Chuckanut Community Forest Restoration Design
By: Camille Gsteiger-Cox

(1) **Restore Compact Soils Where Trails are to be Removed or Narrowed**

a. Test soil composition first to determine the most effective/efficient plan of action (optional).
b. Options for Decompaction of Soils Includes:
    i. Shovel- best for small areas that are not too compact (labor intensive).
    ii. Long bar- provides more water infiltration, punches holes into ground, also good for creating holes for plant cuttings.
    iii. Auger- drills 6-12in deep holes, would require temporary trail closure if used on trails that are to be narrowed not closed.
    iv. Excavator/Backhoe- Big and disruptive but may be needed on the extremely compact and wide trails that now resemble roads. (expensive- requires credentials)
c. Make sure that, after decompaction, soils are able to sustain healthy plants. This can be determined through soil nutrient testing.
    i. If soil shows signs or levels of low nutrients workers can till in amendments (wood chips, biochar, biosolids) or green waste (compost).
        1. Areas good to use in: bare soil with plans to establish vegetation (major focus), pathways to be abandoned (major focus), cut and fill slopes, landings, and other bare soil caused by natural or human disturbances.
        2. Areas to avoid: Excessive slopes, bare rock, and/or adjacent to flowing water.
d. Topsoil is expensive.
e. Soils should be left rough not smoothed out. Rough soils aid in slowing water runoff and therefore promotes water infiltration and seed germination.

(2) **Restoring Vegetation (Natives)**

a. Establish reference sites. This will be what the management and monitoring goals are compared to as well as where things may be transplanted from. These sites may differ on intended reference category (i.e., site specific vegetation, trail restoration being done, trail removal being done).
b. Weeding should be done before any other work is done on site.
    i. Mulch is a good way to mitigate weed regrowth.
    ii. Rodeo (herbicide) is EPA approved to be used near water sites (LAST RESORT).
    iii. Weeding is especially labor intensive.
c. Should consult with botanist, soil scientist, native plant horticulturalist, and landscape architect when needed.
d. Implement passive restoration techniques where possible.
    i. Where climate and soil show enough resiliency.
e. Plant small patches of early successional herbaceous plants and shrubs.
    i. Be sure to mark areas physically and keep detailed records (coordinates with stated perspective) of planting site.
    ii. If needed, a temporary fence can be put in place to deter disruption.
f. For redundancy, plant cuttings, seedlings, and rooted stock of the same species as to increase chances of survival and speed up restoration process.
g. Plant variety and plant density should be noted at reference site.

h. When amending soil be sure to use leaf litter refrain from using soil from an adjacent healthy area or from the reference site because it may result in more damage.
    i. Be sure to be specific in where you take the leaf litter from. Taking only from same plant-community type that is trying to be newly established (ferns, herbaceous plants, shrubs, etc. … NATIVES).
    ii. Amendments can be placed directly in planting hole or can be tilled into the soil.

(3) **Structures/Strategies to Deter Use of Closed Trails and Direct Visitors to Sanctioned Trails**

a. Even if soil decompaction is not required along trail tread, it may be best to still till up the tread.
b. Redistributing nearby rocks and logs on and around the tread but NOT directly along the tread.
    i. The whole purpose is for it to look as natural as possible and then eventual the natural surrounding forest will reclaim and restore the area. Covering a path with rocks and logs does not look natural.
c. See vegetation section for planting strategies.
d. Transplanting low value plants at the entrances/exits of the trails can aid in blocking users.
e. Removing trail signage also can help signal that there is no longer a trail there or one that is usable.
f. Disrupting the visible tread is most important where viewers can see out onto the trail. So, ensuring plant growth and debris along that area is more important than in the non-visible areas (for deterring).
g. By making the usable trail look more appealing to users it will attract people to use those rather than the ones that are closed.
h. If needed “Closed Trail”, “This is Not a Trail”, and other similar signage may be needed to be put up. Even a physical barricade may be necessary.
i. Signage encouraging remaining on designated trail may also be needed although should be widely diffused along trails.
j. Distributing new maps through social media and email could also keep people from getting lost and taking trails that are should no longer be used.

(4) **Restricting Visitors on Narrow Trail Treads**

a. In order for initial trail narrowing to be established the trails may need to be temporarily closed using signage and physical blockades or barriers. Similar to those mentions in sec. (3).
b. The use of temporary fencing along either side of the tread would aid in protecting new vegetation establishments along tread.
c. By using the off/slow season as an advantage to help narrow the trad would allow for less labor and more of a passive narrowing to occur.
    i. This means not clearing trails that need to be narrowed after winter (leaf accumulation).
d. Offering classes to educate the community on what is being done to the CCF and why would also help people understand why it is important to stay on the designated tread.

i. In general, spreading the word about what is being done to the CCF and why is important.
    1. Use social media and CCF website to your advantage.
        a. Plenty of young volunteers would be able to take of this.

e. Allow for more regrowth/narrowing than maybe needed in order to be overly cautious of potential widening as well as lessen the desire to travel the path by majority of users.

(5) **MAP**

Consult with a local hydraulic engineer that is familiar with the area. Hydraulic engineer should have the last say on which structures are used for trail-wetland mitigation, they will know what is best.

a. **Trail wetland Mitigation Structures:**
    i. Small temporary bridges/ramps- structurally sound for intended purpose but not built for longevity. They will extend over the worst sections of trail where obstruction of hydrologic connection has been disrupted. Bridge will remain until restoration is achieved and/or can tolerate bike/foot traffic without impeding successful restoration of the area.
        1. Can be made out of less long term material.
    ii. Boardwalk- will be for areas that will only achieve successful restoration if all bike/foot traffic is removed from the ground floor for a long period of time. They will likely cover longer distances along a trail, seeing as how the CCF does not have live streams or rivers but large sections of wetland (see map).
        1. A treated material should be used, and some sort of anti-slip structure should be used in tandem to prevent liability.
        2. Boardwalks are expensive and require a lot of planning and specialized materials depending on location.
    iii. Culverts- There are many different types of culverts depending on what material is used to build them (wood, log, pipe, etc.). They provide a small channel that can connect two wetlands together or just improve hydrologic flow in a small area. They also come in many sizes depending on the need.
        1. Pan on using a closed top culvert that has piping under trail to restore hydrologic flow.
        2. Low cost but does require some maintenance for keeping the culvert clear of debris.
        3. In combination with initial soil decompaction sites where culverts are installed should be able to reestablish healthy sub-groundwater flow.
    iv. Graveled speed humps (low but wide)- These will be used in combination with graveled pathway. They are place along down sloping sections of trails to slow water flow and aid in decreasing erosion.
        1. Relatively low in cost although will need some maintenance to keep up structure.
        2. As of now, have only ever seen them along trail in Florida.

b. **Locations of Structures**:

i. Small bridges will be mainly used as a temporary fix along the secondary tails to allow for soil decompaction to be successful in the most damaged sections. The rest of the secondary trails having as few structures as possible relying solely on initial decompaction and occasional maintenance throughout the years. (see **Map 1.**)
ii. Boardwalk will be place along South West section of the of the CCF in between wetlands CC1 and GG (see **Map 1.**) This will be the only boardwalk built because the entire section of the trail crosses through wetlands, whereas the others do not.
iii. Culverts will for the most part be used along the primary path (see **Map 1.**) in tandem with gravelling the primary trail. A large culvert will likely be needed at the trail intersection that is located in-between wetland KK and JJ1 due to extreme damage to hydrologic connection/flow and deep soil compaction.
iv. Gravel speed humps will be placed along the down slops of the graveled primary trail to slow water flow and allow it time to seep into the ground. (See **Map 1.**)

Note: All locations should be confirmed by a local hydraulic engineer and should ultimately have final say.

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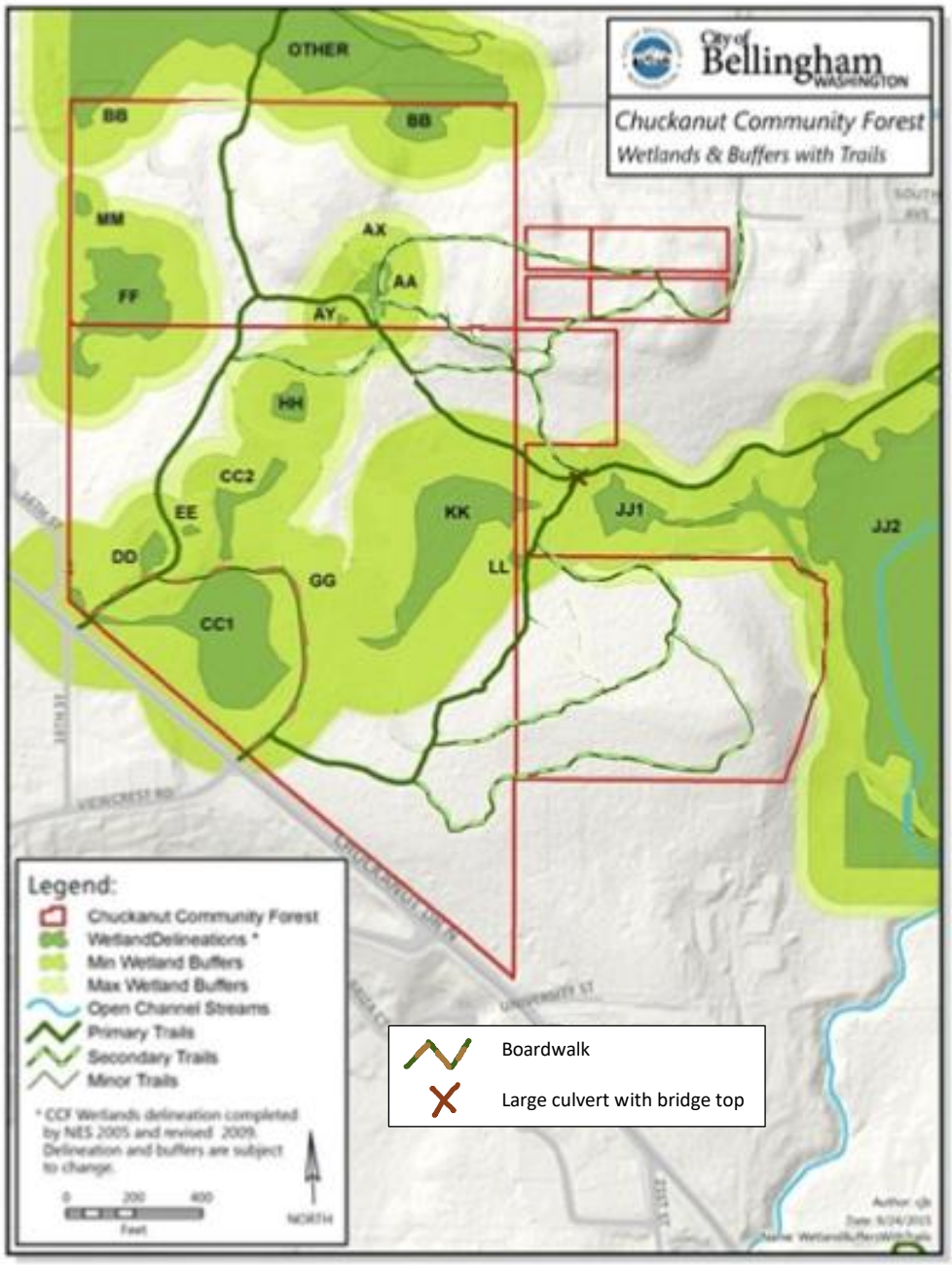
Map 1. ***Proposed Map of Trails and Hydrologic Structures***



(6) **Hydrologic Restoration Approaches**

This approach acknowledges the fact that the primary trails of CCF are heavily trafficked and overtime the ground will become more compact again. So, instead of decompaction strategies having to be applied year after year, requiring trail closure for long periods of time (few days-few weeks depending on compaction extent) the main trail will be widened or narrowed depending on starting width to a uniform width of 8ft.The primary trail will be covered in a thick layer of gravel, culverts will be installed where needed, and gravel humps will be put in place. A boardwalk will be installed using the entrances from Chuckanut Drive N.

a. The intended result from creating such a drastic distinction between the primary and secondary trail structures is that those that want to feel more 'in the woods' will take the secondary trails but those with strollers or wanting to walk in larger groups will tend to keep to the already widened primary trail. The widened trail also offers more safety for you can see what is ahead and behind the user.
    i. The primary trial should be well marked with signs, but the secondary trails should have little signage along the trail and only be well delineated on the map. This is to keep more people off the secondary trails in order to maintain their health for longer.
    ii. Having such a well-defined primary trail will also aid in keeping people off retired trails during the beginning process of closing them and keeping people off of them till regrowth has closed it permanently.
    iii. By making the primary trail 8ft wide it allows for easy passage of bikers and foot traffickers to pass without having to step off the trail. A
        1. pickup truck can vary in width between 6-8ft. If maintenance trucks are needed the primary trail will accommodate their size without any real damage being done to the trail.
            a. It's recommended that vehicles not be allowed on the trail unless absolutely required (for maintenance), never allowed for the public.
    iv. Gravel slows water down and aids with preventing erosion along the trail path.
    v. Will have to consult a local Botanist and land scape architects to ensure no invasive species are introduced with this gravel and which grave type will work best for the intended location and purpose.

b. Different types of culverts varying in size and in material can and should be used along the trails. If restoration is done correctly only the primary trail, which will have the most soil re-compaction, should need culverts placed along it result in hydrologic flow being restored and maintained.
    i. Occasional maintenance of the culverts will be needed to keep the tunnel clear and if the tunnel used is smaller than 9in then a more specialized tool may be needed, the head of shovels tend to be ~9in wide.

ii. Culverts are far more customizable to site specific needs than a bridge would be.
iii. Although piping might be less visually appealing, only the ends should be potentially seen, and the top is more easily bendable into the trail terrain. If pipe is not desired; wood, log, or even stone options are available they just may cost more upfront or would need replacing more often.

c. Small temporary and permanent bridges will be used along the secondary trails as needed.
   i. These bridges should be used sparingly and rely mainly on initial soil decompression to aid with restoring hydrologic flow, where disrupted.
   ii. These will be narrow and fit into the terrain of the wetland landscape.
d. Gravel humps resemble wide and lower to the ground speed humps found on actual roads. These are not intended to slow bikers but actually intended to slow surface water flow to allow a chance for ground absorption along the way.
   i. These decreases puddling at the bottom of the slopes and allows the ground to absorb the water more and have it flow under ground instead.
   ii. An unintended result of these may be that some off-road cyclists may not want to ride along such a trail and so they may go to bike only trails such as those at Galbraith Mt., thus decreasing traffic through the area.
   iii. Unexpensive to make and to maintain.
e. The boardwalk is the most expensive structure of this plan but with everything else being relatively low cost and volunteers being perfectly able to build and install much of the structures there should not be too much strain on the budget.
   i. The boardwalk will extend from one entrance along Chuckanut Drive N., travel along what is now part of the primary trail in between wetlands CC1 and GG, and then connecting to the second entrance along Chuckanut Drive N.
   ii. This boardwalk will need to be built by using the road entrances and then using the boardwalk as its being built as the platform on which the rest is built so not to have to disrupt the surrounding wetland as it is being built.
   iii. Seeing as how the water shouldn't get too high, the boardwalk will not need to be to high up off the ground, and therefore the railings along the boardwalk will likely be optional.
   iv. If gravel were to be placed over this section of the trail, instead of a boardwalk, healthy wetland levels would be hard to achieve and maintain due to the location.

(7) **Monitoring and Evaluation of Effectiveness Assessment**

a. In order to monitor and accurately evaluate the effectiveness of this plan a Standard Operating Procedure (SOP) should be made and used every time an Effectiveness Assessment is done- 1, 5, and 7 years after implementation of restoration design.
b. Assessment should you permanently marked photo points is a good way to measure effectiveness over time.
c. Date of assessments should be done in same growing season each assessment year. So, all done in fall, or winter, or spring, or summer.

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Figure 1. Monitoring and Evaluation of Effectiveness Assessment. The flowing rubric was adapted from Appendix A, Example B (*Woodward, Andrea, and Hollar, Kathy, 2011, Monitoring habitat restoration projects: U.S. Fish and Wildlife Service Pacific Region Partners for Fish and Wildlife Program and Coastal Program Protocol: U.S. Geological Survey Techniques and Methods 2-A11, 36 p*).

Project Name: Chuckanut Community Forest Restoration

Goal(s): Restore compacted soils where trails are to be removed or narrowed, restore vegetation of targeted plant species, maintain narrowed trail treads, restore hydrologic connections between wetlands.

Recreation objective(s): Improve wetland habitat while still allowing public use and enjoyment.

Physical Objective(s): Restore soil conditions and therefore hydrologic connections back to pre-roadway conditions (~70-90 years ago).

Biological Objective(s): Restore native target vegetation abundance and health to pre-roadway conditions (~70-90 years ago).

SMART Objective(s): By year 1 after project implementation, reduce bare ground (where trails where removed/narrowed by X%, increase soil porosity by Y%, increase vegetation by Z%.
By year 5 after project implementation, reduce bare ground (where trails where removed/narrowed by A%, increase soil porosity by B%, increase vegetation by C%.
By year 10 after project implementation, restoration success should be achieved and able to be maintained with ease.

Indicator(s)	**Pre-project conditions and photograph file names**
Soil porosity and compaction, amount of vegetation and distribution, trail flood frequency from users.	Mm/dd/yyyy

	1 Year After Implementation Conditions	**5 Years After Implementation Conditions**	**10 Years After Implementation Conditions**
Desired state during Follow-up visits			
Assessment tool(s)	Visual assessments, permanent photo points, frequent user interviews, soil porosity test	Visual assessments, permanent photo points, frequent user interviews, soil porosity test	Visual assessments, permanent photo points, frequent user interviews, soil porosity test
Estimated state during follow-up: date of visit, description, rough data calculations, photograph file names			
Assessment Results	Desired state (fully, moderately, not) met	Desired state (fully, moderately, not) met	Desired state (fully, moderately, not) met
Are recreational objectives being met?			
Are physical objectives being met?			
Are Biological objectives being met?			
Are maintenance activities occurring as needed?			
Items to check next time			
Comments			