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Subject: ENG – Trip Report
Fort Independence, California
March 20, 2012

Date: April 30, 2012

To: John Harrington
State Conservation Engineer
Natural Resources Conservation Service
Davis, California

File Code: 210-7

PURPOSE: The primary purpose of the field review was to assess the Oak Creek Watershed as a potential field demonstration for Stream Restoration and Streambank Soil Bioengineering Technical Training Workshop that is scheduled for October 2012. A second goal was to assess conditions in the watershed and provide general suggestions to stabilization work.

Students attending this planned workshop will have an opportunity to participate in the construction of various soil bioengineering and streambank restoration treatments that do not involve the use of heavy equipment. Required use of heavy machinery will be accomplished before the class. A secondary goal of this demonstration will be to demonstrate potential stream restoration and bank stabilization solutions that may be appropriate for other areas in the vicinity. Information gained from performance monitoring can be used in future projects. Potential treatments and plans were discussed during this field review. The purpose of this report is to document the trip as well as to provide some suggestions and conceptual designs for this site.

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BACKGROUND: The area visited during this trip is located in Inyo County, California. The upper part of the watershed was forested, but destroyed by fire, and the lower portions of the creek has been manipulated over many years to facilitate irrigation. Water is diverted from the watershed for the Los Angeles Aqueduct system. The Oak Creek watershed suffered a devastating fire in July 2007. A year later in July 2008, a significant rainfall event occurred. There are estimates that over 1-1/2 in/hr of rain fell for 3 hours. Significant flooding and sediment debris flows occurred.

Prior to the site visit, Dr. Pearce had consulted with many stakeholders and had identified interest in a workshop as well as a potential location for the demonstration. An area below Route 395 was selected as a site suitable to demonstrate various stream restoration techniques.

According to Dr. Pearce, the goals for the work in this area are the following:

- Enhancement and creation of fish habitat
- Enhancement of bird habitat
- Enhancement of amphibian habitat
- Demonstration of techniques which have potential application in other areas

It is also suggested that the rapidly evolving nature of the upper watershed would provide for a great illustration of stream evolution and behavior and can be used as a field trip destination in a potential workshop.

<u>FINDINGS AND/OR RECOMMENDATIONS</u>: As noted in the background section of this trip report, the recent fire and flooding had significant impacts on the Oak Creek system. Streams changed course as channels filled with sediment and debris. The upper watershed area still shows significant impacts and ongoing channel avulsions. Photographs of the advancing headcuts and eroding channels are provided in (Figures 1 and 2). This condition can result in pulses of sediment being delivered in excess of transport capacity. However, from a geologic perspective, this situation is not unique. Such significant events have occurred in the past and are likely to reoccur in the future. Soils maps (Figure 3) as well as geomorphic evidence supports this assessment.


Figure 1 (Upper watershed area of Oak Creek (North Fork))


Figure 2 (Upper watershed area of Oak Creek (Middle Fork))

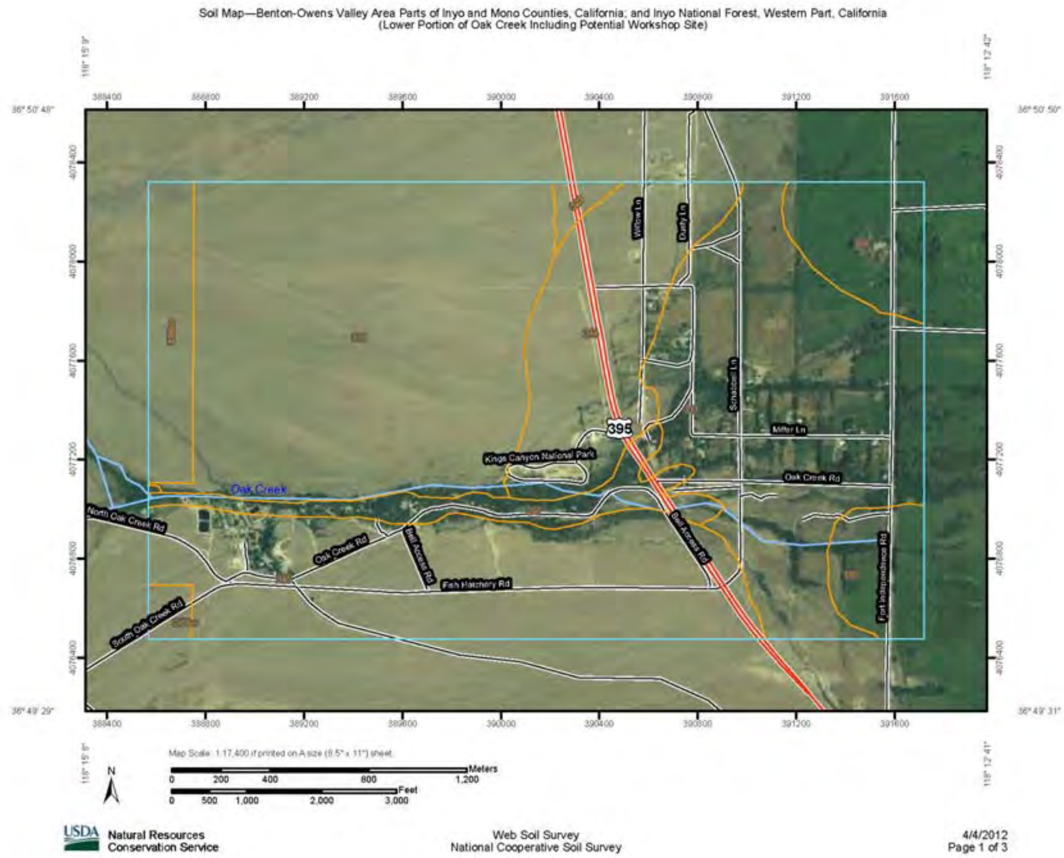

Figure 3 (Web soil survey of area. Map unit symbol 297 is river wash)

There have been suggestions that a true restoration project could be initiated in the watershed. Such work would involve filling and raising the grade of the existing channel and establishing a relatively stable natural channel in the floodplain. However, it is generally agreed that this approach would be expensive. It would also be extremely risky without substantial stabilization throughout the entire upper watershed. It should be expected that even a well designed and constructed cannel will be subject to sudden changes as pulses of sediment flow though the system. Stakeholders in such a project may have unrealistic expectations of a static section, planform, and slope. As a result, it is suggested that a true 'restoration' of the stream not be pursued. The reviewer agrees with Dr Pearce that work is better focused on specific sites and ongoing dredging.

During the subject trip, areas were visited where significant deposition had occurred in the channel. This situation was particularly evident in the upper portion of the watershed. In some of these areas, the channel was nearly filled with cobbles and gravels. An example of this is shown in (Figure 4). Not only is this deposited material posed to remobilize during the next high water event, but it is causing more material to be introduced into the system. Stream flow is forced to the toe of steep slopes near valley walls. The resulting erosion is destabilizing the slopes. Slides may introduce significant sediment material which can adversely impact lower reaches.

Figure 4 (Area where deposition has filled channel and forced flows against bank)

Adequate funding is not available to address this issue at the scale that would be required for it to be addressed on an impact scale. The group discussed economical solutions that have been used in other areas. One to push the larger deposited cobbles against the eroding bank. This is sometimes referred to as the 'Embankment Bench Method' (NEH 654.14K). Drainage from the bank would flow through the granular material. Areas where the channel impacted the bank would be filled and a new channel formed. This 'quick-and-dirty' approach is shown in (Figure 5). Adventitiously rooting live material can be incorporated into this bench. An appropriate source could be some of the willow clumps that are observed in portions of the channel.

If the decision is to pursue this method in order to address areas in the upper watershed, it is suggested that the stakeholders are made aware that the channel will still be active. There are significant sediment pulses being delivered from areas above these sites which may fill the channel again. In addition, the material that is being used to 'protect' the eroding bank is from the channel. If the material moved before, it will likely move again during a high event. The benefit provided by this approach is that by moving the coarse material towards the edge rather than leaving it in the channel, it will take a larger event to move it and the stress on the bank is reduced.

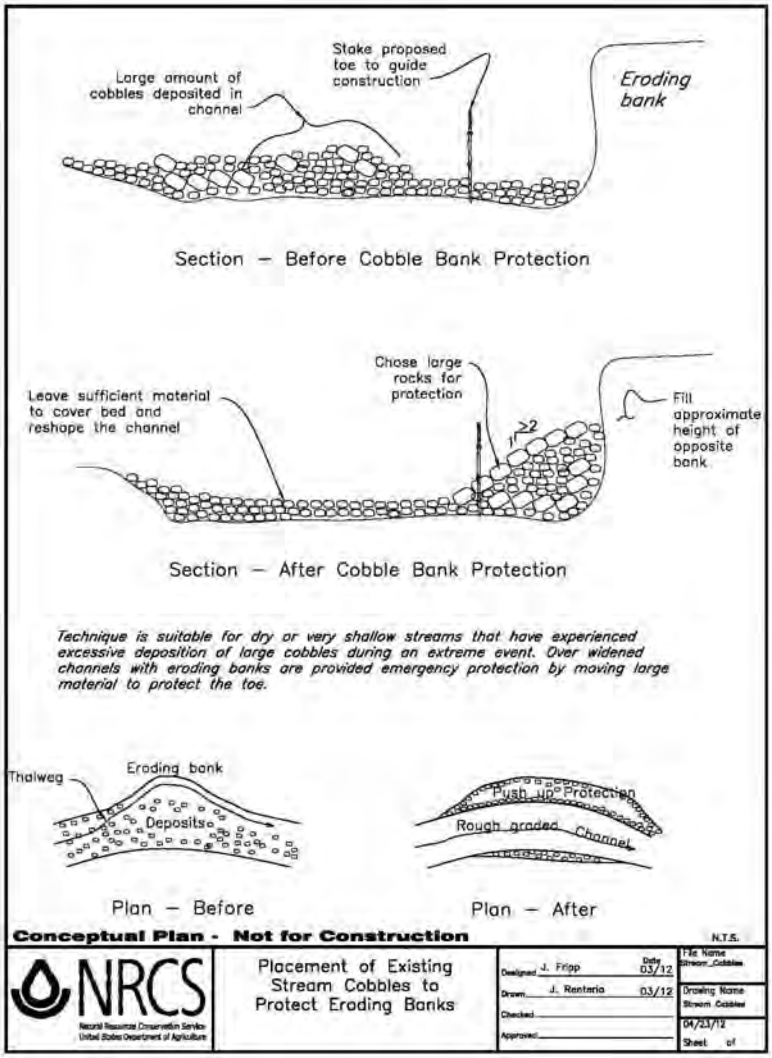

Figure 5 (Concept design for instream bank stabilization)

<u>WORKSHOP SITE</u>: The potential workshop site is located in below Route 395 and on Tribal land. An aerial view is shown in (Figure 6). It is located in a visible area and is also near Tribal offices. It would be suitable for recreational and education purposes. The area had been impacted by the sediment flows resulting from the 2008 event. However, areas above Route 395 are regularly dredged and it is expected that significant additional sediment inflows are unlikely as long as this upper area is maintained. Since the reconstruction of the upstream diversions and monitoring, the discharge is very much controlled as well. The upper portion of the site begins at Route 395 at a single 30-inch CMP. The lower portion flows under a private drive through twin 24-inch CMPs. As a result, the grade is fixed.

Figure 6 Aerial map of potential workshop area (circled))

The site appears to be well suited to demonstrate innovative and locally relevant bank stabilization practices. This site was selected because it is a relatively low-risk site, it has good access and staging characteristics, and it provides an opportunity to demonstrate several different stream restoration and stabilization practices that incorporate both structural and live materials. Per earlier communication, it was agreed that the reviewer would provide conceptual plans to Dr. Pearce. Due to the nature of the discussed treatments as well as time constraints, a separate concept design report will not be prepared.

Geomorphology and Stable Channel Design: The geomorphology of the lower Oak Creek is not natural. The watershed and the river itself has been highly manipulated. In predevelopment times, the floodplain in the site area may have evidenced multiple channels and numerous wetlands. But this floodplain regime has been altered through channelization and diversions for a long time. Restoration to predevelopment conditions is likely not a feasible option. Frequent flooding, and the associated avulsions that would be characteristic of a pre development condition would not be contusive to current riparian land use.

The altered nature of the channel and especially the recent watershed changes in part have resulted in bank erosion. This appears to be mainly the result of sediment and other debris filling the channel and forcing flows against the bank. This deposition has been removed and the stress is no longer present. Hydraulic analysis was performed on the site for a range of discharges. Inlet control conditions for the culverts were assumed to be a boundary condition at the lower portion. Velocities under high conditions likely do not exceed 5 fps. Most flow conditions are highly controlled with velocities on an order of magnitude of 1 fps.

While large slugs or debris flows of sediment can clog the channel and cause avulsions, the channel does appear to be able to transport inflowing sediment load under equilibrium conditions. Field observations during the subject visit indicate that the lower reaches can adequately transport incoming sediment load and are relatively stable when the banks are vegetated. Calculations made using the HECRAS Hydraulic Design routines as shown in (Figure 7) supports this field assessment. This analysis does not indicate that the existing channel is stable but that the current dimensions can adequately transport the inflowing sediment under normal conditions.

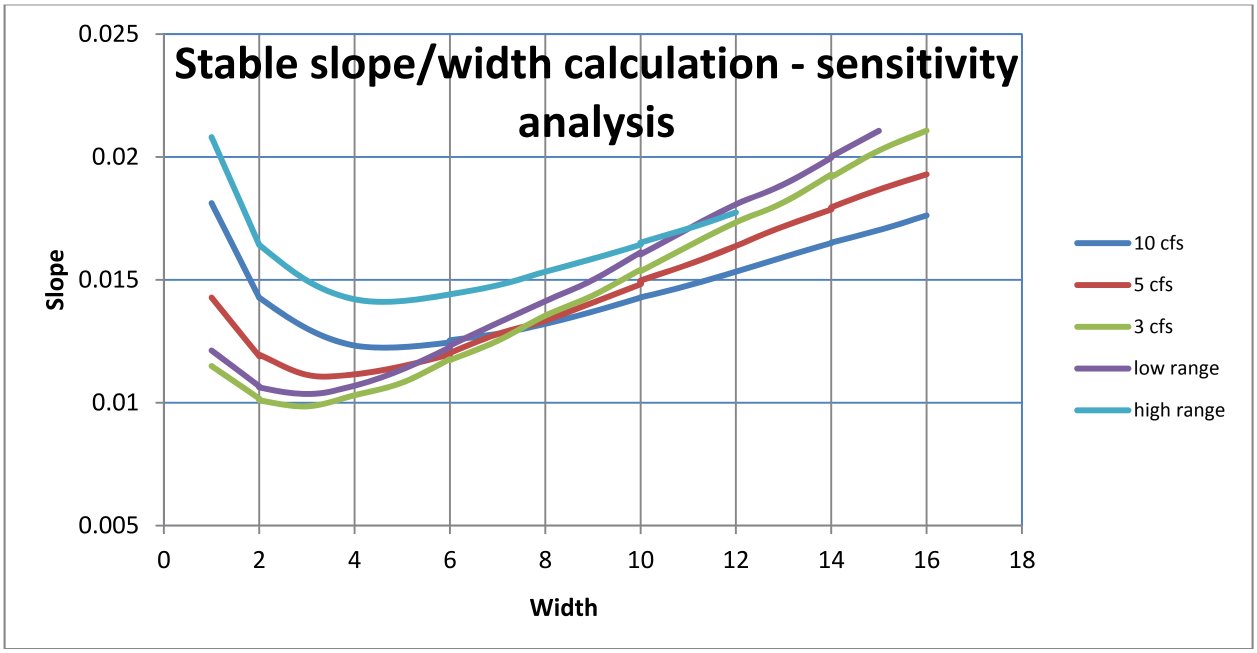

Figure 7 (Stable width/slope calculations and sensitivity analysis)

The analysis shown in (Figure 7) also indicates that excessive inflows of sediment will likely clog the channel. This could adversely impact the project area as it did after the 2008 event. However, it appears that active dredging and channel clearing is currently underway in the immediate area upstream of Route 395 and that this will likely arrest large pulses of sediment before they impact the workshop demonstration site.

Overview of Proposed Treatments: During the exit conference at the field office, Dr. Pearce and the reviewer discussed and refined the locations of the different treatments. A plan view of the site showing the location of the treatments is provided in (Figure 8). This plan is not to scale and only shows the approximate locations and extents of the treatments. Final determination will be made in the field. Each area discussed in more detail below by type. It is noted that fitting treatments into a small site like this can present some unique challenges.

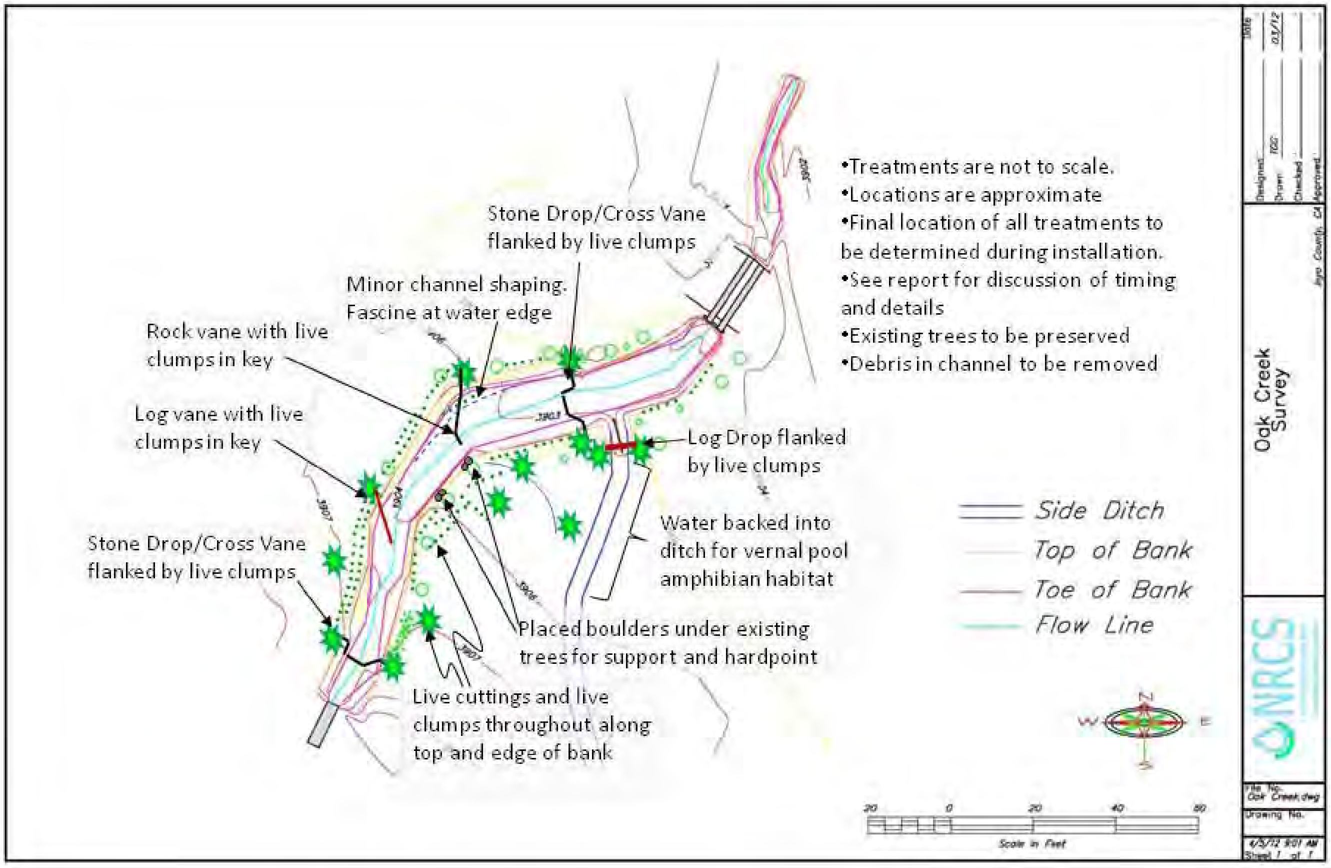

Figure 8 (Overview of proposed treatments)

Treatments:

Drop Structures: Two loose rock structures low stone drop structures are proposed for the project. The locations are as shown in (Figure 8). These types of structures are traditionally used to assure a relatively stable grade. In this site, the grade is fairly fixed by the control provided by the culverts. However, the installation will be a good demonstration and will likely provide for enhanced aesthetics for the expected park like use of the project. In addition, these structures provide enhanced instream habitat through depth and structure.

A proposed concept design for these rock structures is shown in (Figure 9). Height above the bed should be 4 to 6 inches. Care must be taken to assure that the structure does not raise the profile so that it overflows the bank. The minimum key in depth into the bed indicated by the scour analysis is one foot. The minimum rock size should be 12 inches to prevent impacts from visitors. A larger, center weir rock is applicable. The installation of rock drop structures on small channels can present different challenges than installation of a rock structure in a larger channels. The shape and stability of the structure cannot depend on a mass of rock. In general, the structure in this size channel needs to be made of single rock elements which have flat sides as well as of similar size and aspect so that they fit tightly together. It is also important to fill any gaps between the stones with rock (this process is referred to as chinking) to prevent undermining.

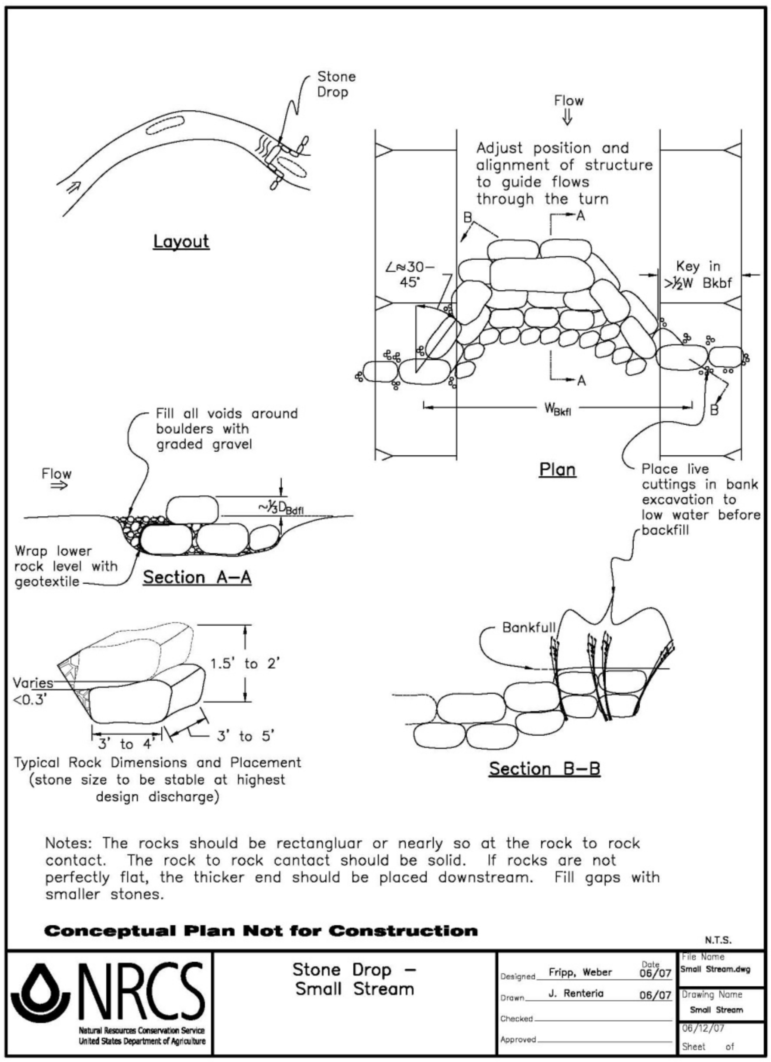

Figure 9 (Concept design for small stone drop)

A log drop is proposed for the side tributary/ditch to demonstrate another grade stabilization approach. It will back up water and create vernal pool wetland habitat. Vernal pools maintain water in wet times sufficient for amphibians but not year round for fish fry which can eat the amphibians. The drop should prevent the movement of fish into the ponded areas. This area is fairly small and it may not support amphibians in all years. A proposed concept design for these structures is shown in (Figure 10). Wood for this can be obtained from the destroyed timber that was lost in the fire. However, it is important to note that the logs must be intact and straight so they can fit tightly together.

All of these drop structures should be keyed into the bank. Live clumps and cutting should be placed into the bank key trench before it is backfilled. This will provide initial shielding to the fill material. By placing the live material before backfilling, it will be more likely that the material extends to the water table. Finally, a well vegetated key will reduce the possibility of flanking.

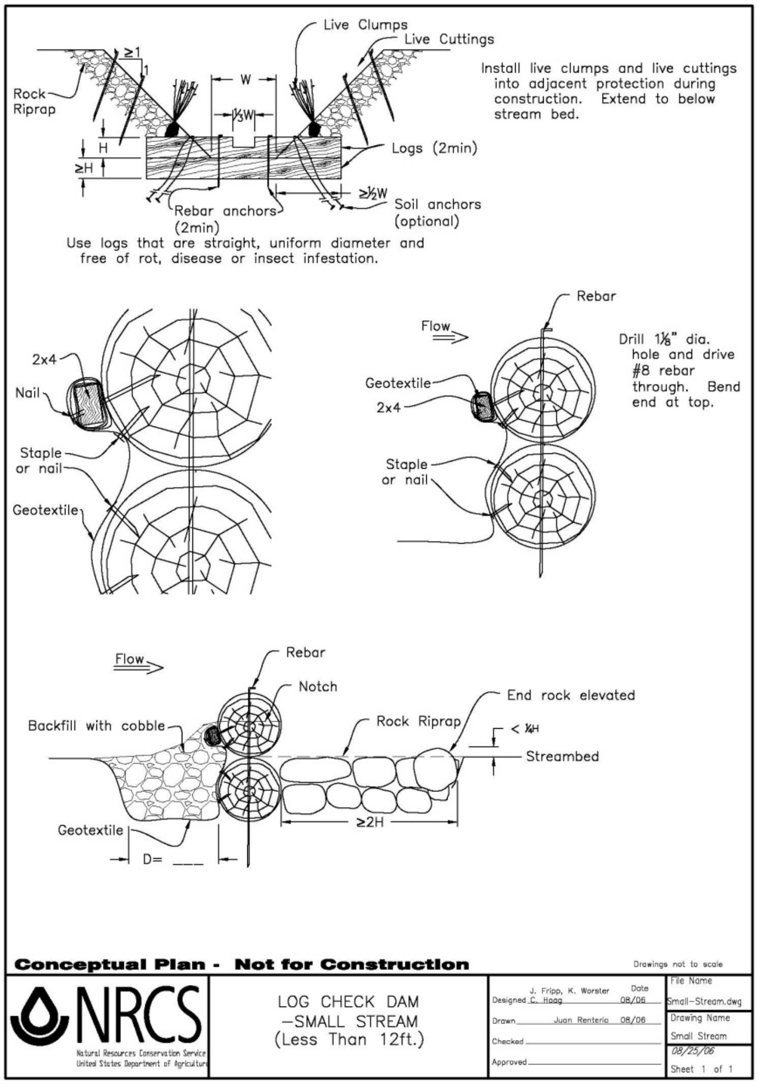

Figure 10 (Concept design for log drop structure)

These structures require grading and the movement of heavy stones and logs. This will require the use of construction machinery. Therefore, these structures should be constructed before the students are on site.

Live Clumps and Live Cuttings: The group noted that the future educational value of the demonstration area would be enhanced with the use of native grasses, bush and tree species.

Therefore a mixture of live clumps and live cuttings is proposed for much of the site. The live cuttings should be of adventitiously rooting material. The use of live cuttings is a rapid and easy technique to vegetate areas with woody material. While providing minimal immediate protection, the cuttings grow and get stronger with time. A concept design is provided in (Figure 11). Spacing should be random at 3 to 5 feet depending on material availability. Even though the riparian area was moist during the subject trip, the live material should be secured and mudded in to maximize good soil to stem contact. For best results, the willows should be planted so that they extend through the damp soils into permanently saturated conditions. As discussed during the subject site visit, a waterjet stinger may facilitate such installation in areas of silts, some sands and some clays. It is noted that the waterjet may not be as helpful in the areas closer to the creek where gravels and cobbles appear to predominate. In that case, a sledge, shovel and pick may be required.

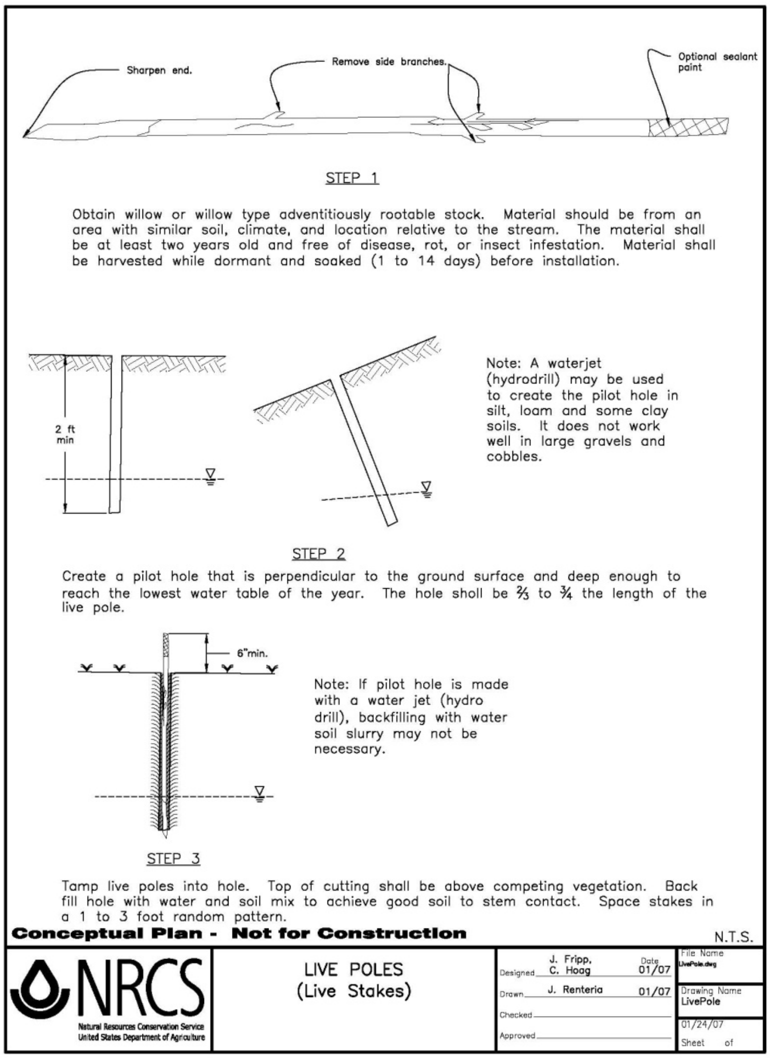

Figure 11 (Concept design of live cuttings)

Live clumps are also proposed for this area as well as other portions of the project area. They provide rapid stabilization and have a high success rate. Live clumps will be able to compete favorably with the existing grasses as their installation requires a measure of scalping the surface. Usually the most problematic issue with the installation of live material such as clumps is excavating deep enough to reach the lowest water table. In this site, the water table is close to the surface in many areas. Where the water table is high, efforts must be made to assure that some of the roots in the live clump are in the aerobic zone. Therefore, the live clump can not be planted too deep. A concept design for live clumps is provided in (Figure 12).

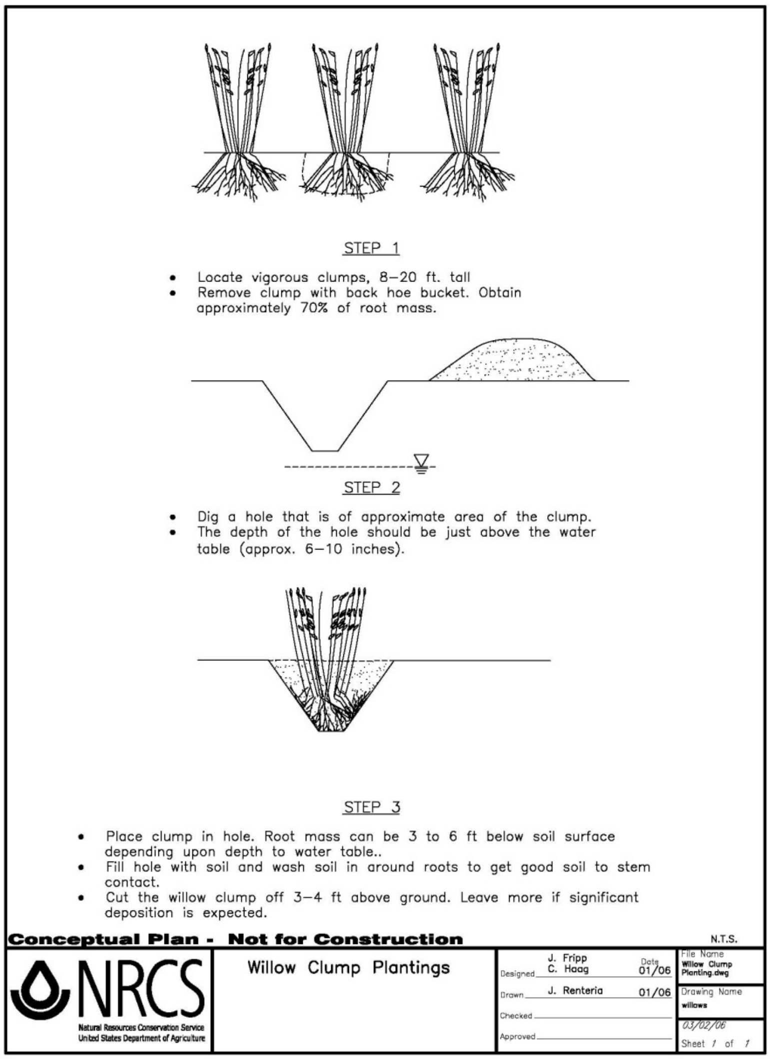

Figure 12 (Concept design of live clumps)

Willows are probably the most common woody plant species used in stream bank soil bioengineering applications. They are versatile, resilient, and relatively easy to establish. They are applicable to all of the techniques discussed in this report (live cuttings, live clumps, and fascines). In addition, while not part of this project, it should be noted that non tree willows can be readily installed through riprap as they remain flexible. It is noted that there areas in the project vicinity where yellow and coyote willow can be harvested. This local harvest would reduce project cost and would increase plant survival. Additional sources for some larger material should be investigated.

Cottonwood plantings may also be appropriate. These have been successfully used in many applications, grow well from live cuttings, and are a tree type species. Cottonwoods prefer moist but well drained soils. They should be planted in the damp soils, not the permanently saturated soils. They should be installed as cuttings and live clumps in this project. It should also be noted that experience has shown that success is improved if the cuttings are taken from sections with smooth bark rather than older, deeper furrowed branches.

Efforts should be made to minimize damage to the live material. Proper harvesting and handling is required for these species. Best results will be achieved if these species are harvested and installed while dormant (fall is best). In drier sites, supplemental irrigation may need to be provided until they become established. However, success can be achieved with leaf-on harvesting and without supplemental irrigation if it is understood that there will likely be a much higher mortality rate of the installed species. More cuttings should be used and particular care should be made in assuring that the cuttings are installed so that they extend to wet or saturated soils.

Student labor can be used to install the live cuttings at this site. The attributes of using different species and sizes of live cuttings can be demonstrated and discussed. The installation of the live clumps can be demonstrated as part of the class. However, an excavator will be necessary to excavate the hole, place the clump, and backfill. A supplemental water source may be necessary in order to wash in the clumps. The students would benefit from seeing this installation. It is unlikely that all of the live cuttings and clumps shown on the plans can be installed during the workshop. However, what is learned at this small portion of the overall project can be readily applied to the rest of the project area after the workshop is concluded.

Vanes: Redirective techniques such as vanes, rock barbs, stream barbs, and vegetative spurs have proven to be effective in moving the thalweg away from the bank and improving sediment deposition along the toe. These can serve to not only establish or set a more stable planform but also to narrow the channel and improve instream habitat.

Two vanes are proposed for the subject demonstration. The first is a rock vane (Figure 13) and the second is a log vane (Figure 14). These structures are typically used to shape/define a channel as well as for bank protection. While the scale of this project likely allows for vegetative control for the channel reach, these structures provide an opportunity to demonstrate this approach. They will also serve to provide enhanced in stream habitat through depth and structure.

The installation of rock vane structures on small channels can present different challenges than on a larger channel. The shape and stability cannot depend on a mass structure of rock. To keep from overwhelming the channel, the structure needs to be made of single rock elements. These rocks need to have flat sides and of similar shapes and size so that they can be individually fit together. It is also important to fill any gaps between the stones with rock (this process is referred to as chinking) to prevent undermining.

This log vane structure includes a woody log element along the alignment of the vane. The rock is only to support the log. The root mass projects from the end to the barb into the scour hole to provide additional habitat benefits. Wood for this structure can be obtained from the destroyed timer that was lost in the fire.

These vane structures require grading and the movement of heavy stones and logs. This will require the use of construction machinery. Therefore, these structures should be constructed before the students are on site.

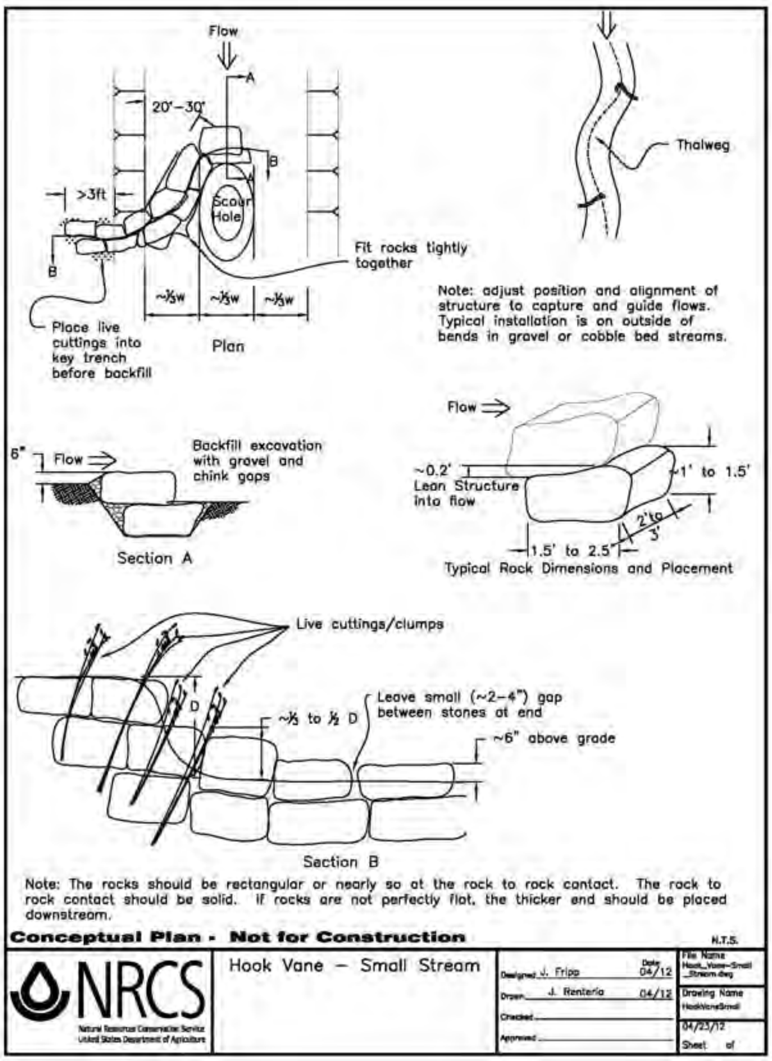

Figure 13 (Concept design for rock vane on a small channel)

Both of these drop structures should be keyed into the bank. Care should be taken to avoid impacting the existing trees. Final location of the vane structures should be determined in the field so that they fit between the existing tress that are on the bank. Live clumps and cutting should be placed into the bank key trench before it is backfilled. This will provide initial shielding to the fill material. By placing the live material before backfilling, it will be more likely that the material extends to the water table. Finally, a well vegetated key will reduce the possibility of flanking.

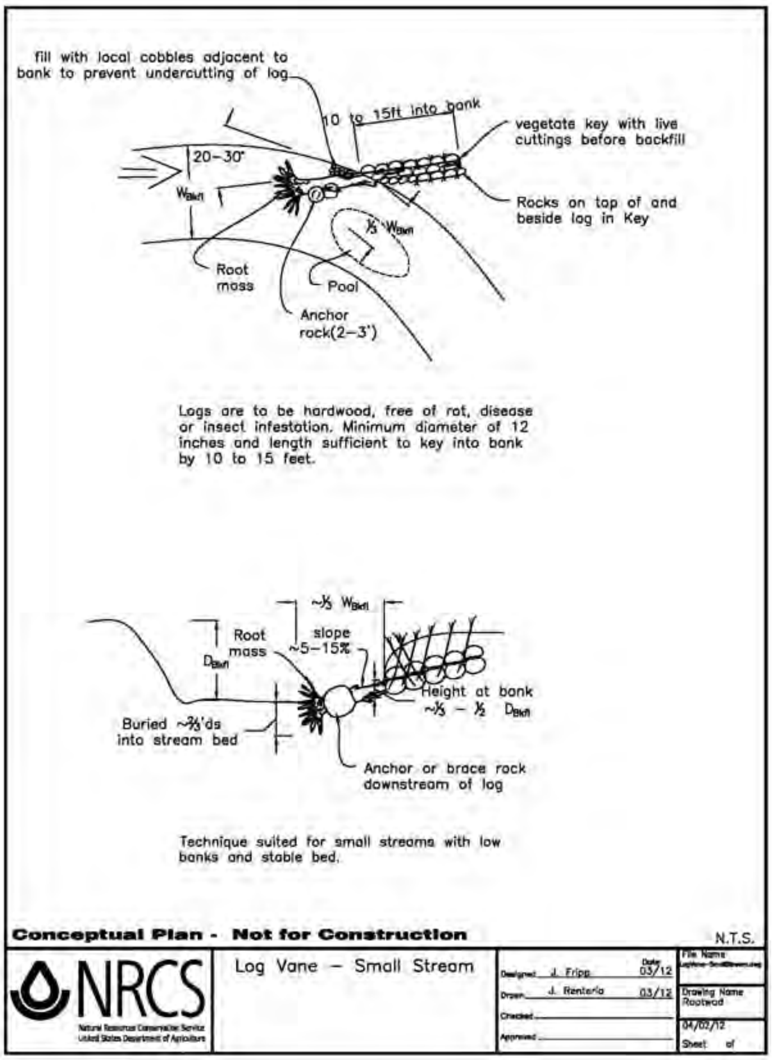

Figure 14 (Concept design for log vane)

Fascine Toe: A portion of the channel should be narrowed and the channel bend softened. The center bar / in-channel material can be used for this part of the project. This area is shown in (Figure 15). A fascine is proposed at the toe of this area. It will provide immediate protection that gets stronger with time as the cuttings root and grow. The fascine should be constructed with live willow cuttings as previously discussed. This area of the bank is under direct stress which provides for a good demonstration of this traditional soil bioengineering practice. Fascines are also a traditional technique and are widely used with success. The establishment of fascines can be adversely impacted by being either too wet or too dry. But this area is controlled with both flow and grade by the lower structure. A concept design of the fascine is provided in (Figure 16).

The grading and realignment should be done with an excavator prior to the class. The fascine can be constructed and installed with shovels and sledge hammers using student labor during the class. String and dead stout stakes are required to secure the material.

Figure 15 (Area for reshaping and fascine installation)

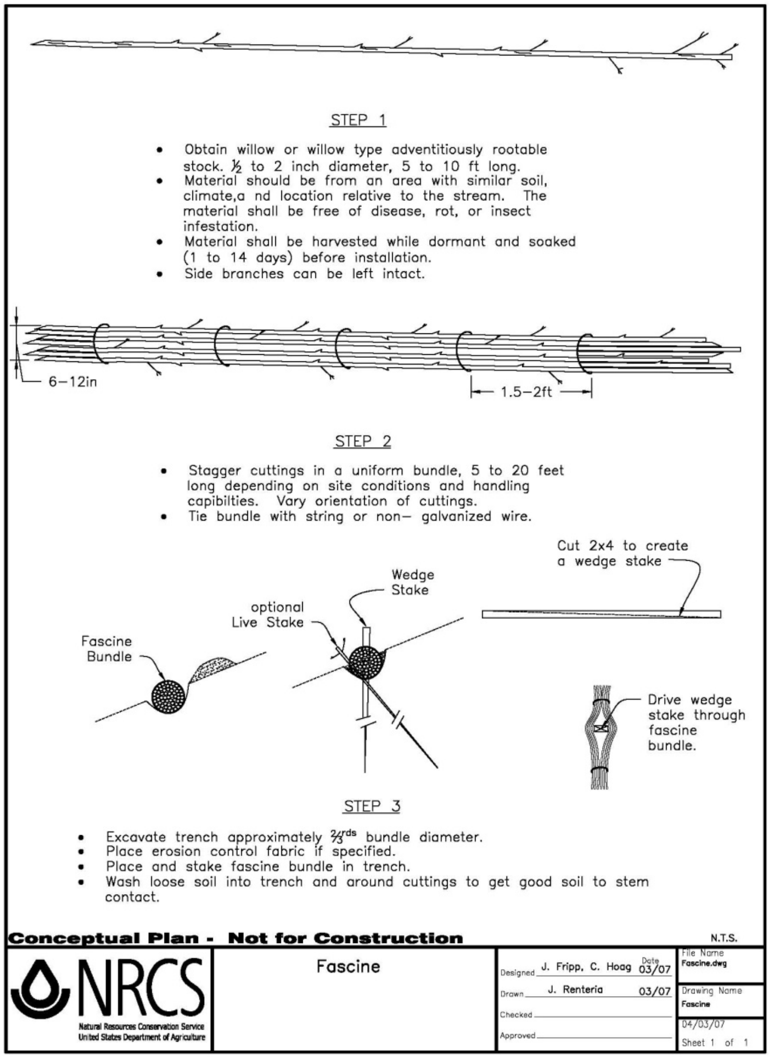

Figure 16 (Concept design of a fascine)

Construction Drawings and Specifications: Conceptual drawings are provided as part of this report. AutoCAD and/or PDF versions of the concept details contained in this report are available upon request. No construction specifications or details drawings have been prepared. If needed for permitting or cost estimate purposes, detailed plans and specifications can be prepared using information shown on the plan drawing and various treatment detail drawings. It should be noted on the final drawings that some variation should be expected during construction. This should be stated as part of any permit application.

Cost Estimate: No cost estimate has been developed. Much of the live material can be harvested from areas in the vicinity of Oak Creek including the Oak Creek watershed. Some of the irrigation and diversion ditches in the valley may provide a good source of material when they are cleaned. However, there will be a need to obtain some of the inert material as well as some costs associated with excavation. A cost estimate can be prepared using, in part, the information shown in notes on the concept drawings for the various treatments.

Permitting Requirement: As with any project, applicable permits and associated regulatory coordination is necessary before work can begin. Coordination by Dr. Pearce with his contacts may be required for the specifics proposed as part of the stream project. It is suggested that the permitting application note that variation from proposed project treatment locations and extents is expected.

Operation and Maintenance (O&M) Plan: An O&M plan has not been prepared. However, this project design relies on the establishment of vegetation. If a moderate storm occurs before vegetation is established and firmly anchors the proposed treatments, there is a potential for bank erosion. Erosion can also be initiated if a significant amount of sediment deposits into the reach. The goal of this project is to mimic natural conditions. Natural channels in this environment can be expected to move and experience some bank erosion during storms. Large storms may cause large movements. Therefore, it should be recognized that, even with an established system, periodic bank erosion is expected and the proposed project may not be as static as a traditionally engineered bank stabilization project.

A maintenance plan should be developed. This plan should include a recommendation to add supplemental live cuttings and to replace or enhance stone material as appropriate. In addition, an most important, it will be necessary to remove debris, trash, and especially sediment deposition that is deposited within the project area. Finally, since this site is inteneded to have a significant public use, some maintenance for removal of trash and repair of potential valdelism should be considered.

Monitoring: The techniques suggested and the plant materials discussed have been successfully used on soil bioengineering projects in other areas. However, it is unlikely that they will perform equally. It is suggested that their relative performance be monitored and compared. Future projects in the area can make use of the lessons learned from the installation and performance of these different techniques. Monitoring of the installed live cuttings different riparian woody plant species could be facilitated with the use of different color marking or sealing paint. The top ends of the cuttings can be dipped into a 50-50 mix of latex paint and water. This paint will also act to reduce desiccation of the installed material. There will likely be continued natural recruitment of live material from upstream sources. In fact this will likely be accelerated by some of the installed practices. By marking or at least mapping and characterizing the installed material, future assessments can include what woody material was installed as well as what might naturally spread into the site.

Workshop Issues: There is much preparation and work that must to be accomplished prior to the class. This includes coordination for lecture facilities including PowerPoint projectors and a screen. Handout material will be provided by NDCSMC for duplication and distribution. Field guides and handouts of NEH-654 will be provided by NDCSMC. For the infield portion of the workshop, the aforementioned work needs to be accomplished and materials collected and stockpiled. In addition, hand tools should be obtained. It should be confirmed that adjacent restroom facilities are available for the field portion of the workshop.

The installation of the fascine and live cuttings may be readily accomplished with student labor during the class. This work readily lends itself to student involvement. This work would be greatly facilitated if a waterjet stinger can be obtained for use during the workshop. It is understood that Dr. Pearce will be able to obtain one. The location and installation of some of the live clumps if done with a small excavator can also be observed by the student during the training. For safety and scheduling, it is suggested that the other practices, including the excavation and rock placement, be completed before the students are on site. The students can be shown these treatments during the workshop and led through a discussion of their purpose and behavior.

Dr. Pearce has requested that the reviewer arrive on the site a few days before the workshop to help coordinate some of the initial construction. This is a good idea but will need to be coordinated when the dates are finalized.

APPRECIATION: We would like to acknowledge and thank the California NRCS staff for an informative and enjoyable visit.

Jon Fripp
Civil Engineer - Stream Mechanics

CONCURRED: ______________________ DATE: 4/30/12
JOHNNY GREEN, Co-Director NDCSMC

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