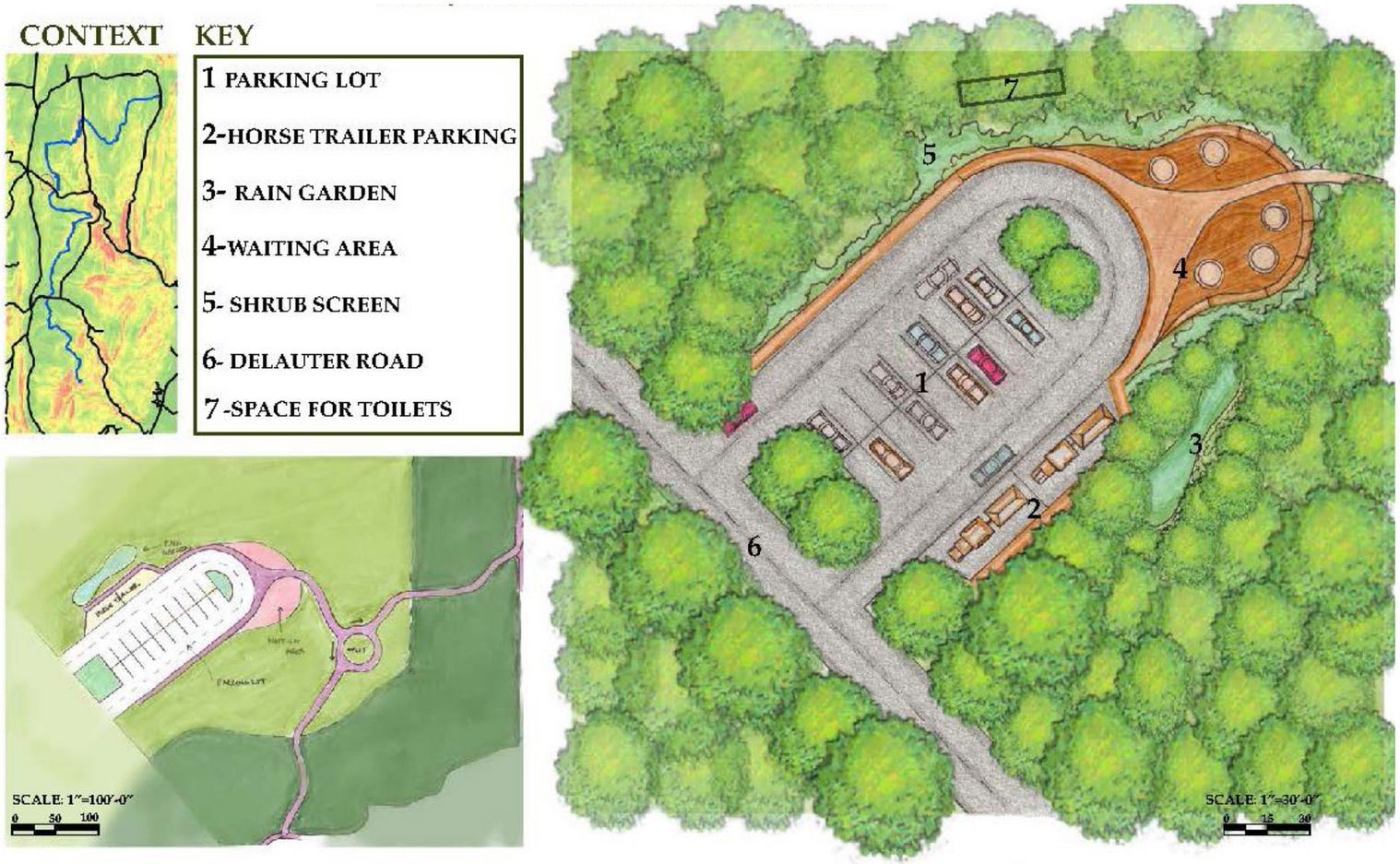


Figure 75. Delauter Concept Plan & Connection to Trail

Figure 76. Delauter Lot Site Plan

Figure 77. Perspective of Horse Trailer

The perspectives above and below demonstates how the horse trailer parking and rain garden will work as well as the welcoming area to the blue trail and all its accomedations for guest and visitors

Figure 78. Perspective of Waiting Area

The overall concept of the parking lot is to create a functional and attractive area for visitors to park on Delauter Road. The parking lot is located 100 feet away from the Blue Trail, providing a buffer necessary to preserve the quality of both the trail and stream systems. The lot has a one way round about allowing for cars to circulate easily through the lot. On the far right there is a rain garden to prevent sediments and waste from the horse from getting into the stream and further more the watershed. The lot fits 20 cars and 2 horse trailers. There is a entrance area to the blue trail that houses kiosks and seating.

Fishing Creek Lot 2

Figure 79. Traffic Circle Precedent

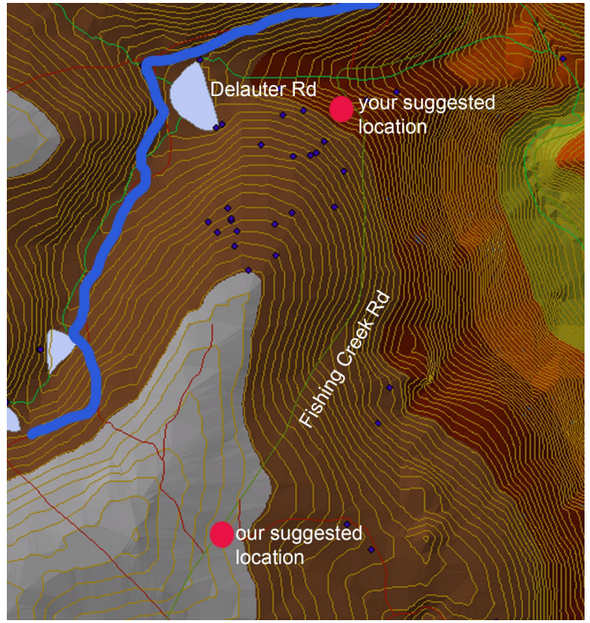


Figure 80. Fishing Creek Lot 2 Context Map

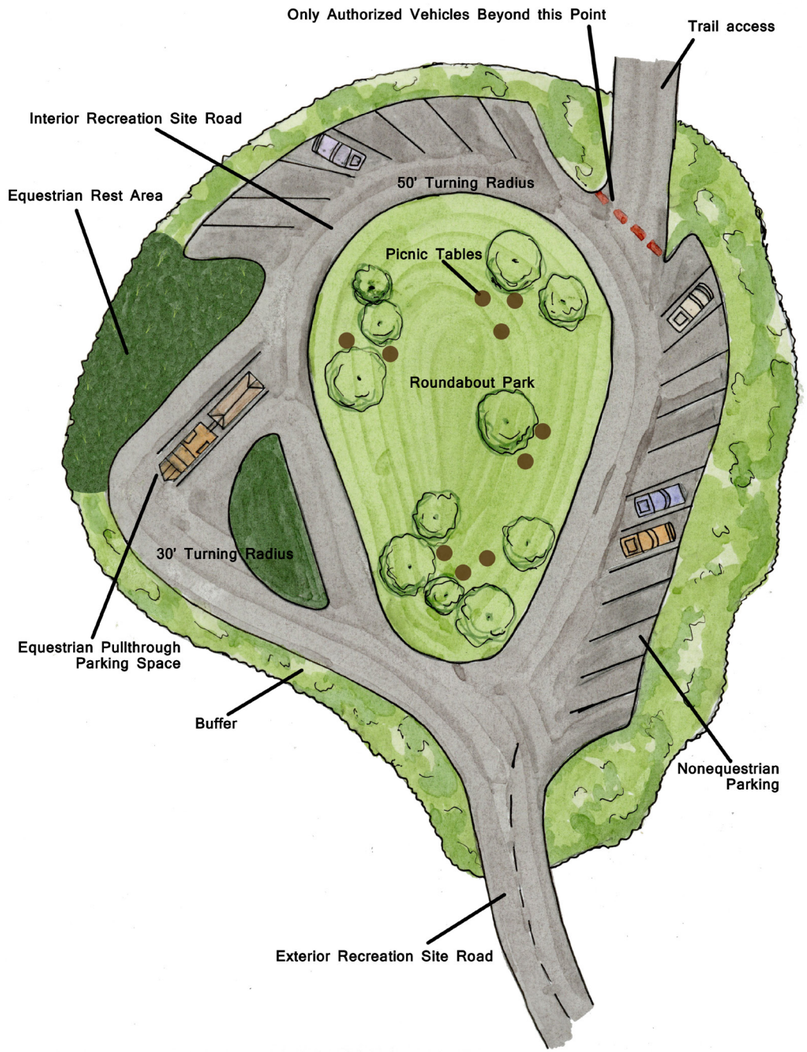


Figure 81. Fishing Creek Lot 2 Site Plan

Figure 82. View Towards the Trail Connection

The suggested location of this parking lot is on Fishing Creek road, about half a mile south of the intersection between Fishing Creek and Delauter road. This new location will provide a suitable, relatively flat area ideal for car and equestrian parking that would not be possible if located further north on the road. Non-sanctioned trails, which start on either side of the lot, connect to the Blue Trail about 0.3 miles away. These trails are the ideal route to either the nearby lake roughly a mile northwest or the reservoir about 0.7 miles to the east. The lot will be accessible by the road leading up from the south. The road to the north of the lot will be blocked off for use only by pedestrians, horses, and emergency vehicles.

The roundabout provides an easy flow for traffic and a gathering space for users of the watershed. The buffer system surrounding the lot is used to infiltrate runoff and create a bioretention barrier.

Visitor Center Designs

Visitor Center 1

The watershed will benefit from a low-key visitor center located in close proximity to the berm and reservoir. We recommend refurbishing the old building near the entrance gate as an open-air space with a few exhibits and seating areas so people can enjoy the space and learn about the watershed.

Our site plan includes an entry road, a 20-car parking area, 2 bus parking spaces, 2 horse trailer parking spaces, and a private driveway and parking area for the caretaker and other key personnel. Our goal is to provide the public an area to gather to enjoy the river, learn about the watershed, and rest before exploring the trails. We wanted to simultaneously allow staff to access the reservoir without calling attention to the water filtration system and the existing buildings near the berm.

The visitor center will consist of interpretive exhibits under the roof of the existing worn-down building. The east end of the building will have compost restrooms and some picnic tables. There will be an open area for kids to run around in so parents can relax and watch their kids play. A lone pathway will lead people along the river through gathering spaces and approach the waterfall. The signs can teach people about the native plants and animals of the area, or display the trail system. The goal of the space is for people to enjoy the natural beauty of the area without getting to close to the machinery and buildings that exist on the site.

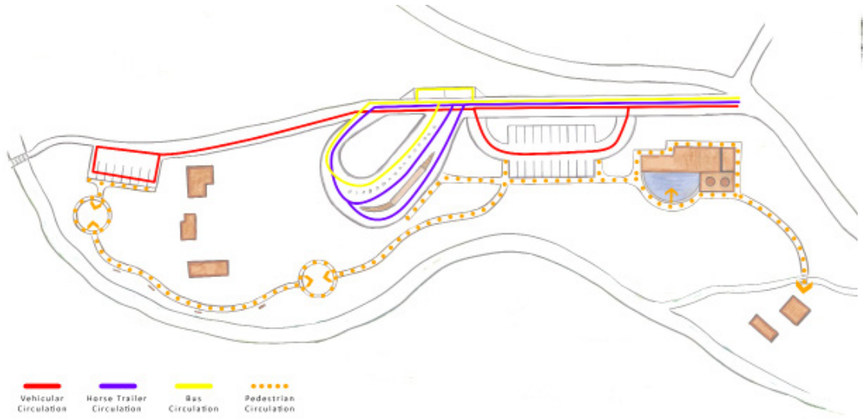


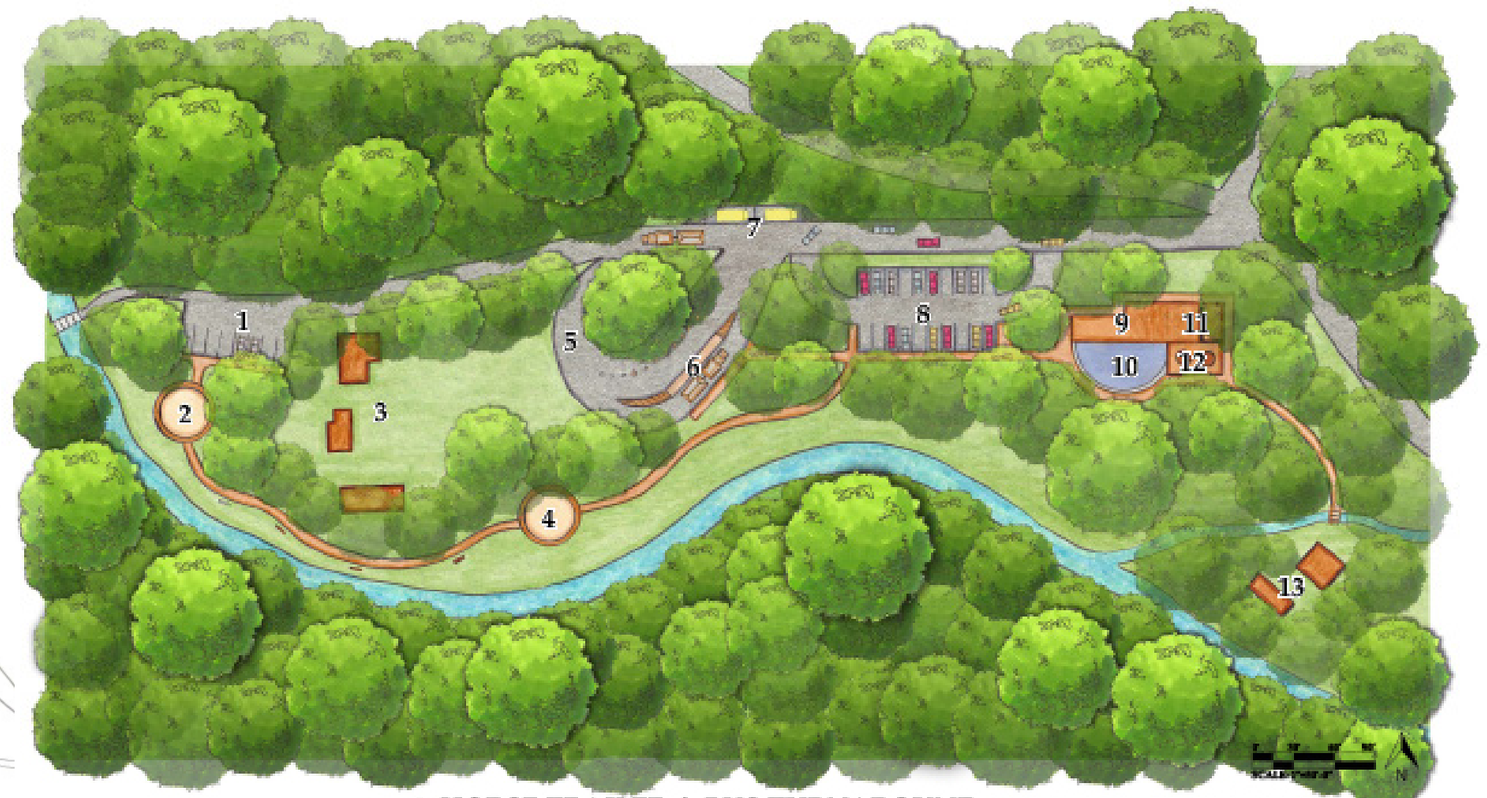
Figure 83. Circulation Diagram 1

Precedents:

Figure 85. Interpretive Exhibits

Figure 86. River-side Signage

Figure 87. Wood Stump Seating



1: PRIVATE PARKING
2: GATHHERING SPACE
3. EXISTING BUILDINGS
4. GATHERING SPACE
5. HORSE TRAILER & BUS TURNAROUND
6. HORSE TRAILER PARKING
7. BUS PARKING
8. VISITOR PARKING
9.VISITOR CENTER BUILDING
10. OUTDOOR PLAY AREA
11. VISITOR RESTROOMS
12. PICNIC AND SEATING AREA
13. EXISTING LODGE AREA

Figure 84. VC Site Plan 1

Materials:

Figure 88. Material Palette

Perspective 1:

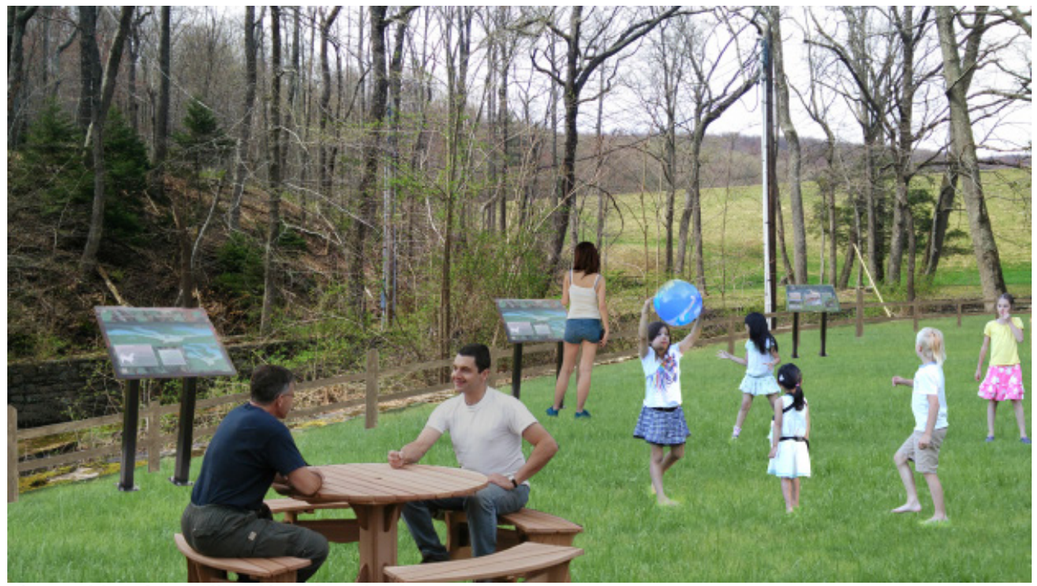


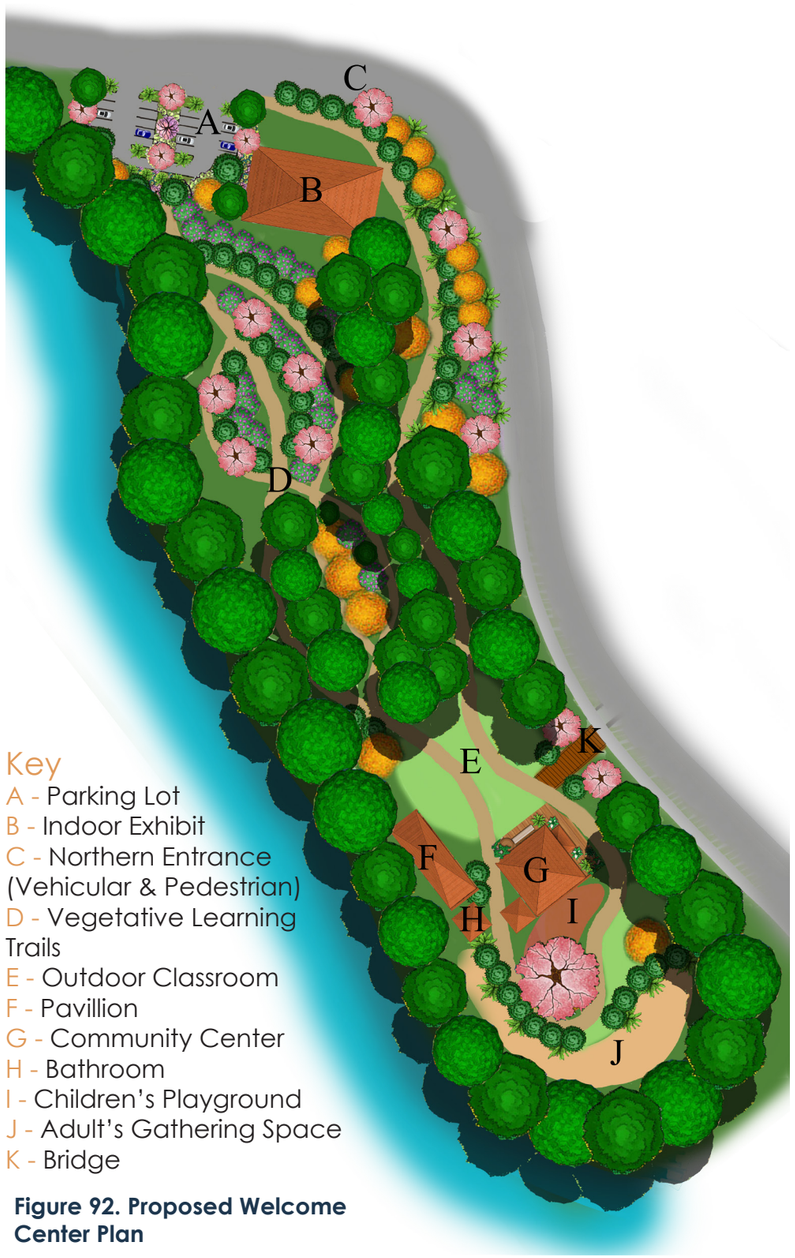
Figure 89. Informative Sign Overlook

Perspective 2:

Figure 90. Semi-shaded Outdoor Seating

Perspective 3:

Figure 91. Pavilion Area



Key
A - Parking Lot
B - Indoor Exhibit
C - Northern Entrance (Vehicular & Pedestrian)
D - Vegetative Learning Trails
E - Outdoor Classroom
F - Pavillion
G - Community Center
H - Bathroom
I - Children's Playground
J - Adult's Gathering Space
K - Bridge

Figure 92. Proposed Welcome Center Plan

Visitor Center 2

A Walk Among Nature

Original Site Layout

Currently the site lacks a welcoming center. Visitors approach the site and have no sense of arrival. Providing a welcome center will orient the visitors to the site and introduce them to the site's overall concept.

There is a disconnect between the northern and southern areas of the welcome center. The northern area has a rundown former sawmill with open lawn sapce towards the left of it. The southern area is connected to the main road by a bridge and contains a pavillion, a locked community center, and open grass space. The space behind these two central areas of the welcome center is forested and has a stream running behind it. Because the site is rundown, it does not attract visitors to spend time there. There is a lack of attention to the site in terms of asthetics and cohesivness. In addition there are few opportunites for entertainment. Creating a cohesive design with amenties and a variety of native vegetation will give the site its missing character.

Figure 93. Original North Entrance

Proposed Design Concept

In order to create a cohesive design, the idea of providing opportunities for learning about native vegetation has been implemented. The new welcome center design includes a variety of native plants that are seen throughout the watershed. This allows the site to serve as an introduction to the watershed as it represents one of its essential aspects. Many areas for learning have been designated throughgout the welcome center, such as, trails with plant tags and descriptions and outdoor classrooms. Visitors can walk amongst the trails to learn about the native trees and shrubs in the watershed.

The new design also includes opportunties for entertainment for children and adults. There is a playground for children located close to the stream where children can listen to the sounds of the water. There is also native vegetation surrounding the playground for children to see and examine. An area for adults to watch their children play and enjoy the views of the native plantings and stream is located next to the playground.

Lastly, the new design provides aesthetic appeal to attract visitors. Many shrubs and ornamental trees have been added to the site to create spaces and provide visual interest, as can be seen in the following perspective images.

Figure 94. Proposed North Entrance

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Figure 95. Original Southern Pedestrian Entrance

Figure 96. Proposed Southern Pedestrian Entrance

New Site Functions

The proposed design includes a variety of site functions in order to provide visitors with activities that are currently not available. Two of the main features include vegetatiove learning trails and an outdoor classroom.

Vegetative learning trails: These trails serve to connect the Northern and Southern areas of the site. They are lined with the native vegetation that are found throughout the watershed. Sign posts including the names and descriptions of the vegetation are located along the paths.
Outdoor classroom: Adjacent to the community center is an open lawn space with repurposed tree trunks as logs for seating. The space allows classes to come discuss their observations.

Figure 97. Proposed Vegetative Learning Trail

Figure 98. Original Welcome Center

Figure 99. Proposed Welcome Center

Visitor Center 3

Theme: Use Existing Mill to Create Historical Visitor's Center

- Transform the mill into an pavilion-like gathering space
- Add a wooden deck surrounding the mill
- Put wood logs and rusty metal sculptures on the western side
- Surround with meandering paths to encourage movement
- Create connection to the island

Perspectives

Figure 100. View Towards Lumber Stack Play Area

Figure 101. View of Revitalized Mill

Funcitional Diagram

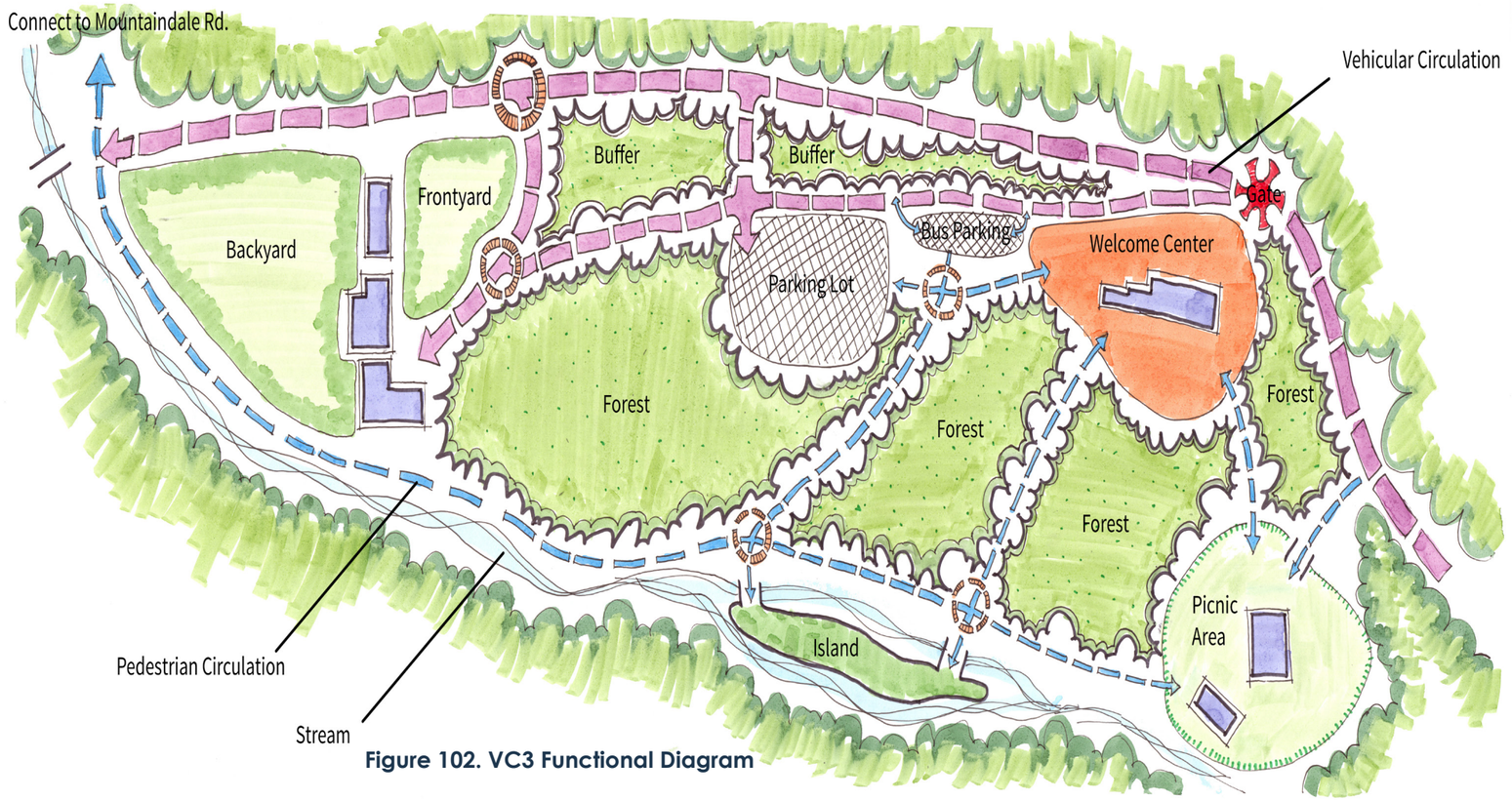

Figure 102. VC3 Functional Diagram

- Provide access to the existing picnic area
- Have visitor center or major gathering area around the old mill
- Have the parking lot next to the visitor center for covinence
- Create an one-way loop vehicular circulation
- Create a path along the stream and connect it to the Montaindale road to let people enjoy the water and more easily to get on trails
- Provide access to the island for restroom

Figure 103. View of Back of Exhibition Pavilion

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Site Plan

1 – Car Parking Area 2 – Horse Trailer Parking Area 3 – Bus Parking Area 4 – Play Area with Old Mill Pieces 5 – Seating Area 6 – Front Garden 7 – Welcome Center Kiosk

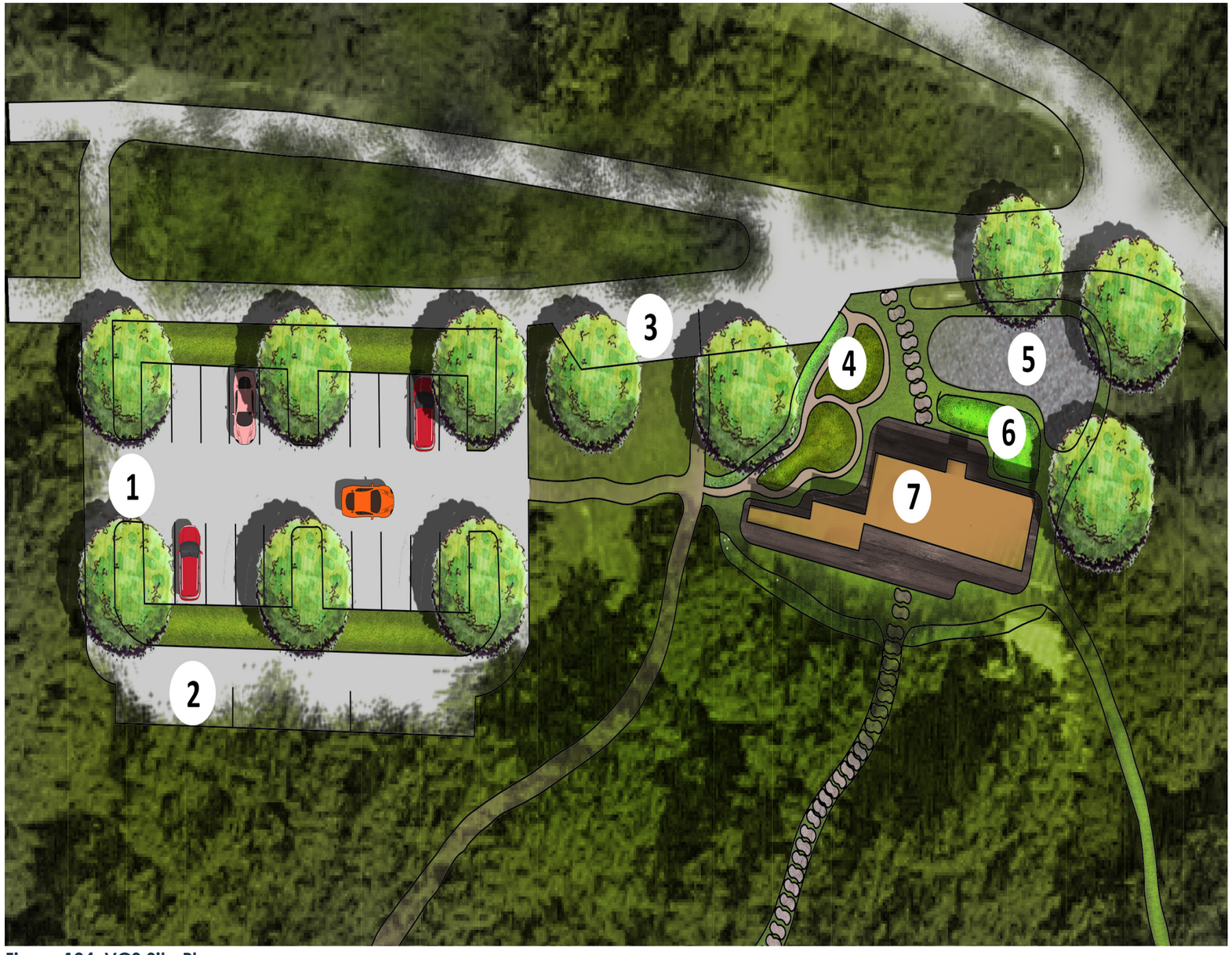

Figure 104. VC3 Site Plan

Figure 105. View from behind pavilion

Figure 106. Path along stream

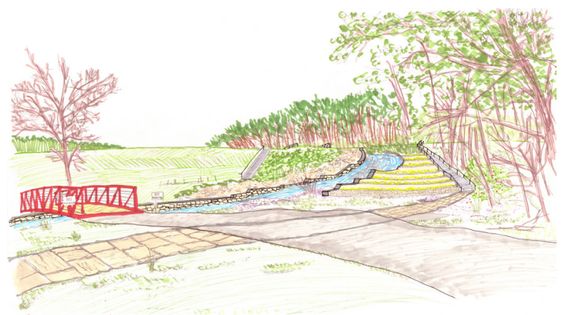

Figure 107. Stairs connecting to Mountaindale Rd.

Figure 108. Entrance View

Visitor Center 4

Theme: Wildlife Exhibition

- The new visitor center will feature outdoor information kiosks, a pavilion area, and open green space
- Another feature of this visitor center is the walkway through an exhibition of wildlife sculptures
- Enjoying the peaceful flow of the stream can be achieved by strolling along the path, relaxing at the stream seating overlook, or crossing the bridge
- Parking areas are provided for visitors, buses, and the family currently living in the exisiting buildings on site

Precedents

Figure 109. Visitor Center Example

Figure 110. Interactive 3D map

Site Plan

Figure 111. VC4 Site Plan

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Figure 112. VC4 Pavilion and Wildlife Info Kiosk

Figure 113. Seating overlooking the stream

Figure 57. Concept Plan & Connection to Trail
Figure 58. Site Plan

Conclusion

Concluding Statement

Overall:

The Frederick City watershed is a vibrant and flourishing destination for countless hobbyists, researchers, and outdoor enthusiasts. However, as we've proved through the course of this report, erosion, sediment buildup, and pollution are posing a great threat to the quality of water the city of Fred erick receives.

Our research concluded that while the trails on site were generally well-placed and effective, the expansive and intricate road system that cuts through the watershed—in addition to the roadside parking it encourages—presents a serious concern for the future water quality of this watershed.

This project was of the greatest scope, we as a studio, had ever encountered. Working at this scale forced us to think in ways we, as designers, never had before. Furthermore, we spent many hours studying GIS maps and acquiring data to get the most vivid understanding of the benefits this site offers, the sensitive areas worth protecting, and the ways in which all stakeholders can enjoy the watershed without conflict.

In addition to the conceptual data we garnered from GIS, we took numerous field trips to the watershed in order to gather physical data by letting our own feet feel the trails and learn the character of the site. On these field trips, our class conducted inventories, analyses, and assessments, which were then compared with the data we had gathered from GIS to develop verifiable recommendations for improving the watershed.

Our class has had a lot of time to discuss, argue, and compromise on the issues that this watershed faces after spending nearly three months analyzing and redesigning it. We believe that our efforts and time have resulted in an accurate depiction of the many realities and concerns that this 7000 acre watershed faces. We hope that our research and recommendations prove useful in the growth and protection of this exquisite piece of land, which means so much to so many.

Thank You.

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