

United States Society on Dams



**Guidelines for Construction
Cost Estimating for
Dam Engineers and Owners**

May 2012

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Dam Engineers and Owners**

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U.S. Society on Dams

Vision

To be the nation's leading organization of professionals dedicated to advancing the role of dams for the benefit of society.

Mission — USSD is dedicated to:

- Advancing the knowledge of dam engineering, construction, planning, operation, performance, rehabilitation, decommissioning, maintenance, security and safety;
- Fostering dam technology for socially, environmentally and financially sustainable water resources systems;
- Providing public awareness of the role of dams in the management of the nation's water resources;
- Enhancing practices to meet current and future challenges on dams; and
- Representing the United States as an active member of the International Commission on Large Dams (ICOLD).

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FOREWORD

Guidelines for Construction Cost Estimating for Dam Engineers and Owners was prepared by the USSD Committee on Construction and Rehabilitation. The White Paper provides support for responsible cost estimating for new dams and dam rehabilitation projects. It has been written for engineers and owners engaged in the planning, design and construction of dam-related engineering projects anticipated to cost up to \$100 million. This represents the collaborative effort of representatives from federal agencies, public utilities, private engineering companies and construction contractors. Stages of project design and associated estimates, the development of a work breakdown structure, direct and indirect project costs, overhead, contingency, profit, and other owner costs are addressed as they relate to responsible cost estimating. Examples of Work Breakdown Structures for various sized projects are also presented.

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1.0 SCOPE AND PURPOSE

These guidelines have been developed to encourage and support responsible cost estimating for new dams and dam rehabilitation projects. This guidance is not intended to serve as a “how-to manual” for cost estimators or others. Rather, the information provided offers a structured reminder of the items that Engineers, Owners, and cost estimating professionals must address when preparing an estimate of expected project costs. Preparation of the various types and levels of cost estimates requires professional experience and sound engineering judgment. More detailed data, such as cost curves, computer programs, contract terms and conditions, etc., that estimators use in the development of cost estimates are not included because of their variable nature and proprietary considerations.

A major factor in Project go/no go decisions is the economic benefit of the project compared to the overall project cost. Market volatility, particularly between 2000 and 2010, highlights the importance of reliable construction cost estimates during design and project development. USSD decided to address this topic in a paper after noting that in recent years several dam projects have experienced contractor bids that greatly exceeded budgets based on Engineers’ Estimates, causing delay and/or cancellation of these much-needed projects after significant up-front costs had been expended.

This document reflects the collaborative effort of representatives from throughout the industry, including input from federal agencies, public utilities, private engineering companies and construction contractors.

To begin, a cost estimate is a prediction of the probable costs of a project or program within a documented scope, to be completed at a defined location and specific future time. An “estimate” refers to the development of a judgment or opinion regarding the approximate project cost at the time of completion. Therefore, an estimate has an inherent uncertainty or expected level of error. The actual cost of the project at completion will differ from the predicted cost due to this inherent uncertainty and other unknown considerations or errors. The objective of the estimator is to be comprehensive in approach to the estimate and thorough in its development. All parties involved in a project must be keenly aware of this when referencing and discussing cost estimates.

Because of the inherent uncertainty associated with cost estimating, adequate risk management and quality control of the estimating process can improve the likelihood of an adequately funded and successfully completed project. Therefore, consideration should be given by the estimator-in-charge to performing some type of risk analysis on the cost estimate, and including the cost of this in the budget for preparing the estimate. Project risks are uncertain events or conditions that, if they occur, will have an impact on the objective, either positive or negative. History has proven that a greater probability exists that costs will increase rather decrease. Risk analysis can provide management with an understanding of the probability of over-running (or under-running) a cost estimate.

In addition to all the items discussed in this report that need to be considered in preparation of a responsible cost estimate, general economic conditions can have a major effect on the accuracy of a cost estimate. The industry has seen, for example, wide variations in the bidding climate in the decade from 2001 to 2011. Shortly after Hurricane Katrina in 2003, sharp increases in most building materials and labor, together with fewer bidders on projects, led to low bids that invariably exceeded the Engineer's Estimate. Then economic conditions declined, which led to more competition and, thus, lower markups by contractors, vendors, and specialty subcontractors for overhead and profit. This, together with some reductions in raw material prices, led to low bid that were considerably below otherwise well prepared cost estimates.

This document has been written for engineers and owners engaged in the planning, design, and construction of dam-related engineering projects anticipated to cost under \$100 million. It has been written to discuss projects that will be delivered by the traditional design-bid-build process; however, most of the topics are relevant to alternative project delivery approaches. It covers the factors involved in the preparation of a cost estimate and is not intended to support bid evaluations.

2.0 STAGES OF PROJECT DESIGN AND ASSOCIATED ESTIMATES

2.1 INTRODUCTION

Effective cost estimating involves the use of data derived from the most current pricing for materials, appropriate wages and salaries, accepted productivity standards, and customary construction practices, procurement methods, equipment needs, and site conditions. Cost estimates are by definition prepared with less than complete information and have inherent levels of risk and uncertainties.

Typically, each new cost estimate for a specific project or feature is based on increasing levels of project refinement and more detailed levels of design data. Cost estimates, which are developed based on the best available information at the time, are expected to reflect reasonable and defensible expectations of costs for a specific level of estimate. As more refined cost estimates are developed, the confidence in and accuracy of the estimate is expected to be higher.

The simplest example might be developing a design to a “Draft” level and then stopping the design process to perform a cost estimate to see if the cost is in line with the owner’s budget. This allows a project owner to change course in a minor fashion (or dramatically) if the design is not compatible with the expected or available budget. The “Final” design would then proceed to completion with a final cost estimate reflecting those mid-course changes.

In both the public and private sectors, many levels or types of classifications of cost estimates exist, typically reflecting an agency’s or company’s naming convention for each successive level of design. No matter the organization, the levels of engineer cost estimating begin at initial planning or design and end with a 100 percent design that is biddable and constructable. With each increasing level of design and cost estimate, the likelihood that the cost estimate reflects the actual project costs increases. This leads to increased confidence in both the design and the estimated project cost resulting expected project cost.

It should be noted that as the level of estimate detail increases, the cost and value to the owner of the cost estimating effort increases. As noted in this section, the cost of preparing an AACE (Association for the Advancement of Cost Engineering) Class 2 or Class 1 estimate could approach 0.1 percent to 0.5 percent of project cost, representing a significant effort. The value of such detail is likely recovered many-fold in the related value of engineering and design decisions made as a result of this detail. Increased detail results from increased effort, which does mean increased cost for estimating. However, overall project cost reductions that result from the more expensive estimate will typically more than justify the expense.

The contradiction always remains, however, that “estimate accuracy” is an oxymoron and that no matter what level of accuracy an agency/owner requires, there is no means of

determining whether the accuracy requirements were met until a project is complete and the actual costs are known.

The following sections illustrate how various agencies and organizations define levels of cost estimating and the level of accuracy associated with those levels. It should be noted that the various approaches are similar and result in increased accuracy as project understanding develops and a higher level of estimating effort is expended.

2.2 ASSOCIATION FOR THE ADVANCEMENT OF COST ENGINEERING (AACE) INTERNATIONAL

AACE International is an international non-profit professional educational association that provides services related to cost estimating, cost/schedule control, and project management to a wide range of professions and industries. AACE defines five levels of cost estimates for a project.

The following matrix presents the level of project definition, typical end use, methodology, expected accuracy, and preparation effort associated with the AACE classifications of cost estimate (reference AACE International Recommended Practice No. 18R-97).

ESTIMATE CLASS	<i>Primary Characteristic</i>	<i>Secondary Characteristic</i>			
	LEVEL OF PROJECT DEFINITION Expressed as % of complete definition	END USE Typical purpose of estimate	METHODOLOGY Typical estimating method	EXPECTED ACCURACY RANGE Typical variation in low and high ranges	PREPARATION EFFORT Typical degree of effort relative to least cost index of 1
Class 5	0% to 2%	Concept Screening	Capacity Factored, Parametric Models, Judgment or Analogy	L: -20% to -50% H: +30% to +100%	1
Class 4	1% to 15%	Study or Feasibility	Equipment Factored or Parametric Models	L: -15% to -30% H: +20% to +50%	2 to 4
Class 3	10% to 40%	Budget Authorization, or Control	Semi-Detailed Unit Costs with Assembly Level Line Items	L: -10% to -20% H: +10% to +30%	3 to 10
Class 2	30% to 70%	Control or Bid/Tender	Detailed Unit Cost with Forced Detailed Take-Off	L: -5% to -15% H: +5% to +20%	4 to 20
Class 1	50% to 100%	Check Estimate or Bid/Tender	Detailed Unit Cost with Detailed Take-Off	L: -3% to -10% H: +3% to +15%	5 to 100

Figure 1. AACE Accuracy Matrix for Estimating Classes

The following graph depicts the expected accuracy boundaries for each of the AACE Estimate Classes. These boundaries are defined in the narrative descriptions of each estimate classification and its respective percent design level.

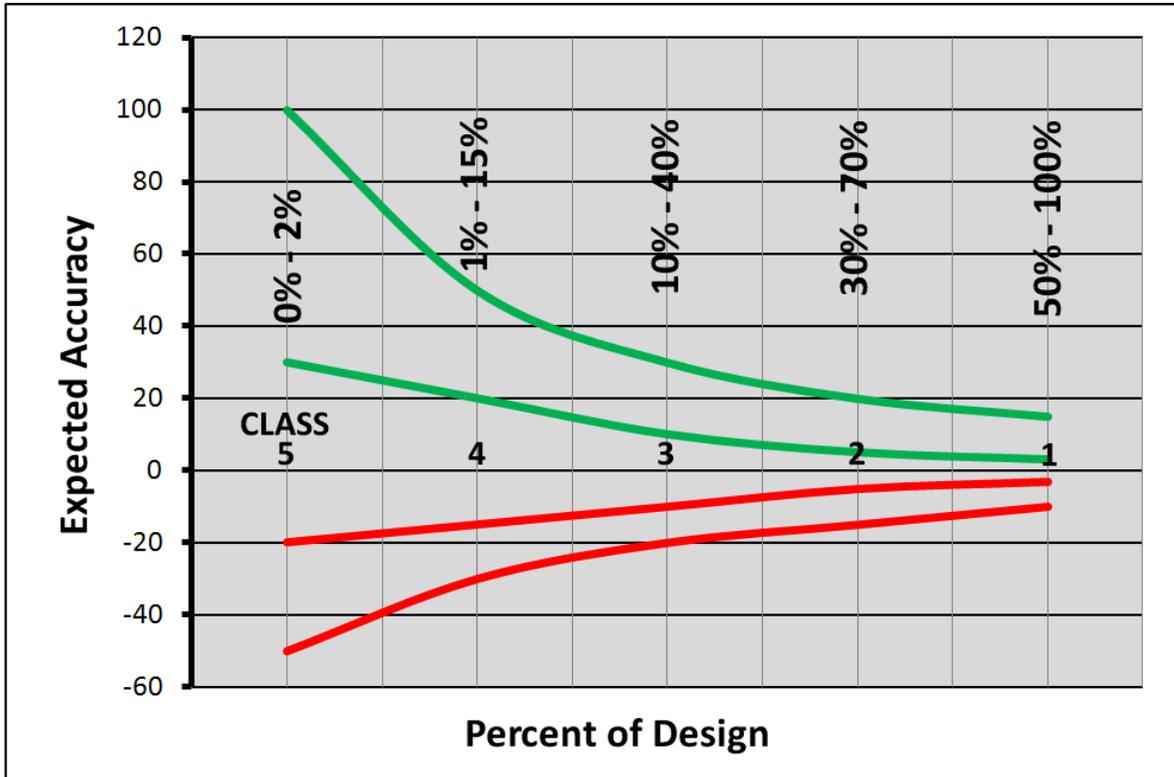


Figure 2. Graphical Representation of Figure 1 (by Authors)

2.3 THE UNITED STATES BUREAU OF RECLAMATION

The U.S. Bureau of Reclamation (USBR) divides projects into two broad categories: Planning Stage and Final Design Stage. Under the Planning Stage, projects are further separated into progressive categories – Preliminary, Appraisal, and Feasibility. In the Final Design Stage, projects are designated by a percent complete until reaching 100 percent and then designated as “Pre-validation.” During the Solicitation Stage (pre-award), an Independent Government Cost Estimate (IGCE) is produced.

The following graph roughly correlates the USBR levels of cost estimating with AACE’s estimates classifications. This figure is intended to show a general relationship between AACE classes of cost estimates and typical USBR cost estimates. A correlation of the respective accuracies is not intended or implied.

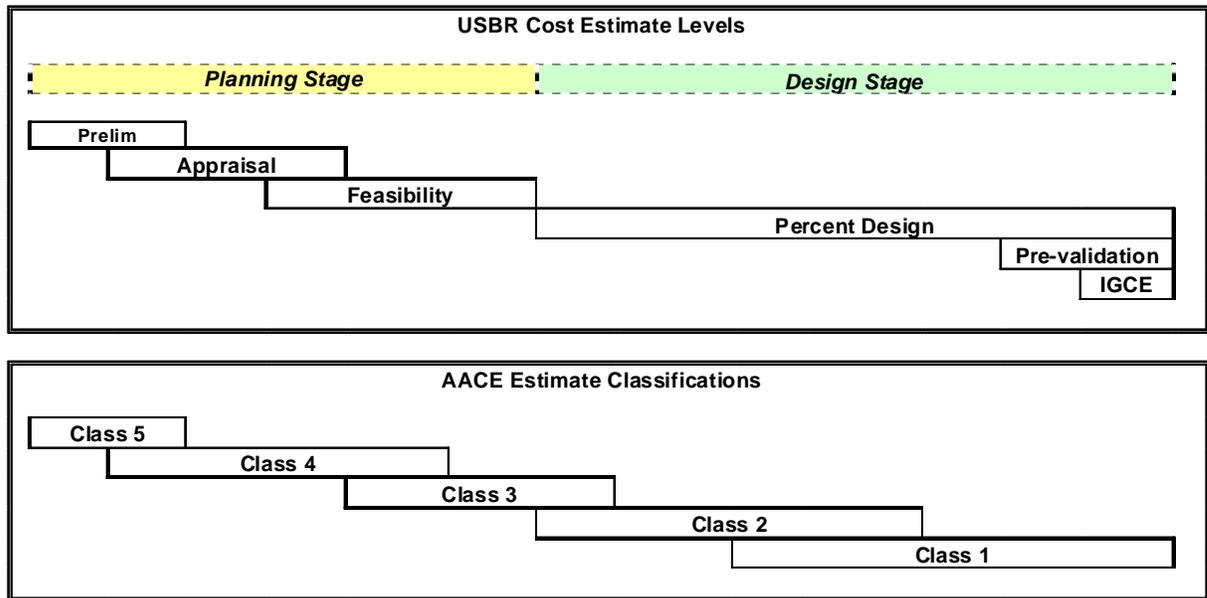


Figure 3. USBR Cost Estimate Level Compared to AACE Classifications

2.4 THE UNITED STATES ARMY CORPS OF ENGINEERS

For cost estimating purposes, the United States Army Corps of Engineers (USACE) divides projects into five categories:

1. Reconnaissance phase
2. Feasibility phase
3. Preconstruction engineering and design phase
4. Construction phase
5. Operation, Maintenance, Repair, Replacement, and Rehabilitation phase

In ER 1110-2-1302 Civil Works Cost Engineering, the USACE references ASTM E 2516-06, Standard Classification for Cost Estimate Classification System, which, as shown below, is effectively the same as that of AACE International accuracy matrix shown previously.

ESTIMATE CLASS	Primary Characteristic	Secondary Characteristic			
	LEVEL OF PROJECT DEFINITION Expressed as % of complete definition	END USAGE Typical purpose of estimate	METHODOLOGY Typical estimating method	EXPECTED ACCURACY RANGE INDEX Typical +/- range relative to best index of 1 [a]	PREPARATION EFFORT INDEX Typical degree of effort relative to least cost index of 1 [b]
Class 5	0% to 2%	Screening or Feasibility	Stochastic or Judgment	4 to 20	1
Class 4	1% to 15%	Concept Study or Feasibility	Primarily Stochastic	3 to 12	2 to 4
Class 3	10% to 40%	Budget, Authorization, or Control	Mixed, but Primarily Stochastic	2 to 6	3 to 10
Class 2	30% to 70%	Control or Bid/Tender	Primarily Deterministic	1 to 3	5 to 20
Class 1	50% to 100%	Check Estimate or Bid/Tender	Deterministic	1	10 to 100

[a] If the expected accuracy range index value of "1" represents +10/-5 percent, then an index value of "10" represents +100/-50 percent.

[b] If the preparation effort index value of "1" represents 0.005 percent of project costs, then an index value of "100" represents 0.5 percent.

Figure 4: ASTM E 2516-06, Standard Classification for Cost Estimate Classification System
(Identical to AACE 17R-97)

ER 1110-2-1302 then goes on to list what classification of estimate is required for the various phases, as follows:

Civil Works Project Phase	Minimum Estimate Classification Required
Rough Order of Magnitude	5
Pre-Authorization	
Reconnaissance	4
Alternative Studies	4
Feasibility Plan	3
Feasibility Sponsor Preferred Plan	3
Project Corporative Agreement	3
Post-Authorization	
General Reevaluation Report	3
Limited Reevaluation Report	3
Planning, Engineering, and Design Phases	
60% P&S	2
90% P&S	2
100% P&S	1
Independent Government Estimate	1

Figure 5. USACE Minimum Classifications for Civil Works Project Phases

The classifications themselves are then further defined as follows:

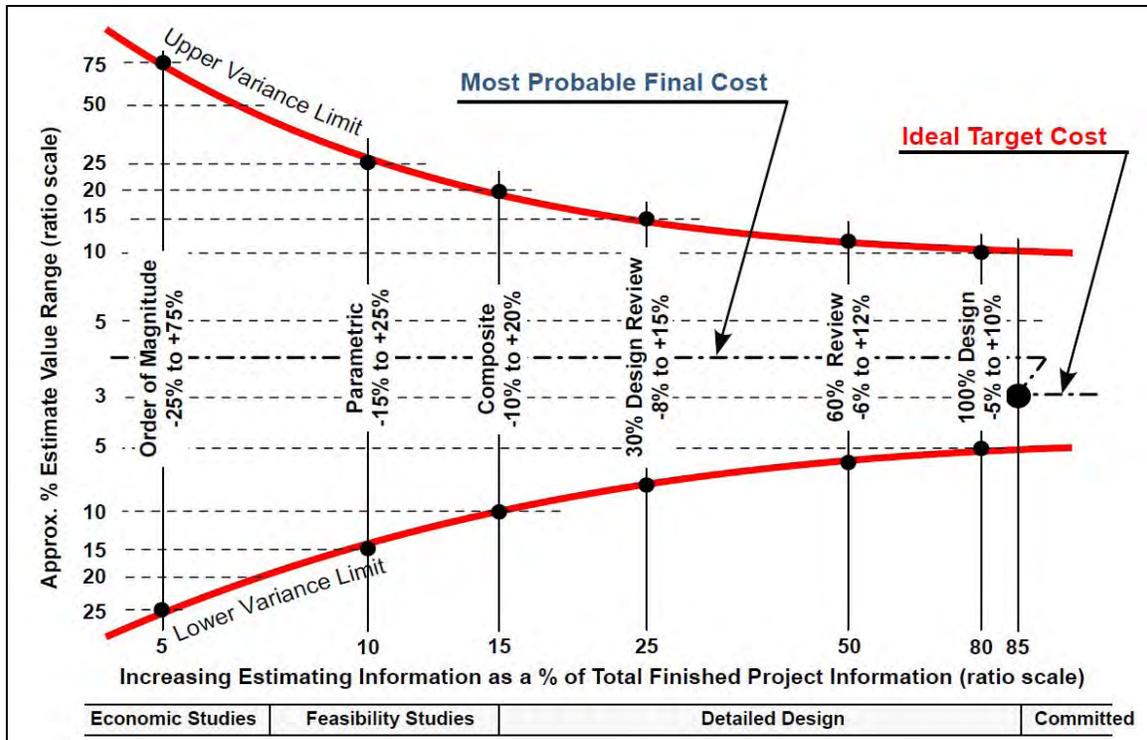
- (1) Class 5 - Considerable risk and uncertainty is inherent in a Class 5 estimate. Each Project Design Team (PDT) shall identify areas of risk and uncertainty in the project and describe them clearly to determine the amount of contingency that must be added to a cost estimate to reduce the uncertainty to an acceptable level. (Contingency is discussed in Section 7 of this paper.)
- (2) Class 4 - Although Class 4 estimates may be more accurate than Class 5 estimates, they are based on a very limited project definition. The PDT shall identify areas of risk and uncertainty in the project and describe them to determine the amount of contingency that must be added to a cost estimate to reduce the uncertainty to an acceptable level.
- (3) Class 3 - Class 3 estimates must be supported by a discussion of the scope of the estimate and the uncertainties associated with each major cost item in the estimate. Special attention will be given to large cost items and items that are sensitive to change. Appropriate contingencies may be applied for each element to account for information that is lacking to more accurately establish

its cost. To accomplish this process, it is vital to identify those areas that significantly contribute to cost uncertainty. Generally speaking, 80 percent of the cost of a project is contained in 20 percent of the estimated work elements. The object is to focus on the uncertainties associated with these so called 20 percent “critical” elements to reduce the cost risk. Results of the risk analysis shall be the basis for determining contingencies.

- (4) Class 2 - A Class 2 estimate may include a PDT project evaluation to determine if additional investigations or studies are necessary to reduce the uncertainties and refine the cost estimate. It shall be accomplished as a joint analysis between the cost engineer and the designers or appropriate PDT members that have specific knowledge and expertise on all possible project risks. It should be noted that the use of cost risk analysis will not reduce the uncertainties associated with the project cost estimate or solve the problems of cost variance due to insufficient investigations or design data. Results of the risk analysis shall be the basis for determining contingencies.
- (5) Class 1 - Class 1 does not imply that all unknowns and risk are eliminated. Estimates prepared to this level should include risk analysis to the degree described in Class 2 above. Results of the risk analysis will be the basis for determining contingencies.

2.5 OTHER ORGANIZATIONS

Numerous additional non-governmental organizations and for-profit companies offer graphs, charts, and tips related to cost estimate accuracy. An internet search of “estimating accuracy” yields a plethora of options for additional information. One of the better illustrations, titled Estimating Accuracy Trumpet, provided by R. Max Wideman, is shown in Figure 6.



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Figure 6. Estimating Accuracy Trumpet

2.6 USSD COMMITTEE ON CONSTRUCTION AND REHABILITATION

For the purpose of this document, based upon typical dam industry experience, the following definitions of project levels of completion for Engineer's Cost Estimates will be used:

- Conceptual (e.g. AACE Class 5)
- Reconnaissance (e.g. AACE Class 4)
- Feasibility (e.g. AACE Class 3)
- Final Design (e.g. AACE Class 2)

In general, only a bidding contractor will expend the funds necessary to produce an AACE Class 1 estimate due to the risk inherent in this role.

2.7 SUMMARY

It is important to recognize standard practices and expectations as outlined in the AACE, USBR, USACE, and Wideman examples in this section. Defining the expected level of detail, accuracy, and expense is important for project stakeholders to understand and should be commensurate with the stage of project development.

Essentially, the level of detail and accuracy increases as the project gets closer to design completion and procurement. As the project evolves, decisions regarding design, cost-benefit, and even project viability depend on appropriate levels of cost information.

Project owners should expect to conduct responsible cost estimates and to bear the cost of doing so. At the same time, they should expect to find value in producing enough detail in the process to make sound decisions regarding the design.

It should be understood by all parties that the accuracy in cost estimating is relative to the amount of information available and level of effort expended. In water resources projects such as dams, bidding contractors who necessarily conduct thorough cost estimates are often 5 to 20 percent different in their bids. A good engineer's cost estimate should typically come within the range of the two or three low bidders.

3.0 DEVELOPMENT OF WORK BREAKDOWN STRUCTURE

3.1 INTRODUCTION

Successful cost estimates use planning techniques to define the project objectives in sufficient detail to support the level of cost estimate being developed. The Work Breakdown Structure (WBS) process assists the project stakeholders in developing the elements of the project scope into hierarchical, manageable and definable work elements that balance the control needs of management with an appropriate and effective level of project data. A well-developed WBS that presents information at the appropriate level of detail and in formats and structures meaningful to those estimating the work is an invaluable tool in overall project management.

3.2 WORK BREAKDOWN STRUCTURE

Developing a WBS is an essential step during the early phases of a project as the scope is being developed by the design team. A WBS has the following characteristics:

- It identifies work as an activity
- It is arranged in a hierarchical structure
- It has an objective or tangible result

This organization of work elements defines a project's scope. Each descending level represents an increasingly detailed definition of the project scope. A detailed WBS provides the foundation for subsequently integrating the work details and deliverables with all other project phases. This ensures that the project includes all of the work needed and also that the project includes no unnecessary work. Both cost estimates and the associated schedules should be built consistent with the project WBS.

A WBS differs from a Bid Schedule or Construction Line Items in that it is more detailed. A WBS can be combined or rolled-up into the Construction Line Items or Bid Schedule Items that are included in construction bid forms.

The design team and cost estimators should develop a project logic diagram and schedule that will generate a clear vision of the project construction sequence and critical path. When creating the logic diagram and construction schedule for a project, the design team should:

- Think through the entire project
- Identify/name major construction activities (develop WBS)
- Think with the completed project in mind
- Think about the interrelationship between project components

3.2.1 Factors to Be Considered

When developing a WBS, the following factors should be considered:

- Each WBS element should represent a single tangible activity
- Each WBS element should represent an aggregation of all subordinate WBS elements
- Each subordinate WBS element should be logically divided into the components that represent how it will be constructed
- A logical coding system should be used for WBS elements in order to clearly represent the organizational structure of the project
- Input should be obtained from knowledgeable experts when necessary

3.2.2 WBS Examples

Appendix A provides two WBS examples, one of a project involving construction of a concrete cutoff wall through an earthen dam, and the second involves a complex roller compacted concrete dam project.

3.3 DEVELOPING THE COST ESTIMATE

Typically, a cost estimator will use one of the following approaches (or a combination of both) to develop the cost estimate:

1. Unit price (historical) estimates are generally prepared using current unit prices. They are prepared using relevant previous bid abstracts, cost curves, catalogs, detailed analyses, vendor quotations, and regression analyses.
2. Detailed estimates are built-up estimates representing hypothetical offeror's bid prices, including all direct costs and indirect costs (i.e., project overheads, business overheads, profit, and bonds) to perform the work required by the solicitation.

Both approaches can result in the same level of confidence in the cost estimate when used appropriately; however, each has its strengths and limitations depending on the level of estimate, the complexity of the project, and relative amount of labor costs versus material costs. Typically the built-up approach is used on major items that are variable and cannot be confidently quantified by unit prices.

Detailed estimates should be developed using a step-by-step process, planning the project in the same manner as a contractor would plan, organize, and conduct the work. These estimates are based on the types and quantities of labor, equipment, and materials required to perform the work. Estimates should also consider production rates, projected weather delays, schedule impacts from various causes, optimal equipment selection, site

accessibility, premium time or multiple shift efficiency factors, haul routes and distances, and availability of materials.

3.3.1 Quantities

When estimates are required before drawings have been prepared, shortcut methods of determining quantities are often used, such as methods wherein the quantities are roughly estimated on the basis of unit quantities for similar structures. Except for appraisal estimates, the quantities for the major items should be obtained from actual layouts developed in sufficient detail for their computation. Appropriate checks and validations of the quantities are necessary. Reasonable allowances must be made for specific pay item quantities, including but not limited to the following: for wasted and unsuitable material; for volume shrinkage in compacted fills; and for overbreak in tunnel excavation, concrete tunnel lining, and backfill.

It is cautioned that quantities should not be increased to cover contingency. Refer to Chapter 8 for further discussion of this matter.

3.3.2 Unit Prices

When estimating the unit price for labor, equipment, and materials required for construction, consideration must be given to numerous factors that influence the cost, such as: geographical location of work; seasonal weather conditions; unusual or special physical conditions; accessibility of the work; accommodations for housing and transportation; materials handling and storage facilities; sources of construction power; availability of labor and materials; types of labor required; wage rates; construction plant and equipment requirements; associated production rates for the anticipated crews; construction schedule; and economic trends.

Consideration should also be given to previous bids on work of a similar nature, and the contractor's actual charges for performing similar work, including overhead, profit, insurance, taxes, risk, etc. The same considerations are required in estimating unit prices for construction to be performed by government forces (force account work), except that the contractor's overhead, profit, insurance, and taxes are supplanted by government supervision for construction, employee benefits insurance, and allowances for leave.

3.4 Pay Items / Bid Schedule

Elements of work with similar units may be combined into a single pay item where they are interrelated and performed in one general operation; unrelated elements of work are not normally combined. Even an item such as "diversion and care of river during construction and un-watering foundations" should be broken down into items that represent the various elements of work unless it is impracticable to limit the contractor to a particular diversion scheme. Each pay item usually represents a separate and distinct class of work, such as furnishing and/or installing a certain type of equipment, excavating or placing a certain type of material, or performing work requiring a certain type of labor or equipment.

3.5 SUMMARY

The cost estimator, the design team, and construction experts should work together to build and schedule the project in order to identify the appropriate level of WBS tasks for a particular project scope. This process provides the cost estimator with input from all of the disciplines that are critical to the execution of the project. The WBS that results from this interaction will assure that the cost estimator has included the appropriate levels of labor, equipment and materials for each major feature of a project. In most cases, the WBS will be more detailed and contain more items than would be reflected in a bid schedule to be incorporated in Contract documents. The bid schedule will include many items that will consist of combined and/or rolled-up WBS line items.

4.0 DIRECT PROJECT COSTS

4.1 INTRODUCTION

As explained in Sections 2 and 3, the level of detail required to address direct costs is dependent on the project design phase and the magnitude or impact of a particular item in the Work Breakdown Structure (WBS) on the overall project cost. Generally speaking, the cost estimator should spend the most amount of time developing detailed cost estimates for those items in the WBS that have the most impact on the overall project cost.

As a practical matter, many contractors break their costs down into four distinct cost types:

- Labor
- Equipment
- Materials
- Subcontracts

This section provides recommendations on how to approach to each cost type.

When developing a cost estimate, the estimator should always include a constructability review and a construction schedule. A thorough review of construction issues during the constructability review will establish a construction plan and identify obstacles and opportunities such as access, work space, weather, and other conflicts. Development of a good construction schedule will similarly identify the overall project approach, while also identifying conflicts in activities, and even equipment selection. This schedule should also consider the effects of double shifting, weather, work windows, work seasons, permit restrictions, etc. As with the cost analysis, the schedule should be updated at each stage of project development, as schedule driven costs may have significant impacts on overall project cost.

4.2 LABOR COSTS

Prior to calculating direct costs for any item in the WBS, approximate labor cost per hour must be calculated for the anticipated crafts. This might include equipment operators, laborers, carpenters, ironworkers, etc. Within each of those crafts, the cost estimator may want to further determine costs for various skill levels within each craft. For instance, a roller operator would likely have a lower wage than a skilled crane operator. A good place to start would be the U.S. Department of Labor's Prevailing Wage Rates available on the U.S. DOL website, www.dol.gov. The cost estimator, knowing the project location, can find base wage rates and benefits required by law for public works projects. While these rates are appropriate for public works projects, and generally mirror union scale rates in the U.S., various factors must be taken into account. In Right to Work states, such as Wyoming and Texas, the wages listed by USDOL may be less than the actual wages normally paid by contractors in that area. Beyond prevailing wage rates,

per diems, or other incentives may need to be added to wages to account for travel to and from projects in more remote locations.

Once the cost estimator has determined the base wages and benefits, an appropriate amount for labor burdens, taxes and overtime must be applied. Burdens and taxes can apply to both base wages and benefits and include FICA (Social Security), Medicare, Federal Unemployment, State Unemployment, and Workers' Compensation. The sum of these burdens and taxes can be as much as 20 to 30 percent or more of the base wage amount. The cost estimator should also consider overtime costs if anticipated on the project. For instance, if the project is anticipated to be managed on five, 10-hour days (50 hours per week), then the cost estimator should calculate the wage for each craft accordingly.

Although crew size and production rates are discussed in Section 4.6, it is worth mentioning here that, when bidding a project with expected union labor, the estimator needs to be aware of local union work rules, which often have additional staffing requirements for different experience levels for various tasks.

4.3 EQUIPMENT COSTS

For the purposes of construction cost estimating and the scope of this paper, equipment costs are defined as machinery such as construction equipment, conveying systems, processing plants, tools, and instruments that are required during construction of the project, but do not remain a permanent part of the project.

As with other direct costs, the estimator should perform detailed analysis using individual equipment costs for significant cost WBS items warranting such analysis.

During the course of cost estimating, the estimator should consider overall project equipment selection based on project conditions, project specification requirements, and knowledge of equipment capabilities. Individual WBS item equipment needs should be addressed within the context of the entire project scope. That is to say, a small excavation or fill task well suited to scraper operation may not be cost-effective if scrapers have no other practical application on the project. Simply put, the cost of mobilization and demobilization of scrapers for that WBS item may not be cost-effective. It is noted that most contractors have their own equipment fleet. Individual contractor bids will be based on utilization of such fleets, thus internal costs for equipment can vary widely between contractors.

Factors affecting equipment selection and, ultimately, equipment costs include, but are not limited to:

- Job schedule (production rate)
- Job size
- Project specification requirements
- Mobilization and demobilization costs

- Air pollution restrictions
- Noise ordinance restrictions
- Type of materials handled or installed
- Availability of space (access, working, storage, standby/lay down)
- Mobility and availability of equipment
- Suitability of equipment for other uses
- Equipment capabilities
- Number of shifts
- Distances material must be moved
- Steepness and direction of grades
- Weather conditions
- Hauling restrictions
- Standby time
- Load bearing conditions
- Contract requirements
- Decontamination and/or disposal of contaminated equipment
- Potential salvage or resale value of plants
- Contractor owned equipment versus rental or leased equipment

In the analysis of equipment costs of any one WBS item, the cost estimator should evaluate the need for spare or support equipment required throughout the project.

Equipment costs can generally be divided into two categories: Ownership Costs and Operating Costs, as discussed below.

4.3.1 Equipment Ownership Costs

Ownership costs are fixed costs, including Capital Cost, Depreciation, Cost of Facilities Capital, and Equipment Overhead. Recovery of these costs for a contractor is generally accomplished by developing an hourly rate for the project. The rate is generally based on the number of expected work hours for the fiscal year, sometimes adjusted for project usage. This is similar to the rate calculations performed by USACE, Equipment Watch Cost Reference Guide / Blue Book, and various state departments of transportation. These ownership costs are briefly discussed below:

- Depreciation spreads the cost of the equipment purchase over a number of years. The basic concept involves determining the decrease in value of the equipment as the equipment ages and expressing this figure as a cost per hour. There are many methods of calculating depreciation, which is beyond the scope of this document.
- Cost of Facilities Capital (CFC) is an hourly cost based on cost formulas in the Equipment Watch Cost Reference Guide. CFC is an allowance for the cost of

money invested in the equipment which takes into account the purchase price of the equipment, the economic life of the equipment, the salvage value, and the cost of money rate (interest, as determined by the U.S. Treasury Department). CFC is intended to compensate a contractor for the capital cost of employing certain facilities (equipment and machinery) in the performance of construction contracts.

- Equipment Overhead is defined as indirect costs associated with equipment ownership. These costs include insurance, property taxes, inspections, licenses, security and storage, and recordkeeping.
- Overhead Labor is charged as part of equipment ownership costs to cover the cost of the labor needed to rebuild and recondition major components, such as engines, undercarriages, transmissions, etc. due to wear and tear.
- Overhead Parts are incorporated into equipment ownership costs to cover the cost of parts required for rebuilding and reconditioning major components, such as engines, undercarriages, transmissions, etc. that are not part of operating costs.

4.3.2 Equipment Operating Costs

Equipment operating costs are those costs associated with field repair, fuel expenses, ground engagement, and electricity costs incurred while operating a piece of equipment. These costs include the following elements:

- Field Repair (Labor) costs are charges to account for labor costs during normal field repair and maintenance, such as adjusting, repairing, or replacing minor components like carburetors, injectors, pumps, seals, batteries, etc.
- Field Repair (Parts) costs are charges to account for minor parts required during normal field repair and maintenance, such as plugs, injectors, pumps, seals, batteries, etc.
- Fuel costs are typically the largest component of equipment operating costs. The estimator should be aware of local fuel costs and factor these costs along with fuel consumption rates to determine this element. The estimator may need to anticipate upward or downward trends in fuel cost during the life of the project. This is especially true of long-term projects. On large projects, fuel costs are sometimes hedged by either the owner or the contractor.
- Lubrication costs are accrued to offset the costs for grease, oils, filters, and the labor and lube truck required to maintain the equipment.
- Tire costs are expenses incurred for tire repair and replacement, if required.
- Ground Engaging Components (GEC) costs are associated with repair or replacement of components such as cutting edges, bucket teeth, ripper teeth, tracked equipment pads, and drums. GECs are directly affected by project conditions, such as rock and ground pH.
- Electricity costs should be accounted for in equipment operating costs by determining the cost of power and the rate of use.

Equipment ownership and operating costs are available to the cost estimator from a variety of sources, including Equipment Watch Rental Rate Blue Book for Construction Equipment, USACE, state departments of transportation, AGC, and others.

4.3.3 Consumables

The cost for normal operating expendables with high variable wear rates (i.e., drill bits, saw blades, etc.) are excluded from Equipment Costs and are considered consumables. These should be accounted for in individual work items under material costs. Guidelines on the costs of consumables are available from numerous equipment manufactures (e.g. Caterpillar, Ingersoll Rand, Sandvik).

4.3.4 Small Tools

The cost associated with small power and hand tools and miscellaneous non-capitalized equipment and supplies should be estimated as a percentage of the labor cost for each project. The allowance must be determined by the cost estimator in each case, based on experience for the type of work involved. Generally speaking, a labor intensive project, such as pipelines, tunnels, or concrete work, will require more small tool costs per man-hour (or work hour) than an equipment intensive project, such as excavation or earthfill placement. Small tools costs generally range from \$1 to \$2 per work hour.

4.4 MATERIAL COSTS

Materials are defined as those items (materials and installed equipment) that are incorporated into and remain part of the feature or structure.

Supplies are defined as those items that are used during construction but do not remain a permanent part of the feature or structure (e.g., concrete forms).

Material and supply costs are an integral part of most cost estimates. For the purposes of this document, the costs of materials and supplies include such elements as fabrication, shipping, warranties, and supplier markups. Taxes are generally handled as one item in the Indirect Project Costs, as detailed in Section 5.

4.4.1 Sources for Pricing

The cost estimator producing an Engineer's Estimate may obtain prices for materials and supplies from various sources, including, but not limited to, catalogs, vendor price sheets, vendor quotations, pricing services (e.g., RSMeans Cost Estimating Manuals, Cost Data Online [Richardson's Engineering], GSA Advantage, etc.), and historical data records (e.g., USBR's EXPECT Program, cost curves, bid abstracts, contractor proprietary database, etc.). The estimator should review the source of the pricing and assess the reasonableness and applicability prior to use. Care should be exercised when using this type of cost data to make proper allowances for long-lead times for manufacture and

delivery, quantity discounts, escalation, location factors, and other factors affecting contractor cost.

As an additional resource, vendor quotes should be obtained for all significant materials and installed equipment (e.g., large quantity or high cost items) and for specialized or not readily available items. Quotations may be received by email, fax, in writing or via telephone. It is preferable to obtain quotes for each project to ensure that the cost is current and that the item meets specifications. It is important to verify the vendor's scope so that pricing is complete. If possible, more than one quote should be obtained to be reasonably sure the quoted prices are complete and representative.

Ensuring that vendors have enough information is important if the engineer is to receive an accurate quote. If the vendor understands the project conditions, intended use, etc., chances are that the resulting cost estimate will be more accurate. Quotes should be kept confidential by the owner and engineer to protect the integrity of the bidding process.

4.4.2 Freight

The estimator should check the basis for the price quotes to determine if they include delivery to the job site. If they do not include delivery, freight costs to the job site must be determined and added. The supplier can usually furnish an approximate delivery cost. For freight, Free on Board (FOB) refers to the point to which the seller will deliver goods without additional charge to the buyer.

If the materials or supplies are FOB factory or warehouse, freight costs to the job site should be added to the cost of the materials or supplies. If the cost of materials or supplies includes partial delivery, i.e., FOB to the nearest rail station or port, the cost of unloading and transporting the materials or supplies should be included in the estimate.

4.4.3 Material Handling and Storage

Estimators should consider costs of off-loading, handling and stockpiling, and warehousing materials.

If the materials or supplies are a large quantity or an item that requires extensive labor and equipment for unloading and hauling, or if they have special handling and/or storage requirements, the estimator should prepare a labor and equipment estimate for the material handling and delivery to the installation or storage location and consider these direct costs.

For common items, such as general construction materials or equipment needing secure storage, the cost for the security fencing and/or site security personnel, temporary building and material handling should be considered as an indirect cost and be included in the job site overhead cost.

4.4.4 Allowance for Waste and Loss Factors

Waste and loss considerations may be included in material unit price calculations. For example, USBR's preferred practice is to leave the pay item (bid item) quantity unchanged and account for waste and loss by increasing the forecast quantity (quantity used to calculate the unit price), thus increasing the unit price while leaving the pay item quantity unchanged. Sometimes the handling of this waste incurs a cost. For instance, drainage blanket aggregates have several layers of waste in handling – waste in the crushing, waste in the loading and trucking, and waste in placement beyond pay lines. If any of these activities will incur waste, it should be accounted for. For example, hauling 10 percent more material will take 10 percent more trucking effort. A note should be included in the estimate explaining the methodology used to determine waste and loss. As an example, 5% material swell can cause a 5% increase in handling effort for that material.

4.4.5 Escalation for Material Pricing

Many projects require that the costs for materials be escalated from the present to the projected installation date. Therefore, quotes are requested in advance of the expected installation date. However, suppliers are reluctant to guarantee future prices and often will only quote current prices especially during inflationary times or times of high product demand. It may be necessary to adjust current prices to reflect the cost expected at the actual purchase date. This cost adjustment, if required, should not be included as a contingency, but should be clearly and separately defined in each estimate. Adjust current pricing to future pricing using appropriate escalation factors and methodologies. Escalation adjustment calculations should be clear and maintained as part of the cost estimate backup documentation. The address of escalation should be coordinated with the escalation approach on the entire estimate. If escalation of the entire project will be handled as one adjustment, then escalation of individual material prices may not be warranted.

4.5 Subcontractor Costs

Generally, the cost estimator is not concerned about whether WBS items are subcontracted or self-performed by the general contractor. However, on water resources projects, numerous opportunities arise for the use of specialty subcontractors and proprietary methods, such as slurry wall construction, foundation improvement technologies, instrumentation, and others. Similar to material costs, the cost estimator should contact specialty subcontractors to better understand the application of techniques and the cost of this work. For the purposes of this document, the costs of subcontracted work include such elements as subcontractor-provided materials, subcontractor taxes, and subcontractor markups. Overall project taxes would generally be handled as one item in the Indirect Project Costs as detailed in Section 5.

4.6 PRODUCTION RATES

In general, to identify labor and equipment costs for estimates, anticipated crews are assembled and time durations are applied for appropriate crews to perform specific quantities of work or WBS items. The durations of time are based on the assumed production rates applied for performing the specified amount of work. For example, if 1,000 cubic yards are to be excavated and a production rate of 50 cubic yards per hour is applied, a production duration of 20 hours is required to perform the specified excavation.

Therefore, the components required to come up with a production rate are the duration of time, the work-hours (and/or equipment hours) involved, and an amount of work produced. The estimated production rates can be assumed based on the estimator's experience (e.g., personal observations and /or time studies), a historical database, cost reference guides such as RSMeans Construction Cost Data Books, Caterpillar Handbook or VSIM Production guidelines, or other sources.

4.7 SUMMARY

As with other elements of a responsible construction cost estimate, the level of detail in developing direct costs needs to be determined according to the magnitude of each WBS item of the estimate. The cost estimator should spend proportionately more time evaluating costs of the more significant WBS items.

The cost estimator should break costs down into four distinct cost types: Labor, Equipment, Materials, and Subcontracts and follow the guidelines established for each above.

When evaluating labor and equipment hourly costs, it is important to find a reasonably good base rate and then factor in additional costs associated with labor taxes, labor burdens, overtime, equipment operating conditions, and other project factors. These hourly labor and equipment rates can then be applied to crews and productions to arrive at expected unit costs and total cost for various WBS items.

5.0 INDIRECT PROJECT COSTS

5.1 INTRODUCTION

Indirect Project Costs are those not addressed in specific Work Breakdown Structure (WBS) items as Direct Costs or recovered as General and Administrative (G&A) Costs. They are generally associated with project-specific overhead costs that occur on the project.

Indirect costs can generally run in the range of 8 to 20 percent of overall project costs. It is important to understand the anticipated construction contract terms and conditions, including which costs must be absorbed as indirect and which are addressed as WBS or bid items. For instance, the contract may anticipate bid items for such costs as a quality control program, safety, or site security. In those instances, related costs will not be included as indirect costs, but addressed in their respective WBS items or bid items.

It is also important to understand the project schedule. Indirect costs can generally be separated into two distinct categories; time-sensitive and cost-sensitive. Time-sensitive indirect costs are driven by schedule. A good example would be job staff. The cost of employing the project management staff is directly related to the schedule. Cost-sensitive indirect costs are driven primarily by the overall cost of the project. A good example of a cost-sensitive indirect cost is bond cost. The cost of performance and payment bonds are directly related to the overall project cost. It is important for the estimator to make this distinction and account for time-sensitive costs properly. Too often, estimators ignore the project schedule when estimating indirect costs.

At the conclusion of this section, recommendations are provided regarding the appropriate estimating strategies for indirect costs for each of the different phases of project development.

5.2 BONDS

5.2.1 Surety Bonds

Surety bonds are three-way agreements between a contractor (the principal) and a second party (the surety) to ensure fulfillment of the principal's obligations to a third party (the obligee/owner) by the surety. The contractor's (principal's) assets are pledged to the surety as part of an Indemnity Agreement.

In most Government construction contracts, the Government is the obligee.

If the principal obligations are not met, the bond ensures project completion or payment, to the extent stipulated, of any loss sustained by the obligee.

5.2.2 Bid Bond

A bid bond is a bond provided by a bidder's surety to guarantee that the bidder will enter into a contract with the owner at the bidder's bid price. Generally, a bid bond has no cost to the bidder (contractor) or project.

5.2.3 Performance and Payment Bonds

A Performance Bond is provided by a surety to guarantee that the contractor provides proper performance of the construction contract, including payment of subcontractors and vendors. A Payment Bond is provided by the surety to guarantee that the contractor pays its third-party obligations associated with the contract. Essentially, the contractor purchases a performance bond and the payment bond is issued jointly at no extra cost. Bond costs vary depending on the industry, location, and financial strength of the contractor seeking the performance bond.

5.2.4 Maintenance and Warranty Bonds

Maintenance and warranty bonds guarantee against defects in workmanship or materials for a stated period of time after the acceptance of the completed work. They sometimes incorporate an obligation guaranteeing "efficient or successful operation," or "nameplate hydroelectric generating capacity," or other obligations of like intent and purpose. Maintenance and warranty bonds carry separate costs from performance and payment bonds. They are significantly less expensive.

5.2.5 Bond Amounts

Concerning U.S. government projects, performance and payment bonds are required for all construction contracts of \$100,000 or more and some form of payment guarantee for lesser value contracts (FAR 28.102). The cost of all payment bonds, performance bonds, maintenance bonds, and other types of bonds deemed to be appropriate by the estimator should be added to the cost estimate.

Performance bond costs are generally scaled so that a higher rate applies to lower value contracts and rates are reduced with increasing contract amounts. A typical example of bond rates is given below:

First \$500,000	\$30 per \$1,000
Next \$1,000,000	\$25 per \$1,000
Next \$5,000,000	\$20 per \$1,000
Next \$10,000,000	\$15 per \$1,000
Remaining rate	\$14 per \$1,000

Using the above example, a \$20 million project would carry a bond cost of $((\$500 \times \$30) + (\$1,000 \times \$25) + (\$5,000 \times \$20) + (\$10,000 \times \$15) + (\$3,500 \times \$14))$ equaling a \$339,000 premium cost, or about 1.7 percent of the contract amount. For the purposes of engineer's cost estimates, a straight percentage rate between 1.5 and 2.5 percent may be

sufficient. Additionally, a premium will be applied for project durations beyond two years.

It is important to recognize the cost of subcontractor performance bonds. Subcontractor bonds are generally more expensive than the prime contractor performance bonds. Rates are typically between 2 and 3 percent of the subcontract amounts and should be applied to the estimate for the expected subcontract amounts. While it is noted that the engineer does not have knowledge of what items will be subcontracted, reasonable assumptions should be made.

Warranty bonds generally run at a rate of about 0.2 percent of the project value per year of warranty beyond one year.

5.3 SAFETY PROGRAM

Analyzing the cost of a project's safety program requires understanding of the contract requirements and the project schedule. The costs of a safety program are generally time-sensitive. If the project general conditions or special provisions require a site safety manager as a separate staff position, this needs to be accounted for in the estimate. A good general approach is to estimate the number of safety positions, i.e., safety manager, site safety representative, etc.; add the cost of safety facilities, such as a first aid station, ambulance, pickup trucks, and office facilities; account for night shift or additional shifts; and develop a monthly cost. The monthly safety program cost can then be applied to the overall duration of the project or safety program.

5.4 QUALITY CONTROL PROGRAM

Estimating the cost of the quality control (QC) program requires a similar approach to that described above for the safety program, again having an understanding of the contract requirements and the project schedule. The cost of a QC program is also time-sensitive. Similar to estimating the safety program, estimate the number of QC positions, i.e., QC manager, QC technicians, etc.; add the cost of QC facilities, such as QC lab, QC equipment, third-party tests, pickup trucks, and office facilities; account for night shift or additional shifts; and develop a monthly cost. The monthly QC program cost can then be applied to the overall duration of the project or QC program.

5.5 CONTRACTOR AND RESIDENT ENGINEER JOB STAFF

Job staff costs are generally associated with salaried project positions, such as project manager, resident engineer, inspector, project general superintendent, area and craft superintendents, staff engineers, project secretaries, etc. It is important to recognize second and third shifts, if required, and also to recognize positions required by the contract. In estimating these costs, a good approach is to list the number of personnel required at each position and the duration of that position required by the project schedule. Fully burdened monthly rates for these positions can then be applied appropriately, as would any per diem costs associated with staff travel. Costs ancillary to

the staff, such as job facilities, pickup trucks, etc., are generally handled in other items discussed in this paper and are therefore not included in staff costs.

Staff positions to address in the estimate may include the following (be sure to address multiple shift requirements):

- Project manager
- Superintendents
- Safety engineers
- Office/field engineers
- Timekeepers
- Foremen
- Master mechanics
- Contracts managers
- Controls engineers
- Quality inspectors
- Resident engineers

5.6 MOBILIZATION AND DEMOBILIZATION

The cost of mobilization and demobilization includes both the freight cost of moving equipment and facilities to and from the project site and the assembly and disassembly of the equipment. Depending on the physical size of the various equipment and the number of individual pieces of equipment, this task can take crews of mechanics several weeks to accomplish. These mechanic crews may also need additional equipment, such as a crane, to assemble certain pieces of equipment. This can happen multiple times over the life of the project as various equipment needs are addressed or as seasonal needs dictate. Another significant mobilization and demobilization cost is the relocation of contractor staff and families to the project site area.

The cost estimator can approach the physical moving of the equipment in terms of hauled miles, or cost per loaded mile. This will vary by the size and weight of equipment, the need for special permits, pilot cars, etc. Generally, the cost estimator should make allowance for each anticipated piece of equipment and make some additional allowance for unanticipated pieces. During the engineering phases of a project, it is not likely that the cost estimator would be able to know where the equipment sources would be and would therefore need to make some type of educated guess as to how far the equipment is likely be shipped to and from the project site. Of equal importance is anticipation as to whether various pieces would need to be moved seasonally to and from the project. Relocation specialists can provide cost information for staff moves.

It is recommended that the cost estimator break down mobilization and demobilization into three categories of work: equipment transportation, equipment assembly/disassembly, and staff relocation.

- Transportation – break the cost down into three categories;
 - Large pieces of equipment requiring heavy duty transports and pilot cars
 - Medium loads requiring lowboys
 - Light loads requiring a truck and trailer or float

Each category can be summarized by the number of loaded miles anticipated and the unit cost for that category of transport. A regional trucking and transportation firm could give the cost estimator an idea of cost per loaded mile.

- Assembly/Disassembly – The cost estimator can estimate the number of crew hours and hourly crew cost to assemble and disassemble the fleet of equipment
- Staff – The cost estimator can use data from relocation specialists for housing, packing, moving, and unpacking, contractor staff time per move, etc, to estimate the cost.

Keep in mind that specialized equipment such as batch plants, aggregate processing plants, and marine barges require special attention and should be addressed individually.

Depending on the level of detail of the cost estimate, the estimator may approach equipment mobilization and demobilization as a percentage of the overall cost of the project. Too often, this is approached as the same percentage on projects of very different nature. The cost estimator should account for such factors as the equipment intensity of large earthwork projects, seasonal mobilizations, and the remote nature of a project requiring equipment to be transported long distances.

5.7 JOB OFFICES AND FACILITIES

Job facilities may include office trailers, shop facilities, furniture, computers, power, heat, sanitary, water, security, and other physical facilities. These are time-sensitive costs. A good approach to estimating the costs of these facilities is to list out the requirements based on the number of staff positions, conference room space, contract requirements, etc., and develop a monthly job facilities cost. This monthly cost can then be applied to the project duration. Don't forget to address setup and tear-down costs as well as engineer/owner facilities required by the contract.

- Contractor's offices
- Owner/engineer offices
- Office furniture and equipment
- Tool and storage (cargo containers, trailers, etc.)
- Shop facilities
- Temporary utilities (electricity, water, communication)
- Temporary toilets
- Lay-down/staging areas

5.8 INDIRECT EQUIPMENT COSTS

Indirect equipment might include site equipment that is not specifically associated with any particular work item or group of work items, but must be absorbed as an overall project indirect cost. Examples of indirect equipment costs might include:

- Trucks and automobiles
- Forklifts
- Generators
- Compressors
- Pumps
- Hoists and scaffolding
- Cranes

5.9 GENERAL AND MISCELLANEOUS

A host of other costs that may not fall into other categories discussed in this section must be addressed. Such costs might include:

- Site security
- Telephones – landlines and mobile
- Temporary fencing
- Yard facilities and improvements
- Office supplies
- Postage and FedEx/UPS charges
- Signs
- Photographs
- Fire suppression
- Drinking water
- Dust control
- Noise control
- Personnel Protective Equipment (PPE)
- Drug testing program
- Permit application costs

5.10 ENVIRONMENTAL PROGRAM

Estimating the cost of an environmental program requires a similar approach to those described above for the QC and safety programs, again requiring an understanding of the contract requirements and the project schedule. The cost of an environmental program is also time-sensitive. Generally, an environmental program will follow the requirements of

various environmental permits. Some of these costs may be accounted for in the direct costs, so coordination of this item and any direct costs, such as silt fences, sediment basins, etc., will be required. Similar to estimating the safety program, begin by estimating the number of environmental positions, i.e., environmental manager; add the cost of associated facilities and equipment, third-party costs, and pickup trucks; account for night shift or additional shifts; and develop a monthly cost. The monthly environmental program cost can then be applied to the overall duration of the project or environmental program.

5.11 CONSTRUCTION SURVEYING AND STAKING

Survey costs generally include establishing a site control survey, construction staking, and as-built surveys. Costs can be both schedule- and cost-driven. Estimating these costs may be a matter of determining the number of survey crew hours needed to keep up with contract requirements and the pace of construction, then applying a crew cost rate to the hours determined. Overall survey costs often run between 0.75 and 1.25 percent of project cost.

5.12 INSURANCE AND WARRANTY COSTS

Many contracts require various types of insurance and/or warranties. Examples follow.

5.12.1 Builder's Risk Insurance

Builder's risk insurance provides monetary reimbursement for losses related to equipment, vandalism, etc. Builder's risk policies can be expensive and often carry high deductibles. It is important to understand the exposure, premium cost, deductibles, etc. If a builder's risk policy is anticipated or required by the contract, it should be addressed in the estimate.

5.12.2 General Liability Insurance

The general liability policy protects the contractor from claims resulting from the contractor's construction operations that result in bodily injury or property damage to a third party. Generally speaking, this policy cost is absorbed in the general contractor's G&A and not as a specific project cost. Project-specific limits required by the anticipated contract, which are higher than normally carried by contractors, will result in additional cost that should be addressed in the estimate.

5.12.3 Truck and Automobile Insurance

Vehicle insurance protects the contractor from claims resulting from the contractor's vehicle operations that result in bodily injury or property damage to a third party. Generally speaking, this policy cost is absorbed in the general contractor's G&A and is not treated as a specific project cost.

5.12.4 Manufacturer's Warranty

A manufacturer's warranty insures against defects in materials, design, and construction from the manufacturer for an item. Generally, the cost is addressed as part of a vendor's quote for major materials or equipment.

5.12.5 Warranty of Construction

This can be thought of as a warranty that work performed under the contract conforms to contract requirements and is free of any defect in equipment, material, or design furnished, or workmanship performed by the contractor or any subcontractor or supplier of any tier. Generally speaking, the performance bond will cover the cost of a standard one year warranty. If the contract requires an extended warranty, such as two years or longer, a premium cost will be added to the cost of the performance bond, or a separate warranty bond will be issued at additional expense to the project. Warranty bonds generally run at a rate of about 0.2 percent of the project value per year of warranty beyond one year.

5.13 TAXES

A detailed discussion of the various types of taxes and their applicability is beyond the scope of this guidance. Tax codes can be very complex and vary with jurisdiction. This section discusses the most common taxes applicable to projects. Taxes can become a significant cost to the project and must be addressed, usually as a line item in the estimate.

5.13.1 Sales Tax

The cost estimator will need to research and provide information about what is taxed and what is exempt on the subject project, given its nature and location.

Materials and supplies are generally subject to sales taxes. Under some state laws, permanent materials for the project are not subject to sales tax. Sales taxes include state tax, local tax (i.e., county, city), and use taxes (taxes on the storing, using, consuming, and sometimes distributing tangible personal property or providing a taxable service, i.e., the contractor will be subject to the use tax in the state where the project occurs).

As of 2011, the following five states had no state sales tax: Alaska, Delaware, Montana, New Hampshire, and Oregon. However, local and use taxes may still apply; the estimator must determine the applicable taxes.

The RSMMeans Cost Estimating books contain reference sections covering state sales taxes. The internet can be used to research the applicability and amount of local and use taxes.

5.13.2 TERO Taxes

TERO is an acronym for Tribal Employment Rights Ordinance. Many Indian tribes have established a tax that is applied to contracts for projects performed on their reservations. Tribes may impose this tax on reservations, but they have no tax authority off reservations. However, in some circumstances TEROs can bill contractors at an agreed upon rate for services rendered, e.g., recruitment, employee referral and related support services even for off-reservation projects.

The TERO tax is normally a percentage of the total gross contract price. The estimator must determine the applicability and amount of TERO tax for each project. Most tribal organizations have a TERO office that can give the estimator guidance on applicable TERO taxes. The internet may also be a valuable tool for this research.

5.13.3 Gross Receipts

A gross receipts tax, sometimes referred to as a gross excise tax, is a tax on the total gross revenues of a project, regardless of their source. A gross receipts tax is similar to a sales tax, but it is levied on the seller of goods or services rather than the consumer. In many states, this applies to the contractor as a seller of goods and services, and must be passed on to the owner and project. Gross receipts tax can also be applied at the city and county levels. The total gross receipts tax rate is a combination of rates imposed by:

- The state
- The counties
- The municipalities

5.14 SUMMARY

As the estimating process progresses for a given phase of the project, the cost estimator should develop a list of indirect project costs that are neither specifically addressed in WBS items (direct costs) nor clearly part of G&A costs.

As the specifications and anticipated contract are developed, the cost estimator should tailor the list of indirect costs appropriately to ensure that each item of cost is accounted for as a direct cost or an indirect cost. The cost estimator should then determine which of the indirect costs are schedule-driven and which are cost-driven so that a more accurate prediction of cost can be made.

While indirect costs can generally run in the range of 8 to 20 percent of overall project costs, this range can be more accurately determined as the cost estimate progresses during the various phases of design development. For example, in the Reconnaissance or Feasibility Phase, it might be sufficient to estimate indirect costs at, say, 15 percent of overall project cost. During the Preconstruction or Construction Phases, it would be more appropriate to define individual sub-items of indirect cost, similar to what has been defined in this section, along with the best estimated cost for each. The cost estimator

could then apply a much smaller percentage, say 2 to 3 percent to account for as yet undefined indirect cost items.

6.0 CORPORATE OVERHEAD

6.1 INTRODUCTION

In this section, the corporate overhead component of a contractor's costs is discussed as it pertains to estimating a project including:

- Defining overhead costs relative to other direct and indirect costs
- Providing a summary of the costs involved in contractor overhead
- Recommending methods to capture overhead costs in a construction cost estimate

Contractor operations involve costs of business that are not related to the construction site and are not job-specific. These overhead costs are typically distributed in the item/unit pricing on the bid schedule and are not readily apparent to a reviewer. Some bid documents may provide a line item for contractor's overhead, but that is uncommon. Corporate overhead does not include profit, which is typically a separate cost, as discussed in Section 8.

A contractor's bid will include the amount of corporate overhead assigned to the project as defined by the project budget and project schedule. The amount assigned to each project is based on the allocation of its corporate overhead distributed among the projects under construction by the construction company. The amount often is related to the project budget and schedule.

6.2 HOME OFFICE / G&A COST ITEMS

Corporate overhead can be generally characterized as home office costs. It encompasses several cost items that are usually considered general and administrative (G&A) costs.

Home office costs relate to the part of the contractor's operation not at the construction site. These costs can include salaries of personnel who are not associated with the actual construction as well as the capital costs of the contractor's land and office, and the operating costs of the home office. These costs also include non-project-related corporate insurances, licenses, interest, officers and board members costs, proposal costs, and non-bid item project costs. Overhead can also include training and health and safety monitoring not directly related to the construction project.

The costs accrued for home office personnel who provide project services, such as communications with the field office, support for preparation of pay requests, tracking of payroll/time accounting, managing operating costs (utilities, fuel, repairs, and rent) are not included in the indirect project costs. These can be considered overhead as well.

6.3 COST TYPES

The home office/G&A expenses element of cost estimate markup must be included in every cost estimate. This includes all costs associated with managing, operating, and maintaining a home office as proportioned to the specific construction project. Examples of these costs include, but are not limited to:

- Home office rent or mortgage
- Home office salaries and benefits
- Home office utilities
- Non-job-specific business taxes, insurance, and licenses
- Home office furnishings, fixtures, and office equipment
- Marketing expenses
- Legal expenses
- Proposal/bid preparation/cost estimating
- Uncaptured construction equipment costs
- Subcontractor management
- Federal government/state government fees
- Debt service

6.4 SUGGESTED CORPORATE OVERHEAD COST

Corporate overhead is based on the efficiency of the contractor at running its own business as well as the built-in costs that exist for all business operations. Typically this cost is expressed as a percentage of construction cost, but it can be expressed as a cost per unit of time.

Corporate overhead costs as a percentage of direct construction costs including contingency but excluding indirect and other costs range from 5% to 15% and average about 10%. These percentages should be used only as a general guideline. Overhead costs will vary with the size of the contractor, the type of industry, the location of the home office, the economic conditions at the time of the job, and many other factors.

Other sources of overhead percentages are available to the estimator, including RSMMeans, Cost Data Online (Richardson's Engineering), USBR Contracting Office data, and the estimator's judgment and experience. Note that heavy civil contractors often have higher corporate overhead costs than commercial builders as referenced in these sources.

6.5 SUMMARY

Overhead is a cost applied to a project involving business operations, fees, insurances, marketing, proposal, and other costs that do not involve any of the activities performed at the construction site. They are the unseen costs that contractors incur to run a successful business. These overhead costs can be applied to a project in different ways and must be considered in a project construction cost estimate.

7.0 CONTINGENCY

7.1 INTRODUCTION

Contingency is the dollar value of the uncertainty in an estimate. This uncertainty can be computed or otherwise defined by various analytical methods, and can be defined for some contract parties by regulatory agencies. Some of the aspects of contingency are discussed in this section. It is noted that contingency is the most controversial element of producing Engineer's Estimates. A major purpose of this report is to standardize the definition and amounts of contingency in Engineers' Estimates for dam projects. It must be emphasized that this section addresses only the contingency as used by engineers in producing an estimate of construction cost. Owner and contractor contingency concepts, although discussed throughout this section, are not the same things.

For project owners, contingency is often a percentage, often 10 percent, added onto a budgetary allocation for a project, to establish the amount of funding necessary to build a project. Contingency in this case is treated as the amount of cost overrun allowed before the owner's project management needs to go back to the source for more money. It is therefore considered to be a measure of estimate accuracy. Contingency is related to reliability of unit cost, but also the reliability of expected quantities based on design information and interpretation. Examples of uncertainties that are estimated as contingency are project schedule and sufficiency of geotechnical exploration.

In the case of regulated investor-owned utilities, this sort of contingency is the amount of cost overrun allowed before the utility must ask the jurisdictional public utilities commission for permission to expend further funds, and for an associated rate hike to cover those funds. Often the permission to expend the funds will be granted, but not the rate hike. In the case of municipal utilities and/or other public entities, the request for additional funding or bonding power must often be put before the voters or their elected or appointed representatives on agency boards and/or legislatures. This request is sometimes denied.

The owner definition of the term contingency as a measure of estimate accuracy described above is **NOT** the definition of contingency used by either an engineer in preparing an Engineer's Estimate or by a contractor preparing a bid. The definition used by an engineer and a contractor is that contingency is the cost assigned to uncertainties in the definition of the project. This very real cost is part of the estimating process. The accuracy of a particular Engineer's Estimate is determined by comparison with a contractor's bid and/or the actual completed project cost.

Equally as important, engineers must guard against placing too much contingency in an Engineer's Estimate. An Engineer's Estimate that contains too many contingency dollars is overpriced. Such estimates can negatively impact project go/no-go decisions.

The amount of contingency in an Engineer's Estimate should start at a high level during early stages of a project when the estimate contains few work breakdown structure (WBS) line items and the project concept lacks detailed definition. It should then

progress to lower amounts as the project concept and then design become better defined and the number of WBS line items increases. It should be noted that there are always considerably more WBS line items used in developing an estimate than there are bid items.

A basic principle here is that the amount of contingency evolves, almost always becoming lower as project knowledge and level of development increases.

The four levels of project development for a dam project (and associated facilities such as hydroelectric plants) are Conceptual Design, during which a conceptual design and conceptual Engineer's Estimate are produced; Reconnaissance (formerly called the Pre-Feasibility Level); Feasibility; and Final Design. A contingency range for each level of project development is recommended. These recommendations for contingency are generally consistent with the guidance of AACE International, referred to in Section 2.

The contingency applied to a WBS line item should be based on the level of uncertainty. The cost of a material item for which the engineer has received a vendor quote should include a lower percentage contingency than, for example, the line item cost of rock excavation, for which the contingency percentage should be based on the quantity and quality of available site-specific geology and geotechnical information.

Always remember: contingency risk cost uncertainty is a real cost that must be included in an Engineer's Estimate in a realistic manner. Contingency of this type is a cost that an owner will likely incur during construction of a project. The engineer preparing an Engineer's Estimate has a duty to properly recognize and include this cost in the estimate, as well as the contractor's expected profit on this cost.

The present document is specifically applicable to the design-bid-build method of project procurement. Engineer's Estimates for projects procured by alternative delivery methods are similar; thus, an engineer should adapt the contingency recommendations made herein in an appropriate manner to other project delivery models.

As a matter of definition, the term line item should be taken to mean a WBS line item, as opposed to a bid item, for the remainder of this section. It should be noted that some engineers place a line item in their estimates that represents unlisted or "known unknown" items. Such a line item is an allowance for direct costs that decreases as project understanding develops. This type of allowance is not part of contingency as used in Engineer's Estimates.

7.2 BUILDING AN ENGINEER'S ESTIMATE WITH CONTINGENCY

Contractors use their own methodologies to compute line item contingencies for their bids. Some contractors apply an overall contingency to each line item, based on their internal experience, local labor rates, and as-delivered and/or installed material costs. Other contractors apply individual contingencies to each of these and other aspects of building up their bid item estimates. In addition, many contractors apply qualitative or even quantitative probabilistic methodology to set contingencies for some or all line items. For the remainder of this section, contingency is defined as the dollars in the

contingency column of a line item, category, subtotal, or total divided by the non-contingency dollars in that line item category, subtotal, or total, to which the contingency applies, expressed as a percentage. It is the engineer's choice as to where or at which level to apply contingency. The purpose of the present section is to provide the engineer with some guidance as to how to include contingency in an estimate.

An example is described as follows: Contingency is applied to construction costs before the contractor markup is applied. Line items in an Engineer's Estimate consist of many columns and/or subcolumns. Common cost columns are described below, and the proper application of certain estimating percentages, such as contingency, also are described, leading to the construction cost estimate. Line items are then completed by adding estimates of other necessary costs to the construction cost estimate.

- The installed cost of a material such as granular fill or 4,000 psi concrete might consist of materials price, labor, equipment, and consumables, such as formwork for concrete.
- The installed cost of vendor-supplied equipment, such as turbines, gates and hoists, with the basic fabricated equipment supplied by the vendor and installation, testing, and start-up supplied by a contractor. Vendor-supplied equipment is a material with a cost often based on quotes from vendors.
- Contractor indirect costs usually are applied as a percentage of installed material cost. (These are discussed more closely in Section 5.) Contractors usually estimate the indirect costs in detail identifying each individual expense including, for example, management and supervision salaries, temporary facilities, and general contract overhead. These expenses are often expressed as a percentage of the direct cost, for comparison with similar projects in the contractor's experience. For an Engineer's Estimate, determination of indirect costs should be based on the engineer's practice and judgment, comparing them with contractor average percentage factors from previous projects in which the engineer participated. Indirect costs should be in the range of 8 to 20 percent for projects in the U.S.
- Contingency in an Engineer's Estimate is a percentage applied to the sum of the installed cost of material, the installed cost of vendor-supplied equipment, and the contractor's indirect cost. A contingency percentage is applied to each line item or to each line item category, subtotal, or the overall total as applicable, according to the level of project development and engineer's methodology.
- Contractor markup, including overhead and profit, usually in the range of 10 to 25 percent, is applied to the sum of the installed cost of material, the installed cost of vendor-supplied equipment, Contractor indirect cost, and Contingency. This number is affected by the complexity of the project, as well as by market conditions.

The Engineer's Estimate for the construction cost of a line item, category, subtotal, or total is the sum of the installed cost of material, the installed cost of vendor-supplied equipment, contractor indirect cost, contingency, and contractor overhead and profit.

Other costs often applied as a percentage on a line item basis in an Engineer's Estimates are:

- Final Design engineering, usually in the range of 5 to 10 percent of the line item construction cost
- Environmental permitting and mitigation costs, usually in the range of 5 to 10 percent of the line item construction cost
- Owner's administrative cost, usually in the range of 0.5 to 2 percent of the line item construction cost
- Construction Management, usually in the range of 5 to 8 percent of the line item construction cost

These various costs are subtotaled and totaled, according to the engineer's practice in order to achieve the Engineer's Estimate.

It should be noted that at the Feasibility and Final Design levels, owners often expect an Engineer's Schedule to be delivered with schedule line items compatible with the estimate line items. The schedule and estimate should be used together to generate a project cash flow prediction.

7.3 MAJOR SOURCES OF UNCERTAINTY CONTINGENCY COST

Major sources of uncertainty for a dam project in the U.S. follow. Many of these uncertainties are interrelated.

1. Insufficient geology and geotechnical information
2. Design changes, including changes in the level of design definition as project development occurs
3. Quantity variations
4. Differing site conditions
5. Price variations, including escalation, commodity shortages, and labor rate variations
6. Schedule risks, such as the effects of strikes, prolongation of the time between receipt of bids and the issuance of a notice to proceed, excess weather delays, late delivery of major equipment, and others

Market conditions, such as local and national levels of construction activity affecting the number of bidders, the availability of performance bonds, and other items.

7.3.1 Insufficient Geological and Geotechnical Information

Often and unfortunately, an owner must limit the amount of geologic and geotechnical investigation undertaken for dams and underground projects due to a lack of available funding. This limitation invariably results in applying higher contingency factors to affected line items to mitigate risk exposure and/or claims when conditions are not as anticipated or portrayed. This risk, which involves either or both quantity variation of changed nature of work, is either transferred to the contractor by the contract terms and conditions or held by the project owner. It is generally understood that each dollar expended in additional investigation will save \$10 in either contingency or claims.

7.3.2 Design Changes

Design changes are changes in the project design concept that naturally occur during the development of a project from concept to final design. During project development, the amount of project knowledge increases, leading to optimization and re-optimization of the project. In particular, as more detailed hydrologic, topographic, in situ geologic and geotechnical information, and material availability information becomes known, a design becomes progressively more refined, reducing uncertainty. This goes hand-in-hand with the increasing number of WBS line items as the design progresses. In effect, dollars move out of contingency and into line items as the design progresses. Please note that this type of design change is not the same as a design change during construction, which is linked to the Engineer's Estimate only in the sense that the potential for design changes during construction is one of the reasons contingency is included in the Final Design Engineer's Estimate. Changes during construction are usually needed to correct conditions unknown at the time of contract award.

7.3.3 Quantity Variations

Quantities will vary as designs develop and material selections are fine-tuned or otherwise changed. Occasionally errors in quantity take-offs occur. Finally, no matter how much exploration has been conducted, some differing site conditions will be discovered only during construction. For example, during geotechnical investigations, the geophysics that determines top-of rock could be inaccurate and the rock is found to be less weathered than expected from the exploration program, resulting in more rock excavation and less common excavation. All of this can lead to quantity variations, and should be covered by contingency. Numerous other potential causes of quantity variation are possible, all of which should be included when setting the appropriate level of contingency at each stage of the project. Similar to design changes, costs associated with quantity variability are moved from contingency into line items as design development proceeds.

7.3.4 Differing Site Conditions

As noted in Section 7.3.3 above, differing site conditions are one of the causes of quantity variations with respect to the Engineer's Estimate. Significant differing site conditions that occur during construction are also a cause of schedule delay and costs associated

with that delay. One major cause of differing site conditions is insufficient geological and geotechnical information due to early phase budget limits. Another is unanticipated restrictions in permits that impose time of day and/or seasonal limits on access to all or portions of the construction site. Such access limitations may not be known in early project phases but become known during later phases.

7.3.5 Price Variations

The price for various line items in the Engineer's Estimate will vary as the design proceeds through the levels of development. Causes of price variations include inflationary escalation, commodity shortages, labor rate variations, and the effects of strikes and lawsuits that lead to unexpected court and/or mitigation costs. Commodity prices can be extremely volatile and should therefore be carefully analyzed to determine the appropriate level of contingency. Possible mitigations/contingency reducers for commodity price volatility are discussed in Section 7.4.

7.3.6 Schedule Risk

Dam projects often have unique schedule constraints, such as requiring the dam to hold water when the spring floods arrive. Missing spring floods by even a month essentially becomes a one-year delay in the owner's ability to generate revenue from the project. Insurance can be purchased to mitigate this particular delay risk and many other delay risks, in which case dollars in contingency flow to insurance premiums in a cost-effective manner.

Consideration of the level of contingency for delays at the feasibility and final design levels of an Engineer's Estimate should include the risk cost of potential sources of delay, including the potential for more or fewer weather days than planned, late or uncoordinated delivery of major equipment, including long-lead items, strikes, fire, and other sources of delay. This uncertainty risk cost contingency depends on the number and duration of delays, cost increases to the contractor for unproductive days, and subsequent acceleration by the contractor to meet schedule requirements.

A particular schedule risk is simply project duration. A short duration schedule leaves little time for recovery from a schedule problem. A long duration includes the opportunity for additional problem events to occur. Projects with seasonal or permit window risk are particularly vulnerable to schedule delay risks since relatively short delays can trigger additional longer delays associated with moving to the next season or permit window. Duration risk is part of contingency.

7.3.7 Market Conditions

Market conditions include geographic location, the local and national levels of construction activity, the availability of performance bonds, the number of potential bidders, those bidders' perceptions of the risks associated with a project, the anticipated length of time between the bid date and the notice to proceed, which increases escalation risk to bidders, and other factors that can affect bid price. An Engineer's Estimate,

particularly at the feasibility and final design levels of project development, should consider all applicable market conditions.

7.4 REDUCING RISK TO REDUCE CONTINGENCY

Engineers can help owners and contractors achieve lower bids, and reflect this in Engineer's Estimates by helping owners understand that accepting reasonable risk or sharing risk with a contractor results in lower bids and lower construction costs. In such cases, contractors will reduce the risk cost included in a bid as contingency. Some of the methods used to achieve this end are listed below. The details of such methods are beyond the scope of this document.

- The risk of highly unpredictable commodity price fluctuations, such as for steel, cement, and fuel for equipment, can be mitigated by hedging, using either guaranteed price delivery contracts or futures contracts. Another method of reducing commodity price risk contingency is to transfer the risk in whole or part to the owner through the use of baseline or indexed bid items.
- Owners can mitigate schedule risk through the purchase of insurance against strikes, excess weather delays, and other risks that can potentially postpone the start of project revenue generation.
- Owners can utilize terms and conditions in procurement contracts that penalize late deliveries, and reward early deliveries and completion where appropriate. (It is not appropriate to accept overly early delivery of major equipment that will utilize precious laydown area for storage of equipment that will degrade outdoors.) Such penalties mitigate this type of risk.
- Owners can mitigate some market condition risk by strategic bid timing, for example scheduling a bid date to be separated by at least a month from the bid date for a similar-sized project that will be built near their project.
- Owners can procure construction services based on alternate delivery methods, such as open book design/build, wherein risk is appropriately shared by the owner and contractor.
- Owners can share risk by accepting the cost of a cofferdam overtopping due to a flood greater than a contractually specified volume.

7.5 CONTINGENCY AT EACH LEVEL OF PROJECT DEVELOPMENT

The total amount of contingency in an Engineer's Estimate should shrink as the project design increases in detail and level of understanding. As noted previously, uncertainty and, therefore, risk contingency dollars flow from contingency into existing and additional line items, quantity changes, hedging, insurance, and other definable items.

The number of WBS line items at each level of project development depends in part on the size/cost of the project. The number of line items and associated estimating and scheduling effort, including the setting of contingency described herein, is appropriate for a project in the \$25 million to \$50 million price range. Larger projects should have more

line items in the Engineer's Estimate, smaller projects, particularly those that will cost less than \$5 million, should have fewer line items. This document offers only general guidelines for the number of line items and associated contingency at each project development level for the indicated project size range. The appropriate number of line items for inclusion at any level of project development is a judgment call to be made by the engineer on a project-by-project basis, as is the amount of contingency applied to any line item, subtotal, or total.

7.5.1 Conceptual Engineer's Estimate

The Conceptual Engineer's Estimate associated with the Conceptual level of project development should typically contain between 10 and 20 WBS line items, based on project complexity, and either an overall contingency can be applied or perhaps two or three line item contingency categories can be developed and assigned to the associated line items. An overall contingency of as much as 50 percent is appropriate here. Civil works at this level of development should have a minimum contingency of 40 percent, and a minimum contingency of 15 percent should be applied to conceptual budgetary quotes from vendors. The Conceptual Engineer's Estimate is equivalent to an ACE Class 5 Estimate (see Section 2.2). The results of Conceptual Engineering work are often used to screen project alternatives for meeting the owner's needs.

7.5.2 Preliminary Engineer's Estimate

The Preliminary Engineer's Estimate associated with the Reconnaissance level of project development should typically include 20 to 40 WBS line items, individual line item contingencies assigned to the one or two largest cost items, and perhaps four additional contingency categories applied to the remaining line items. As a rule of thumb, a total contingency of between 25 percent and 40 percent is appropriate here. Civil works at this level of development should have a minimum contingency of 30 percent, and a minimum contingency of 10 percent should be applied to preliminary budgetary quotes from vendors. The Preliminary Engineer's Estimate is equivalent to an ACE Class 4 Estimate. An owner sometimes will require that a Preliminary Engineer's Schedule be developed along with the Preliminary Engineer's Estimate. The results of Reconnaissance work are often used as an off-ramp by an owner to make a go/no go decision on a project prior to investing the significant funds necessary for a full feasibility study.

7.5.3 Feasibility Level Engineer's Estimate and Schedule

The Feasibility Level Engineer's Estimate and associated Engineer's Schedule could include about 100 or more WBS line items depending on complexity. An individual line item contingency should be assigned to every significant cost line item plus at least five additional line item category contingencies applied to the various other line items. A significant cost line item is any line item responsible for 5 percent or more of project cost, but at least each of the 10 highest cost line items,

The Feasibility Level Engineer's Estimate and its associated Engineer's Schedule are often used by an owner to seek project funding from agency boards, bonds, or lending institutions. The schedule is a necessary part of this process, used as a basis for cash flow analyses and for constructability studies. The final go/no go (or delay) decision on a project is usually justified by the results of a full feasibility study. At this point, sufficient information is available for a prudent investor or agency board member to decide whether to commit funds for project final design and construction. The Engineer's Estimate and Schedule, and the contingency contained in the estimate, needs to be clearly documented and explained to ensure understanding by potential project funding sources. Consulting engineering companies engaged in preparation of Feasibility Level Estimates and Schedules should seek advice and input from construction professionals and/or construction companies to ensure adequate representation of construction issues and concerns, while avoiding the potential for conflicts of interest at the bidding stage. The Feasibility Level Engineer's Estimate and associated Engineer's Schedule is equivalent to an AACE Class 3 Estimate.

7.5.4 Final Design Level Engineer's Estimate

The Final Design Engineer's Estimate, which could contain hundreds of WBS line items, depending on project complexity, should include line item contingencies for at least the 20 highest cost line items. In addition, at least 10 line item category contingencies should be applied to the various other line items. The Final Design Engineer's Estimate and its associated Engineer's Schedule are used by an owner to seek bids. The line item subtotals in the Final Design Engineer's Estimate should duplicate the list of bid items in the contractor's Request for Proposal bid forms. The Engineer's Estimate and Schedule, and the contingency contained in the estimate, need to be clearly documented and explained to ensure understanding by the owner and other appropriate entities. Similar to the recommended practice for Feasibility Level Engineer's Estimates and Schedules, consulting engineers should seek the advice and assistance of experienced construction professionals and/or construction companies to improve the likelihood of arriving at a realistic representation of project cost and schedule, while avoiding potential conflicts of interest for such entities when the project is bid. The Final Design Engineer's Estimate and associated Engineer's Schedule are equivalent to either an AACE Class 2 or Class 1 Estimate depending on specific project requirements.

7.6 SUMMARY

Contingency is a much abused and misunderstood concept. Different definitions are commonly associated with the various participating project entities, owner, engineer, and contractor. Contingency in a contractor's bid is parallel to but not exactly the same as contingency in an Engineer's Estimate. Contingency to an owner is sometimes simply defined as the amount of tolerable cost overrun on a project. In other words, it is a measure of bid estimate accuracy to many owners. This is not at all the meaning of the term with respect to the production of Engineer's Estimates or contractor bids.

Contingency in an Engineer's Estimate is a very real cost that represents the risk cost of uncertainty in a line item, subtotal, or total. This contingency evolves as the level of project detail and understanding increases.

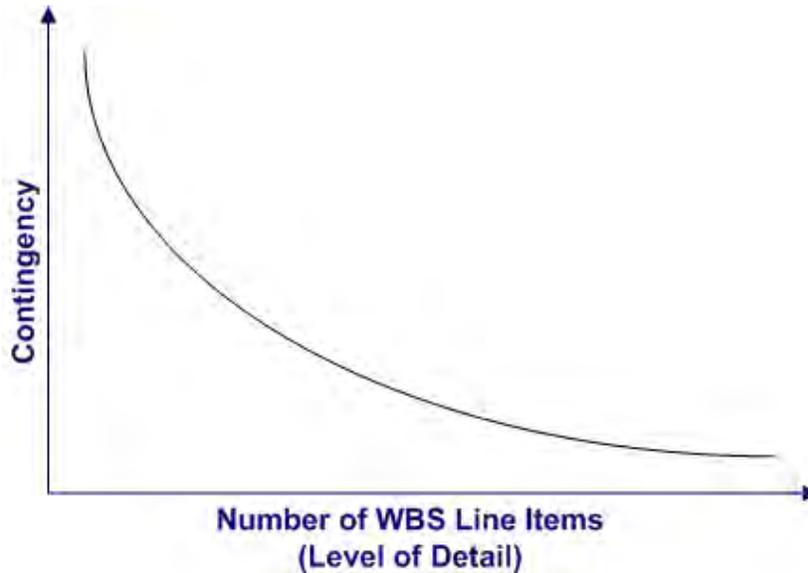


Figure 7. WBS Line Items vs. Contingency

An engineer must perform analyses and exercise judgment in setting contingency amounts, particularly at the Feasibility and Final Design levels of project development.

Engineers are sometimes pressured by project owners to lower contingency amounts to arrive at an estimated cost that meets the owner's perceived allowable cost. This is a disservice to the industry and the project stakeholders. All project interests are best served by responsible cost estimating.

8.0 PROFIT

8.1 INTRODUCTION

Profit is defined in the simplest terms as any revenue remaining after all direct and indirect costs are deducted from the total revenue earned on a specific project. Profit is generally the basis on which tax is computed and a dividend is paid. Profit is reflected in reduction in liabilities, increase in assets, and/or increase in owner's equity.

Profit is the best known metric with which to assess the measure of success for a commercial business enterprise. Profit furnishes the necessary resources for investment in future endeavors. Profit is the primary motivator for private firms to engage in the construction of risky or capital-intensive projects associated with our industry.

In this section, the factors engineers should consider when calculating profit as part of their construction estimate for a project are discussed. A recommended profit range is presented, along with several practices engineers can employ in developing a project cost estimate.

8.2 MARKET CONDITIONS / BIDDING CLIMATE

Market condition variations should be expected given the long durations of some large water resource projects from conceptualization through completion. The owner and engineer should take into account the inevitable changing market conditions through the project's life cycle. These fluctuations and changes should be reflected in each of the five recommended cost estimate classifications, as presented in Section 3. General economic conditions and overall demand impact profits for construction projects. Recessions and economic slow-downs intuitively drive down contract profit demands; but given the size and scope of large projects, this may not occur due to the limited pool of qualified bidders for complex projects. Additionally, the passage of regulations, recognition of public safety concerns and a large influx of funding over a short period of time may create drivers that increase overall dam construction or repair activities nationwide. This market-wide demand may drive desire for increased profits by contractors based on overall limited resources. All of this considered, the owner and engineer must study not only volatile commodities that impact the ability to competitively bid projects and influence project profitably, but also general market demand for quality contractors to execute their specific project. In this light, bidding of projects and services should be timed to ensure the best available resources are attainable at a fair market price and equitable profit margins.

Procurement strategies may impact the perceived risks contracting firms must address in a volatile market through forward-looking strategies and actions. For example, the advanced procurement of fuels or long-term purchase agreement for materials on fixed unit rates is one possible strategy. This may be a critically successful strategy where the nature of a dam construction project exposes the team to market volatility for extended periods of time (measured in years). This natural market variability impacts an estimate's cost and perceived risks, which will be reflected in profitability goals. Owners and their

engineers should recognize this issue and implement strategies that create win-win situations. This win-win approach should be reflected in pricing schedules where risks to the contractor and owner are proactively managed and fenced. For example, providing the contractor with the opportunity to bid fuels or concrete unit prices tied to a local market index reduces or at least shares the risks. Sharing these risks can be the most favorable approach to a project for all parties involved.

Estimators should anticipate that market forces will drive change throughout a project's life cycle. At times, these changes may be significant in terms of overall project cost and the owner should be advised about such fluctuations. The engineer should track market factors that drive this change and maintain a current project cost estimate based on fluctuation in data. Some key market conditions to track include:

- Acquisition Strategy Analysis and Delivery Method – The market is constantly evolving to formulate alternative delivery methods to meet owner requirements and respond to opportunities. This includes innovation in business structures, financing, project staffing, revenue sharing, capitalization, and risk management tools.
- Bidding Climate – Large projects impact local and regional markets in many ways beyond just creating jobs. These impacts may influence labor, materials, logistics and other costs on the project through direct and indirect consequences. Depending on demand, the project may require local resources that normally compete for a service or project to combine forces, resulting in less competition. Really large procurements may reduce the procurement pool to a few qualified contractors and preclude local contractors from participating. This change in competition has a dramatic impact when local market prices are significantly less than the national average and/or if project estimates are based on local wages or resources. Increased demand for limited resources associated with housing and living costs due to an influx of a large workforce on a small community affects pricing too. The timing of the bid and local available labor are also factors that impact the bidding climate.
- Industry Capacity – Profit and fee are impacted as projects increase in size because the number of qualifying contractors available to effectively compete for the project decreases. Owners typically bid these large contracts nationwide. In this nationwide market, other large projects compete for the same resources. This may limit competition and result in increased profit pricing.
- Highly Specialized Designs and Technology – The dam market is constantly evolving and is currently based on a more thorough understanding of our environment and qualifying risks than in times past. Projects may now include specifications for new investigative techniques, complex remedial repairs, and/or novel designs to address their complex issues. These increasingly complex specifications may drive contractors and owners to use specialized or one-of-a-kind equipment operated by highly trained field staff. In addition, challenging environments or working conditions may also require owners to specify the use of specialized materials to address complex issues. Engineering designs and

remedial repairs are driving contractors to develop and implement innovative construction methods to address site-specific safety concerns, operational issues and site condition limitations. All of these factors drive project costs up and heighten perception of risk, which can then limit the available pool of contractors or suppliers.

The engineer and owner should work closely with the contracting pool to understand the perceived risks and constrained resources associated with their project and should be careful to avoid limiting innovative construction methods that may assist in risk management. The owner and engineer must understand the impacts market conditions, schedule, period of performance, and contract terms and conditions have on bidders' profitability expectations.

8.3 NUMBER OF QUALIFIED BIDDERS

Generally speaking, increased competition decreases profit margins where the low bid is the primary factor for selection. This is the underlying assumption driving the competitive bidding environment. The very nature of our projects may decrease the limited pool of available contractors qualified to bid. Owners should understand the use of competition in pricing to achieve project goals. Not all large projects favorably respond to competitive pricing and market forces may not favorably influence project costs with more bidders. Where scopes are not clear or too much risk is perceived, the pricing may not be favorable regardless of the number of bidders. The most important factor is the quality of the bidders, their relationship with the owner, and their ability to understand and control the risks associated with the project.

8.4 PREQUALIFICATION OF CONTRACTORS

The Engineer's Estimate assumes that the work will be performed by a qualified contractor. Prequalifying a pool of contractors reduces risk. A sufficient-sized pool promotes competitive pricing.

8.5 PROFIT

Project profitability is usually in the range of 5 to 15 percent for projects of the size considered in this paper. On particularly risky projects, on projects for difficult owners, for projects with high liquidated damages, and for fixed price contracts, contractors may require the opportunity to earn profits in the range of 20% or more to justify their taking the risk of performing the work.

The owner and engineer should determine a reasonable anticipated contractor profit based on an estimating system that allows reasonable defense of the proposed value. Several approaches and systems commonly used by the industry include weighted factors to substantiate the basis of profit calculations.

The single largest factor in driving estimation of profit is the ability to perceive and control project-related risks. It is recommended that owners spend sufficient resources on the site investigation, engineering analysis, and design activities to address risks associated with their projects. It should be noted that profit includes profit on contingency.

8.6 SUMMARY

Owners and Engineers should appreciate the role that profit plays in motivating the marketplace to respond to their unique project opportunities and site challenges. Transfer of risks, real or perceived, to contractors results in increased profit demand. Profit demand is a function of the contractor's perception of project risks and their ability to reasonably control exposure to loss. Engineers, owners and contractors should collaborate to effectively mitigate risks and develop win-win procurement strategies.

9.0 OTHER OWNER COSTS

9.1 INTRODUCTION

Project costs to owners include many direct and indirect costs that are not necessarily included in the Engineer's Estimate. It is important that the scope of the Engineer's Estimate be clearly understood, particularly as to whether it includes other owner costs. Examples of such costs are:

- Project financing
- Revenue loss due to service interruption
- Owner's project management
- Legal costs
- Environmental permitting
- Rights-of-Way / land acquisition
- Water rights
- Engineering
- Public outreach
- Construction management
- Operation and maintenance
- Operator training

Direct and indirect cost implications that should be considered in the formulation of water resource total project cost estimates are detailed below. In general, the size and complexity of a project is typically proportional to the magnitude of these costs.

9.2 PROJECT FINANCING

Because of the size and magnitude of water resource projects, the method of financing is often crucial to the construction of the project unless the owner has a great deal of capital on hand to self-finance the project. Finance costs can run as little as 1 percent or as high as 5 to 15 percent of project construction cost depending on the project size and complexity and the owner's credit rating. Finance costs should be estimated individually for each project.

The estimated project cost, political factors, and timing of an owner's need for capital will typically influence how a project is financed. The following are several of the avenues that owners take to finance water resource projects.

9.2.1 Government Issued Bonds

Typically two types of bonds can be issued by governmental and quasi-governmental agencies to finance a project: General Obligation Bonds and Revenue Bonds.

A General Obligation Bond is a bond on which tax revenues are used to repay the bond holder. Because repayment is based on collected tax revenues, credit rating agencies give General Obligation Bonds fairly high ratings.

A Revenue Bond is a bond on which repayment relies solely on the revenues generated from a specific agreed-upon revenue stream, i.e., the sale of water, the sale of power, etc.

Often because a revenue stream is less reliable than proceeds collected from property taxes, Revenue Bonds tend to have higher interest rates tied to them than General Obligation Bonds.

9.2.2. Cash Reserves

Some owners may have the funds on hand to self-finance a project. Large owners with small to mid-sized projects often elect to finance a project by this method. If the cash reserves are on hand, there can be little to no lead time needed to finance a project.

9.2.3 Commercial Loans

Financing for small private projects is usually obtained from a commercial bank. The rate the owner pays will be a function of the owner's credit rating, projected revenue generation, and duration of the loan.

9.2.4 Mill Levies

Property taxes can be used for a specific purpose, such as the development of a drainage district. The constituents of a service area typically approve mill levies and the revenues collected from that specific area are then used for the benefit of the area. Mill levies generally have finite durations. Revenues generated from mill levies are used to pay development costs for new projects and maintenance costs for existing projects as well as to pay down principal and interest.

9.2.5 Grants, Loans, and Guarantees

Grants, bond guarantees, and loan guarantees that can be used to finance a project are available from some federal and/or state entities. Federal low interest loan programs exist for the development of new infrastructure, hydropower, water storage and water resource projects. Similar programs are offered by some states as well.

9.2.6 Rate Increases

Either a line item surcharge or unit cost increase to consumer bills can be used to provide cash for the development of new or the rehabilitation of existing infrastructure. Revenue generated from rate increases can be used to build cash reserves for new projects or pay down principal and interest on existing projects. The timing of rate increases can cause the occurrence of political firestorms depending on the season and economic environment. Rate increases caused by the addition of new facility construction cost into

the rate base of public or investor-owned utilities generally require state Public Utility Commission (PUC) approval. PUCs may reject incorporating construction cost overruns into the rate base, thus emphasizing the need for responsible cost estimating.

9.2.7 System Development Charges

These are use fees levied, typically for a finite duration, on consumers in a new service area. Revenues generated by system development charges are used to pay down long-term debt, principal and interest generated by the expansion of a system. These charges are typically not levied on existing customers.

9.2.8 Tap Fees

This fee is typically a one-time fee that a developer pays to hook into an existing system. The revenues generated can be used to pay down principal and interest provided development is occurring. They can also be used to build up cash reserves for future projects.

9.2.9 Taxing Districts

Special districts, typically new service areas, are created in which property taxes are levied on the constituents to finance new infrastructure projects. Revenue generated from these districts is used to finance new project development, which can include the rehabilitation of existing infrastructure servicing the district. The revenues generated can be used to pay down principal and interest provided development is occurring. They can also be used to build up cash reserves for future projects

Owners should look at all financing options with respect to time and dollar amounts and the time it takes to implement these options. Consideration should also be given to seeking contributions and participation from outside entities willing to help pay / finance a portion of the project. Often the regionalization of a project can reduce costs for all participants involved. Short-term interest during construction should also be considered when an owner secures financing for a project.

9.3 REVENUE LOSS DUE TO SERVICE INTERRUPTION

Owner revenue streams may be interrupted due to the construction of a new dam or the rehabilitation of an existing facility. These interruptions should be considered in the overall economic analysis of the project. Interruptions that should be considered include, but may not be limited to, the following:

- Loss of power generation revenue
- Loss of water storage and its impacts to the owner's system
- Environmental impacts
- Loss of fish passage
- Loss of recreation amenities

9.4 OWNER'S PROJECT MANAGEMENT

The owner's cost for the management of a new project is often the function of the size and complexity of the project as well as the owner's involvement in the project management. A general rule of thumb cost for the owner's project management can be in the range of 1 to 3 percent of the total cost of a water resource project.

9.5 LEGAL COSTS

The owner's legal cost is also a function of the size and complexity of the project. If the owner has a legal staff, costs will be much lower than if outside legal consulting is utilized. A general rule of thumb for estimating the cost for the legal services can be in the range of 0.5 to 1 percent of the total cost of a water resource project.

9.6 ENVIRONMENTAL PERMITS

The cost of environmental permitting can be one of the most uncertain aspects of a water storage project. When western water politics get thrown into the permitting mix, it is nearly impossible to estimate the real cost of environmental permitting at the early stages of project planning; especially when the final configuration has yet to be defined.

Right or wrong, in today's political environment, the cost of permitting a project typically includes the formation of alliances with outside entities impacted by the project, and sometimes those not impacted, who receive some sort of compensation, be it storage in the project, water, mitigation funds or some other compensation to not oppose (litigate against) the project.

A general rule of thumb cost for environmental permitting, including mitigation, can range from 5 to 15 percent of the total cost of a water storage project. Note this percentage can be lower or much higher depending on the impacts of the project and the mitigation that the owner is required to perform to obtain its construction permits.

9.7 RIGHTS-OF-WAY / LAND ACQUISITION

The costs of Rights-of-Way and land acquisitions are a function of the size and location of the project. Land values should be determined by researching the value/selling prices of similar tracts of land in the area.

Often project sites are located partially (or totally) on federally controlled land. It is very common to trade land with the controlling government agencies in this situation. The exchange rate of the land is rarely 1:1 and can often be as high as 3:1, depending on the significance of the parcel in question.

9.8 ENGINEERING

The owner's costs of engineering services for a project are a function of the physical complexity of the project as well as its geological, environmental, political, and

regulatory complexity. The costs of engineering services usually range from 5 to 15 percent of the total cost of a project with typical costs on the order of 7.5 to 12.5 percent. The upper limit of this figure can increase with very complex projects in difficult geologic and environmental conditions. In general, rehabilitation projects trend to the upper limits of this range.

Two scenarios clearly illustrate the variability in engineering versus construction costs for rehabilitation projects:

1. A very complex engineering analysis that results in very little required rehabilitation could have engineering costs that exceed construction costs.
2. A very simple engineering analysis that results in rehabilitation being carried out repeatedly (e.g., multiple locations in a tunnel or along a canal) could result in engineering costs representing fractions of a percent of the construction cost.

9.9 PUBLIC OUTREACH

The owner's cost for public outreach for a typical project is small when compared to the other costs realized for a water storage project. In general, it can be expected that public outreach should be less than 0.5 percent of the total project cost for a typical effort expended on this activity. This will hold true in most instances, unless there is extreme public and political opposition to a project and an intense PR campaign is necessary to permit the project. If this situation develops, the cost of public outreach can far exceed this figure.

9.10 CONSTRUCTION MANAGEMENT

The cost of construction management services, including inspection QA services, is typically driven by the complexity of the project as well as the regulatory requirements. The costs for construction management services are on the order of 5 to 15 percent. Very complex projects may exceed the upper bounds of this range, as do very small projects. Construction management costs will also vary according to which federal or state regulatory agency is jurisdictional.

9.11 OPERATION AND MAINTENANCE

The cost of operation and maintenance for a project is a direct reflection on the size and complexity of the project and includes what involvement the owner's staff will have in the day-to-day operations of the facility. The following should be considered when estimating the lifetime O&M costs of a project:

- Does the owner have internal maintenance staff (mechanics, electricians, millwrights etc.) to service the facility or will labor and equipment need to be contracted out?

- Does the owner have qualified dam safety staff to inspect the project or will a consultant need to be hired?
- How remote is the project site?
- Is recreation included in the project?
- How much site security is adequate?
- If the facility has monitoring instrumentation, how will data be gathered and compiled and by whom?
- How often will the owner's staff visually inspect the site?
- Will the owner have full-time caretakers for the facility, and if so, will they reside onsite?
- Will the project generate power? Real significant cost impacts come with the generation of power. The Federal Energy Regulatory Commission (FERC) has a plethora of regulations that must be followed that are not necessarily applicable to projects whose sole mission is water storage. Some of these requirements include annual inspections by FERC, annual exercise of the Emergency Action Plan (EAP) by the owner, FERC part 12 independent inspections on five-year frequencies, Tabletop and Functional EAP exercises on a five-year interval, preparation of security, recreation, instrumentation monitoring, and environmental reports on an annual basis, etc. Refer to FERC regulations for a complete listing of the requirements.
- Are there any state-specific requirements that impact O&M costs (yearly inspections, annual EAP drills etc.)?

9.12 OPERATOR TRAINING

As with O&M above, the cost of operator training will be a function of the complexity of the project as well as the sophistication of the project's owner. An owner that has multiple existing facilities similar to the new facility will realize very low operator training costs. A first-time owner with a complex facility will require a significant investment in the training of the staff in the safe operation and maintenance, both short- and long-term, of the new facility. An owner should consider this in planning a new water storage project.

9.13 SUMMARY

Each project is unique with different site conditions and agreements impacting other costs for the owner. The items discussed in this section are some but not all of the additional costs that should be considered by an owner in the planning for and estimating a water resources project.

APPENDIX A — COST ESTIMATING TEMPLATES

Embankment Dam Master Template

Work Item	Work Item Description	Sub - Item	Sub - Item Description	Units	Quantity	Unit Price
1	Mobilization			LS		
1		00 73 16	Insurance Requirements	LS	0	0
1		01 31 03	Office Supplies	MO	0	0
1		01 31 00	Project Management and Coordination	MO	0	0
1		01 31 04	Engineer's Job Staff	MO	0	0
1		01 31 05	Contractor's Job Staff	MO	0	0
1		01 31 06	Job Offices and Facilities	MO	0	0
1		01 31 07	Communication	MO	0	0
1		01 31 13	Project Coordination	MO	0	0
1		01 32 16	Construction Progress Schedule	LS	0	0
1		01 35 23	Owner Safety Requirements	LS	0	0
1		01 41 24	Taxes	LS	0	0
1		01 41 26	Permit Requirements	LS	0	0
1		01 45 16.13	Contractor Quality Control	LS	0	0
1		01 45 23	Testing and Inspecting Services	LS	0	0
1		01 45 29.33	Testing Laboratory Services	LS	0	0
1		01 51 00	Temporary Utilities	MO	0	0
1		01 52 13	Field Offices and Sheds	MO	0	0
1		01 52 14	Yard Facilities and Improvements	LS	0	0
1		01 56 18	Noise Control	LS	0	0
1		01 56 26	Temporary Fencing	LS	0	0
1		01 35 50	Site security	MO	0	0
1		01 71 13	Mobilization	LS	0	0
1		01 71 14	Indirect Equipment Costs	MO	0	0
1		01 71 15	Demobilization	LS	0	0
1		01 71 23.16	Construction Surveying	LS	0	0
1		01 78 33	Bonds	LS	0	0
1		01 78 36	Warranties	LS	0	0
1		44 11 13	Fugitive Dust Control	LS	0	0
1		01 81 17	Environmental Program	LS	0	0

2	Site Preparation			LS		
2		02 41 00	Demolition	LS	0	0
2		31 25 00	Erosion and Sedimentation Controls	LS	0	0
2		31 23 19.03	Control and Diversion of Water	LS	0	0
2		31 11 00	Clearing and Grubbing	AC	0	0
3	Reservoir Clearing			AC		
3		31 10 13	Reservoir Clearing	AC	0	0
	Construct and Maintain Access Roads					
4				LS		
4		31 24 13.19	Construct and Maintain Access Roads	LS	0	0
4		44 11 14	Water for Dust Control	LS	0	0
5	Dewatering			EA		
5		31 23 19.13	Install and Develop Deep Wells	EA	0	0
5		31 23 19.16	Install and Develop Supplemental Deep Wells	EA	0	0
5		31 23 19.23	Install and Develop Wellpoints	EA	0	0
5		31 23 19.26	Install and Develop Supplemental Wellpoints	EA	0	0
5		31 23 19.33	Install and Develop Jet Eductor Wells	EA	0	0
5		31 23 19.36	Install and Develop Supplemental Jet Eductor Wells	EA	0	0
5		31 23 19.43	Furnish and Install Observation Wells	EA	0	0
5		31 23 19.53	Install and Operate Deep Well Dewatering System	MO	0	0
5		31 23 19.56	Install and Operate Wellpoint Dewatering System	MO	0	0
5		31 23 19.59	Install and Operate Jet Eductor Dewatering System	MO	0	0
5		31 23 19.63	Abandon Deep Wells	EA	0	0
5		31 23 19.73	Unwatering	LS	0	0
6	Earthwork			CY		
6		31 14 13.23	Topsoil Stripping and Stockpiling	CY	0	0
6		31 22 19.13	Spreading and Grading Topsoil	CY	0	0
6		31 23 16.17	Spillway Excavation	CY	0	0
6		31 23 16.23	Common Excavation	CY	0	0
6		31 23 16.27	Rock Excavation	CY	0	0
6		31 23 16.43	Dam Foundation Excavation, Common	CY	0	0

6		31 23 16.46	Dam Foundation Excavation, Rock	CY	0	0
6		31 23 16.49	Excavate Key Trench	CY	0	0
6		35 73 00.23	Common Fill, Earthwork	CY		
6		35 73 00.26	Select Fill, Earthwork	CY		
6		35 73 00.29	Aggregate Base Course, Earthwork	TN		
7	Foundation Treatment			LF		
7		31 32 25	Curtain Grouting	LF	0	0
7		31 32 26	Set-up for Grout Holes	EA	0	0
7		31 32 27	Re-drilling for Grout Holes	LF	0	0
7		31 32 25	Water Pressure Testing of Grout Holes	EA	0	0
7		31 32 29	Pressure Grouting with Cement	Bag	0	0
7		31 32 28	Grout Cement	Bag	0	0
7		31 23 16.63	Initial Foundation Cleaning	SY	0	0
7		31 23 16.66	Final Foundation Cleaning	SY	0	0
7		31 23 16.69	Dental Excavation	CY	0	0
7		03 30 31	Dental Concrete	CY	0	0
7		03 30 32	Rock Fracture Treatment	LF	0	0
8	Foundation Drainage			LF		
8		33 46 13.13	Foundation Drainage Piping	LF	0	0
8		33 46 13.14	Foundation Drainage Manholes	EA	0	0
8		33 46 26	Geotextile Subsurface Drainage Filtration	SY	0	0
9	Rock Foundation Anchors			LF		
9		31 68 13	Rock Foundation Anchors	LF	0	0
	Procure and Process Borrow Materials			LS		
10		35 73 00.13	Develop Borrow Areas	LS	0	0
10		35 73 00.16	Process, Load, Haul, and Place Borrow	CY	0	0
10		35 73 00.23	Common Fill, Earthwork	CY	0	0
10		35 73 00.26	Select Fill, Earthwork	CY	0	0
10		35 73 00.29	Aggregate Base Course, Earthwork	TN	0	0
10		35 43 37.33	Riprap Bedding	CY	0	0
10		35 43 37	Riprap Scour Protection	CY	0	0
10		35 73 00.40	Furnish and Install Blanket Drain Zone __	CY	0	0
10		35 73 00.45	Furnish and Install Chimney Drain Zone __	CY	0	0

10		35 73 00.50	Furnish and Install Coarse Filter Zone __	CY	0	0
10		35 73 00.55	Furnish and Install Fine Filter Zone __	CY	0	0
10		35 73 00.60	Furnish and Install Transition Zone __	CY	0	0
10		35 73 00.65	Furnish and Install Upstream Slope Protection Zone —	CY	0	0
10		35 73 00.70	Furnish and Install Downstream Slope Protection Zone —	CY	0	0
11	Concrete			CY		
11		03 31 33	Outlet Works Concrete	CY	0	0
11		03 31 34	Spillway Concrete	CY	0	0
11		03 31 35	Upstream Concrete Facing	CY	0	0
11		03 31 36	Downstream Concrete Facing	CY	0	0
11		03 21 00	Reinforcing Steel	LB	0	0
12	Dam Instrumentation/Telemetry			LS		
12		13 54 00	Dam Instrumentation	LS	0	0
12		13 54 10	SCADA System		0	0
13	Miscellaneous Metals			LS		
13		05 02 00	Miscellaneous Metals	LS	0	0
14	Outlet Works Control Valves, Piping, Mechanical, and Electrical			LS		
14		40 92 13.33	Outlet Works Control Valves, Piping, Mechanical, and Electrical	LS	0	0
15	Site Restoration			LS		
15		32 92 19	Seeding	AC	0	0
15		32 91 13.16	Mulching	AC	0	0
15		31 25 14.16	Rolled Erosion Control Mats and Blankets	SY	0	0

RCC Dam Master Template

Work Item	Work Item Description	Sub - Item	Sub - Item Description	Unit	Quantity	Unit Price
1	Mobilization			LS		
1		00 73 16	Insurance Requirements	LS		
1		01 31 03	Office Supplies	MO		
1		01 31 00	Project Management and Coordination	MO		
1		01 31 04	Engineer's Job Staff	MO		
1		01 31 05	Contractor's Job Staff	MO		
1		01 31 06	Job Offices and Facilities	MO		
1		01 31 07	Communication	MO		
1		01 31 13	Project Coordination	MO		
1		01 32 16	Construction Progress Schedule	LS		
1		01 35 23	Owner Safety Requirements	LS		
1		01 41 24	Taxes	LS		
1		01 41 26	Permit Requirements	LS		
1		01 45 16.13	Contractor Quality Control	LS		
1		01 45 23	Testing and Inspecting Services	LS		
1		01 45 29.33	Testing Laboratory Services	LS		
1		01 51 00	Temporary Utilities	MO		
1		01 52 13	Field Offices and Sheds	MO		
1		01 52 14	Yard Facilities and Improvements	LS		
1		01 56 18	Noise Control	LS		
1		01 56 26	Temporary Fencing	LS		
1		01 35 50	Site security	MO		
1		01 71 13	Mobilization	LS		
1		01 71 14	Indirect Equipment Costs	MO		
1		01 71 15	Demobilization	LS		
1		01 71 23.16	Construction Surveying	LS		
1		01 78 33	Bonds	LS		
1		01 78 36	Warranties	LS		
1		44 11 13	Fugitive Dust Control	LS		
1		01 81 17	Environmental Program	LS		
2	Site Preparation			LS		

2		02 41 00	Demolition	LS
2		31 25 00	Erosion and Sedimentation Controls	LS
2		31 23 19.03	Control and Diversion of Water	LS
2		31 11 00	Clearing and Grubbing	AC
3	Reservoir Clearing			AC
3		31 10 13	Reservoir Clearing	AC
4	Construct and Maintain Access Roads			LS
4		31 24 13.19	Construct and Maintain Access Roads	LS
4		44 11 14	Water for Dust Control	LS
5	Dewatering			EA
5		31 23 19.13	Install and Develop Deep Wells	EA
5		31 23 19.16	Install and Develop Supplemental Deep Wells	EA
5		31 23 19.23	Install and Develop Wellpoints	EA
5		31 23 19.26	Install and Develop Supplemental Wellpoints	EA
5		31 23 19.33	Install and Develop Jet Eductor Wells	EA
5		31 23 19.36	Install and Develop Supplemental Jet Eductor Wells	EA
5		31 23 19.43	Furnish and Install Observation Wells	EA
5		31 23 19.53	Install and Operate Deep Well Dewatering System	MO
5		31 23 19.56	Install and Operate Wellpoint Dewatering System	MO
5		31 23 19.59	Install and Operate Jet Eductor Dewatering System	MO
5		31 23 19.63	Abandon Deep Wells	EA
5		31 23 19.73	Unwatering	LS
6	Earthwork			CY
6		31 14 13.23	Topsoil Stripping and Stockpiling	CY
6		31 22 19.13	Spreading and Grading Topsoil	CY
6		31 23 16.17	Spillway Excavation	CY
6		31 23 16.23	Common Excavation	CY
6		31 23 16.27	Rock Excavation	CY
6		31 23 16.43	Dam Foundation Excavation, Common	CY

6		31 23 16.46	Dam Foundation Excavation, Rock	CY		
6		35 73 00.23	Common Fill, Earthwork	CY		
6		35 73 00.26	Select Fill, Earthwork	CY		
6		35 73 00.29	Aggregate Base Course, Earthwork	TN		
7	Foundation Treatment			LF		
7		31 32 25	Curtain Grouting	LF		
7		31 32 26	Set-up for Grout Holes	EA		
7		31 32 27	Re-drilling for Grout Holes	LF		
7		31 32 25	Water Pressure Testing of Grout Holes	EA		
7		31 32 29	Pressure Grouting with Cement	Bag		
7		31 32 28	Grout Cement	Bag		
7		31 23 16.63	Initial Foundation Cleaning	SY		
7		31 23 16.66	Final Foundation Cleaning	SY		
7		31 23 16.69	Dental Excavation	CY		
7		03 30 31	Dental Concrete	CY		
7		03 30 32	Rock Fracture Treatment	LF		
8	Foundation Drainage			LF		
8		33 46 13.13	Foundation Drainage Piping	LF	0	0
8		33 46 13.33	Drilled Foundation Drains	LF		
9	Rock Foundation Anchors			LF		
9		31 68 13	Rock Foundation Anchors	LF		
10	Procure and Process Borrow Materials			LS		
10		35 73 00.13	Develop Borrow Areas	LS		
10		35 73 00.16	Process, Load, Haul, and Place Borrow	CY		
10		35 43 37.33	Riprap Bedding	CY		
10		35 43 37	Riprap Scour Protection	CY		
11	Concrete			CY		
11		03 31 33	Outlet Works Concrete	CY		
11		03 31 34	Spillway Concrete	CY		
11		03 31 35	Upstream Concrete Facing	CY		
11		03 31 36	Downstream Concrete Facing	CY		
11		03 21 00	Reinforcing Steel	LB		
12	Precast Dam Facing			SF		
12		03 41 41	Precast Upstream Concrete Facing	SF		
12		03 41 42	Precast Downstream Concrete Facing	SF		

13	Roller Compacted Concrete				CY
13		35 71 13.53	Aggregate for RCC (Coarse)		TN
13		35 71 13.56	Aggregate for RCC (Fine)		TN
13		35 71 13.63	Cement for RCC		TN
13		35 71 13.66	Fly Ash for RCC		TN
13		35 71 13.69	Set up and Tear Down RCC Plant		LS
13		35 71 13.73	RCC Mixing and Placement		CY
13		35 71 13.76	RCC Cooling		CY
13		35 71 13.79	RCC Bedding Mortar		SY
13		35 71 13.83	Gallery Concrete		CY
13		35 71 13.86	RCC Test Section		LS
13		35 71 13.89	Bedding Mix		LS
13		35 71 13.93	Dam Construction Joints		LS
13			Precast Concrete Panels with Membrane Liner		SF
14	Dam Instrumentation/Telemetry				LS
14		13 54 00	Dam Instrumentation		LS
14		13 54 10	SCADA System		LS
15	Miscellaneous Metals				LS
15		05 02 00	Miscellaneous Metals		LS
16	Outlet Works Control Valves, Piping, Mechanical, and Electrical				LS
16		40 92 13.33	Outlet Works Control Valves, Piping, Mechanical, and Electrical		LS
17	Site Restoration				LS
17		32 92 19	Seeding		AC
17		32 91 13.16	Mulching		AC
17		31 25 14.16	Rolled Erosion Control Mats and Blankets		SY

Concrete Cutoff Wall in an Embankment Dam WBS Template

WBS #				Quantity	UOM	Project Cost
I CONTRACT 1 - SITE SETUP				1	LS	
04				1	LS	
04	01	01	-	1	LS	
04	01	01	-	1	LS	
04	01	04	--	1	LS	
04	01	99		1	LS	
04	01	99	16	1	LS	
04	06	59	15	1	LS	
04	01	02	02	5	MO	
04	01	04	02	1	ACR	
04	01	02	02	1	LS	
04	01	02	02	1	LS	
04	01	02	02	1	LS	
04	01	01		1	LS	
04	01	01		1	LS	
04	01	01		400	CY	
04	01	01		1	LS	
04	01	01		1	LS	
04	01	04	02	14,500.00	SY	
04	01	01		1	LS	
04	01	01		1,073.00	CY	
04	01	01		11,280.00	SY	
04	01	01		1	LS	
04	01	02		5	MO	
04	01	04	02	5,334.00	SY	
04	01	99	02	1	LS	
04	01	99	02	11	EA	
04	01	99	02	1	LS	

30	30			I - 30 PLANNING, ENGINEERING AND DESIGN	1	LS
30	23	01		Plans and Specs	1	LS
30	23	01	01	Field Investigation	1	LS
30	23	02	02	Prepare Plans & Specs	1	LS
30	23	02	02	ATR Plans & Specs	1	LS
30	23	04		Environmental Documents & Permits	1	LS
30	23	04		Prepare Environmental Compliance Docs/Permits	1	LS
30	23	05	02	HTRW Studies	1	LS
30	23	05	02	Phase One HTRW Study (Project)	1	LS
30	23	05	02	Phase Two HTRW Study (Project)	1	LS
30	23	09		Contract - Sealed Bids	1	LS
30	23	09	01	Prepare Aquisition Plan	1	LS
30	23	09	01	Prepare Contract Document	1	LS
30	23	09	01	Conduct Contracting Peer Review	1	LS
30	23	10		E&D During Construction	1	LS
30	23	10		Engineering and Design During Construction	1	LS
31				I - 31 CONSTRUCTION MANAGEMENT	8	MO
II CONTRACT 2 - EXPLORATORY, VERIFICATION & GROUT HOLE DRILLING					1	LS
04				II - 04 DAMS	1	LS
04	01	01		II - 04 - 02 Mobilization/ Demobilization	1	LS
04	01	01		II - 04 - 02 - 01 Season 2 - Exploratory Drilling & Grouting	1	LS
04	01	04	02	II - 04 - 07 Right Abutment Construction Ramp	1	LS
04	01	04	02	II - 04 - 07 - 01 Clearing and Grubbing	1.3	ACR
04	01	04	02	II - 04 - 07 - 02 Earthwork - Rock Excavation	34,204.00	BCY
04	01	42	02	II - 04 - 08 Work Platform Across Dam	1	LS
04	01	04	02	II - 04 - 08 - 01 Remove Guiderail	1,675.00	LF
04	01	42	02	II - 04 - 08 - 02 Borrow Area Excavation - Rock Excavation	57,634.00	BCY
04	01	42	02	II - 04 - 08 - 03 Earthwork for Upstream Work Platform - Fill Placement & Compaction	28,838.00	CY
04	01	42	02	II - 04 - 08 - 04 Earthwork for Upstream Work Platform - Riprap Redistribution	13,830.00	CY
04	01	42	02	II - 04 - 08 - 05 18 inch thick Reinforced Concrete Guidewall	711	CY
04	01	04	02	II - 04 - 08 - 06 Pave Upstream Work Platform	13,350.00	SY
04	01	04	02	II - 04 - 08 - 07 Temporary Guiderail	1,675.00	LF

04	01	04	02	II - 04 - 08 - 08 Temporary Chainlink Fence	1,600.00	LF
04	01	42	02	II - 04 - 08 - 09 Excavation Support - Retaining Wall	12,600.00	SF
04	01	42	02	I - 04 - 05 - 09 - A Soil Nailing	840	EA
04	01	42	02	I - 04 - 05 - 09 - B 3" Wire Reinforced Shotcrete Facing	12,600.00	SF
04	01	42	02	I - 04 - 05 - 09 - C 12 inch CIP RC Facing on Soil Nail Wall	467	CY
04	01	01		II - 04 - 03 Site Setup, Maintenance & Operation	1	LS
04	01	01		Signs	1	LS
04	01	02	02	II - 04 - 03 - 02 Environmental Protection	1	LS
04	01	02	02	I - 04 - 03 - 04 - A Erosion and Sedimentation Controls	1	LS
04	01	02	02	I - 04 - 03 - 04 - B Pollution Prevention Measures	1	LS
04	01	02	02	I - 04 - 03 - 04 - C Primary Settling Pond & Trap	1	LS
04	01	99		II - 04 - 03 - 03 Temporary Utilities - Operation	1	LS
04	01	01		II - 04 - 03 - 04 Site Maintenance	11	MO
04	01	42		II - 04 - 04 Exploratory & Verification Drilling	1	LS
04	01	42		II - 04 - 05 Right Abutment Grouting	114,000.00	SF
04	01	42		II - 04 - 05 - 01 Drilling Rock	10,890.00	LF
04	01	42		II - 04 - 05 - 02 Flushing 20-FT Grout Zones	190	HR
04	01	42		II - 04 - 05 - 03 Pressure Testing 20-FT Grout Zones	190	HR
04	01	42		II - 04 - 05 - 04 Grout Components	1	LS
04	01	42		II - 04 - 05 - 04 - A Cement in Grout	1,382,695.00	LB
04	01	42		II - 04 - 05 - 04 - B Aggregates/Sand in Grout	1,618,048.00	LB
04	01	42		II - 04 - 05 - 04 - C Additives in Grout	41,481.00	LB
04	01	42		II - 04 - 05 - 04 - D Bentonite in Grout	48,394.00	LB
04	01	42		II - 04 - 05 - 05 Grout Hole Setups & Connections	42	EA
04	01	42		II - 04 - 05 - 06 Placing Grout	735	HR
04	01	42		II - 04 - 05 - 07 Drill Records	42	EA
04	01	42		II - 04 - 06 Pre-Grouting, Top of Dam	54,417.00	LF
04	01	42		II - 04 - 06 - 01 Drilling	54,417.00	LF
04	01	42		II - 04 - 06 - 01 - A Drilling Dam Fill/Overburden	17,824.00	LF
04	01	42		II - 04 - 06 - 01 - B Drilling Lean Concrete	17,824.00	LF
04	01	42		II - 04 - 06 - 01 - C Drilling Rock	18,769.00	LF
04	01	42		II - 04 - 06 - 02 Flushing of 20-FT Grout Zones	320	HR
04	01	42		II - 04 - 06 - 03 Pressure Testing of 20-FT Grout Zones	320	HR
04	01	42		II - 04 - 06 - 04 Grout Hole Setups & Connections	70	EA

04	01	42		II - 04 - 06 - 05 Placing Grout	1,390.00	HR
04	01	42		II - 04 - 06 - 06 Drill Records	70	EA
04	01	42		II - 04 - 06 - 07 Grout Components	1	LS
04	01	42		04 - 11 - 04 - A Cement in Grout	2,913,353.00	LB
04	01	42		04 - 11 - 04 - B Aggregates/Sand in Grout	3,409,243.00	LB
04	01	42		04 - 11 - 04 - C Additives in Grout	87,401.00	LB
04	01	42		04 - 11 - 04 - D Bentonite in Grout	101,967.00	LB
30	23	01		II - 30 PLANNING, ENGINEERING AND DESIGN	1	LS
30	23	01		Plans and Specs	1	LS
30	23	01	01	Field Investigation	1	LS
30	23	02	02	Prepare Plans & Specs	1	LS
30	23	02	02	ATR Plans & Specs	1	LS
30	23	04		Environmental Documents & Permits	1	LS
30	23	04		Prepare Environmental Compliance Docs/Permits	1	LS
30	23	09		Contract - Best Value (LPTA)	1	LS
30	23	09	01	Prepare Aquisition Plan	1	LS
30	23	09	01	Prepare Contract Document	1	LS
30	23	09	01	Conduct Contracting Peer Review	1	LS
30	23	10		E&D During Construction	1	LS
30	23	10		Engineering and Design During Construction	1	LS
31				II - 31 CONSTRUCTION MANAGEMENT	8	MO
				III CONTRACT 3 - FULL CUTOFF WALL	1	LS
04				III - 04 DAMS	1	LS
04	01	01		III - 04 - 02 Mobilization/ Demobilization	1	LS
04	01	01		III - 04 - 02 - 01 Season 3 - Panel & Secant Wall	1	LS
04	01	01		III - 04 - 02 - 02 Season 4 - Secant Wall	1	LS
04	01	02		III - 04 - 03 Site Setup, Maintenance & Operation	1	LS
04	01	01		Signs	1	LS
04	01	02	02	III - 04 - 03 - 02 Environmental Protection	1	LS
04	01	02	02	III - 04 - 02 - 04 - A Erosion and Sedimentation Controls	1	LS
04	01	02	02	III - 04 - 02 - 04 - B Pollution Prevention Measures	1	LS
04	01	02	02	III - 04 - 02 - 04 - C Primary Settling Pond & Trap	1	LS
04	01	99		III - 04 - 03 - 03 Temporary Utilities - Operation	16	MO
04	01	01		III - 04 - 03 - 04 Site Maintenance	16	MO

04	01	01	III - 04 - 04 Batch Plant - Mob, Setup, Operation, Demob	1	LS
04	01	01	III - 04 - 04 - 01 Construction of Batch Plant	1	LS
04	01	01	III - 04 - 04 - 01 - A Earthwork	5,866.00	CY
04	01	01	III - 04 - 04 - 01 - B Foundation	50	SY
04	01	02	02 III - 04 - 04 - 01 - C Slurry/Sedimentation/pH Pond Setup	1	LS
04	01	01	III - 04 - 04 - 01 - D Concrete Batch Plant Setup	1	LS
04	01	01	III - 04 - 04 - 01 - E Equipment	1	LS
04	01	42	III - 04 - 04 - 02 Operation of Batch Plant	16	MO
04	01	01	III - 04 - 04 - 02 Tear Down Batch Plant	1	LS
04	01	01	III - 04 - 04 - 03 Tear Down Slurry Ponds	1	LS
04	01	42	III - 04 - 05 Panel Wall Through Dam Fill/Overburdened	227,000.00	SF
04	01	42	III - 04 - 05 - 01 Setups & Equip Problems	225	EA
04	01	42	III - 04 - 05 - 02 Hydromill Excavate Panel Wall through Dam Fill/Overburden	45,329.00	CY
04	01	42	III - 04 - 05 - 03 Bentonite Slurry	190,379.00	LB
04	01	42	III - 04 - 05 - 04 Slurry Handling	43,747.00	CY
04	01	42	III - 04 - 05 - 05 Disposal of Slurry	70,000.00	TON
04	01	42	III - 04 - 05 - 06 Off-Site Disposal of Spoils	24,255.00	CY
04	01	42	III - 04 - 05 - 07 Lean Concrete Components	54,390.00	CY
04	01	42	III - 04 - 05 - 07 - A Cement	8,702,431.00	LB
04	01	42	III - 04 - 05 - 07 - B Pozzolan	16,317,059.00	LB
04	01	42	III - 04 - 05 - 07 - C Fine Aggregate/Sand	141,414,000,000.00	LB
04	01	42	III - 04 - 05 - 08 Place Concrete	54,390.00	CY
04	01	42	III - 04 - 05 - 09 Standby	300	HR
04	01	42	III - 04 - 05 - 10 Re-Excavate 25 Incorrect BITES	25	EA
04	01	42	III - 04 - 05 - 10 - A Setups	75	EA
04	01	42	III - 04 - 05 - 10 - B Hydromill Excavate Panel Wall through Dam Fill/Overburden	4,986.00	CY
04	01	42	III - 04 - 05 - 10 - C Bentonite Slurry	20,942.00	LB
04	01	42	III - 04 - 05 - 10 - D Slurry Handling	4,812.00	CY
04	01	42	III - 04 - 05 - 10 - E Disposal of Slurry	7,700.00	TON
04	01	42	III - 04 - 05 - 10 - F Off-Site Disposal of Spoils	2,668.00	CY
04	01	42	III - 04 - 05 - 10 - G Lean Concrete Components	5,983.00	CY
04	01	42	III - 04 - 05 - 10 - G1 Cement	957,267.00	LB
04	01	42	III - 04 - 05 - 10 - G2 Pozzolan	1,794,876.00	LB

04	01	42	III - 04 - 05 - 10 - G3 Fine Aggregate/Sand	15,555,540,000.00	LB
04	01	42	III - 04 - 05 - 10 - H Place Concrete	5,983.00	CY
04	01	42	III - 04 - 05 - 10 - J Standby	100	HR
04	01	42	III - 04 - 06 Secant Cutoff Wall	470,000.00	SF
04	01	42	III - 04 - 06 - 01 Drilling Pilot Holes for Secant Guidance	257,609.00	LF
04	01	42	III - 04 - 06 - 02 Setups	1,022.00	EA
04	01	42	III - 04 - 06 - 03 Drilling Dam Fill/Overburden	3,830.00	LF
04	01	42	III - 04 - 06 - 04 Drilling Lean Concrete	140,802.00	LF
04	01	42	III - 04 - 06 - 05 Drilling Rock	116,807.00	LF
04	01	42	III - 04 - 06 - 06 Off-Site Disposal of Spoils	47,531.00	CY
04	01	42	III - 04 - 06 - 07 Concrete Components	57,037.00	CY
04	01	42	III - 04 - 06 - 07 - A Cement	26,807,390.00	LB
04	01	42	III - 04 - 06 - 07 - B Bentonite	399,259.00	LB
04	01	42	III - 04 - 06 - 07 - C Pozzolan	28,518,500.00	LB
04	01	42	III - 04 - 06 - 07 - D Aggregates	148,296,200.00	LB
04	01	42	III - 04 - 13 - 06 - D1 Fine Aggregate/Sand	85,555,500.00	LB
04	01	42	III - 04 - 13 - 06 - D2 Coarse Aggregate	62,740,700.00	LB
04	01	42	III - 04 - 06 - 08 Place Concrete	57,037.00	CY
04	01	42	III - 04 - 06 - 09 Standby	984	HR
04	01	42	III - 04 - 06 - 10 Re-Drill 50 Incorrect Secants	50	EA
04	01	42	III - 04 - 06 - 10 - A Setups	50	EA
04	01	42	III - 04 - 06 - 10 - B Drilling Dam Fill/Overburden	154	LF
04	01	42	III - 04 - 06 - 10 - C Drilling Lean Concrete	7,040.00	LF
04	01	42	III - 04 - 06 - 10 - D Drilling Rock	5,840.00	LF
04	01	42	III - 04 - 06 - 10 - E Off-Site Disposal of Spoils	2,391.00	CY
04	01	42	III - 04 - 06 - 10 - F Concrete Components	2,852.00	CY
04	01	42	III - 04 - 06 - 10 - F1 Cement	1,340,370.00	LB
04	01	42	III - 04 - 06 - 10 - F2 Bentonite	19,963.00	LB
04	01	42	III - 04 - 06 - 10 - F3 Pozzolan	1,425,925.00	LB
04	01	42	III - 04 - 06 - 10 - F4 Aggregates	7,414,810.00	LB
04	01	42	Fine Aggregate/Sand	4,277,775.00	LB
04	01	42	Coarse Aggregate	3,137,035.00	LB
04	01	42	III - 04 - 06 - 10 - G Place Concrete	5,704.00	CY
04	01	42	III - 04 - 06 - 10 - H Standby	50	HR

04	01	42		III - 04 - 06 -11 Emergency Spillway Work	1	LS
04	01	42		III - 04 - 06 - 01 Concrete Demolition of Emergency Spillway	1	LS
04	01	42		Spillway	1	LS
04	01	42		III - 04 - 06 - 03 Remove Trestle	1	LS
04	01	42		III - 04 - 06 - 04 Repair Spillway Walls	1	LS
04	01	99	02	III - 04 - 07 Instrumentation and Monitoring	1	LS
04	01	99	02	III - 04 - 07 - 01 Supply & Install	35	EA
04	01	99	02	III - 04 - 07 - 02 Monitor	1	LS
04	01	42		III - 04 - 08 Test Specifications and Demonstrations	1	LS
04	01	42		III - 04 - 09 Verification Program & Corrective Grouting	1	LS
04	01	42		04 - 09 - 01 Drilling	2,720.00	LF
04	01	42		04 - 11 - 01 - A Drilling Dam Fill/Overburden	892	LF
04	01	42		04 - 11 - 01 - B Drilling Lean Concrete	892	LF
04	01	42		04 - 11 - 01 - C Drilling Rock	939	LF
04	01	42		04 - 09 - 02 Flushing of 20-FT Grout Zones	12	HR
04	01	42		04 - 09 - 03 Pressure Testing of 20-FT Grout Zones	12	HR
04	01	42		04 - 09 - 04 Grout Components	1	LS
04	01	42		04 - 11 - 04 - A Cement in Grout	145,668.00	LB
04	01	42		04 - 11 - 04 - B Aggregates/Sand in Grout	170,462.00	LB
04	01	42		04 - 11 - 04 - C Additives in Grout	4,370.00	LB
04	01	42		04 - 11 - 04 - D Bentonite in Grout	5,098.00	LB
04	01	42		04 - 09 - 05 Placing Grout	1	LS
04	01	42		III - 04 - 10 Prequalification and QA/QC Testing	1	LS
30	23	01		III - 30 PLANNING, ENGINEERING AND DESIGN	1	LS
30	23	01		Plans and Specs	1	LS
30	23	01	01	Prepare Plans & Specs	1	LS
30	23	02	02	ATR Plans & Specs	1	LS
30	23	04		Environmental Documents & Permits	1	LS
30	23	04		Prepare Environmental Compliance Docs/Permits	1	LS
30	24			Value Engineering Study	1	EA
30	23	09		Contract - Best Value (LPTA)	1	LS
30	23	09	01	Prepare Aquisition Plan	1	LS
30	23	09	01	Prepare Contract Document	1	LS
30	23	09	01	Conduct Contracting Peer Review	1	LS

30	23	10		E&D During Construction	1	LS
30	23	10		Engineering and Design During Construction	1	LS
31				III - 31 CONSTRUCTION MANAGEMENT	60	MO
IV CONTRACT 4 - INSTRUMENTATION					1	LS
04				IV - 04 DAMS	1	LS
04	01	01		IV - 04 - 02 Mobilization/ Demobilization	1	LS
04	01	01		IV - 04 - 02 - 01 Season 9 - Post Construction Instrumentation	1	LS
04	01	01		IV - 04 - 03 Site Setup & Maintenance	1	LS
04	01	99		IV - 04 - 03 - 01 Temporary Utilities - Operation	2	MO
04	01	01		Signs	1	LS
04	01	02	02	IV - 04 - 03 - 04 Environmental Protection	1	LS
04	01	02	02	IV - 04 - 03 - 04 - A Erosion and Sedimentation Controls	1	LS
04	01	02	02	IV - 04 - 03 - 04 - B Pollution Prevention Measures	1	LS
04	01	99	02	IV - 04 - 04 Instrumentation and Monitoring	1	LS
04	01	99	02	04 - 04 - 01 Supply & Install	45	EA
04	01	99	02	04 - 04 - 02 Monitor	1	LS
30	23	01		IV - 30 PLANNING, ENGINEERING AND DESIGN	1	LS
30	23	01	01	Scope of Work	1	LS
30	23	01	01	Prepare Scope of Work	1	LS
30	23	09		Contract - Task Order	1	LS
30	23	09	01	Prepare Contract Document - Task Order	1	LS
30	23	09	01	Conduct Contracting Peer Review	1	LS
30	23	10		E&D During Construction	1	LS
30	23	10		Engineering and Design During Construction	1	LS
31				IV - 31 CONSTRUCTION MANAGEMENT	2	MO
V CONTRACT 5 - POST CONSTRUCTION SITE WORK					1	LS
04				V - 04 DAMS	1	LS
04	01	01		V - 04 - 02 Mobilization/ Demobilization	1	LS
04	01	01		V - 04 - 02 - 01 Season 6 - Post Construction Demo	1	LS
04	01	01		V - 04 - 03 Site Setup, Maintenance & Operation	1	LS
04	01	01		Signs	1	LS
04	01	02	02	V - 04 - 03 - 02 Environmental Protection	1	LS
04	01	02	02	V - 04 - 03 - 02 - A Erosion and Sedimentation Controls	1	LS
04	01	02	02	V - 04 - 03 - 02 - B Pollution Prevention Measures	1	LS

04	01	99		V - 04 - 03 - 03 Temporary Utilities - Operation	1	LS
04	01	99		V - 04 - 03 - 01 Operation	4	MO
04	01	01		V - 04 - 03 - 04 Site Maintenance	208	HR
04	01	42	02	V - 04 - 04 Post-Construction Items	1	LS
04	01	42	02	V - 04 - 04 - 01 Reconstruct Top of Dam	1	LS
04	01	42	02	V - 04 - 04 - 01 - A Demolish Work Platform & Regrade	1	LS
04	01	04	02	V - 04 - 04 - 01 - A1 Remove Guiderail	1,675.00	LF
04	01	04	02	V - 04 - 04 - 01 - A2 Demo Pavement	13,350.00	SY
04	01	42	02	Rock	57,634.00	CY
04	01	42	02	Fill	28,838.00	CY
04	01	42	02	V - 04 - 04 - 01 - A5 Earthwork for Upstream Work Platform - Riprap Redistribution	13,830.00	CY
04	01	04	02	V - 04 - 04 - 01 - B New Guide Rail Along Dam Crest	3,450.00	LF
04	01	04	02	V - 04 - 04 - 01 - C Crest Road Surfacing & Repaving	4,800.00	SY
04	01	01		V - 04 - 04 - 02 Tear Down Staging Areas	1	LS
04	01	01		V - 04 - 04 - 03 Fine Grading, Seedbed Preparation & Revegetation of Disturbed Areas	3	ACR
04	01	04	02	V - 04 - 04 - 04 Repave Site Roads & Parking Lots	1	LS
30				V - 30 PLANNING, ENGINEERING AND DESIGN	1	LS
30	23	01	01	Plans and Specs	1	LS
30	23	01	01	Prepare Plans & Specs	1	LS
30	23	01	01	ATR Plans & Specs	1	LS
30	23	04		Environmental Documents & Permits	1	LS
30	23	04		Prepare Environmental Compliance Docs/Permits	1	LS
30	23	09		Contract - Sealed Bids	1	LS
30	23	09		Prepare Contract Document	1	LS
30	23	09		Conduct Contracting Peer Review	1	LS
30	23	10		E&D During Construction	1	LS
30	23	10		Engineering and Design During Construction	1	LS
31				V - 31 CONSTRUCTION MANAGEMENT	4	MO
				A - 30 TYPE II IEPR SAFETY ASSURANCE REVIEW	1	LS
30	23	10		Type II IEPR Safety Assurance Review	1	EA
				B - 31 PROJECT CLOSEOUT	1	LS
31	25	01		Project Physical Closeout	1	EA
31	25	02		Project Fiscal Closeout	1	EA



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