



Subgrade Structures in Restoration Design

Presented by:
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Wesser Creek

- Tributary to Nantahala River
- Top of old downed tree and limbs formed a debris jam
- Riffle has aggraded above the debris and grade drops through jam





Gabriel Creek

- Small creek near Mars Hill College
- Debris jam at least five years old
- Mostly composed of small limbs which are trapping cobble and sediment





Pickett Branch

- Debris jam formed in incised stream
- Trapped sediment has restored bed profile upstream of debris jam
- Bedload is gravel and sand





Bent Creek

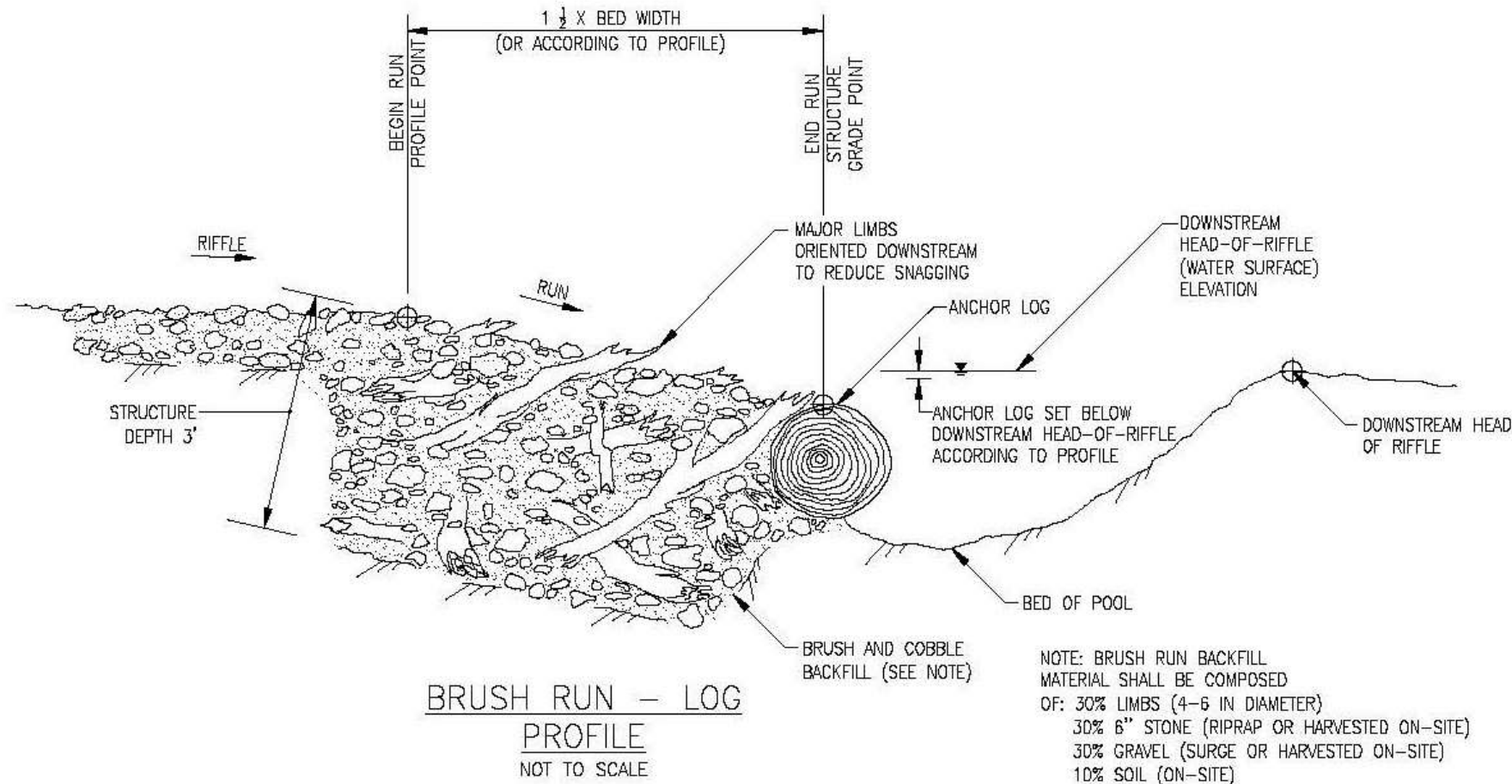
- Small limbs embedded across channel trapping additional small limbs
- Only a small amount of debris, but still affecting the profile
- Multiple profile facets





Brush-run Detail

- Reduces abrupt drop of grade control structures
- Increased roughness
- Simplifies construction
- Can reduce requirement for imported boulders and logs
- Makes better use of onsite material
- Provides long term transition to natural conditions





Cartoogechaye Creek

- Construction: June 2017
- First structure built with flow isolated from main river
- Limbs and brush installed by excavating bed and sinking brush with native cobble
- Site Stats:
 - DA = 38 sq. mi.
 - $Q_{BKF} = 970$ cfs
 - $W_{BKF} = 67$ ft
 - $S_{AVG} = 0.5\%$
 - W/D = 21

 Franklin, NC





Cartoogechaye Creek

- June 2017
- Material buried in rows across the channel bed
- Approximately 20% to 30% of backfill consisted of limbs and brush





Cartoogechaye Creek

- June 2017
- Completed structure prior to release of flow
- Anchor logs placed at downstream end below grade
- Downstream 'V' shape and cross slope to thalweg intended to centralize faster current





Cartoogechaye Creek

- June 2017
- Immediately following connection of flow
- Downstream steeper facet in foreground
- Slightly flatter facet through the structure
- Flatter riffle facet upstream of structure





Cartoogechaye Creek

- June 2017
- After completion of construction
- Bed slope increases from riffle through structure





Cartoogechaye Creek

- July 2017
- Furthest structure at downstream end of project reach
- Larger drop through this last structure
- Three facet slopes:
 - Downstream facet
 - Main structure facet
 - Upstream riffle facet





Cartoogechaye Creek

- Oct 2017
- Following bankfull event in the fall





Cartoogechaye Creek

- February 2018
- Several bankfull and greater events during the winter of 2017-2018
- High baseflow following overbank flow
- Centralized faster current
- Banks intact despite limited protection





Cartoogechaye Creek

- July 2020
- Three years after completion





Cartoogechaye Creek

- June 2022
- Five years after completion
- Incoming sediment reducing facet expression
- Structure naturalizing and becoming part of the river





Peachtree Creek

- Construction:
November 2017
- Two track-hoes working from each bank
- Site Stats:
 - DA = 17 sq. mi.
 - $W_{BKF} = 36$ ft
 - $S_{AVG} = 0.5\%$
 - W/D = 19





Peachtree Creek

- November 2017
- Installed material extended underneath proposed bank
- Brush fill weighted down with native bed material
- Brush component approximately 20% to 30%





Peachtree Creek

- November 2017
- Bed material mix installed
- Prior to reconstruction of banks
- Brush component in this structure is mostly smaller diameter





Peachtree Creek

- February 2018
- Lower central thalweg position helping to collect and centralize flow vectors
- Downstream steeper facet with second facet through the structure
- Banks protected with a coir wrap





Peachtree Creek

- February 2018
- Following overbank storm during construction
- Structure was complete but bank protection matting had not yet been installed
- Structure held well with only minor bank erosion

 Hayesville, NC





Peachtree Creek

- February 2018
- Same structure looking downstream
- No erosion on left bank, even some deposition
- Prompted reconsideration of bank protection method





Peachtree Creek

- June 2022
- 4.5 years after completion
- Incoming sediment has buried some of the structures at the upstream end of the site





Peachtree Creek

- June 2022
- Another structure covered in bed material
- Bed facets still present





Peachtree Creek

- June 2022
- Another structure covered in bed material
- Structure is still influencing the collection and centralizing of flow vectors
- Naturalized bed form





Peachtree Creek

- February 2018
- Structure at downstream end of site following construction
- Larger material included in composition





Peachtree Creek

- February 2018
- Closer view of same structure
- Large protruding pieces were cut down to water surface after this photo





Peachtree Creek


- June 2022
- Same structure 4.5 years later





Peachtree Creek

- June 2022
- 4.5 years after completion
- Structure is still very pronounced
- All three facets still expressed
- Faster central flow and slower flow near the banks

 Hayesville, NC





Paint Fork Creek

- Const: Jan 2021
- Site Stats:
 - DA = 14 sq. mi.
 - $W_{BKF} = 28$ ft
 - $S_{AVG} = 0.3\%$
 - W/D = 17
- Brush pack material carried to top of bank and to the back of the bench
- No coir matting bank protection





Paint Fork Creek

- February 2021
- Brush pack material installed to the back of the bench
- Coir matting bank protection downstream of structure





Paint Fork Creek

- February 2021
- Over-bankfull event during construction
- Faster central flow
- Slower flow along the rough bank margin



Paint Fork Creek

- March 2021
- Following over-bank event
- Deposition in the brush-packed bank material





Paint Fork Creek

- August 2021
- Later the same year
- Following Hurricane Fred





Paint Fork Creek

- June 2022
- Facing upstream
- Fully vegetated banks





Seniard Creek

- Construction November 2020
- Site Stats:
 - DA = 1.3 sq. mi.
 - $W_{BKF} = 17.5$ ft
 - $S_{AVG} = 2\%$
 - W/D = 16
- Constructed over 3000 ft. of main channel
- Constructed 48 structures
- This structure fails two years later





Seniard Creek

- November 2020
- Logs were placed parallel to flow
- Logs were too long to allow proper embedding
- Logs oriented with the flow accelerate velocity and promote sediment movement





Seniard Creek

- June 2022
- Two years after construction



Seniard Creek

- June 2022
- Bed material moved out of structure
- Parallel logs create chutes that accelerate flow
- Logs are not trapping bed material





Seniard Creek

- June 2022
- Bank remains stable despite structure failure
- Scour along bank has exposed buried woody material that is adding roughness
- Dislodged logs adding to flow complexity
- Failed structures potentially offer a source of large wood recruitment



Seniard Creek

- June 2022
- Structure immediately upstream
- No evidence of head-cut propagation
- Failed structure downstream still providing flow resistance





Seniard Creek

- November 2020
- Hanging culvert at upstream end required raising channel grade
- 200-foot-long transition on a 5% grade
- Opted to use same installation technique to construct 200 feet cascade



Seniard Creek

- November 2020
- Constructed from downstream up
- Excavated the sub-grade
- Backfilled with alternating courses of logs, limbs, boulders, and cobble





Seniard Creek

- November 2020
- Backfilled with alternating courses of logs, limbs, boulders, and cobble





Seniard Creek

- November 2020
- Backfilled with alternating courses of logs, limbs, boulders, and cobble





Seniard Creek

- November 2020
- Completed bed without flow





Seniard Creek

- November 2020
- Completed channel
- Material mix carried to back of bench





Seniard Creek

- December 2020
- Immediately follow construction
- Facing downstream





Seniard Creek

- December 2020
- Immediately follow construction
- Facing upstream





Seniard Creek

- August 2021
- One year later
- After Hurricane Fred





Seniard Creek

- June 2022
- Two years after construction





Seniard Creek

- June 2022
- Two years after construction
- Facing upstream





Seniard Creek

- June 2022
- Two years after completion
- Steeper facet at downstream end
- Structure supporting upstream riffle grade



Seniard Creek

- June 2022
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- Steeper facet at downstream end
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Seniard Creek

- June 2022
- Two years after completion
- Steeper facet at downstream end
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Questions?

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