Case Study 1: Mores Creek Floodplain Restoration, Idaho, United States[1]

Purpose of Project: Restore the stream channel and floodplain to improve lateral connectivity and fish habitat, and support the temperature and sediment impairment total maximum daily load (TMDL)

Construction Date: 2006

Total Cost of the Project: Approximately $300,000 USD

Measures Included: Floodplain bench installed to improve stream-floodplain connectivity; streambank stabilization and riparian revegetation; in-channel large wood structures

Multiple Benefits: Increased stream-floodplain connectivity; enhanced fish habitat complexity; improved water quality; expanded recreational opportunities

Project Sponsors/Partners

U.S. Forest Service; West Central Highlands Resource Conservation and Development Council; Trout Unlimited; CH2M HILL (now Jacobs Engineering Group)

Top: Site before restoration

Bottom: Site 2 years after floodplain benching.

Credit: Steve Clayton, Jacobs

Project Description

Mores Creek, a tributary of the Boise River in southwestern Idaho, flows through a 47-square-mile watershed (from the upstream project boundary) primarily on land owned by state and federal agencies such as the U.S. Forest Service. Historical dredge mining disturbed the channel and floodplain, degrading fluvial and ecological processes at the reach and watershed scales. Tailings piles up to 15 feet deep were created throughout the valley bottom, reducing channel-floodplain connectivity and armoring streambanks to limit channel migration. Spawning, migration, and rearing habitat for redband trout and federally listed bull trout was compromised. A TMDL identified temperature and sediment impairment within the watershed. Limited large wood and a general lack of stream channel complexity further impacted aquatic habitat.

Nature-based Solutions Design Approach

The goal of this project was to restore a 6-mile reach of Mores Creek. Major design criteria included:

- improving native fish habitat conditions,
- reducing stream temperature to support the TMDL,
- increasing awareness and recreational opportunities for the local community, and
- incorporating heritage resources into the plan.

The design approach focused on improving overall physical processes, such as channel-floodplain interactions, and implementing structural treatments for habitat complexity to meet Boise National Forest target conditions. Approximately 1,200 linear feet of floodplain benching was performed on river right. Bench width varied, but typical width was 30 feet. Encapsulated soil lifts with brush layers and large wood complexes were installed within the restored reach for streambank stabilization and aquatic habitat. Riparian revegetation used native trees such as willows and cottonwoods, shrubs, and grasses that were harvested onsite.

Several types of background data were collected early in the process to inform the restoration design. Detailed topographic data were collected by surveying cross sections and longitudinal profiles, which were then combined with LiDAR data to create a digital surface. The reach-scale surveys also identified habitat features such as beaver dams, pools, and large wood that could be featured in the overall design. Other data collection included discharge measurements, water temperature recordings, and fish habitat survey data. Using these data, the design reach was divided into geomorphic reaches to identify which sections of Mores Creek required a new channel geometry but could maintain the existing alignment to meet project goals while adhering to land ownership, existing habitat, and project budget.

Analytical channel design was completed using a one-dimensional, steady-flow hydraulic model created in HEC-RAS to simulate existing and proposed conditions, focusing on the 50% annual exceedance probability (AEP) flow. The model was used to perform design iterations to determine a new channel geometry and floodplain elevation that optimized floodplain inundation frequency and duration, balancing calculated channel depth, velocity, shear stress, and mobile particle size. Typical floodplain bench width was set to approximately 30 feet, based on measured conditions at a target cross section. A sediment transport analysis was conducted iteratively using modeled hydraulics from the 50% AEP flow to estimate the potential change in sediment transport (incipient motion based on Shields equation) at each cross section from existing conditions to proposed conditions. Results from this analysis informed design of the elevation and dimensions of the floodplain bench. Two scenarios were analyzed for the proposed conditions – one immediately after the restoration, and another with an increased floodplain Manning's n roughness to represent mature vegetation. Upon achieving results that indicated potential benefits and conditions in alignment with project objectives, the proposed channel geometry was incorporated with fine-scale features, such as large wood placement, to complete the reach-scale design.

Engineering Design Considerations

The key engineering design considerations and constraints included the following:

- The channel was designed so that the 50% AEP flow inundated the floodplain to an average depth of 6 inches, within the range set in the project goals.

- Proposed channel geometries were designed to increase deposition of suspended sediment on the floodplain and slightly decrease suspended sediment transport through the reach upon maturation of floodplain vegetation. Structural treatments, such as willow fascines and large wood, were recommended for the floodplain to increase surface roughness and enhance sediment deposition during overbank flows.

- The project reach was bounded upstream by a road with culvert and along the right by a public campground. Design of new channel and floodplain geometry ensured that the campground property was maintained and that the creek remained accessible to the public.

Ecological Design Considerations

Based on tolerances for bull trout (the indicator species), Boise National Forest used the following management targets as design criteria:

- Number of key pieces of large wood (20 per mile): Logs with a bole at least 20 feet long, 1.5 to 2 feet in diameter, and, for those having root wads, with a root wad span width of at least three times the bole diameter. Spruces were preferred over cottonwood because of their greater longevity. Each log was anchored with at least seven larger rocks, with intermediate diameters two to three times the bole diameter. Trees near the construction site were prioritized for easier implementation and cost savings.

- Number of pools (23 to 39 per mile): The target varied depending on location with the drainage, geology, and other site-specific data. Pools were largely created by the presence of large wood, which was preferred over simple excavation of the pools because the presence of large wood would maintain the pools over time.

In addition to these design features, extensive riparian revegetation was conducted to reduce erosion, shade the stream to moderate water temperature, and provide a seed source for downstream reaches. Trees, shrubs, and native grasses were planted along the floodplain, prioritizing existing onsite species, such as willows.

Operations, Maintenance, and Monitoring

Operations and maintenance were to be performed by the federal partner, U.S. Forest Service. Post-project monitoring was recognized as crucial during design, but specific funding for quantitative monitoring was not secured. Qualitative monitoring such as repeat photography and visual assessments have been conducted. Other monitoring for sediment (turbidity) and temperature has been conducted within the Mores Creek watershed by Idaho Department of Environmental Quality in accordance with its TMDL review.

Lessons Learned

The following lessons were learned over the course of the project, particularly as it relates to nature-based solutions and floodplain benching:

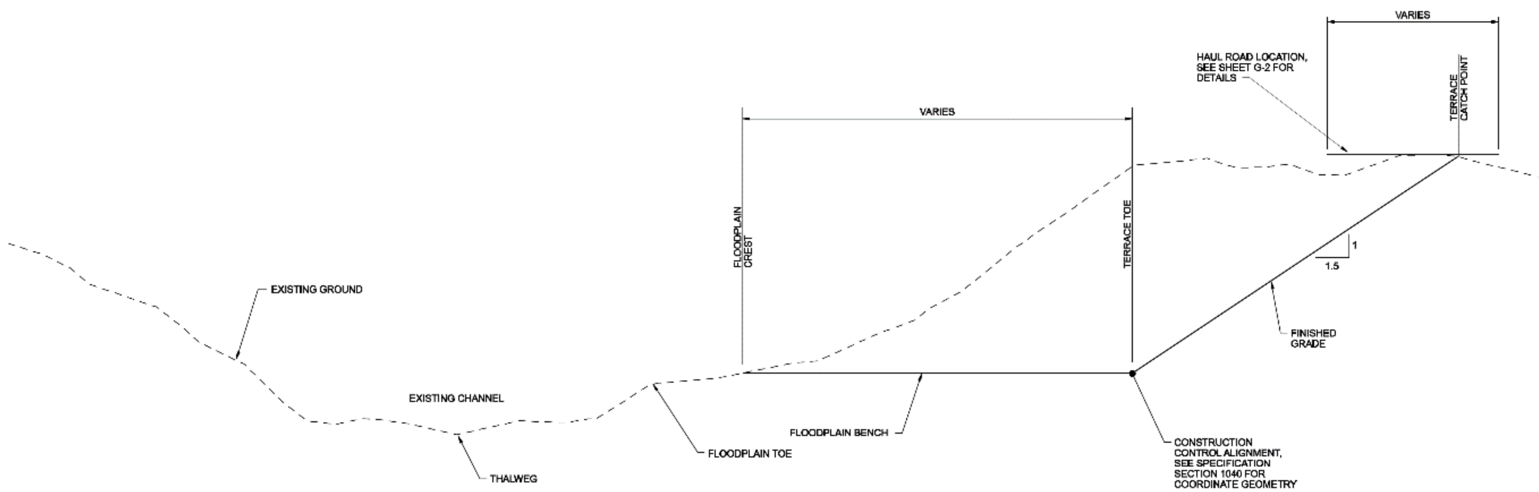
- Dividing the project length into discrete geomorphic reaches based on similar physical and morphological characteristics was useful for developing a suite of restoration techniques to target site-specific conditions such as extreme valley confinement or steeper slopes. Classifying these geomorphic reaches based on whether the channel alignment and geometry were to remain as existing or to be changed allowed designers to focus efforts on more manageable-sized reaches.

- Designing to align with natural physical and biological processes, such as beaver activity, can result in a long-term, self-maintaining system. Beaver dams were included in the calibrated model but were excluded in the proposed scenarios because of their temporary, dynamic nature and to promote a more ecologically conservative approach. This resulted in a lower water surface and, hence, floodplain elevation, which would be more frequently inundated in the presence of beaver dams.

- Engaging the local community, schools, university, and other stakeholders early and often increased project awareness and generated opportunities for public education and involvement with monitoring and volunteering. One stakeholder hired a full-time watershed coordinator to enhance collaboration among agencies and other stakeholders.

Figure 1. Typical section showing the floodplain bench designed for the Mores Creek Floodplain Restoration

Section created by CH2M HILL.[2]



TYPICAL SECTION (FACING DOWNSTREAM)
NTS

Figure 2. Plan view of a portion of the Mores Creek Floodplain Restoration, showing the floodplain bench and structural treatments

Plan created by CH2M HILL.[2]

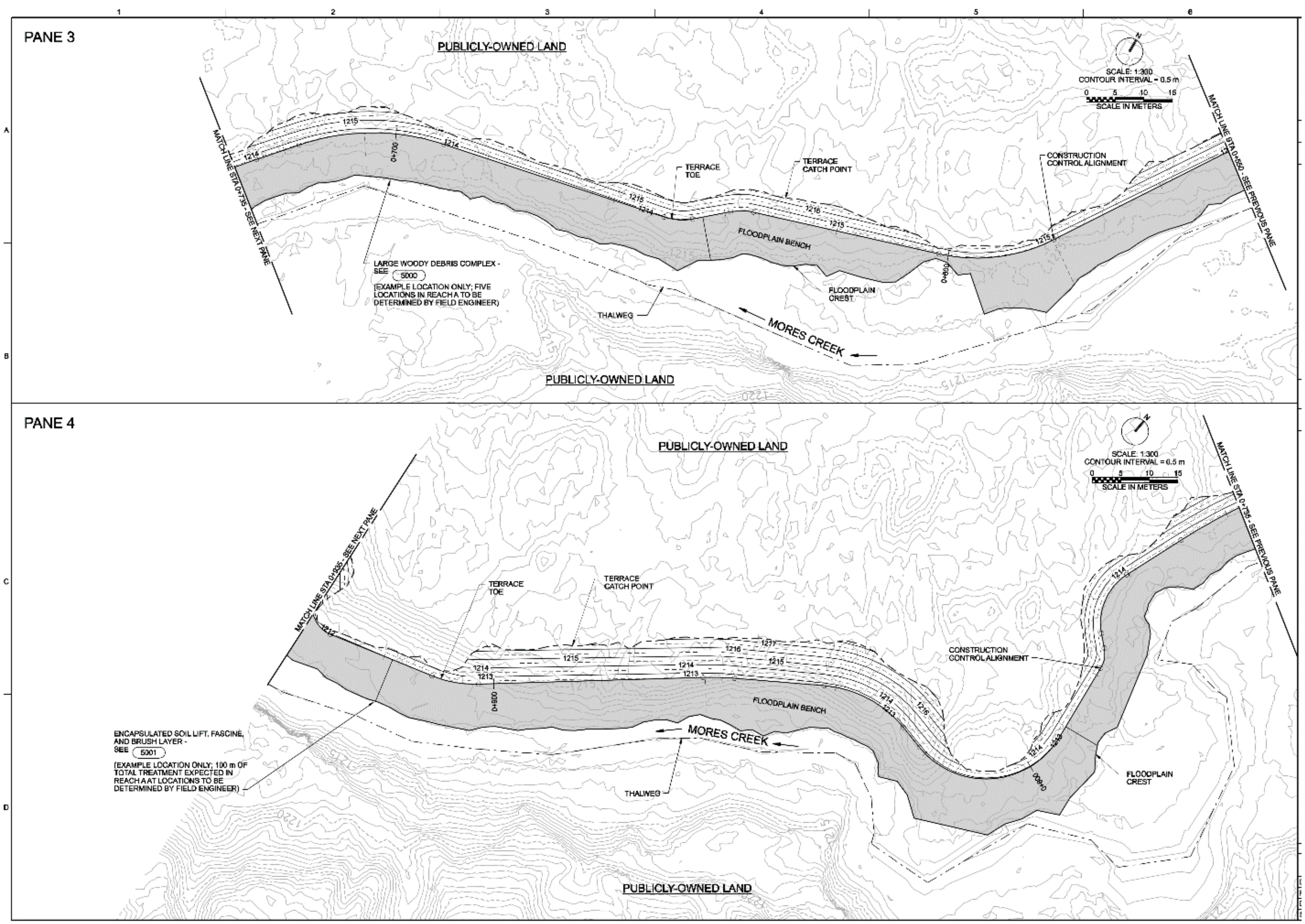


Figure 3. Photo series of the Mores Creek Floodplain Restoration showing a downstream view of the floodplain bench and vegetation. Photos were taken pre-construction (2005; top left), immediately post-construction (2006; top right), 2 years post-construction (2008; bottom left), and 14 years post-construction (2020; bottom right)

Photos shared with permission by Steve Clayton, Jacobs.

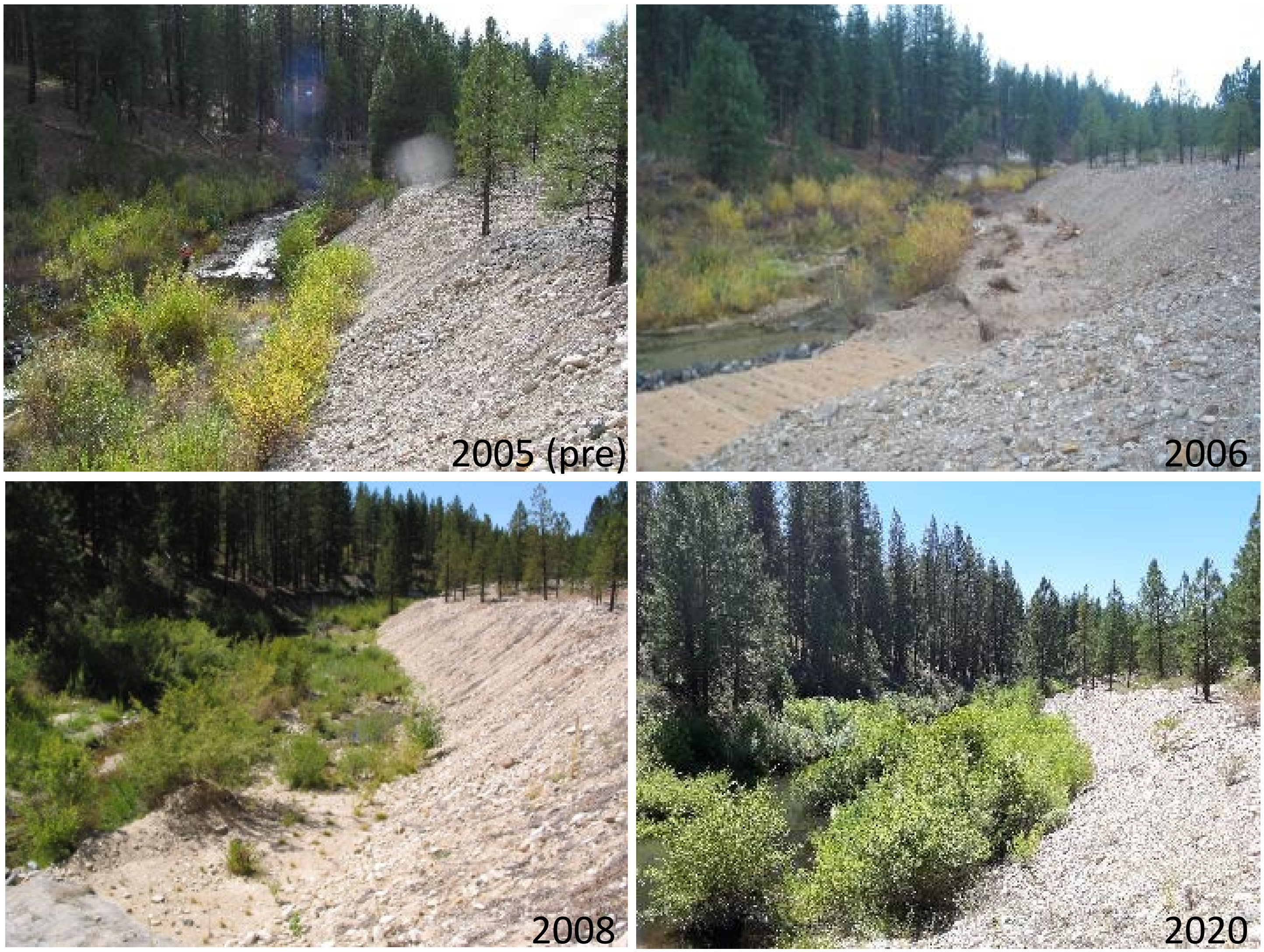
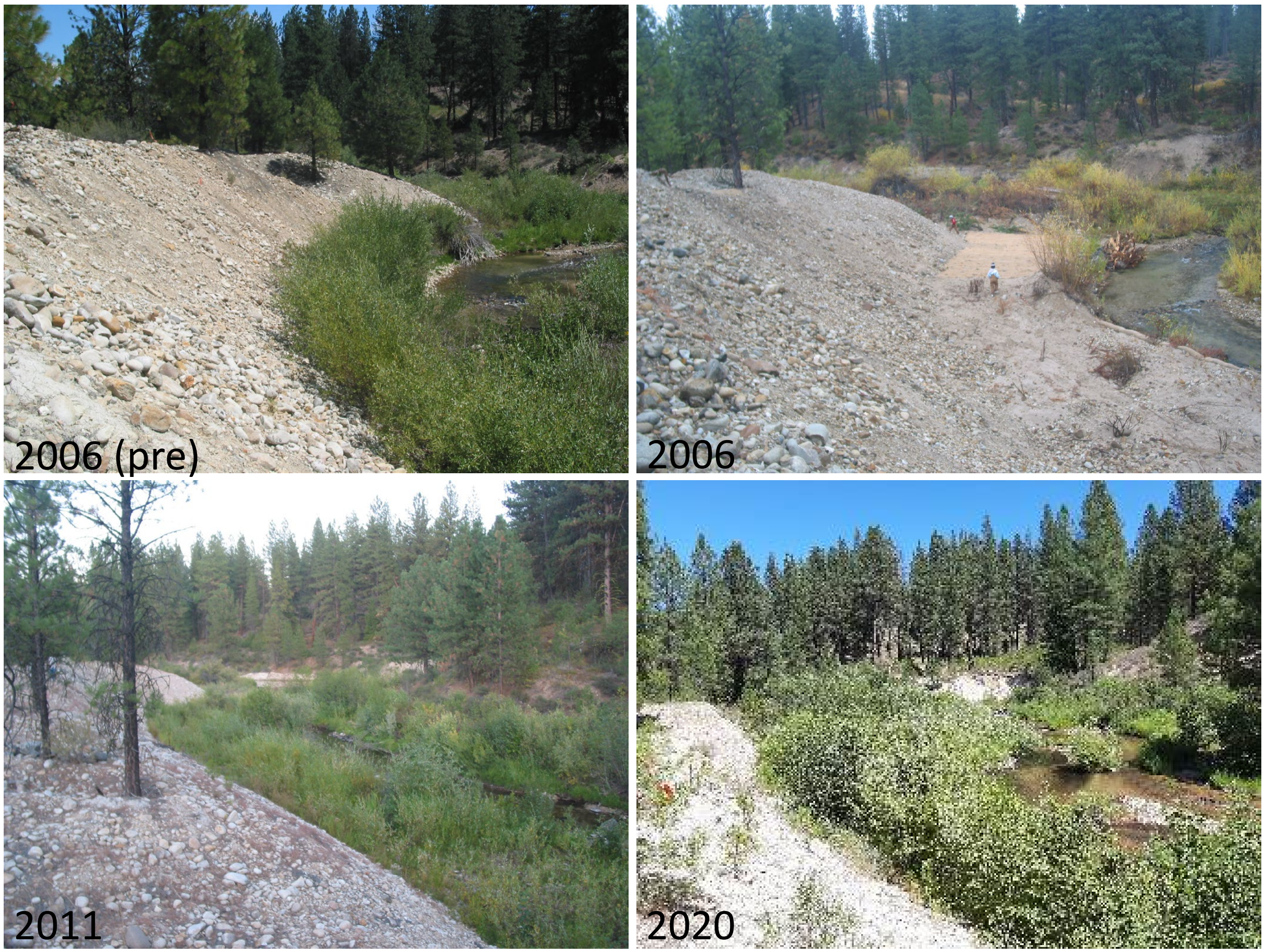


Figure 4. Photo series of the Mores Creek Floodplain Restoration, showing an upstream view of the floodplain bench and vegetation. Photos were taken pre-construction (August 2006; top left), immediately post-construction (October 2006; top right), 5 years post-construction (2011; bottom left), and 14 years post-construction (2020; bottom right)

Photos shared with permission by Steve Clayton, Jacobs.



References

[1] CH2M HILL. 2006. Mores Creek Floodplain Restoration, Conceptual Design. Technical Memorandum 3. Prepared for U.S. Forest Service and West Central Highlands Resource Conservation and Development Council. Pages 1-33.

[2] CH2M HILL. 2006. Mores Creek Floodplain Restoration Project. Final Design Drawings. Prepared for West Central Highlands Resource Conservation and Development Council. Drawings P-2 and G-3.