

## DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION (DRISI)

### Research Initial Scope of Work

#### SUBMITTAL FORM - FY 13/14

---

I. **Project Number:** P858  
**Project Title:** Culvert Project Planning Cost Estimate Tool

II. **Task Number:** 2528  
**Task Title:** Culvert Project Planning Cost Estimate Tool

III. **Project Problem Statement:**

Caltrans needs reliable Project Planning Cost Estimates to be able to properly justify projects, analyze various project alternatives, budget for projects, and program projects. Cost estimates for the Caltrans project development process include all capital outlay costs, including right of way, structures and landscaping. Project Planning Cost Estimates need to be developed using a consistent and comprehensive methodology. One of the goals of cost estimating is to insure that items of work are properly identified and estimated to avoid cost overruns which may lead to delayed or canceled projects.

Culverts are an important part of a highway complex allowing water to flow through a roadway section. They are necessary to protect both the roadway and adjacent property from water damage and are often a major portion of the cost of a road. Additionally culverts can be used by fish and wildlife to traverse a highway helping to meet obligations under environmental law, policy, and Caltrans goals.

In the past when culverts were designed to insure fish passage emphasis was often given to accommodating returning spawning runs of anadromous salmonids. However, now designs are beginning to consider the stream and shoreline habitat requirements and need for unimpeded movement of slower and smaller fishes along with amphibians, turtles, and other aquatic and terrestrial organisms. These approaches generally result in constructing larger culverts than conventional hydraulic approaches. To be able to compare alternatives and plan for transportation projects it is necessary to be able to provide planning level estimates for culverts that facilitate fish and wildlife passage.

IV. **Objective:**

The objectives of this task are:

- To develop a project planning cost estimating tool suitable for use by Preliminary Environmental Analysis Report (PEAR) staff and Project Development staff to calculate a reliable planning cost estimate for standard culverts and for culverts that facilitate fish and wildlife movement. The tool must be useful in comparing costs among crossing concepts and providing a useful cost estimate planning and budgeting needs. It must also be useful in identifying costs and issues for permit negotiations. The tool must produce estimates that meet the criteria for Project Planning Cost Estimates as specified in the Caltrans Project Development Procedures Manual including the specified contingencies as well as the PEAR process.

- The tool should provide useful cost comparisons between standard Caltrans culvert designs and bank spanning designs such as the US Forest Service designs, both for fish passage and for animal passage. That is, the tool should provide cost comparison estimates that will be useful in addressing currently typical Caltrans culvert designs and alternate designs that reflect typical regulatory agency desires, including USFS Aquatic Organism Passage (AOP) designs.
- To develop a knowledge base on culvert design and project cost estimating relating to culverts. This knowledge base must be useful in developing or improving the methods to create cost comparisons and project cost estimating. Additionally this knowledge base must be useful for Caltrans and other engineering organizations for collecting and sharing crossing design cost information and for creating common knowledge on the value of various crossing implementations.

#### **V. Task Description of Work and Expected Deliverables:**

The following is a draft high level work breakdown structure for the Culvert Project Planning Cost Estimate Tool project:

- Develop the criteria for animal passage to be used in the culvert project planning cost estimates (e.g. relation to bankfull width, flow velocity in the culvert related to the streams flow velocity, water depth at low water, and etc.). The deliverable is a report section listing the criteria and explaining why the criteria are important for use in estimating culvert costs.
- Develop the characteristics of culverts that can be used to make Project Planning Cost Estimates (e.g. material to be used, length of culvert, height of fill, presence of footings, excavation & etc.). The deliverable is a report section listing the characteristics and explaining why the criteria are important for use in estimating culvert costs.
- Based on work performed in the previous tasks develop a knowledgebase of culvert costs throughout the state broken down by region. The deliverable is the knowledgebase.
- In consultation with Caltrans determine the platform (e.g. spreadsheet application) for the tool. The deliverable is a report section detailing what platform was selected, and why it was selected.
- Develop algorithms to be used for making Project Planning Cost Estimates. The deliverable is a report section detailing the algorithms.
- Develop the draft Culvert Project Planning Cost Estimate Tool. The deliverable is the draft project planning tool presented to Caltrans for review.
- Develop the final, validated Culvert Project Planning Cost Estimate Tool. The deliverable is the final tool acceptable to Caltrans along with a final report covering the entire project.

Deployable Products:

This project has two deployable products:

1. A knowledge base of regional culvert cost information that can be used in developing planning cost estimates for culverts.

2. A planning cost estimating tool suitable for use by Preliminary Environmental Analysis Report (PEAR) staff and Project Development staff to calculate a useful planning cost estimate for standard culverts and for culverts that facilitate fish and wildlife movement.

## **VI. Background:**

Environmental law and policy require appropriate mitigation of impacts to sensitive protected organisms. Also, among Caltrans goal's is stewardship: to preserve and enhance California's resources and assets including such natural resources as fish and wildlife. So Caltrans designs, builds, and maintains the state highway system not only to meet transportation objectives, but also to help conserve sensitive fish and wildlife populations. It is well known that roads can create barriers to fish and wildlife movement resulting in reduced populations due to restricting access to needed habitat resources, genetic isolation, or preventing migration into habitat after a local extirpation. When properly designed culverts can be used by fish and wildlife to safely cross a roadway and reduce the negative consequences of roads as barriers to animal movement.

In recent years maintaining aquatic organism passage has become an important criterion in culvert design. Several options such as active channel culverts, low slope culverts and stream simulation culverts and modified hydraulic design that allow better aquatic animal passage than traditionally designed culverts exist. Additionally, features that facilitate passage for terrestrial animals through culverts such as unwetted sides and sufficient head clearance can be used to promote connectivity for those animals. For instance, the extended stream crossing concept is an example of combining aquatic and terrestrial animal crossing considerations.

Culverts designed to accommodate biotic passage are often perceived to be more expensive to construct than culverts designed considering only the efficient movement of water across the road. This increased cost is due to such factors as larger culvert size, increased excavation costs, and an increased need for labor. MAP-21 along with other laws and policies encourages the consideration of the environmental impacts and the examination of environmental impact mitigation costs early in the project planning process.

Having a tool that helps provide good planning estimates for various culvert options would allow better option selection and ensure proper funding for appropriate mitigation. Reliable cost estimates are necessary for responsible fiscal management. Reasonable properly developed cost estimates are needed to ensure that items of work are properly identified and estimated to avoid cost overruns which may lead to delayed or cancelled projects while appropriately mitigating environmental impacts. Thus, cost estimates need to be prepared using a consistent and comprehensive methodology.

## **VII. Estimate of Duration: 24 Months**

### **VIII. Related Research:**

- 1) Comparing Life Cycle Costs of Fish- and Wildlife-Friendly Culverts with Conventional Culvert Designs - Caltrans Preliminary Investigation  
[http://www.dot.ca.gov/research/researchreports/preliminary\\_investigations/docs/culvert\\_lcaa\\_pi\\_1-8-12.pdf](http://www.dot.ca.gov/research/researchreports/preliminary_investigations/docs/culvert_lcaa_pi_1-8-12.pdf)
- 2) "The Economics of Culvert Replacement: Fish Passage in Eastern Maine," John Long, State Economist, Maine Natural Resources Conservation Service, revised March 2010.  
<ftp://ftpfc.sc.egov.usda.gov/Economics/Technotes/EconomicsOfCulvertReplacement.pdf>
- 3) Cost Analysis of Alternative Culvert Installation Practices in Minnesota, Minnesota Department of Transportation, Report No. MN/RC 2009-20, June 2009. <http://www.lrrb.org/PDF/200920.pdf>

### **IX. Deployment Potential:**

There is high potential for implementation of this project's products described above. The research is in the preliminary stage and this project is an entire endeavor and not an incremental part of a larger effort. This project's primary sponsor is the Division of Environmental Analysis.

### **X. Author: Harold G. Hunt**

**Date:** 5/29/2013