Water Resource Challenges and Opportunities for Resilient Trail and Recreational Facilities

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Purpose



- Trails compete for space on functioning and impaired landscapes.
- Landscape preservation and enhancement can provide valuable <u>ecosystem services and social benefits</u>.
- Identify water resource challenges and opportunities associated with trails & recreational facilities.
- Provide tools and examples to assist with Planning, Design, Construction, Maintenance.



Presentation Objectives



- OPPORTUNITIES
 - Structural
 - Project-specific
- SCOPE OF WORK
 - Water resource efforts in trail planning
- TOOLS OF THE TRADE
 - Desktop
 - FEMA Primer
 - Stream Geomorphology
- IMPLEMENTATION
 - Floods
 - Volunteer scale efforts
 - Funding sources for water resources
 - Inspiring Example Project
 - Chantilly Ecological Sanctuary at Briar Creek

Structural Opportunities



Greenways and Trails Commission Mission Statement

To support and promote the development of an environmentallyfriendly system of connected trails and greenways to improve health, active travel, economic development, and recreation in coordination with towns, cities, communities, businesses, non-profit organizations and adjacent counties.



CCONNECT BUNCOMBE

Making Greenways Happen

Structural Opportunities



• Critical water resource decisions occur at all phases of projects

Planning – Construction – Maintenance

• Do our planning studies adequately identify <u>and</u> guide future navigation of specific WR issues?





As Greenway development along the River is explored in County, flooding considerations will need to be addressed.

- 1. <u>What are specific risks</u>: prolonged flooding/inundation, high flow paths, erosion and sedimentation...? Provide mapping where known.
- 2. <u>Where can the reader get more information</u> does a flood study exist, what format is the flood model in, what other data is available, how can the data be used to inform trail design?
- Inform the reader less about options unless they are site-specific and more about process/next steps – e.g. analysis of ... should be used to identify siting issues and potential risk mitigation.

Structural Opportunities - Planning



In order to obtain a floodplain development permit, a hydraulic analysis and No-rise

certification is needed whenever modifications are made in

the Floodway or Non-encroachment Area of a FEMA-regulated floodplain.

Because of an additional expense of approximately \$10k
 with CLOMR review fee *the detailed designs for the greenway should* weigh the costs and benefits of actions which could avoid

this

more expensive and lengthy CLOMR permitting process.

Projects which are able to demonstrate no-rise may be permitted based on this analysis, but may still require post-project as-built survey and map revision (LOMR) if reductions are significant enough to warrant remapping.

Structural Opportunities



- Land Acquisition is an early & critical phase to be able to address landscape issues, but...
- Early stages challenged by data/depth of analysis

Structural Opportunities



- Collaborate!
- Seek out volunteers that want to take on water projects
- Seek out stakeholders with local water and land issue expertise



Trail maintenance help from local school

Project Opportunities Identify overlapping infrastructure needs







McPherson Park, Greenville, SC



Town Branch Greenway, Asheville, NC

Project Opportunities Design for water



John Favro, Trails Consultant

how the trail affects water flow and how the trail is affected by water...





- contributing drainage area
- erosion sources
- cross slope and shoulder
- seeps/wetlands
- flooding risk
- streambank erosion risk



Evaluate true risk ... probability vs. consequence







"My toddler's favorite playground has been flooded or destroyed."

Project Opportunities Consider life-cycle costs when siting trails





Often you see a trail traversing completely flat terrain. This is usually done because it is easier to build a trail on flat ground than on a side hill where the builder must cut a bench into the hill. Flat terrain is not the place to build a trail.



John Favro, Trails Consultant and American Trails Board Chair

https://www.americantrails.org/resources/ sustainable-trails-doing-it-right-the-first-time

French Broad River Greenway near Hominy Creek Park

Project Opportunities Educate yourself about techniques / practices





Stream bioengineering techniques can be cost-effective and low maintenance



Understand what is it we are trying to protect





- What does habitat or water quality treatment look like?
- Is the trail layout sensitive to existing natural landscape functions?
- Are there adjacent opportunities?



Preserve natural functions

What are the functions of trees and woody debris on the floodplain landscape?

- Should we maintain floodplain greenways as we do parks?
- Compromise: Selected viewsheds and education







The floodplain is the natural place for a river to dissipate its energy





Identify new opportunities

 City parks, lawns, and green spaces have the potential to sequester carbon when properly managed and have the potential to become climate change regulators as urban land managers learn how to utilize the unique conditions present in urban and wildlife urban interface ecosystems.

"Climate of the Southeast United States..." (Ingram et al., 2013)

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Inventory and mapping of Water Resource issues and other opportunities & constraints





 Evaluate stream erosion, stormwater and flood risk to projects – trail integrity & safety





- Analyze trail siting constraints, stream crossings (bridges/culverts), stormwater conveyance crossings, overland flow
- Recommend alternatives for challenging stormwater or riverine issues





- Stream & Wetland (404/401) delineation
 - Delineate ephemeral vs. intermittent/perennial streams
 - Advise on and complete permitting & mitigation requirements
 - Evaluate/coordinate species issues with USFWS- bats, plants and others
- Floodplain management and modeling
 - Prescribe use of available tools/data for planning & design
 - Inundation frequency
 - Risk analysis \rightarrow Probability v. Consequence
 - Permitting considerations
 - Conduct alternatives / iterative modeling to avoid adverse flood impacts
- Erosion and sediment control



• Design and oversee implementation of stormwater management





- Review of land use history
- Vegetation management issue identification





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Desktop Tools

- QL1 Lidar
- ArcGIS Online (AGOL)
- Imagery
- Streamstats



QL1 & QL2 LiDAR



- Eastern NC QL2 (quality level 2)
- Western NC collected using Gieger mode (high density) LiDAR and is a higher quality level (QL1) only because it's <u>8 points per square meter</u> compared to 2 points per square meter for the QL2.
- QL1 and QL2 LiDAR have the same vertical <u>accuracy of within 3 4 inches.</u>

Web link → <u>https://sdd.nc.gov/sdd/NCIDLogin.aspx</u>

Process → Download data, separate bare earth using GIS or CAD tools, plot topography or thin data and then plot



ArcGIS Online (AGOL) is a Lifecycle Tool



plan – communicate – construct – maintain

- Project Planning
- Field Design
 Verification
- Stakeholder Coordination
- Construction Management
- Public Relations
- Research & Development



Field App



AGOL Web Map



Web Application

AGOL – Laurel Creek Greenway Concept 🔊



Planning, Design Verification, Team Collaboration

- Database houses existing and proposed layers
- Use with submeter GPS & bluetooth for high accuracy mapping
- Manage and geotag photos



AGOL - Mouth of Mud Planning Project Analysis, Stakeholder Coordination





WILDLANDS

🖸 Edit ×

ENGINEERING

A story map

AGOL - Reedy Creek Construction App





Online Imagery An invaluable assessment & screening tool





Online Imagery An invaluable assessment & screening tool

ArcGIS 👻 NCDOT Historical Aerial Imagery Index



https://www.arcgis.com/home/item.html?id= 91e02b76dce4470ebd7ec240ad202a04

NCDOT Imagery



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USGS Streamstats Site Hydrology



- Drainage area, land use statistics, USGS regression flows
- Develop flows / flood probability estimates for ungaged streams



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Floods



Make observations and develop take-away lessons

- Create a Design \rightarrow Maintenance feedback loop
 - Trail siting?
 - Crossing and stormwater pipe stability?
 - Overland flow issues?
- Map and track maintenance efforts \rightarrow AGOL






Floods



What should be done to repair, rehabilitate or realign trails

- Repair/maintenance work can be short-sighted
- Periodic review of efforts to assess appropriate future action
- Evaluate flood frequency & watershed hydrology to understand future risk





Volunteer scale efforts



Maintenance



Maintenance shed at Hominy Creek Greenway

Volunteer scale efforts

- Addressing Water Issues is Fun!
 - Maintenance
 - Redesign / Relocation









Funding Sources



- CWMTF Planning & Design/Construction grants
- EPA 319
- NCDEQ Division of Water Resources
- Stream/wetland mitigation (more constrained)
- Pigeon River Fund in parts of WNC
- Local regulations such as compensatory storage offset requirements in floodplains
- Local stormwater program funding



Inspiring Examples:

Chantilly Ecological Sanctuary at Briar Creek



Site Overview









FEMA Buyout of Floodprone Properties



Conceptual Design





FEMA Floodplain





Briar Creek





Chantilly Park Tributary





Storm Water Quality BMPs

Constructed Wetland









Pond



Post-Construction Aerial





FEMA Primer



How can we use regulatory requirements to enhance projects

- Use available data (flood frequency, flood depth, inundation maps) to site trails, NOT JUST GET PERMITS
- Backup data with site observations and talk to people who have witnessed flooding





FEMA Primer



• What is a Floodplain? Floodway? Non-encroachment area?



Figure 1—Floodway Schematic

• More questions: Refer to FEMA 480 – NFIP Study Guide and Desk Reference

FEMA Data Hubs

- HEC-RAS Models
- Flood Insurance and Online Rate Maps (NC FRIS)
- Flood Insurance Study Excertps
 - Profiles
 - Tables

NC FRIS

https://fris.nc.gov/fris/Index.aspx? FIPS=097&ST=NC&user=General%2 OPublic

FEMA Map Service Center

https://msc.fema.gov/portal/home



FEMA Mapping Data



• Shape files for floodplain, floodway, cross sections locations, 100-year WSEs

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FEMA Model Formats



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FEMA Models & Profiles



• Use cross section and profile data in models

(Profiles are also available as .pdf in FIS or through NC FRIS)

• Useful for understanding flood risk, add more frequent Q's too



FEMA Inundation Mapping



100-year flood at Patton Park, Hendersonville, NC



FEMA Inundation Mapping



10-year flood at Patton Park, Hendersonville, NC



Stream Geomorphology Primer

- Streams are influenced by
 - Their valleys
 - Rock, vegetation and artificial hardening
 - Prior straightening or deepening
 - Influence of pipes
- Predictable response to disturbance based on bankfull thoery









Stream Geomorphology Primer





- Bankfull is a physical channel indicator
- Bankfull flow and area can be empirically related to drainage area (regional curves)





Stream Geomorphology Primer Stream stability and evolution



• Stream adjustment is a predictable response starting with incision and influences water quality and habitat



Stage 3: Widening

Stage 1: Stable



Stage 4: Deposition and Stabilization



Stage 5: Quasi-Equilibrium Stable



Steven Yochum, Guidance for Stream Restoration (Version 4), USFS

Stream Geomorphology Primer Stream stability and evolution





Stream Geomorphology Primer Stream stability and evolution





Cluer and Thorne, 2013



