ROAD WATER INTERACTION STANISLAUS NATIONAL FOREST

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Executive Summary

The purpose of this project is to perform variety of watershed related tasks including the collection of data used for road condition assessments, road restoration needs, meadow restoration, soil condition monitoring, aquatic organism passage, and rangeland condition monitoring in the areas affected by the Rim Fire and across the whole forest as related to serve weather related impacts from heavy precipitation events in 2016-2017.

Project Objectives

During this summer internship, the project was split into two portions. The primary portion of the project included collection of data used for road condition assessments and road restoration needs. The bulk of the inventory work included using standard protocols for road assessments and submission of projects for funding under Emergency Relief for Federally Owned roads. The secondary portion of the project was related to watershed restoration effects in the area affected by the Rim Fire. Work was conducted with soil scientists, and hydrologists to identify restoration needs and engage in pre-project preparation for planned restoration efforts. Evaluation of aquatic organism passage and survey for rare and endangered species was also part of the project.

This project has reassured my career path and made me feel confident about my current field of study. Although there are multiple career opportunities with USDA, the field of Engineering excites me the most. Before starting this project, I was not aware of application of Civil Engineering in the Forest Service. I was only aware of Civil engineering work done by NRCS where they would help conserve Natural resources (i.e., Design irrigation systems) to help conserve water, take appropriate approach to prevent erosion, etc. Upon completion of this project, I acquired understanding regarding duties of Forest engineers, Facilities engineers in the Forest Service. This project has helped me apply multiple skills which I acquired in school under constant supervision of professionals. Upon completing my bachelor's degree on May 2018, I am planning on pursuing any engineering related career with any USDA agency preferably NRCS.

Prior to beginning of this project, I had few number of goals in mind. Firstly, I never had opportunity in life to collect real life data. I wanted to improve my skills on data collection. Secondly, I wanted to apply computer applications to model data. Last goal I had in my mind was to improve my communication skills. This project has given me numerous opportunities to go out in the field to collect data such as cataloging road damage, pre-meadow restoration surveys, meadow soil analysis, and collect piezometer data installed in meadows. After collecting data, I could use numerous software's for modeling. This project has improved my skills with Excel, ArcGIS, and AutoCAD. Lastly, getting opportunities to spend time with numerous professionals has improved my communication skills. Upon completion of the project, I could successfully accomplish the goals I had set.

There were multiple tasks performed at this project. The first phase of the project lasted almost 6 weeks which included cataloging road damage from heavy precipitation from 2015-2016 storms, conducting road surveys to come up with road plans for Timber Sale, Modeling Failures using computer, preparing cost estimate plans, installing signage to open certain roads for public use, and entering bridge evaluation reports into Excel. Second phase of the project was broad as there were multiple opportunities to work with professionals from different fields like biology, hydrology, and soil scientists. Task performed in this phase include wetland delineation, survey for endangered species, pre-and post-restoration monitoring of meadows, and monitoring invasive weeds in meadows. Last task of the project included inspection and repair of water systems on the forest ranging from simple hand pumps to complex chlorination plants.

Project Approach

During first phase of the project, a systematic approach outlined by Forest Engineer was used to accomplish the tasks. First part of the project was to become familiar with road assessment protocol. This included understanding fill slope failures, pavement design, culvert design, drivable water bar design, lead off ditch design, and appropriate signage requirements. Various handbooks and manuals were provided by the staff to accomplish this task. Secondly and most vital part of the project was going out in the field to collect data and to catalogue damage. This included measuring width, depth, and slope of failure, existing depth and material of pavement and all other necessary measurements to create a computer model and to come up with cost estimate. Since there were multiple failure sites examined daily, best strategy was to use field tablet to record data, take pictures, and save them with GPS coordinates of the failure. This strategy proved to be very successful as there was no mixing of data. Caltrans' road manual and Forest Service's supplemental manual was used to give recommendations to correct problems. There are multiple maintenance level roads on the forest and those roads need to be in optimum condition for hauling timber during timber sales. Road maintenance map for upcoming timber sales was provided by the officials. The strategy adopted was to drive or walk each segment of road in timber sales map cataloging repairs such as culvert cleaning, curve widening, fill slope failure etc. and georeferencing locations using hand-held GPS devices. AutoCAD and Excel played a vital role in computer modeling. Using unit prices generated from previous projects, and using well laid out Excel templates increased efficiency of this part of the project. Storms from 2015-2016 did tremendous amount of damage to the roads and Stanislaus

National Forest's road crew had to work hard to get some of them ready to be opened back to the public. Before opening roads for public access, it was compulsory to install proper signage to warn traffic about upcoming hazards on the road. The strategy adopted was to examine each repaired site thoroughly and to use Caltrans standards for installing signage and delineators. Around 35 signs such as Single Road Ahead, Pavement Ends Ahead, Stop Ahead, etc., and 100 delineators were installed on 5-mile section of a road to bring road to standard where public could drive through it safely (Appendix, Figure 2).

Bridge inspection is vital because it is important to maintain an accurate knowledge of the condition of the bridges so that repairs and replacement can be coordinated and provide confidence for the Forest Service for safe use of the bridges. The Forest Service conducts bridge inspections every two years and records all the data on paper. Recently, the Forest Service came up with a strategy to save all the bridge inspection reports in Excel format. This will allow much faster and easier access to reports for repairs etc. There was no easier and faster approach to accomplish this task. Reports from previous years need to be entered manually into the computer.

Second phase of the project started with wetland delegation. Wetland delineation defines boundaries within a meadow which fall under "waters of United States". For this task, 1987 Army Corps Wetland Delineation Manual was used. When defining boundary, various soil samples were dug around the meadow to check water table, redox reaction of soil, and type of soil (Appendix, Figure 1). Approach for this part of the project was to basically follow the Manual and establish the boundary and record it using handheld GPS. Monitoring endangered

species was part of second phase during which Aquatic Biologist Steve Holdeman conducted survey of yellow legged frog. Going over handbook for Yellow legged frog give information regarding their habitat, elevation, conditions etc. which played a key role during field survey.

Erosion is a primary enemy of well-established meadows. All unrestored meadows showed signs of erosion degrading stream channels and there was convincing evidence of head cuts advancement.

Water systems play a vital role at forest service campgrounds. Availability of fresh water for drinking use and potable water for toilets attracts more visitors to the forest. Most of these water systems require constant maintenance and require permits from the state. Tasks for this project include taking water samples and sending them to lab for water quality analysis and adding chlorine to water for disinfectant purposes.

Project Outcomes

After inspecting multiple damaged road sites and evaluating roads for timber sales, it turns out that undersized culverts and improper cleaning of culverts is responsible for majority of road damage. Most of the installed culverts are not capable of handling 100-year return period floods. Before every winter it is very import important to clean catch basins of culverts and pull lead off ditches with the grader. However, the road crew for the forest consists of only two people and Stanislaus National Forest road network is approximately 2200 miles. Shortage on staff and resources to do road maintenance leads to some of the roads to tourist destinations inaccessible, makes firefighting harder, and results in expensive repair costs

instead of cheap maintenance. For instance, simple cleaning of culvert inlet costs only few hundred dollars but when not done results in expensive fixes costing thousands of dollars. Another interesting outcome from this project was understanding the importance of putting up warning signs before opening roads to the public. This segment of the project helped understand legal liability for dangerous conditions.

Second phase of the project was a unique learning experience as I had no previous knowledge and experience with meadows and endangered species. Meadows are very important habitats in the forest. They represent less than 1% of the entire area of our forest, yet they have very high species diversity in terms of plants, animals (butterflies, bees, other pollinators, etc.). California meadows have experienced more than a century of degrading influences which have resulted in less efficiency of its critical functions. Findings from this project indicate that budget needs to be increased so that meadows can be restored to pristine condition. Head cuts from erosion result in lower water table in meadow which hurts the diversity of plants. After going out and taking piezometer readings at one research meadow, it can be concluded that such devices should be installed at all the meadows for more accurate monitoring so that proper maintenance can be done to the meadow before it degrades further (Appendix, Figure 3). The Rim Fire has resulted in tremendous amounts of erosion. Some animals don't do very well in habitats that have excessive sedimentation in water. Fish, like trout have a challenging time laying eggs and eggs have a challenging time because all the sediment can suffocate them when they are growing into little fish. Such an environment is not good because it makes it worse for endangered species such as Yellow legged frog and results in decreased fish population. Since

fishing is one of the top recreational activities on the National Forest, lower no of fish can result in fewer visitors thus hurting the local economy.

Conclusions

This project was a great learning experience. Tasks performed during this project included collection of data used for road condition assessments, road restoration needs, meadow restoration, soil condition monitoring, aquatic organism passage, and rangeland condition monitoring. Many valuable skills were gained from this project such as computer based programs, how to do wetland delineation, groundwater monitoring, and water quality monitoring. This was by far one of the best projects I have worked on.

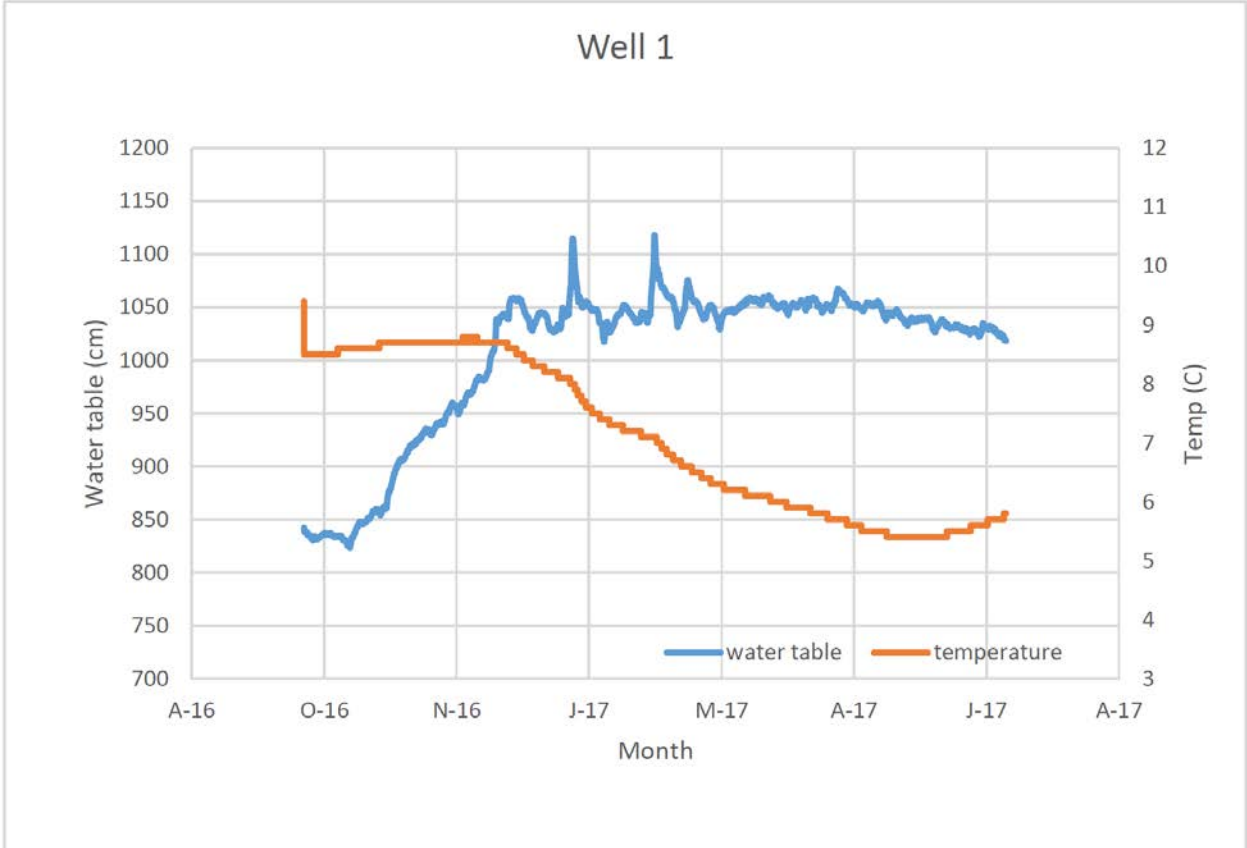# Appendices

Figure 1: Inspecting soil type for wetland delineation

Figure 2: Installing signs

Figure 3: Water table of a meadow