Canaan Valley NWR - Cross Valley Trail Feasibility Study

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For:
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Introduction

Canaan Valley, located in northeastern Tucker County, West Virginia, is approximately 13 miles long and 3 – 5 miles wide. It is bounded by Canaan Mountain and Brown Mountain to the west and Cabin Mountain to the east. In addition to containing the headwaters of the Blackwater River, Canaan Valley contains the largest freshwater wetland complex in West Virginia. Canaan Valley National Wildlife Refuge was established in 1994 to preserve its unique high elevation wetland system and to protect fish and wildlife resources. A system of trails within the refuge currently provide the public with opportunities for hiking, bicycling, horseback riding, and cross country skiing, Hunting and fishing are also allowed.

Vanasse Hangen Brustlin, Inc. (VHB) conducted a feasibility study at the Canaan Valley National Wildlife Refuge in Davis, West Virginia to assist the U.S. Fish and Wildlife Service evaluate potential options for development of a cross valley trail within the refuge. Two locations were considered for potential trail development, both of which utilize an old abandoned rail grade: 1) Corridor A – the north rail grade and 2) Corridor B – Jack Neal's Ford to the south. The intended purpose of the trail is to provide an east-west connection across the valley. Both rail grades traverse vast expanses of sensitive bog habitat that contain rare plant communities. The purpose of this feasibility study was to generally evaluate the feasibility of converting these abandoned rail grades into pedestrian, bicycle or equestrian trails in a manner that will not compromise the long-term health of sensitive natural systems within the refuge.

In order to evaluate the feasibility of a cross valley trail through the refuge, VHB coordinated with refuge staff as well as the Canaan Valley Institute to identify key issues and discuss construction access for both sites. VHB also conducted a field review to assess and document the existing conditions of each corridor. Conditions evaluated in the field included:

- Suitability of the rail grade itself
- River crossings
- Location of wetlands or inundated areas within the rail grade corridor
- Accessibility for construction purposes
- Existing infrastructure (bridges, culverts, etc.)

Based on this information, VHB developed a range of feasible alternatives for each corridor and conducted a charrette with U.S. Fish and Wildlife Service staff and staff from the Canaan Valley Institute in order to discuss issues associated with each alternative. Based on this charrette, the alternatives were slightly modified and evaluated in terms of cost, durability/maintenance, the potential area of disturbance, wetland impacts, constructability, and construction access.

It is important to note that this feasibility study is a precursor to other steps that must be completed in order to determine whether a cross valley trail through refuge property can become a reality. In particular, the U.S. Fish and Wildlife Service must make a "compatibility determination" in accordance with the National Wildlife Refuge System Improvement Act. The compatibility process must evaluate a range of issues associated with a proposed activity or facility on refuge property. These issues include potential impacts to wildlife, conflicts with other users, cumulative impacts, invasive species, consistency with refuge purposes, etc. This process has not yet been completed for the trails described in this study or for other trails that may be necessary to connect a cross valley trail with the existing trail network.

The results of the feasibility study are summarized in the following sections.

Field Review

A field review of both corridors was conducted the week of October 22, 2007. Each corridor was photographed and features were marked in the field using a portable Geographic Information System (GIS) device. A summary of each corridor is provided below.

Corridor A – North Rail Grade

For study purposes, the northern rail grade runs from the Brown Mountain Overlook Trail to the west, to the old jeep trail on the eastern side of the valley, a distance of approximately 7,000 feet. The corridor was accessed from Camp 70 Road to the west via Brown Mountain Trail and Brown Mountain Overlook Trail. From a point on the eastern portion of the Brown Mountain Overlook Trail (due east of the rail grade), a relatively steep but short (400-foot) descent is required to reach the abandoned rail grade on the floor of the valley. Once on the floor of the valley, the corridor traverses thickly vegetated bog habitat interspersed with beaver ponds, with the rail grade completely inundated for the first 2,200 feet. High, dense vegetation is common through this section, often blocking views of the surrounding valley.

The rail corridor then appears on a small upland knoll, and continues across pristine bog habitat on a raised grade, roughly 8 to 10 feet wide, that is somewhat overgrown but otherwise dry and in good condition for a distance of approximately 4,400 feet to the jeep trail. Roughly 1,400 feet west of the jeep trail, the rail corridor crosses the Little Blackwater River. The river is relatively shallow in this location and is approximately 20 feet wide. Once reaching the junction with the jeep trail, the Study Team proceeded due east, up steep grades on Cabin Mountain until reaching A-Frame Road.

Access to this rail grade for construction purposes does not appear feasible from Camp 70 Road or from A-Frame Road due east from the rail grade due to steep topography. However, refuge staff indicated that access may be possible through the private property to the north, via a private road off of A-Frame Road. The condition of this access road was not assessed as part of this study.

Corridor B – Jack Neal's Ford

For study purposes, the southern rail grade runs eastward from the Swinging Bridge Trail off of Camp 70 Road to the jeep trail west of Middle Ridge Trail on the eastern side of the Valley, a distance of approximately 11,000 feet. Currently, a steel cable suspension bridge is used to cross the Blackwater River at the western terminus. The Canaan Valley Institute (CVI) has final design plans for a 10' wide prefabricated weathering steel truss bridge at the site of a former railroad bridge near Camp Seventy that will be constructed over the Blackwater River just west of the suspension bridge on CVI property. Based on coordination with Dan Wheeler at CVI, the new bridge has been designed for an AASHTO H-10 truck to accommodate occasional use by small vehicles (i.e. pick-up trucks). CVI anticipates that the bridge will be constructed the summer of 2008. Corridor B can be readily accessed by potential trail users from the new bridge location. However, the new bridge will not support heavy construction equipment.

After crossing the Blackwater via the existing suspension bridge, the rail corridor proceeds along a clearly defined upland path on the old rail grade for approximately 1,400 feet. For the next 4,500 feet, the rail grade alternates between being elevated (and dry) and being inundated where the rail grade has been rutted out by historic ATV activity. The rail corridor also crosses a small stream, 1 to 5 feet wide, through this section. Most of the inundated sections through this section have evolved into functional wetland systems and pond habitat. Some small areas appear to be only periodically under water and do not support wetland vegetation. Where it is not inundated, the rail grade is generally 10 to 15 feet wide. The rail corridor then crosses the Blackwater River for a second time, at what is referred to as Jack Neal's Ford. In this location, the western embankment is highly eroded and steep. The crossing itself is approximately 50 feet wide. At the time of field review, the depth of the river was 2 to 3 feet.

After this crossing, the rail grade continues eastward on an elevated rail grade for another 4,000 feet before reaching an expansive beaver pond complex. The defined rail grade is generally 10 to 15 feet wide, crossing a vast wetland complex considered a rare plant community. Evidence of erosion and prior disturbance within the wetland habitat can be observed south of the rail grade just past the river crossing. Evidence of beaver activity becomes increasingly prominent as the rail corridor traverses eastward, with ponded areas becoming larger and deeper. In this section of the corridor, beavers have also degraded the rail grade itself, digging into the earth embankment and cinder substrate on the south side of the rail grade. Numerous

holes and bank dens are evident. Towards the eastern terminus of the corridor, the rail grade is completely inundated by an expansive beaver pond for a distance of approximately 700 feet. Several lodges and dams with signs of recent activity are visible. Just past this inundated area, the rail corridor proceeds on a short upland section for another 100 feet before intersecting with the jeep trail.

Based on coordination with the Canaan Valley Institute (CVI), access to this rail grade for construction purposes appears feasible using an existing haul road on CVI property. In addition, the new bridge over the Blackwater River being constructed by CVI will support light trucks capable of carrying small amounts of construction material or small equipment.

Charrette

A charrette was held on December 10, 2007 at the refuge headquarters in Davis, West Virginia. The charrette was attended by employees of the U.S. Fish and Wildlife Service as well as individuals representing the Canaan Valley Institute. The following is a summary of issues and comments developed through the charrette process:

Corridor A – North Rail Grade

Connectivity

- Jeep trail to the east is in very poor condition; extensive wetlands
- A-Frame Road is already maintained – perhaps the trail should connect this facility
- Although the north rail grade itself is shorter than the south rail grade, it is longer when combined with the connecting trails, i.e. Brown Mountain Overlook Trail and Brown Mountain Trail
- Connects to Western Pocahontas land and A-Frame Road

Compatibility with Surrounding Land Use

- Consider the potential for future development north of the refuge

Sensitive Habitat

- Rare plant species are located immediately north of the rail corridor – potential for impact to these species if located near a trail

Visitor Experience

- While a boardwalk through the wetlands on the north rail grade may give the visitor a tunnel effect experience from the high vegetation, it could also provide good birding opportunities
- Provides opportunities for historical interpretation

Corridor B – Jack Neal's Ford

Connectivity

- Overall, provides excellent potential for connectivity to local and regional trail system
- Provides connection to CVI property and Canaan Valley State Park
- Part of a "Valley" trail system, both existing trail network and future trail network
- Better corridor in terms of trail network spacing

Visitor Experience

- This corridor is easier for the public to access
- Greater potential to give more people the refuge experience since it is easily accessible
- Provides opportunities for historical interpretation
- Priceless part of the refuge – the center of the valley

Design

ADA Accessibility

- ADA accessible routes will be provided in the southern portion of the valley
- Consensus among the group that a trail along either one of these rail corridors will NOT be ADA accessible

Trail Width

- CVI uses 2-foot trail for bicycle/pedestrian accommodation – designed to be one directional loops
- The refuge's goal is not limited to providing just one-way loops
- 32-inch minimum for single-track pedestrian only trail (Forest Service Trail Accessibility Guidelines)
- Design trail at least to ATV standards for future maintenance
- A 4-foot minimum needed to accommodate an ATV for maintenance purposes
- 8-foot also accommodates equestrian users
- Consider 4-foot, 6-foot, and 8-foot options

Materials

- Timber is not necessarily accessible for horses
- Consider using carpet or tile glue on timber to prevent skid
- Concern with potential leachate from pressure treated lumber

Use of Fill Material

- Placing fill material in wetlands is not consistent with refuge purpose
- Use of limestone material is not appropriate because it changes the soil pH, making conditions conducive to invasive species
- Consider possibly using existing rail grade itself for fill material
- Use of boardwalk reduces need for fill material

Maintenance

- Will need trail to be ATV accessible for trail maintenance
- Durability is important since the refuge does not have the resources or funding for significant maintenance activities

Other

- Signage should be kept to a minimum
- Refuge staff to complete federally mandated "compatibility determination", including evaluation of compatibility with refuge purposes and refuge system mission for each trail corridor

Pros and Cons of Trail Development

This section summarizes some of the pros and cons of developing a trail along the two corridors based on a combination of field observations and input received during the charrette.

Corridor A – North Rail Grade

<u>Pros</u>

- Raised rail grade on eastern half is in relatively good condition
- Relatively easy stream crossing at Little Blackwater River
- Trail is shorter and traverses less sensitive wetland habitat than more southern rail grade

Cons

- Pristine wetland habitat with rare plant species and sensitive habitat that could potentially be impacted by trail users
- Not readily accessible from Camp 70 or A-Frame Road for construction purposes assuming that construction will require large vehicles or heavy equipment
- May require significant trail improvements and/or new trails to connect a cross valley trail with the existing trail network on both sides of the valley

Corridor B – Jack Neal's Ford

Pros

- Readily accessible from Camp 70 Road and Canaan Valley Institute property to the west for construction purposes assuming that construction will require large vehicles or heavy equipment
- Good connectivity to Camp 70 Road and trails west of valley
- New bridge over Blackwater River at western terminus to be constructed by CVI in 2008

Cons

- More difficult stream crossing at the Blackwater River mid-point along the corridor due to steep/eroded embankment and wider river
- Trail corridor is longer and goes through the center of the largest wetland complex in the State of West Virginia with rare plant communities that could potentially be impacted by trail users
- Rail grade on eastern half is in relatively poor condition due to excavation by beavers
- Will require trail improvements and/or new trails to connect a cross valley trail with the existing trail network west of the valley

Alternatives

In order to evaluate the feasibility of trail development along these corridors, a variety of potentially feasible alternatives were developed in order to evaluate cost, potential impacts, and other factors. Variations among alternatives include the width of the trail, the material used for boardwalk construction (lumber versus plastic), the extent of boardwalk, and trail location. Some of the issues considered and assumptions made when developing these alternatives are discussed below.

Americans With Disabilities Act (ADA) Compliance

Based on input from the U.S. Fish and Wildlife Service during the December 2007 charrette, none of alternatives described below were developed to be in compliance with ADA (Americans With Disabilities Act) standards since the goal of the refuge is to provide ADA accessible trails elsewhere on the refuge.

Trail Width

In general, trail width is largely dependent upon the targeted user groups (pedestrian, bicycle, equestrian, etc.), the anticipated volume of users, and the trail setting. While single-track wilderness trails for pedestrian use or mountain bikes can be relatively narrow, trails intended for two-way travel by pedestrians and bicyclists should be wider to allow for passing. The American Association of State Highway Transportation Officials (AASHTO) guidelines *recommend* a minimum trail width of 8 feet for a shared use trail in order to accommodate both bicyclists and pedestrians. Typical design criteria for pedestrian trails and shared use trails are provided in Appendix A. While the targeted user groups have not been formalized, the following assumptions were made for the Cross Valley trail alternatives:

- A 4-foot minimal typical section will allow ATV's trail access by refuge staff for maintenance purposes.

- An 8-foot typical section is assumed to represent the maximum needed to adequately accommodate multiple users in Canaan Valley including pedestrians, bicyclists, and equestrians because of the relatively low volume of users expected.

- An 8-foot typical section was assumed for improvements to the existing rail grade because 1) the rail grade is of sufficient width to accommodate that width, and 2) trail users may not be able to step off the trail or pull over to allow for passing because of wet areas on both sides of the rail grade.

- A 4-foot typical section was assumed for new trail sections on uplands because 1) the footprint of disturbance is minimized, and 2) trail users will be able to step off the trail or pull over to allow for passing.

- Motorized vehicular use (except ATV's) will not be possible on any of the alternatives presented below because they are all less than 10-feet wide. ATV use for maintenance purposes would be accommodated for each alternative, however.

- For boardwalks, alternatives were evaluated for a 4-foot, 6-foot, and 8-foot typical section.

- For cost estimating purposes, an 8-foot typical section was assumed for bridges to represent the maximum condition. Smaller bridges would be correspondingly less in terms of cost.

Trails in Wet Areas

A variety of trail design options exist for spanning wet areas. These typically include turnpikes, causeways, puncheons and boardwalks.

Simply put, a turnpike is an elevated trail that usually requires some degree of drainage. Drainage is often provided by excavating ditches along the trail. It is frequently built by constructing a "box" using logs, lumber or stone and then filling it with soil, gravel or other pervious material. A causeway is similar to a turnpike but without a ditch. Both of these methods involve the placement of fill material in wetlands for the length of the trail and can potentially affect the water table and alter surface flows. While geotextiles with a larger rock base can be used to improve water flow through the base of the structure, these types of treatments were excluded from consideration for large wetland crossings due to permanent wetland impacts from filling. In part due to their potential for environmental impacts, turnpikes and causeways are most appropriate for relatively short trail sections. At Canaan Valley, the filling of small pockets of wetlands on the existing rail grades, which are basically large causeways, would essentially be re-creating or "restoring" the rail grade causeways. Maintenance requirements are relatively high as the fill material may settle, particularly in areas with soft soils.

Puncheons on the other hand are wooden walkways consisting of a wooden deck placed on stringers to elevate the trail across wet areas. Stringers are supported on mud sills laid in trenches. Mud sills are typically made of logs, treated posts, planks, or concrete blocks. The softer the soil conditions, the more frequent the mud sills need to be placed. Puncheons are not recommended in areas prone to flooding as they may float away. Although more environmentally friendly than turnpikes and causeways, puncheons also result in wetland impacts as a result of the horizontal sills needed to support the stringers and from the shading of vegetation under the walkway.

While puncheons may be feasible at Canaan Valley, they were not considered at this time since, from a regulatory perspective, elevated boardwalks are typically considered the least environmentally damaging alternative when crossing wetland areas. While boardwalks may also result in shading impacts (depending on their height), vertical piling has less fill impact than the horizontal support system needed to support stringers for puncheons. However, additional consideration of puncheons should be given during the design process based on additional geotechnical studies and coordination with state/federal permitting agencies. Maintenance requirements for both puncheons and boardwalks are moderate and depend on the materials used.

Constructability

The remote location and wet soil conditions across the valley render some methods of construction cost prohibitive and they have a bearing on the types of materials that are most feasible to use. The use of extremely heavy equipment for construction is not a viable option for this location. For example, the use of cranes to set a prefabricated bridge in place is not a feasible option. In addition, it is not likely that a pile driver can reach the Blackwater River crossing along the south rail grade to drive pilings into the river. The use of concrete for bridge abutments or bridge decking is also not a very cost effective option because a concrete truck will not be able to readily reach the stream crossing. Small amounts of concrete, however, can be brought in for fair-weather crossings. All of the alternatives developed for this study are assumed to be constructible using smaller vehicles and equipment, and assuming access along existing trails. Once vehicles and/or equipment access the sites, materials may even need to be carried in or shuttled in on ATV's in certain areas. Although the access routes for both corridors were not evaluated in the field, it is assumed that the access route to the south rail grade, through CVI property, is slightly better than access to the north rail grade.

Materials

For purposes of this study, two different material types were considered for structures (boardwalks and bridges): pressure treated lumber and recycled plastic. When considering these materials, there is a trade-off between cost and durability, with plastic generally costing at least twice as much as timber but lasting roughly twice as long. For example, the average life span of a timber bridge is approximately 25 years while plastic bridges are estimated to last approximately 50 years. For comparative purposes, untreated logs of durable wood have a useful life of less than 20 years. In addition to durability, recycled plastic is also considered to be a more renewable and sustainable resource than wood.

Corridor A – North Rail Grade

■ A-1a: Pressure Treated Lumber Boardwalk + Resurfacing of Existing Rail Grade

- Short section of **new 4-foot wide trail (400 feet long)** from Brown Mountain Overlook Trail to floor of valley
- **4-foot, 6-foot, and 8-foot wide boardwalk** options through wetlands on western portion, for a distance of approximately 2,200 feet
- Minor improvements to rail grade through eastern portion, approximately 4,400 feet long, to provide an **8-foot wide trail** section (clearing of vegetation, minor grading, application of surface material such as gravel)
- **8-foot wide and 20-foot long timber bridge** over Little Blackwater River

- A-1b: Plastic Boardwalk + Resurfacing of Existing Rail Grade
  - Short section of **new 4-foot wide trail (400 feet long)** from Brown Mountain Overlook Trail to floor of valley
  - **4-foot, 6-foot, and 8-foot** wide boardwalk options through wetlands on western portion, for a distance of approximately 2,200 feet
  - Minor improvements to rail grade through eastern portion, approximately 4,400 feet long, to provide an **8-foot wide trail** section (clearing of vegetation, minor grading, application of surface material such as gravel)
  - **8-foot wide and 20-foot long timber bridge** over Little Blackwater River

- A-2 Upland Trail On New Location + Resurfacing of Existing Rail Grade
  - **New 4-foot wide trail** north of rail grade along property boundary, approximately **4,000 feet long** through western portion, leading to existing rail grade mid-way along corridor
  - Several short sections of plastic boardwalk over wetlands along new trail alignment, **4-foot, 6-foot, and 8-foot** wide options, total distance of **200 feet**
  - Minor improvements to rail grade through eastern portion, approximately 4,400 feet long, to provide an **8-foot wide trail** section (clearing of vegetation, minor grading, application of surface material such as gravel)
  - **8-foot wide and 20-foot long timber bridge** over Little Blackwater River

- Stream Crossing Options

For cost estimating purposes, VHB assumed a free-standing traditional timber bridge due its constructability and relatively low cost ($50,000). Either timber pier bents or larger timber cribs filled with stone could be placed directly on the stream bottom or adjacent bank and would be the lowest cost options. Given the narrow width of the Little Blackwater River in this location and relatively short length of bridge needed, it is anticipated that the bridge can be designed so that the pier bents or cribs do not have to be placed in the stream itself. If the structures can be cited on the adjacent banks, impacts to the stream bed and to existing hydrology/hydraulics are expected to be minimal. The design life of either option is expected to be approximately 25 years. Other options are described below.

Bridges

- A "timber" bridge could be constructed using recycled plastic, greatly increasing the durability and decreasing maintenance requirements. A life span of 50 years is estimated for a plastic bridge. The cost could, however, as much as triple over the cost of lumber - $150,000.
- A bridge with cast-in-place concrete abutments/wing walls and either a concrete or steel deck would also have a long design life (50 years), and low maintenance requirements, but it would be the most difficult to construct in this location - $90,000.

Fair Weather Crossing

- Involves the placement of concrete pad and/or rip rap on the stream bed – approximately $10,000
- Low cost but would likely require more maintenance than a bridge, particularly after storm events.

Shallow Stream Fords

- Involves placement of small rocks, gravel and stepping stones on stream bed – approximately $5,000
- Least expensive option but may require maintenance particularly after rain events

Corridor B – Jack Neal's Ford

B-1a: Pressure Treated Lumber Boardwalk Parallel to Rail Grade + Limited Resurfacing of Existing Rail Grade

- Minor improvements to rail grade at both termini (clearing of vegetation, minor grading, application of surface material such as gravel) from 1) new bridge at western terminus to first inundated area, a distance of 2,200 feet, and 2) eastern edge of beaver pond to intersection with jeep trail at eastern terminus, a distance of 100 feet. Provide an **8-foot wide trail** section.
- Remainder of rail grade not used for trail purposes
- **4-foot, 6-foot, and 8-foot wide boardwalk** options for approximately 9,000 feet parallel to rail grade
- **8-foot wide and 50-foot long timber bridge** over Blackwater River
- **8-foot wide and 40-foot long elevated boardwalk** over swale

B-1b: Plastic Boardwalk Parallel to Rail Grade + Limited Resurfacing Existing Rail Grade

- Minor improvements to rail grade (clearing of vegetation, minor grading, application of surface material such as gravel) from 1) new bridge at western terminus to first inundated area, a distance of 2,200 feet, and 2) eastern edge of beaver pond to intersection with jeep trail at eastern terminus, a distance of 100 feet. Provide an **8-foot wide trail** section.
- **4-foot, 6-foot, and 8-foot wide boardwalk** options for approximately 9,000 feet parallel to rail grade
- **8-foot wide and 50-foot long timber bridge** over Blackwater River
- **8-foot wide and 40-foot long elevated boardwalk** over swale

- B-2: Major Improvements to Existing Rail Grade

  - Minor improvements to entire length of rail grade that is not inundated (clearing of vegetation, minor grading, application of surface material such as gravel) to provide an **8-foot wide trail** section, approximately 9,800 linear feet total
  - Bring **most inundated areas of rail grade up to existing grade by adding fill** material, approximately 800 linear feet of fill area
  - **Stabilize bank** of rail grade using rip rap for 4,000 feet from the Blackwater River eastward to beginning of beaver pond complex
  - **4-foot, 6-foot, and 8-foot wide plastic boardwalk** options through beaver complex at eastern terminus for a distance of approximately 700 feet
  - **8-foot wide and 50-foot long timber bridge** over Blackwater River
  - **8-foot wide and 40-foot long elevated boardwalk** over swale

- B-3: Combination Boardwalks + Rail Grade Improvements

  - Minor improvements to rail grade that is not inundated (clearing of vegetation, minor grading, application of surface material such as gravel) to provide an **8-foot wide trail** section, a distance of approximately 8,875 linear feet
  - **Fill some small areas** currently inundated through western portion (lower quality habitat), approximately 125 linear feet of fill area
  - **Sections of plastic boardwalk**, **4-foot, 6-foot, and 8-foot wide** options, over some larger areas currently inundated through western portion (higher quality habitat), approximately 1,600 linear feet
  - **Stabilize bank** of rail grade using rip rap for 4,000 feet from the Blackwater River eastward to beginning of beaver pond complex
  - **4-foot, 6-foot, and 8-foot wide plastic boardwalk** options through beaver complex at eastern terminus for a distance of approximately 700 feet
  - **8-foot wide and 50-foot long timber bridge** over Blackwater River
  - **8-foot wide and 20-foot long elevated boardwalk** over swale

- Stream Crossing Options

For cost estimating purposes, VHB assumed an elevated boardwalk bridge for the smaller swale because of its constructability and relatively low cost. The length of this span was increased to 40 feet in order to mitigate potential hydrological impacts.

For the larger crossing over the Blackwater River, VHB assumed a free-standing traditional timber bridge due its constructability and relatively low cost ($130,000). Either timber pier bents or larger timber cribs filled with stone could be placed directly on the stream bottom and would be the lowest cost options. The Hydraulic Engineering Center's River Analysis System (HEC-RAS), a computer software program commonly used by engineers to model the hydraulics of water flow through natural channels, should be used to quantify potential impacts to stream hydraulics as a result of placing structures in the river. In general, the pier bents would be more susceptible to stream scour, but the larger footprint of the timber

cribs would have slightly more environmental and hydraulic impacts. The design life of either option is expected to be approximately 25 years.

Other options for the Blackwater River crossing are discussed below.

Bridge

- A "timber" bridge could be constructed using recycled plastic, greatly increasing the durability and decreasing maintenance requirements. A life span of 50 years is estimated for a plastic bridge. The cost could, however, be up to triple over the cost of lumber - $390,000.
- A bridge with cast-in-place concrete abutments/wing walls and either a concrete or steel deck would also have a long design life (50 years), and low maintenance requirements, but it would be the most difficult to construct in this location - $200,000.
- A prefabricated weathering steel truss bridge would be the most cost effective bridge at this length but it would require a crane for construction, a construction method that is not feasible at this location - $180,000.

Fair Weather Crossing With Bank Stabilization

- Involves the placement of concrete pad and/or rip rap on stream bed - $10,000
- Due to the steep grades on both embankments, timber "steps" and bank stabilization would be required - $20,000
- May require regular maintenance due to continued erosion of the embankment
- This option would be the least expensive but would likely require the most maintenance.

Comparison of Alternatives

Tables 1 and 2 compare the alternatives in terms of cost, ease of maintenance/durability, constructability (including access to the site), potential secondary wetland impacts as a result of shading from boardwalks, and permanent impacts from the placement of fill material in wetlands. In accordance with current regulatory guidance, it is assumed that small diameter piles used for boardwalks do not constitute a "fill" impact. In addition, it is assumed that all boardwalks will have secondary wetland impacts from shading. All values should be considered preliminary in nature based on GIS level information. For purposes of this feasibility study, the wetland impacts do not include temporary construction impacts. All temporary and permanent impacts to wetlands would need to be further evaluated through coordination with the permitting agencies during the permit process.

Table 1 Comparison of North Rail Grade Alternatives

Alternative	Cost	Ease of Maintenance / Durability	Constructability	Wetlands Shaded (ac)	Wetlands Filled (ac)
A-1a: Lumber Boardwalk + Rail Grade Resurfacing (8' Section)					
4-foot Boardwalk for western section (2,200 ')	$326,800	Fair	Fair	0.2	0.0
6-foot Boardwalk for western section (2,200 ')	$480,800	Fair	Fair	0.3	0.0
8-foot Boardwalk for western section (2,200 ')	$986,800	Fair	Fair	0.4	0.0
A-1b: Plastic Boardwalk + Rail Grade Resurfacing (8' Section)					
4-foot Boardwalk for western section (2,200 ')	$546,800	Good	Fair	0.2	0.0
6-foot Boardwalk for western section (2,200 ')	$854,800	Good	Fair	0.3	0.0
8-foot Boardwalk for western section (2,200 ')	$1,866,800	Good	Fair	0.4	0.0
A-2: New Upland Trail (4') + Rail Grade Resurfacing (8' Section)					
4-foot Boardwalk along new trail (200 ')	$380,800	Very Good	Fair	< 0.1	0.0
6-foot Boardwalk along new trail (200 ')	$408,800	Very Good	Fair	< 0.1	0.0
8-foot Boardwalk along new trail (200 ')	$500,800	Very Good	Fair	< 0.1	0.0

Preliminary cost estimates do **not** include survey, geotechnical investigations, design, permitting, or mitigation costs. They also do not include any costs needed to upgrade existing trail networks that provide access to these corridors.

Table 2 Comparison of South Rail Grade (Jack Neal's Ford) Alternatives

Alternative	Cost	Ease of Maintenance / Durability	Constructability	Wetlands Shaded (ac)	Wetlands Filled (ac)
B-1a: Lumber Boardwalk Parallel to Rail Grade					
4-foot Boardwalk	$1,051,100	Fair	Good	0.8	0.0
6-foot Boardwalk	$1,684,600	Fair	Good	1.2	0.0
8-foot Boardwalk	$3,766,100	Fair	Good	1.6	0.0
B-1b: Plastic Boardwalk Parallel to Rail Grade					
4-foot Boardwalk	$1,956,100	Good	Good	0.8	0.0
6-foot Boardwalk	$3,223,100	Good	Good	1.2	0.0
8-foot Boardwalk	$7,396,100	Good	Good	1.6	0.0
B-2: Major Improvements to Existing Rail Grade (8' Section)					
4-foot Boardwalk at eastern terminus only (700 ')	$784,600	Very Good	Fair	< 0.1	0.7
6-foot Boardwalk at eastern terminus only (700 ')	$889,600	Very Good	Fair	0.1	0.7
8-foot Boardwalk at eastern terminus only (700 ')	$1,244,600	Very Good	Fair	0.1	0.7
B-3: Combination Boardwalk + Rail Grade Improvements					
4-foot Boardwalk (2,300 ')	$1,034,000	Good	Fair	0.2	0.5
6-foot Boardwalk (2,300 ')	$1,363,000	Good	Fair	0.3	0.5
8-foot Boardwalk (2,300 ')	$2,454,000	Good	Fair	0.4	0.5

Preliminary cost estimates do **not** include survey, geotechnical investigations, design, permitting, or mitigation costs. They also do not include any costs needed to upgrade existing trail networks that provide access to these corridors.

Wetland s and Water Quality

Since one of the Fish and Wildlife Service's primary goals at the refuge is to protect wetlands, the following section summarizes some of the main wetland and water quality issues associated with development of a cross valley trail.

Impacts

Overall, the north rail grade options result in fewer impacts to wetlands than the south rail grade regardless of alternative. The reason for this is two-fold: 1) the north rail grade corridor is much shorter, and 2) the eastern half of the north rail grade is in relatively good condition. Unlike portions of the south rail grade, the eastern portion of the north rail grade has no pockets of wetlands and it has not yet been compromised by beaver activity. As a result, impacts to wetlands will be limited to secondary impacts from boardwalk shading. One way to significantly reduce wetland impacts is to establish an upland route to the north for the western portion of the trail. Doing so would result in less than 1/3 acre of wetland impacts,

At the southern corridor, all of the wetland impacts associated with a B-1a and B-1b (extensive boardwalk) are from shading. No fill impacts are anticipated at a conceptual level. Shorter sections of boardwalk used for B-2 and B-3 would also result in secondary shading impacts but they are far less than shown for B-1a and B-1b. One point to consider is the fact that boardwalks do not necessarily result in shading impacts. The higher the boardwalk is elevated, the less likely shading impacts are to occur. On other projects, VHB has seen the U.S. Army Corps of Engineers use the following guidelines:

- For a 4-foot wide boardwalk, no shading impacts if boardwalk is elevated a minimum of 4 feet over wetlands;
- For a 6-foot wide boardwalk, no shading impacts if boardwalk is elevated a minimum of 7 feet over wetlands;
- For an 8-foot wide boardwalk, no shading impacts if boardwalk is elevated a minimum of 9 feet over wetlands.

Other factors to consider, particularly for a boardwalk elevated 7 or 9 feet over the wetland, are the safety implications and visual impacts in a place like Canaan Valley. A 4-foot wide boardwalk elevated 4 feet over the wetland system is probably the most feasible scenario. Whether or not this scenario constitutes a shading impact would ultimately have to be determined by the U.S. Corps of Engineers during the permit process.

In terms of permanent fill impacts for B-2 and B-3, a breakdown of impact type is summarized below to clarify how the totals were derived:

B-2:	0.2 acres of fill in all inundated areas of rail grade (total 800 feet) 0.5 acres of fill from riprap to stabilize 4,000 feet of embankment
B-3	>0.1 acres of fill in some inundated areas of rail grade (total 125 feet) 0.5 acres of fill from riprap to stabilize 4,000 feet of embankment

For alternatives B-2 and B-3, the majority of fill impacts are expected to occur as a result of stabilizing the embankment along the western portion of the rail grade. For purposes of this study, it was assumed that the fill material used to stabilize the embankment would extend on average approximately5 feet horizontally into existing wetlands. Other bank stabilization techniques, such as a bulkhead, would likely result in less impacts. However, their effectiveness in terms of deterring beavers from burrowing into the bank would have to be further investigated.

Alternative B-3 has less fill in inundated areas along the rail grade and the fill is placed in areas considered to be lower quality wetlands than found elsewhere on the rail grade. They were considered lower quality because they were relatively small and either exhibited seasonal inundation, had very shallow water, or did not appear to be dominated by hydrophytic vegetation. In fact, these areas may not even be considered jurisdictional by the regulating agencies. Placing fill material in these depressions is not expected to negatively impact hydrologic conditions.

Alternately, inundated areas with higher quality wetlands typically exhibited deeper (and permanent) water, were larger, and supported a variety of aquatic plant and animal species. Alternative B-2 assumes that all inundated areas, including higher quality wetlands are filled. From that perspective, alternative B-2 is more damaging to wetland systems. Furthermore, the placement of fill material in these deeper and permanent wetland systems could negatively affect the hydrology of adjacent wetlands.

For estimating purposes, it was assumed that fill in inundated areas covered a width of 12-feet (8-foot trail surface + 2 foot shoulder on both sides). Once jurisdictional waters of the U.S. (including wetlands) are formally delineated, impacts can be more accurately quantified.

Refuge Goals

One of the U.S. Fish and Wildlife Service's primary goals at Canaan Valley National Wildlife Refuge is to protect its unique high altitude wetland system. Any trail development option that results in a substantial loss or degradation of wetlands is in direct conflict with these goals. It is beyond the scope of this feasibility study to determine what constitutes a substantial loss of wetlands relative to refuge goals.

Permitting

Development of any of the trail alternatives will require a variety of wetland and water quality permits including:

- Section 404 wetland permit from the U.S. Army Corps of Engineers
- Section 401 water quality certification from the WV Department of Environmental Protection
- NPDES stormwater management permit from the WV Department of Environmental Protection

The most rigorous review will be through the Section 404/401 permit process. Since some of the alternatives in the north rail grade have less than ½ acre of impact, they may qualify for a Nationwide Permit. Those alternatives with over ½ acre of impact will need an Individual Permit. However, given the sensitive habitat and pristine wetland communities in the valley, it is possible that the Corps of Engineers will require an Individual Permit for any of the alternatives eventually carried forward.

The goal of the permit process will be to identify the least environmentally damaging and practicable alternative, avoiding and minimizing impacts to the extent possible. For example, if the south rail grade is selected for trail development, one way to minimize impacts to wetlands under option B-1a or B-1b (construction of a long section of boardwalk parallel to the rail grade) would be to construct the boardwalk over the existing rail grade rather than parallel to the rail grade. This would decrease potential impacts from the shading of wetlands. Generally, spanning wetlands with boardwalks will be viewed more favorably than filling existing wetlands.

In addition to potential impacts to wetlands and streams, other factors that will be taken into consideration include potential impacts to threatened and/or endangered species as well as historic properties. Additional investigations/surveys may be required to quantify impacts to all these resources during the permit process.

In terms of compensation for unavoidable impacts, opportunities certainly exist within the refuge for on-site mitigation via restoration in areas that have previously been degraded by human activity. Developing an effective restoration plan will be an important element of the permit process.

Preliminary Conclusions

- While less expensive to build as a stand-alone trail, construction of a trail on the north rail grade could also require significant improvements to the existing trail network that accesses the corridor, potentially increasing costs significantly.

- Access to a north rail grade trail for both trail users and construction does not appear as convenient as access to the south rail grade.

- Developing either of the rail grades will result in temporary and permanent impacts to wetlands, and these impacts may or may not be consistent with U.S. Fish and Wildlife goals to protect wetlands in Canaan Valley.

- Development of the north grade is expected to have fewer impacts to wetlands than development of the south rail grade.

- Development of either rail grade has the potential to impact rare plants and rare plant communities within the refuge.

- The south rail grade provides better regional trail connectivity.

- Beaver activity has severely compromised the integrity of the rail grade along the eastern half of the south rail grade. If the beaver population continues to grow, deterioration of the rail grade is likely to continue at an accelerated pace. If the rail grade is not stabilized, rehabilitation of the rail grade itself through that area will become more costly over time.

- Development of a trail on either rail grade is technically feasible

- Among alternatives, pedestrians (including cross country skiers), bicyclists, and equestrians are accommodated to varying degrees of effectiveness. The final trail design should take into consideration the targeted user groups to ensure that they are adequately accommodated.

Future Actions for Trail Development

As previously described, the U.S. Fish and Wildlife Service must complete a compatibility determination process to evaluate a range of issues associated with a cross valley trail. After this process, if the refuge decides to pursue development of a cross valley trail, other actions that would need to occur include:

- Compliance with the National Environmental Policy Act (NEPA)
- Public involvement
- Agency coordination
- Preliminary engineering
- Additional technical studies such as geotechnical investigations, ground survey, wetland delineation, historic property survey, and survey for threatened/endangered species
- Final design of selected alternative
- Permit acquisition

Appendix A

UNPAVED SHARED USE TRAIL
DESIGN CRITERIA

CRITERIA		REFERENCE
Design User	Group B/C Bicycles & Pedestrians	VHB
Design Speed (D)	15 mph unpaved surface	AASHTO 1999 Bicycle Guidelines
Design Friction Factor (f)	0.10 (50% f for paved surface)	AASHTO 1999 Bicycle Guidelines
Radius Horizontal Curve	125 ft minimum (D=15 mph)	AASHTO 1999 Bicycle Guidelines
Cross-slope	2% 3% maximum super elevation	AASHTO 1999 Bicycle Guidelines
Stopping Sight Distance	Bicycle Height of eye 4.5 ft Bicycle Object Height 0 ft Vehicle Height of Eye 3.5 ft Vehicle Object Height 2 ft	AASHTO 1999 Bicycle Guidelines
Profile Grade	0.3% minimum 5% maximum (ADA compliant) For sustained lengths 8.3% for up to 200 feet w/ 5′ rest intervals @5% 10% for up to 30 feet w/ 5′ rest intervals @5% 12.5% for up to 10 feet w/5′ rest intervals @5%	AASHTO 1999 Bicycle Guidelines Forest Service Trail Accessibility
Length Vertical Curve	Per Table 3 – based on grade difference and SSD	AASHTO 1999 Bicycle Guidelines
Typical Section		
Tread Width	8 ft minimum	AASHTO 1999 Bicycle Guidelines
Shoulder Width	2 ft. graded	AASHTO 1999 Bicycle Guidelines
Shoulder Cross Slope	1:6 maximum	AASHTO 1999 Bicycle Guidelines
Horizontal Clearance	3 ft to obstructions 5 ft from top of slope >3:1desirable	AASHTO 1999 Bicycle Guidelines
Vertical Clearance	8 ft minimum	AASHTO 1999 Bicycle Guidelines
Lateral Clearance	Per Table 4 - based on curve radius on horizontal curves and SSD	AASHTO 1999 Bicycle Guidelines
Structures Width	Equal to width of path	AASHTO 1999 Bicycle Guidelines
Structure Railing	≥36″Vertical Drop, 42″ High Railing Required <36″Vertical Drop, edge curbing may be utilized	Forest Service Wetland Trail Design & Construction (2007)
Trail Surface	12″ Gravel (Locally Available w/in Canaan Valley)	Avail. materials to be Researched

PEDESTRIAN TRAIL
DESIGN CRITERIA

CRITERIA		REFERENCE
Design User	Pedestrians	VHB
Cross-slope	5% Maximum 2% Typical	Forest Service Trail Accessibility
Profile Grade	5% maximum (ADA compliant) For sustained lengths 8.33% for up to 200 feet w/ 5′rest intervals @5% 10% for up to 30 feet w/ 5′ rest intervals @5% 12.5% for up to 10 feet w/5′ rest intervals @5% No more than 30% of the Trail >8.33%	Forest Service Trail Accessibility
Tread Width	32″ Minimum - Single Track 5′ Minimum (ADA Passing Width) 6′ Desired	Forest Service Trail Accessibility
Trail Surface	Firm and Stable 8″ Gravel (Locally Available @ Canaan Valley)	Forest Service Trail Accessibility Avail. materials to be researched
Tread Obstacles	2 in. maximum	Forest Service Trail Accessibility