Section 2

Cost-Estimate Preparation/ Lessons Learned

1

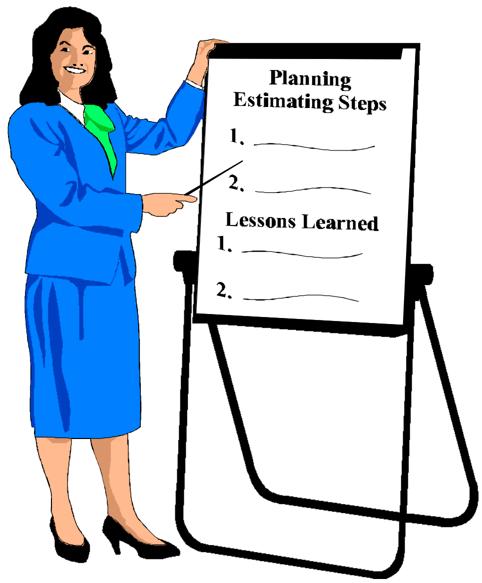
Section 1 reviewed cost-estimating concepts from guidances to methods. Three types of cost estimates were defined: planning, preliminary, and detailed. In Section 2, we will deal with the application of those cost-estimating concepts.

This section will go through a step-by-step process to prepare both a planning and a detailed cost estimate. A real-life DOE project will serve as the example for the application of each process step. In Section 2.1, the preparation of a planning cost estimate is demonstrated, and in Section 2.2, the preparation of a detailed cost estimate is demonstrated.

Notes / Discussion Points / Lessons Learned:

Section 2.1

Preparation of a Planning Cost Estimate/Lessons Learned



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This section will discuss the methods for developing planning estimates. The principles discussed in Section 1 will be used to demonstrate the development of a planning estimate. A real-life DOE project will serve as the example for this exercise.

Planning Cost Estimate

The following topics will be covered in this section:

- Definition of a planning estimate
- Cost-estimating methods
- Flow process for planning cost estimates
- Discussion and demonstration of each process step
- Lessons-learned applications

Notes / Discussion Points / Lessons-Learned: ______________________________

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Planning Cost Estimate

What is a Planning Estimate?

2

Discussion Leader/Facilitator Notes: Refer to the tables in Section 1.5, Types of Cost Estimates.

Planning estimates are based on limited information and are thus subject to considerable variation. Their accuracy also depends on the amount and quality of information available as well as the judgment and experience of the estimator. See Section 1.5, Types of Cost Estimates.

Planning estimates may be used for the following tasks:

- Establishing the probable out-year project costs
- Evaluating the general feasibility of a project
- Evaluating cost consequences of proposed design modifications
- Screening a number of alternatives
- Dealing with a situation in which the cost of preparing a detailed estimate outweighs the benefits received or when time constraints do not allow a more detailed estimate to be prepared.

Notes / Discussion Points / Lessons-Learned: ______________________________

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Cost-Estimating Methods

Common Cost-Estimating Methods for Planning Estimates

- **Historical Data**
- **Expert Opinion**
- **Cost Model**
- **Range Estimating**
- **Cost-Estimating Relationships**

3

Discussion Leader/Facilitator Notes: Refer workshop participants to Sections 1.6, Cost-Estimating Methods and Tools.

Estimating methods often used in planning estimates include use of historical data, expert opinion, cost model, range estimating, and cost-estimating relationships (CERs). These methods are used either independently or in conjunction with one another to develop a complete estimate.

- Historical Data

  Site history records and files on a similar type work can be an extremely valuable resource in preparing estimates. CERs are typically based on some type of historical data. Most cost-estimating organizations will maintain historical data for estimating.

- Expert Opinion may be used when other techniques or data are not available. Several specialists can be consulted until a consensus cost estimate is established.

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Notes / Discussion Points / Lessons-Learned: ______________________________

Section 2.1: Preparation of a Planning Cost Estimate/Lessons Learned

- Cost models are usually parametric models that are built using some form of CER or parametric equation. The three most common software parametric tools used at DOE facilities are as follows:
  - RACER
  - FAST Model / INSITE
  - Enhanced Cost-Estimating Relationship Program

  (Reference "Catalog of Cost-Estimating Models and Evaluation of the Development of a Cost-Estimating Tools Library on Electronic Media, Volume 3" for a description of these software packages.)

- The Range-Estimating method is also referred to as optimistic-pessimistic estimating. It is a simple, effective method and a useful tool in obtaining an estimate when there is a wide range of potential cost. The estimate is obtained by developing a 3-point estimate (optimistic, most likely, and pessimistic) and then calculating an expected value by using a beta distribution as follows:

$$\left(\frac{\text{Optimistic} + 4\text{x most likely} + \text{pessimistic}}{6}\right)$$

  Refer to Section 1.6, Cost-Estimating Methods and Tools, for more detail on range estimating.

- CERs can be simple cost factors or ratios to more complex relational equations. Calculations include unit calculation, ratios, factors, scale of operations/power sizing, indexes, analogies, and parametric models, each of which is discussed in detail in Section 1.6, Cost-Estimating Methods and Tools.

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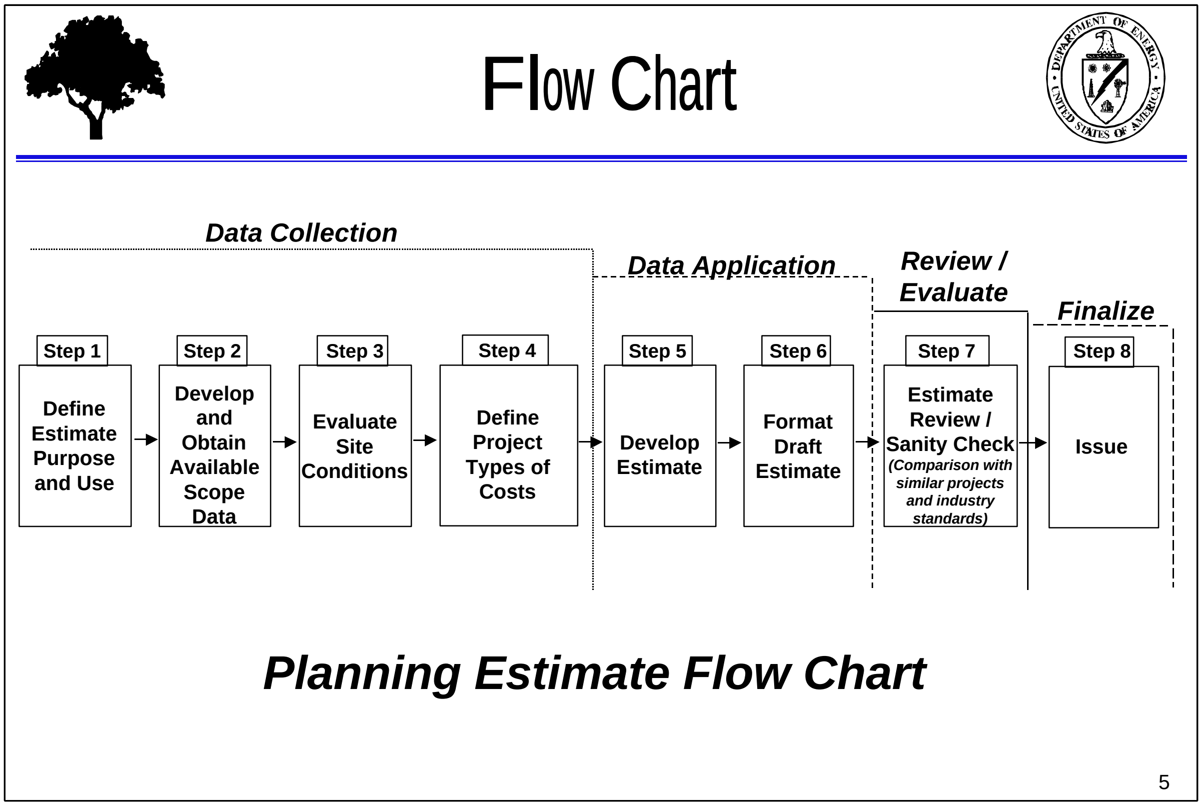
Section 2.1: Preparation of a Planning Cost Estimate/Lessons Learned



Discussion Leader/Facilitator Notes: The facilitator is to explain the example project and discuss each step of the process first generally and then specifically as to how the step would be applied to the example problem. The group will then discuss results of the example problem and related issues of interest and share lessons learned. The facilitator may want to leave this slide on the second projector for reference as each step is discussed.

The flow chart represents a typical process and the steps for the development of a planning cost estimate. Although this process is shown as a finish-to-start process, it is actually an iterative and concurrent process for most steps.

A planning cost estimate will be developed for a DOE example project using the estimating methods discussed and working through the steps shown in the flow chart.

Notes / Discussion Points / Lessons-Learned: ______________________________

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How to Prepare a Planning Cost Estimate

Real Example Problem Estimate Description

DOE Facility Brine Pond Project Remediation

6

Discussion Leader/Facilitator Notes: The facilitator is to introduce and go through the example project with the participants, discussing key items (italicized) of the project.

The example project that we will use throughout Section 2, first to demonstrate the development of a planning estimate and then to demonstrate the development of a detailed estimate, is the remediation of a brine pond at a DOE facility, a geothermal test facility in the Southwest.

Notes / Discussion Points / Lessons-Learned: ______________________________

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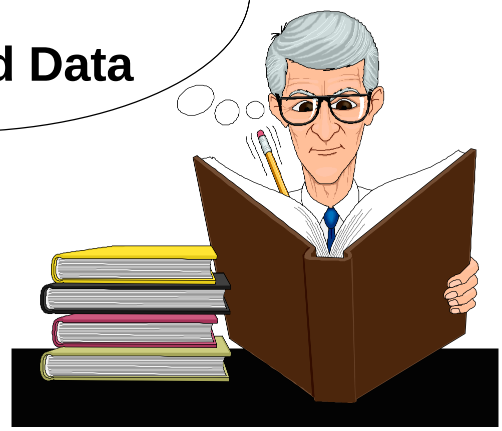
How to Prepare a Planning Cost Estimate

Brine Pond Project

Scope and Data



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Discussion Leader/Facilitator Notes: The facilitator is to review this project with participants, highlighting and discussing key items of the project. Present as much information as the group is comfortable with. Key elements are highlighted (bolded and underlined). You may want to have the group read the scope up front before starting the example.

The following pages describe this project.

Notes / Discussion Points / Lessons-Learned: ______________________________

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Brine Pond Before Remediation

8

This is a picture of the brine pond area. The left hand side of the slide shows the intake structure. The dike is also visible on the left-hand side and in the distance.

Notes / Discussion Points / Lessons-Learned: ______________________________

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Section 2.1: Preparation of a Planning Cost Estimate/Lessons Learned

Discussion Leader/Facilitator Notes: In this section, we will discuss highlights of the provided scenario and the scope of the Brine Pond Project.

Brine Pond Estimating Scenario

As your day begins, you ***find yourself on a conference call with your boss and the Headquarters Cost Manager***. Apparently, a ***little problem is developing at a local***, almost forgotten site, in your ***field operations area of responsibility***. ***Brine Pond was a holding pond for waste brine from the geothermal desalting plant at the East Mesa Site.*** Apparently, ***some local and at least one national environmental activist organizations have become concerned*** about the migration of chloride, sodium, and sulfates from Brine Pond to the nearby aquifers used for agricultural irrigation, some located as close as approximately 500 feet to the southwest of the site. Although water samples have indicated values well below the range of concern, the perception exists of contaminant migration off a DOE site. The situation has been further heightened by local press coverage of the groups' recent meetings with local citizen groups. Now a national investigative reporting team has contacted Headquarters for additional information and has requested a meeting with the Deputy Director of the Environmental Restoration Office to discuss the facts of this situation. He has reviewed the facts of the situation and the history and supports an attempt to remedy this problem as quickly as possible and wants to incorporate funding for this under a priority funding allocation.

As the field office Cost Manager, ***you are being asked to prepare a "quick and dirty" cost estimate to determine whether this remedy is within the budgetary constraints***. At the end of the teleconference, your boss tells you that he will bring you the information he has on the project. Unfortunately, ***information is limited.*** ***Research and discussion with personnel familiar with both the site and the area provides the following information.***

Current Site Layout

The ***Geothermal Test Facility (site) is located*** in the Imperial Valley ***in southern California,*** about 1.5 miles north of Interstate 8. The Imperial Valley is the ***largest desert irrigation*** development in the United States with over half a million acres of ***otherwise arid desert lands that have been transformed into one of the most productive agricultural are in the nation by the importation of Colorado River water.*** ***In addition to its agricultural value, the area is as a significant source of geothermal power resources.*** The investigation and development of geothermal resources in the East Mesa area resulted in the construction of the DOE test facility. ***Vegetation in this area is scarce and consists largely of scattered creosote bushes,*** except along some of the larger washes, where vegetation is abundant.

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Notes / Discussion Points / Lessons-Learned: ____________________

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The land is relatively flat with a sloping surface that merges gradually with the central Imperial Valley. The site elevation is approximately 28 feet above mean sea level. A north-south road running from the ***frontage road that parallels Interstate 8 provides access to the site.*** Several abandoned structures and assorted machinery on-site have fallen into disrepair. ***The entire site encompasses approximately 10 acres, including the 6-acre holding pond.***

The former brine-holding pond is west of the main site buildings. It is ***roughly square (540 ft by 500 ft), covering an area slightly greater than 6 acres.*** ***An 8-ft-high soil berm surrounds the pond.*** The ***pond side slopes are estimated at 3:1 inside slope and 1.5:1 outside slope, horizontal to vertical.*** ***An 8-in. layer of brine sludge remains in the pond.*** ***The brine layer is underlain by a 6-in. protective sand layer over a 10-mil polyvinyl chloriced (PVC) liner.*** ***No free-standing water is in the pond.*** The brine layer is moist with the consistency of a ***plastic clay below the first 2 to 4 in., which is typically dry and brittle.***

Site History

The U.S. Bureau of Reclamation initiated studies of the geothermal resources at this site in 1968 as a potential method of augmenting the Lower Colorado River water supply. Operation of experimental desalting plants at the site began in 1972. DOE became the exclusive operator of the site in October 1978. Operation of three pilot-scale geothermal desalting plants was among numerous geothermal research activities performed at the site. The three pilot-scale plants included a vertical tube evaporator, a multistage flash evaporator, and a high-temperature electrodialysis unit.

The PVC-lined brine-holding pond was installed in 1972 to temporarily store and evaporate both brine blow-down water and untreated brines extracted in the geothermal exploration process.

During ***site operations from 1972 to 1975, the waste brine was discharged into the holding pond.*** Loss rates from the pond as a result of evaporation were estimated to range from as high as 60 gallons per minute (gpm) in the summer to 0 gpm during the winter. The disposal capacity of the pond was inadequate to handle increased site activities; consequently, a waste brine reinjection system was installed in 1976. The holding pond was used intermittently after installation of the reinjection system, both to supplement the reinjection system and to provide for brine disposal when the reinjection system was inoperational. The ponded brine was monitored monthly for dissolved oxygen, total

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Notes / Discussion Points / Lessons-Learned: ______________________________

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dissolved solids, pH, and conductivity. ***Geothermal research activities at the site were eventually discontinued in the late 1970s and early 1980s as commercial-scale geothermal power development matured in the region.***

In addition to the DOE facility, several commercial geothermal power plants are within a 2-mile radius of the site. A wetlands area is located approximately 500 ft southwest of the pond. A canal runs about 2 miles to the west of the site.

Climate and Precipitation

The climate of the East Mesa area is characterized by extreme aridity with a ***yearly mean temperature of 73.1F*** and monthly means that range from a low of 55.5°F in January to a high of 92.1°F in July. ***Mean annual precipitation*** (entirely as rainfall) ***recorded over the period 1951 to 1980 was 2.40 in., with most rainfall occurring during the early spring and fall and almost none during the months of April, May, June, and July***. Annual evaporation is extremely high, exceeding precipitation.

Contaminants

Potential contaminants in the brine waste include the following.

1. ***Dissolved minerals (chloride, sodium, and sulfates)***
   Elevated levels of dissolved minerals caused by subterranean contact with mineralized strata under conditions of high temperature and pressure.

2. ***Naturally Occurring Radionuclides***
   In many geothermal areas, a large part of the subterranean heat flow originates from the huge quantities of stored heat within the mantle and the core of the earth. However, in nonseismic areas this fact usually accounts for only a part of the total heat flow; nearly all of the balance is believed to be derived from radioactivity in crustal rocks, where most of the earth's radioactive elements are believed to occur. Therefore, deep geothermal brines that occur in crustal rock can contain radioactive isotopes.

3. ***Petroleum Hydrocarbons/Oil and Grease***
   Petroleum hydrocarbons/oil and grease are suspected because of plant operations and use of the pond for disposal.

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Notes / Discussion Points / Lessons-Learned: ______________________________

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Contaminant levels are not expected to be high enough to require personnel protection above a Level D or Level C.

As required by the Occupational Safety and Health Act (OSHA) 29 Code of Federal Regulations (CFR) 1910, personal protective equipment (PPE) is used to protect the wearer from hazards in the work area. Levels of protection include Level A (maximum) all covered, including self-contained breathing apparatus (SCBA); Level B, breathing air and lesser skin protection than Level A; Level C, cartridge respirator and skin protection; and Level D, durable clothes.

Proposed Remediation

The proposed remediation for the brine pond is to remove brine waste from the 6-acre pond in one continuous operation. The brine and a sand layer and the 10-mil PVC liner will be excavated. The waste material will be loaded onto trucks and shipped off-site to the disposal facility closest to the site. The pond's concrete intake structure and steel discharge pipes will be removed under this project. Once the pond has been certified clean, it will be backfilled to existing grade using the dike material around the pond and supplemented with imported fill. In addition to these clean-up activities, indirect activities will include construction management, permitting, bonds, engineering, and project management.

The brine pond is 6 acres with dimensions of approximately 540 ft X 500 ft. The pond is surrounded by earthen dikes averaging 8 ft high with slopes of 1.5:1 (outside) and 3:1 (inside). The width at the top of the dike is 12 ft (refer to the cross-section figure provided). The waste material in the pond consists of an average of 8 in. of brine and 6 in. of sand. This waste is underlaid by a 10- mil PVC liner. The base of the pond is approximately 3 ft below the bottom elevation of the surrounding dike.

After discussions and meetings, the following estimating assumptions were determined to be valid for this planning estimate.

1. ***Work can generally be done under Level D personal protective equipment conditions with possibly some Level C areas. (See the preceding information about OSHA personal protective equipment levels.)***

2. ***The contractor will provide industrial hygiene monitoring (mainly dust monitoring).***

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Notes / Discussion Points / Lessons-Learned: ______________________________

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3. ***All required utilities are assumed to be available at the site.***

4. ***Sufficient and qualified labor is available to support construction needs and schedule requirements*.**

5. ***Dewatering systems are not required during excavation.***

6. ***Brine and sand material will be disposed of off-site.***

7. ***No major weather delays will be encountered.***

8. ***Soil is clean under the liner.***

9. ***Contaminant levels will be as expected (see previous page).***

10. ***Contracting will be fixed price.***

Schedule Assumptions

This project would be accomplished later this year. Earlier information had proposed that this project be 2 to 4 months in duration with completion by the end of the fiscal year.

Notes / Discussion Points / Lessons-Learned: ______________________

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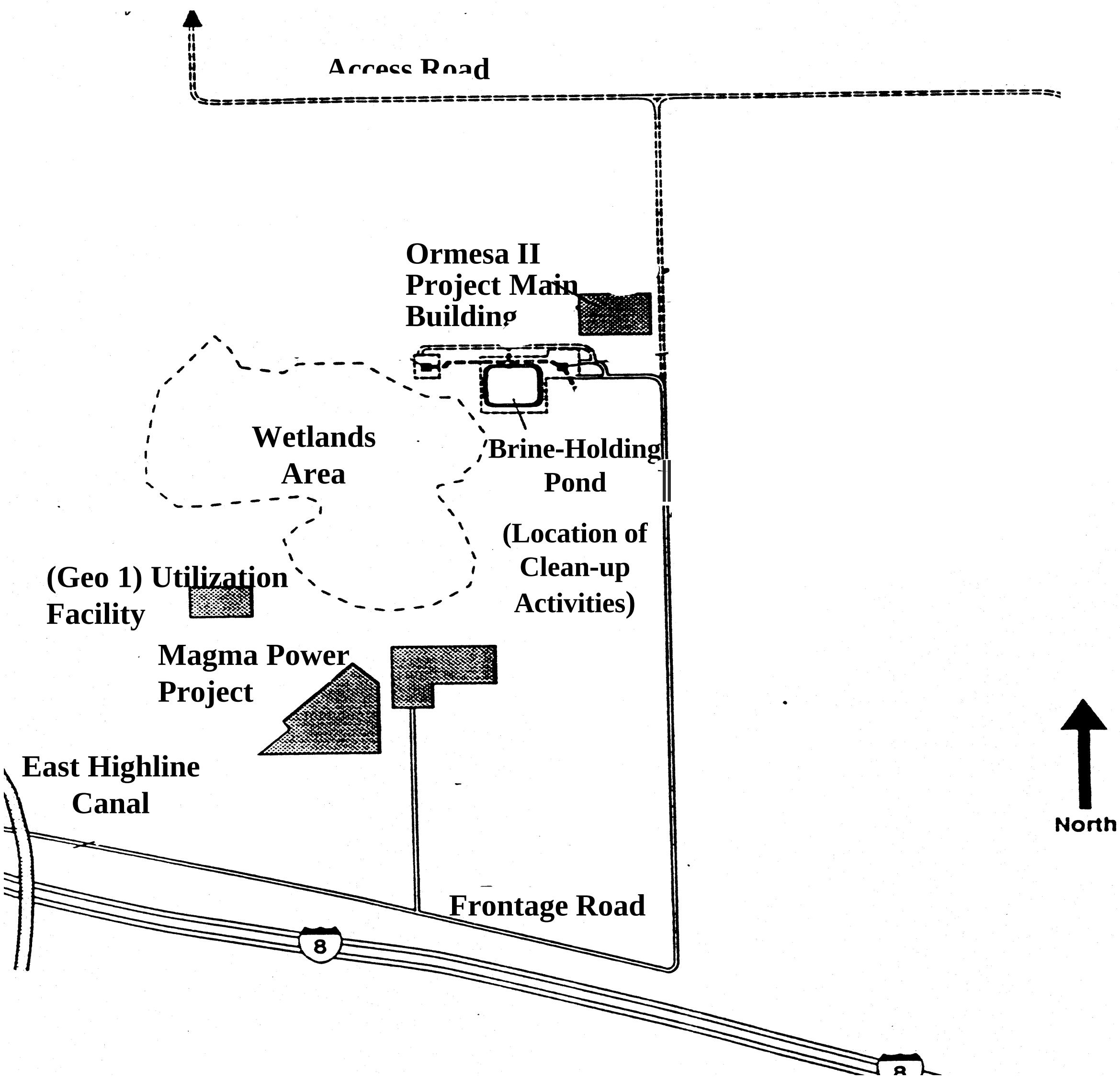
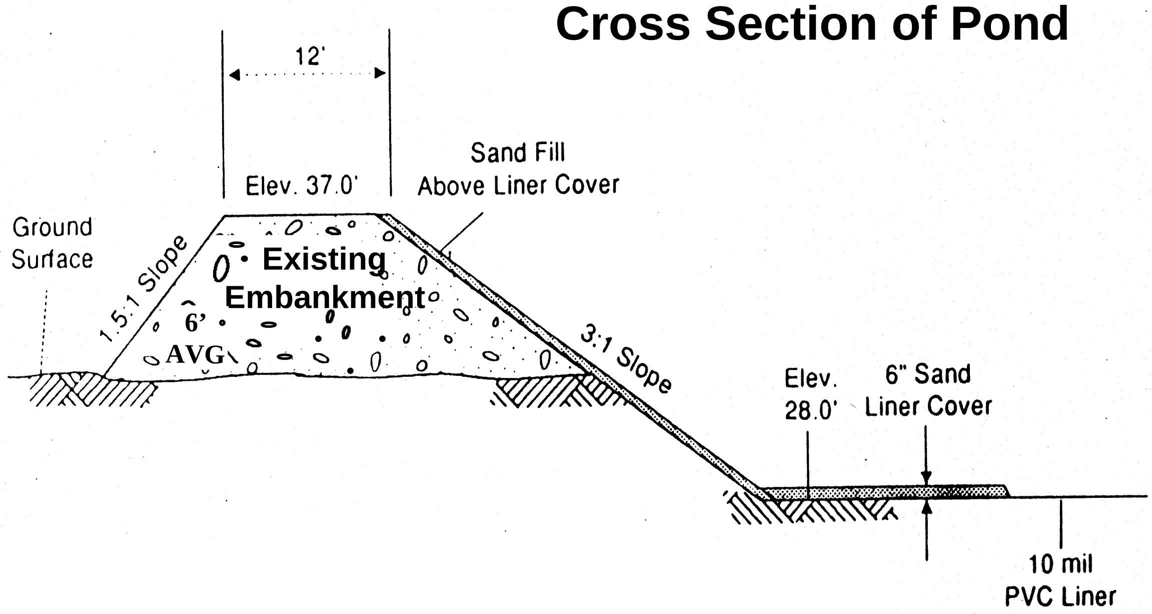
General Site Layout



Discussion Leader/Facilitator Notes: This general site layout of the project shows the location of the brine-holding pond that will be remediated. The pond is just east of a large wetlands area and southwest of the project main building. Other items of interest are the interstate access and the canal in the southwestern corner of the plan.

Notes / Discussion Points / Lessons-Learned: ____

Cross Section of Pond



Discussion Leader/Facilitator Notes: This drawing shows a cross section of the pond and the dike. This cross section shows that the existing dike (embankment) is about 6 ft high, 12 ft wide on top, with an inside slope of 3:1 and an outside slope of 1.5:1. The pond area is lined with a 10-mil PVC liner with a 6- in. sand fill on top of the PVC liner.

Notes / Discussion Points / Lessons-Learned: ______________________________

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How to Prepare a Planning Cost Estimate

For each step of the estimating process, we will

1. **Discuss the general application of each step**
2. **Apply it to the example project**
3. **Discuss and share lessons learned**

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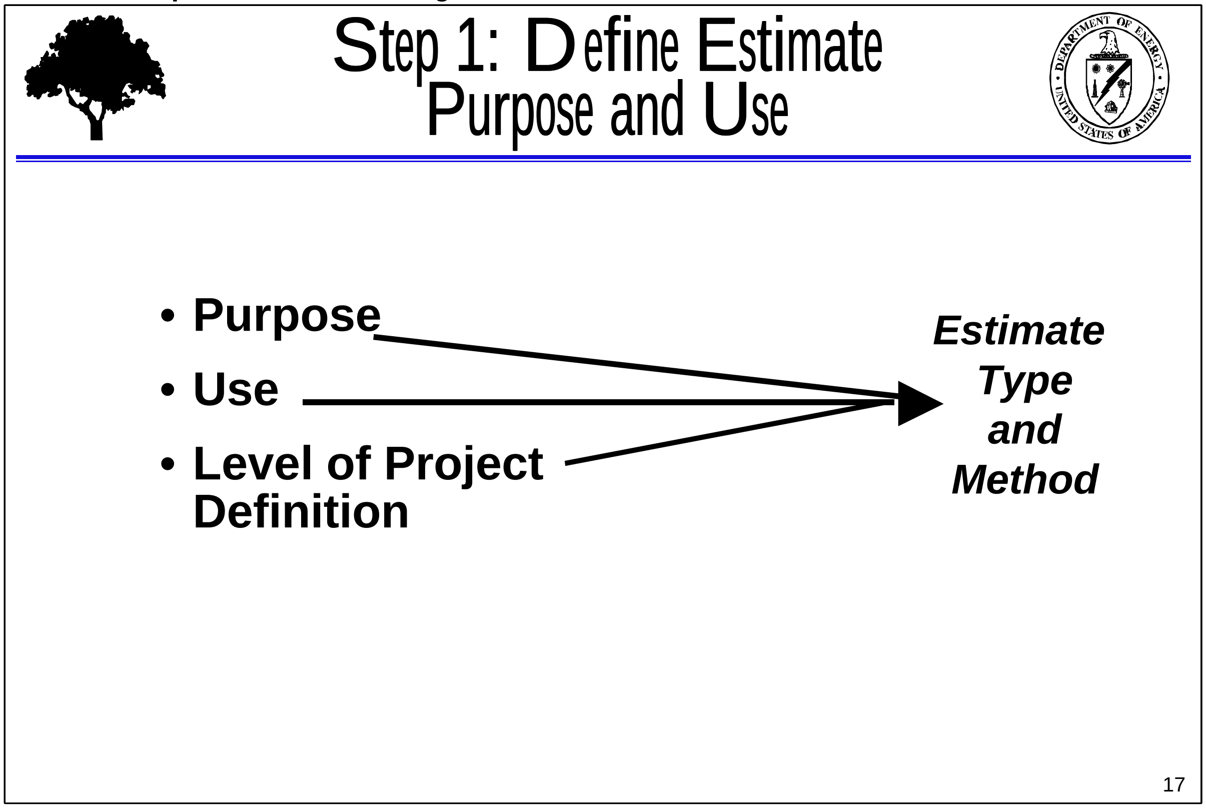
The process we will use for walking through the cost-estimating process for planning cost estimates is to take each step of the estimating process on Page 5, and:

1. Discuss the general application of each step.
2. Apply the step to the example project (Brine Pond).
3. Discuss, as applicable, the results of the example problem and related issues of interest and share any lessons learned.

Notes / Discussion Points / Lessons-Learned: ____________________



Discussion Leader/Facilitator Notes: The facilitator is to ask participants to discuss why the Brine Pond Estimate is being done and its use. Define the estimate purpose. Then discuss and define an appropriate estimate type.

General Application — Step 1

Identifying the intended use and purpose of the estimate will prove essential for determining the appropriate estimate type (planning, preliminary, or detailed). The purpose and intended use with the level of project definition determines the estimate type and methods that should be used.

Application to Brine Pond Project — Step 1

For the example Brine Pond Project:

Q What is the purpose and intended use of this project estimate?

A To provide a planning cost estimate to determine whether this project is feasible within the budgetary constraints.

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Notes / Discussion Points / Lessons-Learned: ______________________________

Q What estimate type is appropriate and why?

A A planning estimate is appropriate because

1. The purpose is to obtain a planning or idea of funding that may be required for this project.

2. The use of the estimate is to evaluate the feasibility of pursuing this project.

3. The scope of the project is limited and very conceptual at this time.

4. The time period required to complete the estimate does not allow for a more detailed estimating effort.

Notes / Discussion Points / Lessons-Learned: ________________________________

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Be careful to identify and understand the estimate use!

- Always document carefully your estimate purpose and use.
- Always ensure that your estimate states the type of estimate it is.

Notes / Discussion Points / Lessons-Learned: ________________________________

Step 2: Develop and Obtain Available Scope Data

Resources:

- **Written documents containing project information, history, and scope**
- **Team meetings**
- **Discussions with personnel familiar with the project**
- **Information about similar projects**

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Discussion Leader/Facilitator Notes: The facilitator is to allow participants to add any additional items/questions to this list.

<u>General Application — Step 2</u>

- Develop and obtain available scope information by thinking through how the work will be accomplished and the required process or work elements that will be required.

- The estimator will question what will be required and how the work will be accomplished. The estimator will then obtain answers to questions using available resources.

<u>Application to Brine Pond Project — Step 2</u>

On the example Brine Pond Project, example questions may include such items as the following:

Q Where will material be disposed, and what permitting or approvals will be required?

A Material is most likely nonhazardous or at least at very low levels of hazardous waste. Therefore, it is reasonable to assume disposal at a local disposal facility.

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Notes / Discussion Points / Lessons-Learned: ______________________________

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Q What will be required for containment of materials during transportation?
Lined trucks?
Covered trucks?
Loading area to clean dirt off tires before loading?

A Even if material is nonhazardous, public perception will require lined and covered trucks. A loading area to clean dirt off the exterior of the trucks before departure will be required.

Q Will any special training be required?

A No.

Participants may list other questions that need to be considered to develop an estimate.

Q What contaminant levels do we think we have?

A Dissolved minerals (chloride, sodium, and sulfates), elevated levels of dissolved minerals and radioactive isotopes caused by subterranean contact with mineralized strata under conditions of high temperature and pressure. Petroleum hydrocarbons/oil and grease are suspected because of plant operations and use of the pond for disposal.

Contaminant levels are not expected to be high enough to require above a Level D or Level C personnel protection.

Notes / Discussion Points / Lessons-Learned: ______________________________

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Step 3: Evaluate Site Conditions

- **Condition of site**
- **Location (weather and environment)**
- **Access**
- **Security**
- **Facilities (utilities, storage, clearings, etc.)**
- **Contamination control (containment of material during loading and transporting)**

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Discussion Leader/Facilitator's Notes: The facilitator is to get the participants to discuss and define what has been described about the site conditions of the Brine Pond Project.

General Application — Step 3

- A site visit, if possible, can provide valuable insight to the estimator in evaluating and understanding what the project will involve or require.

  If a site visit is not feasible, pictures or discussions with personnel who are familiar with the site can provide needed information about site conditions.

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Notes / Discussion Points / Lessons-Learned: ____________________

Application to Brine Pond Project — Step 3

Q What do you know about the site conditions of the Brine Pond Project?

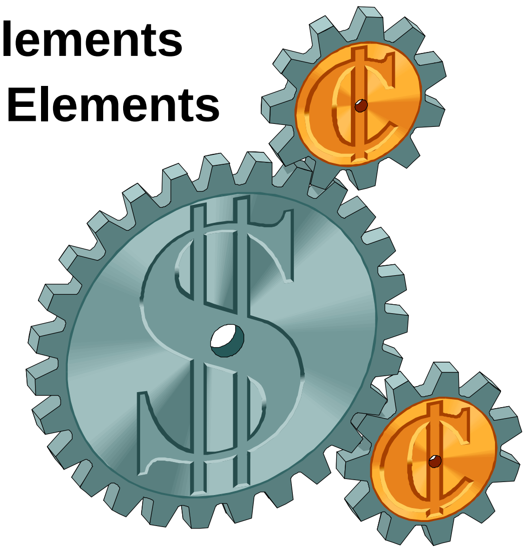
A

1. It is an unused site, and the facilities are in disrepair.
2. It has a warm and mild climate with little rainfall.
3. It is located close to the interstate and has little or no vegetation.
4. The site is already secured from access by the public; however, no security requirements will affect workers.
5. Utilities are available on-site. Open space will allow for ample storage and access.
6. Because of the dry climate, dust may be a problem and may require monitoring. Staging areas for removal and transportation of waste off-site will be required to load and clean trucks before departure.
7.
8.
9.

Notes / Discussion Points / Lessons-Learned: ____________________

Step 4: Define Project Types of Costs

- **Direct Work/Cost Elements**
- **Indirect Work/Cost Elements**
- **Escalation**
- **Contingency**



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General Application — Step 4

As defined and discussed in Section 1.7, Types of Costs, typically include direct costs, indirect costs, escalation, and contingency. These components or elements will define work elements that will eventually make up the work breakdown structure (WBS).

Application to Brine Pond Project — Step 4

Q What are the project components to remediate the Brine Pond Project?

A Suggested items of categories for the Brine Pond Project include the following:

Direct Work/Cost Elements:

- Excavate waste
- Excavate dike fill
- Transport waste to disposal site
- Disposal (costs)
- Place dike fill

(Continued on next page)

Notes / Discussion Points / Lessons-Learned:

- Demolish concrete intake
- Scrap steel discharge pipes and structures
- Health & Safety Program
- Mobilization/Demobilization

Indirect Work/Cost Elements:

- Construction Management
- Permitting
- Bonds and Insurance
- Engineering and Project Management

Escalation:

Contingency:

Notes / Discussion Points / Lessons-Learned:

Step 5: Develop Estimate

Develop estimates for each of the types of costs.

- **Direct Cost:**
  - — **Determine quantity or magnitude**
  - — **Establish the rates and/or factors**
  - — **Calculate or derive cost**

(Direct Cost continued on next slide)

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General Application — Step 5

- Estimates are developed for each of the types of costs defined in Step 4.
- Estimates for the direct costs are typically developed by
  - – Determining the quantity or magnitude of work
  - – Establishing appropriate rates and/or factors to apply
  - – Calculating or deriving cost based on quantity and rate

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Notes / Discussion Points / Lessons-Learned: ____________________

Step 5: Develop Estimate (Continued)

Brine Pond Project

Direct Costs:

Excavate dike material

1. **Calculate or determine the quantity of material**
2. **Determine the unit cost**

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Discussion Leader/Facilitator Notes: The facilitator is to walk through development of the cost for one element of direct cost, which is the excavation of the dike material. The facilitator is to have the R.S. Means "1997 Facilities Construction Cost Data 12th Annual Edition" to demonstrate where the reference materials have been obtained in the following examples.

Application to Brine Pond Project — Step 5

For this step, the facilitator will first demonstrate the calculation of one of the components of direct costs of this project, excavation of the waste material. The facilitator will demonstrate the calculation of the quantity of material and then determine the unit cost for excavating the waste material.

Excavation of waste material will be calculated using a crawler-mounted backhoe. In Section 2.2, the detailed estimate calculation will be based on the use of a D8R dozer.

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Notes / Discussion Points / Lessons-Learned: ______________________________

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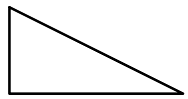
1. Calculate or determine waste quantity of material

<u>Pond Size:</u>
540 ft x 500 ft
Waste and sand thickness = 1.16 ft
(8 in. + 6 in. = 14 in.
÷ 12 in./ft = 1.16 ft)

Side slopes

1.16´



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Calculation of the Brine and Sand Waste Quantities

Description	No. Pcs.	Length (ft)	Width (ft)	Height (ft)	Quantity	Total Quantity
Excavation Brine and Sand						
Pond Waste - Excavation	*1*	*540*	*500*	*1.16*	*313,200 cf*	
Side Slopes	*1*	*540*	*3.48*	*1.16*	*2,180 cf*	
	1	*500*	*3.48*	*1.16*	*2,018 cf*	
				Total	*317,398 cf*	
					÷ 27	
					11,756 cy	
Bank Measure					*use*	*12,000 bcy*
Add 20% for Expansion					*2,351 cy*	
					14,107 cy	
Loose Measure					*use*	*14,400 lcy*

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Volume of triangle = 1/2 (base, height, and length) x 2 sides of pond = 1/2 (base, height, and length) + 1/2 (base, height, and length) = 1 (base, height, and length)
Triangle = 1.16 ft high x 3.48 ft base

12,000 cy bank measure
14,400 cy loose measure
(20% Expansion factor)

2. Method of accomplishment

Includes level cut into dike exterior wall to create pond entry and loading point. Excavator will locate in Brine Pond surface area and excavate toward equipment to minimize contamination spread. The excavator will load trucks.

3. Determine gross unit costs to use

Defined assumptions
- General excavation
- Level D
- Open site
- Nonhazardous

The following two resources are used to derive a rate for excavation of this dike:

(Continued on next page)

Notes / Discussion Points / Lessons-Learned: ______________________________

Section 2.1: Preparation of a Planning Cost Estimate/Lessons Learned

Resource 1 - Historical project data

Actual information on the Lauie Pond Project. This project appears to be an excavation project that was completed last September. The Lauie Pond Project is in southern California. However, the Lauie Pond Project was in a dense vegetation area. The locations and conditions of the Lauie Pond and the Brine Pond projects appear to be comparable.

Final Cost Report for Lauie Pond Project

PROGRESS PAYMENT ESTIMATE

Payment Estimate No. 04 Page 1 of 1
Date of Preparation 2-14-97

Subcontractor: CEP Environmental	Total Approved S/C Amount $541,465	Work Order No.
Project: Lauie Pond Project	Subcontractor Start Date 6-20-96	Subcontractor No 30177/677 Release No. 1
	Subcontractor Comp. Date 9/14/96	Modification No. 1

Description	Units	% to Date	Unit Price	PRIOR PERIOD Up to (Date) Qty	Amount	CURRENT PERIOD Up to (Date) Qty	Amount	TOTAL TO DATE Qty	Amount
Contract Award		100	-		-		-		-
Submittals of Bonds	1 LS	100	7,466.00	1 LS	7,466.00	1 LS	7,466.00	1 LS	7,466.00
Pre Meetings	2 EA	100	4,300.00	2 EA	8,600.00	2 EA	8,600.00	2 EA	8,600.00
Worker Training	1 LS	100	6,412.00	1 LS	6,412.00	1 LS	6,412.00	1 LS	6,412.00
Insurance	1 LS	100	18,666.00	1 LS	18,666.00	1 LS	18,666.00	1 LS	18,666.00
On-site Modifications	6 EA	100	24,069.33	6 EA	144,416.00	6 EA	144,416.00	6 EA	144,416.00
Site-Specific Medicals	20	100	102.50	20	2,050.00	20	2,050.00	20	2,050.00
Clearing (wooded)	5 ACR	100	14,100.00	5 ACR	70,500.00	5 ACR	70,500.00	5 ACR	70,500.00
Excavation Pond Waste	5560	100	4.28	5560	23,797.00	5560	23,797.00	5560	23,797.00
Hauling	5560	100	14.00	5560	77,840.00	5560	77,840.00	5560	77,840.00
Backfill	5560	100	5.09	5560	28,300.00	5560	28,300.00	5560	28,300.00
Remove Structure	1 EA	100	11,000.00	1 EA	11,000.00	1 EA	11,000.00	1 EA	11,000.00
Construction Mgt.	1 LS	100	11,962.00	1 LS	11,962.00	1 LS	11,962.00	1 LS	11,962.00
Eng. Oversight	1 LS	100	10,555.00	1 LS	10,555.00	1 LS	10,555.00	1 LS	10,555.00
Project Management	1 LS	100	24,628.00	1 LS	24,628.00	1 LS	24,628.00	1 LS	24,628.00
Substantially Complete		100	-		-		-		-
Complete Punch List	20 EA	100	425.00	20 EA	8,500.00	20 EA	8,500.00	20 EA	8,500.00
Mob. and Demob. Site	1 LS	100	11,190.00	1 LS	11,190.00	1 LS	11,190.00	1 LS	11,190.00
Unit Price Over Excav.	2870	100	5.00	2870	-	2870	14,350.00	2870	14,350.00
Modification	1 EA	100	61,535.00	1 EA	-	1 EA	61,535.00	1 EA	61,535.00
					Total: $465,882		Total: $541,767		Total: $541,767

Research has obtained the preceding actual quantities and costs for the Lauie Pond Project.

Excavation for the Lauie Pond Project cost $23,797 for excavation of 5560 cy of material

5560 cy @ $23,797 = $4.28/cy rate loose measure

$5.14/cy or bank measure

$$\left(\frac{\$4.28/\text{cy loose measure} \times 14{,}400 \text{ cy loose measure}}{12{,}000 \text{ cy bank measure}} = 5.14/\text{cy bank measure} \right)$$

(Continued on next page)

Notes / Discussion Points / Lessons-Learned: ______________________________

Resource 2 - Estimating standards - R.S. Means

In Section 1.8, we demonstrated the use of the ECHOS Unit Cost Book. The use of R.S. Means is very similar to ECHOS. We will now use the R.S. Means *1997 Facilities Construction Cost Data 12th Annual Edition.* Using this standard industry estimating guide, we obtained the following excavation rates.

The Earthwork Sheet, Page 62 (shown on next page) from the R.S. Means *1997 Facilities Construction Cost Data 12th Annual Edition.*

Discussion with our excavation expert reveals that for this project the preferred method to obtain reasonable production rates would be to use a hydraulic crawler-mounted backhoe with a 3-cy-capacity bucket using the method of accomplishment described earlier. The base rate is obtained from the Earthwork Sheet (as shown on the following page).

$2.34/cy base rate (for Bulk Bank Measure, common earth)

Factors or adders are required to adjust this role for conditions of our project. These factors include the following: [Rates are obtained from the Earthwork Sheet (as shown on following page).]

Productivity factors
15% added for loading into trucks (B)
60% added for heavier or stiff (C)

0% Level D (assumed safety level)
75% total productivity factors

$2.34/cy base rate
75% increase
$4.095

A location index is also appropriate for this cost. From the city cost indexes (as shown on the page after the earthwork sheet) the location index for Site Work in the San Diego area is 99.6:

$4.095 x .996 = $4.08/cy.

Based on a comparison of these two rates ($5.14/cy and $4.08/cy), the estimator decides to use the
$5.00 x 12,000 cy bank measure
$60,000

(Continued on next page)

Notes / Discussion Points / Lessons-Learned: ______________________

____

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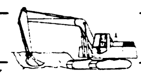
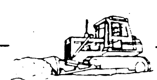
022 | Earthwork

2 SITE WORK

		022 200 | Excav./Backfill/Compact.	CREW	DAILY OUTPUT	LABOR-HOURS	UNIT	1997 BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P	
234	5460	4 mile round trip	B-34E	200	.040	C.Y.		.85	3.23	4.08	4.95	
	5600	Bury boulders on site, less than 0.5 C.Y., 300 H.P. dozer										
	5620	150' haul	B-10M	310	.039	C.Y.		.95	3.58	4.53	5.50	
	5640	300' haul		210	.057			1.41	5.30	6.71	8.10	
	5800	0.5 to 1 C.Y., 300 H.P. dozer, 150' haul		300	.040			.98	3.70	4.68	5.65	
	5820	300' haul		200	.060			1.48	5.55	7.03	8.50	
238	0010	**EXCAVATING, BULK BANK MEASURE** Common earth piled										
	0020	For loading onto trucks, add								15%	15%	(B)
	0050	For mobilization and demobilization, see division 022-274										
	0100	For hauling, see division 022-266										
	0200	Backhoe, hydraulic, crawler mtd., 1 C.Y. cap. = 75 C.Y./hr.	B-12A	600	.027	C.Y.		.68	.92	1.60	2.09	
	0250	1-1/2 C.Y. cap. = 100 C.Y./hr.	B-12B	800	.020			.51	.89	1.40	1.79	
	0260	2 C.Y. cap. = 130 C.Y./hr. 	B-12C	1,040	.015			.39	.94	1.33	1.65	
	0300	3 C.Y. cap. = 160 C.Y./hr.	B-12D	1,280	.013			.32	1.67	1.99	2.34	(A)
	0310	Wheel mounted, 1/2 C.Y. cap. = 30 C.Y./hr.	B-12E	240	.067			1.69	1.39	3.08	4.23	
	0360	3/4 C.Y. cap. = 45 C.Y./hr.	B-12F	360	.044			1.13	1.25	2.38	3.18	
	0500	Clamshell, 1/2 C.Y. cap. = 20 C.Y./hr.	B-12G	160	.100			2.54	2.95	5.49	7.30	
	0550	1 C.Y. cap. = 35 C.Y./hr.	B-12H	280	.057			1.45	1.98	3.43	4.49	
	0950	Dragline, 1/2 C.Y. cap. = 30 C.Y./hr.	B-12I	240	.067			1.69	2.03	3.72	4.94	
	1000	Dragline, 3/4 C.Y. cap. = 35 C.Y./hr.	"	280	.057			1.45	1.74	3.19	4.24	
	1050	1-1/2 C.Y. cap. = 65 C.Y./hr.	B-12P	520	.031			.78	1.52	2.30	2.92	
	1100	3 C.Y. cap. = 112 C.Y./hr.	B-12V	900	.018			.45	1.13	1.58	1.97	
	1200	Front end loader, track mtd., 1-1/2 C.Y. cap. = 70 C.Y./hr.	B-10N	560	.021			.53	.65	1.18	1.58	
	1250	2-1/2 C.Y. cap. = 95 C.Y./hr.	B-10O	760	.016			.39	.65	1.04	1.34	
	1300	3 C.Y. cap. = 130 C.Y./hr.	B-10P	1,040	.012			.28	.79	1.07	1.33	
	1350	5 C.Y. cap. = 160 C.Y./hr.	B-10Q	1,620	.007			.18	.70	.88	1.07	
	1500	Wheel mounted, 3/4 C.Y. cap. = 45 C.Y./hr.	B-10R	360	.033			.82	.65	1.47	2.04	
	1550	1-1/2 C.Y. cap. = 80 C.Y./hr.	B-10S	640	.019			.46	.49	.95	1.28	
	1601	3 C.Y. cap. = 100 C.Y./hr.	B-10T	1,100	.011			.27	.39	.66	.87	
	1650	5 C.Y. cap. = 185 C.Y./hr.	B-10U	1,480	.008			.20	.60	.80	.98	
	1800	Hydraulic excavator, truck mtd, 1/2 C.Y. = 30 C.Y./hr.	B-12J	240	.067			1.69	2.53	4.22	5.50	
	1850	48 inch bucket, 1 C.Y. = 45 C.Y./hr.	B-12K	360	.044			1.13	2.17	3.30	4.18	
	3700	Shovel, 1/2 C.Y. capacity = 55 C.Y./hr.	B-12L	440	.036			.92	1.09	2.01	2.67	
	3750	3/4 C.Y. capacity = 85 C.Y./hr.	B-12M	680	.024			.60	.81	1.41	1.84	
	3800	1 C.Y. capacity = 120 C.Y./hr.	B-12N	960	.017			.42	.65	1.07	1.39	
	3850	1-1/2 C.Y. capacity = 160 C.Y./hr.	B-12O	1,280	.013			.32	.70	1.02	1.28	
	3900	3 C.Y. cap. = 250 C.Y./hr.	B-12T	2,000	.008			.20	.61	.81	.99	
	4000	For soft soil or sand, deduct								15%	15%	
	4100	For heavy soil or stiff clay, add								60%	60%	
	4200	For wet excavation with clamshell or dragline, add								100%	100%	(C)
	4250	All other equipment, add								50%	50%	
	4400	Clamshell in sheeting or cofferdam, minimum	B-12H	160	.100			2.54	3.46	6	7.85	
	4450	Maximum	"	60	.267			6.75	9.20	15.95	21	
	8000	For hauling excavated material, see div. 022-266										
242	0010	**EXCAVATING, BULK, DOZER** Open site										
	2000	75 H.P., 50' haul, sand & gravel	B-10L	460	.026	C.Y.		.64	.62	1.26	1.72	
	2020	Common earth		400	.030			.74	.71	1.45	1.98	
	2040	Clay		250	.048			1.18	1.14	2.32	3.17	
	2200	150' haul, sand & gravel		230	.052			1.28	1.24	2.52	3.44	
	2220	Common earth		200	.060			1.48	1.42	2.90	3.97	
	2240	Clay 		125	.096			2.36	2.28	4.64	6.35	
	2400	300' haul, sand & gravel		120	.100			2.46	2.37	4.83	6.60	
	2420	Common earth		100	.120			2.95	2.85	5.80	7.90	
	2440	Clay		65	.185			4.55	4.38	8.93	12.20	
	3000	105 H.P., 50' haul, sand & gravel	B-10W	700	.017			.42	.60	1.02	1.34	
	3020	Common earth		610	.020			.48	.69	1.17	1.55	

Notes / Discussion Points / Lessons-Learned: ______________________________

Section 2.1: Preparation of a Planning Cost Estimate/Lessons Learned

Look under the San Diego table for the first column, "Site Work." This index is defined as 99.6.

City Cost Indexes

	DIVISION	CALIFORNIA																	
		OXNARD			PALM SPRINGS			PALO ALTO			PASADENA			REDDING			RICHMOND		
		930			922			943			910 - 912			960			948		
		MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL
2	SITE WORK	93.1	109.3	105.6	78.8	112.6	104.8	113.1	107.8	109.1	79.1	111.6	104.1	98.0	111.1	108.1	125.8	107.8	112.0
031	CONCRETE FORMWORK	98.9	124.3	120.6	93.6	124.0	119.6	99.1	138.1	132.4	90.2	123.8	118.9	98.5	125.2	121.3	122.0	137.9	135.6
032	CONCRETE REINFORCEMENT	109.1	110.7	110.0	111.3	110.8	111.0	99.9	112.1	106.8	113.9	111.1	112.3	105.7	110.7	108.5	99.9	111.5	106.4
033	CAST IN PLACE CONCRETE	96.6	122.4	107.5	87.8	123.3	102.8	99.1	123.4	109.4	83.2	119.8	98.6	109.2	119.6	113.6	114.1	126.7	119.4
3	CONCRETE	116.8	119.9	118.4	108.5	120.1	114.4	111.7	126.8	119.3	109.2	118.7	114.0	127.2	119.3	123.2	127.2	127.8	127.5
4	MASONRY	111.1	117.4	115.0	83.0	121.3	106.8	104.7	141.9	127.8	104.1	126.0	117.7	111.4	117.4	115.2	125.5	130.3	128.5
5	METALS	104.7	99.4	102.7	110.3	99.6	106.3	101.6	107.4	103.7	92.5	97.7	94.4	109.2	99.5	105.6	101.6	106.5	103.4
6	WOOD & PLASTICS	97.0	122.8	110.2	93.8	122.6	108.6	106.0	138.4	122.7	84.2	122.2	103.7	98.4	124.3	111.7	131.4	138.4	135.0
7	THERMAL & MOISTURE PROTECTION	108.7	118.4	113.2	119.0	120.4	119.6	108.9	137.8	122.3	104.4	120.6	111.9	109.4	117.9	113.3	109.8	134.8	121.4
8	DOORS & WINDOWS	104.7	116.9	107.6	103.9	116.6	107.0	106.1	126.7	111.1	99.7	116.6	103.8	107.5	115.7	109.5	106.1	126.9	111.1
092	LATH, PLASTER & GYPSUM BOARD	95.1	123.4	113.6	93.0	123.4	112.9	93.3	139.3	123.4	85.2	123.4	110.2	95.6	125.1	114.9	102.5	139.3	126.6
095	ACOUSTICAL TREATMENT & WOOD FLOORING	130.3	123.4	125.9	128.9	123.4	125.4	123.6	139.3	133.7	123.4	123.4	123.4	137.5	125.1	129.5	123.6	139.3	133.7
096	FLOORING & CARPET	125.9	121.3	124.8	128.1	115.2	125.0	114.6	121.2	116.2	119.7	120.1	119.8	125.1	121.2	124.2	123.1	121.2	122.6
099	PAINTING & WALL COVERINGS	122.2	119.8	120.8	119.6	120.4	120.0	127.1	132.8	130.5	124.7	120.4	122.2	122.2	109.4	114.7	127.1	129.9	128.7
9	FINISHES	122.2	123.3	122.7	119.0	122.2	120.6	118.7	135.1	127.1	114.5	122.7	118.7	123.7	122.8	123.2	123.3	134.7	129.1
10 - 14	TOTAL DIV. 10 - 14	100.0	118.4	103.9	100.0	118.0	103.8	100.0	143.2	109.1	100.0	116.8	103.5	100.0	139.5	108.3	100.0	143.2	109.1
15	MECHANICAL	100.1	123.5	110.4	96.7	122.4	108.0	96.8	147.8	119.2	96.6	122.4	107.9	100.1	117.8	107.9	96.8	142.3	116.8
16	ELECTRICAL	97.5	117.9	111.1	99.3	108.0	105.1	111.1	136.9	128.3	113.3	124.7	120.9	102.6	91.3	95.1	112.6	129.2	123.6
1 - 16	WEIGHTED AVERAGE	106.1	117.3	111.5	103.2	116.1	109.4	105.4	132.0	118.2	101.3	118.9	109.8	109.0	112.3	110.6	109.6	128.5	118.7

	DIVISION	CALIFORNIA																	
		RIVERSIDE			SACRAMENTO			SALINAS			SAN BERNARDINO			SAN DIEGO			SAN FRANCISCO		
		925			942,956 - 958			939			923 - 924			919 - 921			940 - 941		
		MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL
2	SITE WORK	85.2	112.6	106.3	90.7	114.4	108.9	108.8	111.9	111.2	63.8	112.6	101.3	83.3	104.5	99.6	127.2	114.6	117.5
031	CONCRETE FORMWORK	102.7	124.1	121.0	104.6	125.8	122.7	100.3	128.6	124.5	103.8	124.0	121.0	101.1	123.4	120.2	105.6	143.0	137.6
032	CONCRETE REINFORCEMENT	108.1	110.7	109.6	103.3	110.9	107.6	109.6	111.3	110.6	108.1	110.7	109.6	110.3	110.5	110.4	116.4	112.2	114.1
033	CAST IN PLACE CONCRETE	96.3	123.4	107.8	100.1	121.5	109.1	90.7	121.3	103.6	61.6	123.3	87.7	91.2	111.9	99.9	114.0	127.4	119.6
3	CONCRETE	116.8	120.2	118.5	119.6	120.3	120.0	129.8	121.5	125.6	82.9	120.1	101.7	116.0	115.9	116.0	128.1	130.4	129.3
4	MASONRY	83.6	118.9	105.6	106.2	121.5	115.8	105.4	127.8	119.3	92.7	118.9	109.0	96.3	115.7	108.4	133.4	141.4	138.4
5	METALS	110.8	99.7	106.7	99.6	100.6	99.9	109.8	101.1	106.6	110.4	99.5	106.4	110.1	99.5	106.2	108.3	108.9	108.5
6	WOOD & PLASTICS	99.3	122.6	111.3	105.4	124.4	115.2	103.2	127.7	115.8	104.6	122.6	113.8	97.7	122.6	110.5	109.2	143.8	127.0
7	THERMAL & MOISTURE PROTECTION	119.7	120.0	119.8	117.6	119.7	118.6	104.6	125.7	114.4	118.0	119.9	118.9	115.6	111.7	113.8	109.3	139.3	123.3
8	DOORS & WINDOWS	107.3	116.8	109.6	117.1	115.7	116.7	106.1	120.9	109.7	104.0	116.6	107.0	105.9	116.9	108.5	108.2	131.1	113.7
092	LATH, PLASTER & GYPSUM BOARD	95.1	123.4	113.6	92.7	125.1	113.9	96.4	128.5	117.5	96.8	123.4	114.2	90.1	123.4	111.9	96.8	144.6	128.1
095	ACOUSTICAL TREATMENT & WOOD FLOORING	130.3	123.4	125.9	132.1	125.1	127.6	136.1	128.5	131.2	130.3	123.4	125.9	131.9	123.4	126.4	133.5	144.6	140.7
096	FLOORING & CARPET	130.3	121.3	128.1	118.1	121.2	118.8	126.8	121.2	125.5	132.3	115.4	128.2	129.5	120.5	127.3	115.6	121.2	117.0
099	PAINTING & WALL COVERINGS	119.6	123.5	121.9	125.1	111.6	117.2	122.2	133.5	128.8	119.6	119.1	119.3	122.0	122.1	122.0	127.1	141.9	135.8
9	FINISHES	120.5	123.6	122.1	120.3	123.2	121.8	125.1	128.5	126.8	120.2	122.1	121.1	120.6	123.3	122.0	122.0	139.5	130.9
10 - 14	TOTAL DIV. 10 - 14	100.0	118.0	103.8	100.0	140.0	108.4	100.0	140.3	108.4	100.0	118.0	103.8	100.0	117.8	103.7	100.0	144.8	109.4
15	MECHANICAL	100.1	123.4	110.3	100.1	122.7	110.0	96.7	118.1	106.1	96.7	122.2	107.9	100.1	121.2	109.4	100.2	173.1	132.2
16	ELECTRICAL	93.4	108.0	103.1	103.0	110.4	108.0	92.6	121.8	112.0	99.3	110.9	107.0	95.8	93.9	94.5	107.4	149.9	135.7
1 - 16	WEIGHTED AVERAGE	105.4	116.2	110.6	107.3	117.5	112.2	107.8	120.1	113.7	100.5	116.3	108.1	105.8	111.5	108.5	111.4	141.1	125.7

	DIVISION	CALIFORNIA																	
		SAN JOSE			SAN LUIS OBISPO			SAN MATEO			SAN RAFAEL			SANTA ANA			SANTA BARBARA		
		951			934			944			949			926 - 927			931		
		MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL
2	SITE WORK	129.2	104.9	110.5	100.3	111.7	109.1	122.5	107.9	111.2	102.7	114.7	112.0	77.0	112.6	104.4	93.0	111.8	107.4
031	CONCRETE FORMWORK	101.2	142.0	136.1	106.4	123.9	121.3	107.8	138.0	133.6	116.4	137.7	134.5	104.5	124.1	121.2	99.4	124.1	120.5
032	CONCRETE REINFORCEMENT	106.0	112.1	109.5	111.1	110.6	110.8	99.9	112.1	106.8	100.7	112.0	107.1	111.9	110.7	111.2	109.1	110.7	110.0
033	CAST IN PLACE CONCRETE	115.6	125.3	119.7	102.5	122.1	110.8	110.4	124.3	116.3	128.5	122.9	126.1	84.2	123.3	100.7	92.5	122.2	105.1
3	CONCRETE	125.7	129.2	127.5	126.9	119.6	123.2	122.7	127.1	124.9	151.3	126.2	138.6	105.8	120.1	113.1	114.9	119.8	117.3
4	MASONRY	146.6	142.2	143.8	107.6	117.2	113.5	125.2	141.1	135.1	102.2	141.0	126.4	81.2	119.3	104.9	105.8	118.9	113.9
5	METALS	111.1	107.8	109.9	106.9	98.9	103.9	101.5	107.3	103.6	103.0	102.7	102.9	110.4	99.5	106.4	104.5	99.3	102.6
6	WOOD & PLASTICS	104.5	143.4	124.5	106.4	122.8	114.8	115.7	138.4	127.4	118.2	138.1	128.4	106.8	122.6	114.9	97.0	122.8	110.2
7	THERMAL & MOISTURE PROTECTION	105.5	138.4	120.8	104.3	115.0	109.3	109.4	137.1	122.3	125.4	136.2	130.4	119.5	120.7	120.1	103.7	116.5	109.7
8	DOORS & WINDOWS	96.9	130.3	105.0	103.7	115.6	106.6	106.0	128.1	111.4	115.9	127.9	118.8	103.1	116.6	106.4	106.0	116.9	108.6
092	LATH, PLASTER & GYPSUM BOARD	96.2	144.6	127.9	105.1	123.4	117.1	96.7	139.3	124.6	98.4	139.3	125.2	97.9	123.4	114.6	95.1	123.4	113.6
095	ACOUSTICAL TREATMENT & WOOD FLOORING	121.8	144.6	136.6	136.1	123.4	127.9	123.6	139.3	133.7	132.1	139.3	136.8	130.3	123.4	125.9	130.3	123.4	125.9
096	FLOORING & CARPET	122.8	121.2	122.4	134.1	108.8	128.0	117.8	121.2	118.6	127.6	121.2	126.0	133.1	119.3	129.8	125.9	108.8	121.8
099	PAINTING & WALL COVERINGS	124.3	133.5	129.7	122.2	119.8	120.8	127.1	132.8	130.5	122.4	127.9	125.6	119.6	120.4	120.0	122.2	119.8	120.8
9	FINISHES	121.3	138.1	129.9	127.9	121.1	124.4	120.6	135.1	128.0	122.2	134.3	128.4	121.5	122.9	122.2	122.3	121.1	121.7
10 - 14	TOTAL DIV. 10 - 14	100.0	143.7	109.2	100.0	118.3	103.8	100.0	143.3	109.1	100.0	142.2	108.9	100.0	118.0	103.8	100.0	118.3	103.8
15	MECHANICAL	100.1	148.0	121.2	96.7	122.6	108.1	96.8	136.0	114.0	96.7	154.8	122.2	96.7	122.6	108.1	100.1	123.4	110.4
16	ELECTRICAL	105.9	136.9	126.5	92.1	112.7	105.8	111.1	142.0	131.7	105.2	111.9	109.6	99.3	112.8	108.3	90.5	112.2	105.0
1 - 16	WEIGHTED AVERAGE	110.6	132.7	121.3	106.9	116.0	111.3	108.4	130.6	119.1	111.6	129.2	120.1	103.1	116.8	109.7	105.0	116.4	110.5

COST INDEXES

Notes / Discussion Points / Lessons-Learned: ______________________________

Step 5: Develop Estimate (Continued)

- **Indirect Cost:**
  Determine appropriate magnitude of effort (usually as a percentage)
- **Escalation**
- **Contingency**

33

General Application — Step 5 (continued)

- Estimates for the indirect costs are typically developed by determining the appropriate magnitude of effort, which is usually derived as a percentage of direct costs, project costs, a rate, or the amount for a required time period.
- Escalation is applied to direct and indirect costs to inflate the cost from base-year dollars that the estimate represents to the time period in which the project is assumed to be accomplished. [Escalation calculations were discuss and demonstrated in Section 1.8, Cost-Estimate Process (Detailed Estimates)].
- Contingency is usually applied as a percentage of costs based on project risks and uncertainty. Contingency amounts can be applied to individual project elements or to total project costs. On planning estimates, contingency is usually applied to total project cost rather than to specific project elements. Contingency normally would be within the accuracy range of the estimate type. (Contingency was discussed and demonstrated in Section 1.8).

Notes / Discussion Points / Lessons-Learned: ______________________

Section 2.1: Preparation of a Planning Cost Estimate/Lessons Learned

Step 5: Develop Estimate (Continued)

Date: March 8, 1996
Rev: 0
Estimator: EJC

Brine Pond Project
Excavation and Removal or Residues to a Disposal Facility
Planning Construction Estimate Summary

CODE STRUCTURE	ITEM	UNIT COST	UNIT	QTY	ITEM COST
HTRW #	*Direct Costs*				
331.01.01	Mobilization				
331.10.03	Demolish concrete intake				
331.10.05	Scrap steel discharge pipes & structures				
331.05.12.01	Excavate dike fill				
331.05.12.02	Excavate waste	$5	cy	12,000	$60,000
331.22.07	Health & Safety Program				
331.20.01	Place dike fill				
331.19.21	Transport waste				
331.19.22	Disposal cost of waste				
331.21.04	Demobilization				
	Total Direct Costs				
	Indirect Costs				
331.22.01	Construction Management				
331.01.03	Permitting				
331.22.12	Bonds				
331.22.04	Engineering and Project Management				
	Total Indirect Costs				
	Contingency				
	TOTAL PROJECT COSTS (Rounded to nearest $10,000)				

34

Discussion Leader/Facilitator Notes: This is a sample format. Assume G&A has already been applied. Directs and indirects are fully burdened. The format will vary from each site and each organization.

- The rest of the estimate will be obtained and calculated similarly to that demonstrated for the excavation of the dike.
- Each direct cost element will be obtained by quantifying the work or materials and then applying the unit rate and/or pricing.
- Based on past experience, the indirect cost items are typically calculated as percentages.
- Escalation and contingency are added as discussed in Section 1.8 and will be demonstrated again in Section 2.2.
- Items are then totaled to obtain the Total Project Cost.

Notes / Discussion Points / Lessons-Learned: ______________________________

Step 6: Format Draft Estimate

- **Format the estimate**
- **Prepare the documentation.**
  - **Describe the assumed technical scope.**
  - **Provide the schedule assumptions.**
  - **Record the estimate basis and assumptions.**
- **Present the estimate clearly and concisely.**

35

Discussion Leaders/Facilitator Notes: The facilitator is to refer participants back to material presented in Section 1.9, Documentation Provided in Cost Estimate, for determining appropriate estimate documentation.

- The planning estimate and documentation must be formatted and documented to communicate clearly how the estimate was developed and the assumptions that were made. Providing backup and documenting assumptions are extremely important tasks in planning estimates because the lack of project definition requires more gross assumptions that can affect and vary cost significantly.

- Documentation must
  - Describe the technical scope of the project, including assumptions about the scope.
  - Provide schedule assumptions for project duration as well as the expected time period for executing the project.
  - Include the estimate basis and all assumptions made in the estimate process. How rates and costs were derived is important information to support the estimate.

- The estimate should be presented in a format that communicates the project costs clearly and concisely.

Notes / Discussion Points / Lessons-Learned: ______________________________

Step 7: Estimate Review/Sanity Checks

- **Comparison with similar projects and industry standards**
- **Peer review**
- **Project team review**

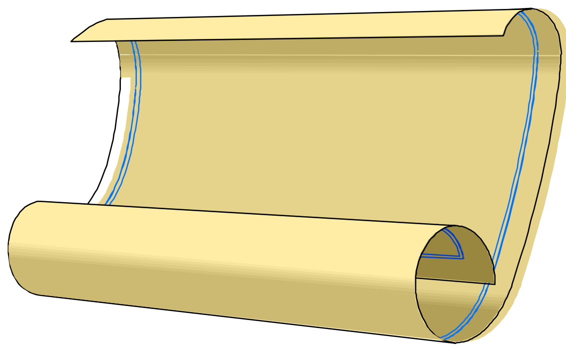
36

- As with all estimates, the review process is the most important step in the estimating process.
- The review process for the planning estimate should include some sanity checks and gross comparisons with similar projects to ensure that the estimate is indeed “in the ball park.”
- Peer reviews and project team reviews are also critical for ensuring that the estimate is reasonable and that all aspects have been considered.
- Document reviewers

Notes / Discussion Points / Lessons-Learned: ____________________

Step 8: Issue

Issue estimate for intended use



37

Clearly identifying the estimate type and intended use of the estimate as part of the estimate can help prevent an estimate from being misused for purposes that may require a higher accuracy level than that required for a planning estimate.

Notes / Discussion Points / Lessons-Learned: ______________________________

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Section 2.1: Preparation of a Planning Cost Estimate/Lessons Learned

Real-Life Planning Estimate

Date: March 8, 1996
Rev: 0
Estimator: EJC

Brine Pond Project
Excavation and Removal or Residues to a Disposal Facility
Planning Construction Estimate Summary

CODE STRUCTURE	ITEM	UNIT COST	UNIT	QTY	ITEM COST
HTRW #	Direct Costs				
331.01.01	Mobilization	$10,000	Lot	1	$6,000
331.10.03	Demolish concrete intake	$9,000	Lot	1	$9,000
331.10.05	Scrap steel discharge pipes & structures	$3,000	Lot	1	$3,000
331.05.12.01	Excavate dike fill	$5	cy	12,000	$60,000
331.05.12.02	Excavate waste	$5	cy	12,000	$60,000
331.22.07	Health & Safety Program	$5,000	Month	1	$5,000
331.20.01	Place dike fill	$3	cy	12,000	$36,000
331.19.21	Transport to DUMLAW	$10	Ton	16,800	$168,000
331.19.22	Dispose waste - DUMLAW	$55	Ton	16,800	$924,000
331.21.04	Demobilization				$4,000
	Total Direct Costs				$1,275,000
	Indirect Costs				
331.22.01	Construction Management	$40,000	Month	1	$40,000
331.01.03	Permitting @ 2%		Lot	1	$25,500
331.22.12	Bonds & Insurance @ 7% of Direct Costs				$89,250
331.22.04	Engineering and Project Management	$75	hours	1,500	$112,500
	Total Indirect Costs				$267,250
	Contingency @ 25% of Direct & Indirect Costs				$385,563
	TOTAL PROJECT COSTS (Rounded to nearest $10,000)				$1,930,000

38

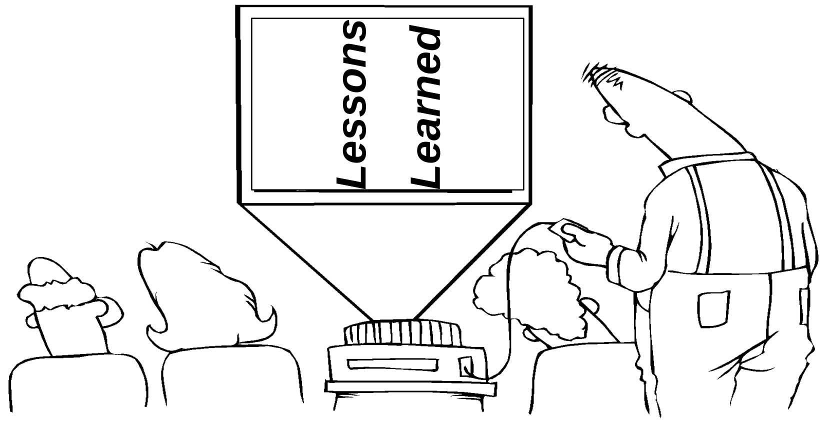
Discussion Leaders/Facilitator Notes: The facilitator is to stress the fact that this is solely the construction project and does not include EPA permitting, design, O&M, etc.

The "real-life" planning estimate summary sheet for this project is shown here. The backup documentation is in the project file.

The above project cost-estimate summary sheet is a lump-sum construction cost estimate for the remedial action for the Brine Pond Project.

Notes / Discussion Points / Lessons-Learned: ______________________

Lessons Learned



39

1. Does anyone disagree with the range of +50% to -30% for the planning estimates?

   What impact could different ranges have on the work?

2. Does everyone agree that the planning estimate is comparable to the DOE planning estimate and the feasibility estimate?

3. Does everyone agree with the ranges on each of these estimates, -50% to +100% and -30% to +80%, respectively?

4. Does anyone have any other ways that the planning is used?

5. Does everyone agree with the ways to use it as they are identified?

6. Has anyone had any problems with using this type of estimate in these ways?

(Continued on next page)

Notes / Discussion Points / Lessons-Learned: ______________________________

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7. On the subject of estimates being changed by management, here are a few typical questions.

   Have you ever had a manager change your estimate?

   How did you handle that situation

   What did you do to prevent future changes?

8. For estimate misuse, have you ever had someone change your final estimate?

   What system should exist to prevent estimate changes?

   Have they been successful in preventing this?

9. Have your estimates ever been misused?

   What can prevent this misuse from happening?

   What did you do to prevent this misuse?

Notes / Discussion Points / Lessons-Learned: ______________________________

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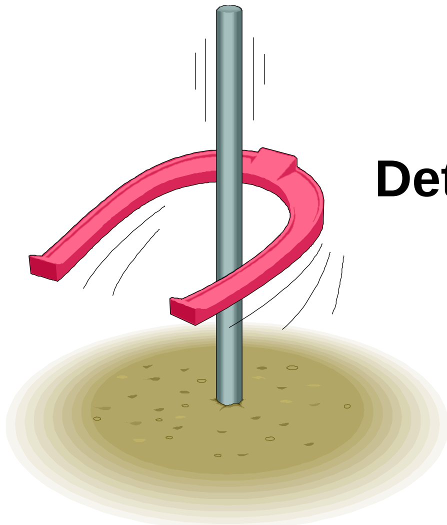
Section 2.2



Preparation of a Detailed Cost Estimate/ Lessons Learned

1

The detailed cost-estimate process was defined in Section 1.8 as a four-phase process (information collection, estimate development, evaluation, and review). Each phase has multiple steps.

This section will provide step-by-step examples that demonstrate the development of a detailed cost estimate by:

1. Discussing the general application of each process step

2. Demonstrating the application of that estimate step to the real-life DOE project

3. Discussing lessons learned

The real-life DOE project used to demonstrate this process will be the same Brine Pond Project used in Section 2.1.

Notes / Discussion Points / Lessons Learned: ______________________________

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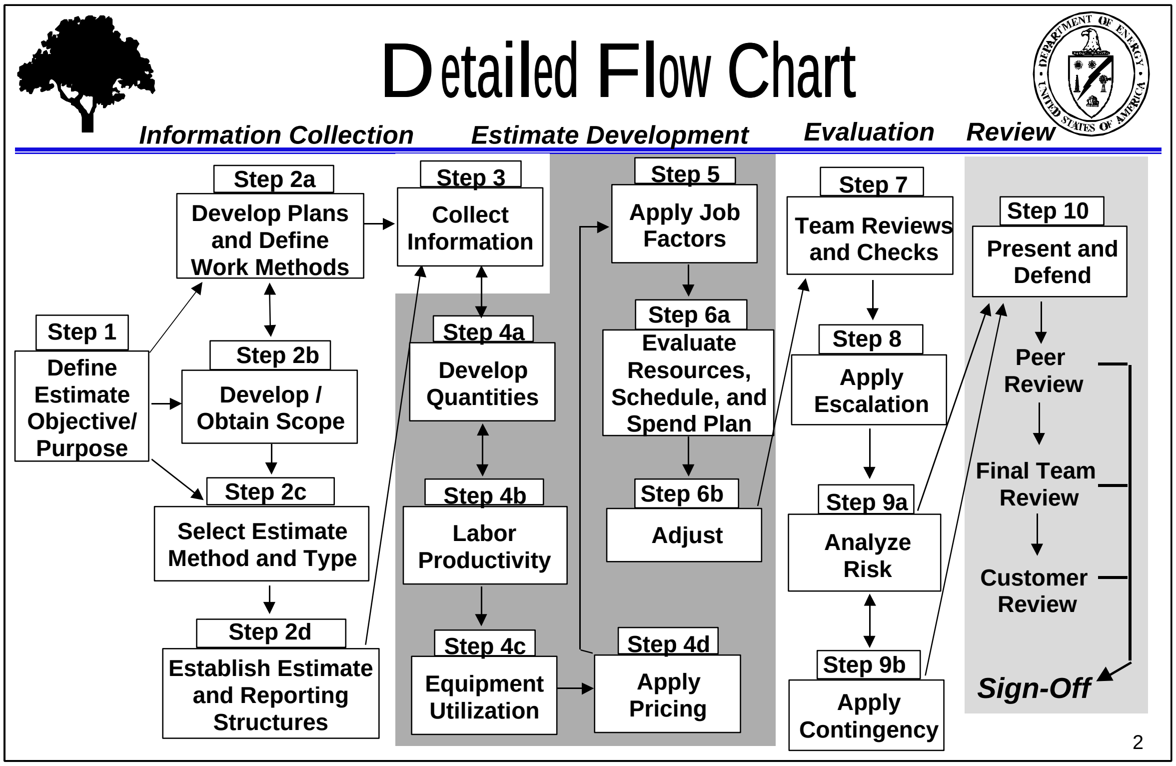
Section 2.2: Preparation of a Detailed Cost Estimate/Lessons Learned



Discussion Leader/Facilitator Notes: The facilitator is to refer participants back to material covered in Section 1.8. The facilitator is to leave this slide up on a second projector for reference as each step is discussed.

This section will review each step of the detailed cost-estimating process, which was discussed in Section 1.8, Cost-Estimate Process (Detailed Estimates), and demonstrate development of the Brine Pond Project detailed estimate.

Notes / Discussion Points / Lessons Learned: ______________________________

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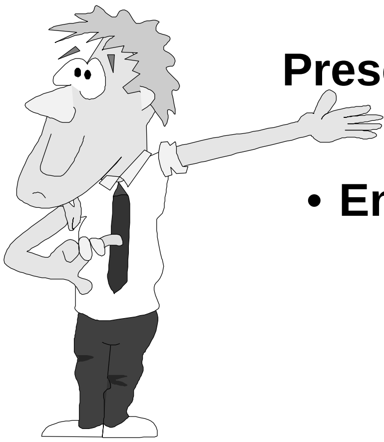
Definite Estimate



Presentation of Real Estimate Example

- **Environmental Restoration Program Brine Pond Closure**

3

Discussion Leader/Facilitator Notes: The facilitator is to review information with the participants. General site conditions and information about site location are presented in the following pages.

In the preceding subsection, we saw how a planning estimate was prepared to evaluate the feasibility of a Brine Pond Project. In this section, we will demonstrate the development of a detailed estimate on this same project.

At this point, we will assume that enough time has elapsed since the planning estimate was done for the Brine Pond Project to have a more detailed scope definition. In fact, several updates and revisions to this estimate have likely been done as the project has matured. The following pages provide the current information about the Brine Pond.

Notes / Discussion Points / Lessons Learned: ______________________________

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Brine Pond Information

Provide the Brine Pond Project Scope and Data for Detailed Estimate

4

Discussion Leader/Facilitator Notes: The facilitator should review the following project scope data with the participants. Key areas as identified in bold italics should be emphasized.

The following pages describe this project.

Notes / Discussion Points / Lessons Learned: ______________________________

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Cleanup Objective

The Colorado River Basin Regional Water Quality Control Board (CRWQCB) issued Cleanup and Abatement Order (CAO) Number 96-023 for the remediation of the brine pond. The contaminant of concern in the brine pond waste was elevated concentrations of soluble arsenic. The CAO requires that the U.S. DOE submit to the CRWQCB a Construction Work Plan for remediation of the site by July 1.

Remediation activities should begin in August and take about 3 months to complete. A Closure Report will be required. The goal will be to recommend a "no further action" status for the site under the CAO requirements. If that can be achieved, requests to rescind the CAO for this site will be submitted.

The primary objective of the clean-up project will be to remediate the brine-holding pond at the site in accordance with the CAO. Based on the CAO, the clean-up objective is to remove the brine pond wastes (i.e., brine residue, protective sand layer, and liner) for disposal at an approved off-site facility and return the site to unrestricted use.

Quantitative clean-up criteria will not be established for the subgrade soil below the pond liner. Therefore, the clean-up criteria are to be defined as the removal of the brine wastes (i.e., brine residue, sand, and liner), thereby ***removing the source, which might be a potential threat to the groundwater beneath the site.***

Climate and Precipitation (see the Scope Description provided in Section 2.1)

Permitting

No permits are required for the project based on discussions with the following regulatory agencies:

- Colorado River Basin Regional Water Quality Board
- Imperial County Planning Department
- Imperial County Public Works Department
- Imperial County Air Pollution Control District
- Imperial County Solid Waste Local Enforcement Agency

Notes / Discussion Points / Lessons Learned: ______________________________

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Scope of Work

The following activities will be required for remediation:

- ***Develop a work plan, a health and safety plan***, and related attachments pursuant to the project scope of work, and obtain U.S. DOE approval for submittal to CRWQCB by July 1.
- ***Provide site security*** for the remediation/construction area.
- ***Improve the access road to the pond area.***
- ***Demolish, remove, and dispose of the concrete inlet/outlet structure*** (north side of pond).
- ***Excavate the brine residue and the sand layer and remove the liner from the brine pond*** (pond cross-section detail below).
- ***Transport and dispose of the brine residue, sand layer, and liner from the brine pond at an approved off-site disposal facility.***
- ***Collect five confirmatory soil samples from the excavation cavity and analyze them for leachable arsenic.***
- ***Backfill the Brine Pond to grade and restore the disturbed surfaces to "natural" conditions (typical restoration cross section below).***
- ***Prepare a Closure Report.***
- Obtain CRWQCB approval of ***site closure*** with no further action under the CAO.

Field Activities

Field work is scheduled to take 3 months; however, schedule durations will be recalculated based on the estimate.

Field work will be subcontracted and will include the following tasks:

- ***Mobilization***
- ***Temporary facilities and site setup***
- ***Excavation of brine pond waste, sand, PVC liner, and dike material***
- ***Waste transportation and disposal***
- ***Confirmatory sampling***
- ***Backfill/site restoration***
- ***Health and safety monitoring***
- ***Document deviations from construction work plan***
- ***Final inspection and demobilization***

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ______________________________

In thinking through the construction process, the project team has established the following construction methods and process to employ on this job.

Mobilization, Temporary Facilities, and Site Setup

Mobilization activities will require mobilizing the required field personnel and equipment.

Temporary facilities and utilities will be needed to support the field activities. A ***field office trailer equipped with a telephone and electricity will be needed***. ***Construction water can be obtained from an existing pipeline that supplies irrigation water to a nearby facility***. ***Additional temporary facilities*** should also include setup of ***portable restrooms/wash facilities; a 100,000-gal water storage pool; 10,000-gal water tank stand; soil pipeline area; personal and equipment decontamination areas; equipment storage area; ingress and egress pathway for vehicles; and posting appropriate project signs for in-progress removal work.***

Haul roads will be constructed with standard road-base (gravel) material. ***A temporary equipment decontamination area will be set up.*** ***The Exclusion Zone will encompass both the excavation area and the brine waste stockpile area.*** ***The decontamination area will be constructed with a perimeter berm and a sloped pad underlain by 2-in. gravel and lined with 10-mil polyethylene plastic sheeting.*** ***A small sump area and a pump will be located in the center of the pad.***

Equipment and vehicles will be decontaminated before being released from the Exclusion Zone. ***Dry brushing or wiping will be used to minimize the volume of water requiring treatment and/or disposal.*** ***Pressure washing will be used when needed.***

Personnel who enter the Exclusion Zone on foot or leave their vehicles or equipment while in the Exclusion Zone will be required to undergo decontamination procedures at the personal decontamination area.

Excavation

Before excavation, the ***concrete inlet/outlet structure*** at the north end of the brine pond ***will be removed and decontaminated for disposal.*** ***High-arsenic-level areas will be excavated first and stockpiled separately.*** Following stockpiling of the high-arsenic-level soil, the remaining general removal excavation will begin. ***A combination of scraper, dozer, and loader will be used to remove brine waste and the liner.*** ***The excavation soil and liner will be stockpiled.*** ***As excavation approaches the brine waste stockpile and loading area, material will be loaded directly into trucks for transportation.***

(Continued on next page)

Notes / Discussion Points / Lessons Learned:

A water wagon will be used within the brine pond (i.e., Exclusion Zone) to moisture condition the brine waste before and during excavation for dust control. A water truck will be used to control dust on the haul roads during loading operations.

Waste Transportation and Disposal

Transportation and disposal activities will begin after completion of waste profiling and acceptance requirements by the disposal facility. Waste is expected to be non-RCRA hazardous with elevated concentrations of soluble arsenic. Because the geothermal origin of the waste and associated NORM component in the waste streams, disposal will be required at DUMLAW Environmental's Class I Disposal Facility near Westmoreland, California. The Westmoreland landfill is the only disposal facility in southern California permitted to accept NORM geothermal waste streams. The waste will be transported in covered semi-end dump trucks by a licensed hazardous waste transporter.

To ensure that trucks are within weight requirements, each load will be weighed using portable scales at the loading area before it leaves the site.

Confirmatory Sampling

Confirmatory soil samples will be collected and analyzed in the pond cavity to ensure clean conditions before backfilling. Analysis will be performed by an off-site laboratory for leachable arsenic by EPA Method 1312/6010A.

Backfill and Site Restoration

Backfilling will begin upon receipt of confirmatory analytical results indicating that contaminant levels are within acceptable limits. Noncontaminated soil from the pond's perimeter berms will be used in the excavated area to match the existing grade of the surrounding topography. ***Additional fill material probably will not be needed to complete final grading of the site.***

The brine pond and adjacent disturbed areas will be restored to a native desert condition, including creating a hummock surface and grading the general area to match existing surrounding topography. The hummocky or mounding surface can be created using an excavator and a loader.

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ______________________

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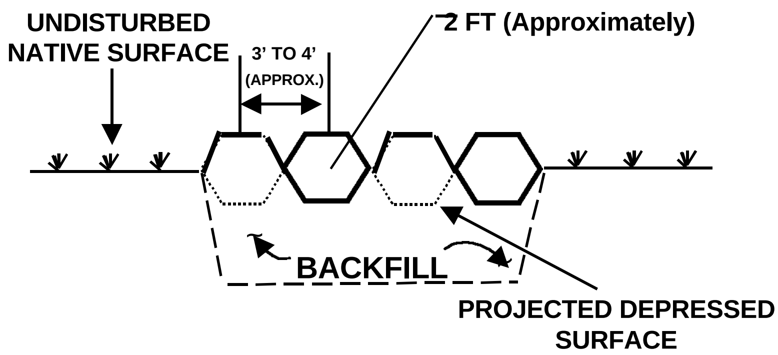
TYPICAL RESTORATION CROSS SECTION

NOT TO SCALE

(Shows hummock surface configuration)



Health and Safety

Daily Tailgate Safety Meetings will be held. On-site personnel will need to be monitored for heat stress. Dust and silica will be monitored. Work will be performed in Level C protection within the Exclusion Zone.

Demobilization

Demobilization activities will include dismantling and/or removing the equipment and temporary facilities that were used.

Notes / Discussion Points / Lessons Learned: ______________________________

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How to Prepare a Detailed Estimate

This section of the workshop will include:

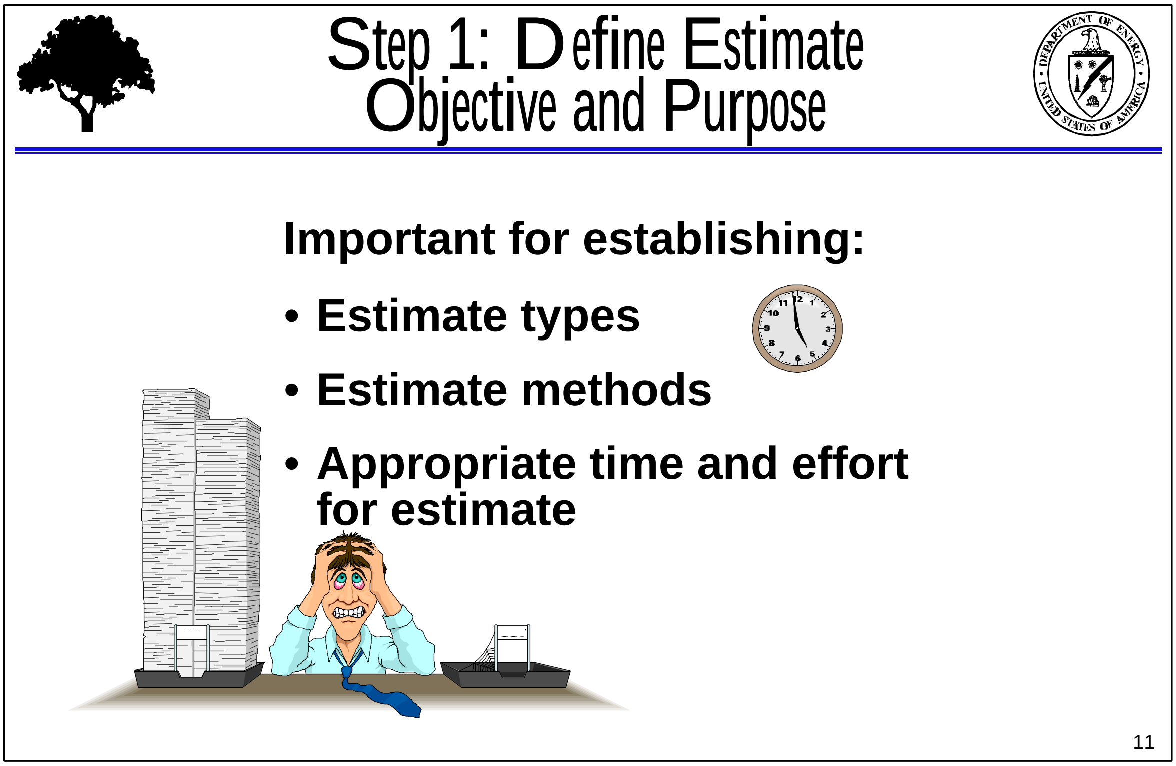
1. **Review of the general application of each step of the detailed estimate process.**
2. **Application of each step to the Brine Project to demonstrate how to apply that step of the estimate process to the Brine Pond example.**
3. **Discussion of results of the example problem, related issues of interest, and sharing of lessons learned.**

10

Discussion Leader/Facilitator Notes: Refer participates to the flow process showing steps using the second projector.

Each step of the detailed estimate process will now be reviewed, demonstrated, and discussed as defined above.

Notes / Discussion Points / Lessons Learned: ______________________________



Discussion Leader/Facilitator Notes: Refer participants to the flow process showing steps using the second projector. Discuss with the participants what the purpose and objective of this estimate would be at this point in the process. The facilitator is to point out that this is hopefully not the first re-estimate since the planning estimate. Various estimate revisions and re-estimates should be assumed to have occurred as the project definition has matured.

General Application — Step 1

- Determining and understanding the estimate objective and purpose is important in establishing:
  - Estimate type
  - Estimate methods to employ
  - Appropriate time and effort to be devoted in estimate preparation.

- Performed by project manager with customer agreement, the estimate objective and purpose is:

Application to the Brine Pond Project — Step 1

- Define the cost-estimate objective and purpose for the Brine Pond estimate.

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ______________________________

Section 2.2: Preparation of a Detailed Cost Estimate/Lessons Learned

Q What is the purpose of this project estimate?

A The purpose is

- To update the estimate to reflect the current project definition and known conditions.
- To provide a government estimate for subcontractor bid evaluation.

Q What are the objectives of this project estimate?

A The objectives are

- To obtain an estimate that incorporates current project definition and reflects only the defined scope in the statement of work.
- To provide an estimate with enough detail and in a comparable format to evaluate the reasonableness of subcontracted bids.

Notes / Discussion Points / Lessons Learned: ______________________________

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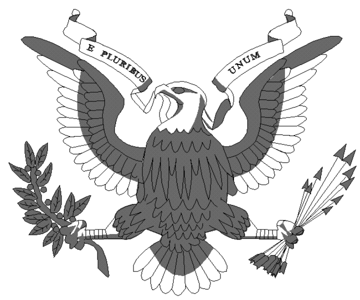
Step 1 (Continued)

Issues with Government Estimates



13

Discussion Leader/Facilitator Notes: Because the estimate will be used as a government estimate, some issues relevant to government estimates follow.

- Government estimates are used to determine the reasonableness of competitive bids received in connection with fixed-price contracts and serve as a control in evaluating cost estimates prepared by a prime cost-type contractor. Sometimes government estimates are called engineer's estimates.

- A government estimate must include only the scope of work as defined in the request for proposal (RFP). If the estimator or project team discovers or redefines a scope that is different from the RFP, a revision to the RFP will have to be issued before the changes are incorporated in the government estimate. (Example: the RFP statement of work specifically defines 1000 cy of material to be installed and the estimator calculates 1500 cy by a quantity takeoff. A revision to the RFP must be issued before the 1500 cy revision is incorporated in the government estimate).

- The estimator should not communicate or discuss estimate issues with subcontractors unless the procurement agent is present. The estimator must be careful when obtaining estimate quotes.

- Confidentiality of the government estimate is critical until bids are received.

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ______________________________

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Section 2.2: Preparation of a Detailed Cost Estimate/Lessons Learned

- Typical procurement guidelines on cost-plus estimates (specific procurement practices can differ between field offices).
  - If the subcontractor estimate is within 10% of the government estimate, the work can be awarded without negotiations.
  - If the subcontractor estimate is between 10% and 50% of the government estimate, negotiations are held to resolve differences.
  - If the subcontractor estimate is outside 50% of the government estimate or if the government estimate represents a different scope of work than specified by the RFP, the procurement can be thrown out, requiring a rebid.

Notes / Discussion Points / Lessons Learned: ______________________________

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Step 2a: Develop Plans and Define Work Methods

Sources:

- **Planning meetings**
- **Project team members**
- **Traditional methods**
- **Subject experts**

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<u>General Application — Step 2a</u>

The estimator and the project team members develop and define how the work will be accomplished. The sources of this information include the following:

- Planning and project meetings
- Project team members (refer to Section 1.2 for the makeup of the project team)
- Traditional methods
- Subject matter experts

<u>Application to Brine Pond Project — Step 2a</u>

The method of work accomplishment is defined in the project description provided earlier. As the estimator goes through the estimate process, he will develop these assumptions in more detail.

Notes / Discussion Points / Lessons Learned: ______________________________

Step 2b: Develop and Obtain Scope

ANSWER

16

Discussion Leader/Facilitator Notes: Discuss these questions and answers with the participants.

<u>General Application — Step 2b</u>

Questions of who, what, how, when, and why will be answered as the scope information is obtained or even developed as part of the estimate process.

<u>Application to Brine Pond Project — Step 2b</u>
For the Brine Pond Project detailed estimate, obtain the answers to the following questions.

Q Who?

A Subcontract the on-site project cleanup to one prime subcontractor. The project team will oversee subcontract work.

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ______________________________

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Section 2.2: Preparation of a Detailed Cost Estimate/Lessons Learned

Q What?

A Remediation of the Brine Pond site.

Develop a clean-up work plan, a health and safety plan, and related attachments pursuant to the project scope of work, and obtain U.S. DOE and CRWQCB approval.

- Provide site security for the remediation/construction area.
- Improve the access road to the pond area.
- Demolish, remove, and dispose of the concrete inlet/outlet structure.
- Excavate the brine residue and sand layer, and remove the liner from the brine pond.
- Transport and dispose of the brine residue, sand layer, and liner from the brine pond to an approved off-site disposal facility.
- Collect five confirmatory soil samples from the excavation cavity, and analyze them for leachable arsenic.
- Backfill the brine pond to grade, and restore disturbed surfaces to a “natural” condition.
- Prepare the Closure Report.

Q How?

A Traditional standard construction methods will be employed for excavation work. High-arsenic-level areas will be identified, excavated first, and stockpiled. The remaining general removal excavation will be accomplished using a scraper, a dozer, and a loader. Excavated material will be stockpiled near the loading area. Excavation near the loading area will be directly loaded into transport trucks. Dust will be controlled by using a water wagon.

Transportation trucks will be loaded in a contamination-reduction loading area. Trucks will be lined and covered. Trucks will transport waste to a Class I disposal site. Landfill class waste categories are as follows:

Class I - Toxic, hazardous, corrosive waste
Class II - Non-RCRA (i.e., asbestos)
Class III - Sanitary (i.e., garbage)

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ______________________________

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Backfill operations of the pond will begin once the confirmatory sample analysis confirms clean conditions. The pond and any adjacent disturbed areas are to be restored to a "native desert" condition. An excavator, a loader, and a compactor will be used.

The health and safety program will include development of an approved Health and Safety Plan. Heat stress, dust, and silica will be monitored. Daily safety meetings and reports will be required.

Q When?

A Construction work plan remediation of the site must be submitted to CRWQCB by July 1, as specified by the Cleanup and Abatement Order. Work is scheduled to begin in August and will take about 3 months.

Q Why?

A The Cleanup and Abatement Order issued by CRWQCB (CAO Number 96-023) requiring remediation of the site. The contaminant of concern in the Brine Pond waste is elevated concentrations of soluble arsenic. The goal is to close the site with "no further action" required and request rescinding of the Cleanup and Abatement Order.

Notes / Discussion Points / Lessons Learned: ____

Step 2c: Select Estimate Method and Type

Criteria:

- **Estimate use**
- **Scope definition available**
- **Consideration of time and resources to prepare estimate**

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Discussion Leader/Facilitator Notes: The facilitator is to encourage discussion of the estimate type and methods to be used on the Brine Pond Estimate.

General Application — Step 2c

Using knowledge obtained in the preceding steps, the estimator will determine the type of estimate that is appropriate based on estimate use, scope definition of project, and the time and resources that are available to develop the estimate.

The estimating methods that will be used are also determined.

Application to Brine Pond Project — Step 2c

For the Brine Pond Project estimate, a detailed estimate is the appropriate type of estimate based on current project definition and estimate accuracy requirements.

The estimating methods that will be used in the estimate will include detailing each element of this project, quantifying it, and applying a production and/or cost value to it. Historical experience on previous projects of this type and traditional construction standards will apply to this project.

Notes / Discussion Points / Lessons Learned: ______________________________

Step 2d: Establish Estimate and Reporting Structures

- **Work Breakdown Structure (WBS)**
- **Code of Accounts (COA)**
- **Reporting structure**
- **Need to integrate into budget or control system**

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Discussion Leader/Facilitator Notes: Encourage open discussion about the defined project WBS and estimate structure items that should be considered for the Brine Pond Project.

<u>General Application — Step 2d</u>

Forethought must to be given on how to structure the estimate.

- The estimate must be summarized by the project WBS.
- Organization and use of the estimate by code of accounts will provide comparison and consistency across projects.
- Consideration should be given to output reports and special summarization that may be required for this project.
- Usually, using the project WBS in the estimate process will support integration and the estimate in the budget and control systems; however, other requirements may be needed to support and to use the estimate in the budget or control systems.

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ________________________________

Work Breakdown Structure

A Work Breakdown Structure (WBS) is the result of project/program planning, which establishes the physical work packages or elements and the activities within those packages that completely define a project. It organizes the physical work packages into levels that can be developed into a summary. It shows the relationship of all elements of a project and provides a sound basis for cost and schedule control.

From the inception of a project to its completion, a number of diverse activities must take place. These activities include cost estimating, budgeting, accounting, reporting, controlling, and auditing. A WBS establishes a common frame of reference for relating job tasks to each other and relating project costs at the summary level of detail.

Because the WBS divides the project into work elements, it can also be used to interrelate the schedule and costs. The work elements or their activities can be used as the schedule activities, thus enabling resource loading of a schedule, resource budgeting against time, and developing a variety of cost budgets plotted against time.

Code of Accounts

A Code of Accounts (COA) is a logical breakdown of a project into controllable elements for cost control and reporting. The breakdown is a numbered, logically organized structure.

A cost code system or COA is established early in a project and is used for its duration. An organized numbered structure for a project is developed. This standardization is used in developing, collecting, organizing, and reporting of project data.

The COA organizes data at a detail level that is summarized into higher levels. As the detail of a project increases, more detail levels can be developed.

The COA is used during the estimate stage to organize the costs. As a project progresses, the same COA is used, but the elements of data are updated. By comparing the changes in the elements of the COA, one can identify variances and trends. Using the same COA will provide consistency between the estimate and the actual cost data for cost control.

HTRW Cost Structure

The HTRW is becoming accepted as the standard cost structure for environmental projects. EM is encouraging all EM estimates to use the HTRW Cost Structure. The HTRW was designed as a WBS but can be used as a COA or a cost-structured WBS.

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ______________________________

Application to Brine Pond Project — Step 2d

Because part of the Brine Pond Project estimate will be used as a government estimate, this estimate should be formatted to support any required summarization or reports as defined by the RFP statement of work.

The project WBS for remediation includes the following structure. Project WBS levels may be preceded by DOE WBS elements such that the remediation would actually be Level 6 or some other level in the overall WBS. The WBS is cross-walked to the HTRW code structure, as shown below.

Project WBS	HTRW No.	Description
8	331	Remediation
8.1	331.01	Preconstruction Activities
8.1.1	331.01.03.08	Work Plan and Health and Safety Plan
8.1.2	331.01.02.02	Kickoff and preconstruction meeting
8.2	331	Remedial Construction
8.2.1	331.01.01	Mobilization
8.2.2	331.10.03	Remove concrete intake
8.2.3	331.10.05	Remove discharge pipes
8.2.4	331.05.12.01	Excavate waste
8.2.5	331.05.12.02	Excavate dike
8.2.6	331.22.07	Health and Safety Program
8.2.7	331.20.01	Place dike fill
8.2.8	331.19.21	Dispose waste - offsite
8.2.9	331.21.04	Demobilization
8.3	341	Postconstruction: Final Report

Notes / Discussion Points / Lessons Learned: ______________________

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Step 3: Collect Information

Significant Factors

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General Application — Step 3

The collection of information is a step that will actually continue through the entire estimate development; however, the estimator must identify and collect enough information so that the estimating process can proceed logically and orderly.

Significant Factors:

- Scope, including a project-specific document, reports, and design drawings
- Equipment
- Quantities
- Unit prices
- Man-hour rates
- Labor rates
- Indirect rates
- Escalation rates
- Overheads

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ______________________________

Section 2.2: Preparation of a Detailed Cost Estimate/Lessons Learned

Application to Brine Pond Project — Step 3

Items to consider before starting the Brine Pond Project estimate include the following:

- Weather
- Duration
- Disposal Area
- Transportation
- Backfill volumes and available material

Notes / Discussion Points / Lessons Learned: ____________________

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Step 4a: Develop Quantities

Quantities can be obtained from:

- **Takeoffs**
- **Tables or lists of quantities**
- **Previous projects**
- **Team member inputs**

25

Discussion Leader/Facilitator Notes: The facilitator is to lead the group calculating from the project information the volume of waste material to be disposed of off-site. The facilitator should communicate that the method (and the answer) provided here is just one way of arriving at an estimate.

<u>General Application — Step 4a</u>

The estimator must obtain or calculate quantities to establish the magnitude of work to be performed. Quantities can be derived by the following methods.

- Quantity takeoffs – the process of measuring, counting, and calculating quantities from design drawings, plans, or sketches.
- Tables or quantity lists can sometimes be obtained from documents that contain tables or lists of specific quantities. Work plans will often provide quantities such as number of samples.
- Bill of materials provided by designers/engineers.
- Material quantity lists provided from computer-aided design.
- Previous project data or earlier estimates.
- Project Team members' input as to the magnitude of quantities.

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ____

Application to Brine Pond Project — Step 4a

Development of the quantities for the Brine Pond Project will be accomplished primarily by quantity takeoff. One can calculate, based on site plans and known dimensions of the pond, material quantities for the following tasks:

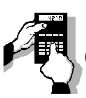
- Excavation of dike material
- Excavation of brine and sand waste
- Removal of the PVC liner
- Material to be transported
- Volume of material to be disposed
- Backfill volume
- Intake structure, pipe removal, and disposal

Other quantities needed will include confirmatory sampling quantities, which will be determined by the project team or expert opinion.

Because of time constraints, we will not go through all elements of the estimate in this workshop. We will focus on two of the Brine Pond waste-estimate items: (1) HTRW Number 331.05.12.01, “Excavation,” and (2) HTRW Number 331.19.21, “Waste Transportation and Disposal,” to demonstrate the estimate process of Steps 4, 5, and 6. The disposal cost of the estimate was chosen because it is a major cost driver of the project.

The excavation of the waste material was chosen to demonstrate the calculation of a detailed estimate for excavation of the waste based on the use of a D8R dozer. Section 2.1 demonstrated the excavation and loading calculation as a planning estimate using a hydraulic crawler. Although equipment is suited for certain jobs and conditions, selection and use of equipment can vary based on subcontractor performance and availability (what the subcontractor owns and what is available). Selection of equipment will affect the time and cost to complete the work activity.

For both of these cost elements, the quantity of material for Brine Pond will be needed. First we will calculate this quantity.



Calculation:

As a group, calculate the quantity of material that will be disposed of in an off-site landfill.

1. The first step is to determine what waste will be excavated and what waste disposed of. The classification/waste profile of waste to be disposed will also be determined.

   A. Brine and sand waste from the pond is based on the following information.
      - We will assume that this waste is non-RCRA California – hazardous material with elevated concentrations of soluble arsenic.
      - Some waste will be California – nonhazardous, but because of the geothermal origin, is NORM.

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ______________________________

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- Information states that, based on both the NORM component and the arsenic levels, a Class I Landfill (excavated with brine and sand) will be required.

B. Liner Material (excavated with brine and sand).

C. Construction facilities that are contaminated during construction.

Other waste will include:

- Intake structure, which will be decontaminated before disposal
- Noncontaminated construction debris.

2. Calculate quantities (hint: refer to quantity takeoffs completed in Section 2.1)

In Section 2.1, we calculated the quantity for the brine and sand waste as follows.

Calculation of the Brine and Sand Waste Quantities

Description	No. Pcs.	Length (ft)	Width (ft)	Height or Weight (ft)	Quantity (cf)	Total Quantity (cf)
Excavation Brine and Sand						
Area = 540' x 500' ~6 acres						
Assume Waste Avg. =						
14" thick = 8" brine + 6" sand						
Excav. Pond Waste						
Pond Waste - Excavation	*1*	*540*	*500*	*1.16*	*313,200*	
Side Slopes	*1*	*540*	*3.48*	*1.16*	*2,180*	
	1	*500*	*3.48*	*1.16*	*2,018*	
				Total	*317,398*	
Add 20% for Expansion					*63,480*	
					380,878	
					USE	*385,000*

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Removal of the liner will be performed during the excavation process. The thickness of this liner is 1/10,000 in.; however, volume will include voids and additional material excavated during the process. Assume an excavation of 5 in., including the liner and the earth below the liner. Recalculate quantities, adding 5 in. of depth. Change the depth of 1.16 in. to 1.57 in., and recalculate the preceding quantities to **515,499 cf = 19,093 cy.** These calculations are shown below.

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ____

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These calculations are as follows:

Calculation of the Brine, Sand, and Liner Waste Quantities

Description	No. Pcs.	Length (ft)	Width (ft)	Height or Weight (ft)	Quantity (cf)	Total Quantity (cf)
Excavation Brine and Sand						
Area = 540' x 500' ~6 acres						
Assume Waste Avg. =						
19" thick = 8" brine+6"sand+5" liner & below						
Excav. Pond Waste & Stockpile						
Pond Waste - Excavation	*1*	*540*	*500*	*1.57*	*423,900*	
Side Slopes	*1*	*540*	*3.48*	*1.57*	*2,950*	
	1	*500*	*3.48*	*1.57*	*2,732*	
				Total	*429,582*	
Add 20% for Expansion					*85,916*	
					515,499	
					use	*515,500*

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Because pricing for disposal is typically by weight (tons), conversion of this quantity to tons is calculated to be

515,499 cf x 65 lb/cf (clay and sand) ÷ 2000 lb/ton = 16,754 tons

Use 16,800 tons

(The amount 65 lb/cf was obtained from the table of material weights provided on the following page. The source document for the weight table is the International Harvester Company, *Basic Estimating,* Third Edition.)

(Continued on next page)

Notes / Discussion Points / Lessons Learned:

Section 2.2: Preparation of a Detailed Cost Estimate/Lessons Learned

TABLE OF MATERIAL WEIGHTS

MATERIAL	POUNDS PER CU. FT
Alumine	60
Aluminum Chips	15
Aluminum Hydrate	18
Aluminum Ore	75-85
Aluminum Oxide	120
Aluminum Silicate	49
Alum	45-60
Ammonium Chloride (Cryst.)	52
Ammonium Sulphate	55-62
Ammonium Superphosphate	55-60
Andesite Stone	181
Asbestos, Shred	20-25
Ashes	40
Asphalt	100
Asphalt, Crushed	45
Asphaltium	87
Bakelite, Powdered	30-40
Barite or Baryte	180
Bark, Wood	10-20
Barley	38
Basalt Rock	181
Bauxite, Crushed	75-85
Beans, Castor	36
Beans, Navy, Dry	48
Bentonite	51
Block, Paving	136
Blood, Dried	30
Bluestone	110
Bonemeal	55-60
Bones, Crushed (1/2")	35-40
Bones, Gran.	50
Borax, Powdered	53
Bran	16
Brewers Grain, Dry	25-30
Brewers Grain, Wet	55-60
Brick, Hard Clay	125
Brick, Soft Clay	100
Brick, Paving	157
Brick, Pressed	140
Buckwheat	40-42
Caliche	90-95
Cast Iron Borings	130-200
Cement, Natural	56
Cement, Portland	90
Cement, Portland, Set	183
Cement, Portland, Bag	93
Cement, Portland, Barrel	93
Cement, Rosendale, Bag	69
Cement, Rosendale, Barrel	69
Cement, Western, Bag	64.7
Cement, Western, Barrel	64.7
Chalk, Crushed	85-90
Chalk, Pulpy	75
Charcoal	18-25
Cinders, Coal	40
Cinders, Blast Furn.	57
Clay, Fire	130
Clay, Dry	63
Clay, Wet	110
Clay, Out of Water	80
Clay and Gravel, Dry	100
Clay and Gravel, Out of Water	65
Clay and Sand, Out of Water	65
Coal, Anthracite	60
Coal, Bituminous	50
Cocoa Beans	30-40

MATERIAL	POUNDS PER CU. FT
Coffee, Green	32
Coke	23-42
Concrete, Cinders	110
Concrete, Gravel	152
Concrete, Limestone	150
Concrete, Sandstone	145
Concrete, Trap Rock	155
Copra	22
Copra, Cake	25-30
Copra, Ground	40-45
Copper, Ore	120-150
Corn, Shelled	45
Corn, Meal	38-40
Cottonseed, Dry	18-25
Cottonseed, Cake	40-45
Crushed Stone	100
Cullet	80-120
Diabase, Broken	175
Dolomite, Broken	110
Earth, Dry, Loose	70
Earth, Dry, Rammed	90
Earth, Dry, Shaken	82
Earth, Damp, Loose	78
Earth, Damp, Rammed	96
Earth, Damp, Shaken	100
Earth and Gravel, Dry, Loose	100
Earth and Gravel, Dry, Rammed	120
Earth and Gravel, Wet	120
Earth and Sand, Dry, Loose	100
Earth and Sand, Dry, Rammed	120
Earth and Sand, Wet	120
Feldspar (1 1/8")	65-70
Fire Brick	145
Fire Clay	130
Flaxseed	45
Flourspar	82
Fuller's Earth	35-40
Garbage	43
Gravel, Dry	110
Gravel, Out of Water	60
Granite	168
Gypsum, Crushed	100
Gypsum, Powdered	60-80
Hematite, Broken	200
Ilmenite, Ore	140
Iron, Ore	145
Lead, Ore, Broken	300
Lime, Quick, Loose	53
Lime, Quick, Shaken	55
Limestone, Solid	168
Limestone, Loose	96
Limonite, Ore, Broken	155
Magnetite, Ore, Broken	200
Marble, Solid	165
Marble, Loose	96
Mica, Broken	100
Mortar, Set	103
Mud, Dry	90
Mud, Packed	115
Mud, River	90
Mud, Wet	108
Mustard Seed	45
Nitrate, Chilean	72-85
Peas, Dried	45-50
Peanuts, Shelled	20-25
Peat, Dry	25

MATERIAL	POUNDS PER CU. FT
Peat, Wet	70
Phosphate Rock, Broken	110
Phosphate Rock, Granular	90
Phosphate Rock, Sand	90-100
Pitch	69
Plaster of Paris	98
Parphyry, Broken	100
Powder (Blasting)	62
Pumice, Ground (1/4")	42-45
Quartz	162
Quicklime	95
Rice	36-48
Riprap, Limestone	80
Riprap, Sandstone	90
Riprap, Slate	105
Riprap, Rubble	65
Rock Salt, Broken	95
Rubber	95
Rubbish	8
Salt, Dry, Coarse	45-50
Salt Cake, Dry	85
Saltpeter	69
Sand, Dry, Loose	97
Sand, Shaken	100
Sand, Wet	118
Sandstone	149
Shale	162
Slag, Blank	70
Slag, Screenings	100
Slag, Machine	96
Slag, Sand	55
Slate	175
Snow, Fresh	5-12
Snow, Wet	15-50
Soda Ash	20-65
Sodium Nitrate	72-85
Soybeans, Whole	45-50
Steel Chips, Crushed	25-85
Stone, Crushed	85-100
Street Sweepings	31
Sugar Beet Pulp, Dry	12-15
Sugar Beet Pulp, Wet	25-45
Sugar, Raw	55-65
Sugar, Granular	100
Sulphate of Potash	80
Sulphur	125
Talc, Broken	110
Tanbark, Ground	55
Tankage	45
Tar	62
Tile	110
Trapstone	187
Wheat	45-48
Wood Chips	12-20
LIQUID	
Water	8.3 lbs/gal
Water	62.4 lbs/cu ft 7.4805 gal/cu ft
Diesel Oil	7.1 lbs/gal
Oil, Petroleum	6 lbs/gal
WOOD	
Fir	25-32 lbs/cu ft
Maple	33-43
Oak	41-70
Pine	26-44

Notes / Discussion Points / Lessons Learned: ____________________

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Step 4c: Equipment Utilization

- **Identify equipment required and the actual "driver"**
- **Develop cycle time and production**
- **Modify production for a Level D condition**
- **Develop labor, material, and equipment costs**

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General Application — Step 4c

- Identify the equipment required to perform the activity in the most cost-effective manner.
- Determine which piece of equipment is the actual "driver" for the activity in the equipment selection.
- Develop cycle time and productivity for the equipment that is the "driver" for the activity.
- Modify production for any special conditions (e.g., Level D condition)
- Develop labor, material, and equipment costs.

Application to the Brine Pond Project — Step 4c

- The Brine Pond waste quantities that were calculated in the previous step will now be used in calculating the equipment use and excavation cost for the Brine Pond waste materials.

Notes / Discussion Points / Lessons Learned: ______________________________

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Equipment Identification

Dozer

- **Stripping, Pioneering, and Land Clearing**

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In the evaluation and identification of equipment appropriate to perform this activity, the dozer was recommended based on its performance in the following areas:

- Stripping: best machine where material does not require moving over 500 feet one way.
- Pioneering: excellent for opening up cuts, removing boulders, and constructing access roads.
- Land clearing: best machine available that can be used for both large and small trees.

Notes / Discussion Points / Lessons Learned: ______________________________

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Equipment Identification (Continued)

Support Equipment

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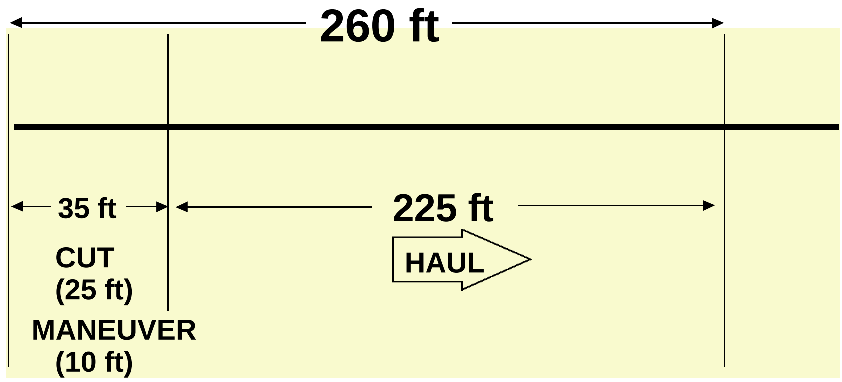
Support equipment needed for this excavation work will include:

- Water wagon (10,000 gal.)
- Water stand (10,000 gal.)
- Grader
- Pick-up truck or van (used for labor transportation to and from job)

Notes / Discussion Points / Lessons Learned: ______________________________

Average Dozer Distance



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The distance that the dozer will be moving the material is calculated based on the pond size. The calculation for the Brine Pond would be:

500 ft + 540 ft ÷ 2 = 520 ft

520 ft ÷ 2 = 260 ft

260 ft - 35 ft for cutting (25 ft) and maneuvering (10 ft) = 225 ft

The average haul distance is 225 ft.

Notes / Discussion Points / Lessons Learned: ______________________

Cycle Time

- **LOAD BLADE**
- **HAUL**
- **DUMP**
- **RETURN**

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Cycle time of equipment includes:

- Loading of the blade,
- Hauling,
- Dumping, and
- Returning.

Each of these items will be calculated on the following slides to obtain the total cycle time.

Notes / Discussion Points / Lessons Learned: ______

Cycle Time – Load Blade

- **Load blade in 25 ft**
- **Maneuvering into position adds an additional 10 ft**
- **Loading time = 0.18 min**

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Loading time for a crawler dozer is a part of the total cycle time. In most material, a dozer will load its blade in about 25 ft. The time consumed in picking up the load is between 0.15 and 0.20 minutes, depending on material conditions.

In figuring the production of a crawler dozer, as well as with all earth-moving estimates, common sense is essential. Study the soil and evaluate job conditions.

Be sure that you understand why the time it takes to load a dozer blade pioneering in rocky soil will not equal the loading time of the same machine in light clay.

Earth mixed with sand and gravel is fairly difficult material to handle, so a conservative 0.18 min will be used for the loading time.

Loading time = 0.18 min

Notes / Discussion Points / Lessons Learned: ______________________________

Cycle Time – Hauling

Drawbar Pull (DBP)

DBP = Dozer Payload x Coefficient of Traction

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With crawler dozers, another type of resistance enters the picture, caused by the load itself as it moves over the ground. Friction is created at the point of contact, where one material rides over another. This resistance is calculated by the use of the appropriate Coefficient of Traction. Simply multiply the weight of the load by the coefficient of traction. This step is necessary to accurately determine required Drawbar Pull (DBP), which in turn, will give us crawler speed.

Grades do not affect crawler dozer performance as a general rule, unless they are of an extreme nature. Do not be concerned with grade resistance or grade assistance for a crawler tractor until it exceeds ± 5 percent.

To calculate DBP, we will first need to find the dozer payload and coefficient of traction. The dozer payload will require determination of the blade capacity and the material weight.

Notes / Discussion Points / Lessons Learned: ______________________________

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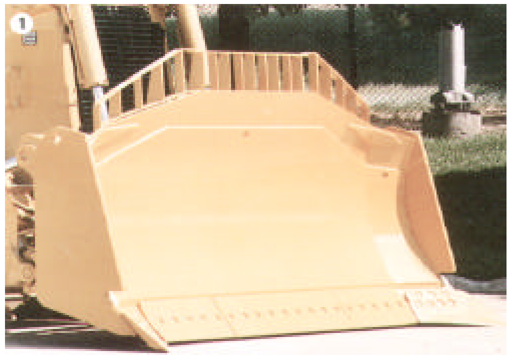
Cycle Time – Hauling



- **Blade capacity for the D8R track-type tractor dozer with a semi-u blade = 11.4 cy**
- **Material weight for brine and wet sand = 3,500 lb/bcy**

37

- The blade capacity for the “D8R track-type tractor” dozer is obtained from the manufacture’s *D8R Track-Type Tractor* brochure (referenced in Appendix C).

- The chart obtained from the brochure is shown on the next page.

  A D8R Dozer with a semi-u blade can hold **11.4 cy.**

- Material weight for the brine and wet sand is obtained from the material weights table on Page 39 and is determined to be 3500 lb/bcy.

Notes / Discussion Points / Lessons Learned: ____

Cycle Time – Hauling

Bulldozers

Tag link dozer coupling brings blade closer for better balance and control.

Blade		8 SU	8 U	8 A
Blade capacity (SAEJ1265)	m^3	8.7	11.7	4.7
	yd^3	11.4 ⇦	15.3	6.1
Width with blade (over end bits)	mm	3937	4262	4978
	ft/in	12'11"	14'0"	16'4"
Blade height	mm	1690	1740	1174
	ft/in	5'7"	5'9"	3'10"
Digging depth	mm	582	582	628
	in	22.9	22.9	24.7
Ground clearance	mm	1231	1231	1308
	ft/in	4'0"	4'0"	4'4"
Maximum tilt	mm	951	1028	729
	ft/in	3'1"	3'5"	2'5"
Weight*	kg	4570	5135	5099
	lb	10,074	11,320	11,241
Total operating weight**(with blade)	kg	32,945	33,509	33,475
	lb	72,630	73,875	73,800

* Does not include hydraulic controls, but includes blade tilt cylinder.

** Includes hydraulic controls, blade tilt cylinder, coolant, lubricants, full fuel tank, ROPS/FOPS cab, 560 mm (22") moderate service track, and operator.

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Notes / Discussion Points / Lessons Learned: ______________________

Section 2.2: Preparation of a Detailed Cost Estimate/Lessons Learned

Material Weights Table

This table provides a list of common material and swell %.

	Approximate In-Bank Weight (lbs/cu. Bank Yd.)	Approximate In-Bank Percent Swell to Loose Measure	Approximate In-Bank Correction Factor From Loose Measure
Ashes (hard coal)	700-1000	7.5%	0.93
Ashes (soft coal)	1080-1215	7.5%	0.93
Bauxite	2700-4325	33.3%	0.75
Clay, dry	2300	17.6%	0.85
Clay, light	2800	25.0%	0.80
Clay, wet	3000	33.3%	0.75
Coal, anthracite	2450	35.0%	0.74
Coal, bituminous	2000	35.0%	0.74
Coal, steam (compacted)	1890	39.0%	0.72
Copper, ore	3800	35.0%	0.74
Earth, dry	2700	25.0%	0.80
Earth, moist	3000	25.0%	0.80
Earth, wet	3370	17.6%	0.85
Earth, with sand and gravel	3100	11.0%	0.90
Gypsum	4300	75.0%	0.57
Gravel, dry	3250	12.3%	0.89
Gravel, wet	3600	13.6%	0.88
Granite	4600	49.0 - 79.0%	0.67 - 0.56
Iron ore, hematite	6500-8700	122.0%	0.45
Limestone, blasted	4200	67.0 - 75.0%	0.60 - 0.57
Loam	2700	21.5%	0.83
Mud, dry	2160-2970	21.5%	0.83
Mud, moderately packed	2970-3510	21.5%	0.83
Rock and stone, crushed	3240-3920	35.0%	0.74
Sand, dry	3050	12.3%	0.89
Sand, wet	3500	15.0%	0.87
Shale, soft rock	3000	66.7%	0.60
Slate	4590-4860	66.7%	0.60
Trap rock	5075	64.0%	0.61

Material weight for brine and wet sand = 3,500 lbs/bcy

39

Material weight for the brine and wet sand is determined to be 3500 lbs/bcy.

Note:
The material value from the previous material weights table has changed. The new material value is brine and wet sand because of the use of water trucks.

Using this chart, wet sand is read to be 3500 in-bank weight (lbs/bcy) and an in-bank correction factor of 0.87.

Source: International Harvester Company, *Basic Estimating,* Third Edition

Notes / Discussion Points / Lessons Learned: ______________________________

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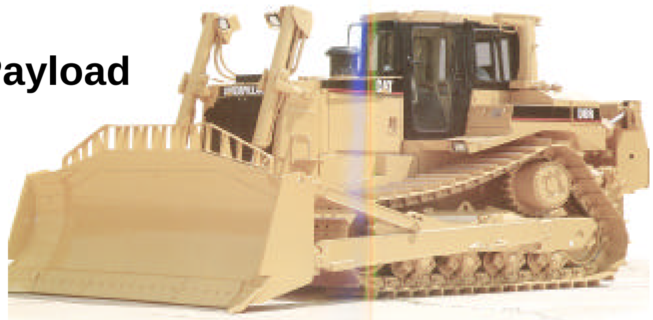
Cycle Time – Hauling (Continued)

Dozer Payload



Payload calculation:

Payload = Blade capacity x loose weight of material
= Blade capacity x bcy x in-bank correction factor
= 11.4 cy x 3500 lbs/bcy x 0.87 = 34,713 lbs

40

The payload is calculated as:

Payload = blade capacity x loose weight of material

The bank weight of material is changed to loose weight of material by use of a correction factor. The material weight and the correction factor is obtained from the preceding page.

Loose weight = bcy x in-bank correction factor

Payload = Blade capacity x bcy x in-bank correction factor

= 11.4 cy x 3500 lb/bcy x 0.87 correction factor

= **34,713 lbs**

Notes / Discussion Points / Lessons Learned: ______________________________

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Coefficient of Traction Table

		COEFFICIENTS OF TRACTION			
		Rubber Tires		Tracks	
Standard Tables	**Type of Surface**	**Dry**	**Wet Surface**	**Dry**	**Wet Surface**
	Smooth blacktop	.8 - 1.0	.6 - .9	--	--
.88 - 1.0	Rough concrete	.9 - 1.0	.8 - 1.0	.3 - .6	.3 - .6
	Hard smooth clay	.6 - 1.0	.1 - .3	.4 - .7	.2 - .4
.40 - .58	Hard clay loam	.5 - .8	.15 - .4	.6 - .9	.4 - .9
	Firm sandy loam	.4 - .8	.25 - .8	.6 - 1.0	.6 - 1.0
	Spongy clay loam	.4 - .6	.15 - .3	.7 - 1.0	.6 - .9
.40 - .44	Rutted clay loam	.3 - .5	.15 - .3	.7 - 1.0	.6 - .9
.20 - .35	Rutted sandy loam	.3 - .4	.2 - .5	.7 - 1.0	.7 - 1.0
.36	Gravel road, firm	.5 - .8	.3 - .9	.7 - .9	.7 - .9
	Gravel, not compacted	.3 - .5	.4 - .6	.5 - .9	.6 - 1.0
	Gravel, loose	.2 - .4	.3 - .5	.4 - .7	.5 - .8
.20 to .35	Sand, loose	.1 - .2	.1 - .4	.3 - .5	.4 - .7
.20	Snow, packed	.1 - .4	.0 - .3	.2 - .6	.2 - .6
	Ice, roughened	.1 - .3	.0 - .2	.1 - .4	.0 - .3
.12	Ice, smooth	.0 - .1	.0 - .0	.0 - .1	.0 - .1

41

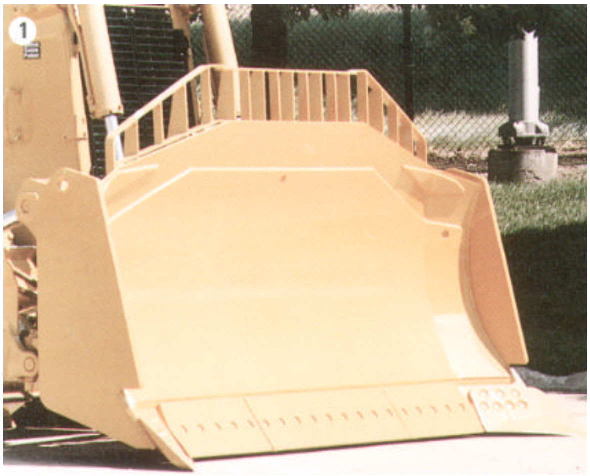
Production curves and tables can be found in the *Caterpillar Performance Handbook*, Edition 27.

To calculate the dozer speed, the drawbar pull must first be calculated by obtaining the coefficient of traction and multiplying it by the payload (previous page). The coefficient of traction is read from the above table as 0.6.

Coefficient of Traction = 0.6

Notes / Discussion Points / Lessons Learned: ______________________________

Cycle Time – Hauling (Continued)



Drawbar Pull (DBP)

= Dozer Payload x Coefficient of Traction

= 34,713 lbs x 0.6

= 20,828 lbs

42

The Drawbar Pull (DBP) is needed to obtain the dozer speed. DBP is calculated as the dozer's payload times the coefficient of traction.

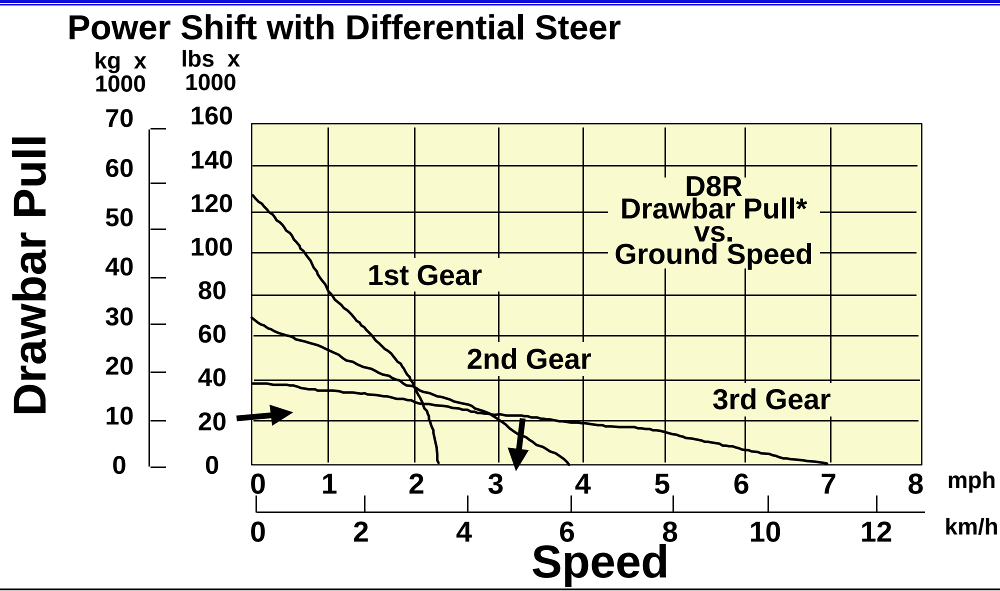
DBP calculation as follows:

DBP = payload x coefficient of traction
= 34,713 lbs x 0.6
= 20,828 lbs

Drawbar Pull = 20,828 lbs

Notes / Discussion Points / Lessons Learned: ______________________

Cycle Time – Hauling (Continued)



43

Discussion Leader/Facilitator Notes: This chart is from the Caterpillar's "D8R Track-Type Tractor" brochure, which is provided in Appendix C.

The chart was used to obtain the dozer speed based on the calculated drawbar pull.

Read across from the weight located on the left side for 20,828 lbs to where it intersects the gear curve. Read down at that point to see that the maximum speed would be 3.2 mph.

Dozer Speed = 3.2 mph

Notes / Discussion Points / Lessons Learned: ______________________________

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Cycle Time – Hauling

Haul Time

= 225 ft average distance ÷ (3.2 mph x 88 ft/min)
= 225 ft ÷ 282
= 0.8 min

44

Now that we have the distance and the speed, the haul time can be calculated.

The haul time is calculated as the average distance divided by the speed.

Average Haul Distance is 225 ft (260 ft - 35 ft for cutting and maneuvering).
Speed = 3.2 mph

$$\text{Haul Time} = \frac{\text{average distance}}{\text{speed}}$$

$$\text{Haul Time} = \frac{225 \text{ ft}}{3.2 \text{ mph} \times 88 \text{ ft/min}}$$

Haul Time = 0.8 min

Note:
88 ft/min is a conversion <u>to change mph to ft/min.</u>
88 ft = distance moved per minute when traveling at the rate of 1 mph.

$$\frac{\text{mile}}{\text{hr}} \times \frac{5280 \text{ ft}}{1 \text{ mile}} \times \frac{1 \text{ hr}}{60 \text{ min}} = 88 \text{ ft/min.}$$

Notes / Discussion Points / Lessons Learned: ____________________

Cycle Time – Dump

Dump Time = 0.10 min

45

The dump time is known to be 0.10 min

Notes / Discussion Points / Lessons Learned: ____

Cycle Time – Return

Return Time

= Distance ÷ Speed

= 260 ft ÷ (5 mph x 88 ft/min)

= 0.59 min

46

The return time is the distance divided by the speed.
The distance = (haul + maneuvering and cutting time) = 260 ft

Five mph is considered an average return time for crawler dozers. However, if speed is limited to a certain gear range, use maximum speed in that range as a return speed.

$$\text{Return Time} = \frac{\text{distance}}{\text{speed}}$$

$$\text{Return Time} = \frac{260 \text{ ft}}{5 \text{ mph} \times 88 \text{ ft/min}}$$

$$\text{Return Time} = 0.59 \text{ min}$$

Note:
88 ft/min is a conversion to change mph to ft/min.
88 ft = distance moved per minute when traveling at the rate of 1 mph.

$$\frac{\text{mile}}{\text{hr}} \times \frac{5280 \text{ ft}}{1 \text{ mile}} \times \frac{1 \text{ hr}}{60 \text{ min}} = 88 \text{ ft/min.}$$

Notes / Discussion Points / Lessons Learned: ____

Total Cycle Time

Load Blade	**=**	**0.18 min**
Haul	**=**	**0.80 min**
Dump	**=**	**0.10 min**
Return	**=**	**<u>0.59 min</u>**
Total	**=**	**1.67 mins**

47

The total cycle time is calculated by the addition of the load blade, haul, dump, and return times.

Cycle Time = Load Blade Time + Haul Time + Dump Time + Return Time
= 0.18 min + 0.80 min + 0.10 min + 0.59 min

Cycle Time = 1.67 mins

Notes / Discussion Points / Lessons Learned: ______________________

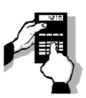
Production

Production = I x H x (E ÷ C)

P - Production in cubic yards
I - In-bank correction factor
H - Heaped capacity of blade
E - Efficiency of work/hour
C - Cycle time of the machine in minutes

48

Production is now calculated as:



$$P = I \times H \times (E \div C)$$

Where:

P = Production in cubic yards
I = In-bank correction factor
H = Heaped capacity of blade
E = Efficiency of work/hour
C = Cycle time of the machine in minutes

Notes / Discussion Points / Lessons Learned: ______________________________

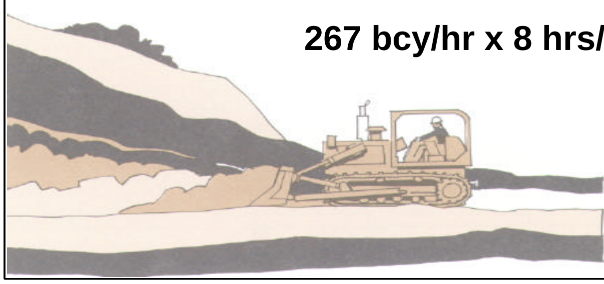
Production (Continued)

Production = I x H x (E ÷ C)

I - In-bank correction factor (0.87)
H - Heaped capacity of blade (11.4 lcy)
E - Efficiency of work/hour (45 mins/hr)
C - Cycle time of the machine in minutes (1.67 mins)

P = 0.87 bcy/lcy x 11.4 lcy x (45 mins/hr ÷ 1.67 mins)
= 267 bank cubic yards (bcy)/hr

267 bcy/hr x 8 hrs/day = 2136 bcy/day



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- For the Brine Pond waste:
  - I is the in-bank correction factor from the table on Page 39 (using wet sand material).
  - H is the heaped capacity of blade from Page 38.
  - E is the efficiency per hour (45 mins/hr) for a Level D condition.
  - C is the cycle time of the machine in minutes from Page 47.

  Referenced in the *Caterpillar Performance Handbook*, Edition 27.

- Production quantity per hour for the Brine Pond waste is:

P = I x H x (E/C)

P = 0.87 bcy/lcy x 11.4 lcy x (45 mins/hr ÷ 1.67 mins)

= 267 bcy/hr

- Production quantity per day is:

= 267 bcy/hr x 8 hrs/day

Production = 2136 bcy/day

Notes / Discussion Points / Lessons Learned: ______________________________

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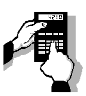
Brine Pond Excavation

Job Duration

Total Excavation = 15,910 bcy or 16,000 bcy
= 16,000 bcy ÷ 2136 bcy/day
= 7.5 Days
Use = 8 Days

50

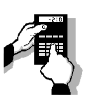
- The Brine Pond waste excavation duration is calculated as the quantity to be excavated divided by the production rate.
  - The quantity of cy to be excavated was calculated in Step 4a (Page 28) to be 429,582 bcf (value prior to adding the expansion).



429,582 bcf ÷ 27 cf/cy
= 15,910 bcy

Use 16,000 bcy

  - The production rate was calculated on the previous slide to be 2136 bcy/day.



$$\text{Job duration} = \frac{\text{quantity}}{\text{production rate}}$$

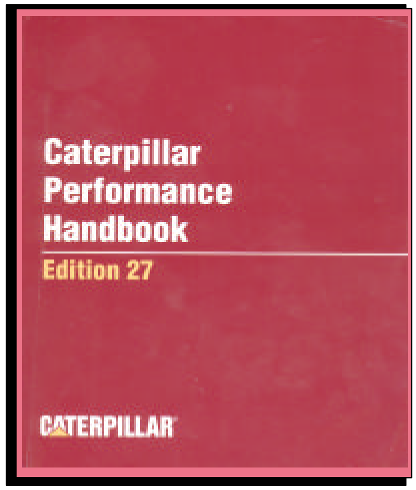
$$\text{Job duration} = \frac{16{,}000\ \text{bcy}}{2136\ \text{bcy/day}}$$

= 7.5 Days

Use 8 Days

Notes / Discussion Points / Lessons Learned: ____________________

Reference Material



51

Production curves and tables can be found in the *Caterpillar Performance Handbook*, Edition 27.

The following pages calculate the equipment and labor costs based on the 8-day job duration of this activity.

Notes / Discussion Points / Lessons Learned: ______________________________

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Equipment Costs

Caterpillar Equipment	Hours		Cost/Hr		Total Cost
D8R Dozer	64	x	44.1	=	2,822
631 Water wagon	64	x	74.6	=	4,775
Water stand (10,000 gal)	64	x	4.37	=	280
14G Blade	64	x	40.3	=	2,579
Van	64	x	7.25	=	464
			Total Equipment Cost		**$10,920**

52

Equipment cost comes from information provided by the subcontractor in the proposal bid.

		Equip Cost/Hr	+	Fuel/Hr	=	Cost/Hr
CAT D8R Dozer	=	$31.10	+	$13		$44.10
CAT 631 Water wagon	=	$54.60	+	$20		$74.60
CAT Water stand	=	$ 4.37	+	$0		$4.37
CAT 14G Blade	=	$31.30	+	$9		$40.30
VAN	=	$ 4.25	+	$3		$7.25

The cost of each piece of equipment is calculated based on hours used times cost per hour. The total equipment cost is the addition of the cost of each piece of equipment.

Notes / Discussion Points / Lessons Learned: ______________________________

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Labor Cost

	Number Req'd		Duration		Cost/Hr	=	Total
Operators	3	x	64 hrs	x	32.09	=	6,161
Laborer	1	x	64 hrs	x	24.57	=	1,573
Supervisor	1	x	64 hrs	x	32.09	=	2,054
Meals/Lodge	4	x	8 days	x	82.00	=	2,624
			Total Labor Cost				**$12,412**

53

The labor cost provided by the subcontractor on the proposal bid is

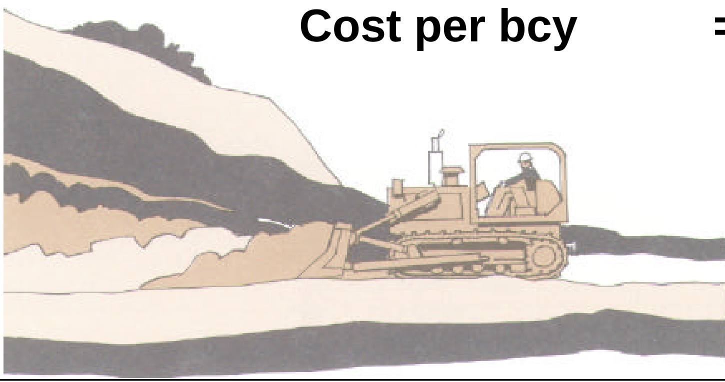
Operators	=	$32.09/hr
Laborers	=	$24.57/hr
Supervisor	=	$32.09/hr
Lodging	=	$52/day
Meals	=	$30/day

The costs for each labor resource is the number of resources x the duration x the cost per hr. The total labor cost is the addition of each resource cost and the meal and lodging costs.

Notes / Discussion Points / Lessons Learned: ______________________________

Total Excavation Cost

Equipment cost	**=**	**$ 10,920**
Labor cost	**=**	**$ 12,412**
Total	**=**	**$ 23,332**
Cost per bcy	**=**	**$ 1.46**



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The total excavation cost is the addition of the equipment plus the labor costs.

The cost per bcy is the total cost divided by quantity to be excavated.

$$\text{Cost per bcy} = \frac{\$23{,}332}{16{,}000 \text{ bcy}}$$

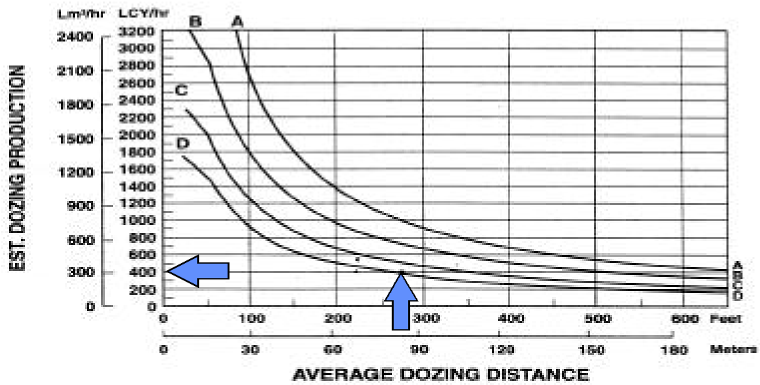
Cost per bcy = $1.46

Notes / Discussion Points / Lessons Learned: ______________________________

Alternate Production Calculation

Average haul distance = 260 ft
400 lcy/hr x 0.87 bcy/lcy = 348 bcy/hr
348 bcy/hr ÷ 60 mins/hr = 5.8 bcy/mins
5.8 bcy/min x 45 mins/hr = 261 bcy/hr

Estimated Dozing Production
Semi-Universal Blades
D8R through D11R



Key
A - D11R - 11SU
B - D10R - 10SU
C - D9R - S9U
D - D8R - 8SU

Note:
This chart is based on numerous field studies made under varying job conditions. Refer to correction factors.

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The calculation just demonstrated for the excavation of the Brine Pond waste could also be performed based on charts provided in the *Caterpillar Performance Handbook* (Pages 1-50).

The estimated dozing production is read from chart based on the average haul distance of 260 ft. For a D8R dozer (Curve D) at an average dozing distance of 260 ft, the estimated dozing production is read from the chart to be 400 lcy/hr. Bcy are changed to lcy, by using the correction factor of 0.87. The efficiency factor adjustment is made by first changes from hrs to mins and then multiplying by the efficiency factor of 45 mins/hr.

Note:
The in-bank correction factor is 0.87. The efficiency factor for Level D condition was determined to be 45 mins/hr.

This calculation is a much simpler and faster method than the previously demonstrated method. The end result of this method obtains a production value that is very close to the amount calculated in the previously demonstrated method.

First production method (Page 49)	=	267 bcy/hr
Alternate production method	=	261 bcy/hr

Notes / Discussion Points / Lessons Learned: ____________________

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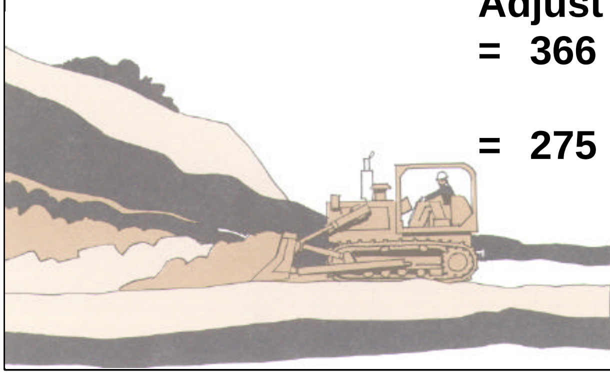
Rule-of-Thumb Method

Dozer Production = (Net power x 330) ÷ (haul + 50)
= (305 x 330) ÷ (225 + 50)
= 100,650 ÷ 275
= 366 bcy/hr

Adjust for efficiency
= 366 bcy/hr ÷ 60 mins/hr x 45 mins/hr
= 275 bcy/hr



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Another way of obtaining the dozer production is by the rule-of-thumb method.

Dozer Production = (Net power x constant) ÷ (haul + 50)

The net flywheel power of the dozer engine is 305 from Caterpillar specification sheet.
The constant is 330
The haul distance is 225 ft

Dozer Production = (305 x 300) ÷ (225 + 50) ÷ (60 mins/hr x 45 mins/hr)

Dozer Production = 275 bcy/hr

This calculation is also a much simpler and faster method than the first production calculation method. Moreover, the end result of the rule-of-thumb method is a production value that is close to the amount calculated in the first production method demonstrated.

First production calculation method	=	267 bcy/hr
Alternate-chart calculation method	=	261 bcy/hr
Rule-of-thumb method	=	275 bcy/hr

Notes / Discussion Points / Lessons Learned: ______________________

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Step 4c: Equipment Utilization Summary

57

We have demonstrated three methods of calculating the excavation of the Brine Pond wastes duration and costs.

The loading and hauling would now also have to be calculated. These items would be calculated in a similar manner of determining the equipment, calculating the cycle and production times, and then applying the costs.

Due to time constraints, we will not demonstrate these calculations.

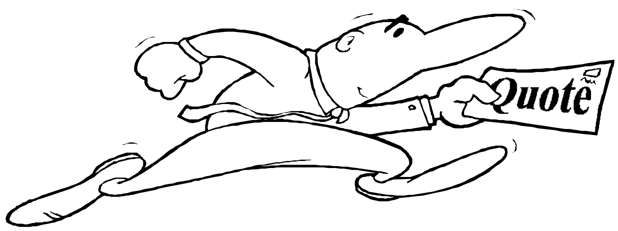
The next step (4d) will be to apply pricing. Because the cost of disposal is a cost-driver in this project, we will look at the pricing for the disposal costs.

Notes / Discussion Points / Lessons Learned: ________________________________

Step 4d: Apply Pricing

Sources:

- **Vendor quotes**
- **Pricing catalogs**
- **Historical data/previous projects**



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Discussion Leader/Facilitator Notes: The facilitator should lead the group in discussion and determination of a price for the waste disposal of the brine pond material. No right or wrong answer is provided. (Note: Estimating is not an exact science. The "right" answer is never known for sure until after the work has been completed and actual costs are known.)

General Application — Step 4d

- For detailed estimates, vendor quotes/estimates are the preferred pricing source for significant cost items.
- Historical data, especially if they are actual, are also a valuable resource for price information. However, the estimator should be knowledgeable and aware of any project differences and/or changes that have occurred that could affect the price.
- Pricing catalogs and data bases are probably the most commonly used resource, especially for smaller items.

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ____

Application to Brine Pond Project — Step 4d

Obtain and apply pricing for the Brine Pond Project - HTRW 331.19.21 Brine and Sand Waste Disposal

Because the disposal cost is a cost driver on this project, a vendor estimate is the best source of obtaining this pricing information.

The following quotes have been obtained and summarized. (A copy of one of the obtained quotes is provided on the following page as an example.)

- DUMLAW Environmental Services (a Class I landfill located approximately 21 miles from the project site) responded to a request for a quote from the DOE estimator.

  Nonhazardous: $48.00/ton + 10% county tax + $350 profile fee

- We have three responses to a request for an estimate put out by our prime contractor, MOH Remediation Services, Corporation. These responses provide the following cost information:

  1. Universal Environmental - $65/ton + 13.50/ton tax

  2. Envirotech Consulting Services - $66/ton + 6.00/ton NORM + $7/ton tax (tax applicable to the first 5,000 tons of material disposed in a calendar month).

  3. OST Trucks and Cranes - $66/ton + $6.60/ton tax

Based on this information, at what amount are we going to price this material disposal?
(Determining price information based on obtained information is an experience and judgment call. As a group, discuss and determine the pricing to use.)

Hint:
Bid award was for 16,800 tons @ $1,318,800 (without overhead and fee) = $78.50/ton.
Actual cost for 21,284.08 tons was $1,680,417 of brine waste = $78.95/ton.

Notes / Discussion Points / Lessons Learned: ______________________

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Section 2.2: Preparation of a Detailed Cost Estimate/Lessons Learned
Example Quote

D U M L A W

ENVIRONMENTAL SERVICES

Secure Landfill

FAX TO:	*Sam Jones*	*FROM:*	*Elpidio Abrajan*
FAX #:	*(555) 637-2078*	*FAX #:*	*(619)344-5555*
SUBJECT:	*Price Quotation*	*PAGE:*	*1 OF 2*

Mr. Jones
DEPARTMENT OF ENERGY

Dear Mr. Jones:

SUBJECT: Transportation and disposal of contaminated soil

DUMLAW Environmental Services is pleased to submit for your consideration the following quote for disposal and transportation of your waste material. DUMLAW is a total service company dedicated to providing the highest standard of waste management. We offer a turnkey service with a professional staff that can assist you to properly label, manifest, transport and dispose of these materials in accordance with all applicable local, state and federal requirements.

DISPOSAL FACILITY: DUMLAW Environmental Services, Westmorland, CA.

WASTE STREAM:	*Contaminated Soil*
NON HAZARDOUS:	*$48.00 PER TON PLUS 10% county tax*
DISPOSAL METHOD:	*Secured Landfill*
PROFILE FEE:	*$350.00*
PROFILE EXPIRATION:	*One year after the approval date*
MINIMUM CHARGE:	*$500.00 per load*

All prices quoted are good for 30 days.

DUMLAW Environmental Services (Imperial Valley), Inc.
Post Office Box 231 Westmorland, California 92281
Phone 619 351-5600 Fax 619 344-5555

Notes / Discussion Points / Lessons Learned: ______________________________

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Section 2.2: Preparation of a Detailed Cost Estimate/Lessons Learned

Page 2
DUMLAW Environmental Services

To expedite your request, this quote has been prepared based on the information received from you. Any variations between the information received and actual data from sample and waste profile may require modification of this quote. If you have any questions or concerns please do not hesitate to call us.

If the foregoing proposal is acceptable to your company, kindly sign and date the enclosed copy of this letter.

Thank you for your interest in DUMLAW Environmental Services.

Sincerely,
Elpidio Abrajan
Customer Service Representative

Notes / Discussion Points / Lessons Learned: ______________________________

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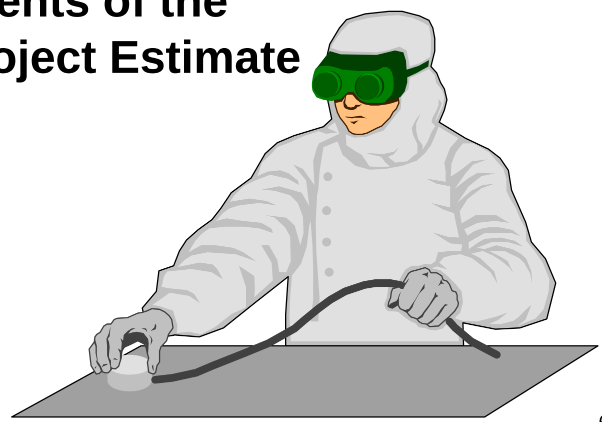
Other Elements

Other elements of the Brine Pond Project Estimate



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This project is primarily an excavation-and-disposal project. We have concentrated on the escalation disposal estimates because of the magnitude of these costs.

ER projects have other types of project estimates, such as decommissioning or other remediation technologies. The removal of the intake structure and piping on this project is a mini-decommissioning project.

Considerations for estimating D&D projects include the following issues:

- Congestion
- Access
- Height
- Dress-out
- Confined space
- Method of capturing waste removed
- Removal operations
- Demolition

Notes / Discussion Points / Lessons Learned: ______________________________

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Step 5: Apply Job Factors

Considerations used to adjust rates or costs to account for specific job conditions.

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Discussion Leader/Facilitator Notes: The facilitator is to encourage discussion and add to these lists if necessary.

General Application — Step 5

Job factors are applied to unit rates or pricing to adjust for specific conditions that will effect productivity or cost. Usually, factors are applied as percentages to either the total or a portion of cost. Caution should be taken to ensure that factors are not inappropriately added on top of each other. It is also important to ensure that a factor is not being added to a base that already includes conditions for which the factor is adjusting.

Job factors may include adjustment for the following issues:

- Security
- Confined space
- Escorts
- Location
- Weather
- Time of year
- Union versus nonunion labor
- Contamination dress-out level (Level D)
- Complexity
- Congestion
- Height

Application to Brine Pond Project — Step 5

Conditions that may affect the production rates or cost for the Brine Pond Project include the following:

- Weather - heat stress in the late summer months.
- Dress-out Level C

Notes / Discussion Points / Lessons Learned: ____________________

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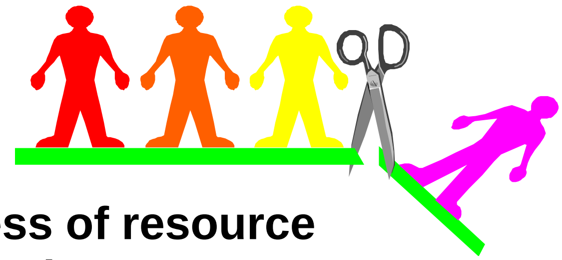
Step 6a and 6b: Evaluate Resources, Schedule, and Spend Plan, then Adjust



Evaluate:

- **Reasonableness of resource allocation over time**
- **Schedule feasibility of time periods**
- **Spend plan versus funding available**

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Discussion Leader/Facilitator Notes: At this time, discuss the spend plan and funding needs.

General Application — Step 6a and 6b

Once the hours and pricing have been calculated, the estimate must be evaluated to ensure that

- Resource allocation over time is reasonable. Consider the number of resources available and space limitations. (Can the resources physically fit in the work space?)
- The scheduled time periods are feasible and appropriate.
- Project estimated cost (spend plan) reasonably reflect funding available.

Application to Brine Pond Project — Step 6a and 6b

For the Brine Pond Project:

Excavation/backfill work rates were calculated considering the following factors:

- Cycle times
- Space and movement for equipment to be efficient

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ______________________________

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- How equipment will work together

Haul times were calculated considering

- Load and unload times (minimize trucks waiting on each other)
- Number of trucks available
- Cycle times

Once the pricing is complete, the estimate still needs to be evaluated for overall manpower and equipment availability. Overall schedule durations must be evaluated, and the preparation of a spend plan will help evaluate funding requirements.

Adjust the estimate and schedule as necessary to achieve reasonable resource and spending plans.

Notes / Discussion Points / Lessons Learned: ______________________

Step 7: Team Reviews and Checks

- **Peer review**
- **Project Team review**
- **Customer review**

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General Application — Step 7

Reviews are the most important step in the estimating process and are essential to obtaining an accurate estimate. An estimate that is accurate without going through review is correct only because of sheer luck—luck that the estimator didn't overlook something, make a mistake, or misunderstand some element of the estimate.

One cannot stress enough the importance of reviews!

Notes / Discussion Points / Lessons Learned: ______________________________

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Peer Review and Checks

Real-Life Examples of the Impacts of Peer Reviews

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Discussion Leader/Facilitators Notes: Share an example of where estimate reviews have had a significant impact on improving or preventing major errors in a submitted estimate or a case where a major error could have been prevented if an estimate had been reviewed. Here are three good examples related to peer review.

Examples:

Jail Project:

Construction of a jail in California was bid and awarded at a $65M fixed-price contract. The estimate had not included costs for security glass, monitors, or window bars. This was a $12M mistake that the contractor had to absorb. Because of time pressures to get the bid in on time, peer reviews were not done.

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ______________________________

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Dredging Job:

On a high-visibility dredging project in Washington State, peer review of the estimate revealed that disposal costs were significantly low. The review had concentrated on disposal costs because this cost was a significant item in the project total costs. The estimate had used cost data from a previous job as well as relying on third-hand information from staff members. Peer review revealed that the cost data used were not accurate for the Washington State project. The lesson learned on this project is that the estimator should not have relied on old information or third-hand information for a significant cost item. The estimator will get the best information directly from the source.

Airport:

A company bid on and won a contract to build an airport. The estimate process for bidding the $1 billion project was broken into disciplines. Peer review on this estimate uncovered that the furniture cost had not been included (a $10M omission). Because of the peer review process, this error was found before the bid was submitted.

Notes / Discussion Points / Lessons Learned: ______________________________

Step 8: Apply Escalation

DOE (FM) Published Escalation

http://146.138.131.98/FM-20/escal97.html

(Note: The project manager is to check with the program to verify that FM-published rates should be used for their program area.)

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Discussion Leader/Facilitator Notes: Work the group through the calculation of escalation for disposal costs on the Brine Pond Project.

General Application — Step 8

Steps in calculating escalation:

Step A: Determine the midpoint of each activity from the schedule.

Step B: Select appropriate DOE-HQ FY rates.

Step C: Apply the compound escalation rate.

Escalation is compounded. Therefore, 2 years escalated at 5%/year is cost x $(1.05)^2$. It is not the addition of 0.05 + 0.05, which would equal cost x (1.10).

Escalation rates can be accessed on the web at http://146.138.131.98/FM-20/escal97.html

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ______________________________

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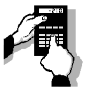
Application to Brine Pond Project — Step 8

(Recalculate disposal costs based on delaying the project 8 years. Base year is end of FY 1998, and work will be accomplished end of FY 2008.)



Calculate:

Work together to recalculate the disposal estimate for the Brine Pond Project based on a 8-year delay.

Escalation:

Step A: Midpoint of activity --> end FY 2002 (8-year delay)

Step B: Select appropriate DOE HQ FY rates

January 1997 Update

Departmental Price Change Index
FY 1999 Guidance
Anticipated Economic Escalation Rates
DOE Construction Projects

	Energy Research and Nuclear		Fossil		Conservation and Solar		Defense Programs and Gen. Const.		Environmental Restoration		Waste Management	
Fiscal Year	Index	%Change	Index	%Change	Index	%Change	Index	%Change	Index	%Change	Index	%Change
1997	.976	2.1	.976	1.9	.978	1.8	.978	2.6	.976	2.4	.980	1.9
1998	1.000	2.5	1.000	2.5	1.000	2.3	1.000	2.2	1.000	2.5	1.000	2.1
1999	1.028	2.8	1.028	2.8	1.027	2.7	1.024	2.4	1.028	2.8	1.026	2.6
2000	1.059	2.9	1.057	2.9	1.055	2.8	1.053	2.8	1.057	2.9	1.053	2.7
2001	1.090	2.9	1.087	2.8	1.084	2.7	1.081	2.7	1.089	3.0	1.082	2.8
	1.122	3.0	1.118	2.9	1.115	2.8	1.111	2.8		3.0	1.112	2.8
2003	1.158	3.2	1.153	3.1	1.148	3.0	1.142	2.8	1.156	3.0	1.144	2.9

Based on the materials and labor data contained in the Energy Supply Planning Model and appropriate escalation rates forecasted by Data Resources, Incorporated, it would be expected that DOE projects conform to those rates shown above. Guidelines for the implementation of DOE Order 430.1, "Life-Cycle Asset Management," recommend that any local rates different from those above be submitted to the Office of Project and Fixed Asset Management for approval, prior to their use. Additional advice and assistance can be obtained from the Associate Deputy Secretary for Field Management, Office of Project and Fixed Asset Management 202-586-9706.

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ______________________________

Escalation rates chosen for use are the environmental restoration rates.

From the table, the "%" change is

2.8% for FY 1999
2.9% for FY 2000
3.0% for FY 2001
3.0% for FY 2002

The compound rate for the 4 years is calculated as

$$1.028 \times 1.029 \times 1.03 \times 1.03 = 1.122 .$$

Because the base year of FY 1998 is the same base year of the table (index = 1.00 for FY 1998), the index provides the compound rate multiplier of 1.122 for FY 2002.

Step C: Apply compounded escalation rates

Costs x Disposal cost x Compound escalation rate

Disposal cost x 1.122 = Escalated cost to FY 2002 dollars (actual $ as used in engineering economy terms).

Note:

With an 8-year delay it would be better to escalate each year's cost based on a spend plan rather than escalating at the mid-point of the entire eight years.

Notes / Discussion Points / Lessons Learned: ____________________

Step 9: Analysis Risk and Apply Contingency

Identify and evaluate project risk factors
and
determine the appropriate contingency level

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Discussion Leader/Facilitator Notes: Work the group through the evaluation of risks and the determination contingency for disposal costs on the Brine Pond Project with a 8-year delay in project execution.

<u>General Application — Steps 9a and 9b</u>

- Risk consideration should include
  - Project unknowns
  - Variables
  - Visibility of project and stakeholder involvement
  - Estimator's confidence in quantities, definition, pricing, etc.
  - Project complexity
  - Technology maturity
  - Project duration
  - Future work

- Contingency levels should be appropriate to cover reasonably the project risks identified.

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Notes / Discussion Points / Lessons Learned: ______________________________

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Application to Brine Pond Project — Steps 9a and 9b

(Evaluate risk and apply contingency to the disposal cost estimate that projected a 8-year project delay. Provide an owner estimate for disposal costs.)

Work together to evaluate risks for the disposal costs for the Brine Pond Project based on a 8-year delay. Determine as a group the appropriate contingency to apply to this cost element.

Identify Risks:

Risk events, related probability of event occurring, cost % impact, and schedule % impact related to a 8-year extension of this work are evaluated and determined by the project team. This information is represented in the following table.

Risk event or condition	Probability score	Cost impact	Weighted cost impact	Schedule impact	Weighted schedule impact
1. Political difficulties	20%	10%	(.20) (.10)= .02	20%	(.20) (.20)= .04
2. Increased tax and/or regulations	40%	6%	(.40) (.06) = .024	0%	---
3. Disposal cost increases beyond price inflation	60%	20%	(.60) (.20)= .12	0%	---
			.164		.04

Note:
These probabilities do not come out of a book. The project team determines the factors and probabilities.

Cost Impact:

* Weighted Total Cost Impact is 0.164 = 16.4%

Recommend a contingency level of around 16% for disposal cost delay of 8 years to FY 2008.

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ______________________________

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Schedule Impact:

Weighted Total Schedule Impact is 0.04

Current estimated duration is 3 months.

3 months x 0.04 Weighted Total Schedule Impact = 0.12 months

Recommend a schedule contingency of 0.12 months or 2.5 work days
(20 work days/month x 0.12 = 2.5 days)

Total project schedule with contingency float should be 3 months + 0.12 month float = 3.12 month (critical path should be scheduled with 2.5 work days of float).

(This is an example of one way to evaluate risk and its related impact to cost and schedule. Whatever method is used to analyze risk impact, it is the responsibility of the project team.)

Notes / Discussion Points / Lessons Learned: ______________________________

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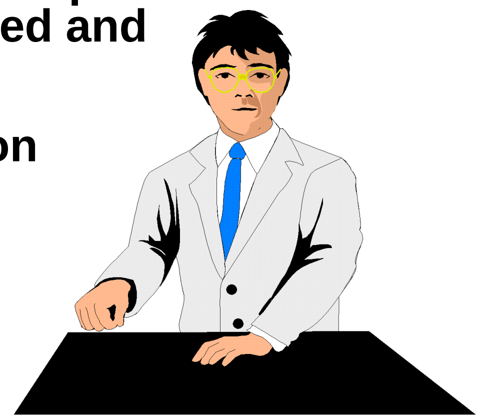
Step 10: Present and Defend

- **Estimate package (scope, schedule, cost estimate) assumptions and basis clearly defined and documented**
- **Report presentation**



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- The estimate package must be a completed, documented package that includes scope, schedule, and cost-estimate details. It must clearly explain assumptions and the basis for the calculations and estimate.
  - Estimate type
  - Project scope
  - Constraints or special conditions
  - Performance specifications
  - Source documents used for scope
  - Schedule time periods/milestones
  - Quantity calculations
  - Sources of rates and pricing
  - Resource requirements
  - Explain factors applied
  - Identify risk factors that were used to determine contingency
  - Supporting backup
  - Estimate history
  - How estimate was developed
  - Who developed estimate
- Report presentation must be such that information is meaningfully summarized and represented.

Notes / Discussion Points / Lessons Learned: ______________________________

Section 2.2: Preparation of a Detailed Cost Estimate/Lessons Learned

Real-Life Detailed Estimate

Date: August 8, 1997
Rev: 3
Estimator: AEF

Brine Pond Project
Excavation and Removal or Residues to a Disposal Facility
Detailed Construction Estimate Summary

Project WBS	HTRW #	ITEM	UNIT COST
		Direct Costs	
8.2.1	331.01.01	Mobilization	$6,000
8.2.2	331.10.03	Remove concrete intake	$9,000
8.2.3	331.10.05	Remove discharge pipes	$3,000
8.2.4	331.05.12.01	Excavate waste, load, and haul	$60,000
8.2.5	331.05.12.02	Excavate dike	$60,000
8.2.6	331.22.07	Health & Safety Program	$5,000
8.2.7	331.20.01	Place dike fill	$36,000
8.2.8	331.19.21	Dispose waste - offsite	$1,092,000
8.2.9	331.21.04	Demobilization	$4,000
		Total Direct Costs	$1,275,000
		Indirect Costs	
	331.22.01	Construction Management	$40,000
	331.01.03	Permitting	$26,000
	331.22.12	Bonds	$89,000
	331.22.04	Engineering & Proj. Mgmt.	$113,000
		Contingency	$386,000
		Total Indirect Costs	$654,000
		TOTAL	**$1,929,000**

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The “real-life” detailed estimate summary sheet for this project is shown here.

Notes / Discussion Points / Lessons Learned: ____________________

The Actual Outcome of Example Project

The Real-Life Answer

Government Estimate:	**$1,929,000**
DOE Estimate Review:	**$1,965,000**
Subcontract Bid:	**$2,658,093**
Actual Project Costs:	**$2,634,736**

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Discussion Leader/Facilitator Notes: The facilitator is to review Real-Life Estimates as well as what actually occurred on this project as included on the next pages. Lessons Learned on this project or similar projects.

The following pages provide the actual cost-estimate summaries, and the actual final cost performance report provides information about how the real-life Brine Pond Project example actually came out.

Share Lessons Learned on this project or other similar projects.

Notes / Discussion Points / Lessons Learned: ____

Brine Pond Closure
Summary Cost Comparison

Description	Government Estimate	DOE Review Team Estimate	Difference Team - Government
Mobilization	$6,000.00	$4,000.00	($2,000.00)
Remove Concrete Intake	$9,000.00	$9,000.00	$0.00
Remove Discharge Pipes	$3,000.00	$3,000.00	$0.00
Construct Decon. Pad	$0.00	$11,000.00	$11,000.00
Excavate Waste, Load, and Transport	$60,000.00	$69,000.00	$9,000.00
Dispose Waste - Offsite	$1,092,000.00	$849,000.00	($243,000.00)
Excavate Dike	$60,000.00	$54,000.00	($6,000.00)
Place Dike Fill	$36,000.00	$165,000.00	$129,000.00
Final Survey	$0.00	$1,000.00	$1,000.00
Health and Safety Program	$5,000.00	$20,000.00	$15,000.00
Demobilization	$4,000.00	$3,000.00	($1,000.00)
Subtotal	$1,275,000.00	$1,188,000.00	($87,000.00)
General Contractor Markup on Subcont.	$0.00	$44,000.00	$44,000.00
Construction Management	$40,000.00	$167,000.00	$127,000.00
Permitting	$26,000.00	$24,000.00	($2,000.00)
Bonds	$89,000.00	$30,000.00	($59,000.00)
Engineering & Project Management	$113,000.00	$119,000.00	$6,000.00
Contingency	$386,000.00	$393,000.00	$7,000.00
Subtotal	$654,000.00	$777,000.00	$123,000.00
TOTAL	**$1,929,000.00**	**$1,965,000.00**	**$36,000.00**

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Discussion Leader/Facilitator Notes: This is an estimate comparison between the government estimate and the DOE government estimate review for the Brine Pond Project.

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ____

Actuals

Brine Pond Actuals for brine waste disposal:

- **Bid awarded: 16,800 tons at $1,318,800 (without overhead and fee) = <u>$78.50/ton</u>**
- **Actual cost: 21,284.08 tons at $1,680,417 of brine waste = <u>$78.95/ton</u>**

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In Step 4d, we discussed and calculated the waste disposal costs.

The actual Brine Pond waste disposal awarded bid and actuals are as follows:

Bid awarded: 16,800 tons at $1,318,800 (without overhead and fee) = $78.50/ton
(Bid estimate is shown on the next page.)

Actual cost: 21,284.08 tons at $1,680,417 = $78.95/ton

(Final cost performance project report showing actual cost is provided at the end of this section.)

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ______________________________

Section 2.2: Preparation of a Detailed Cost Estimate/Lessons Learned
Bid Estimate:

DOE Brine Pit Rev. 1 (18904A)
Worksheet Number: 1900300 - DISPOSAL FEES

Number:	1900300 Operation: DISPOSAL FEES		
Quantity:	16,800.00	Unit: TN	
Prod:	1.000 TN/	Dure: 16,800.00	
Estimator: GKM	Revised: 06/16/96		Rev. Num: 0
	Start Date: 08/15/96		End Date: 08/14/96

WORK CODE

Field	Code	Description
BID ITEM NO.		
RESOURCE TYPE:		
HTRW - LEVEL 2:		
HTRW - LEVEL 3:		
HTRW - LEVEL 4:		
CALENDAR YEAR:		

Line	Group/Code	Description	Quantity Unit	Manhr	Subcont.	Other	Total $
1.00	6400 /SOIL-DEB	DISPOSAL FEE CONTAM. DEBRIS/SOIL	16,800.00 TON	0.000	78.500		0.000
78.500							
				0.000	1318800.0	0.000	1318800.0
2.00	6400 /DEBRIS	DUMP FEE NON-CONTAM CONS. DEBR	6.00 LOAD	0.000	0.000	91.380	91.380
				0.000	0.000	548.280	548.280
3.00	6400 /DEBRIS	MISC CONTAM MATL IN DRUMS	5.00 DRUMS	0.000	100.000	0.000	100.000
				0.000	500.000	0.000	500.000
4.00	6400 /DUMP-10	DISPOSAL FEE ON 10 CY	2.00 LOAD	0.000	200.000	0.000	200.000
				0.000	400.000	0.000	400.000
	Worksheet Totals:		16,800.00 TN		1,319,700	548	1,320,248

G2 ESTIMATOR (TN)

Notes / Discussion Points / Lessons Learned: ______________________________

Section 2.2: Preparation of a Detailed Cost Estimate/Lessons Learned

Contract No. DACW45-94-D-0008
Delivery Order No. ___________
<<Project Description>>

CONTRACT BID

Cost Category	Direct Costs	Fringe Benefits %	Fringe Benefits $	Total Direct Labor	Operations Support %	Operations Support $	Supplies/ Insurance	Cost of Sales	Selling Pool %	Selling Pool $	Cost Before G&A	G&A Expense %	G&A Expense $	Total Project Costs
Labor:														
Full-Time	217,976.63	27.1%	59,071.67	277,048.30	38.8%	107,494.74		384,543.04	2.0%	7,690.88	392,233.90	6.8%	26,671.91	418,905.81
Temporary	0.00	12.2%	0.00	0.00	38.8%	0.00		0.00	2.0%	0.00	0.00	6.8%	0.00	0.00
Labor Total	217,976.63		59,071.67	277,048.30		107,494.74		384,543.04		7,690.88	392,233.90		26,671.91	418,905.81
Project Supplies							1.3%	2,833.70	2.0%	56.67	2,890.37	6.8%	196.55	3,066.92
Insurance							0.8%	1,743.81	2.0%	34.88	1,778.69	6.8%	120.95	1,899.64
Travel	6,162.85							6,162.85	2.0%	123.26	6,286.11	6.8%	427.48	6,713.57
Owned Equipment	11,515.00				38.8%	4,467.82		15,982.82	2.0%	319.66	16,302.48	6.8%	1,108.57	17,411.05
Rental Equipment	126,061.72							126,061.72	2.0%	2,521.23	128,582.95	6.8%	8,743.64	137,326.59
Fuel	36,573.00							36,573.00	2.0%	731.48	37,304.46	6.8%	2,536.70	39,841.16
Inventory	1,497.68							1,497.68	2.0%	29.95	1,527.63	6.8%	103.88	1,631.51
Field Purchases	135,889.00							135,889.00	2.0%	2,717.78	138,606.78	6.8%	9,425.26	148,032.04
Affiliates	0.00							0.00	2.0%	0.00	0.00	6.8%	0.00	0.00
Subcontractor	234,128.60							234,128.60	2.0%	4,682.57	238,811.17	6.8%	16,239.16	255,050.33
Transportation & Disposal	1,321,257.24							1,321,257.24	2.0%	28,425.14	1,347,682.38	6.8%	91,642.40	1,439,324.78
Team Subcontractor	0.00							0.00	2.0%	0.00	0.00	6.8%	0.00	0.00
Total Cost	2,091,061.72		59,071.67	277,048.30		111,962.56		2,266,673.43		45,333.46	2,312,006.92		157.216.48	2,469,223,40

Fee Computation:	Fee Percent	Fee Base	Total Fee
	7.50%	2,469,223.40	185,191.76
Facilities Capital Cost of Money (from DD1861)			3,678.01
Total Contract Price			2,658,093.17

Discussion Leader/Facilitator Notes: This is the summary report of estimated cost from the awarded contract bid for the Brine Pond Project.

Notes / Discussion Points / Lessons Learned: ______________________________

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Section 2.2: Preparation of a Detailed Cost Estimate/Lessons Learned

COST PERFORMANCE REPORT - WORK BREAKDOWN STRUCTURE (Format 1)

1. TITLE	2. REPORTING PERIOD	3. IDENTIFICATION NUMBER
BRINE POND PROJECT	December 1, 1996 THRU December 31, 1996	DACW45-94-D-005 D.O. 0036
4. PARTICIPANT NAME AND ADDRESS	5. COST PLAN DATE AUGUST 19, 1996	6. START DATE August 19, 1996 7. COMPLETE DATE November 19, 1996

8. NEGOT. COST	9. ESTIMATED COST OF AUTHORIZED UNPRICED WORK	10. TARGET PROFIT/FEE PROFIT/FEE %	11. TARGET PRICE	12. ESTIMATED PRICE	13. SHARE RATIO	14. CONTRACT CEILING	15. ESTIMATED CEILING
			$2,930,000		N/A	N/A	N/A

WBS ELEMENT		CURRENT PERIOD					CUMULATIVE TO DATE					AT COMPLETION		
		BUDGETED COST Work Scheduled	BUDGETED COST Work Performed	CURRENT PERIOD	VARIANCE Schd.	VARIANCE Cost	BUDGETED COST Work Scheduled	BUDGETED COST Work Performed	ACTUAL COST	VARIANCE		BUDGETED	REVISED ESTIMATE	VARIANCE
0100100	MOBE EQUIPMENT PERSONAL						$19,514	$19,514	$19,514			$20,118	$19,514	$602
0100308	PLANS/SCHEDULE/PERMITS						$33,687	$33,687	$33,687			$33,687	$33,687	
0100400	SITE PREP. TEMP FACILITIES SURVEY						$52,268	$52,268	$52,268			$52,621	$52,268	$353
0200602	SAMPLING & ANALYTICAL						$33,778	$33,778	$33,778			$37,080	$33,778	$3,302
0800100	EXCAVATE SOIL & LOADOUT		$3,445	$3,445			$184,212	$184,212	$184,212			$208,208	$184,212	$23,996
0800190	DUST COVER		$1,329	$1,329			$73,073	$73,073	$73,073			$102,185	$73,073	$29,112
0800191	BACKFILL WITH BERM		$4,579	$4,579			$68,129	$68,129	$68,129			$60,736	$68,129	($7,393)
1009000	DEMO LINER AT SPRAY POND		$46	$46			$9,542	$9,542	$9,542			$9,514	$9,542	($28)
1900201	TRANSPORT TO DISPOSAL SITE						$223,480	$223,480	$223,480			$262,805	$223,480	$39,325
1900300	DISPOSAL FEES						$1,680,417	$1,680,417	$1,680,417			$1,846,541	$1,680,417	$166,124
2003000	RE-ESTABLISH ROADS		$495	$495			$16,989	$16,989	$16,989			$37,868	$16,989	$20,879
2100300	DECON/DEMOB EQUIPMENT & PERSONAL		$606	$606			$16,374	$16,374	$16,374			$33,131	$16,374	$16,757
2100500	CREW ROTATION						$8,557	$8,557	$8,557			$8,964	$8,557	$407
2100603	FINAL REPORT	$8,518	$8518	$8518			$8,518	$8,518	$8,518			$9,065	$8,962	$103
8009020	SITE VISIT						$2,012	$2,012	$2,012			$2,012	$2,012	
9900000	ADMINISTRATION & SUPPORT	$19,603	$19,603	$19,603			$204,186	$204,186	$204,186			$205,467	$212,147	($6,680)
7. WBS TOTAL		$26,121	$38,621	$38,621			$2,634,736	$2,634,736	$2,634,736			$2,930,000	$2,643,141	$286,859
8. VARIANCE ADJUSTMENT														
9. TOTAL CONTRACT VARIANCE										22. SIGNATURE OF PARTICIPANT'S FINANCIAL REPRESENTATIVE				
10. DOLLARS EXPRESSED														

Discussion Leader/Facilitator Note: This is the final cost performance report for the real-life Brine Pond Project. It shows the total actual cost of this project.

Notes / Discussion Points / Lessons Learned: ______________________________

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Section 2.2: Preparation of a Detailed Cost Estimate/Lessons Learned

83

This is a photo of the actual work on the Brine Pond Project.

Notes / Discussion Points / Lessons Learned: ______________________

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Section 2.2: Preparation of a Detailed Cost Estimate/Lessons Learned

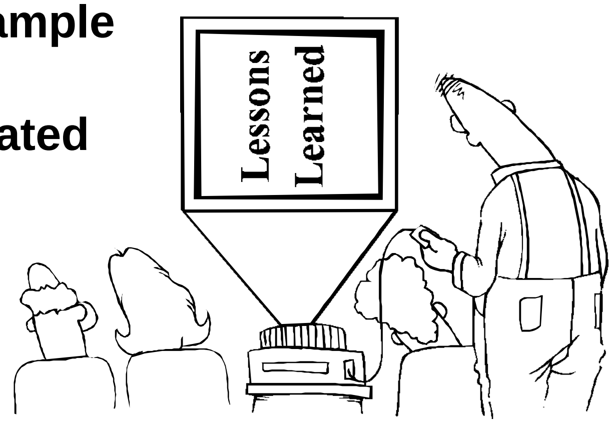
84

This is a photo of actual work on the Brine Pond Project.

Notes / Discussion Points / Lessons Learned: ______________________________

Lessons Learned

- **Discuss lessons learned on this project example**
- **Share other related experiences**



85

1. The disposal costs for the Brine Pond Project turned out to be quite an example. The bid was for 16,800 tons @ $78.50/ton for a total cost of $1,318,800. In an attempt to reduce costs, plans were changed to arrange for disposal at an out-of-state disposal facility. Disposal costs at the out-of-state facility were estimated to be in the $20/ton range as opposed to $78/ton. Considerable time, effort, and expense were expended pursuing this change. Political resistance to transporting materials across state lines eventually eliminated out-of-state disposal as an option. Material was disposed of at the DUMLAW Environmental's facility located 21 miles from the project at $78.95/ton.

2. Once the project team is established, does it stay the same from conceptual to detailed phases? What might happen when the right personality chemistry doesn't exist?

3. WBS elements should be consistent across projects. Are they? Does everyone use the HTRW as their guideline? If not, why not?

4. If significant factors to support and estimate are missing/unavailable, how do you address the problem? How is it documented?

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ______________________________

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5. How are you assured that pricing data are accurate?

6. To obtain quotes, as shown in the example, takes time. How do you factor this into the overall project schedule?

7. One example experienced a major change in an assumption by going to an out-of-state disposal facility. How are cost-estimate changes factored in when assumptions change? What potential problems could this produce?

8. How do you ensure that job factors are not improperly added on top of each other?

9. Who decides what type of review of the cost estimate is done? Who selects the team? Is their cost factored into the overall cost estimate? How is the review documented? If changes are needed after the review, does a second review of those changes occur?

10. The lessons learned from the jail project, dredging job, and airport examples are good. Two lessons learned were from negative events. The trend is for lessons learned to come from accidents or errors that are negative events. How many positive lessons learned are usually identified? How can this be improved?

11. Who ensures that all potential risk events are included in the evaluation of risk and how do they do it?

12. In our example, the subcontract bid was very different from the government estimate. Would this be a red flag for a re-examination of the government estimate? How should this be handled?

Notes / Discussion Points / Lessons Learned: ______________________________

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Section 2: Transition Slide

Completed:

- ✓ **Cost-Estimating Concepts**
- ✓ **Preparation of a Planning Cost Estimate**
- ✓ **Preparation of a Detailed Cost Estimate**

Left To Go:

— **Validation of a Cost Estimate**
— **Cost-Estimate Validation**
— **Cost-Estimate Validation Process**
— **Cost-Estimate Validation Example**

87

We have covered the planning and detailed estimate processes, demonstrating the application of both processes by using the same real-life example project (Brine Pond Project). We will now go to the next section, in which we discuss the validation process of a cost estimate.

Notes / Discussion Points / Lessons Learned: ______________________________