Improving Environmental Cost Estimates: Final Report

Requested by:

American Association of State Highway and Transportation Officials (AASHTO)

Standing Committee on the Environment

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1. Introduction

1.1 Objective

Environmental costs can significantly affect the overall cost of transportation projects; however, estimating practices for environmental costs are not as well documented as those for more traditional cost elements. For this reason, the AASHTO Standing Committee on the Environment decided on the need for guidance with regard to best practices for estimating environmental costs in transportation projects.

The objective of NCHRP project 25-25(39) was to develop guidelines on improved methodologies for estimating environmental costs in transportation projects. Improving transportation project cost estimating practices has the potential to improve the overall management of the project delivery process. Improved accuracy in cost estimating directly contributes to improved project financial management and project scheduling.

The project statement for NCHRP 25-25(39), entitled, "Improving Environmental Project Cost Estimates" states, "Accurate cost estimating for transportation projects involves a wide variety of factors, strategies, and challenges. Some of the costs of a transportation project relate directly to environmental factors…," including avoidance, mitigation, environmental enhancements, and the costs of preparing environmental documents. To this end, NCHRP 25-25(39) undertook a study of methodologies to improve cost estimating for environmental aspects of transportation projects, as a supplement to NCHRP Report 574 on general cost estimating principles and practices. The NCHRP 25-25(39) research team was asked to distinguish genres of environmental costs and to find out if and how Departments of Transportation (DOTs) estimate environmental costs in planning, project development, construction, and maintenance, to develop a guide of best practices. Early direction from the panel was that this research should focus on costs related to direct, quantifiable environmental costs and not attempt to include indirect external costs such as global climate change, green house gas emissions, and mobile source air toxics.[1]

The research team approached the project by performing a literature search, mailing a survey to DOTs to determine current practices, and following up with telephone interviews of respondents and states otherwise identified as pioneers in environmental project cost estimating. This document is a compilation of research into current practices, with a focus on project cost estimates for programming and project management, to ensure that all costs are captured and estimated. An earlier interim report, submitted in March 2008, provided a broader and more detailed overview. The ultimate product of this study is a guidance document, which is available separately.

1.2 The Importance of Cost Estimating at DOTs

Accurate estimation of project costs is essential for successful project delivery. The reliability of project cost estimates at every stage in the project development process is necessary for responsible fiscal management. Difficulties predicting and controlling costs generate many problems and risks for DOTs. Impacts to financial accountability and accurate project

scheduling are among the most serious. Projects may be delayed or cancelled when costs unexpectedly exceed those planned. DOT management must deal with the disruption in priority programs presented by cost increases and the fact that other projects have to be delayed or removed in order to accommodate higher project costs.

Management needs information about events and factors that can influence and increase costs, early in the project, in order to manage project budgets. Unreliable cost estimates can generate severe problems in a DOT's programming and budgeting, in local and regional planning, and result in staffing and budgeting decisions that compromise the effective use of resources. In turn, this affects the DOT's relationship with the state's Transportation Commission, Legislature, local and regional agencies, and the public. When a cost estimate falls short, a DOT's credibility declines too. Cost escalation can cause the public to lose confidence in the ability of transportation agencies to effectively perform their responsibilities.

An example from the Virginia DOT (VDOT) underscores these points. According to the 2002 audit of the Springfield Interchange project in Northern Virginia, VDOT had to postpone or cancel 166 projects because costs were underestimated on other projects.[2] A 2001 Joint Legislative Audit and Review Committee study found that VDOT tended to underestimate construction costs significantly at each phase of project development.[3] This experience was a key factor in VDOT developing national model systems for public accountability. Such feedback and accountability provided dramatically improved internal information systems and revised the DOT's cost estimation process, and the results are reported through the agency's performance "dashboard." Public and legislative confidence in the agency has risen markedly, since these improvements.

1.3 Cost Estimation in a Challenging Environment

Estimating the cost of highway projects accurately and consistently early in their development is a nationwide challenge, receiving the attention of an AASHTO Task Force on Project Oversight and AASHTO's Subcommittee on Design Cost Estimating. State DOTs must formulate fiscally constrained plans 20 years into the future, in an environment in which budgets, materials costs, and regulatory requirements and expectations are changing. Unforeseen engineering complexities and constructability issues, changes in economic and market conditions, local governmental and stakeholder pressures, and transformation of community expectations can also impact and compromise the reliability of cost estimates. Many of the latter issues have to do with the environment.

Keeping up with these changes requires good documentation of the assumptions embedded in the estimates in the first place. Good documentation is the key to estimates that have longevity because they are easier to update without starting from scratch, and it is easier to identify and explain the elements causing the change.

1.4 Defining Environmental Project Costs

1.4.1 Costs are defined by the Purpose of the Estimate

What counts as an environmental project cost, and what is relegated to other costs depends on the purpose of the estimate. The purpose could be any of the following:

- Estimate project costs for the purpose of programming a budget
- Manage project team performance once the project is underway
- Determine accountability for project costs during development and after project completion
- Evaluate the cost of certain approaches to regulatory compliance with environmental laws, and determining cost effectiveness
- Evaluate the reasonableness of cost proposals by consultants

Each of these purposes may define environmental project costs a little differently. The DOT may choose to track certain cost data as environmental for project estimating purposes, while using a different approach if asked to estimate costs for a one time study. Consequently, an environmental cost is what the study purpose defines as an environmental cost. A fixed set of universally recognized environmental costs does not exist for transportation.

1.4.2 DOT Cost Estimating Stages

For the purpose of cost estimating discussions, it is necessary to identify the different phases of project development usually carried out at a DOT; methods for cost estimating often vary by the project development stage. Terminology for referring to development stages varies between states. For the purposes of this study, the phases and common environmental components are described and defined below.

- **Planning**—Pertains to system-level planning and project identification. Broad environmental issues identified during the planning phase may include identification of general or known environmental issues in the project area, establishment of the purpose and need for the National Environmental Policy Act (NEPA) purposes, or preparing Tier 1 NEPA documents. The Safe, Accountable, Flexible, Efficient Transportation Equity Act: a Legacy for Users (SAFETEA-LU) mandates that transportation plans include potential mitigation activities and potential areas to carry out these activities. Once a project is programmed in the Statewide Transportation Improvement Plan (STIP) for funding, it is no longer in the planning stage.
- **Project Development**—Pertains to development of a specific project and is referred to as preliminary engineering in some organizations. The project requires specific NEPA documentation if federally funded. Final alternative selection is made during this phase. For an environmental impact statement (EIS) project, this period extends to the signing of the Record of Decision (ROD); for environmental assessments (EAs) the period extends to the Finding of No Significant Impact (FONSI). Categorical Exclusion (CE) projects may spend little time in this stage. The project development phase includes

activities required by SAFETEA-LU for coordination, the development of environmental impact analyses for all applicable disciplines, preparation and approval of the Draft EIS, Final EIS, and ROD or the EA and FONSI, as it may be, consultation for permits, and preliminary development of the project design, including environmental mitigation.

- **Final Design**—Pertains to the preparation of final design plans and bid documents, right-of-way (ROW) purchase, final determination of mitigation needs, intergovernmental agreements regarding mitigation, final design of mitigation, and final preparation or modification of permits. Archaeological recovery may be undertaken during this period.
- **Construction**—Pertains to the post-bid construction of the roadway, and mitigation such as wetlands or habitat replacement, noise abatement features, landscaping, moving of cultural properties, and monitoring contractor environmental performance.
- **Maintenance**—Pertains to normal roadway maintenance activities that may require environmental permits or other clearances, including Section 404 of the Clean Water Act and stormwater management permits, a biological assessment if endangered species are present, monitoring activities to guarantee wetlands performance, or maintenance of permanent environmental features, such as wildlife crossings or water quality facilities.

1.4.3 Traditional Project Components to be Excluded

Some of the more traditional components of transportation projects, such as stormwater drainage system components, may be considered environmental costs since elements of contemporary stormwater systems are implemented to comply with environmental regulations regarding water quality; however, stormwater is a good example of an element that is also considered essential for basic transportation engineering purposes. Most DOTs do not think of these components as environmental costs because stormwater conveyance is a necessary element to avoid undermining the road itself and make the roadway work. DOTs were controlling stormwater for decades before the Clean Water Act added such requirements, with new emphasis on water quality and filtering runoff for treatment purposes, not just to slow flow or encourage infiltration.

DOT cost characterization and estimating practices for elements such as water quality are well established; they can readily estimate the cost of a stormwater management system, and DOTs generally do not find it necessary to parse out what is environmental and attributable to compliance requirements with individual (often overlapping) laws and regulations. If engaged in a study of environmental costs related to water quality protection, parsing the costs of design and construction of stormwater facilities between that part of the system necessary for water conveyance, and that part necessary to filter water may be necessary to understand the cost of compliance with the Clean Water Act. The same would be true for sizing culverts for fish passage, designing erosion control plans, controlling rock fall, and preventing landslides. Since the purpose of this study is to focus on project cost estimates for programming and project management, "environmental" costs traditionally included in transportation design will not be included as environmental costs, as the normal estimates of design and construction of standard roadway features captures those costs.

Instead, the focus of this document is on environmental costs that are distinct from commonly included components of the transportation facility, such as drainage.

1.4.4 Costs Characterized as Environmental Costs

Planning and Project Development Costs

This cost element includes activities carried out by staff and consultants trained in environmental planning and regulatory compliance. Activities usually consist of technical studies, consultations with regulating agencies, consultation with design staff, participation in evaluation exercises, writing technical reports, mitigation planning and design, negotiating agreements, production of permits, and the production and publication of NEPA documents— EAs, EISs, and documentation for CEs. Other activities may include environmental scoping for the purpose of work scope identification and issues identification. Public and agency involvement are required in the development of the purpose and need for the project and in development of project alternatives. These activities may be more extensive on controversial projects and can be counted either as environmental activities or as public involvement activities, depending on how the work is organized and who performs it. For programming and project development, it is important to capture these costs; less important is whether they are labeled environmental.

Environmental Mitigation Costs

Highway projects frequently result in mitigation that must be constructed or work that must be performed as mitigation for impacts to the environment that is not strictly part of the transportation facility; e.g. the soil on which the road is built and constructed. Commonly, environmental mitigation is performed for wetlands, cultural, archaeological, and noise impacts. These costs are included in the construction cost estimate and take place just prior to or during construction, and are usually part of the construction bid. For example, when transportation projects create unavoidable wetland impacts, other wetlands must be enhanced, restored, created, or preserved. Wetland mitigation costs vary based on the type of impact, cost of real estate, and the required replacement ratio. Retaining walls may be added to the design to avoid a wetland or to minimize impacts. Wetland mitigation costs typically include, but are not limited to:

- All items required to restore a wetland (i.e., excavation and embankment construction, vegetation)
- ROW required for wetland mitigation (actual acquisition costs)
- Any items required as a condition of a Section 404 permit
- Removal of invasive plant species
- Revegetation
- Silt fence
- High visibility fencing
- Roadway retaining wall

- Wetland earthwork
- Retaining wall used to avoid a wetland
- Annual monitoring, reporting and maintenance of the constructed or restored wetland
- Alternatively, purchase of credits from a wetland bank

Other mitigation efforts such as noise mitigation may require the installation of noise abatement walls. Cultural mitigation may require special landscaping, moving a historic property, or historic studies and recordation of a property that will be lost because of the project.

All of the costs listed above are distinctly environmental costs. They are not activities required just to make the roadway work or to avoid immediately undermining the investment, as with drainage. The cost for most mitigation is relatively easy to estimate by the time of bid letting. However, since some of the activities listed above may be subsumed within the total of that type of activity on the project, environmental costs may not be readily discernible from construction costs after the fact, or even during the bid, if not separated out as bid items. For example, grading and excavation for the wetland may be included in grading and excavation for the roadway and may not occur as a separate item. The same is true for such items as silt fencing and revegetation. This may not matter if the main purpose of the cost estimate is to come up with an appropriate overall project cost estimate, but if the purpose is to monitor costs for program assessment, then it is important to enable budgetary tracking of environmental costs throughout the process.

Cost of Avoidance

Some environmental regulations require that the protected resource first be avoided, then impacts minimized, and finally mitigated, if impacts are not avoidable. Some see this as an additional environmental cost. In such a case, avoidance would be defined as the cost of the proposal that avoids the impact, minus the cost of the project, and include mitigation costs of not avoiding the impact. This calculation may be made as alternative actions are considered during project development. However, in determining expected project costs for the purpose of project management, avoidance is almost never considered an environmental cost. The roadway or road feature cost would be calculated in the same way as the rest of the roadway in the project is calculated.

Environmental Costs During and Post-Construction

Permits or quality control plans during construction may require environmental staff consultation or monitoring during construction and mitigation monitoring following construction. States vary on how they account for post-construction monitoring costs. Some wetlands mitigation banks require an endowed fund to cover future maintenance in perpetuity; other states handle these costs as part of maintenance costs, and do not parse them out as project environmental costs.

2. Research Methodology

To address the issues raised regarding cost estimating, and in an attempt to find the best practices to be included in the Guidance, the team performed a literature search and contacted all state DOTs by email. Following the email survey, the research team conducted in-depth telephone interviews of states that appeared the most promising.

2.1 Literature Review

The comprehensive literature review included a review of published research reports, journal articles and conference publications. A list of material reviewed is contained in Appendix A.

2.2 Survey of DOTs

The design of the survey document intended to capture key information concerning current practices in managing DOT environmental cost estimating. All state DOTs, plus the District of Columbia and Puerto Rico were asked about environmental cost estimating practices; the survey is included in Appendix B. Utah, Florida, Montana, Illinois and Alabama responded to the survey. Illinois and Alabama indicated that they did not estimate environmental costs per se; an informal check indicated that this is also the case with other non-respondents. The contact list is in Appendix C. States that do environmental estimates or tracking were asked to send examples of environmental estimates and estimating guidelines.

2.3 Telephone interviews

States that responded to the Email were contacted to verify the information and expand on the issues therein. In addition, states that were listed in other studies and reports as having experience in tracking and estimating environmental issues were contacted by phone and interviewed. The research team conducted in-depth follow up interviews with Maryland, Montana, Oregon, Washington, Utah, Pennsylvania, and Florida. Florida responded after the survey was completed, so information contained in this report regarding Florida is from previous research.

3. Research Results

3.1 Literature Review

The literature review identified a number of existing studies with examples of costs that DOTs use to develop cost estimates for environmental mitigation. Appendix C presents recent sample costs from state DOTs. These include costs for noise walls, drainage and stormwater control, vegetation establishment, and other areas.

While results and relevant points from our literature review are included throughout the whole of this report, the following sections summarize the main studies.

3.1.1 Center for Transportation and the Environment 1997 Study

North Carolina State University's Center for Transportation and the Environment (CTE) published a study in 1997 that assessed the costs of environmental compliance for highway projects, including the NEPA process. FHWA's report on the *Performance of Environmental Streamlining* concluded that the CTE study "…has probably been the most rigorous attempt to quantify the impact of the NEPA process on highway project costs." It specifically states, "All past economic analyses of the costs of environmental regulations have completely overlooked their impacts on the construction and repair of highways." However, the FHWA report also notes that state transportation department engineers have suggested in other studies that the additional costs attributed to environmental compliance are at least 8 to 10 percent of the construction and repair expenditures for Federal Aid projects."[4]

CTE's study involved a survey of environmental officials at 50 state DOTs, from which 19 responses were received.[5] The survey questionnaire requested a variety of information regarding expenditures for Federal Aid and state projects involving either new construction or repair, along with the percentage of the cost attributed to environmental compliance activities. CTE found, as we did for NCHRP 25-25(39), that most survey respondents were unable to provide the requested environmental compliance cost information and that the survey response was considered to be too small to be statistically valid, and of limited use.

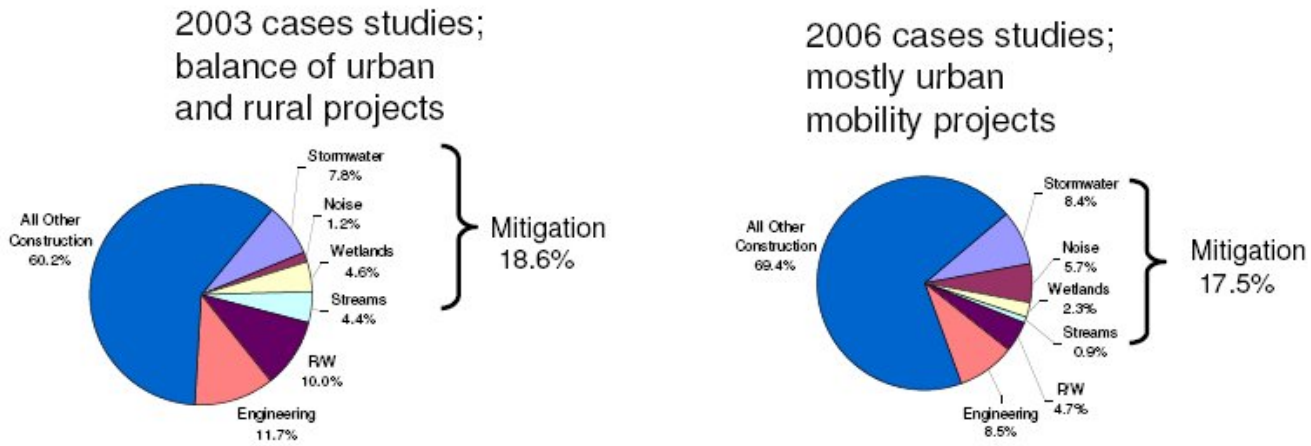
CTE's study found that of those states that did keep records on staff time and compliance costs, the additional costs were generally found to be less than 10 percent. By comparing cost increases between 1990 and 1994 when wetland and water quality regulations were being implemented, the researchers concluded that Section 404 permitting affected the cost of highway projects, along with the number of National Priority hazardous waste sites, sites on the National Register of Historic Places, the presence of threatened or endangered species, and acres of farmland. Nevertheless, the study was not able to determine the full extent of environmental compliance costs, and it noted the difficulty of isolating the costs of the separate factors and regulations as percentages of the total for uniform application to all projects.

3.1.2 Washington State DOT Study of Mitigation Costs on 21 Projects

To date, WSDOT has conducted case studies on 21 highway projects (14 in 2003, 7 more in 2006), to illuminate the cost of mitigation for highway projects in Washington and whether mitigation undertakings and costs were reasonable in relation to project objectives.[6] All of the projects studied in 2006 were funded by the 2003 "nickel" gas tax increase.

WSDOT is considered to have some of the highest mitigation requirements in the nation, due to the large number of threatened and endangered species, cultural resources related to Native Americans, wetlands, and water quality issues. The 2003 investigation performed case studies on fourteen projects with a total value of $427.44 million and found that 18.6 percent of the total cost of the projects was spent on mitigation.[7] In early 2006, case studies on seven additional projects with a total value of $641.4 million, focused on urban projects with generally higher mitigation costs, found 17.5 percent of the total cost of the projects was spent on mitigation.[8] In the 2006 set, costs ranged from 1 percent to 24 percent of total project costs. WSDOT's breakdown of mitigation costs is as follows:[9]

Source: Washington State DOT Mitigation Cost Studies, 2003 and 2006, p. 6



No clear pattern emerged for the scale of mitigation costs in relation to overall project size at WSDOT; the location and setting of a specific project in relation to neighborhoods, streams, and wetlands were much more critical factors, as might be expected; i.e., the richness of the environment translated into increased costs to accommodate and preserve the resources. Highway expansion in urban areas often required noise mitigation.

The mitigation feature costs represented in the report were total costs, and each of the mitigation categories included:[10]

- Construction cost (actual cost from bid document or engineer's estimate).
- Allocated share for state sales tax; generally estimated to be approximately 8 percent added to overall construction contract amount.
- Right of way (actual acquisition cost).

- Allocated share of contractor's mobilization; usually estimated to be approximately 10 percent of overall construction amount, for ease of computation.
- Allocated share of WSDOT cost for construction engineering and administration added an amount considered equal to 6 to 14 percent of the construction contract amount.
- Allocated share of WSDOT Planning and Design added an amount ranging from 5 to 15 percent of the overall project costs.

3.1.3 Findings from a National Study of Environmental Costs on Six Projects

For a report to Congress, FHWA engaged a study of costs on six "typical" projects with environmental impacts, ranging from the rehabilitation of a two-lane rural highway in Montana, to the replacement of a major Interstate interchange in a rapidly growing suburb of Seattle. The study included environmental work that resulted in two EISs, two EAs, and two CEs. [11]

- Environmental costs for the case study projects averaged about 8 percent of total project costs, with a range from 2 percent (12300/12600 S, Utah) to 12 percent (US 113, Maryland; Bob Creek Bridge, Oregon). These estimates do not include categories of costs that the research was not able to address, including air quality assessment in planning, environmental costs arising during facility operations and maintenance, and costs specifically attributed to the use of Context Sensitive Solutions (CSS).
- Environmental costs for projects that had an environmental component in planning, environmental review, and the design phases averaged about 23 percent of the total preconstruction phase cost of the project. The range was from 8 percent (U.S. 113, Maryland) to 41 percent (Alexauken Bridge, New Jersey).
- Construction costs are typically the largest element of total project cost (ranging from 65 to 80 percent in the case study projects). Environmental costs typically represent a small percentage of construction costs, although the dollar amount for such work (land purchase, mitigation construction, and special equipment) may be substantial. The case study projects experienced environmental-related construction costs that averaged 4 percent of total construction costs for the projects, with a range of 1 percent ($640,040 for 12300/12600 S, Utah) to 13 percent ($18,223,080 for US 113, Maryland). Where mitigation construction was required, the construction-related environmental costs constituted the largest portion of the project's total environmental costs.
- For the small projects studied, environmental costs for preconstruction activities outweighed environmental costs incurred during construction. The reverse was true for larger projects.
- Expenditures on stormwater management, landscaping, and wetlands during construction are large environmental cost drivers. Those construction costs had a much bigger impact on total project costs than staff and consultant time spent on the project studies and design engineering.
- Environmental mitigation related land acquisition costs vary among projects. Where such acquisition is required, the costs can be significant.

- Project design and construction changes to accommodate environmental concerns can add costs, but such costs are difficult to identify, segregate, and measure.

3.2 Research Findings by Topic

The following is a compilation of information gathered from both the literature review and the interviews by topic area.

3.2.1 Key Environmental Cost Estimating Issues for DOTS

There are many reasons why state DOTs question the benefits of tracking environmental costs and why efforts to identify and track environmental costs are so limited: [12]

- Insufficient labor and financial resources are available to develop, implement, and maintain appropriate financial management information systems.
- Inconsistency among existing state financial management information system protocols for breaking down project costs and coding them. The methods for collecting and categorizing costs differ greatly from state to state.
- Separating environmental costs from non-environmental costs is quite difficult, especially in the category of avoidance costs. Multiple project or program needs often underlie particular expenditures of time or money and are difficult to separate.
- Reliable ways to identify the costs of "the path not taken" when design changes are made or when other actions are taken or not taken for environmental reasons are generally not available.

DOTs Regularly Estimate a Limited Set of Environmental Costs

DOTs regularly estimate a limited set of environmental costs, such as those outlined in Appendix C. These include hydraulic/drainage/stormwater management, landscaping and revegetation, and noise walls.

DOTs typically do not estimate costs during the planning, programming, or early project development phase for impacts to natural and cultural resources and project changes generated by these issues or impacts to low income or minority populations. Some states apply a flat percentage to all projects, to help estimate costs for preparing environmental documents. For example, Colorado DOT has estimated and allocated 2 percent of total project costs for NEPA on major projects. Noise walls were the only mitigation for which CDOT ever developed costs, in project development. CDOT does not estimate environmental costs in planning, except for programmatic advance mitigation, as for species and habitat in the eastern third of the state in CDOT's interagency Shortgrass Prairie Initiative. CDOT developed and utilized an innovative mechanism, a state-funded revolving fund of $5 million, for the purposes of advance mitigation. Projects drawing on the mitigation later reimburse the fund as they go to construction. One difficulty with such a bank or revolving fund is that they can "tie up" revolving fund resources for a long period of time, before the project is actually constructed and funds are available for re-use in another "loan."

Cost Mingling

Many environmental costs are intertwined with those for design and construction. DOTs often track costs separately for wetland mitigation and for erosion and sediment control unit items but it is possible to isolate other environmental costs such as project development costs for specific activities performed by environmental staff and consultants. The most frequent example is bridges and culverts designed not only for water conveyance but also for fish or wildlife passage.

Departmental Accounting Systems Are Not Set Up to Track Environmental Costs as Separate Items

Good cost estimating requires the feedback of actual cost tracking to perfect future estimates. Most state financial management systems were not set up to capture cost data by specific function such as environmental, particularly in the planning and project development phases. Financial management information systems that could expand labor categories and be reoriented or tailored to provide more detailed cost categorization would require an investment in labor and financial resources to develop, implement, and maintain the system. States are reluctant to allocate this, in the face of other needs, unless it becomes a part of a general up-grade in the financial management system. In addition, separating some environmental costs from non-environmental costs is quite difficult, as one action may support multiple project or program needs.

Some States Are Upgrading Their Systems to Better Track Environmental Costs

Some states are altering or supplementing their accounting systems to environmental costs more closely. For example, in 2005, the Kentucky Transportation Cabinet (KTC) introduced 22 new activity codes for use by environmental staff and a comparable set of 22 codes for tracking consultant activity that are expected to improve the agency's cost tracking capabilities. MD State Highway Administration (MDSHA) tracks all staff time and preconstruction consultant activities using the agency's Financial Management Information System. Elements of Oregon DOT's cost tracking methodology include planning costs, preliminary engineering/environmental costs, right-of-way costs, design costs, construction costs and maintenance costs. Utah is now adding environmental aspects to their Project Management system, ePM, which tracks the budget estimate, performance against the budget, and collects actual labor through the timesheets of individuals.

3.2.2 Issues Related to Environmental Costs Overrun

Project Management Factors That Influence Total Project Cost

In 2000, Reilly and Thompson's survey of 1400 international projects found significant cost and schedule overruns suggestive of poor management in at least 30 percent and likely more than 50 percent of projects, though specific data were not reliable in that segment. Their survey pointed to the following factors as the most common influences of project success or failure with regard to cost overruns: [13]

- Expertise, capability and policies of the owner
- Political changes in the middle of projects
- Poor decision making and lack of continuity
- Inappropriate contracting procedures
- Inadequate agreement about requirements and impacts
- Lack of understanding and control of external events

Likewise, in their December 2004 study, VDOT cited many reasons as to why final project costs can exceed initial estimates. In some cases, project scoping is not sufficiently detailed or potentially costly items such as traffic management devices, crossovers, turn lanes, and others are added as time goes by. In other cases, unforeseen environmental issues arise that require amelioration, or the methods used to estimate costs are incompletely or inconsistently applied."[14]

Other Factors Contributing to Environmental Cost Overruns

We find several of the above factors to be relevant in relation to environmental costs on projects; however, of the factors above, the following may have the most connection to environmental costs on transportation projects and point to possible improvements:

- **Political changes**. Political changes in the middle of a project often affect funding and thus the scope of the project, which in turn may affect the anticipated environmental issues, needs and mitigation.
- **DOT policies**. Many DOTs have internal policies and budgeting structures that limit the amount of environmental analysis that occurs during planning and could minimize risk later on. Funding for environmental analysis in planning typically comes out of the state's budget, whereas Federal Aid covers 80 percent of project environmental costs during project development and construction. Additionally, resource agencies are accustomed to permitting based on design-level detail, rather than consulting and permitting where feasible in planning, with its attendant costs. Consequently, DOTs tend to apply their greatest environmental effort and expenditure toward the end of the process.
- **Lack of continuity and disagreement about impacts and mitigation requirements**. To some extent, staff turnover issues lead to disagreement about environmental impacts and requirements. Turnover often leads to loss of project knowledge, particularly on large projects with lengthy schedules. If the turnover is in the regulatory agency ranks, it

can lead to changes in expectations and requirements, adding six months to a year to project development, resulting in cost overruns.

- **Project scope changes result in additional mitigation requirements**. A study on the cause of cost overruns at one of the most well known and expensive highway projects in recent memory, Boston's Central Artery or "Big Dig," found that environmental costs, particularly very significant mitigation requirements (new scope), were a contributing factor in that project's severe cost overruns.[15]
- **Lack of oversight.** Recent analyses point to the lack of adequate oversight as a large factor in cost overruns.[16]
- **Inadequate agreement about requirements and impacts**. Inadequate risk assessment is another primary factor in cost overruns.[17] Flyverberg's team found that routine underestimation of costs spans all continents, project types, and decades, concluded that explanations such as -- unforeseen technical problems, accidents, optimism – are unsubstantiated. "We also maintain that such risk can and should be accounted for in forecasts of costs, but typically is not." [18] Although not explicitly addressed, the indication is that inadequate risk assessment and risk management apply equally to environmental cost management.

3.2.3 Challenges to Environmental Cost Estimation

A 2006 FHWA report to Congress found that limited environmental cost data are available, and that efforts to track environmental costs still are minimal. So, what are the challenges that keep DOTs from moving ahead with environmental cost estimating and tracking?

Difficulty Assigning Costs to Some Environmental Resources

A common practice among estimators for getting early "ballpark" cost estimates for road projects is to use a current cost per square foot or linear mile for the roadway or bridge project contemplated. This method, called parametric cost estimation, relies on a relationship of cost to the road feature. Whereas a roadway of X length and design generally requires Y yards of materials, the same is not true of natural and social resources. There is not a parametric formula for determining the number of acres of wetland mitigation needed or artifacts recovered per mile of highway. Therefore, road features are not predictive of the cost of environmental mitigation. Each project is unique in its collection of environmental issues, and therefore requires trained environmental staff to spot likely issues and put a price on them. This effort is likely more time consuming and requires more data than may be required for the engineering estimate for the transportation project. Often, this effort doesn't occur at the early programming stage, when the project is first entered in the STIP, so from the very inception, the project is underfunded.

Determining Which Costs Are Environmental

Determining which costs are environmental can be a primary challenge. As previously discussed, while there is agreement that project wetland or habitat mitigation are environmental costs, other costs that have historically been part of the engineered features included with highways, e.g. ditches and drainage elements, are considered environmental costs.

Long Time Spans for Project Development and Mitigation Identification

Long time spans between project development and mitigation identification complicate environmental cost estimation on projects, as numerous changes to the project scope and schedule may occur. Collaborative processes for alternative identification, impact and mitigation identification involve the public and other agencies. The direction of project development is not always predictable. There may be public and agency requirements for mitigation that the DOT did not foresee nor account for in the project cost estimate.

Uncertainty with Regard to Environmental Impacts, with Planning Level Data

While tools such as predictive habitat modeling, GIS, and environmental resource data bases have greatly extended the ability to use planning level data to assess environmental impacts, many factors that influence project environmental costs are undefined during the early stages of planning and project development. For example, the nature of prospective archaeological sites in the project area is usually unknown in the planning phase. Subsequent studies will identify the existence, precise location, nature, and relative value of sites during the NEPA process and preliminary design or not. In some cases, this information won't be known until construction. Similarly, the existence and location of endangered plants may not be determined until far into the NEPA process. Potential cost impacts are contained within results yet to be seen and decisions yet to be made, such as the selection of the preferred alternative alignment, the resulting right-of-way impacts, and environmental mitigation required for permits or compliance with environmental regulations.

3.2.4 Attitudes Expressed Concerning Environmental Cost Estimating

"There Needs to be a Good Reason" to Expend More Effort Characterizing Environmental Costs

While DOTs sometimes voice concern about environmental requirements and the associated costs, they also recognize that costs may be notably difficult to assign and monetize.

In response to the question, —"Are there environmental elements within the planning-development-construction-maintenance process for which you think costs can and should be estimated or tracked, which are not, currently?" — DOTs generally answered "no." One clarified: "There would have to be a good reason to do something different than current methods."

These results are consistent with FHWA's findings in a 2005-2006 study on costs of environmental compliance.[19]

> FHWA Case Studies Research found that many states question the benefits of tracking environmental costs in light of the expense of such efforts. The research identified only four states (Maryland, Montana, Oregon, and Washington) that currently have experience with extensive cost tracking efforts in the environmental area. Our research revealed that Utah recently added environmental labor costs to its project development tracking system.

As part of the NCHRP 25-25(39) research effort, some DOTs pointed out that more could be done with existing collected information to estimate and track all project costs for each specific work category. It was noted, "This would provide a mechanism to better manage

costs, provide more accurate estimates and also receive credit for work completed (especially important with environmental activities)."

Where DOTs Want to Devote Environmental Cost Estimating Effort: Mitigation Costs

DOTs are interested in better and earlier estimation of mitigation costs, such as those for wetlands and habitat replacement. Lead DOTs and natural resource organizations have begun to develop excellent methods to identify or project impacts, potential costs, and even design and negotiate mitigation during the planning phase.

Other desirable environmental cost information includes preliminary engineering costs for environmental studies. Florida DOT has made particular strides in this area; needed environmental studies are identified through environmental screenings at the planning and pre-programming phases, and the costs for such studies are estimated and included in the work program or STIP.

Emerging Issues

Emerging environmental issues causing DOTs concern include air toxics, health effects, and especially climate change. FHWA is tracking the extent and ways in which climate change is being addressed in NEPA documents. AASHTO and lead states have begun to explore and address anticipated DOT action in reducing carbon dioxide emissions. At this point, the future cost of dealing with these topics is unknown and not readily estimated; however, leading economists have concluded that the cost of inaction greatly exceeds the cost of action.[20] In addition, AASHTO, FHWA and NCHRP efforts are underway to estimate the cost-effectiveness of the classes of strategies that DOTs may undertake to reduce emissions.

3.2.4 Best Practices in Environmental Cost Estimating

The 25-25(39) research also uncovered a number of excellent and proven models, which are assisting DOTs in more accurately estimating environmental costs. The following sections discuss these processes.

3.3 Processes for Cost Estimating

Sound project cost estimating processes have the following elements:

- Definition of the environmental cost categories
- Identification of environmental elements in the project being estimated
- Recordation and compilation of all project cost estimates
- Ability to adjust cost estimates for risk and uncertainty
- Recordation of actual costs as the project progresses
- A feedback loop to the project manager, and ideally to the team, on actual costs versus estimated costs of a project
- Evaluation of final costs at the end of the project

- Ability to adjust the estimating process for future projects

In addition to the above, cost estimating for special studies requires:

- Ready access to environmental cost data
- Data in a format that this interpretable as environmental cost data

The following section identifies practices in use that address one or more of the elements above.

3.3.1 Defining a Good Cost Estimate

DOTs are finding that a good cost estimate involves integrated planning, a concept that FHWA and progressive DOTs have been promoting for the past decade. Integrated planning involves thorough review and joint consideration of the opportunities, factors, and impacts suggested by the planning products of other entities. With SAFETEA-LU and the emergence of integrated planning, there has been particular emphasis on utilizing existing conservation plans and consulting with the entities that develop such plans.

WSDOT revamped the state's estimating process, producing a trademarked approach they call Cost Estimate Validation Process (CEVP).[21] WSDOT's recommendations for generating a good cost estimate are highly relevant for better estimation of environmental costs; these areas correspond to major areas of environmental guidance development the past several years:

WSDOT Elements of a Good Cost Estimate	Sample Guidance Development – Environmental Aspects
1. Integrate planning, environmental, engineering and construction	Integrated Planning and Planning Environmental Linkages Resources, FHWA: http://www.environment.fhwa.dot.gov/integ/resources.asp AASHTO, Environmental Stewardship Practices, Procedures, and Policies for Construction & Maintenance
2. Consider history (escalation) and local circumstances	Context Sensitive Solutions, Community Impact Assessment
3. Identify and characterize risk and opportunity	Eco-Logical, federal interagency guidebook describing a framework for making infrastructure projects more sensitive to wildlife and ecosystems through more integrated planning, new partnerships, and cooperative conservation
4. Identify and quantify items that have a major affect, including environment, right-of-way, escalation, schedule, and phasing	Early consultation is widely recommended and now SAFETEA-LU Section 6001 and 6002 requires certain elements and activities to be included in the development of long-range transportation plans, including: • Consultations with resource agencies, such as those responsible for land-use management, natural resources, environmental protection, conservation and historic preservation, incl. comparisons of resource maps and inventories • Discussion of potential environmental mitigation activities • Participation plans that identify a process for stakeholder involvement
5. Consider and incorporate uncertainty, variability and risk	There is little in the way of environmental guidance; however, planning level environmental analysis has proven to reduce

WSDOT Elements of a Good Cost Estimate	Sample Guidance Development – Environmental Aspects
	risk related to environmental matters and changing agency decisions in planning (e.g. FDOT Efficient Transportation Decision Making Process)

WSDOT's approach is notable in the degree to which risk is explicitly considered.

3.3.2 How DOTs are Tracking Environmental Costs

Very few states have performed in-depth studies of environmental costs. Those that have, like Oregon DOT, have done so in a special and time-consuming effort mandated by a state legislature. Oregon DOT does an environmental cost study for their state legislature every other year, but no longer attempts to break environmental costs down by federal, state, and local regulations or by discipline. Instead, the report is prepared by asking divisions and crews what percent of their time is spent on environmental issues and using their best professional judgment/recollection. Estimates can be made by crew, if assumptions used are consistent across the group. When estimates are variable, a more in-depth listing occurs of who does environmental work, and what percent of their time such work entails. Oregon DOT has also found that for small projects (93 percent of projects), almost all ROW acquisition is associated with environmental needs.

The following categories of data are likely to provide the primary sources of information on environmental costs in most DOTs: [22]

- **Environmental work, commitment and workflow tracking systems**. Caltrans, Maryland, New York, Texas, Vermont, and Virginia have all developed electronic systems supporting management and tracking of environmental work, across specialty areas. Section 4 of this report will review some of these systems and elements that contribute or may contribute to environmental cost tracking. For example, Washington State has a system oriented toward environmental commitment tracking, but their system does not track environmental labor or other costs. Future project management system improvements scheduled for the agency may incorporate environmental labor and other costs.

- **Improved project management systems**. Some DOTs are making major investments in improved project management systems. WSDOT has invested nearly $15 million. Utah DOT is developing an electronic project management (ePM) system using an Oracle database platform, which will include about 25 environmental-related activity codes and allow better tracking of staff time and consultant costs. The ePM provides information on the planning, funding, scheduling and staffing of UDOT design projects. It will also allow project managers to predict environmental costs (NEPA documentation and permits) based on standard defaults for different types of activities. [23]

- **Mitigation estimation and tracking**. Caltrans, Montana, North Carolina and Washington have developed databases or other systems to project and track mitigation.

- **Maintenance and asset management systems**. DOT maintenance management systems track labor for different categories of maintenance activities. A few DOTs have developed special asset management systems for stormwater facilities. Maryland's

system is the most extensive and well known, with a reliable rating system and improvement approach that has thus far achieved a grade of "fully functional" on 90 percent of facilities. Oregon and Virginia are in the process of integrating their culvert/stormwater/drainage feature management systems into wider asset management systems and approaches.

- **Financial information management system data**. All state DOTs maintain agency-wide electronic systems for managing financial information that are a potentially valuable resource for tracking environmental costs. In 2005, the Kentucky Transportation Cabinet (KTC) introduced 22 new activity codes for use by environmental staff and a comparable set of 22 codes for tracking consultant activity that are expected to improve the agency's cost tracking capabilities.[24] Maryland SHA's Financial Management Information System tracks all staff time and preconstruction consultant activities.[25] Many DOTs, however, rely on antiquated mainframe-based computer programs to run their financial systems and these are poorly set up to disaggregate environmental costs.

- **Contractor and consultant contract records**. DOTs may be able to gather considerable amounts of information from consultant and contractor contracting records, but this usually requires careful project-by-project scrutiny of documentation.

Oregon DOT developed detailed methodologies for measuring costs on a program level, including costs for planning, preliminary engineering, environmental, right-of-way, design, construction and maintenance.[26] Systems to support environmental cost tracking in development or in use in Oregon, South Dakota, Virginia, and Washington are discussed in greater detail in section 4 of this report,

3.3.3 Identification of Environmental Issues

In order to estimate environmental costs, environmental elements of the project need to be identified; however, such issues and factors are not always readily apparent and some topic areas require research before the issues are revealed. Other issues arise as a product of public involvement. DOTs that are trying to better predict environmental costs are employing a variety of approaches to reveal environmental issues very early in project conceptualization, when cost estimates are first made.

Washington State DOT Environmental Workbench

WSDOT maintains a GIS (Geographic Information System) "Environmental Workbench" and other sources of environmental data used to identify and document potentially affected environmental resources. WSDOT staff then use this information to identify opportunities to avoid or minimize environmental impacts of any alternative transportation solutions under consideration and potentially eliminate alternatives with unacceptable or greater environmental consequences. For the statewide multi-modal transportation plan, state law directs WSDOT to identify and document potential affected environmental resources in coordination with relevant regulatory agencies, including local governments, and give the agencies an opportunity to review the environmental resource documentation. Documenting environmental information and analyses used in the planning process, and environmental impact avoidance or minimization actions taken allows the information to be used later to expedite environmental review and permitting during the design and

environmental review, environmental permitting, and PS&E phases of the WSDOT transportation decision-making process.

Florida's Efficient Transportation Decision Making Process

At Florida DOT, a planning screen occurs in conjunction with the development of long-range transportation plans, as part of the agency's Efficient Transportation Decision Making Process (ETDM). This initial screening of planned projects allows participants to review project purpose and need statements and comment on the potential impact of projects to environmental and community resources very early in the planning process. FDOT uses the environmental screening tool (EST) to evaluate direct and indirect effects of proposed projects. This opportunity enables planners to adjust project concepts to avoid or minimize adverse effects, consider mitigation alternatives, and improve project cost estimates through early consideration of environmental matters and decisions on needed studies. Participating agencies evaluate cumulative effects to resources on a system-wide basis in connection with the planning screen. The interrelationships between land use, ecosystem management, community values, and mobility plans are considered through integrated agency planning. Key recommendations and conclusions regarding potential project effects are provided in the Planning Summary Report. This report provides information to help planners stage transportation priorities in long-range transportation plans and is available electronically to resource agencies and the public.

SAFETEA-LU

Through SAFETEA-LU, many of the activities previously considered good practice are now mandatory measures to strengthen consideration of environmental issues and impacts within the transportation planning process and to encourage the utilization of planning products in the NEPA process. In addition, SAFETEA-LU requires certain coordination with regulatory agencies that may affect the scope of environmental work. Notable among the requirements, DOTs must consult with participating agencies on the methodology required in the environmental studies. The definitions of the study area and method of analysis can affect environmental costs.

Engaging the SAFETEA-LU coordination processes early in the project development process can assist in gaining early agreement on the level of analysis required and help in making cost estimates for environmental activities. For example, Oregon DOT formed a monthly working group with regulatory agencies called the Collaborative Environmental Transportation Agreement and Streamlining (CETAS), which regularly reviews projects. The group developed a series of concurrence points for EIS projects, which it sometimes applies to EA projects as well. Such groups, if working in a cooperative fashion, allow for superior communication with regulatory agencies resulting in more agreement on analysis methodology, appropriate mitigation, and fewer surprises mid-course in project development, all of which leads to better cost estimation and cost control.

3.3.4 Identification of Mitigation Needs—Unique Approaches

Early identification of potential mitigation needs, particularly the large ticket items such as wetland and habitat replacement, have generated a unique approach is some states. These states employ a variety of processes to identify future mitigation needs early in the process, and plan for mitigation that is more effective from both the cost standpoint and the habitat

standpoint. These processes offer an opportunity to improve cost estimation for mitigation and make accurate estimates available earlier in the process.

North Carolina's Ecosystem Enhancement Program

Wetland impacts used to be a major barrier to project implementation in North Carolina and achievement of the state's legislative objectives for extension of highway systems statewide. NCDOT effectively surmounted this barrier with extensive interagency collaboration on development of an advance mitigation planning process administered through the state's Ecosystem Enhancement Program (EEP).

NCDOT provides EEP an annual Project Impact Report of all anticipated wetland, buffer and stream impacts by year for seven years into the future, for each 8-digit watershed. Impacts are projected for each Transportation Improvement Program (TIP) project number and/or NCDOT Division operations impacts by year. For anticipated wetland impacts, NCDOT and EEP provide estimates in the following units: acres of riverine, non-riverine and coastal marsh; for buffers, the units are square feet; and for streams, the units are linear feet. This greatly streamlines the delineation process because no further wetland type assessment is required. NCDOT submits quarterly updates throughout the year.

NCDOT makes their initial forecasts from vegetation and land cover data layers. When information that is more detailed is available from technical reports in NEPA documents, that data overrides the planning level estimates. By the minimization stage, approved permit drawings are available and NCDOT further minimizes impacts. NC EEP mitigates the remaining impacts according to the highest needs in each watershed and in conjunction with the priorities determined by local communities.

WSDOT Transportation Project Mitigation Cost Screening Matrix

WSDOT developed a Transportation Project Mitigation Cost Screening Matrix or screening tool to help transportation planners identify proposed projects that may benefit from the application of watershed-based mitigation. It helps to:[27]

- Identify projects that may benefit economically or have improved project delivery by using watershed-based mitigation.
- Identify projects that should have minimal environmental impacts or where mitigation should be relatively uncomplicated and inexpensive.
- Give early warning about projects that may be financially, logistically, or administratively difficult to mitigate.
- Allow timely development of other mitigation options such as low impact development and watershed-based mitigation.
- Identify areas where multiple transportation projects could benefit from watershed characterization.

The screening tool analyzes readily available data on urbanization, floodplain areas, soil types, topography, wetlands, hazardous materials, parks and other cultural resources. Projects that encounter these features commonly have the highest environmental mitigation costs, especially for stormwater treatment and wetlands replacement. The tool generates a

mitigation risk index (MRI) consisting of a single score that estimates the percentage of land area within the project limits that will likely experience logistical difficulties or elevated costs for environmental mitigation in the right-of-way.

Mitigation Planning and Cost Estimating at Caltrans

Caltrans contracted with the UC Davis, Information Center for the Environment (ICE) to facilitate mitigation needs assessments and develop new methods to improve the ability to do long-range planning for mitigation needs. The project includes long-range mitigation plans and analysis, a mitigation project study, and updating and adding records to the existing Caltrans BioMitigation database.

Using GIS and conservation planning approaches, Caltrans is developing a long-range (10-year) mitigation needs summary and biological mitigation plans for each District/Region. Elkhorn Slough, a partnership with the Nature Conservancy and other conservation organizations, was the first pilot. The report includes a cost-benefit analysis of in-house Caltrans biological map development (land cover and habitat classification data) and a process for ongoing data analysis and strategic mitigation planning, including model mitigation, conservation banks, and programmatic agreements to serve multiple transportation projects. In conjunction with this, Caltrans funded an analysis of past Caltrans mitigation projects to compare approaches and costs.

3.3.5 Cost Estimating Processes Prior to STIP Development

State DOTs' methods for producing preliminary cost estimates vary widely, especially in consideration of environmental costs. For example, Indiana's Cost Estimation Guidance says with regard to environmental costs only that "expected environmental problems" such as hazardous materials or wetland mitigation should be taken into account in cost estimates.[28] Ohio DOT provides a sample of what is included in a corridor level cost estimate for the Appalachian Highway:[29]

- Erosion control/clearing/grading/drainage/minor structures
- Environmental mitigation
- Roadside improvements such as landscaping, and rest areas or overlooks

Utah and Oregon are among the states beginning to do pre-programming/scoping for environmental aspects of projects through on-site visits by specialists. UDOT is on its second pilot project for this approach.

Montana Department of Transportation (MDT) uses a tool that rigorously applies project man-hours and duration for environmental staff, but this tool is used only for scheduling the delivery of the project and not for cost estimates. Nevertheless, MDT uses such systems as a source of data for environmental cost estimating. The current accounting system is not set up to automatically capture and report environmental costs, and MDT has not explored to see whether it could be easily adapted to capture costs, given the questionable value of the data and difficulty dividing environmental costs from the required engineering costs to accomplish the project.

Caltrans, Florida, Maine and Minnesota DOTs have more detailed processes, as described below.

Caltrans Preliminary Environmental Analysis Report

The Preliminary Environmental Analysis Report (PEAR) provides the initial environmental evaluation of a project and all feasible alternatives before Caltrans programs a project in the STIP or State Highway Operation and Protection Program (SHOPP). The PEAR also estimates the scope, schedule, and costs associated with completing environmental compliance.

Because the environmental process can have substantial bearing on the project alternatives, design, costs, schedule, and delivery, the PEAR must clearly present and discuss the results of preliminary environmental studies in order to identify environmental constraints that may affect design. The information contained in the PEAR serves as the foundation for the environmental team to begin studies in the Project Report phase, facilitating early consultation with federal and state resource agencies.

The PEAR Handbook - Guidelines for Preparation of the Preliminary Environmental Analysis Report refers to several other documents. The Environmental Studies Request Form records such things as:

- New alignment or a realignment
- Tree removals
- Work off the paved roadway
- Vegetation removal, trenches, grading or other ground disturbance
- Drainage work or work in channels or wet areas
- Structures are present on or adjacent to the proposed ROW,and whether additional ROW is needed,
- Materials sites locations and quantities needed
- Publicly owned lands involved.

Caltrans' Preliminary Environmental Analysis Report format requires a brief summary of key environmental issues, required studies, permits, and mitigation for each practicable alternative, including a time and cost estimate, and any constraints likely, such as construction windows, biological monitoring, Native American consultation, monitoring, and acquisition of Permits to Enter. An accompanying spreadsheet details the costs. Also summarized for each practicable alternative are any special processes such as a NEPA/404 merger, seasonal constraints, Section 7, or Section 4(f) that may affect project delivery and require unusual, exceptional, or extended environmental processes. The report describes anticipated mitigation measures to reduce, minimize, or compensate for project impacts and includes a cost estimate for each mitigation measure. Examples include:

- Fish & Game 1601 Agreement
- Coastal Development Permit
- State Lands Agreement

- National Pollutant Discharge Elimination System (NPDES) Permit
- US Army Corps of Engineers (USACE) Section 404 Permit- Nationwide
- USACE 404 Permit- Individual
- USACE Section 10 Permit
- USACE Section 9 Permit
- Noise attenuation
- Special landscaping
- Archaeological
- Biological
- Historical
- Scenic resources
- Wetland/riparian costs are estimated to the nearest thousand dollars and include all costs to complete the commitment including: 1) capital outlay and staff support; 2) cost of right-of-way or easements; 3) long-term monitoring and reporting; and 4) any follow-up maintenance.

The report also lists all required environmental technical reports or studies and is reviewed and signed by the Environmental Office Chief and the Project Manager. A PEAR Support Cost Matrix of environmental personnel and activities is included to assist in estimating.

Pre-Programming Cost Estimation in FDOT's Efficient Transportation Decision Making Process

As previously discussed, Florida's ETDM Process involves a Planning Screen and a Programming Screen, and the latter occurs before projects are funded in the FDOT Five-Year Work Program. Receipt of input about the potential affects to environmental and community resources helps FDOT execute the scoping step for NEPA and other federal and state environmental laws. Lead agencies decide on a NEPA class of action for each priority project which is summarized along with potential project effects, preliminary project concepts, reasonable project alternatives, and scoping recommendations.

If interagency participants on the Environmental Technical Advisory Team identify potential dispute issues that are not resolved in the course of programming screen discussions, a project is either not programmed or FDOT may initiate a dispute resolution process to precede programming. Potential disputes may also be identified through the public involvement process and require resolution prior to the project being advanced into the design or construction phase of the Work Program. Needed environmental studies, costs, and affects on a project's timeline are all decided prior to programming, effectively increasing the accuracy of the cost estimate.

Enhanced Scoping Processes at Maine and Minnesota DOTs

Better data collection and compilation of lessons learned are helping DOTs to address some of their major cost estimation challenges, especially those related to environmental matters. The processes now incorporate the following steps:

- Describe the scope of solutions for all issues early in project development
- Evaluate the quality and completeness of early cost estimates
- Identify major areas of variability and uncertainty in project scope and costs
- Track cost impacts of design development that occurs between major cost estimates
- Cost control during project delivery starts with accurate cost projections

The goal of the project scoping process is to have a well-defined project with a reliable cost estimate and delivery schedule before it appears in the STIP. This requires comprehensive scoping of each project.. Maine and Minnesota DOTs are among those that developed detailed scoping guidance or enhanced scoping processes. Scoping is receiving increased attention because good scoping produces:

- Better cost estimates
- Alignment with performance goals
- Less rework
- Predictable delivery schedule
- Greater public trust
- Improved coordination with partners
- Everybody on the team working toward the same goal

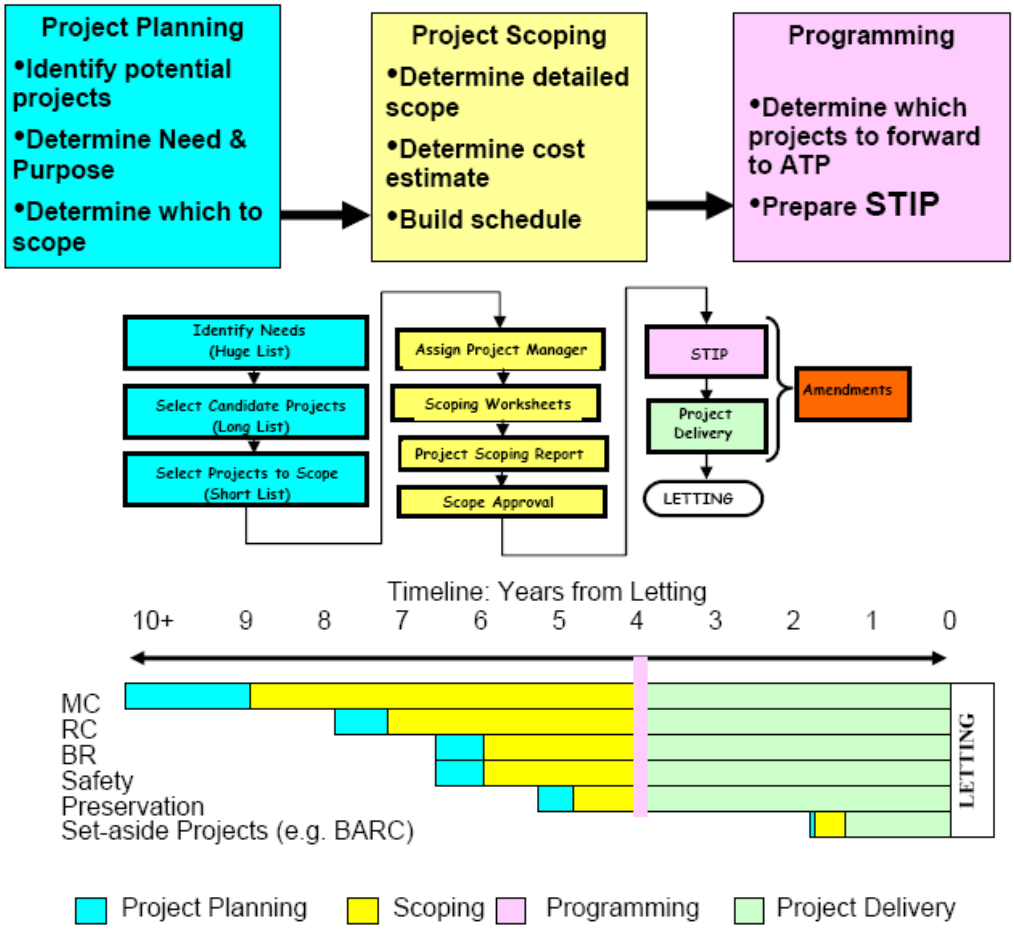
Early and comprehensive scoping before a project appears in the STIP, is characteristic of an excellent process. The scoping process includes narrowing the number of projects to just a few more than will likely be programmed. Mn/DOT assigns a project manager to guide each project on the short list through scoping and project development and functional groups provide written recommendations on what should be included in the scope of the project. Scoping is completed within a specified timeframe. In order to utilize staff time effectively, Mn/DOT bases the number of projects selected for detailed scoping on the size of the program and the fiscally constrained District budget.

Documentation of the scoping process for each project is critical to avoid confusion regarding the scope of the project, save time revisiting decisions, minimize tort liability, and pass information on to those working on the project. Scoping may involve 5 to 10 percent design completion on less complex projects and some safety projects or greater percent design completion depending on project complexity. Complex projects may require up to 25 percent design.

Maine DOT's Enhanced Project Scoping Process documents a project's purpose and need and provides a well-defined scope of work, cost and schedule. The goal is to reduce the likelihood of conflict with communities and the public regarding project expectations and to provide a basis to manage the project scope and cost throughout the project development process. Maine applies scoping to a prioritized pool of projects contained in the Six-Year Plan or to any other viable project being considered for advancement to the Work Plan. Information relative to project purpose, existing physical and environmental conditions, as

well as information derived through contacts with municipal officials and the public, are collected by Planning and Project Development's multi-disciplinary project teams. Minimum elements addressed in the scoping process include project purpose and need, environmental conditions, statewide and regional considerations, municipal input, and information on physical conditions, property ownership, and utilities.

Minnesota uses a revised scoping process to get a handle on design changes and to improve overall cost estimation. To accentuate the importance of the scoping decisions, signatures from district management are required on the project scoping report and scoping amendments. To keep changes in check, Mn/DOT implemented a formal amendment process for changes to the approved scope. In addition to documenting the change, the scope amendment process evaluates the affect on the program and project delivery prior to approval of the change. Mn/DOT saves all planning lists, the project planning report, early notification memos, scoping worksheets, project scoping report, and scope amendments in the Electronic Document Management System (EDMS). Mn/DOT's process is depicted below:



Mn/DOT Scoping Guidance, 12/2006, www.dot.state.mn.us/tecsup/xyz/plu/hpdp/scoping/scoping-hpdp.pdf

Mn/DOT has also developed a number of tools to aid in the scoping process:

- **Master Project Document List –** a list of the documents used in the Mn/DOT scoping process with space for adding links and completion dates to keep track of documents.
- **Planning Lists/Spreadsheets –** track needs, candidates and projects through the planning process.
- **Project Planning Report –** a short summary of information gathered and decisions made in the project planning process.
- **Early Notification Memo –** a memo and project summary to inform various offices of the project and solicit input: HPDP Forms: Early Notification Memorandum
- **Scoping Worksheets –** worksheets for each functional group provide a list of the basic things to consider when scoping a project and documenting the functional groups' recommendations.
- **Project Scoping Report –** summarizes the scope (both what is in and what is not in the scope).
- **Scope Amendments –** a form used to document the affects and approval of scope changes.
- **Project Modification Program Evaluation Document –** a form used to document a change to the program and determine the effects thereof.

Virginia DOT Cost Estimating System and Scoping Improvement Process

As part of their cost estimating improvement effort, VDOT found that one of the key underlying issues was that VDOT did not have a consistent, documented, statewide approach for developing project cost estimates early in the life of a project (i.e., at the scoping stage).[30] Engineers tended to base early estimates on judgment, history, and incomplete project information.[31]

In 2002, VDOT formed a committee to improve the project scoping process and develop an appropriate scoping model for statewide use. The premise behind the committee's recommendations was that the more information planners have on a project at the early stages, the better their estimates would be. In interviews, VDOT staff saw thorough and well-documented project scoping as inextricably entwined with a project cost estimation system. One VDOT District respondent expressed the need for intense and complete scoping of each project as the only way to obtain a truly accurate (or at least the best possible) estimate. In the opinion of the respondent, such scoping should involve full participation from all professional disciplines and outside input from local political officials. Another respondent mentioned the difficulty of estimating projects when each seems unique.[32]

VDOT's Project Scoping Committee recommended raising the profile and importance of scoping at VDOT. The recommendations included best practices for:

- The structure of the scoping team
- Preparation for the scoping meeting

- Communication among staff
- Documentation of the process
- Definition and control of scope creep
- Re-scoping of projects when there are significant changes

VDOT's improvement processes also benefited from good linkages between the Cost Estimation Improvement Task Force and Project Scoping Committee. One member of the project cost estimation task force, VDOT's Fredericksburg District Location & Design Engineer, joined the VDOT Project Scoping Committee as its co-chair. This person kept the Cost Estimation Improvement Task Force continuously updated on the progress of the Project Scoping Committee.

Members of the cost estimation task force, along with staff from VDOT's IT Applications Division, worked to help develop a new project development website as an intranet-based repository that contains all information for every VDOT project. All information about a project is available through the website. Estimates, plans, maps, documents, video, project cross sections, the names of project contacts (and how to reach them)—anything that is pertinent to the project—can be viewed on the site. The site is searchable by project number and by district and displays detailed information about individual projects, such as location, description, scope of work, project status, and project manager. An email feature enables staff accessing the site to contact the project manager. All these features enable staff to access critical information on any given project in a one-stop shopping format. Perhaps most crucial, it enables VDOT to maintain, save, and eventually archive the history of every project from cost estimates to environmental documents in one location.

Washington State DOT's On-Line Scoping Forms

When a project is identified, WSDOT utilizes a series of on-line forms to document the results of the project scoping process, when the scope (work and materials), schedule, expected performance outcome, and budget of a project. The Environmental Review Summary form, in particular, identifies the potential environmental issues and impacts, any proposed mitigation, and any NEPA documents and environmental permits that are likely to be required. When the lead federal agency approves an Environmental Review Summary (ERS), it is changed to an Environmental Classification Summary (ECS) for NEPA purposes.

Early cost estimates are automatically updated as the project is better defined and design decisions are made and entered in the summary forms. The user selects a variance that reflects the user's best estimate of the range of potential estimate variability for each phase. Recognizing there are many exceptions to a standard estimate type, WSDOT provides the following as a starting point:[33]

Estimate Type - Typical Variance (+/-)
Preservation - Paving - 10%
Design Level - 20%
Pre-Environmental - 30%
Pre-Field Review - 50%

The goal of the new definition process is to reduce the variance to 10 percent or less before the project is programmed, if possible. Products used to achieve this are:

- Project Definition Form
- Design Decisions Summary Form
- Environmental Review Summary Form
- Environmental Classification Summary Form

3.3.6 Estimating during the Transition from Planning to Project Development

Project planning cost estimates are used in the analysis of alternatives, approval, and for programming. The initial programmed cost appears the first time a project is listed in the STIP. Approval of the project by management allows the project to transition from the project planning phase to the project design phase. The DOT knows the general project features and can identify many contract items of work, particularly for NEPA CE projects. In addition, the items of work identified and estimated during the project planning phase should now be better defined as work that will be completed by the design staff, environmental staff, other functional units, or by consultants.

Oregon DOT uses, a green book they call the "Frogger," which lists average costs for various sizes of efforts for environmental products. The Frogger is broken down into concrete tasks such as the Preliminary Mitigation Plan, Wetlands Report, and Final Mitigation Plan. Categories are in terms of low, medium, high, in dollars not hours, and cost categories are updated using actual prices, determined by invoices over the year, and averaged. Costs are determined separately by region (5 regions) since the rural nature of some regions require much more travel and time to reach the project area for research. The Frogger is used to generate good estimates for projects that will be put out for bid, and to check hours and costs submitted by consultants for contract.

The project manager may ask the Region Environmental Coordinator or environmental specialists on staff for cost estimates and they may conduct field visits for better estimates. The estimates are prepared during scoping and applied during budgeting for the STIP. The project manager submits the cost estimate with the prospectus for the project. The Region Environmental Coordinator, who is part of a multi-disciplinary team that evaluates new projects, estimates the environmental costs. Planning staff do not utilize the Frogger. As projects move forward into the project development phase, estimates are updated using professional judgment. When the project is at the mitigation design stage following completion of preliminary engineering design, called DAP—Design Acceptance Point, estimates are made for wetland replacement based on dollars/ acre and historic data. Each region has a unique process. The region with the largest volume of projects is often the first to try new approaches; Regions share approaches at cross-regional meetings.

Estimating Costs of the NEPA Process and Environmental Documentation

Few DOTs have established processes for estimating the costs of the NEPA process and associated environmental documentation, outside of the application of a percentage of project costs (e.g. Colorado DOT allocated 2 percent of construction costs for major projects). At many DOTs, engineers make such estimates with little or no consultation with

environmental specialists, though environmental generalists and specialists are playing increasing roles in some states, as reflected in this report. Utah DOT is making a particular effort to get a handle on consultant hours for environmental work on projects, as detailed in the section on project management systems.

Maryland SHA estimates person-hours for each task and compares that with consultants' budget estimates. If the department's estimates and consultant's estimates are within 15 percent, the SHA can process the contract without further negotiation. MDSHA uses an Excel spreadsheet developed in the environmental office, to estimate hours. The engineer sends the Excel spreadsheet, using estimates based on professional judgment, to the contract manager. The spreadsheet constitutes documentation for contract purposes. Due to time constraints, MDSHA is not able to follow up on actual costs at the end of the project. MDSHA considers successful consultant contract negotiation as the measure of success in relation to the NEPA work.

Some DOTs have a more formal process, supported by environmental assessment and calculation tools, as described with regard to Caltrans and Florida DOT. Delaware DOT includes line items for estimating the costs of environmental studies in their capital transportation project cost estimate form. Over the course of a seven-page form, Delaware DOT requires a detailed summary of location and environmental studies costs, preliminary engineering costs, real estate costs, and construction costs.

Some DOTs track the hours needed to complete environmental documents or document review and the hours to complete specific environmental tasks such as a wetland delineation or a Section 7 clearance memo (Utah is one such example). However, few DOTs formally track and utilize cost information from environmental studies for formal use in ongoing cost estimating though the prior costs of studies inform the best professional judgment of those involved in project cost estimating.

NEPA Costs and Estimating Practices at Other Agencies

As part of this study, the research team contacted other federal agencies to ascertain practices with regard to estimating, budgeting, and tracking costs of preparing NEPA documents.

- FTA reported that they do not have NEPA cost estimate (or actual) data.[34]
- The Department of Energy (DOE) tracks and reports its NEPA costs on a quarterly basis. For example, for fourth quarter 2007, DOE reported that the median and average costs for the preparation of two EAs for which cost data were applicable was $261,000. Cumulatively, for the 12 months that ended September 30, 2007, the median cost for the preparation of 14 EAs for which cost data were applicable was $90,000; the average was $168,000.[35] Median completion time was 14 months and the average was 22 months. EISs for the previous 12 months took 17 months and cost $2.5 million on average.[36]

3.3.7 Estimating Costs of Context Sensitive Solutions, Value Engineering and Other Processes

Frequently, questions arise about the cost of context sensitive solutions (CSS), with the implication that this process costs more than a traditional process. Some professionals think

that CSS is about aesthetic treatments or bike/pedestrian accommodations and thus believe CSS is about adding cost or resolving project issues through "giveaways" to stakeholder groups. Rather, CSS is a process for building consensus with the public throughout project delivery from planning through construction and maintenance to ensure the transportation solution advances community goals and enhances the quality of life in addition to addressing the transportation problem. While the CSS process does not generate a very different project in some cases, other times the process may generate different solutions for the road feature itself, enhancements in the community associated with the transportation feature, or innovative ways to treat environmental mitigation required because of project impacts. Many times, solutions identified through the CSS process result in a net savings for the project, particularly on larger or controversial projects.

Value Engineering (VE) can produce unexpected results. However, since VE has as its goal to achieve equal value at reduced cost, the Project Manager can usually expect costs to decrease. The cost of doing a VE study is usually predictable; however, the cost of the feature subject to VE analysis may not be. VE studies do produce estimates of cost as a central theme of the study, so these costs are subject to the best estimates, though they may occur late in the process and require a budget amendment.

Cost estimating for the outcome of either of these processes is difficult at the early stages of the project. Acquiring knowledge of community issues prior to programming the project is the best insurance for an adequate estimate. Large projects that will require significant public collaboration may call for contingency funds and skilled leadership of the public involvement process to estimate project budgets and then to stay within the budget. CSS and VE are a powerful combination, as described below. In the quotes from state DOTs, it is apparent that CSS and VE can lead to downsizing projects as well as adding features, making it difficult to estimate ultimate costs of using the processes. In such cases, estimating may require a structure that has openings for estimate adjustments, particularly if the costs go up, rather than down. The DOT also may take the view that the solution must be subject to the cost control of the budget, and all proposed solutions must fit within that proposed project budget, or else others must fund additional costs. MoDOT has taken steps toward the latter, as part of the state's "practical design" cost savings approach.

3.3.8 Desirable Elements of a Cost Estimating System

A fully integrated system of cost estimating requires the following:

- A defined and documented estimating process used throughout the agency
- A thorough understanding by estimators of the process and how it relates to project management
- A method for early identification of environmental issues and likely mitigation needs
- A method for evaluating the project to determine work required to deliver the project
- Clear establishment of the work scope of the project being estimated
- Estimators knowledgeable in requirements of the work scope being estimated
- Agreement on work scope and estimates with staff performing the work

- Knowledge by working staff of performance targets to maintain the budget
- Recordation of timecard feedback to the system
- Procedure for gathering cost data, post completion, for analysis to determine the accuracy of estimates
- Data from actual performance routinely cycled back into the estimates for subsequent projects
- Compilation of construction cost data based on whether the item is environmental mitigation
- Development of cost estimating procedures for built mitigation features
- Distinction of environmental features during the engineer's estimate
- Use of such data in the next round of project cost estimates during programming

3.3.8 Current Leaders in Cost Estimating

The research team did not find an example within the DOT responses or within the literature research where all of these conditions are met. The ePM system used by Utah comes closest to the ideal. Several DOTs use elements of this process without being part of an agency-wide system. Several states have parts of a system that they are working toward broadening into an integrated system; Caltrans, FDOT, and WSDOT are notable among these. Some states (likely many) have individuals that have improved cost estimating for their sections through the individual effort of compiling data and sharing it within their own work groups to improve estimating. Oregon DOT, Maryland SHA, and Virginia DOT are key examples of where individuals, a small working group, or even a division has made improvements that benefit the agency in cost estimating.

4. Conclusions and Recommendations

4.1 Need for Clearer Understanding of Purpose for Determining Environmental Costs

Project management cost estimates need to capture all the costs of the project while avoiding either double counting on the one hand or failing to count costs on the other. To this end, a project estimate is not concerned with the fact that a designed feature, such as a culvert, will serve two purposes—water conveyance and fish passage. The only concern is the cost of the effort and that the product meets project requirements. The design engineer can estimate the cost of design and construction and the biologist can estimate cost of the permit acquisition and study of fish impacts. Together, the estimates represent the total project costs for the culvert with fish passage capability. The project manager is not concerned that the culvert co-mingles road and environmental aspects; however, it is important that the project manager understand that fish passage will be required in the culvert, so that the estimate for the design and construction of the culvert is appropriate.

On the other hand, if the DOT has undertaken to determine the cost of constructing fish passages, then the agency would need to examine the cost of the biologist, the cost of the fish passage aspects of the culvert, and determine the portion of the designer's time spent on the fish passage design. Since these sorts of studies are undertaken only rarely, it is not usually worth the effort for the DOT to evaluate such divisions of effort on a regular basis. Decisions and methodologies for making such distinctions will be highly dependent on the intent and purpose of the study at hand. The methodology for determining the cost divisions of co-mingled products should be devised and well defined within the study.

4.2 Need for a Sound Basis for Cost Estimating

The number of negative responses on the survey and the lack of knowledge by senior environmental staff of how their agency performs cost estimating revealed that there are few effective processes for environmental cost estimating within the DOTs. Many states use a unit price for estimating costs of the project to be included in the STIP. Unit pricing expresses total costs per unit of finished product, such as dollars per lane/mile. To this, DOTs add a standard percent of project construction costs to cover all pre-construction activities including planning, environmental clearance, and design.

Unit price estimates, while standard in construction estimating, are ineffective in estimating environmental project costs, since environmental costs do not vary based on the lane/miles of road roadway to be constructed. In addition, the actual cost of project development relative to the cost of construction varies so widely even on small projects that it is inadequately predictive of project development costs and environmental costs as well. Furthermore, mitigation requirements vary widely from project to project and can be a sizeable portion of the construction cost on small projects. Better project and program cost control is therefore reliant on better cost estimating techniques for the project development

phase, in general. Usually bottom-up cost estimating yields a better result for environmental activities.

Bottom-up estimating starts with a list of all activities to complete the project (scope of work). Personnel are assigned to the tasks (organization breakdown structure) and then hours of effort required are assigned to each person for each task. All hours are multiplied by the rate of pay of each participant. Other expenses include travel, equipment, and other services required to complete the task. Together, this produces the cost estimate for that task. There are additional project-specific nuances, but even this basic calculation will give a more reliable estimate than a percent of construction cost.

Good estimates rely on a reasonable knowledge of the amount of effort required to accomplish a task. This is the most difficult part of the estimating task. A review of existing databases for the level of effort for work performed on previous projects gives the estimator a good starting point for predicting future work. All estimating systems benefit from a feedback loop. Building better project cost estimates, including environmental cost estimates, requires better training in cost estimating for all staff involved and requires more involvement of environmental staff in the process.

Project cost estimates exist within overall project management processes and techniques. All estimators should be trained in overall project management processes in order to have a context for understanding the importance and role of cost estimating and cost control. Project team members with a broad understanding of the project manager's role are most likely to be supportive. They are also more likely to understand the need for better cost estimates and be willing to contribute to the improvement of estimating processes.

4.3 Agency-Wide Systems—Limitations and Opportunities

The research team did not find any completely integrated agency-wide systems, but several states are working toward that goal incrementally. Utah has implemented a system called ePM. Caltrans has a defined process for doing project cost estimates, with update periods, and regular intervals of evaluation. Florida has an automated system for identifying environmental issues early so clearances occur in a timely fashion and costs and needed studies may be identified early. Several states rely on spreadsheets compiled within a work unit. These may be as effective or more effective in determining costs but they lack the convenience of automated cost gathering, as well as the efficiencies and cost effectiveness of data sharing throughout the agency.

Conversion to agency-wide systems is limited by lack of funds, lack of interest in or perceived need for changing systems, and the complications of introducing new systems into existing systems. Given these obstacles, it is recommended that the practitioner make what improvements can be made at a staff level, and pursue system improvements through participation with other managers as the opportunity arises, building coalitions for larger change efforts. The first step in cost estimate improvement is to gain a thorough understanding of cost estimating and project management principles. The next step is to acquire data on performance at the individual or section level. These data will be useful in many ways, even if the opportunity to participate in the estimating process does not

currently exist. Just knowing one's own rate of production on a product can be a step toward improved future cost estimates.

4.4 Cost Data is a Powerful but Untapped Tool

Most DOTs routinely collect data on construction costs so that they can make reasonable engineer's estimates prior to bid, but they do not do the same for services provided by environmental professionals, or for costs related to built mitigation. Gathering environmental cost data may mean working across planning and development, construction, and maintenance divisions within the DOT. Each of these entities may have their own cost tracking systems, set up for their immediate purpose.

A wealth of data exists within these systems regarding environmental costs, but it takes determination to find it and interpret it. At the end of the day, the DOT accounts for all costs expended for a project within the cost accounting system, including all environmental costs. The challenge is to separate them from other costs, then to use the data effectively to predict and manage future costs. With a concerted effort, the DOT can identify environmental costs. However, in order for the DOT to commit the resources to accomplish agency–wide environmental cost identification, there needs to be a reason to do so.

4.5 Finding a Reason to do Environmental Cost Estimating

Embedded in the survey "No" responses, comments about lack of resources, and the frustration over how to do environmental cost estimating are DOT managers' assessments of the effort that would be required and realizations regarding current staffing limitations. Such limitations combine to make environmental cost estimating a relatively low priority in their agencies.

There are many reasons why good estimates are critical to sound project and program management. Among them are:

- Ability to track, manage, and correct performance during the development of a project
- Ability to identify process problem areas, and to measure the effectiveness of corrections
- Ability to value-engineer solutions to environmental mitigation
- Ability to determine cost effectiveness of environmental programs, processes, and solutions after construction
- Ability to gain credibility for the environmental program

These reasons apply as well to the overall project delivery system at the DOT.

Even if environmental costs are only estimated at the individual or section level, these data can be used for the following:

- Individual or section performance tracking and assessment
- Program and process assessment

- Workload projection, workload leveling, and to support requests for additional labor, or redeployment of labor

Good cost estimation and good cost control are fundamental to the management of any agency and vital to DOTs in a period of declining funds, increasing transportation demand, and public resistance to tax increases to fund transportation projects. Earning the respect of the public so they are willing to support increased funding will require gaining the skills of cost estimation and cost management to improve public credibility.

Cost estimating and cost control will become of increasing importance in DOTs. Environmental managers and staff need to be in the position to participate effectively when that time arrives.

APPENDIX A

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APPENDIX B

Survey

NCHRP 25-25(39) Improving Environmental Project Cost Estimates

The Transportation Research Board (TRB) is conducting research on improving environmental cost estimating for transportation projects for AASHTO, as part of the National Cooperative Highway Research Program. ICF International is conducting this research under contract to TRB. The goal of this effort is to identify sound practices for estimating and documenting environmental costs. The project will develop guidelines on improved environmental cost estimating methodologies for transportation projects.

In order for the environmental cost estimating guidelines to reflect the latest experience and the most complete perspective, as well as to provide guidelines that are implementable and practical, your colleagues need your input. Please forward the questionnaire to the appropriate people involved in estimating environmental costs at your agency, from planning through maintenance. Thank you for your participation! Please send survey by February 15, 2008 to mvenner@icfi.com or 9947 W Oregon Place, Denver, CO 80232.

Your Name, Title, Phone, Email:

1. Does your agency **estimate** "environmental" costs of projects? Y/N
   If applicable, **please describe what environmental costs this includes**, does not include, or is limited to during:

   Planning –

   Project Development –

   Design –

   Construction –

   Maintenance –

2. **If the costs are collected, are they distinguished as environmental costs**? **Or are they co-mingled with other activities**?
   If co-mingled, would you be able to separate them out as "environmental costs" if asked to do so?
   Please explain why/why not, obstacles, etc. including why you/your agency may think it is important or unnecessary to do so.

3. **What type of environmental risk assessment/planning does your agency do**? (Please attach descriptive information, if available, in addition to a couple sentences here).
   Are costs attached to these risks?

Who would be the best contact in your agency to get a list of environmental risk areas considered in your risk planning?

4. Are there **environmental elements within the planning-development-construction-maintenance process for which you think costs can and should be estimated or tracked**, which are not, currently? If so, please describe.

5. **Contacts for environmental cost estimating by phase**. Who would be the best contacts (name, position, phone, email) at your agency to learn more about how costs are estimated and tracked in
   Planning –

   Project Development –

   Design –

   Construction –

   Maintenance –

6. **Does your agency collect information on and/or categorize actual environmental costs incurred**? Please indicate Y/N and **describe how this information is used**, if you know, during:
   Planning - Y/N. How used:

   Project Development - Y/N How used:

   Design – Y/N How used:

   Construction – Y/N How used:

   Maintenance – Y/N How used:

7. If you are estimating and/or collecting "environmental" costs, **what methods or software/information systems are used in each phase**?
   Planning –

   Project Development –

   Design –

   Construction –

   Maintenance –

8. What **problems have you encountered with current environmental cost estimating and cost tracking methods**?

9. Do you have **opinions about the gaps and deficiencies in current methods used** in your organization?

10. **What are some of the broader issues in your state that you see influencing DOTs' needs to estimate and track project environmental costs, in the future**?

Finally, please send the research team copies of any of the following that you/your agency use. Attn: Ralph Ellis, PE, PhD., University of Florida Engineering Department, Gainesville, Florida, 32611-6580.

- Any environmental cost estimating guidance your agency uses or has developed
- Environmental cost data references used by your agency
- Representative environmental cost estimates
- Reports generated from these data

APPENDIX C

States Contacted for Survey

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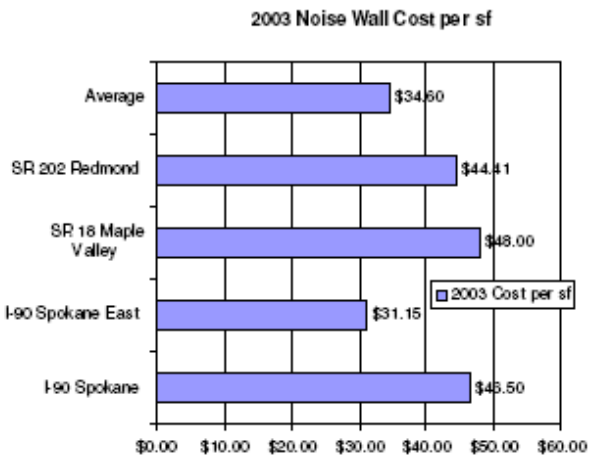
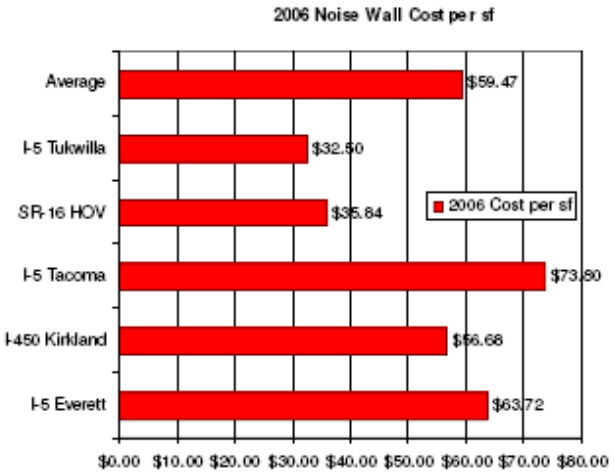
APPENDIX D

Sample Costs

From Washington State DOT's Mitigation Cost Case Studies

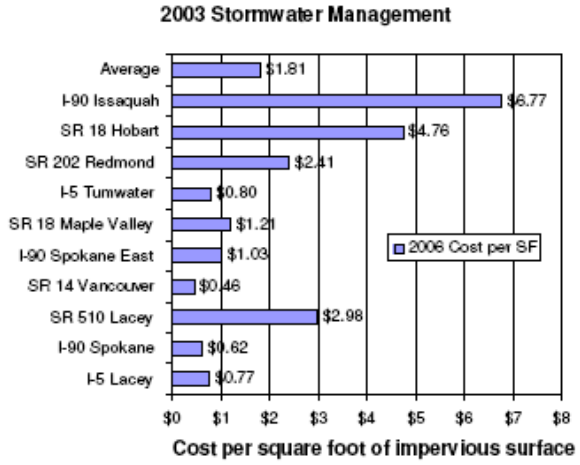


Four of the fourteen projects studied in 2003 included noise walls. The average cost per SF was $34.60 per SF. The combined square footage in the 2003 studies was equivalent to 2.3 miles of ten foot tall noise wall.

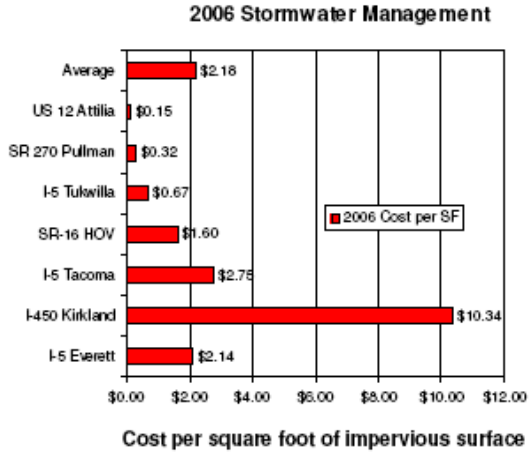


Five of the seven projects studied in 2006 included noise walls. The average cost per SF was $59.47 per SF. The combined square footage in the 2006 studies was equivalent to 11.7 miles of ten foot tall noise wall. The increased average cost over the 2003 studies is mostly due to an increase in footing design for seismic and wind resistance and the inflation of construction material such as concrete and steel.

Noise Walls



From the case studies performed in 2003 the average cost to manage stormwater was $1.81 per square foot of impervious surface. The large variation from project to project are mostly due to the need to purchase property for stormwater management facilities.



From the case studies performed in 2006 the average cost to manage stormwater was $2.18 per square foot of impervious surface. The large variation on the I-405 Kirkland project is the project is building facilities large enough to manage the stormwater for planned future expansion. By taking I-405 out of the equation the average cost to manage stormwater is $1.63 per square foort of impervious surface. The guidance from the WSDOT's new Highway Runoff Manual is beginning contributing to the efficiencies in the design of stormwater management facilities.

From Connecticut DOT's Preliminary Cost Estimating Guidelines, 2007

Drainage

12" R.C.P. $55/L.F.
15" R.C.P. $65/L.F.
24" R.C.P. $70/L.F.
48" R.C.P. $135/L.F.
Simple Catch Basins $2,200 Ea.
Double Catch Basins $3,500 Ea.
Complex Basins ("CM-2") $4,500 - $6,000 Ea.
Sedimentation Chambers: (Vortechs, etc.)
10' x 4' $20,000 Ea.
13' x 7' $24,000 Ea.
18' x 12' $45,000 Ea.

Sedimentation Control System

$4.00/L.F.

Furnishing & Placing Topsoil

<1,000 S.Y. $10.00/S.Y.
1,000 - 5,000 S.Y. $7.50/S.Y.
>5,000 S.Y. $6.00/S.Y.

Turf Establishment

<1,000 S.Y. $4.00/S.Y.
1,000 – 5,000 S.Y. $2.00/S.Y.
>5,000 S.Y. $1.40/S.Y.

Sodding $12.50/S.Y.

Noise Barriers

Walls - Timber
Roadway - Use $17.50/S.F.
Structure - Use $20/S.F.

Noise Barrier Wall - Durisol (Concrete Panel, Steel Columns)
Good Site Conditions - $20/S.F.
"Hard" Site Conditions - $25/S.F.
(Uneven Terrain, Rock Present)

IV. INCIDENTALS AND CONTINGENCIES
Project Value Incidentals Contingencies
Less than $1 million 25% 10%
$1 - 5 million 21% 10%
$5 - 50 million 15% 10%
Over $50 million 12% 7%
Percentages are applied to the sum of (A) Roadway Items + (B) Structure Items + (C) Environmental Items + (D) Traffic Items + (F) Lump Sum Items

VII. UNDERESTIMATED ITEMS
The following is a list of contract items whose final quantities or values often show large increases by project completion. Designers need to be aware of these items.
Item # Description Unit
0970004 Trafficperson Est.
0101117 Controlled Material Handling C.Y.
0202315 Disposal of Controlled Material Ton
0202103 Rock Excavation C.Y.
0950005 Turf Establishment S.Y.
12091XX Pavement Markings L.F. or S.Y.

From Ohio DOT's February 2008 Environmental Cost Reference Figures

From ODOT's Procedure for Budget Estimating (MS Excel - Updated 2/14/08)

Erosion Control Cost Information

Seeding & Mulching			
	sq yd	$1	
Sodding			
	sq yd	$15	
Rock Channel Protection		cu yd $75	Ranges from $50 - $110 depending on type
Erosion Control for bridge rehab			
	Units	2,000	Earthwork cost $0 - $400,000
	Units	15,000	Earthwork cost $400,000 and up
	each	$1	Erosion Control for bridge replacement
	Units	1,500	Earthwork cost $0 - $100,000
	Units	3,000	Earthwork cost $100,000 - $200,000
	Units	7,000	Earthwork cost $200,000 - $300,000
	Units	10,000	Earthwork cost $300,000 - $400,000
	Units	20,000	Earthwork cost $400,000 and up
	each	$1	Erosion Control for all other projects
	Units	3,000	Earthwork cost $0 - $100,000
	Units	6,000	Earthwork cost $100,000 - $200,000
	Units	10,000	Earthwork cost $200,000 - $300,000
	Units	17,000	Earthwork cost $300,000 - $400,000
	Units	24,000	Earthwork cost $400,000 - $1,000,000
	Units	35,000	Earthwork cost $1,000,000 - $2,000,000
	Units	42,000	Earthwork cost $2,000,000 - $3,000,000
	Units	85,000	Earthwork cost $3,000,000 - $4,000,000
	Units	120,000	Earthwork cost $4,000,000 - $5,000,000
	Units	170,000	Earthwork cost $5,000,000 - $10,000,000
	Units	300,000	Earthwork cost $10,000,000 and up
	LF	$100	Exfiltration Trench
	lump		See 'Other' costs below
	cu yd	$15	Top Soil
			Erosion Control Plan
Erosion Control Plan			
2.5 miles	$1,000	Resurfacing Projects w/ little to no earthwork use $500-$2000 per every 2.5 mi.	
lump	$5,000	Projects $50,000 - $1 mil	
lump	$10,000	Projects $1 mil - $5 mil	

lump	$20,000	Projects over $5 mil use
lump	$50,000	Projects over $10 mil and heavy with earthwork can go up to $50,000

Drainage Costs

Underdrains			
	ft	$8	
Conceptual Estimating Techniques	mile	$150,000	four lane divided with outside & inside shoulder drainage
Culverts			
Type A: < 5'			
			Pipe Structures - Reinforced concrete pipe, 706.02. Includes granular bed, setting pipe and backfill
	ft	$350	up to 60"
	ft	$25	Removal of existing (up to 60")
	cy	$1,400	Concrete Masonry - In place headwalls / wingwalls
Conceptual Estimating Techniques	each	$1,500	Concrete Masonry - In place headwalls for Type A
			Corrugated Metal Pipe, 707.02 / Structural Plate Pipe, 707.03. Includes granular bed, setting pipe and backfill. (headwalls, cofferdams & sheeting costs are separate)
	ft	$300	up to 60"
	ft	$25	Removal of existing (up to 60")
	cy	$1,400	Concrete Masonry - In place headwalls / wingwalls
Conceptual Estimating Techniques	each	$1,500	Concrete Masonry - In place headwalls
Type A: 5'-10'			
			Pipe Structures - Reinforced concrete pipe, 706.02. Includes granular bed, setting pipe and backfill
	ft	$550	66" - 78"
	ft	$900	84" - 108"
	ft	$100	Removal of existing (66" - 108")
	cy	$350	Concrete Footing
	cy	$1,400	Concrete - headwalls / wingwalls
Conceptual Estimating Techniques	each	$2,000	Concrete - In place headwalls / wingwalls
			Corrugated Metal Pipe, 707.02 / Structural Plate Pipe, 707.03. Includes granular bed, setting pipe and backfill. (headwalls, cofferdams & sheeting costs are separate)
	ft	$600	66" - 78"
	ft	$850	84" - 108"
	sq ft	$12	Removal of existing structure, based upon sq ft of deck / surface area
	cy	$350	Concrete Footing
	cy	$1,400	Concrete - headwalls / wingwalls
Conceptual Estimating Techniques	each	$2,000	Concrete - In place headwalls / wingwalls
			Precast Box Structures, 706.05 Includes granular bed, setting pipe and backfill. (headwalls, cofferdams & sheeting costs are separate)
	ft	$650	6' x 4' thru 8' x 4'
	ft	$1,000	8' x 5' thru 10'x 4'
	ft	$1,250	10' x 5' thru 12' x 4'
	sq ft	$20	Removal of existing structure, based upon sq ft of deck / surface area
	cy	$350	Concrete Footing
	cy	$1,400	Concrete - headwalls / wingwalls
Conceptual Estimating Techniques	each	$7,500	Concrete - In place headwalls / wingwalls
Type A: 10'- 20'			
			Corrugated Metal Pipe, 707.02 / Structural Plate Pipe, 707.03. Includes granular bed, setting pipe

			and backfill. (headwalls, cofferdams & sheeting costs are separate)
	ft	$1,400	114" - 150"
			Removal of existing structure, based upon sq ft of
	sq ft	$15	deck / surface area
	cy	$350	Concrete Footing
	cy	$1,400	Concrete - headwalls / wingwalls
Conceptual Estimating Techniques	each	$7,500	Concrete - In place headwalls / wingwalls
	ft	$1,300	12' x 4' thru 14' x 4'
	ft	$1,500	14' x 5' thru 16' x 4'
	ft	$2,000	16' x 5' thru 18' x 4'
	ft	$2,500	18' x 5' thru 20' x 10'
			Removal of existing structure, based upon sq ft of
	sq ft	$18	deck / surface area
	cy	$350	Concrete Footing
	cy	$1,400	Concrete - headwalls / wingwalls
Conceptual Estimating Techniques	each	$10,000	Concrete - In place headwalls / wingwalls
Median Drainage	ft	$150	
	each	$5,000	Barrier Median Inlet, Single Slope
BMP's	lump	***	BMP - Best Management Practices *** This item is designated as a future pay item. There is no current cost data available.
Closed Storm System	lump	**	** Contact Office of Estimating for specific cost requests. Individual item costs are available in *Estimator 2.2*.
			Includes granular bed, setting pipe and backfill.
	ft	$75	Storm, Type B or C
	each	$1,500	Catch Basin, No. 3A
	each	$3,000	Manhole, No. 3
Conceptual Estimating Techniques	ft	$215	Average cost of storm per foot of curbed road. Includes Storm, Type B or C, Catch Basin, No. 3A, and Manholes.
	lump		See 'Other' costs below

Landscaping

		Note: Often when projects have a significant amount of landscaping to be performed, a fund is set aside to accomplish that work. If available, that dollar amount should serve as the estimate. Below are amounts to assist if the fund value is not available.
lump		
each	**$40**	Shrubs, small, 12" - 18"
each	**$75**	Shrubs, Large, 2' - 5'
each	**$300**	Deciduous Trees, small
each	**$600**	Deciduous Trees, large
each	**$100**	Evergreen Tree, small, 1' - 5'
each	**$300**	Evergreen Tree, Large, 6' - 8'

Noise Barrier

Noise Barrier

		Per square foot of face of wall. Noise Wall construction includes drilled shaft excavation along with rebar and concrete, structural steel shape post/and or precast post, noise wall panels, precast cap and sealing of concrete surfaces.
sq ft	**$25**	
lf	**$400**	Assume avg height of 16' through out.

New Categories of Environmental Cost Assessment in Planning

Health Effects Analysis

More data about public health related to vehicle exhaust is beginning to emerge, particularly the greater impacts on those who live, work, or go to school near roads. Cal/EPA is among the state public health agencies that have found that air pollution from nearby traffic may pose a health risk, even in areas with good regional air quality. One study, which involved air monitoring and a health survey of about 1,100 students at 10 Alameda County, CA elementary schools located various distances from major roads, found moderately higher rates of asthma and bronchitis symptoms (such as wheezing and excessive phlegm) in children residing and attending school in neighborhoods with higher levels of traffic-related air pollution. Scientists from OEHHA and the Lawrence Berkeley National Laboratory collaborated on the study, which was published in the September 1, 2004 issue of the American Journal of Respiratory and Critical Care Medicine.

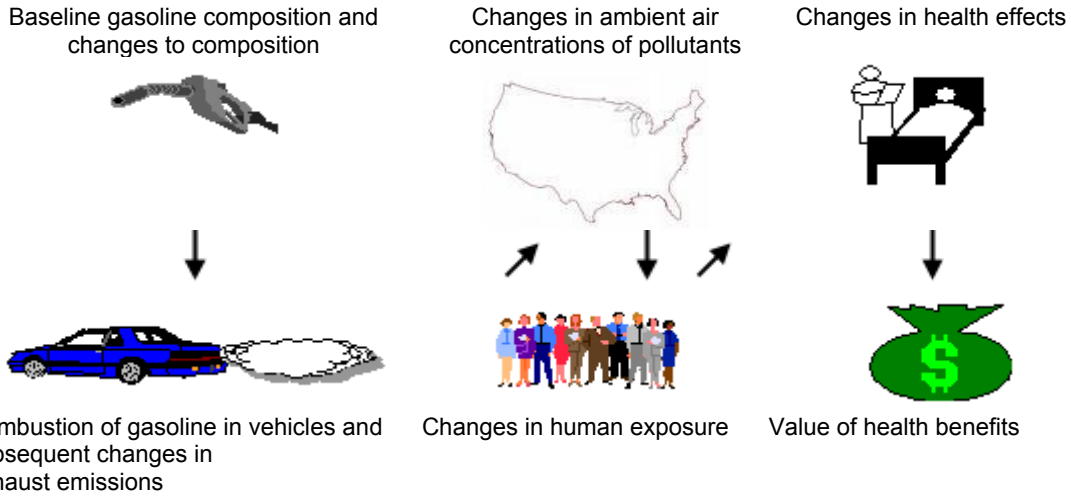
A companion study by scientists at OEHHA and the state Department of Health Services, published in Environmental Health Perspectives in January 2004, was the first in the United States to evaluate the relationship between measured levels of traffic-related pollutants and respiratory symptoms. In light of previous studies that have found traffic pollution levels to be higher within 500 feet downwind of major roads, the study estimated the number of schools within 500 feet downwind of roads with traffic volumes exceeding 25,000 vehicles per day and 50,000 vehicles per day. The study found that about 2.3% of public schools (about 170 schools) enrolling about 150,000 students are located within 150 meters (500 feet) of roads exceeding 50,000 vehicles per day. An additional 7% of public schools (about 530 schools) enrolling about 570,000 students are located within 500 feet of roads with 25,000 to 50,000 vehicles per day. Furthermore, using school demographic data and 2000 census data, state scientists found that schools located closer to high-traffic roads had higher percentages of African-American and Hispanic students compared to the schools having no busy roads nearby. The schools located near high-traffic roads also had higher percentages of socioeconomically disadvantaged students (such as those receiving free/reduced price school meals or who are English language learners).[37]

When considering health aspects in transportation planning, system and corridor analyses, programming and project alternatives, DOTs measure lives saved, fewer hospital visits and lost school/work time, and resources saved. The diagram below shows the process for the analysis of estimating health benefits from transportation considerations. For example, California found that:

- Attaining the California PM standards would annually prevent about 6,500 premature deaths (lives shortened by an average of 14 years), or 3% of all deaths. In comparison, motor vehicle crashes caused 3,200 deaths and homicides were responsible for 2,000 deaths (CARB 2002a, and CDHS 2000).
- Attaining the California PM and ozone standards would annually prevent approximately (CARB 2003a): 4,000 hospital admissions for respiratory disease; 3,000 hospital admissions for cardiovascular disease; and 2,000 asthma-related emergency room visits.

Attaining the California PM and ozone standards would annually prevent about (CARB 2003a): 400,000 cases of lower respiratory symptoms (such as a cough) in children ages 7-14; 400,000 cases of upper respiratory symptoms (such as, runny nose, wet cough, and burning, itching, red eyes) in children ages 9-11; 8,000 cases of chronic bronchitis; 500,000 cases of respiratory illnesses (including colds and flus) in adults ages 18-65; and 350,000 asthma attacks (all ages). Although statistics are not available for cases of lung cancer caused by all air pollutants, it is estimated that exposure to diesel PM causes about 250 excess cancer cases per year in California (CARB 2000). A recent study provides evidence that exposure to particulate air pollution is associated with lung cancer (Pope et al. 2002). This study found that residents who live in an area that is severely impacted by particulate air pollution are at risk of lung cancer at a rate comparable to non-smokers exposed to second-hand smoke. Definitive lung cancer mortality numbers as a result of air pollution cannot yet be determined, but this study found an approximately 16 percent excess risk of dying from lung cancer due to fine particulate air pollution. In addition, the hearts of sensitive individuals (for example, the elderly) may be affected when they breathe in fine particulate matter. One study shows that individuals with existing cardiac disease can be in a potentially life-threatening situation when exposed to high-levels of ultrafine air pollution (Peters et al. 2001). Fine particles can penetrate the lungs and may cause the heart to beat irregularly or can cause inflammation, which could lead to a heart attack.

Steps in Estimating Health Benefits



- On a statewide basis, 1.3 million school absence days would be avoided annually if the current levels of ozone were reduced to attain the established 1-hour state standard (CARB 2004).
- Figures related to asthma costs and the valuation of air pollution exposure are significant and staggering. The benefits of California's air quality program exceeds the costs by a ratio of about 3 to 1 (CARB 2003c). In 1998, it was estimated that asthma costs in California totaled $1.3 billion with hospitalizations and medications representing the largest direct expenditure (Asthma and Allergy Foundation of America 1998). Adult asthma patients spent an average of $5,000 annually on medical expenses, lost wages, transportation, asthma-control products, and other asthma related expenses (Cisteinas et al. 2003). Furthermore, an annual value of over $3.5 billion is associated with hospitalizations and the treatment of major and minor illnesses, and about 2.8 million lost workdays each year, are all related to air pollution exposure in California. In addition, the value of premature deaths resulting from exposure to air pollution in excess of the State's PM2.5 standard is $43 billion (CARB 2003a, CARB 2003b, CARB 2002a, U.S. EPA. 1999).

Resources for further information include:

- EPA's, Our Built and Natural Environments: A Technical Review of the Interactions between Land Use, Transportation, and Environmental Quality
- NCSL's The Built Environment: Is There a Connection between Sprawl & Health?
- FHWA's Emissions Benefits of Land Use Planning Strategies
- TRB Special Report, Does the Built Environment Influence Physical Activity?

APPENDIX E

Sample Environmental Cost Estimating Forms

Washington DOT Scoping Forms

At WSDOT, costs are estimated from an early point and automatically calculated as the project is defined and design decisions are made and entered in the summary forms below. The form user is asked to select a "Variance" for each phase and the Total (variance total is not calculated). The "Variance" reflects the user's best estimate of the range of potential estimate variability for each phase. Recognizing there are many exceptions to a standard estimate type, WSDOT provides the following as a starting place:
[38]

Estimate Type - Typical Variance (+/-)
Preservation - Paving - 10%
Design Level - 20%
Pre-Environmental - 30%
Pre-Field Review - 50%

The goal of the new definition process is to reduce the variance to 10% or less before the project is programmed, if possible.

- Project Definition Form/Instructions
- Design Decisions Summary Form/Instructions
- Environmental Review Summary Form/Instructions
- Environmental Classification Summary Form

Caltrans' guidance is similar, suggesting that in planning, prior to programming, contingencies should be from 30% to 50% at this stage, depending on the factual data available for preparing the estimate.[39]

After completion of the public hearing process, selection of the preferred alternative, and completion of the environmental document, Caltrans estimates that the contingency may drop to 15%.[40]

Caltrans Preliminary Environmental Analysis Report (PEAR) On-Line System

Preliminary Environmental Analysis Report

Project Information

District __ County ___ Route ___ Kilometer Post (Post Mile) _____ EA_____
Project Title: Brief descriptive phrase, e.g., CAPM, Curve Re-alignment, Passing Lane, etc.

Project Manager _____ Phone # _____

Project Engineer _____ Phone # _____

Environmental (Manager) Office Chief_____ Phone # _____

Environmental Planner Generalist _____Phone # _____

Project Description

Purpose and Need: Write a concise statement of the project purpose and need. Do this with the project proponent. This statement should also be in the PSR.

Description of work: Write a brief summary of the proposed work that will be done. Include work required that is incidental to the project, such as: access roads, utility relocation, de-watering, etc.

Alternatives: Identify all project alternatives (including no-build). If alternatives are no longer being considered, state why. Do not select or identify a preferred alternative. Describe each alternative still under consideration.

Anticipated Environmental Approval

CEQA

- Categorical/Statutory Exemption
- Negative Declaration / focused ND
- Environmental Impact Report

NEPA

- Categorical Exclusion
- Finding of No Significant Impact
- Environmental Impact Statement

1. Identify the anticipated environmental document for the proposed project.
2. Identify who should be the CEQA lead agency.

3. Estimate the length of time (months) required to obtain environmental approval and total person hours to complete the identified tasks.

PSR Summary Statement

For each practicable alternative, write a brief summary of key environmental issues, studies required, permits, and mitigation. Include a time and cost estimate, and any constraints likely, such as construction windows, biological monitoring, Native American consultation, and acquisition of Permits to Enter.

Special Considerations

For each practicable alternative, summarize any special processes such as NEPA/404, seasonal constraints, Section 7, Section 4(f) that may effect project delivery and require unusual, exceptional, or extended environmental processes.

Anticipated Project Mitigation (for standard PSR only)

For each practicable alternative, prepare short summary paragraphs for each focused area of mitigation of all anticipated mitigation measures required to reduce, minimize, or compensate for project impacts. Include a cost estimate for each mitigation measure. Summarize the total of all mitigation costs at the end of this section, in the summary statement and on the Mitigation and Compliance Cost Estimate (Attachment A).

Disclaimer

This report is not an environmental document. Preliminary analysis, determinations, and estimates of mitigation costs are based on the project description provided in this report. The estimates and conclusions provided are approximate and are based on cursory analysis of probable effects. This report is to provide a preliminary level of environmental analysis to supplement the Project Study Report. Changes in project scope, alternatives, or environmental laws will require a re-evaluation of this report.

Reviewed by:

_____ Date: _____

Environmental Office Chief

_____ Date: _____

Project Manager

Environmental Technical Reports or Studies Required

	Study	Document	N/A
Community Impact Study	○	○	○
Farmland	○	○	○

Section 4(f) Evaluation	○	○	○
Visual Resources	○	○	○
Water Quality	○	○	○
Floodplain Evaluation	○	○	○
Noise Study	○	○	○
Air Quality Study	○	○	○
Paleontology	○	○	○
Wild and Scenic River Consistency	○	○	○
Cumulative Impacts	○	○	○
Cultural			
ASR	○	○	○
HSR	○	○	○
HASR	○	○	○
HPSR	○	○	○
Section 106 / SHPO	○	○	○
Native American Coordination	○	○	○
OTHER			
Finding of Effect_____	○	○	○
Data Recovery Plan_____	○	○	○
Hazardous Waste			
ISA (Additional)	○	○	○
PSI	○	○	○
OTHER			
_____	○	○	○
Biological			
Endangered Species (Federal)	○	○	○
Endangered Species (State)	○	○	○
Species of Concern (CNPS, USFS, BLM, S, F)	○	○	○
Biological Assessment (USFWS, NMFS, State)	○	○	○
Wetlands	○	○	○

Invasive Species	∘	∘	∘
Natural Environment Study	∘	∘	∘
NEPA 404 Coordination	∘	∘	∘
OTHER _____	∘	∘	∘
Permits			
401 Permit Coordination	∘	∘	∘
404 Permit Coordination	∘	∘	∘
1601 Permit Coordination	∘	∘	∘
City/County Coastal Permit Coordination	∘	∘	∘
State Coastal Permit Coordination	∘	∘	∘
NPDES Coordination	∘	∘	∘
US Coast Guard (Section 10)	∘	∘	∘

Discussion of Technical Review

Use brief paragraphs focused on topics that will need environmental review. Indicate the absence of issues to document that they were considered. Follow the Checklist when preparing the summary discussion. Make a separate statement for each viable alternative. ***Samples follow****:*

Socio-economic and Community Effects. The project is not expected to have any effects on the local community or the economy.

Farmlands. N/A

4(f) Impacts. The project may create 4(f) issues if it results in any temporary or permanent impacts to the following properties…..

Visual Effects. A visual assessment will be required and should include potential project effects and any appropriate mitigation. Design of the upgraded guardrail may require and include visual impact mitigation. Tree removal must be avoided to minimize the effect on the visual setting. Vegetation removed from any properties found to be historically significant may become a sensitive issue.

Water Quality and Erosion. The site should be evaluated for potential water quality impacts associated with the project. If site dewatering is required for new construction, a dewatering plan is required. Site access for construction must be included in any water quality analysis.

Floodplain. A floodplain evaluation report will need to be prepared to analyze the effects of the alterations to the bridge footings on the 100-year floodplain.

Air and Noise. Potential air quality and noise impacts are…. The proposed project is included in the Regional Transportation Plan dated…which has been found to be in conformity with the Clean Air Act State Implementation Plan.

Wild and Scenic River. There is a potential for impact to (name of river), a Federally designated wild and scenic river.

Cultural Resources. An archeological survey will be required for the project. The proposed Area of Potential Effect (APE) must include all access roads, work areas and staging areas beyond the existing paved highway. A historic survey of resources related to… may be required. Any subsequent changes in project scope may require additional archaeological or historical review.

Native American Coordination. The following Native American tribes or groups may have any interest in or be affected by the proposed project…

Hazardous Waste/Materials. An Initial Site Assessment (ISA) will be required to address the potential for hazardous waste. The risk ranking for ... is ….

Biological Resources. This project may affect sensitive biological resources. Formal consultation with National Marine Fisheries Service on the coho salmon and steelhead will be required. Formal consultation with the USFWS on the tidewater goby and the mountain beaver may be required. The existing bridge should be inspected for the presence/absence of bats, nesting swallows and other protected species. Bird and bat surveys should be completed in the spring/summer season. The California Natural Diversity Data Base (CNDDB) does not indicate any other known sensitive biological resources in this location. There are no known sensitive plant species in this location.

Wetlands. A delineation of jurisdictional wetlands and waters of the United States needs to be done. Executive Order 11990 requires an avoidance alternative analysis for wetland impacts unless there is no practicable alternative available. Impacts to waters of the U.S. and wetlands from the project and any temporary access roads will need to be quantified.

Invasive Pest Plant Species. Executive Order 13112 requires that any Federal action may not cause or promote the spread or introduction of invasive species. This project may…

Right-of-Way Relocation or Staging Area. No new Right-of-Way is indicated for this project. Material sites and disposal sites are indicated, but not identified. These areas, which must be identified prior to initiating environmental studies, will require complete environmental evaluation as part of this project.

Mitigation (*For standard PSR only*). Mitigation for temporary and permanent impacts to sensitive biological resources (wetlands, riparian vegetation, regulated plants and animals) will be required. Mitigation for impacts to waters of the United States and tidewater goby habitat may be required. Construction windows between June 1 and October 15 may be required for coho mitigation, and temporary bat roosts may be required for bats displaced by construction disturbance. Avoidance of swallow nests, or nest exclusion netting may be required from March 1 through August 31. Reasonable mitigation costs are generally considered to be up to 10% of the project cost. For this project, mitigation could include swallow exclusion, restricted construction scheduling, habitat enhancement, habitat restoration, or habitat replacement; the cost of which is estimated to be around $200,000.

Permits. Permits from the State Department of Fish and Game (1601), U. S. Army Corps of Engineers (an individual 404 Permit will probably be required because wetland/waters impacts may exceed the threshold acreage), U.S. Coast Guard (Section 10), and the Regional

Water Quality Control Board (401) will be required. Additional permits for the material site and disposal site may be required.

Coastal Zone. This project is within the County coastal jurisdiction and will require a County Coastal Development Permit. It is not within state coastal jurisdiction nor within state appealable jurisdiction.

List of Preparers

Hazardous Waste Review by	Date
Biological Review by	Date
Cultural Review by	Date
Community Impact Review	Date
Visual Review by	Date
Floodplain Review by	Date

Attachment A - PEAR Mitigation and Compliance Cost Estimate*(Standard PSRs Only)
Dist.-Co.-Rte.-KP/PM:_____EA:_____
Project Description: _____
_____
_____
_____

Person completing form/Dist. Office.:_____Project Manager:_____
Phone number:_____
Date:_____

	Mitigation			Compliance
	Project Feature1	**Enviro. Obligation2**	**Statutory Require.3**	**Permit & Agreement4**
Fish & Game 1601 Agreement				
Coastal Development Permit				
State Lands Agreement				
NPDES Permit				
COE 404 Permit- Nationwide				
COE 404 Permit- Individual				
COE Section 10 Permit				
COE Section 9 Permit				
Other:				
Noise attenuation				
Special landscaping				
Archaeological				
Biological				

Historical				
Scenic resources				
Wetland/riparian				
Other:				
TOTAL (Enter zeros if no cost)				

Costs are to be reported in $1,000's.
Costs are to include all costs to complete the commitment including: 1)capital outlay and staff support; 2) cost of right-of-way or easements; 3) long-term monitoring and reporting; and 4) any follow-up maintenance.
[1] Mitigation that Caltrans would normally do if not required by a permit or environmental agreement.
[2] Mitigation that Caltrans would not normally do but is required by conditions of a permit or environmental agreement.
[3] Mitigation that Caltrans would not normally do and is not required by a permit or Enviro. Agreement, but is required by a law.
[4] Non-mitigation Caltrans would not normally do but is required by conditions of a permit or agreement.
*Prepare a separate form for each practicable alternative in the PSR.

APPENDIX F

Sample Environmental Labor Cost Coding Categories

The following example of environmental labor cost coding categories was taken from Wisconsin DOT Facilities Development Manual, Division of Transportation Investment Management-Contract Administration Unit (DTIM-CAU) Procedure, 8-10-1.[41]

762 Envir Imp-Air Quality Work includes activities associated with analysis of air quality including data gathering and modeling.

763 Envir Imp-Archaeology Work includes contracting for, meeting about, and assisting in archaeological surveys, investigations and data gathering.

765 Envir Imp-Contaminated Sites Work includes contacts, meetings, site visits, negotiations and other tasks associated with all phases of contaminated site investigation and remediation.

766 Envir Imp-Drainage/Storm Water Work includes all activities above and beyond normal roadway drainage practices. It includes design of storm water management best management practices including retention and catch basins. Also negotiation of storm water.

767 Envir Imp-Environmental Documents Work includes activities to prepare environmental impact statements, environmental assessments and environmental reports. Include required meetings and time required to prepare and review environmental documents.

768 Envir Imp-Erosion Control Work includes design and installation of project erosion control and landscaping. FINAL DESIGN (Post DSR)

768 Envir Imp-Erosion Control Include initial surveys and data gathering to determine the existence and potential impacts on and of archaeological and historical sites, contaminated sites, wetlands and air and noise analysis in the appropriate individual activity code.

769 Envir Imp-History Work includes activities associated with the 106 and Chapter 44 processes to determine existence, impacts and any required mitigation of historical sites

796 Envir Imp-Sound Quality Work includes analysis and data gathering of project noise impacts. Activities Associated with the design, procurement and installation of noise barriers.

797 Envir Imp-Species/Habitats Work includes analysis of impacts on endangered and threatened species including Development and implementation of conservation plans.

798 Envir Imp-Wetlands/Waterways Work includes analysis and data gathering of project wetland impacts; procurement of required permits and water quality certifications; design, installation, monitoring and maintenance of wetland mitigation sites including wetland bank sites.

Endnotes

[1] NCHRP 25-25(39) panel comments and response of the research team accepting that direction, August 2007.

[2] U.S. Department of Transportation, Office of the Inspector General. *Audit of the Springfield Interchange.* Washington, D.C., November 2002.

[3] Joint Legislative Audit and Review Commission. Review of Construction Costs and Time Schedules for Virginia Highway Projects A Report in a Series on Transportation Issues in Virginia. House Document No. 31. Richmond, Va., January 2001.

[4] FHWA, "Chapter 2.0: Summary of Related Research," Evaluating the Performance of Environmental Streamlining: Development of a NEPA baseline for Measuring Continuous Performance. http://www.environment.fhwa.dot.gov/strmlng/baseline/section2.asp

[5] Smith, V. Kerry, Roger Von Haefen, and Wei Zhu, *Environmental Compliance Costs: Where the Rubber Meets the Road*. The Center for Transportation and the Environment, North Carolina State University, Raleigh, NC, July 1997.

[6] Washington State DOT, Environmental Mitigation Cost Case Studies, http://www.wsdot.wa.gov/projects/mitigation/

[7] Washington State DOT, 2006 Mitigation Costs Study, Executive Summary, http://www.wsdot.wa.gov/NR/rdonlyres/81ADC6F8-D9EE-4164-9F93-2F285E02D3AC/0/2006_ExecutiveSummary.pdf

[8] Washington State DOT, 2006 Mitigation Costs Study, Executive Summary, http://www.wsdot.wa.gov/NR/rdonlyres/81ADC6F8-D9EE-4164-9F93-2F285E02D3AC/0/2006_ExecutiveSummary.pdf

[9] Washington State DOT, 2006 Mitigation Costs Study, Executive Summary, http://www.wsdot.wa.gov/NR/rdonlyres/81ADC6F8-D9EE-4164-9F93-2F285E02D3AC/0/2006_ExecutiveSummary.pdf

[10] Washington State DOT, Mitigation Cost Study, 2006, p. 6 http://www.wsdot.wa.gov/NR/rdonlyres/B54AF681-8AE3-4F50-A517-475FDF17F5B7/0/2006_Overview.pdf

[11] FHWA, Report to Congress on Costs Associated with the Environmental Process: Impacts of Federal Environmental Requirements on Federal-aid Highway Project Costs, August 2006, p.21.

[12] FHWA, Report to Congress on Costs Associated with the Environmental Process: Impacts of Federal Environmental Requirements on Federal-aid Highway Project Costs, August 2006, p.21.

[13] Reilly 2000, cited in www.wsdot.wa.gov/NR/rdonlyres/C09A005C-417A-4056-A83A-311EAE715242/0/ReillyCEVPMangementofCostRisk2.pdf

[14] Cheryl Kyte, Michael Perfater, Stephen Haynes, and Harry Lee, "Developing and Validating a Highway Construction Project Cost Estimation Tool," Virginia DOT and Virginia Transportation Research Council, Charlottesville, Virginia, December 2004.

[15] Fred Salvucci, former MassHighway Administrator, paper/presentation at ITA Amsterdam, 2003 cited in Reilly.

[16] Amy Goldstein, Myriad Reports Pointed To Big Dig's Problems: Project Insiders Blame Negligence, Not Ignorance, Washington Post, Sunday, July 23, 2006; Page A03 http://www.washingtonpost.com/wp-dyn/content/article/2006/07/22/AR2006072200645.html

[17] Bent Flyvbjerg, Mette Skamris Holm, and Søren Buhl, "Underestimating Costs in Public Works Projects: Error or Lie?" *Journal of the American Planning Association*, Vol. 68, No. 3, Summer 2002. © American Planning Association, Chicago, IL, p. 279.

[18] Bent Flyvbjerg, Mette Skamris Holm, and Søren Buhl, "Underestimating Costs in Public Works Projects: Error or Lie?" *Journal of the American Planning Association*, Vol. 68, No. 3, Summer 2002. © American Planning Association, Chicago, IL, p. 279.

[19] FHWA, Report to Congress on Costs Associated with the Environmental Process: Impacts of Federal Environmental Requirements on Federal-aid Highway Project Costs, August 2006, p. 2.

[20]Martin Weitzman, "Structural Uncertainty and the Value of Statistical Life in the Economics of Catastrophic Climate Change,

[21] Washington State DOT, www.wsdot.wa.gov/Projects/ProjectMgmt/RiskAssessment/

[22] FHWA, *Costs Related to Compliance with Federal Environmental Laws: Case Studies in the Federal-Aid Highway Program: Final Report*, Jul 2006. p. iii. https://nepa.fhwa.dot.gov/ReNEPA/ReNepa.nsf/All+Documents/AD3B902A775A2FCB85257219000DF2F1/$FILE/FINALAppA.TransTechReport10.23.06.doc

[23] FHWA, 2006, p. A-12.

[24] Ibid, p. A-6.

[25] Ibid, p. A-8.

[26] Ibid, p. A-10.

[27] Washington State DOT, Watershed Screening Tool, Ed Molash (360) 705-7496 or Molashe@wsdot.wa.gov, http://www.wsdot.wa.gov/Environment/Watershed/screeningtool.htm,

[28] Indiana DOT, Cost Estimating Guidance, Section Page 20-1.0, www.in.gov/dot/div/contracts/standards/dm/paper/Ch-20.pdf.

[29] Ohio DOT, 2007 Appalachian Development Highway System Cost Estimate, Table B - Design Classification and Cost Estimate by Estimate Sections with Corridor Totals, www.dot.state.oh.us/.../2007costestimate/Corridor%20C%20-%20Corridor%20Map%20and%20Segent%20Data.pdf

[30]Cheryl Kyte, Michael Perfater, Stephen Haynes, and Harry Lee, "Developing and Validating a Highway Construction Project Cost Estimation Tool," Virginia DOT and Virginia Transportation Research Council, Charlottesville, Virginia, December 2004. p. ii.

[31] Ibid.

[32] Ibid, p. 8.

[33] Washington State DOT, Scoping Guidance, http://www.wsdot.wa.gov/Environment/Compliance/ComplianceGuidance.htm# scoping.

[34] Personal communication, Carl Bausch, Federal Transit Administration, US Department of Transportation. February 27, 2008.

[35] Department of Energy, NEPA Lessons Learned Quarterly Report, December 2007, p. 29.

[36] Department of Energy, NEPA Lessons Learned Quarterly Report, December 2007, p. 29. http://www.eh.doe.gov/NEPA/lessons.html, Ph. 800-472-2756, email denise.freeman@eh.doe.gov .

[37] An abstract of the children's respiratory health study is available online at http://ajrccm.atsjournals.org/cgi/content/abstract/170/5/520, and hard copies of the study can be obtained by contacting OEHHA. The statewide school survey is available online at http://ehp.niehs.nih.gov/members/2003/6566/6566.pdf.

[38] Washington State DOT, Scoping Guidance, http://www.wsdot.wa.gov/Environment/Compliance/ComplianceGuidance.htm#scoping.

[39] Caltrans, Project Development Procedures, 12/2007, p. 11.

[40] Caltrans, Project Development Procedures, 12/2007, p. 13.

[41] Wisconsin DOT Facilities Development Manual, Division of Transportation Investment Management-Contract Administration Unit (DTIM-CAU) Procedure, 8-10-1. , www.wsdot.wa.gov/NR/rdonlyres/45B85BFF-6813-439C-B82B-3AE50544A023/23817/DetermineEstimateBasis.pdf