# Guide to Estimating Environmental Costs

*Requested by:*

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Standing Committee on the Environment

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# Introduction

## Purpose of the Guide

The purpose of this guide is to give the Department of Transportation (DOT) Project Manager, the Transportation Program Developer, and the Environmental Practitioner direction in estimating environmental costs for transportation projects. This guide is based on best practices used in the industry, and best project management practices used in any industry.

## What are Environmental Project Costs?

What counts as an environmental project cost depends on the use of the cost estimate being generated. What is assigned as an environmental cost varies depending on each purpose.

Common uses for environmental cost estimates are:

- Identifying project costs for the purpose of estimating and identifying project funding needed for a transportation program.
- Projecting project cost for project management purposes including cost management and work force assessment.
- Identifying costs related to certain processes and regulations for the purpose of process improvement or modification of regulations.
- Assessing environmental program cost-effectiveness.

This guide is primarily directed at actual out-of-pocket costs for developing and constructing transportation projects. It addresses the labor, material usage, equipment usage, and travel expenses of staff or consultants doing environmental analysis and documentation during project planning and development. It addresses purchase of right-of way, materials, installation labor and additional purchases for major environmental mitigation features such as wetlands restoration and noise walls during construction. In other words, this guide addresses costs that become evident as project charges at the end of project development and construction.

In accordance with the panel's direction, this guide does not address the "theoretical" environmental costs to society of impacts that are not mitigated or the "cost of avoidance." On the other hand, a DOT may have other purposes for estimating environmental cost beyond program development and project management. Internal and external questions about the cost and effectiveness of environmental programs arise from time to time. These questions may require a different approach to defining the environmental costs of projects. While the primary focus of this guide is on estimating costs for project programming, project management, and construction purposes, each phase of project implementation has a section addressing how costs might be captured differently if the purpose is a study of how environmental regulations affect the costs of projects.

The reader may ask why a study on how environmental regulations affect the cost of projects would be different from project costs. The focus of this guide is to assist Project Managers in accurately predicting total project costs for the purpose of assigning adequate funding during programming, for managing the project as it develops, and for assessing performance after completion. To this end, the Project Manager wants to identify all costs, but is not necessarily interested in labeling them, other than to identify who will perform the work.

For the purpose of the project estimate, the Project Manager wants to avoid double counting. Confusion arises where one element serves two purposes, usually in design. For example, a culvert may provide services relating to both water conveyance and fish passage. The culvert may have additional elements, such as baffles, to facilitate fish passage. The "environmental" component of the project's costs would include the environmental staff providing direction on the type and placement of culvert elements needed to benefit the fish in question; however, if an engineer is designing a culvert to address drainage and fish passage, the Project Manager will account for this work item as engineering. It is not important to the Project Manager for budget purposes, that the culvert may provide fish passage as well, and therefore may not be of interest to legislators or others as an "environmental" cost of the project. The projected project cost is captured in the number of hours that the engineer will work, and the cost of fish mitigation will be embedded in the engineers estimate for the culvert.

However, if a study were underway to determine the cost to the agency of providing fish passage, some effort would need to be given to determine the engineer's time spent making the culvert passable to fish, and the cost of baffles and size of pipe would need to be compared to one designed to convey water only. A study would need to parse the costs, whereas the Project Manager has all costs accounted for. Therefore, it is important when discussing environmental cost to define the purpose of the data collection, and to define what will and will not be counted as an environmental cost for that defined purpose.

For the purpose of this guide, an environmental cost is one that directly arises from the labor, travel costs, equipment or material usage of an environmental staff member or consultant, the cost of production of an environmental document, and the cost of construction or performance of an environmental mitigation feature that is distinct from other roadway features during construction. For example, wetlands replacement and noise wall construction would be an environmental cost. Added roadway necessary to avoid an environmental feature would not be considered an environmental cost. Work performed by engineering staff is not an environmental cost if their time is fully accounted for under project management, design, or construction management. The Project Manager's focus is to capture all the project costs, while not double counting.

# Fundamentals of Cost Estimating

## Types of Cost Estimates

Transportation projects evolve from the early concept stage through final design. At each step in the process, the scope of the project becomes more defined. Design decisions are made and design details are added. Project cost estimating also evolves throughout the project development process. Different estimating methods and tools may be used at each stage of project development.

Traditionally, cost estimating at DOTs has followed the approach used in the construction industry, estimating costs by average cost per constructed unit, such as cost per lane-mile. This method is call unit price estimating. The pre-construction work has often been estimated as a percent of construction cost. This method may work adequately for constructed environmental elements, such as noise walls and wetland replacement where construction cost histories can be developed on a linear foot basis for noise walls, and a per acre basis for wetlands. However, constructed environmental elements are frequently not identified early enough to include them in early estimates.

In addition, using a percent of construction cost for environmental project development costs has not proven satisfactorily predictive. Environmental effort is as much dictated by the location of the project as the type or length of the project. For example, widening a shoulder in a rural area may generate no impacts, or it may impact prime wetlands, threatened and endangered habitat, or archaeological sites. Widening a shoulder in an urban area may generate no impacts, or it may eliminate parking, bicycle and pedestrian facilities, or business access, or damage a historic property or park. Successful estimation of environmental elements requires an evaluation of the project site prior to estimation. Bottom-up estimating is discussed below as a method for addressing environmental estimates

The following methods and stages of cost estimating draw from the traditional engineering estimate approach. Approaches have been added where needed to help adapt this methodology to estimating environmental cost.

Generally, cost estimating at various stages are categorized as conceptual, engineer's, or contractor's detailed estimates. These stages are further described below.

### Conceptual Estimates

When the need for a project has been identified and basic scope parameters have been determined, the DOT needs to know the possible range of cost for the project. Conceptual estimating involves applying average costs for various parameters (termed parametric costs) from similar past projects to the basic scope parameters of the current project. For example, the conceptual cost for a new roadway might be estimated using a parametric cost per lane-mile. Similarly, the cost of bridge structures may be estimated from the span length. Conceptual estimates would also include estimating the cost of planning, environmental, and design activities based upon identified deliverables. This can be accomplished by identifying likely activities from a checklist, such as noise and air analysis, and using average costs for these efforts in the estimate. The accuracy of these early estimates is of course not as good as that produced by more detailed methods that come later; however, the conceptual cost estimate is sufficient for planning purposes.

## Engineer's (Owner's) Estimate

As the design nears completion and work quantities can be determined from the plans, an engineer's estimate is prepared representing the expected contractor bid price for the work. Often the estimating process involves compiling a listing of standard work quantities taken from project plans and applying average unit prices to the work quantities to develop a total project construction cost. Unit price values are generally obtained from historical bid data maintained by the DOT. To some degree, the estimator may consider project specific factors such as location when applying unit prices.

By its nature, the Engineer's Estimate has the cost of constructed environmental mitigation imbedded in the estimate since at this point, mitigation and constructed features are incorporated into the design of the project.

## Contractor's Detailed Estimate

Contractors will base their cost estimate on the completed final design plans and specifications. Most transportation projects utilize unit price bidding where the owner supplies the work quantities and the contractor bids unit prices; however, for various reasons contractors often do their own verification of quantities. The estimating procedure used is sometimes called a "bottoms up approach." For each work activity, the contractor will determine a means and method for performing the work. More specifically, this will involve determining the crew (equipment and personnel) and materials required. Material unit costs are determined from current vendor quotes. The crew cost per unit of time is known. The estimator must assign a production rate to the crew for this work activity. Given the crew cost per unit of time and the production rate, a unit cost can be calculated. Obviously, the contractor's bid unit prices would also include a markup of overhead costs and profit.

As with the Engineer's Estimate, the Contractor's Detailed Estimate has the cost of constructed environmental mitigation and use of staff as environmental monitors embedded into the estimate and bid.

## Bottom-Up Estimate—Scope of Work and Price Estimate for Consultant Contracts and In-House Project Development

The above three stages of cost estimates focus on the cost of constructing the finished product and frequently treat development costs as a percent of the construction price. During the project development phase, however, much of the cost is attributable to services and intermediate products such as environmental and engineering studies, permits, public involvement, planning, and traffic analysis. The need and level of effort for these services rarely varies based on the length of the highway, lane-miles, or bridge length. The level of effort is more often dictated by the location of the project, the number of resources impacted, and the regulations activated by the project. Therefore, estimating during this phase is most successful when the Project Manager develops a scope of work (SOW) for the effort in each of these categories. The scope should be developed in consultation with the practitioners of each discipline that will be needed, since many have complex regulatory demands that vary by project. The cost should be developed by doing a bottom up estimate that requires estimating hours of effort required for each discipline's involvement in the project. Travel costs, equipment, material, and publishing costs will also need estimation. Appendix A is a sample bottom-up cost estimate spreadsheet based on a SOW for a Draft Environmental Impact Statement (DEIS). This example is for a consultant project.

# Estimating Principles

Each of the stages above are approached by using one of two methods of cost estimating—unit price estimating or bottom-up estimating. The principles of each are addressed below.

## Precision

All cost estimates are estimates of future costs. Cost estimates always vary to some degree from the actual costs. Accuracy of the estimate is dependent upon the following:

- Level of design detail (or SOW definition)
- Quality of the cost data
- Skill of the estimator

## Unit Price Estimating

In unit price estimating, the estimator first determines the required quantities of work. For construction cost, the work units are aligned with standard bid items prescribed by DOTs. For example, the work unit might be general excavation measured in cubic yards. Quantities are measured from the project drawings. The estimator prices each work item by applying a unit price to the total quantity for that item. Unit costs are obtained from a historical database. Most DOTs maintain a unit price bidding database of average unit costs. The reliability of unit price estimating depends largely on the unit pricing used. If the project compares favorably with the "average project," using average unit pricing may be acceptable; however, this may not be the case if the project differs significantly from the norm.

Experienced estimators performing unit price estimating will evaluate key work elements and the applicability of historical unit pricing. This often involves an analysis of crew cost and material cost, as a check against the historical unit cost data.

### Bottom-Up Estimating

In bottom-up estimating rather than estimating the cost as a per unit cost of the finished product, the cost is developed primarily by looking at the hours of effort required to perform certain tasks. The estimate requires that a roster of required activities be developed first (SOW), that level of expertise be identified to do the work, that a level of effort (number of hours of labor) be identified for each activity, and a rate of pay for each participant be identified. In this approach, it is important to identify everyone that will work on the project including support staff, reviewers, editors, and managers, distributed over all the activities. It is also crucial to identify costs such as equipment, travel, publishing, and other direct costs required to complete the tasks.

## Cost Elements

### Real Estate

Transportation projects frequently require the purchase of right-of-way. These costs involve the entire acquisition cost including administrative labor, surveys, and the purchase cost of the property.

### Labor Cost

"Bare or raw" labor cost is the money paid directly to the worker. A number of additional costs must be added to the bare cost. These additional items include:

- Employer provided fringe benefits; that is medical, retirement, etc.
- Payroll taxes
- Payroll insurance

Unit labor cost is controlled by the total unit cost per unit of time (a known figure) and the productivity of the crew (an estimate of how many hours it will take to perform the task).

### Travel and Lodging

Travel and lodging expenses include the following cost elements:

- Airfare, cab, car rental, and fuel
- Lodging
- Per diem (food)
- Miscellaneous, phone calls, etc.

### Equipment Cost

Equipment operating expenses include the following cost elements:

- Rental cost
- Fuel and lubrication
- Repairs (if owned)

- Service and maintenance (if owned)

Equipment ownership costs consist primarily of depreciation cost. Like labor cost, equipment cost is highly dependent on crew productivity.

Equipment may be contractor owned, in which case all of the above operating and ownership costs would apply. Equipment may also be rented. Rental arrangements vary among equipment type and rental companies. The rental equipment may be provided on an hourly basis including the operator and all fuels and servicing of the machine. Bare rentals are also possible, with the renter responsible for the operator and upkeep of the machine.

## Material Costs

Material costs are usually categorized as either permanent or expendable materials. Expendable materials are those that are not left in place, such as temporary structures and formwork. Of the project cost components, material costs are the most predictable. Material quantities can be accurately measured and current pricing is readily available.

## Indirect Costs and Profit

Direct costs are those costs that can be directly attributed to a project. They include the labor, equipment, and material costs required to perform project activities. There is a second category of direct cost sometimes called "project general expenses." This mainly includes time-related project costs necessary for managing the project, but not directly attributable to a specific work component. Such costs include supervision and project site facilities. Project general expenses are itemized and costs are calculated based upon the expected project duration.

Indirect costs are those organizational costs that cannot be directly attributed to a specific project. These indirect costs are called "general expenses or home office overhead." They include costs such as home office staff salaries, legal and accounting, and office expenses. Usually, indirect costs are applied as a percentage of direct costs.

Bid or proposal pricing offered by contractors or by consultants will include a profit markup. DOT unit price data obtained from bid prices includes both indirect cost and profit. The pricing structure for consultant work is somewhat different from that of construction. Usually, direct cost of labor is calculated from the estimated required staff hours at an agreed hourly rate. Direct costs other than labor are added as "other direct costs." A multiplier is applied to the direct cost to cover general expenses and profit.

## Cost Estimating Issues When Estimating Costs for Consultants versus In-House Staff

Many states use consultants exclusively for environmental work on large transportation projects, but some use in-house staff for some or all of the project activities. It is important to recognize that these two labor sources are treated differently in project charging, and if not identified early, can substantially impact the project budget.

DOT in-house staff generally charge to the project by using loaded labor costs only: raw labor (wages) plus benefits, taxes, and any other associated labor cost. The DOT overhead is not charged to the individual project. On the other hand, consultant labor includes the same labor, benefits, taxes, and any other associated labor costs; but more importantly, the company overhead is also included in the project charges. Overhead rates are frequently on the order of 150 percent of the loaded labor rate. In figuring the project cost then, if in-house staff cost X dollars, and the consultant staff is paid at the same wage rate, the cost to the project of using consultant labor is 250 percent of the in-house cost, for the same number of hours worked. It is important therefore to determine who will perform work, in-house staff or consultants, early in the process.

It should be noted that this practice does not mean that the DOT does not have an overhead rate, known or unknown, or that it is less than 150 percent. It means that it is accounted for in other ways within the organization's budget, and that projects are not burdened with the DOT overhead if in-house staff are used.

In trying to determine which to use, in-house staff or consultant staff, it is best to start with a defined SOW and an estimated number of labor hours required for each major work item. Using labor hours as a base allows the manager to make a quick assessment of in-house staff workload and labor availability. If the labor or required skill set is not available, the likely choice is consultant staff. The labor hour estimate can then help determine the reasonableness of consultant cost proposals.

## Importance of Documenting Assumptions

Estimators must make certain assumptions about the project scope and performance methods. Early in project planning and development, cost estimators base their cost estimating on assumptions concerning the project scope. It is essential that estimators include documentation of the basis of the estimate within the larger estimate. This is important because, as discussed previously, project estimates evolve and are revised as design details are changed. The person doing the final engineer's estimate may not be the person that developed the first conceptual early estimate. As assumptions are replaced by decisions, the Project Manager will want to be able to determine the impact on the project budget. If assumptions have been set up in a spreadsheet, updated costs can be generated rather quickly by plugging new cost decisions into a well-ordered spreadsheet of project costs. Consider the following example:

The assumptions for constructing 10 acres of wetlands for mitigation may be as follows:

| | |
|---|---|
| 15 acres of land @ $35,000/acre. | $525,000 |
| Grading of 10 acres @ 1 acre/day X $3,500/day | $35,000 |
| Water supply @ $20,000 | $20,000 |
| Planting @ $10,000/acre | $100,000 |
| Management @ 15% of cost | $102,000 |
| Total cost of wetlands equals: | $782,000 |

With the assumptions stated in a spreadsheet for this estimate, the estimator can support the cost estimate, and can readily make new estimates by inserting new numbers; for example, if the number of acres or the price per acre changes. Such assumptions give a rational basis to negotiations if costs need to be adjusted.

# Identifying and Estimating Environmental Costs by Project Development Phase

## Estimating Environmental Costs during Program and Project Planning

The term "Planning" is used with significant variability across the state DOTs. For this guide, planning means the period of time when projects are identified through system planning and are put in a State Transportation Implementation Plan (STIP). Typically, this period requires a cost estimate for inclusion in the budget and programming in the STIP. Planning products sometimes include an environmental component, typically an environmental baseline built from existing databases, geographic information system (GIS) data, or brief field visits. Early National Environmental Policy Act (NEPA) processes may occur such as establishing Purpose and Need, beginning the scoping engagement with other agencies, and public involvement. These activities may be characterized as environmental costs; however, for the purposes of this guide, any production of a NEPA document will be considered in the Project Development phase, regardless of how it is characterized at any one DOT.

### Overall Approach

During the planning phase, it is important to assess the spectrum of environmental issues that will likely become the subject of future studies and mitigation planning. This is commonly done through some environmental review process early in the conceptualization of the project. Environmental review in planning can take several approaches. Increasingly, states are investing in GIS data to perform early review and analysis and to support expert decision making. The most developed example of this approach is Florida's Environmental Screening Tool. The tool contains hundreds of data layers and early coordination and comment by resource agencies on Environmental Technical Advisory Teams. Projects in the 20-year long range plan are reviewed and another screening effort occurs at programming. These reviews enable all necessary site studies to be determined (and thus cost estimates generated) prior to project programming.

In states without extensive, comprehensive GIS databases, staff are still able to perform early assessment as certain baseline environmental data are available in every state and ecoregion. Moreover, state DOTs and state Natural Heritage Programs (located in universities or the state department of environment or natural resources) are increasingly performing predictive habitat modeling to identify likely habitat with a high degree of confidence, greatly reducing the need for on-site surveys.

Reducing the need for species surveys on-site does not eliminate the need for a site visit to assess multiple environmental risks and opportunities. Some environmental topics, notably the ones involving social and economic impacts, may not have databases that reflect the issues. For these topics, conversations with local planners and community service agencies often give the best insight into issues that will arise. A best management practice (BMP) for environmental review during planning often involves a site visit by an environmental generalist to review the site and assess the likely presence of environmental issues. States that employ this approach frequently have checklists and processes for reviewing each environmental discipline for its potential involvement in the future project. They may also have a rough estimate of costs to address certain types of studies. See Appendix B for a sample spreadsheet used by one DOT to estimate costs, in this case, for a Class 2 – Categorical Exclusion (CE) project.

There has been a trend over several years to formally involve other agencies in early identification of issues and establishment of the scope of the effort that should be undertaken to address the issues. Most recently, the Safe, Accountable, Flexible, and Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) initiated a requirement for early environmental review including analysis of other agency and non-governmental organization (NGO) resource plans that have been developed, to ensure these planning products are utilized and leveraged in transportation planning. The SAFETEA-LU approach elevates identification of opportunities, instead of just environmental risks or impacts. DOTs may be able to contribute to the execution of important conservation objectives on the local, regional, watershed, ecoregional, or state levels, effectively raising the value of their investments in mitigation or land preservation by ensuring that such investments are targeted to the greatest environmental needs or to investments that satisfy multiple environmental objectives at once. Eight federal agencies have signed onto this approach, which they called "EcoLogical." Agencies and partners are best able to realize the advantages of multiple agency collaboration when issues and goals are identified early, which also facilitates cost estimating and identification of funds.

Over 90 percent of projects pursued by DOTs are relatively small, low impact projects. The environmental approaches outlined in this section may suffice for most of these, to develop adequate project estimates. These approaches provide a more accurate and informed estimate than a straight percent for environmental work. Smaller projects vary significantly in up-front development costs, and the up-front development costs tend to be a larger percent of the overall project cost. Preliminary engineering costs for small projects can range to 20 percent or higher, whereas large projects frequently have project engineering costs below 10 percent. Environmental issues are frequently the source of much of the variability. This means that attention to estimating environmental costs on small projects is as important as it is for large projects, since collectively such small projects make up the bulk of the construction program.

In the past, environmental costs were often not calculated at all and left to be absorbed in the contingency, an approach which generated considerable stress for Project Managers striving to keep costs within budget and resource agency specialists working with the DOT to identify what needed to be done to comply with environmental laws—without a budget allocation to do so. Early assessment with regard to environmental issues and cost estimates can go a long way toward creating project budgets that can be met.

## Typical Environmental Costs during this Phase

Typical environmental cost factors during this phase may include the following:

- GIS work to create databases.
- Analysis of resource plans from other agencies and NGOs.
- GIS analysis of proposals or project sites for environmental issues.
- Field visits to the project area by an environmental generalist (or multiple specialists on more problematic sites) to assess environmental needs and environmental SOW.
- Coordination with regulatory agencies.
- Participation by environmental personnel in developing Purpose and Need statements.
- Participation in air quality analysis for metropolitan planning organizations (MPOs).
- Creation of environmental baseline reports for use in planning products.
- Surveys for archeological resources, endangered species, and wetlands, on smaller CE projects.
- Estimates of potential costs of mitigation that will be constructed, or for which in-lieu payments will be made.

## Estimating Mitigation Costs

Wetlands replacement or enhancement and noise abatement such as sound barriers can be large ticket items during construction, so it is important that funding be identified for them as early as possible. Opportunities to leverage or partner with other agencies should be identified; this often occurs in conjunction with review of existing resource plans and objectives, such as local watershed plans, state wildlife conservation plans, or ecoregional conservation plans from NGOs such as The Nature Conservancy.

Good historical databases of past mitigation on a per unit basis will help the practitioner make reasonable estimates. Wetlands databases should be divided into three areas based on mitigation site type: those that are in or near urban areas, those that are in rural areas, and those that are in estuarine areas. This division is required as prices can differ considerably depending on the location and type of wetland displaced. The price of right-of-way for near urban area mitigation and the difficulty in finding estuarine sites make these types of wetlands very expensive on a per acre basis to replace. If the state has experienced ease in agency acceptance of in-lieu payments or the purchase of wetlands bank credits, these costs can be used in the estimate.

A few states have statewide in-lieu fee programs, which have greatly facilitated the ease and therefore increased the environmental benefit of mitigation investments because such programs typically target resources to address the greatest water quality, wetland functionality, or ecoregional habitat needs in the watershed, or seek to accomplish all three in one investment. This is a fundamentally different approach than directing investment to where a piece of land for restoration was (or could be) economically purchased by the state or a private wetland mitigation banker. North Carolina and Florida have statewide programs, administered by watershed or regional water districts, respectively. Oregon DOT has targeted advance mitigation for its Oregon Bridges program by ecoregion. The advantage of these systems for cost estimating is that the cost of mitigation can be more reliably forecast.

Noise abatement construction may have a cost per square foot, or a cost per decibel guideline, which is used to determine reasonable cost relative to the mitigation achieved. A construction bid history on cost per lineal foot or some other unit of measure is probably available from the construction office. Estimates of potential mitigation costs can therefore be made where noise abatement is likely to be a significant part of the cost of construction.

## Costs that may be Categorized Either as Environmental or Planning

Early transportation planning activities may involve a variety of transportation professionals, including planners, environmental professionals, public involvement specialists, and engineers. From a practical point of view, with a focus on capturing project costs, it does not matter how the cost of participation of these professionals is labeled. The participation of all professionals could be labeled as planning, or it could be labeled by the expertise that is brought to the effort, in which case there would be four categories: planning, engineering, environmental, and public involvement. These choices are up to the budget compiler, and may rely on individual DOT protocols. For the purposes of special studies, it is most useful if the budget is broken down by both activity and who will perform the activity. Studies are often categorized by functional area.

## Estimating Environmental Costs in Planning

Evaluation of Environmental Justice populations (EJ) and initiation of the Context Sensitive Solutions (CSS) decision making process are two examples of environmental activities that may start during planning. Both have attracted attention of the environmental community and generated interest in what they cost. The first thing that should be noticed is that both of these environmental items are processes, not products; however, the CSS and EJ processes may lead to a different outcome with respect to alignment, project features, and mitigation. Neither CSS process nor EJ analysis determines the alternative.

One can count the cost of labor, material, travel, and other such related costs that were used to develop a project with EJ issues or use of a CSS process; this information is not available until the process is complete, but information may be collected to generate a historical record, for use in future cost estimating. The following is a typical list of activities needed to generate costs for an EJ evaluation or use of a CSS process:

- Determination of EJ populations within the study area, and the best outreach vehicles to communicate with them.
- Determination of stakeholders (other than EJ populations) within the study area or potentially affected by the project, and the best outreach vehicles to communicate with them.

- Interviews and surveys.
- Establishment of teams and groups for input to the project development, and a definition of the decision structure that will govern choices.
- Use of facilitators to manage interaction among all groups.
- Development of environmental baseline information to describe the context and guide alternative development. Cost of professionals needed to develop this information.
- Communications tools and media, such as Web sites, newsletters, fliers, posters, presentations (video and PowerPoint), and handouts.
- Attendance at meetings, meeting arrangements—such as space rental, refreshments, and equipment.
- Participation of environmental staff to evaluate ideas and provide input to committees, teams, and groups.
- Publications, studies, written and printed data to document each stage of development.

Most of the activities previously listed would normally be counted as public involvement activities. A few of these activities are understood to be always environmental and most often involve environmental staff. If looking at the cost of EJ, then only the activities above that identify or focus on EJ populations should be counted. If CSS processes are being analyzed for cost, all the activities above should be counted since EJ is required as part of any planning process. If evaluating the cost of performing the CSS activities, versus the cost of performing whatever was considered "normal process," then a roster of activities that would have been performed in its place would have to be generated and the costs of those activities estimated, after which the difference would need to be compared.

Gathering costs of performing CSS or EJ activities only determines the cost of identifying the EJ or CSS agenda for the project. What cannot be answered is whether CSS is always a cost-effective approach. Research exists arguing and substantiating that CSS is cost-effective, in some cases.[1] Local communities sometimes prefer smaller scale and less expensive approaches than the DOT initially envisioned. For instance, the elimination of interchanges on US 285 in mountainous bedroom communities outside of Denver is an example of a less costly solution that was achieved at the community's request.

Rather than cost, CSS and EJ analyses promise greater inclusiveness and flexibility that leads to a project that better fits community needs. Arguably, such projects are less likely to experience community and agency opposition, lawsuits, and other project delays, all of which lead to increased project cost. In some cases, such opposition has led to project cancellation. Robust CSS and EJ efforts help avoid such risks.

The concern is that the CSS process itself costs time and money upfront and, if not properly managed, the process may lead to added expensive features not necessary for the main purpose of the project, compromising the transportation purpose to the extent that the

[1] C. Gaskill, Cost-Benefit Study of Applying Context Sensitive Solutions to US 285, West of Denver, Colorado. Transportation Research Board Annual Meeting, 2007. Paper #07-0098.

public investment in the project becomes questionable relative to other priorities. The CSS process is most likely to save time and money in the long term. The costs of what might have been done can be estimated, but not known definitively. As with the cost of "avoidance," it would require assuming the cost of the "road not taken." The actual cost of doing EJ and CSS in terms of labor, material, travel and expenses to accomplish it can be estimated at the beginning of the project, and would be known at the end of project development. DOTs can track and utilize such information if they find it helpful in estimating; to date, our contacts and interviews find this is not worth the effort to do.

# Environmental Costs and How to Estimate them during Project Development

## Defining Project Development Phase

This phase is primarily applicable to projects that fall into NEPA Class 1 and 3, requiring an Environmental Impact Statement (EIS) or Environmental Assessment (EA). Class 2 projects, which are categorically excluded, will be discussed in the Final Design phase. This phase encompasses all environmental work that occurs between the Notice of Intent and the approval of the Record of Decision (ROD) or Revised Environmental Assessment/Finding of No Significant Impact (REA/FONSI), which constitutes federal approval to enter into final design for federally funded projects. It also includes activities required under both NEPA and SAFETEA-LU; activities that are required under the Endangered Species Act (ESA) and Clean Water Act (CWA); and other federal and state laws, regulations, executive orders, and agreements regarding environmental disciplines that occur by the time the ROD is completed.

With respect to environmental activities, this is usually the most intensive phase of the project with the most extensive environmental costs, though it may not represent the largest environmental cost to the project. The largest costs are often the construction costs of mitigation measures planned during this phase, but accounted for in construction. DOTs and resource agencies have been working over the past several years to streamline processes so that a greater proportion of the resources are spent on "on the ground" environmental improvements rather than consultation processes, on paper or in meetings, which occur during this phase.

## Overall Approach

Some DOTs have a second round of project budgeting during project development. At this time, detail may be available to estimate the full cost to develop the project and perform all associated environmental analysis, interagency consultation, and documentation in NEPA and permits, rather than the cost of construction alone. Whether or not this second round of budget or estimate updating occurs, best practice at this point in the project requires the development of a scope of work that contains all the activities and products that will be delivered during this phase, usually in order of production. From this, a schedule of activities and a work breakdown structure (identification of who is going to do the work) can be produced. Whether the project will be done with in-house staff or by a consultant, the development of such estimate support tools pays off dramatically in being able to predict costs, plan for and control work products, perform workload leveling, and respond to project changes. Most DOTs have access to project management software that allows quick changes, updates, and summary feedback. If these tools are not available, electronic spreadsheets like MS Excel can be used effectively to organize the work activities, accomplish cost estimations, and create schedules. This is where the two old adages come into play: 1) plan the work, and work the plan, and 2) if you fail to plan, then plan to fail.

Costs for this phase should be developed in consultation with the environmental practitioners. The level of effort varies from project to project, even within a single discipline. Environmental generalists may be unable to assess the precise level of effort required for each discipline, but if the specialists are not available, environmental generalists or supervisors should be consulted. Historic databases generated from past efforts are extremely useful to cross check proposed level of effort and to estimate level of effort in the absence of staff input. The SOW should be discussed at the same time as the cost estimate to gain assurance that expectations of the Project Manager and the specialist match up. This is also a necessary step if consultants will preform the project. The DOT negotiator should have guidance on expected level of effort before contract negotiations.

One significant cost risk must be mentioned. SAFETEA-LU now requires collaboration on the methodology to be used in the environmental analysis. If the regulatory agency requires something different after collaboration that is greater than the level of effort specified by the DOT environmental specialist, the project budget could suffer and work could be delayed while the contract is amended. It may be advisable to specifically plan for contingencies in this area by including contingency items that can be activated by approval of the Project Manager. This is not the place to be optimistic; rare is the environmental document that comes in under budget. There are too many factors, influencers, and approvers outside the control of the Project Manager or the DOT to be able to perfectly control this part of the project development budget.

## Typical Environmental Costs during this Phase

This section will address typical activities for a NEPA Class 1-EIS project in order to address all environmental activities that might occur during this phase. An EA would typically involve these activities or a shorter list, so the following list can be used to build a scope of work for either. Typical environmental cost factors during this phase may be:

- Submittal of a draft Notice of Intent to issue an EIS for the project.
- Identification of cooperating and participating agencies and development of a Coordination Plan (SAFETEA-LU requirement).
- Initial scoping meeting with regulatory agencies, identification of key issues, follow-up meetings.
- Collaboration with cooperating and participating agencies on the methodologies to be used (SAFETEA-LU requirement).
- Development of Purpose and Need for the project, if not already developed.

- Development of criteria for evaluating alternatives and dismissing alternatives.
- Participation in evaluating concepts and narrowing the range of alternatives to be studied.
- Participation in project alternative development, consultation with design and public involvement teams (in some agencies, environmental staff may lead the alternative development stage).
- Development of a description of the Affected Environment for each environmental discipline. This may be done as a separate activity at the beginning of alternative development or may be combined with the next step. This step may include GIS analysis, field visits, field work, agency contacts, purchase of data and documents, travel expenses, rental of equipment, other methods of data search and collection, and documentation in written and graphic form.
- Analysis of environmental impacts, development of mitigation, and documentation in technical reports for the following disciplines:
  - Air quality
  - Noise
  - Hazardous Materials and waste sites
  - Energy
  - Transportation, traffic, and access[2]
  - Social, community services, emergency services, neighborhood cohesion
  - Environmental Justice
  - Economics
  - Land Use and Planning
  - Right-of-way[2]
  - Parks and Recreation
  - Historical and archaeological
  - Aesthetics, visual resources
  - Aquatics
  - Vegetation and terrestrial habitats
  - Wetlands
  - Wildlife
  - Endangered and threatened, rare and other protected species
  - Topographic and geologic issues[2]
  - Water quality[2]
  - Hydrology[2], floodplains, floodways
  - Section 4(f) Statement addressing public parks and recreation facilities, game preserves and refuges, historic and archaeological properties eligible for or listed on the National Register of Historic Places.

[2] Items may be developed by staff other than environmental specialists within the DOT. This may be accounted for in budgets for crews that are primarily engineers, geologists, or right-of-way specialists. As long as the costs are captured and the work accounted for, characterizing it as “environmental” work is not important for project management purposes unless a special study to characterize such costs is underway. The DEIS author’s time to summarize the findings under these topics into the DEIS should be recognized as an environmental expense.

  - GIS activities to support environmental analysis

- Editing, graphics, and publication activities to support technical reports.
- Internal and external reviews of technical reports, response to comments, editing and publication activities to perfect technical reports.
- Writing the DEIS and 4(f), editing, graphics development, and internal quality reviews.
- Review, editing and approval cycles to gain Federal Highway Administration (FHWA) approval to release for public review. At the minimum, three reviews should be planned. It is likely that four or more will be needed.
- Editing and comment-response activities between reviews.
- Production of DEIS documents, compact discs, and Web versions of documents. Distribution of such materials.
- Participation in the public hearing and generation of hearing transcript.
- Collection of comments, compilation of comments, and development of responses.
- Evaluation and selection of the Preferred Alternative, which may require additional research and participation in several meetings and documentation of the preferred alternative for administrative record.
- Additional environmental research to respond to comments.
- Refinement of mitigation measures for the Preferred Alternative, which may involve several disciplines—typically biological, hydrological, noise, stormwater treatment, historic and archaeological resources, 4(f) properties impacted, and access issues.
- Preparation of a Biological Assessment (BA), consultation with National Marine Fisheries Service (NMFS) or U.S. Fish and Wildlife Service (USFWS) or both if threatened and endangered species are involved. Biological Opinions may be required from NMFS, USFWS, or both before proceeding.
- Preparation of the Final Environmental Impact Statement (FEIS), which requires updating with respect to the Preferred Alternative, response to comments, updating impact discussion if comments are received.
- Internal and external review of draft FEIS, response to comments, and ensuing edits.
- FHWA review of draft FEIS for approval (allowing for at least two review cycles).
- Printing and distribution of FEIS.
- Participation in public meetings (this is standard practice but not required).
- Collection of comments, compilation of comments, and development of responses.
- Draft text of the ROD.

- Some states have review and concurrence cycles required by a formalized agreement with state and federal agencies. Time and labor for these review activities should be budgeted if they apply. The concurrence points typically are as follows:
  - Purpose and Need
  - Range of Alternatives
  - Criteria for Selection
  - Preferred Alternative
- SAFETEA-LU 6002 requires review and participation by agencies that are cooperating or participating agencies in the following steps:
  - Purpose and Need
  - Range of Alternatives
  - Methodology
  - Level of detail for the analysis of alternatives
- Additional research or coordination required because the state has a State Environmental Policy Act (SEPA) or equivalent.
- Land use actions required in some states to complete environmental documents.

## Costs that can be Counted Either Way

Several topic areas reported in a DEIS or EA would need to be addressed by a transportation project even if NEPA were not in the picture. These include traffic analysis, right-of-way, hydrology, geology, and drainage. Staff members that perform these tasks usually have a primary purpose that is different from environmental reporting, and the environmental technical report is an added work item or is drawn from technical reports with another purpose. As long as the activities are accounted for in the project budget, it does not matter to the development of the project whether these are counted as environmental activities or other activities. In fact, the activities address multiple functions and needs. Once again, the question of apportioning these costs may come up when doing special studies to determine the cost of compliance with particular regulations. To date, only a handful of state legislatures have made such a request.

## Estimating Costs for Special Environmental Cost Studies

It is certain that elements of engineering design exist to satisfy various environmental laws. Drainage facilities today typically have features that treat stormwater runoff to remove pollutants and to slow the pace of returning water to streams. Some may also have special design features to facilitate fish or wildlife passage. The hydraulics engineer may be evaluating not just what the river will do to the pier, but what the pier will do to the water, its inhabitants, and channel geomorphology. Will the pier cause a net rise in the projected flood elevation? The right-of-way agent spends some time evaluating sites for purchase to locate a wetlands mitigation site. Are these environmental costs? Yes, if the study is structured to define them this way. Is it worth tracking these costs separately on a day-to-day basis? No, it is not likely to be worth the effort, nor are staff likely to report their time effectively if asked to divide their time by purpose, rather than activity. Such feedback on environmental costs is useful only for an occasional study. Therefore, it is better to devise ways to separate and estimate these costs when such occasions arise, rather than as a matter of course.

Special environmental studies can be approached in two ways. If the study is known before the project is undertaken, tasks can be described and discretely labeled as environmental, and then given unique charge numbers. As long as the staff member understands when to use the charge number, and when not to, the costs can be effectively captured. If the study begins after the project is underway or complete, then the practitioner can be asked to estimate the percentage of time they have spent addressing environmental aspects versus road required aspects. (According to reported studies, addressing environmental aspects requires approximately 15 percent of the total project time.) The percentage can then be applied against the number of hours spent on the project by that practitioner, which should be available from project accounting information.

### Reducing Environmental Costs

An obvious goal for tracking and estimating environmental costs is reducing the cost of compliance. To this end, during this phase and the final design phase, states are evaluating the cost of mitigation. As previously mentioned, Washington State DOT has begun to perform value engineering analysis of environmental mitigation and has discovered ways to maintain or increase quality while reducing costs. Meanwhile, states such as Missouri and Idaho have undertaken "practical design" with the explicit focus of reducing ancillary costs. The project development phase is an excellent time to begin these inquiries, as the EIS and permits are being formed in the phase within which the DOT is making commitments regarding mitigation. Evaluating alternative methods to meet mitigation requirements during this phase will help avoid backtracking during final design and rework of the design and re-documentation of results.

## Environmental Costs and How to Estimate them During Final Design

### Defining Final Design

Final Design is the time between the ROD or REA/FONSI and bid letting for NEPA Class 1 and 3 projects and, for purposes of this study, from project start to bid letting for Class 2, CE projects. Typically, this period encompasses all design activities for the selected alternative, including survey, preliminary and final design, definition and acquisition of right-of-way, preparation of final plans and specifications, and final definition of and design of plans and specifications of environmental mitigation measures, final environmental permits, and execution of intergovernmental agreements. At the end of this phase, the project is ready for construction.

## Typical Environmental Costs during this Phase

The following environmental activities are undertaken during this phase:

- For Class 2 projects:
  - Review the project to identify environmental issues; if none, prepare documentation to support a CE.
  - If there are minor issues, identify and initiate surveys to clear the project.
  - Survey the project area (by a botanist) to identify the presence/absence of endangered plant species.
  - Survey the project area (by fish biologist) at water-body crossings if listed fish species are present.
  - Survey for other listed species as required.
  - Prepare a BA as needed.
  - Survey for archaeological and cultural properties as indicated.
  - Document any environmental issues revealed and addressed. Document confirmation of CE status.
- For all classifications, completion of environmental permits; for example, Clean Water Act Sections 404 and 401.
- Completion of activities related to the federal Endangered Species Act: BA, BO, and re-consultation as necessary.
- Design, plans, and specifications for wetland and habitat mitigation.
- Design, plans, and specifications for noise attenuation.
- Design, plans, and specifications for landscaping related to environmental mitigation (beyond normal re-vegetation of construction disturbed areas).
- Modification of the design, waterway, or local boundary of the regulated floodway to meet FEMA requirements.
- Moving plans, permits for historic buildings, bridges, and other items.
- Final 106 documentation for impacts to historic properties.
- Consultation with designers on facilitation of fish and wildlife passage or crossings.
- Consultation with USFWS, NMFS, or state fish and wildlife departments on fish or wildlife passage designs and impacts.
- Development of environmental monitoring plans during construction.
- Preliminary removal of migratory birds from bridge and construction sites, as well as screening to prevent nesting during construction.
- Archaeological testing and recovery in preparation for construction.
- Negotiate and complete Intergovernmental Agreements (IGA) for the continued care and maintenance of environmental mitigation features.

- Incorporation of BMPs related to natural environmental features and permit stipulations into project specifications.

## Estimating and Tracking Environmental Costs during this Phase for Project Management Purposes

As in earlier phases, for project management purposes it is sufficient to estimate and track costs during this period by the staff that is performing the work. If performed by an environmental staff member, then the work should be considered an environmental cost. If performed by a designer, then costs would be categorized with other engineering costs.

To a large extent, estimating costs during this period is more established than for other phases. As the mitigation measures become construction features, costs are more easily interpreted in the same vein as other road and bridge construction costs. The unit pricing system becomes applicable as the mitigation is interpreted as construction elements such as yards of excavation and acres of right-of-way for wetlands mitigation. For DOTs to track such construction activities separately by function, special efforts or modifications are likely needed with regard to the state's cost and activity tracking system.

## Estimating and Tracking Environmental Costs for Historical Databases and Special Studies

It is always useful to establish databases of reoccurring costs. These databases are very helpful in projecting future cost budgets, and may be useful in evaluating programs, processes, and practices. If the DOT desires to routinely collect data on the cost of development of certain items, then the work and cost tracking should be structured from the beginning to track this data. Some items could be broken out by work item, such as design, plans and specification for wetlands and noise mitigation. If so, it can be given a unique charge number, or if performed by an individual associated with this specific design function, costs can be tracked by the individual's participation on the project.

As mentioned earlier, some environmental items such as stormwater management are so co-mingled in the basic design of a road, that separating out the cost of regulatory compliance from the necessary features to convey water from the road surface can only be accomplished by definition and estimate. Such components and costs are neither self-defining nor directly traceable. Yet, since water quality issues are one of the largest mitigation costs for a DOT and such costs continue into maintenance costs, efforts to quantify the costs and evaluate programs directed at complying with clean water regulations should be undertaken from time to time. Caltrans has undertaken some of the most detailed research in this area.

Information on the costs of particular environmental features or a project's overall mitigation approach may be collected and examined as part of a value engineering effort or an environmental cost study; each approach can be used to inform the other. This information can be valuable in making tradeoffs and changing materials, such as deciding to use permeable pavements and thus reducing or eliminating the need for treatment facilities and associated additional land cost adjacent to the road. In either case, designers are the best estimators of the labor required to meet many of these requirements, and the materials and methods available to accomplish the goal and should be consulted when trying to separate regulatory costs from the basic functional cost of a design feature.

The final design phase is frequently the first effort to put actual costs on mitigation elements. Once the plan is developed, and the engineering estimate is developed, gathering estimated costs for all the materials and labor needed to accomplish the mitigation plan should be relatively easy. If mitigation is identified in discrete bid items, it is easier to gather such data in the engineer's estimate and to determine the bids for these items. However, if costs are co-mingled, the estimating engineer should be of assistance is isolating and compiling environmental costs.

# Environmental Costs and How to Estimate them during Construction

## Defining the Construction Phase

The construction phase is defined as the period from the award of the contract to final contract payment. This phase may last for years and it frequently encompasses the greatest project costs, as well as the greatest environmental costs. During this period, many practices and processes are directed at safety of the crew and public and protection of the environment. The transportation facility and environmental mitigation features are constructed. As before, the same items—water quantity (drainage) and water quality—are being addressed simultaneously. Parts of some of these activities could be counted as environmental mitigation, or not, but they are not readily separable. Some measures affect the comfort of the public—for example, noise and air quality during construction. Since they are listed in the DEIS as mitigation measures, they will be addressed here as potential environmental compliance costs. This period of project development is the most tracked and documented of all phases. Extensive data is available and is usually compiled by the DOT in order to use such information to estimate current costs of construction materials and activities.

## Typical Environmental Activities during the Construction Phase

Activities that should always be counted as environmental costs during this phase are as follows:

- Archaeological recovery (and associated documentation) if undertaken during construction; may also occur during final design.
- Construction of replacement wetlands or wetlands enhancements.
- Construction or enhancement of habitats.
- Screening off areas that are no-work areas because of environmental restrictions.
- Having an environmental monitor on site during construction.
- Fish shocking to remove fish from harm's way during construction.

- Marking certain vegetation, trees, and other plants available for preservation.
- Moving and relocating historic properties.
- Documentation of historic properties prior to removal or demo0lition.
- Planting certain landscapes to preserve environmental aspects of a property.
- Use of bubble curtains to protect fish from sound during in-water work.

### Typical Activities during this Phase That Are in Place to Preserve the Environment, but May Not Be Counted as Such

There are several activities that respond to environmental permits, but which may or may not be counted as environmental costs. These depend on definitions established by the study. Examples of these activities are as follows:

- Erosion control measures, such as seeding slopes
- Silt fences and filters to reduce water turbidity
- Holding ponds
- Maintaining equipment out of the water body or ordinary high water
- Diapering equipment
- Using coffer dams
- Restricting work hours due to noise issues
- Use of dust suppressants
- Use of temporary noise walls
- Use of geocloth (to avoid impacts from certain equipment)
- Use of quieter rock removal techniques (to avoid noise)
- Turning off idling equipment
- Application of BMPs
- Meetings with crews to inform them of environmental issues

It is easier to capture costs for some of these activities than for others. For example, it would likely be relatively easy to determine the cost of the use of dust suppressants, but the cost of turning off idling equipment would be difficult and would need to be estimated based on word of mouth feedback from the contractor. While costs could be estimated for these items, the labor of collecting the data and the quality of the data are not likely to support a decision to measure these items on a routine basis. If this data is needed, contractors are likely the best source of estimates of the value of these items. Some information may be available from bid documents, billing documents, and databases kept by the DOT on construction costs by resource or activity.

# Environmental Costs and How to Estimate them during Maintenance

## Defining the Maintenance Phase

Usually, project costs relative to a new project cease to be identifiable during maintenance, where work is designated by class of work activity. Maintenance may also have separate individual projects that are small, such as maintaining and upgrading drainage facilities, and performed at once for a set of projects in certain vicinity. From a Project Manager point of view, this phase has few if any environmental aspects that need to be projected. However, from an institutional environmental cost perspective, this phase has significant cost of compliance issues, and may account for over quarter of the DOT's environmental costs (27 percent of the DOT's environmental costs in the case of Oregon, according to the agency's 2003 Environmental Cost Study). Cognizance of environmental asset management costs is rising at DOTs, and it is expected that more data on the maintenance costs of environmental assets will be collected and available in the future. In this section, Maintenance will be discussed relative to environmental cost estimating, based on information currently available.

## Typical Environmental Activities that Relate to Projects during this Phase

Some new construction projects have activities that spill over to the maintenance phase. Most notable of these are environmental commitments that require monitoring of rehabilitation sites for a period of time, typically 5 years, to guarantee establishment of the appropriate vegetation and habitat. While such requirements most often apply to wetlands, annual maintenance or evaluation of management practices can extend to other types of habitat restoration. Features such as culverts that provide fish habitat may also be the subject of agreements to maintain the culverts so they do not become perched or filled with debris or cobbles. Sediment basins may need to be cleaned annually, to prevent stream sedimentation and maintain an adjacent high quality trout stream.

Remediation may be an environmental cost during maintenance if the mitigation fails, or does not perform adequately. Most of these activities are distinct, carried out by environmental staff and in-house maintenance staff, or posed and contracted out as small restorative projects where costs can be directly tracked. This data can then be used to estimate future budgets for these activities. As DOTs lack sufficient funds for regular road maintenance activities, DOTs have encountered difficulties in finding staff, funds, and sometimes expertise to maintain environmental facilities. Increasingly, environmental commitment tracking databases and cost tracking for these less traditional maintenance activities are coming together to facilitate environmental asset management and budget planning for maintenance. These issues will be examined in NCHRP projects 25-25(47) and 25-25(51), to be completed in 2009.

## Typical Environmental Activities that Relate to Environmental Compliance during Routine Maintenance

A DOT's wide range of maintenance activities include some performed for environmental compliance and many performed for other purposes, with an environmental element. Maintenance activities with an environmental connection include the following:

- Acquiring permits and clearances, such as 404 permits, and BO/BAs for the ESA.
- Cleaning filters in stormwater treatment facilities.
- Maintaining swales and ditches relative to CWA requirements.
- Maintaining culverts for fish passage.
- Removing invasive plant species from roadways.
- Maintaining historic bridge structures in accordance with NRHP listing requirements.
- Complying with NPDES requirements.
- Confining hazardous spills/cleaning up the sites.
- Maintaining and properly using hazardous materials.
- Using chemicals that prevent or control ice with respect to requirements regarding waterways.
- Maintaining bridges and highway right-of-ways in accordance with protected plant, animal, and aquatic species.
- Avoiding historic and archaeological materials within the highway right-of-way.

For budget estimating purposes, the activities that accomplish this work are relatively easy to estimate from year to year. On the other hand, separating out the environmental element from the general purpose of maintaining the roadway is difficult. In studies that have done this, cost estimates were made crew by crew, and even staff member by staff member. Staff members were asked to estimate the percentage of their time required to fulfill environmental regulations over and above what would be required to just maintain the highway in working condition. These percentages were then applied to labor costs, crew by crew. The staff members that performed these tasks could usually identify costs of acquiring permits and clearances.

# Tools for Estimating, Tracking, and Managing Environmental Cost

## State of the Art

The best system for accomplishing estimating, tracking, and managing costs—environmental or other—has the following characteristics:

- Is electronic and can be accessed by all staff, including consultants, from their desks, or even on laptops in their trucks.
- Is enterprise-wide and integrates all projects undertaken by staff.
- Can be resource-leveled and allows for the integration of outside resources to achieve balance.
- Lists all project activities and codes them as to whether the institution considers them environmental or some other classification.
- Allows the practitioners to enter their own hours required for performance of the task with Project Manager approval.
- Allows for schedule information to be entered, and information related to when an activity can start relative to completion of another; that is, predecessor- successor information.
- Allows the practitioner to give direct feedback via a timesheet, as work is performed
- Requires practitioners to update timesheets daily.
- Allows practitioner to see performance against the estimated performance in hours
- Allows Project Manager to monitor performance on a daily basis by the following parameters:
  - Hours worked by employee by task
  - Accrued cost and hours by task
  - Estimated hours versus performed hours
  - Identify competition for resources by other projects
  - Identify schedule status
- Allows for updates as schedule changes are made.
- Allows for flexibility in schedule construction and how process elements are linked so the Project Manager is not forced to accept a "one size fits all" project process.

- Can be queried for a compilation across any common element in the work items, both as budgeted and as performed. For instance, the length of time scheduled, effort in hours budgeted and cost in dollars for a BA or other task, hours estimated versus hours worked (productivity), the length of time taken (duration), number of hours worked (effort), and dollars expended to do the work.

We did not discover a program that does all of the above during research for this project, but some programs do most of the above. For example, ePM in use by Utah DOT can do many of these activities. This program is being introduced staff by staff within the DOT. The design staff are using it, and environmental staff members are being integrated into the system. Notable aspects of the program are that it integrates on-line weekly timesheets with the project accounting system. In this way, the necessary activity of timesheet reporting automatically provides input to the project tracking system and enterprise cost estimating and tracking databases. All staff can review performance by grouped tasks. For instance, environmental work is coded as such, and any staff member can view performance against the estimate, anytime. The system is disadvantaged by having the number of environmental activities defined and fixed. Furthermore, the network of task elements in the schedule and their relationship is fixed, causing some frustration and the use of work-arounds when the project does not exactly fit the schedule network.

Other state DOTs which have some automation that addresses elements of this list include Washington State DOT, Maryland State Highway Administration, Virginia DOT, and Caltrans. All state DOTs have at least an automated accounting of hours worked and dollars spent attributable to the project.

## Project Management Software

Many Project Managers manage individual projects using commercial off-the-shelf (COTS) software, such as Primavera and Microsoft Project. While many of the attributes described in the previous section are available through this sort of software, in most cases project management software is not available or used on an enterprise-wide basis—serving estimators, designers, and contracts, for example. Systems or software may lack accessibility by all team members or connections to enterprise reporting of actual hours worked, such that programs lack important functionalities for the DOT. In addition, the large amount of data inputs required are often not automated or only minimally automated, so these project management systems are labor intensive. DOT Project Managers report doing project input in bunches, so the system is not always up to date.

Frequently, some DOT regions or work groups use the system less than others, so that use of these tools is not standard across the agency. If the project is not either small enough that little labor is required to update it, or large enough that staff dedicated to schedule and performance management can be employed to update it, then the software is less likely to be used or cost effective. During construction, construction management software with many of the above features is usually supported with staff dedicated solely to the upkeep of the schedule and activities. The feedback from the system goes primarily to the Construction Manager though, so crew members do not gain awareness of cost issues. The effort is directed at a single project, and the focus is time and cost management.

# Spreadsheets and Databases

Spreadsheets and databases are probably still the most frequently used tools to estimate costs of the projects and to gather historical data. Typical spreadsheets for a project list tasks and subtasks to be accomplished—these should come from the scope of work—and staff or position level of staff that are identified to accomplish the tasks. The spreadsheet should also address expenses such as equipment, materials, travel, per diem, lodging, and space rental. A rate of pay is essential to developing a cost spreadsheet. For projects done in-house, the rate of pay will usually include wages plus salary expenses, usually called a loaded rate. For use of consultants, there will be a loaded rate plus overhead plus a fixed fee or materials cost. The spreadsheet will be calculated in hours worked. It is important that costs always be built from the bottom up with hours worked as the common denominator.

If there is an opportunity to do so, unique numbers should be established for tasks and even subtasks in the spreadsheet. If these numbers can then be migrated to the timesheet and accounting systems, gathering data on environmental performance will be greatly facilitated. An example might be:

123445.06.01.234 where,

> 123445 = the project tracking number or charge number
>
> 06 = the task number, Task 6 Prepare DEIS
>
> 01 = the subtask number. Task 6.01 Prepare Biology Report
>
> 234 = the employee ID, would only appear on the individual's timesheet, and in the accounting compilation.

Whatever scheme is used to capture detail, it should be easily sortable within the method—spreadsheet, or database—selected by the DOT.

Even if it is not possible to capture all of this information in an automated system, it may be possible to put it into a timesheet or other reporting instrument, and have the data compiled later.

DOTs have many databases, even when an integrated system is lacking. At the minimum, there would be a database to capture charges on a project by project basis. Data from these sources usually is exportable to desktop spreadsheet software like Excel, where it can be sorted and compiled. Various systems carry different collections of identifiers of charges. If the database has at least the date of the charge, the individual, and the project charged, then the compiler with the aid of the project schedule can make educated guesses about how to accrue the cost to a particular task, even without other identifying data such as task or subtask. For example, if there are several weeks of time charges to the project by the biologist when the Biology Report is scheduled for production, it is highly likely that those costs should be accrued to that activity. If this is done for several projects, then historic averages can be developed from which to make early estimates of project costs for projects in the planning stage.

For projects performed by consultants, the project budget is usually constructed by task. If it is a time and material contract, the contractor will likely share the detail of the hours and costs per contract task described in the SOW for the project. Charges may or may not reflect the actual hours worked on that particular task since the consultant will seek to balance task overruns and under runs to perform within the overall value of the contract; however, the contract budget is a good indicator of the consultants experience with certain environmental bid items. For certain types of contracts—lump sum—this detail may not be available.

Bid and payment record information should be available from the DOT construction office for all projects constructed. Most DOTs capture cost data to develop information for future engineering estimates and to track trends in costs for highway components. Since usually the most costly part of the process of delivering a highway project is construction, DOTs have focused on this aspect of cost estimating for many years. The issue faced here is untangling the environmental costs from other construction costs, since the construction activities may be same for mitigation as for highway construction. For example, both may require grading and revegetation, so the DOT and contractors may not separate costs accruing to each category. The best way to access costs is to keep them separate; ideally mitigation is a separate bid item, showing up as a separate charge.

Another approach is to go back to the engineers estimate to determine what percent of the grading was projected as needed for the mitigation, then applying that percentage back to the project billing for grading. Biologists and wetlands designers or landscape architects may also be able to discern certain types of vegetation that were specified for wetlands replacement, so that plantings can be divided by those that went to mitigation, and those that were used in general re-vegetation. The same approach can be applied to other environmental mitigation.

This effort may seem overwhelming, but most DOTs undertake this sort of mitigation on only a few projects each year, and only a small number are completed each year. These can be identified by environmental staff so that the effort is focused only on those projects. If there are a large number, then the projects can be sampled, rather than all of them counted. This level of effort need only be undertaken about every five years to have a reasonably reliable historic database for future estimates.

# Cost Risk Management

Cost risk for environmental costs arises from anything that increases the level of effort, delays the progress of the project, or adds unplanned features to the project. As with cost risk for any project cost, the level of risk increases with the level of unknowns , the level of complexity of the project and the level of control that lies outside the purview of the Project Manager, and outside the DOT. Many aspects of the project addressed as environmental topics introduce the prospect of uncertainty into the project, and therefore cost risk. The public involvement process can interject broader solutions than contemplated by the DOT. Regulatory agencies have external control of permits and approvals that translate into greater effort, longer time periods, and added project features.

The act of discovery inherent in environmental research can uncover resources that need protection, cause changes in alignment, or add features and requirements to the project that were not anticipated. The level of complexity of the project often translates into a more comprehensive project team. The more teams, subteams, consultants, subconsultants, and decision levels involved in the project, the more opportunity there is for miscommunication, and misspent effort driving up project costs.

Since the cost of construction is usually the largest project cost, just delaying the project construction start can add significant inflation cost to the overall project. Exhibit 1 addresses common cost risk elements related to environmental costs and suggests best practices to control costs related to these risks.

**EXHIBIT 1**
Common Cost Risk Elements Related to Environmental Costs and Associated Best Practices

| Nature of Risk | How the Risk Impacts the Project | Ways to Control or Avoid Costs |
|---|---|---|
| Budget is initially too small for project development, construction—environmental aspects were not taken into account | Starting with a too small project budget leads to attempts to fit the environmental effort to the budget, rather than to the project demand. This inevitably leads to delays and gradual scope-creep, followed by project budget revisions as successive adjustments are made when regulatory agencies push back and request additional information. Since the review happens in the middle of the process, other staff such as engineering may also be committed to design that now will not be approved, or must be done over again. | Most environmental requirements are relatively standard at this point. Experienced environmental staff usually know what resource agencies will require. An environmental review of the project site and overview of the proposed facility will lead to the best estimates for development costs, as well as reasonable estimates of the types of mitigation that will be required.<br><br>Use of historic databases can give a good rough estimate of the construction cost of likely mitigation. |
| Public concerns identified late | At the minimum it will require editing of documentation, at the maximum, will cause redesign, reanalysis, and a redo of documentation. In the worst cases, development is abandoned and a new process to address and evaluate the transportation need must be reinitiated at a later time. | Budget for broad public involvement at the beginning of significant projects. Include many vehicles of communication including a Web site with e-mail address, surveys, public meetings, fliers, etc.<br><br>Address all concerns and document in some fashion, even if responding to an unfounded fear.<br><br>Mention in the DEIS and other documentation what is not impacted, as well as what is impacted, particularly if the subject was raised during the public involvement process. |
| Environmental agency concerns raised late in process | Can cause a redo of environmental analysis, redesign of the project, delay of permits or approvals, public disharmony between government agencies which can be exploited by project opposition, mitigation that is beyond the estimate, or inappropriate mitigation proposed.<br><br>May be caused by turn over in personnel at the regulatory agency.<br><br>May occur when requesting the final permit during final design. | Include environmental professionals when identifying issues, and establishing budgets at the beginning of the project.<br><br>Check with them again once they have done initial field work. Request a "round robin" environmental professional comment session on the proposed alternatives or early concepts. Specialists should be given frequent opportunities for interdisciplinary discussion so that one discipline's mitigation does not generate another's impact.<br><br>Include all agencies that will be regulating and commenting in the Coordination Plan (SAFETEA-LU requirement).<br><br>Do the SAFETEA-LU methodology review with all appropriate agencies, plus all similar agencies with participating governments; that is, the Environmental Services Department of the city government, etc. |

**EXHIBIT 1**
Common Cost Risk Elements Related to Environmental Costs and Associated Best Practices

| Nature of Risk | How the Risk Impacts the Project | Ways to Control or Avoid Costs |
|---|---|---|
| | | Document the methodology agreement.<br><br>Document all meetings with agencies making sure to list who was present at the meeting, and what concerns were raised or agreements reached. Resolve all concerns and complete agreements. Do not be tempted to ignore or brush aside issues raised. If the issue can not be addressed, or will not for a justified reason, then resolve that understanding before the publication of public documents, if possible.<br><br>If new personnel at regulatory agencies make new demands that seem inappropriate, elevate the issue within that agency.<br><br>Be willing to generate greater detail to satisfy agencies if needed to get the permit. |
| Complexity of the project | The greater the number of people involved in decision making and project development, the greater the opportunity for miscommunication, lack of communication, and project drift relative to the understanding of the project.<br><br>Project details get changed without proper notification to environmental staff overseeing such resources.<br><br>Project Manager not aware of how new information may affect specific staff environmental practitioners. | If the project is large, there should be an environmental leader for the environmental effort. This person should be included in all leadership team decisions.<br><br>Regular communication to all staff working on the project should go out that identifies changes and decisions being made. This should include support staff such as editors and graphic artists. Establishing an All Team e-mail list at the beginning of the project assures that all team members remain informed. It also compensates for the Project Managers lack of knowledge of each discipline's demands. It may be difficult for the Project Manager to always identify what might be important to environmental staff. This allows the team to self-identify what is relevant.<br><br>Keep a running log of questions asked and answered during the project that all team members can access. |
| Late discovery of environmental issues | Many environmental issues require research to determine their presence, and it may not be apparent that they are likely to be impacted by the project. Examples are presence of archaeological resources, presence of rare plants outside the blooming season, properties eligible for the National Register of Historic Places but not listed, existence of neighborhood patterns, EJ issues and deed restrictions on certain properties, particularly publicly owned properties. Late discovery after the alternatives have been established, or even later, leads to rework by several project team | Environmental professionals have access to databases and expertise early in the process, and can make an early probability assessment of the likelihood of the presence of certain resources. Their input very early in the process can reduce the probability of late discovery.<br><br>Once the project is underway, early surveys for Threatened and Endangered Species, archaeological sites, and historic properties will help guide alternative development away from problem areas. Determination of property ownership and status, particularly of public properties, is also useful.<br><br>Determination of section 4(f) status of parks, public recreation, and game refuges is relatively easy at the early stages of the project. More difficult is determination of 4(f) |

**EXHIBIT 1**
Common Cost Risk Elements Related to Environmental Costs and Associated Best Practices

| Nature of Risk | How the Risk Impacts the Project | Ways to Control or Avoid Costs |
|---|---|---|
| | members. The later the discovery, the greater the impact on project cost. | status for potential historic properties that are not listed, and for which a Determination of Eligibility is not yet complete. The DOE process should be completed as soon as possible to avoid late changes. |
| Project drift | When environmental issues are not determined early, and the progress of the project is not outlined from the beginning, projects can chase one environmental issue after another in succession until the project team is exhausted, the public loses interest, and the political consensus to do the project is lost.<br><br>Some opposition groups deliberately use environmental regulations to stall projects, hoping that these factors will in fact occur.<br><br>Projects will be attacked at their weakest link, not necessarily on the aspect related to what the opposition is interested in. All parts of the study need to be rigorous to survive an organized opposition. Environmental processes are the key entry to opposing a project because they are the only aspects of the project that by law require public input and process. Normally, most legal challenges are lost on procedural issues, not substantive issues, but poor substance can relate to poor procedures. Both need to be rigorous. | Projects need to anticipate and identify issues that will develop into major work items or require a long time frame as early as possible, then plan how to address them, and carry out the plan.<br><br>A decision process with roles and responsibilities should be a part of the initial plan. The basic agenda of future meetings should be planned from the beginning, with clear decision points for items such as establishing Purpose and Need, evaluating concepts, defining the final alternatives to be studied, developing screening or selection criteria, and the preferred alternative selection process. Extra meetings should be planned at the beginning for times when it will take more than the scheduled meetings to reach a decision.<br><br>Political decision makers should be made aware from the very beginning if there are laws governing choices which will be outside their authority or influence such as ESA and section 4(f).<br><br>All contacts with outside agencies should be documented, including a list of people present at the meeting. All issues, regardless of whether the DOT finds them relevant should be addressed and agreement reached either through discussion, research, changes in the design, or mitigation. Acceptance of each agreement should be documented.<br><br>All parts of the DEIS/FEIS or EA/REA/FONSI should be performed at the required level. Having no weak links in the process or documentation is the best insurance against legally driven attacks on the project. There is no way to prevent attempts to sue, but there are ways to make the project process least vulnerable so that the DOT will prevail in the event of a suit.<br><br>Managing the flow of decision making, addressing issues early, anticipating issues and doing proper research, analysis, avoidance, minimization, mitigation, issue resolution and design are the strongest methods for avoiding project drift, cost increases, and potential project cancellation. |
| Losing the project purpose to environmental | To keep the peace with public opposition, agency representatives, the Project Manager and Project Development Team allow any requested mitigation or | All of the mentioned add-ons exist today as legitimate aspects of public highway projects in the US. Any of them are appropriate, in the proper setting. However, none of them are appropriate for all projects. Controlling environmental cost risk relies on |

**EXHIBIT 1**
Common Cost Risk Elements Related to Environmental Costs and Associated Best Practices

| Nature of Risk | How the Risk Impacts the Project | Ways to Control or Avoid Costs |
|---|---|---|
| mitigation demands | design feature, just to get to agreement on the alternative. The cost of added design features begins to be a very substantial part of the project construction budget.<br><br>Items typical of add-ons are: bicycle and pedestrian facilities and overcrossings, transit lanes, and facilities, decorative features in the design, signature designs of bridges, landscaping, moving and preserving historical buildings and materials, added studies, wetlands and habitat enhancement, contributions to another community feature as compensation for impacts, noise walls designed to enhance a gateway entrance to the city, special treatments to rock cuts to age them so they fit in the environment, wildlife crossings, enhanced and park like settings for water treatment. | the Project Manager to recognize when an add-on is appropriate. Controlling cost also relies on having a process to say no when the add-on does not meet the project purpose or required mitigation.<br><br>Controlling the project features starts with having a clearly defined purpose and need statement. If multimodal issues are to be addressed by the project, bike/ped facilities should be addressed. If the project is not to be multi-modal, then bike/ped facilities may not be appropriate.<br><br>The project should be aware of transportation planning for the area and be prepared to further goals of the transportation plan relative to other modes if the plan indicates the facility is part of the plan for other modes. If the plan states that bike/ped facilities are planned for a river crossing and that it is a transit and freight corridor, then the project should be prepared to address these modes from the beginning of the project.<br><br>If other agencies have interests in the immediate area that lead to an added feature, but the project does not actually impact the resource, then the agency should be invited to participate in the planning, but can also be asked for a financial commitment.<br><br>Good decision structures allow project teams to resist inappropriate pressures. The top of the decision structure should have authority to commit resources for the agencies involved. Requests for consideration of add-ons should be well documented with respect to cost-effectiveness, place in community goals, how it fits with the project Purpose and Need, reasons to support the add-on, and reasons not to, cost effect on the project budget, and identification of funds to cover the costs.<br><br>A lesser step may be taken if the feature is desirable but not within the funding scope of the project. The project can be designed not to preclude the feature being added in the future. |

# Implementation

Before discussing implementation, it is necessary to acknowledge that the states vary considerably in size, population, and resources. This is reflected in the DOTs that serve them. Some states may have relatively uniform environmental issues across the state, while others, like California, have vast variability among the regions within the state with some very rural, and others highly urban. Thus, there is no approach or system that fits all states equally well, nor may one be equally applicable across a single state if the state is large and diverse. This means that more often than not, cost estimating systems are not directly transferable between states and are more likely home grown. Taking this condition as a given, there are still some universal principles that apply to implementing improvements in cost estimation, plus some lessons learned from states that have attempted it.

## Knowledge of Cost Fundamentals

The first step in implementing improved environmental cost estimating is gaining a clear understanding of cost fundamentals. All costs ultimately break down to time spent (hours of labor), rate of pay, material and equipment used, land purchased, per diem costs, services used from others, the cost of overhead and fees, and the price of capital (interest on the funds used to finance the effort). This is as true for environmental costs as it is for engineering or construction costs.

Over many years, engineering staff have gained enough experience with costs related to highway construction that the shorthand approach of unit cost estimating, cost per lane-mile, or cost per square yard of bridge surface can be used in programming construction estimates with some degree of reliability. Environmental activities and features, however, cannot be quantified by the same measure. Environmental activities vary by the number and nature of impacts to resources and by the number of regulations triggered by the project, which in turn typically require separate mitigation, not by lane-mile. Environmental cost estimation requires a closer evaluation of the nature of the project and an in-depth knowledge of environmental work requirements in order for the estimator to come up with a reliable estimate.

Implementing better environmental cost estimating requires thorough knowledge of both cost estimating principles and an understanding of the nature and range of work of environmental professionals. A fundamental understanding of transportation construction is also very helpful so that environmental issues can be more readily projected. The first step, then, in implementing improvements to environmental cost estimating is to find staff that understand environmental work requirements and provide them with cost estimating training and tools. Training in basic project management skills is also useful so that the estimator understands the context within which the estimate is needed and the limitations of the estimate.

## Finding the Right Champions for Change

Instituting a change regardless of the size of the change requires a change agent, a champion for the change, as well as an understanding of who are the targets of the change and their needs, issues, and likely objections. Change of any kind in large organizations is challenging. If change is to be successful, the institution must identify its champions and cheerleaders for change. In resource-stretched DOTs, the comment heard several times during the development of this guide was that there had to be substantial reason for additional data collection and documentation effort, in order to do environmental cost estimating differently. So first and foremost, those wanting the change need to identify exactly what they need and why they need it, to develop the rationale, justification, and compelling message for the change.

Individuals selected to implement the change need to be optimistic, committed to the change, and have the understanding of both the broad picture, and the detail required to implement the change. They need to be respected by colleagues for both their knowledge of the content of their discipline (environmental) and their leadership abilities among their colleagues. Commitment to stay the course while the change is being implemented is also critical to successful implementation.

## Right Sizing the Change

Large enterprise-wide systems such as Utah's ePM system obviously have much to offer to both project management and project staff. Enterprise wide systems give a universal place to gather, organize, and store data, and are able to turn data into information that guides work. Cost is just one of many elements tracked by such systems. Schedule, performance assessment, direct and frequent feedback, and storage of historic data are several other products and outcomes of using the system. The bottom line is increased control over projects, and greater efficiencies and usefulness of data. Most DOTs currently collect such data, but without the organizing factor of a project management system, it is of limited value.

The most significant challenge of integrating such systems is the initial cost of creating them. Implementing costs are measured in millions of dollars, and time to develop and deploy them is measured in years, two to four years or more. Developing such systems likely requires legislative approval, championship at the DOT director's level, enterprise wide teams to develop system architecture and implement accounting systems, development of underlying project development process networks, teams to work with training the enterprise in how to use the system, intelligence technology staff to make sure all elements are compatible with current systems and to engineer the transition, staff from various sections of the DOT to test the system, and new equipment to run the system on. The best time to take on changes of this magnitude are when there are efforts to upgrade or replace major elements of the existing systems for activities such as accounting, payroll, or scheduling.

Much smaller changes, some within the scope of a single manager or even a staff member, can also be instituted which can add efficiency and accuracy to estimates. These changes may need no more approval than the managers own decision to do it, or at most, the immediate supervising manager's approval. An expenditure of as little as 80 hours of staff time or less can make future estimating more accurate and efficient for that crew or staff person.

At the most rudimentary level, a supervisor can gather timesheets from crew members for a year or more, categorize the work that staff members do, and compile the hours for doing the work, or ask each staff member to do so. Most DOTs have payroll information by staff member by project. These data can be gathered and analyzed for the same result, and for larger groups. Databases on costs of constructed items can also be compiled as they are completed, or searches of the construction cost data can be made for costs of several projects and compiled. These can be analyzed for cost per acre of wetland replacement, for instance. Efforts at this level require finding a staff member with willingness to cross organizational lines to gather data, an understanding of the data when they find it, and enough patience to find their way through datasets which are not necessarily organized for the job at hand. As little as 40 hours of effort will yield significant results. Usually the data is not in the format most useful for the effort, so the compiler must be willing and resourceful to achieve good results. While such efforts are not automated, and lack all the other benefits of an automated system including easy updating, they are nevertheless well worth the expenditure of staff time. The data can be used for other purposes such as projection of staff needs, evaluation of consultant proposals, longitudinal comparisons of cost, and determining if staff members are efficient workers.

## Starting Where You Are, Watching for an Opportunity

Large changes in systems are not made in isolation from other factors driving the change. If a system level change is about to be instituted, it was likely triggered by outside forces such as the current accounting system becoming antiquated, a legislative demand to change, loss of funds driving an efficiency initiative, or collective demand across the organization to respond to failures and revise the system. Until one of these larger drivers emerges, system changes may be difficult to implement without high level leadership.

In the meantime, the environmental professional can start where he or she is. Using the spreadsheet, pencil and paper, and database approach described in the previous section, better estimating can be developed at the crew and section level. Environmental managers can use these data for program and project estimates, and staff resource demand estimates. The manager can educate himself or herself regarding cost estimating and project management. If organizational teams are formed to improve budgeting and management processes, the manager can join and advocate for improvements in processes and tools. If the opportunity for larger scale change comes about, the manager can position to be a leader in the change, become a champion or cheerleader for change, contribute to the development of a new process or system, and be a tester of new systems.

Sound management practice requires knowing the cost of performance and working toward cost efficiency as well as quality. Information regarding cost factors is the only sound basis for making good management decisions. Therefore, whether the organization is ready to adopt a state of the art project management system, or leaves the manager to find the information on their own, environmental cost data is needed, and can be acquired.

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APPENDIX A

# Sample Cost Estimate of a Scope of Work

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| | Consultant Name or DOT Staff | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | General Classifications | | | | | | | | | | | | | |
| | Principal in Charge | Sr.Project Manager | DeputyProject Manager | Sr. Eng/Planner/Scientist/Staff | Jr.Project Engineer / Planner | Office Engineer /Jr. Planner/Scientist | Design Engineer/Jr. Planner | Senior Technician | Technician / Surveyor | Project Assist. / Office | **Total Labor Hours** | **Labor Dollars** | **Expenses** | **Labor & Expenses** |
| **Loaded Labor plus overhead** | $200 | $180 | $150 | $150 | $130 | $90 | $80 | $80 | $60 | $60 | | | | |
| **Task 7: NEPA Document** | | | | | | | | | | | | | | |
| Task 7.1 Biological Resources Tech Memo | | 2 | | 36 | 64 | 188 | | | 20 | 14 | **324** | **33,040** | | |
| Task 7.2 Programmatic Biological Assessment for Technical Drilling | | | | 8 | 60 | 44 | | | 4 | 3 | **119** | **13,380** | | |
| Task 7.3 Land Use Tech Memo | | 3 | | 14 | 24 | 58 | 200 | | 15 | 14 | **328** | **28,720** | | |
| Task 7.4 Social Tech Memo | | 3 | | 14 | 24 | 32 | 200 | | 4 | 12 | **289** | **25,600** | | |
| Task 7.5 Economic Tech Memo | | 3 | | 14 | 24 | 30 | | | 2 | 12 | **85** | **9,300** | | |
| Task 7.6 Environmental Justice Memo | | 2 | | 4 | 16 | 35 | 100 | | 1 | 3 | **161** | **14,430** | | |
| Task 7.7 Visual Resources Tech Memo | | 3 | | 14 | 184 | 98 | 40 | | 30 | 20 | **389** | **41,580** | | |
| Task 7.8 Construction Impacts Tech Memo | | 3 | | 6 | 38 | 20 | | | | 4 | **71** | **8,420** | | |
| Task 7.9 Noise Study Tech Memo | | 3 | | 12 | 174 | 152 | 80 | | 260 | 12 | **693** | **61,360** | | |
| Task 1.7.10 Cultural Resources Tech Memo | | | | 16 | 24 | 130 | 40 | | 4 | 12 | **226** | **21,380** | | |
| Task 1.7.10.1 Historic and Architectural Research | | | | 1 | 4 | 22 | 60 | | 2 | | **89** | **7,570** | | |
| Task 1.7.10.2 Determination of Eligibility | | | | 10 | 18 | 194 | 60 | | 2 | 9 | **293** | **26,760** | | |
| Task 1.7.10.3 Finding of Effect (FOE) | | | | 8 | 18 | 88 | 20 | | | 10 | **144** | **13,660** | | |
| Task 1.7.10.4 Phase 1 Archeological Survey | | | | 20 | 14 | 78 | 60 | | 2 | 10 | **184** | **17,360** | | |
| Task 1.7.10.5 Programmatic 4(f) Evaluations | | | | 1 | 10 | 26 | | | 2 | 3 | **42** | **4,090** | | |
| Task 7.11 Phase 1 Environmental Site Assessment | | | | 16 | 20 | 154 | | | | 6 | **196** | **19,220** | | |
| Task 7.12 Air Quality Tech Memo | | 3 | | 44 | 24 | 150 | | | | 12 | **233** | **24,480** | | |
| Task 7.13 Right-of-Way Tech Memo | | | | 14 | 24 | 22 | | | | 11 | **71** | **7,860** | | |
| Task 7.14 Water Resources Tech Memo | | 2 | | 16 | 24 | 222 | | | 20 | 12 | **296** | **27,780** | | |
| Task 7.15 Geological Resources Tech Memo | | 1 | | 140 | 40 | 32 | | | 20 | 12 | **245** | **31,180** | | |
| Task 7.16 Section 4F Background Paper | | 3 | | | 24 | 24 | 120 | | 20 | 8 | **199** | **17,100** | | |
| Task 7.17 Draft Environmental Impact Statement | | 24 | | 34 | 406 | 352 | 484 | | 20 | 106 | **1426** | **140,160** | | |
| Task 7.18 Agency Review | | 2 | | 4 | 40 | 10 | | | 8 | 13 | **77** | **8,320** | | |
| Task 7.19 Participating Agency Review | | 8 | | 4 | 24 | 6 | | | 2 | 26 | **70** | **7,380** | | |
| | | | | | | | | | | | | | | |
| Computer (@4.00/hr) | | | | | | | | | | | | | **25,938** | |
| Communication (@1.00/hr) | | | | | | | | | | | | | **7,188** | |
| Reproduction | | | | | | | | | | | | | **5,000** | |
| Outside Service Expenses | | | | | | | | | | | | | **3,000** | |
| Postage/Freight | | | | | | | | | | | | | **-** | |
| Travel | | | | | | | | | | | | | **3,000** | |
| **Total Expenses** | | | | | | | | | | | | | **44,125** | |
| **Total Hours** | | 65 | | 450 | 1322 | 2167 | 1464 | | 438 | 344 | **6250** | | | |
| **Task 7 Total** | | $11,700 | | $67,500 | $171,860 | $195,030 | $117,120 | | $26,280 | $20,640 | | **$610,130** | **$44,125** | **$654,255** |

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APPENDIX B

# Estimate Worksheet for Environmental Work on Class 2 Projects

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| Responsible Party | Crew Number | Activity Name | High-end Hours | Median Hours | Low-end Hours | Project Hours | Notes |
|---|---|---|---|---|---|---|---|
| **Project Coordination - Class 2 Projects** | | | | | | | |
| REGION ENVIRONMENTAL COORDINATOR | 4620 | PDT Participation and resource specialist coordination | 450 | 250 | 120 | | Hours include resource specialist coordination, preparation of Environmental Baseline Report, preparation of specifications, and preliminary and advance plan review. |
| ENVIRONMENTAL PROJECT MANAGER | 7520 | 4(f) Documentation | 80 | 35 | 10 | | Applies to non-historic 4(f) resources. 4(f) documentation includes Individual Determination, Programmatic Determination, and Di Minimis Determination. |
| **Biological Resources** | | | | | | | |
| BIOLOGIST | 4620 | Preliminary Biology Scoping Report | 40 | 24 | 16 | | Preliminary scoping reports are those generated from the office and might include database searches (e.g., ORHIC, RES Maps, phone calls, etc.). |
| BIOLOGIST | 4620 | Botany Survey and Report | 40 | 24 | 16 | | Includes ESA plant and noxious weed surveys. |
| BIOLOGIST | 4620 | Environmental Baseline Report - Biology | 32 | 24 | 16 | | Includes preparation of the biology section of the Environmental Baseline Report. Hours do not include monitoring. |
| BIOLOGIST | 4620 | General Biological Resources Report | 120 | 80 | 40 | | May be applicable for non-listed species. |
| BIOLOGIST | 4620 | Biological Assessment | 250 | 200 | 150 | | State and Federal Endangered Species Act (ESA) Species. Includes preparation of the BA and agency consultation to acquire BO or concurrence letter. Hours do not include monitoring. |
| BIOLOGIST | 4620 | Biological Evaluation | 250 | 200 | 150 | | ESA and non-ESA (on Federal Lands ) species (C-3 species). |
| BIOLOGIST | 4620 | No-Effect Documentation | 40 | 24 | 16 | | State and Federal Endangered Species Act (ESA) Species. |
| BIOLOGIST | 4620 | Existing Programmatic Permits (Biological Opinion Notification and Variance Authorization Requests) | 80 | 40 | 24 | | Any use of existing state or federal ESA programmatic permits. |
| RESOURCE LIAISONS | | Biological Project Support (*see below*) | | | | | Includes biological support from ODFW, NOAA Fisheries, and USFWS |
| | | General ODFW Support | 200 | 100 | 20 | | ODFW |
| | | ODFW Fish Passage State Statute | 200 | 100 | 20 | | ODFW Fish Passage Statute Implementation |
| | | ESA Section 7 Consultantion - NMFS | 56 | 32 | 24 | | NOAA Fisheries |
| | | ESA Section 7 Consultantion - USFWS | 56 | 32 | 24 | | US Fish and Wildlife Service |
| | | Avion/Other Species Management | 130 | 70 | 40 | | APHIS - May relate to CE support, since the majority of APHIS support comes during construction and may take the form of avian exclusion or removal from structures. AHPIS charges is $50/hr. Some of APHIS work is done prior to let and some is done |
| **Wetland Resources** | | | | | | | |
| WETLAND SPECIALIST | 4620 | Wetland Scoping, Baseline, Delineations Reports, and Jurisdictional Determination forms. | 200 | 80 | 60 | | Includes wetland scoping, preparation of Wetland Scoping Report, Environmental Baseline Report, Wetland Delineation Report, and Jurisdictional Determination forms. |
| WETLAND SPECIALIST | 4620 | Wetland Impact Assessment and Mitigation Concept | 380 | 100 | 0 | | Determination of impacts, assessment of wetland functions, avoidance measures, and preparation of conceptual mitigation plan. (Submitted with permit application to USACOE and DSL) |
| LANDSCAPE ARCHITECT/ WETLAND SPECIALIST | | Wetland Mitigation Plans and Specifications | 350 | 200 | 10 | | Mitigation design, grading plans, planting plans, and initial estimate. Note - this assumes Land. Arch. consultants will perform the work. |
| **Water Quality** | | | | | | | |
| WATER QUALITY SPECIALIST | 7510 | Water Quality Report | 260 | 190 | 120 | | Water Quality report is required if more than 1,000 sq. meters of impervious material is added to a project. Includes preparation of Environmental Baseline Report and impact assessment report and mitigation plan. |
| RESOURCE LIAISONS | | Water Quality 401 Certification | 25 | 15 | 10 | | DEQ Liaison coordination on 401 Certification and review of stormwater management plans. |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Noise** | | | | | | | |
| ACOUSTICAL SPECIALIST | 7510 | Noise Report | 250 | 200 | NA | | Higher hours relate to rural projects; Median hours apply to urban projects. **Noise Study Requirements**: addition of a continuous through lane, significant shift in roadway alignment, new roadway on a new alignment (includes ramps), or removal of acoustical shielding requires a noise study. Addition of a left turn lane without an acoustically significant shift does not require a noise study. |
| **Air Quality** | | | | | | | |
| AIR QUALITY SPECIALIST | 7510 | Statewide Air Quality Report Applicability | NA | NA | 5 | | **NAAQS Attainment Area -** Determine if project is applicable under the Statewide Air Quality Report. (Includes MSAT Analysis) |
| AIR QUALITY SPECIALIST | 7510 | Air Quality Conformity Memorandum | 24 | NA | 10 | | **NAAQS CO Nonattainment/Maintenance Area** - Conformity Memorandum required; no hot spot analysis or report required (Includes MSAT Analysis) |
| AIR QUALITY SPECIALIST | 7510 | CO Hot Spot Analysis Memorandum | 80 | 65 | 55 | | **NAAQS CO Nonattainment/Maintenance Area** - CO hot spot analysis required; assumes one intersection (memorandum format). (Includes MSAT Analysis) |
| AIR QUALITY SPECIALIST | 7510 | Air Quality Conformity/PM 10 Qualitative Hot Spot Analysis Memorandum | 24 | NA | 10 | | **NAAQS PM 10 Nonattainment/Maintenance Area** - Conformity Memorandum required; PM 10 qualitative hot spot analysis required; assumes one intersection (memorandum format). (Includes MSAT Analysis) |
| AIR QUALITY SPECIALIST | 7510 | Air Quality Conformity Memorandum | 24 | NA | 10 | | **NAAQS CO and PM 10 Nonattainment/Maintenance Area** - Conformity Memorandum required; No CO hot spot analysis and PM 10 qualitative analysis needed (memorandum format). (Includes MSAT Analysis) |
| AIR QUALITY SPECIALIST | 7510 | CO Hot Spot Analysis/ PM 10 Qualitative Memorandum | 90 | 75 | 65 | | **NAAQS CO and PM 10 Nonattainment/Maintenance Area** - CO hot spot analysis and PM 10 qualitative analysis required; assumes one intersection (memorandum Air Quality Report format). (Includes MSAT Analysis) ). |
| **Cultural Resources** | | | | | | | |
| ARCHAEOLOGIST | 7510 | Archaeology Report | 375 | 245 | 110 | | Includes literature review, Phase 1 field surveys (includes probing) and Environmental Baseline Report preparation. Phase 2 testing is estimated at $25,000 to $50,000 per site. Phase 3 Data Recovery estimated at $100,000 to $300,000 per site. |
| ARCHAEOLOGIST | 7510 | Archaeology Clearance | 150 | 80 | 25 | | Includes coordination with SHPO. |
| SHPO LIAISON | | SHPO Concurrence | 150 | 80 | 25 | | Includes processing archaeological reports and issuing concurrence letters. |
| CULTURAL RESOURCES SPECIALIST | 7510 | Historic Resources Clearance | 250 | 115 | 30 | | Includes Section 106 documentation (DOE/FOE/MOA); Baseline Report; PA Memo to the File. Includes plans and specification review and SHPO coordination. |
| CULTURAL RESOURCES SPECIALIST | 7510 | 4(f) Documentation & Clearances | 80 | 35 | 10 | | 4(f) documentation includes Individual Determination, Programmatic Determination, and Di Minimis Determination. |
| **Permits** | | | | | | | |
| PERMIT COORDINATOR | 4620 | 404/DSL Fill/Removal Permit | 145 | 70 | 30 - 50 | | Low end hours apply to projects that are non-notifying for USACOE and/or minimal disturbance GA for DSL. If project required preparation of Joint Permit Application for wetland or waterway impacts; use 50 hours for Low-end estimate. |
| ODOT DSL PERMIT LIAISON | | DSL Removal/Fill Permit Support | 34/20 | 30/18 | 28/16 | | First hourly estimate is for projects with wetland delineation; second hourly estimate is for projects without wetland delineation. Includes processing Joint Permit Applications for wetland or waterway impacts and issuance of permits or notifications. |
| ODOT ACOE PERMIT LIAISON | | 404/DSL Fill/Removal Permit | 34/20 | 30/18 | 28/16 | | Includes processing Joint Permit Applications for wetland or waterway impacts and issuance of permits or notifications. |