Emergency Watershed Protection (EWP) Program

2013 Colorado Flood Recovery Phase 2

PROJECT ENGINEERING GUIDANCE

Version 2.1 Final: 01/26/2016

Flood Damaged Stream in Larimer County, Colorado

A Cooperative Effort among Federal, State, County, City, Watershed Coalitions, and Local Organizations.

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

USDA United States Department of Agriculture
Natural Resources Conservation Service

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PURPOSE

The purpose of this document is to provide guidance to NRCS staff, Emergency Watershed Protection (EWP) project sponsors, consultants and others involved in the design of EWP-funded flood recovery projects. This document provides the basic design approach to Phase 2 EWP projects and background information for project design reports for each EWP project.

EWP PROGRAM AUTHORITY

The NRCS's authority to provide technical and financial assistance for natural disasters, including flood recovery projects, is established by 7 CFR Part 624 establishes. The GM 390-14, National EWP Program Manual contains NRCS policy for administering EWP as set forth in 7 CFR Part 624

To assess EWP eligibility, a Damage Survey Report (DSR) must be completed. The DSR is the primary document in the planning process to record all assessments, evaluations and planning decisions for EWP

recovery measures. The DSR must include sufficient information to document eligibility as described in the Program Manual. A preliminary *cost estimate* is included in the DSR for budgeting purposes and to determine an order of magnitude cost. The cost estimate is expected to change during design. Project funding is not restricted by the initial DSR cost estimate; revised project cost estimates may be higher or lower. However, increases to the initial cost estimate will require re-evaluation of the benefit-cost ratio and the sponsor's ability to fund the project, either of which could jeopardize the project.

Unless otherwise approved by the EWP Program Manager, EWP flood recovery projects should be restricted to those where the DSR has been approved by NRCS and the project sponsor.

To better understand EWP eligibility for flood recovery, the following is excerpted from the EWP Program Manual.

Part 513.3 Eligibility for Recovery Assistance, Section D, Eligible Measures. NRCS will only provide assistance for measures that:

- Reduce threats to life or property from watershed impairment, including sediment and debris removal.
- Remove debris deposited by a natural disaster that would affect runoff or erosion.
- Restore the hydraulic capacity to the natural environment to the maximum extent practical based upon pre-event conditions.
- Are economically, socially, and environmentally defensible and technically sound.

Part 511.4 Limitations, Section A. The following are excerpts from the EWP Manual for work that is expected to be encountered for Phase 2. For complete list of limitations, refer to the manual.

EWP program **funds may not be used to:**

- Perform O&M, such as the periodic or routine work necessary to maintain the efficiency and effectiveness of a measure to perform as originally intended (e.g., removing sediment or debris from reservoirs or debris basins)
- Increase the pre-disaster capacity of a channel by constructing a new channel, enlarging the old channel, or relocating the stream. Modifying the channel based upon regional curve data [or engineering hydrologic analysis], which maintains the same channel capacity upstream and downstream and is necessary to stabilize the channel, is allowable. Sediment and debris removal is not considered new construction.
- Solve watershed or natural problems that existed prior to a natural disaster.
- Repair, rebuild, or maintain public or private transportation facilities (e.g., roads, bridges) or correct damage to transportation facilities administered by Federal Highway Administration, Department of Transportation.
- Landscaping practices exclusively for aesthetic purposes.

SCOPE OF WORK

Engineering services are needed to implement flood recovery measures within riparian corridors impacted by the September 2013 flooding. The scope of engineering assistance required for eligible EWP projects should include:

- Visiting the site, recording field notes, taking photographs, and observing site conditions;
- Developing a conceptual plan (15%) of proposed work to share with stakeholders;

- Obtaining necessary survey data to design the project;
- Gathering basic design data through field work and research;
- Providing a *design report* (see *A1: NRCS Design Report Guidance*);
- Preparing engineering designs, construction drawings and specifications, construction cost and construction time estimates;
- Preparing an Operation and Maintenance (O&M) Plan, and Quality Assurance Plan (QAP);
- Obtaining NRCS conceptual and final design review for projects designed by or through a sponsor (see *A2: DOLA/CWCB 30% Design Guidelines*). A 30% Design may be acceptable for fast-track and design-build projects, if required permits and land rights are in place.
- Performing construction observation and quality assurance tasks; and
- Coordinating work with State and NRCS representatives.

QUALIFICATIONS AND APPROVAL PROCESS

All EWP engineering work must be performed under the direction of a Colorado licensed, Professional Engineer. Design approvals should follow NRCS policy.

NRCS design approval process is outlined in GM 210-V, National Engineering Manual (NEM) Parts 505 and 511 and stated in the Cooperative Agreement between NRCS and the project sponsor. Before project construction, NRCS must perform a functional design review for work prepared by non-NRCS engineers. For more complex designs (NRCS Job classification of VI or greater), predesign conferences must be held with representatives from NRCS, the project sponsors, owners, and the engineer. Projects containing any one of the following are considered class VI or greater:

- Channel bed stabilization work with a design flow of 2,000 cfs or greater, or velocity of 12 ft/s or greater.
- Streambank protection work with bankfull flow of 20,000 cfs or greater, or velocity of 12.5 ft/s or greater.
- Sediment control basins over 15 feet high.
- Any design project that could result in loss of life if it failed.

Projects designed by NRCS employees and affiliates shall be classified, reviewed and approved according to NRCS policy described in NEM Amendment CO18, March 2006, Part 501, Subpart A, REVIEW AND APPROVAL. Projects designed by NRCS staff and affiliates require approval by the NRCS engineer with the appropriate level of delegated job approval authority for the projects being approved.

FINAL REVIEW & APPROVAL

When the sponsor is responsible for design work, the sponsor will make final review and approval of project designs with NRCS concurrence.

DESIGN OBJECTIVE

EWP projects must reduce threats to life or property by mitigating future flooding or erosion concerns caused by the disaster. EWP projects must demonstrate:

1. Combined beneficial effects exceed combined adverse effects;
2. Compliance with Federal, State, County, Tribal, and local laws;

3. Acceptance from affected individuals and communities;
4. Effectiveness in restoring or protecting the natural resources;
5. Achievement of desired outcome; and
6. Economic, environmental, social and technical defensibility.

Projects may be planned to provide temporary or permanent protection. Projects may include elements that meet EWP design objectives, and components constructed without EWP assistance.

DESIGN STANDARDS

Design guidance is described in NRCS Conservation Practice Standards (CPS) available in Section IV of the NRCS Field Office Technical Guide (eFOTG). The following Conservation Practice Standards are most likely to apply to flood recovery work. Note: the numbers following the practice title are the CPS number, such as CPS 584 for Channel Bed Stabilization.

- Access Road (ft), 560 – use for sites where a temporary access road is required to get to work site.
- Aquatic Organism Passage (ac, cy), 396 – portions of this may apply to channel work.
- Channel Bed Stabilization (ft), 584 – applies to in-stream structures that span the streambed.
- Clearing and Snagging (ft), 326
- Critical Area Planting (ac), 342 – applies for re-vegetation along streambanks.
- Mulching (ac), 484 – for all disturbed areas outside of the normal flow channel.
- Open Channel (ft), 582 – use in locations where a complete new channel is proposed.
- Riparian Forest Buffer (ac), 391 – use where forested areas were destroyed by flooding and required to stabilize the soil.
- Riparian Herbaceous Cover (ac), 390 – applies to herbaceous plantings within stream corriders.
- Sediment Basin (no), 350 – applicable for sediment basins required in design or for erosion and sediment control.
- Shallow Water Development and Management (ac), 646 – portions may apply to floodplain areas.
- Stormwater Runoff Control (ac), 570 – applicable to erosion and sediment control plans.
- Stream Crossing (no), 578 – may be necessary where a compelling reason exists to provide one.
- Stream Habitat Improvement and Management (ac), 395 – provides guidelines for improving stream habitat during restoration work.
- Streambank and Shoreline Protection (ft), 580 – this practice standard is applicable to most EWP sites.
- Structure for Water Control (no), 587 – may apply to work on or around irrigation diversions.
- Wetland Restoration (ac), 657 – may be applicable for some floodplain restoration portions of designs.

Other practices may be used as determined necessary by the NRCS project representative or Sponsor.

Other design references include:

Additional design standards and guidance can be found in the following references:

NRCS. 2014, 27.3. Colorado NRCS Engineering Technical Note 27 - Guidance for Stream Restoration. NRCS. Denver, CO.

NRCS. 2008. National Engineering Handbook Part 654 - Stream Restoration Design. USDA - Natural Resources Conservation Service. Washington, D.C.;

NRCS. 2008. National Engineering Handbook Part 650, Chapter 13, Wetland Restoration, Enhancement or Creation.

Hoag, Chris and Jon Fripp. 2002. Streambank Soil Bioengineering Field Guide for Low Precipitation Areas. USDA - Natural Resources Conservation Service Plant Material Center. Aberdeen, ID.

NRCS. 1996. National Engineering Handbook Part 650, Engineering Field Handbook, Chapter 16 - Streambank and Shoreline Protection. USDA - Natural Resources Conservation Service. Washington, D.C.

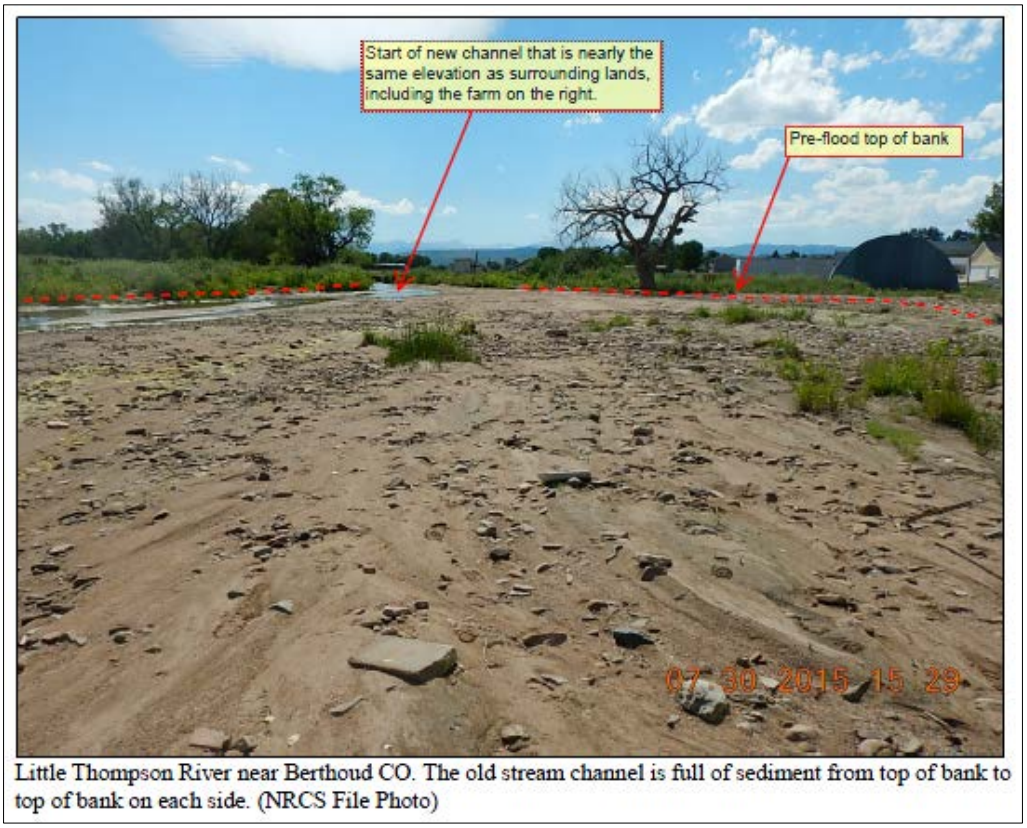
For Additional Tools, Spreadsheets, Related Links, Publications, and Stream Restoration Treatments, go to: NRCS Stream Corridor Restoration.

DESIGN APPROACH FOR FLOOD RECOVERY PROJECTS

For work covered by this guidance, the **level of protection*** provided will be limited to the 100-year pre-flood flow or up to the extent of protection that existed before the flood, whichever is lower. For example, for a sediment removal site, if a value at risk would flood at 400 cfs before the flood, and it will flood at 100 cfs now because the channel is full of sediment, then EWP could pay for excavating enough sediment to restore the 400 cfs capacity. Where channel shaping is required, the designer should use a multi-stage channel cross-section to include a low flow channel, bankfull channel, protected streambanks, and a riparian zone up to the level of protection existing before the flood. Where necessary to restore channel capacity or to protect life and property, bankfull floodplain benches may be extended or restored. Using a proper width to depth ratio for the stream type and flow improves sediment transport, which makes a more functional channel. Upland areas are only included if they pose additional risk to life and property. The cross-section (see *Figure 1*) shows the six major riparian zones and primary flow stages.

* Level of protection may be increased beyond that authorized by EWP when paid for separately by non-EWP funds. Work beyond the scope of EWP must be shown and accounted for separately by design and construction documents so that EWP-funded work can be clearly discerned from additional work.

The goal is to reduce the erosion or flood risk by restoring the stream to a naturally stable condition whenever feasible and practical. In some cases, this will be the pre-flood condition, when those conditions can be determined. In many cases, the pre-flood boundary conditions are so different that they would not work in the current river systems. Before the flood, sediment loads were much lower than they are now. There are also many locations where the entire floodplain is several feet higher or lower than previously. On the Little Thompson River near Berthoud, the river channel filled from bank-to-bank with sediment, effectively raising the streambed to the elevation of surrounding land (*see Photo 1*).



Little Thompson River near Berthoud CO. The old stream channel is full of sediment from top of bank to top of bank on each side. (NRCS File Photo)

Photo 1 - Example of excessive aggradation entirely filling the pre-flood channel

The following is a suggested design approach for most EWP flood recovery projects that include stream restoration features:

1. Review conceptual design with a stream restoration engineer or fluvial geomorphologist to confirm design concept and the appropriateness of implementing the desired restoration and stabilization measures, which may include:
   a. Bank reshaping, including a bankfull bench;
   b. Wood revetments for bank stability and habitat improvement;
   c. Re-vegetation practices (vegetation is most enduring and ecologically valuable);
   d. Bioengineering (combination of plantings, biodegradable materials, and bank shaping);
   e. Floodplain restoration, including debris removal, sediment removal, fill, floodplain flow capacity, grading, and re-vegetation.
   f. Channel shaping and bed stabilization, including considerations for these flow stages: low, bankfull, and flood.
   g. Riprap or alternate channel bank erosion protection measures.

2. For the hydrologic and hydraulic analysis of the channel, use the appropriate *design flows* for each project reach, considering at least: low flow, bankfull, and floodplain. Use the best data available, including reference reaches, geomorphic indicators, regional curves, regression analysis, USGS gage data, and other information. In the absence of better information, the low flow could be estimated from 7-day, 10-year low flow data; *bankfull flow* estimated as the flow with a return

interval between 1-2 years; and floodplain flow could be based on a 100-year flow from hydrologic reports recently completed by CWCB and CDOT. The hydrology reports are available at: Post-flood Hydrology Reports.

3. Obtain cross section and longitudinal profile geometric data.
   a. Field collected or LiDAR data may be used as approved by the *project engineer*.
   b. Compute slope from longitudinal profile, survey data, or other available information.
4. Estimate Manning's n. Use bed particle-size based estimate if adequate data is available, otherwise use photographic guidance documents, other available publications, and professional judgment.
5. Use the most appropriate hydraulic equations to determine discharges and velocities at the project site.
   a. Use velocity and shear stress to determine the best streambank protection materials. In-stream structures may also be used to deflect flow away from banks.
   b. Use estimated water surface elevations plus freeboard (≥ 1 foot) to set the top elevation of protective measures for the bankfull channel.
6. Consider using a *bankfull bench* if substantial bank shaping is planned to shift channel away from a property of concern:
   a. Use the *bankfull flow* to size the main channel and bankfull cross-section;
   b. Use the most appropriate methods to protect the toe and streambanks to provide the most natural appearance. This may include a combination of various measures, including bioengineering, rock toe, toe wood, reinforced earth, rock riprap, revegetation, or wood revetments;
   c. For incised streams and streams with tight site constraints, the bankfull bench width should be at least 10% of the design bankfull width, or a minimum of 5 feet.
7. Use smooth transitions, with bank protection keyed into undisturbed surfaces (or other stable locations) upstream and downstream of the project site. Bank protection on bends should extend the full length of the bend from the point of curvature (PC) to the point of tangency (PT). Common key-in features for ends of protection include boulders, fully vegetated banks, trees, willow thickets, existing riprap, and other stable banks. Work should also be keyed into the bank perpendicular to channel centerline at each end of the protection, and vertically into the streambed to a depth determined from scour analysis.
8. Evaluate potential negative impacts to opposite banks, flood elevations, channel capacity, upstream, and downstream.

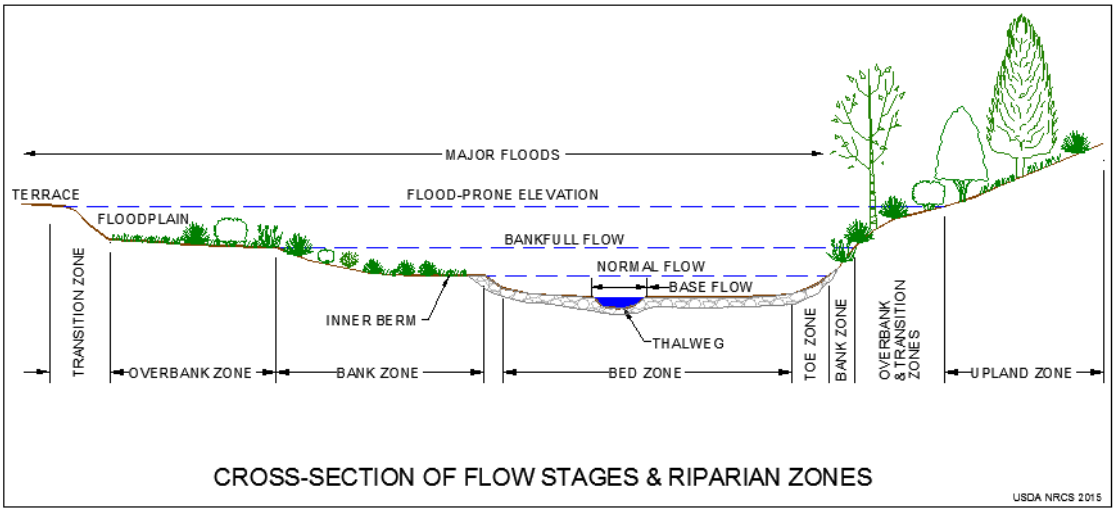


Figure 1 - Cross Section of Flow Stages and Riparian Planting Zones

Vegetative protective measures should use seed and plantings best suited for riparian zone, climate, and elevation. The use of biodegradable *erosion control fabric* is recommended to stabilize streambank soils until plantings can establish. Erosion control fabric would normally be used on banks between normal and bankfull flow levels.

BASIC DATA FOR PROJECT DESIGN

The engineering design folder should include all the data used for design decisions. As a minimum, this should include the following as listed under each design component.

Site Contacts and Project Information. Early in design, confirm and document the following information directly in the design record or otherwise included by reference to another document(s):

- Project contact information for:
  - NRCS project lead,
  - Designer,
  - Sponsor(s),
  - Owner/Decision maker
- Damage Survey Report;
- Project location;
- Project objective and existing flooding risk;
- Land rights/easements & permitting status;
- Local funds availability; and
- Selected construction contracting method(s)

Topographic Information. For in-stream flood recovery, gather data to describe the longitudinal profile and estimate the channel slope over a distance of about 10 times the design bankfull channel width

upstream and downstream of project (e.g., a stream with a bankfull width of 40 ft would require a longitudinal profile of at least 800 feet). When possible, the stream profile should start and end at the head of a riffle. Topographic information should include: right edge of water (REW), left edge of water (LEW), thalweg (TW), pools, riffles, bankfull indicators (BKF), existing bank tops and toes, scour holes, headcuts, bedrock ledges, major depositions, restricting features, constrictions, nick points, key elevations of structures being protected, and other data required for design. If multiple channels exist (braided), obtain the water surface elevations at edges for the channel carrying the most flow. Provide survey dates with the data so that gage data can be correlated with the flow on the day of survey. Also see the requirements of Appendix A2, which requires wetland delineation.

Collect topographic information to define cross-sections of the site as needed for the hydraulic analysis and to define the riparian zones shown in *Figure 1*. Extend cross-sections to capture at least the full width of the floodplain. If pools are present, obtain one or two representative pool cross-sections.

Most potential EWP sites have LiDAR (Light Detection and Ranging) topographic data at sufficient resolution to develop a 1-meter DEM (digital elevation model) and 1-foot contours. Where available, LiDAR data can provide the base topographic information, including cross sections and longitudinal profiles. LiDAR data from 2013 is available at: 2013 LiDAR Data. When available, NRCS will provide links to the most current LiDAR data.

Set at least three **control points** (CP) for return site surveys, construction, and monitoring. The control point should consist of a 5/8" or larger rebar, an existing benchmark, or other semi-permanent and stable marker. Include a sketch of control point locations in survey field book with measurements from landmarks to help locate in the future. Use survey-grade GPS equipment to obtain latitude, longitude, and elevation for benchmarks and control points with OPUS corrections as needed.

Hydrology. Use the best available data and field surveys to assess the hydrology and design flow rates. At a minimum, use the design bankfull and 100-year flow to evaluate capacity and stability of the bankfull channel and floodplain, respectively. Use engineering judgment and best available data to establish low flow rates. For hydrology and hydraulic calculations (for design use), use **revised post-flood data** where available. However, the provided protection will still be based on pre-flood data, where available. In other words, the design analysis will need to show pre-flood flows to establish the channel capacity that can be provided by EWP funds, but the channel, structures, and protection measures have to be designed to survive the revised post-flood flows. So, when checking shear stress, scour, rock stability, and velocities, the design must be able to withstand the more stringent conditions between pre-flood flows or post-flood flows. If there are situations where the engineering analysis requires protection beyond pre-flood flows for survivability, the EWP Program Manager will make a determination with regard to the level of protection that is acceptable.

USGS StreamStats regression equations are available for flow frequency analysis, but should not be used as the only source of information.

Hydrology and hydraulics guidance was also issued from the State of Colorado in: Memorandum on H&H, 9/21/2014. This document contains information regarding the "no-rise: certification requirements.

USGS Gage data is available at: USGS Water Watch.

Hydraulics. Hydraulic analysis should include data required under the hydrology and hydraulics section of the attached design guidelines (*A2: DOLA/CWCB 30% Design Guidelines*), as minimum. The design record must document the methods, assumptions, input parameters, and output results.

If normal flow conditions can be assumed, an EXCEL based spreadsheet tool, xsecAnalyzerVer15.xlsm, can provide the appropriate level of analysis for most sites. Complicated sites or projects may warrant the use of more sophisticated software such as HEC-RAS, RiverMorph, or other hydraulic modeling programs. When applicable, supercritical flow conditions should also be evaluated.

Hydraulic analysis should use the Manning's n factor that best represents the channel boundary conditions. Consult with a hydraulic engineer or hydrologist with expertise in channel flow resistance to help select the most appropriate Manning's n value. Two suggested references for estimated Manning's n values are: USGS Verified Roughness Values, and USGS Water Supply Paper 1849.

Geotechnical. Flood recovery designs must consider the on-site soil characteristics. Design reports should identify features and assumptions related to:

- Soil classification and engineering properties;
- Presence of bedrock in the streambed or at nick points;
- Degree of saturation and phreatic conditions;
- Presence/absence of soil layering; and
- General slope stability characteristics.

Where riprap is planned, the designer must determine the need for a filter, soil separation, or bedding component under riprap.

Determine and document the gradation of streambed particles using the *Wolman Pebble Count* method, gradation by a soils lab, or sieve analysis. For simplicity and standardization of data, the pebble count is the preferred method. Obtain the pebble count from a riffle section. Use this data for hydraulic calculations. The most important particle sizes are the D_{50}, D_{84}, and D_{100}. Alternatively, the method outlined in USFS RMRS-GTR-74 (2001) is also acceptable.

If deemed necessary by the designer, collect and analyze point bar samples to assist with sediment transport analysis.

The predicted or known reason for streambank failures should be documented. Failure modes will help determine the most effective restoration method. Example streambank failure modes include slope instability, failure of bank material, or sapping. If the reason cannot be determined, document as undetermined.

Rock size and gradation limits for toe revetments can be determined from methods in the NRCS Technical Supplement TS14C, Stone Sizing Criteria, Part 654, National Engineering Handbook.

Typically when the ratio of $D_{15\text{-riprap}}$ /$D_{85\text{-subgrade}}$ is greater than 5, a filter is required between the subgrade and the riprap. Consider using sand/gravel bedding as an alternate to geotextile on sites where machine placement of rock is likely to damage the geotextile. NRCS National Engineering Handbook, Part 633 Soil Engineering, Chapter 26 – Gradation Design of Sand and Gravel Filters is the recommended reference for filter design.

Geotextiles may be used as a filter material between rock revetments and the natural bank material where the rock can be placed without damaging the geotextile. It is important to have the ground well prepared for the geotextile, and the geotextile itself well anchored to prevent movement before rock placement. Limitations on the maximum height of rock drop should be stipulated by the designer and followed by the contractor. Geotextiles should have permeability 100 times that of the soil subgrade.

Rock-fall and landslide treatments should be planned and designed by qualified geotechnical engineers in cooperation with a geologist skilled in identifying and mitigating such hazards.

Structural. Structural revetments (concrete walls, & similar structures) should be analyzed for stability (overturn, sliding, and bearing). Basic requirements for structural design are in NRCS NEM Part 536.

Avoid using gabions whenever possible. If included in a design, explain why they were necessary in the design report.

Document the stability of wood log revetments as described in NRCS NEH Part 654 Stream Restoration Design and with an excel spreadsheet tool, *Root Wad Calculator*, located at Stream Restoration Spreadsheet Tools along with other design spreadsheets [Scroll to bottom of screen].

Construction Drawings. Construction drawings should contain sufficient detail to communicate the design to the contractor and reviewers. The *project engineer* will determine the details to be included with consideration for the complexity of the project and the proposed contracting and payment methods.

Where applicable, standard drawings may be used to expedite the design. Flood-specific standard drawings are **available to NRCS personnel** from the Colorado EWP SharePoint site [only available to NRCS personnel]. These drawings are available, upon request, from NRCS.

Construction drawings should have a cover sheet that contains, as a minimum:

- Project name and location to the nearest ¼ section;
- Drainage area in square miles;
- Engineer, inspector, EWP sponsor, and owner contact information;
- Standard NRCS utility notification details, or equivalent information;
- Index of the applicable drawings and specifications;
- General notes and anticipated construction quantities, when room allows;
- NRCS job approval class;
- Valid Colorado PE seal, signed & dated; and
- Review and approval signatory blocks.

Plan view drawings should include enough information to identify and layout project components. Plan views should show designated work area limits, construction staging areas, existing features, known utilities, ingress/egress routes, references to details, benchmarks, centerlines, north arrow, scale, waste/borrow locations, haul distances, and stationing as needed for the contractor to install the project components. Provide notes for trees and other items that are to remain undisturbed.

Provide sheet keys if there are over 10 drawings in a plan set.

One drawing should include a symbol legend, abbreviations, general notes, and a table with northing, easting, elevation, and point descriptions for control points.

Permit requirements and responsibilities should be clearly communicated on the drawings.

Provide appropriate number of cross-section sheets for existing and proposed conditions. Provide the longitudinal profile of stream with existing and proposed conditions.

Provide enough details to show the project meets NRCS technical requirements, and to clearly show construction requirements for the contractor. If several of the same structures are included in the design, provide a reference table with key design information for each structure, such as slope, vane length, elevations, etc.

No construction drawings should be released to the owner or contractor until they have been approved as described in the QUALIFICATIONS section.

Construction Specifications. The *project engineer* should determine the type and extent of construction specifications needed for each project with consideration for the project complexity and intended contracting method. Whether they are found in notes on the drawings or a formal document, the specifications need to adequately describe the materials and construction requirements necessary to build the project.

All EWP projects are required to be built to NRCS specifications or better. NRCS specifications are available online at NRCS eDirectives, under Handbooks, Title 210, National Engineering Handbook, Part 642. Engineers may use their own specifications provided the meet or exceed NRCS specifications.

Cost and Construction Time Estimates. An engineering cost estimate (opinion of probable cost) is required for each project. The estimate will be based on the engineer's opinion of the local cost for equipment, labor, materials and permits, including reasonable overhead and profit for the contractor.

Provide an estimate of the calendar days needed (construction time) to complete the project, including lead times for materials, mobilization, demobilization, complexity, resources, construction constraints, adverse weather, winter shutdown, and other applicable time requirements. Provide the construction time estimate to the sponsor and the entity administering the construction contract.

Operation and Maintenance Plan. Designers should strive to make project components as maintenance-free as possible. Components should be resilient, and designed for site conditions. Each project should have a written site-specific operation and maintenance (O&M) recommendations. EWP policy requires project sponsors to perform O&M responsibilities for a prescribed period, typically at least 5 years after project completion. The O&M plan should include provisions for annual inspections, and intermittent inspections after significant flow events. NRCS has O&M recommendations for each conservation practice. NRCS standard O&M recommendations can be modified to meet specific project needs. After each project is completed, attach the O&M plan to sponsor's O&M agreement. NRCS conservation practices and standard O&M requirements are available at: Field Office Technical Guide, under the state and county, FOTG Section IV, Standards and Specifications.

Sponsors should set aside funds to cover O&M responsibilities.

Typical items to consider for flood recovery O&M plans are:

- Visually inspect the bank treatment and all installed structures at least annually, and after heavy rainfall occurs. Repair damages as soon as practical. Check in-stream structures from the bank or a dry location using digital photos and binoculars (if needed).
- Check all banks, rock, wood, and structures for accelerated weathering, displacement, or significant changes since the original construction. Replace to original grades if necessary.
- Check for scour or excessive erosion of streambanks and stream crossings.
- Inspect vegetation and plantings more frequently during the first year after construction. During the first part of the growing season, check the vegetation every week or two. Maintaining good bank vegetation is important to the success of the project.
- Monitor vegetation and plantings for damage caused by animals, insects, and disease. If necessary to protect vegetation, install fencing or concrete-sand protection.
- Maintain vigorous growth of desirable vegetation. This includes reseeding, watering, weeding by hand, replanting, mulching, and removal of invasive plants when necessary.

- Investigate settlement or large cracks in the soil, streambanks, or structures to determine their cause and if repairs are needed.
- Maintain fences to control access (as applicable).
- Remove debris that could cause damage to installed structures and bank treatments, or if debris poses a safety hazard.
- DO NOT mow or fertilize the vegetation within 35 feet of the edge of normal water flow.
- Take some photographs of the installation for your own records and to share with NRCS representatives. Your feedback will help NRCS improve future installations.
- Monitor the installation as required by permit conditions.

CONSTRUCTION QUALITY ASSUARANCE

Quality Assurance Plan (QAP). The QAP defines *quality assurance* (QA) duties. The *project engineer* should prepare a QAP that identifies activities necessary to confirm each project is constructed according to site-specific plans and specifications. The QAP outlines the technical and administrative expertise required, identifies the individuals with that expertise, outlines the frequency and timing of technical assistance, estimate the contract completion date, and shall be approved by all responsible supervisors. Example QA Plans are available upon request from NRCS.

For non-NRCS designed projects, the sponsor is responsible for construction quality assurance either directly or through consultants. For NRCS-designed projects, NRCS is responsible for quality assurance.

The sponsor is responsible for conducting preconstruction meetings with the appropriate parties.

Construction Records and As-Built Drawings. The project engineer determines the type and extent of project records. Project records should reflect NRCS Policy, the complexity of the project, design life, and contracting methods. Keep a written job diary or field notes (electronic or hard copy) for each project. For more information, see A3: Guidance for Preparation of Record Documents.

The project notes should be concise, but sufficient to document:

- Meetings to discuss the project or site visits;
- Preconstruction meetings;
- Type and quantity of labor and equipment used;
- Inspection and acceptance of materials and project components;
- Photographs detailing site conditions;
- Decisions and approvals to modify the design;
- Significant discussions with the contractor; and
- Construction quantities.

As-built drawings and record documents are required for each project. As-built drawings may be in electronic or “red lined” hard copy form. The as-built documentation should identify substantial changes

to the plans and specifications made during construction, the name of the contractor, and the project completion date. The as-built drawings or records must be approved by the responsible engineer.

Final Inspection and Acceptance. An NRCS representative with appropriate engineering job approval authority should participate in the final inspection and acceptance of all projects, regardless of who was responsible for the design and construction QA. The NRCS representative (government representative) will confirm whether the project was built to NRCS standards and specifications, and identify project elements that may be ineligible for EWP assistance. Final inspection and NRCS acceptance may be documented on NRCS Form CO-ENG-12 or on the as-built record/drawings. For non-NRCS designed projects, the sponsor is responsible for obtaining as-built drawings with the certification statement (see SUBMITTALS FROM SPONSOR TO NRCS).

SEDIMENT AND DEBRIS REMOVAL CONSIDERATIONS

NRCS EWP funds may be used to remove all flood deposited anthropogenic debris (structural material, vehicles, appliances, etc.) and sediment (sand, gravel, cobble, boulders, etc.) where necessary to reduce threats to life or property by restoring the pre-flood hydraulic capacity of channels and floodplains.

NRCS recognizes the value of natural woody material in the riparian corridor where it supports ecological functions retains sediment and contributes to channel stability. Therefore NRCS will not use funds from the EWP program to remove large woody material (4 or more inches in diameter) from impaired channels and floodplains, except where it is necessary to:

- Reduce threats to life or property by restoring the pre-flood hydraulic capacity of channels and floodplains.
- Reduce potential for large wood to accumulate at bridges, culverts, and other in-channel infrastructure in quantities that could cause damage or impair functions of those structures; or
- Facilitate construction of other in-channel recovery measures.

Sediment and debris removal shall be planned and performed according to Colorado NRCS Conservation Practice Standard 326 – *Clearing and Snagging* (Website Link: Colorado eFOTG), and the following:

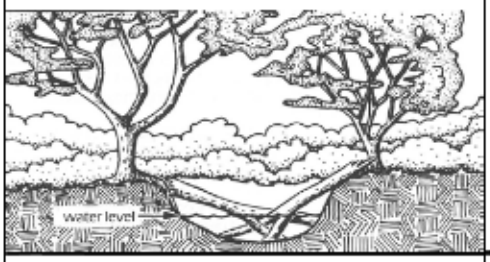
The contractor must provide a disposal plan for clearing and snagging for review and approval by the NRCS/sponsor/owner's representative. The disposal plan for anthropogenic debris must be according to all applicable local regulations and Colorado Department of Health and Environment requirements titled: 2013 Floods - Guidance: Management and Disposal of Flood Debris.

Excavation of sediment is limited to the quantity necessary to meet hydraulic requirements of design flows for the channel and floodplain. Where the extent of flood damage makes it difficult to identify the pre-flood channel capacity, excavation shall be limited to the quantity necessary to construct a stable channel and floodplain with capacity to safely pass the design flow. "Safely" refers to a flow depth and velocity that will not damage the property being protected.

Sediment excavation must be planned to avoid leaving an unstable headcut at the upstream end of the excavated reach, and may include constructing grade control structures where necessary. When the streambed requires reconstruction, a thalweg channel should be provided in the design to provide aquatic organism passage during low flow periods.

Clearing and snagging should only remove as much large wood as needed to reestablish the pre-flood capacity of the channel and floodplain. Leave large wood in the riparian zone where it does not create a risk to life or property, and where possible consider using logs to construct channel and bank stabilization measures. The following are some additional guidelines with regard to large woody debris:

- To the extent possible, leave logs with a diameter greater than 1/3 the flow depth that are aligned or can be realigned at an angle less than 30 degrees with the direction of flow.
- Large wood with a diameter of less than 1/3 the flow depth left in the floodplain should be anchored.
- All flood deposited woody debris within 20 channel bankfull widths upstream from a bridge, culvert, or other infrastructure at risk may be removed to reduce potential for damaging or impairing the functions of the structure.
- During mobilization to the construction site, minimize disturbance to the primary stream channel, side channels, and streambanks.
- Additional guidance is provided by Figure 2 - Woody Debris Management Classification.

Condition	Description	Management Action
Condition 1 	Large Wood (LW) is primarily composed of material that can be transported downstream during high flows and occupies less than 10% of the flow cross section area.	No action unless it is necessary to remove or reposition and anchor the material to prevent accumulation at bridges, culverts or other infrastructure.
Condition 2 	LW is composed of multiple pieces that may span the channel, but do not cause upstream ponding.	Material may be removed or repositioned and anchored on site to reduce localized erosion or to reduce the flow obstruction to less than 10% of flow cross section area.
Condition 3 	LW spans the entire channel and is causing some flow reduction; however areas of flow through the structure exist.	Material should be removed or repositioned and anchored as needed to reduce the volume remaining to less than 10% of the flow cross section.
Condition 4 	LW is a major stream obstruction with compacted debris and significant accumulated sediment.	Materials will require extensive use of heavy equipment to reduce the volume remaining to less than 10% of the flow cross section. Reposition remaining LW and anchor if necessary.

*Adapted for use with the 2013 Colorado Flood from American Fisheries Society. 1993. *Stream Obstruction Removal Guidelines*. South Carolina Wildlife and Marine Resources Department. Columbia, SC. as cited in "*A Primer for Large Woody Debris Management*", City of Rochester Hills, Michigan; September 2007.

Figure 2 - Woody Debris Management Classification

ENVIRONMENTAL CONSIDERATIONS

Endangered Species Concerns. There are three known endangered species that must be considered during planning, design, and construction of all EWP projects. The US Fish and Wildlife Service has a document titled "*Frequently Asked Questions and Recommended Conservation Measures to Avoid and Minimize Impacts to the Preble's Meadow Jumping Mouse (Zapus hudsonius preblei), the Ute Ladies'-tresses Orchid (Spiranthes diluvialis), and the Colorado butterfly plant (Guara neomexicana ssp. coloradensis) from Emergency Flood Response Activities Along Streams, Rivers, or Transportation Corridors in Colorado"* Internet Link: Preble's Meadow Jumping Mouse FAQ Feb 2014. Additional

information is available from the USFWS Mountain-Prairie Region. The designer should incorporate USFWS requirements into each project design, to the extent feasible.

Below are some recommendations to minimize and document impacts to the Preble's Meadow Jumping Mouse (PMJM), Ute Ladies'-tresses Orchid, and Colorado butterfly plant:

- Minimize the number and footprint of access routes, staging areas, and work areas.
- Minimize the disturbance to site and surrounding areas – applicable to all project sites. Plan construction work to keep hauling and tracking in-and-out to a minimum.
- Locate access routes, staging areas, and work areas within previously disturbed areas.
- Avoid fragmenting linear riparian corridors.
- To the maximum extent practicable, limit crushing, trampling or removing remaining vegetation, such as willows, trees, shrubs, and grasses within the work area.
- Track acres or square feet of riparian and upland habitats either temporarily or permanently affected by these activities.
- During the PMJM active season (May 1 – November 1), work only during daylight hours.
- Document project before and after conditions with photographs.
- Rip compacted access routes and replant to weed free, native seed mixes and plants.

Whenever possible, use alternatives to riprap, including bio-engineering, large wood structures, in-stream structures, plantings, biodegradable erosion control fabric, and other methods outlined in NEH 654, Stream Restoration Design. If required by site conditions, rock riprap may be specified.

The NRCS encourages the use of on-site or locally-available materials, such as logs, rootwads, transplanting native plants, boulders, and salvaged topsoil.

When practical and appropriate, reconnect the bankfull channel with the floodplain to restore natural stream processes. For incised channels, evaluate the use of grade control structures and bankfull benches when appropriate for the site.

Designs should specify methods that sustain stream ecosystem and natural functionality, and reduce flood risks.

Guidelines on soil bioengineering methods may be found in NEH 654, TS 14I, Streambank Soil Bioengineering. Other state-of-the-art bioengineering methods may also be used.

PERMITS

The sponsor or appropriate delegate is responsible for determining which permits are needed, the permit administrating agency, how to obtain a permit, permit requirements and how to implement the permits. All necessary permits must be obtained before the start of construction.

Unless specifically required by the sponsor, owner or permitting agency, project designs and construction plans will not include permit requirements typically developed by the contractor. For example, contractor developed permits may include stormwater discharge permits or construction site dewatering permits.

Designs shall include appropriate provisions for Erosion and Sediment control per local, state, or federal requirements. Best management practices should be incorporated into the design or specified for inclusion in the construction contract documents.

SUBMITTALS FROM SPONSOR TO NRCS

To the greatest extent practical and as allowed by State and NRCS rules and procedures, submittals should be done by electronic means (email or shared websites). Drawings may be submitted in AutoCAD (dwg) or Adobe (pdf) formats. Final drawing submittals with engineering seals shall be in Adobe format.

Suggested minimum submittals include the following:

- ❑ Conceptual design drawings (15%) with enough detail to convey the scope of project with the major components shown on a plan view drawing.
- ❑ Preliminary design (30%) drawings, specifications, design report, calculations, cost estimate (opinion of probable cost), construction time estimate, quality assurance plan, O&M plan, and according to guidance in the Appendix. Also see DELIVERABLES.
- ❑ Copies of all required permits, and results of cultural resources assessments as applicable.
- ❑ Copies of land rights and right-of-entry permissions as applicable. Before writing a construction agreement, the sponsor must submit a **signed ADS-78** to document that land rights were obtained. An attorney's opinion must be attached to the form certifying an examination of the real property instruments and files was made and found to provide adequate land title, rights, permission and authority for the purpose(s) of the project.
- ❑ Final design documents (100%) for construction. Depending on the contracting method, and pace of the project, the final design documents may be the record (as-built) drawings.
- ❑ Status reports with photographs at key milestones during construction.
- ❑ Record (as-built) drawings and other documentation of changes made during construction.
- ❑ Monthly status reports to NRCS throughout the duration of sponsor's agreement with NRCS.

A Professional Engineer will seal engineering documents and the following statement shall appear with the engineer's signature on the cover sheet of construction drawings, cover of specifications, and within all reports:

I certify to the best of my professional knowledge, judgment, and belief, these plans (or this report) meets applicable NRCS standards.

Project designs, drawings, and specifications must meet NRCS standards and technical criteria, and shall be submitted to the NRCS State Conservation Engineer for **functional review and concurrence**. Before contracting for construction, submit project documents to:

John Andrews, PE
State Conservation Engineer
USDA-NRCS Colorado State Office
DFC Bldg 56, Rm 2604
Denver, CO 80225-0426
john.andrews@co.usda.gov

OTHER RESOURCES

There is a large volume of information developed by groups working in the flood recovery/river restoration fields. Much of this information is available on various websites. Some informative websites include:

Colorado Water Conservation Board

Big Thompson River Restoration Coalition

Coalition for the Upper South Platte

Fish Creek Coalition

Boulder County Creek Recovery & Restoration

Poudre River Watershed Coalition

Fourmile Creek Watershed

Fountain Creek Watershed

Coal Creek Canyon Watershed

St. Vrain Creek Watershed Info

Little Thompson Watershed Restoration Coalition

Middle South Platte River Alliance

Lefthand Watershed Oversight Group

TERMINOLOGY

The following descriptions are for use in this document.

bankfull flow: A frequently occurring peak flow whose stage represents the incipient point of flooding. It is often associated with a return period of 1-2 years, with an average of 1.5 years. It is expressed as the momentary maximum of instantaneous peak flows rather than the mean daily flow.

design flow: The discharge (cubic feet per second) used by the engineer to design components of a project, such as low flow channel, channel-forming flow, in-stream structures, bank protection, and flood flow. An engineer may use several different design flows to evaluate design components. These flows should be as determined by the hydrologist or engineer using the best available data. Discharges should be consistent with the State's post-flood hydrologic studies.

Government Representative (GR): An NRCS employee responsible for oversight of non-federal contracts, agreements, designs, and construction to ensure compliance with NRCS standards and specifications.

NRCS Technical Representative: An NRCS employee responsible for ensuring that work is done according to NRCS standards and specifications.

pre-flood conditions: The pre-flood conditions will be determined from flood insurance study mapping, and other available survey information from before September 2013.

project engineer: The engineer responsible for a project or site and the person responsible for technical aspects of the project. This may be a consultant, NRCS engineer, or an engineer from a project sponsor. The approving engineer for design and construction documents must have appropriate job approval authority or meet NRCS requirements for non-NRCS engineers.

recurrence interval: The recurrence interval is based on the probability that the given peak flow event will be equaled or exceeded in any given year. For example, if a peak flow of a certain discharge at a site is said to have a 100-year recurrence interval, there is a 1 in 100 (or 1%) chance that a peak flow of that discharge will occur in any given year. [Also see USGS (9/21/2015): http://water.usgs.gov/edu/100yearflood.html]

submittal: project documentation at primary stages during planning, design, and construction.

Document Notes:

1. Special thanks to the following document contributors and reviewers: John Andrews, Kevin Houck, Chris Sturm, Rob Molacek, Michael Blazewicz, William Spitz, and Randy Mandell. Edited by TJ Burr.
2. Version 2.0 of this document was completed on September 28, 2015. Many copies of this version were distributed to watershed coalitions and other interested parties.
3. Version 2.1 was considered finished and ready for approval on December 23, 2015, but will not be a "final" document until signed by all approvers.
4. Please submit errors or recommended changes to TJ Burr, NRCS, at tee.burr@co.usda.gov.

APPROVALS

To the best of our knowledge, information and belief, this engineering guidance document has been prepared in conformance with all applicable NRCS EWP Program and engineering policies. It is expected that the guidance will evolve during EWP Phase 2 implementation. The following is a record of approvals given to the original guidance document and subsequent revisions.

Date	Approved by	Title
1/25/2016	John E. Andrews, PE	NRCS State Conservation Engineer
1/26/2016	Tim Macklin	NRCS EWP Program Manager
1-26-16	Kevin Houck, PE	CWCB Project Sponsor

APPENDIX - Contents

A1: NRCS Design Report Guidance

The following information (where pertinent) should be included in the design report along with other pertinent technical data. Adjust the content of the design report according to the complexity of the project. State of Colorado requirements must also be satisfied per A2: CDBG-DR 30% Design Guidelines (Revised 12/16/2015).

1. Prepare a design report that includes applicable and pertinent information as listed below, construction time, assumptions, O&M, construction review, and design authority (designer and approver signs last page of report).
2. Relevant background information.
3. Description of site location and setting.
4. **Purpose and Objective of Project** with a description. Rationale for the selected conservation practice. Rationale for other major work items included in project.
5. **Cause of problem** or instability, e.g., livestock access, watershed alterations, flow deflection into bank, aggradation, degradation, mining, farming, removal of vegetation, etc.
6. **Alternatives** considered, and reasons for recommending or not recommending.
7. Brief discussion of **Project Benefits and Risks**.
8. Basis for design; references.
9. Basic design data and assumptions.
10. **Hydrology** calculations, assumptions, and data sources. Include descriptions of physiographic province; watershed; drainage area; comparison of design flows obtained; and rationale for selected flows. Also see state requirements at Hydrology and Hydraulics.
11. **Hydraulic Analysis & Design** to include existing and design flows; rock sizing calculations; scour calculations; sediment transport analysis (Also see Sediment Transport Analysis); and a table ***key morphological characteristics*** for existing, design, and reference conditions. Provide a minimum of the following morphological characteristics as applicable to each design flow evaluated:
    a. Valley Type (Rosgen)
    b. Valley Width, feet
    c. Stream Type (Rosgen)
    d. Drainage Area, Square Miles
    e. Flow, cfs (Q_{bkf})
    f. Mean Velocity, ft/sec
    g. Water Surface Slope, ft/ft (S)
    h. Flow Width, ft (W_{bkf})
    i. Mean Depth, ft (d_{bkf})
    j. Width/Depth Ratio (W/D)
    k. Cross-Sectional Area, ft^2 (A_{bkf})
    l. Maximum Depth (d_{max})
    m. Width of Flood-Prone Area, ft (W_{fpa})
    n. Entrenchment Ratio (W_{fpa}/W_{bkf})
    o. Sinuosity (k) (SL/VL)
    p. Meander Width Ratio (MWR), W_{belt}/W_{bkf}
    q. Pool-to-Pool Spacing
    r. Shear Stress, psf
12. **Hydraulic Analysis** Results from HEC-RAS, RiverMorph, or other Hydraulics Program (include the most pertinent information); some of this can be in the Appendix:

a. Cross-sections showing bankfull
b. Longitudinal Profile with Bankfull Slope
c. Particle Size Summary (If pebble count was done)
d. Channel Classification/Morphological Data
e. Bank Erosion Hazard Index – for Erosion Savings Estimates
f. Shear Stress – RiverMorph printout (BEHI or X-Sec Report)

13. **Structural design**. A summary of assumptions, loading conditions, and design procedures.
14. **Environmental Considerations** and Concerns, including Threatened & Endangered species that may be present at the site.
    a. Include a copy of SVAP 2 (Stream Visual Assessment Protocol) in the Appendix of report. Note that regulators are looking to see an "uplift" of riparian environment from pre- to post-construction conditions.
    b. Special concerns related to erosion and sediment controls; and
    c. For aquatic habitat, see Aquatic and Terrestrial Species Habitat Requirements.
15. **Geology** description or report (if available). Include relevant geologic information, such as presence of bedrock (if known), type of rock, slope stability concerns at and adjacent to site, and etcetera.
16. Description of streambed & banks, including vegetation and predominant materials.
17. Soil report from the NRCS Websoil Survey (if relevant to design) – basic information on soil types at the site with project location marked; hydrologic soil groups.
18. Discussion of special **materials**, recommended sources, and use of on-site materials.
19. Description of the **specifications** used for the project and where they originated from.
20. **Construction Time** estimate.
21. **Construction review**. A summary of those items, conditions, or features encountered during construction that require a field review by designer, geologist, soil engineer, or other specialist to ensure that conditions anticipated during design are consistent with the design assumptions. Include a request for timely notification; recommendation for a preconstruction conference.
22. Provide **O&M Plan** separate from design report (or as an attachment) to include permit conditions, such as post-construction monitoring.
23. Prepare a **QA Plan** to document how quality assurance during construction will be achieved, including assigned personnel and methods to-be used.
24. Provide **supporting calculations**, data, backup information, and results in an Appendix.
25. Optional. Provide p**hotographs** of completed projects and methods similar to proposed design.
26. Provide engineer's **cost estimate** as a separate document for internal use by owner, sponsor, and NRCS. Construction cost estimates should not be shared with potential contractors.
27. **Approval Authority**. For projects designed by NRCS, this includes signature and date of the designer and approver on the last page. A statement of qualification and availability may also be included as verification that necessary resources are available to implement the project. For projects designed by non-NRCS engineers, the state licensed engineer shall **seal, sign, and date** the cover of the design report, or as required by state engineering rules and regulations.

Reference: NRCS National Engineering Manual (NEM), Title 210, Part 511, Design.

A2: CDBG-DR 30% Design Guidelines (Revised 12/16/2015)

MEMORANDUM

To: CDBG-DR Watershed Resilience Pilot Program Grantees

From: KC McFerson, CDBG-DR Watershed Program Manager, DOLA
Tim Katers, CDBG-DR Planning Program Manager, DOLA
Chris Sturm, Stream Restoration Coordinator, CWCB

Date: December 16, 2015

Re: **CDBG-DR 30% DESIGN GUIDLEINES FOR PLAN DEVELOPMENT (revised 12/16)**

CDBG-DR watershed planning grants have requested up to 30% design of high priority river reaches as their planning deliverable.[(1)] Through the State of Colorado Technical Assistance Team, the Department of Local Affairs (DOLA) and Colorado Water Conservation Board (CWCB) have developed 30% design guidelines for watershed coalitions (Coalitions) and project consultants. These 30% design guidelines are intended to ensure that CDBG-DR planning and implementation grants result in consistent deliverables that are compliant with CDBG-DR grant requirements. This analysis defines 30% design as the development of a plan set to a level of sufficient detail to evaluate major design features prior to advancing to the construction phase. The CDBG-DR program dictates that 30% designs will provide clear direction for detailed project engineering and specifications to be completed in the future. In order for the projects to be eligible for funding in future CDBG-DR implementation grant cycles, the design work must 1) describe the science-based risk analysis it has employed in its design, and 2) identify resilience performance standards that can be applied to the projects upon completion of construction (See Federal Register, Vol. 79, No. 106, June 3, 2014). The following outline should be used as guidance.

I. ASSESSMENT

Project Goals Statement

- Clear statement of project goals, objectives, and a definition of project success (developed in collaboration with Coalition and stakeholders).

Site Assessment

- Review of geology, ecology, hydrology, geomorphology, soils, water quality conditions
- Riparian assessment and wetland delineation
- Photo documentation (e.g., pre-project, pre-flood, post-flood, historical)
- Basemap development including but not limited to:
    - Political/property boundaries
    - Infrastructure and utility locations
    - Topographic survey (1' contour development from LIDAR and traditional survey methods)

- Supporting GIS/CAD layers
- Aerial photograph (as background of planview and project location map requested by ACOE for permitting)

Hydrology and Hydraulics

- Watershed hydrology - evaluated for peak, low, and pertinent stage/duration flows as necessitated by the design goals. Data obtained from CWCB, gage data, StreamStats, and/or other appropriate sources.
- Hydraulic model development for existing conditions. Water surface elevations, stream velocity, shear stress and stream power shown in relation to stage and discharge through the reach. Hydraulic modeling should be developed on a publically available and non-proprietary software that will allow for any follow-up studies or projects to utilize the same files without significant software acquisition fees. If the use of proprietary software is necessary to perform a better product then coordination between the grantee and contractor is required prior to use.
- Hydraulic model development for proposed alternatives. Water surface elevations, stream velocity, shear stress and stream power shown in relation to stage and discharge through the reach.
- No-rise analysis for work within regulatory floodways or other areas of local applicability

Geomorphology

- Identification of existing and proposed stream style or type, bedform, planform, and channel evolution stage
- Discussion of erosive or depositional processes and analysis of cause(s) of instability
- Channel and floodplain dimensions including low-flow, bankfull, and various flood stages
- Reference reach data
- Identification of vertical and lateral channel controls (Geotechnical analysis)
- Identification of Fluvial (Erosion) Hazard Zone

Sediment Transport Analysis

- Shear stress, velocity and stream power as a function of stage and/or discharge
- Preliminary sediment transport capacity analysis to estimate bed aggradation or degradation over time if designing an alluvial (mobile bed) channel[(2)]
- Preliminary incipient motion analysis at design flows if designing a threshold channel[(2)]
- Preliminary scour depth calculations for design floods

Aquatic and Terrestrial Species Habitat Requirements

- Species of concern and habitat that needs evaluation
- Fish passage requirements (burst speeds, depth, velocity, cover)
- Define seasonally appropriate floodplain, lateral and longitudinal connectivity requirements
- Riparian vegetation target community
- Evaluation of existing and potential invasive species
- Consideration of construction windows for sensitive species

Alternatives Analysis

This may be optional if the Master Plan or previous efforts have already identified a desired plan.

- Preliminary/Concept plans with appropriate alternatives (2-3) given the site conditions and restoration potential
- Define evaluation criteria and decision-making process
- Evaluation of alternatives and selection of preferred alternative

II. 30% DESIGN FOR PREFERRED ALTERNATIVE

Project Design

- Existing and proposed (typical) channel dimensions including low-flow, bankfull, and various flood stages as well as typical floodplain grading/roughness
- Existing and proposed channel alignment and river corridor/floodplain alignment
- Existing and proposed channel profile
- Identification of project limits and required easements
- Location of in-channel and floodplain structures
- Location of fish passage structures and features
- Other elements as identified in the project goals and multiple objectives, as applicable
- Preliminary engineering typical drawings for all structure types- preliminary size calculations, use, and location explained

Opinion of Probable Cost and Quantities

- Itemized with specific cost and quantity breakdown (provide range of expected costs - low/high/median)
- Budget narrative

Draft Planting Plan (if applicable)

- Identify existing/on-site species and desired plant community
- Identify potential revegetation needs with species and estimate quantities
- Suggest if amendments and/or other supporting supplies are needed
- Develop preliminary re-vegetation timeline

Draft Monitoring Strategy

- Determine monitoring strategy for "as-built" conditions (to determine if a project was constructed according to design plans) and/or Measurable Results (effectiveness monitoring to determine the long-term bio-geo-chemical response of the restored system compared to pre-project conditions). Identify parameters and protocols that will be monitored
- Draft timeline and responsibilities table (including pre-project monitoring responsibility)
- Monitoring map identifying proposed sites
- Description of how parameters monitored will provide information to support understanding of success/failure of project goals and/or aid in adaptive management and maintenance of the project

Preliminary Permit Work (identification of all permits needed - suggestions/materials/indexing for how to develop the final permit request)

- ACOE 404 (NWP-27 for DR-funded projects; NWP-37 (PCN) for EWP projects)
- CDPHE and local stormwater management plan and permits
- County/Town floodplain development permit
- Roadway permits
- Other local and state permits as appropriate
- *Environmental Review including NEPA/SHPO (will be done by DOLA contractor AGEISS)*

Proposed Timeline

- Proposed timeline through construction with key milestones (Include identification of steps to bring project to Final Design)

III. DELIVERABLES

- Preliminary Basis of Design Report -- explains and documents hydrology, hydraulics, sediment transport, geomorphic features, and ecology and provides support for the selection, layout, and size of each design component. Typically includes:
    - Hydrology/Hydraulics data: preliminary models, results, and supporting electronic files (models, AutoCAD, and GIS)
    - Geomorphological data: cross-sections, pebble counts, photos
    - Sediment Transport Analysis: preliminary results and supporting data
    - Ecological data: habitat features, target plant communities, wetlands, etc.

- 30% Plan Set:
    - Existing conditions plan (base map, planview, profile, cross-sections)
    - Proposed conditions plan (planview, profile, cross-sections)

- Detail drawings
- Note: 30% design plans need to be signed and stamped by a registered PE or PH in the state of Colorado if they will be used for construction
- Note: The ACOE permitting office has requested that all plans include a planview map depicting the extent of the project overlaid on an aerial photograph. The ACOE will need a discrete location (coordinates), a description of the project and impacts, and dimensions of the impacts (acres of impact below OHW).

Additional Supporting Documents, including:

- Draft Planting Plan: Planimetric map, spreadsheet estimate of plants and quantities
- Permit Plan: Summary of permits, contacts, and estimated schedule
- Draft Monitoring Plan: monitoring parameters/methods/frequency/responsible party timeline, suggested monitoring locations map.
- Opinion of probable costs
- Next steps guidance – Note: additional design needs and adjustments to bring a project to construction are based on a technical review of 30% designs and public and stakeholder input. It is likely that 30% designs that are more specific and define a clear pathway towards permitting and construction will be more competitive for additional funding requests.

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(1) - From *Colorado Resilience Planning Grant: Program Guidelines*

"Watershed Coalition Plans, Studies, and Analyses:
These planning funds can be used for watershed coalitions to address critical and time-sensitive recovery needs to further develop and/or prepare future projects for implementation, and to develop longer-term plans that are multi-objective, seek to integrate existing plans with the Watershed Master Plan or develop integrated projects. Examples of plans, studies and analyses may include, but not be limited to: drainage studies, geomorphic assessments, flood studies, environmental assessments, watershed assessment plans, riparian conditions assessments, aquatic/terrestrial habitat condition assessments, river restoration reports, watershed coalition master plans, sediment transport modeling, hydraulic modeling, erosion hazard zone mapping, sewer and water system analyses, and wildlife habitat preservation plans. Studies that address areas such as stream restoration or enhancement, land use, economic development, green infrastructure, recreation and community connectivity to the river, hazard mitigation, and infrastructure (e.g., utilities and roads) are also eligible. Broad, regional/multi-jurisdictional planning projects and studies will be highly competitive. Planning and conceptual design projects that achieve multiple objectives and maximize community-wide benefit by further developing prioritized watershed master plan projects will make Watershed Resilience project implementation applications more competitive in later rounds of funding.

Typically engineering and design for a specific project is not eligible. These funds may be spent on conceptual design, but as a general rule are to not exceed 30% of project design work.

Additionally the funds may be spent to study and analyze a recovery concept further, such as resilience scenario planning (including rough cost estimate development)."

(2) For the purposes of these guidelines, threshold and alluvial channels are defined as follows:

Threshold channels are those designed to have an armored bed which mobilizes at a specified design discharge (e.g., some moderate, above-bankfull flood event). Threshold channels tend to have smaller sediment load from upstream and/or route finer bed material through due to a steeper slope. They are designed using various incipient motion type design procedures determined on a case by case basis, one example found in Chapter 8 of Part 654 of the NRCS National Engineering Handbook, *Stream Restoration Design* (2007)

Alluvial channels are those that tend to have finer beds (e.g, sand to gravel range) and/or shallower slopes. Depositional features such as point bars are more prevalent due to shallower slopes and/or a greater supply of sediment. Alluvial channel design requires consideration of sediment transport capacity and continuity of the incoming sediment load as stable channel dimensions (e.g., no net aggradation or degradation over time) are much more sensitive to sediment supply factors. An example of these types of analyses are outlined on pages 9-28 to 9-48 in Chapter 9 of Part 654 of the NRCS National Engineering Handbook, *Stream Restoration Design* (2007) although other procedures exist and should be applied based on the project/site needs.

A3: Guidance for Preparation of Record Documents (As-Builts)

The following is a list of some information required for NRCS as-built drawings. Even though most of the engineering profession refers to as-built drawings as record documents, many NRCS references still use the term "as-built". For additional guidance, see NRCS NEM 512, Subpart F, July 2010.

- ❑ Record as-built drawing information in the field as deviations from the construction documents occurs. Document all changes to drawings and specifications with **red ink**, including plotted AutoCAD drawings.
- ❑ Describe all significant changes in writing using notes and by updating the graphical information. Record this information on the sheets where the changes occurred.
- ❑ Review project documentation to check for changes: change orders, modifications, field adjustments, job diary, etc., and document them appropriately.
- ❑ AutoCAD drawings should clearly show the original design information and as-built information using varying line weight, color, shading, hatching, dimensioning, notes, and separate layers. Use the layer "as-built." Consider using thick red lines for changes.
- ❑ For details installed as designed, place a checkmark next to the title for the detail. ☑
- ❑ If a **detail** is not used, place a red X across it and note why it wasn't used or cite the modification that removed it.
- ❑ For new details used, include "Added" in the heading label and on the plan sheet where used.
- ❑ Document **field changes** made to the details during construction.
- ❑ Include as-built station information for pertinent features and details, such as for cross-section locations. For as-built cross-sections, use format XS 510+00. Define XS in the Standard Abbreviations (if provided).
- ❑ Include pertinent **geologic information**, such as items discovered during construction, rock layers, springs, unstable soil conditions, slips, etc.
- ❑ Label each sheet of the drawing as "**AS-BUILT**."
- ❑ The **title sheet for record drawings** must be the final design title sheet, including the PE stamp and signature or other approver's signature. This can be done by adding as-built info to the final design Adobe PDF file. On the **title sheet**, provide the following information:
  - Name of Contractor,
  - Contract number, and date,
  - Construction completion date,
  - Contract amount [If known],
  - Names of construction inspectors,
  - QA consultant information (contract signer, company name, address, contract number, order number, contract date),
  - **Name and signature of the Approving Engineer, GR, or COR** under the following certification statement: All work under contract was installed according to the as-built drawings and specifications, and the as-built drawings are a true and correct record.
- ❑ Position the as-built text so that the original text is still readable.

- ❑ Put the as-built legend on same sheet as original legend, or make pertinent changes to design drawing legend. Text size should be consistent with the final design drawing text.
- ❑ Add new abbreviations used in the as-built text (XS, SWD, U/S, D/S) to the Standard Abbreviations sheet, if applicable.
- ❑ Bring display order of as-built text "to front," to appear overtop the contour labels.
- ❑ Make a reproducible copy at a sheet size of 11" x 17" for easy copying when needed in the future. Match the sheet layout of the original contract drawings.
- ❑ If AutoCAD Civil 3D is used, provide NRCS with DWG and PDF versions, including imported survey data.
- ❑ Provide as-built **specifications** in PDF format.
- ❑ **Distribution** of "As-Builts": 1) NRCS, 2) State of Colorado, CWBC, 3) Local sponsor, owner, coalition, or participant – the sponsor is responsible to submit to permitting agencies as required.