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Gas Tank and Convenience Store Remediation

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Managing Civil Engineering Projects
Civil & Environmental Engineering 100

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Purpose
ACME Gas Station, 1700 El Camino Real, Palo Alto, CA, wishes to update its fuel dispensing system and convenience store. The scope of the work includes removing the old underground fuel storage tanks, surrounding contaminated soil, and fuel dispensers, and placing new tanks, dispensers, and clean soil in their place. At the same time, the old convenience store structure is to be torn down and replaced with a larger building. Our organization has received an RFP for this project, which is crudely estimated as a $1,000,000 job. The following document gives my argument that our firm should bid on this project, and it gives an approach for a successful bid. This project has the potential for great profit for our firm.

As with any undertaking that has the potential for profit, the project contains risks. The nature and location of this project create three main sources of unease for our company. First, the fact that gasoline-contaminated tanks and soil must be removed creates two distinct sources of risk. In terms of safety, there is a danger during the entire course of excavating, stockpiling, and disposing of the contaminated soil that a worker or a random passerby will be exposed to the hazardous material. The loss of reputation, as well as any fines or litigation, incurred in the case of an accident would be very expensive for our firm. Second, there is a danger for more extensive contamination than originally thought. Extra time spent testing and removing excess contamination could cause the project to over-run the finish date. Finally, the fact that the project takes place during the Northern California winter means that rainy weather could play an uncontrollable role in delaying the project. Precipitation stops any planned dirt work, especially if there is a danger of the runoff flowing through hazardous excavation material.

However, this project is extremely promising because the nature of a standard lump-sum contract protects us from acutely feeling two of these risks. Standard contracts protect a general contractor from penalties if a project schedule slips because of an excessive amount of rainy weather, so our firm could not be held responsible for the full cost of lost profits if a delay occurs because of weather. Likewise, the amount of contaminated soil to be removed will be specified in the contract, and any excess will be grounds for a change order. The precedents are well established on this account. While we of course will want to work as hard as possible to prevent a change order in case of either weather or excess contamination, our profits will not be on the line for this job. We will be working to enhance our reputation and ability to make a profit in the future. We do face the acute safety risk, but it is a risk that can be successfully managed. The following is the approach for doing just that.
Section 1: Scope and Risk

- Main Project Goals
- Main Organizational Goals
- Subcontracting
- Subcontracting Relationships
- Project Organization and Personnel Resources
- Final Scope of Work For Our Firm
- Key Points Concerning Scope

Main Project Goals

- Remove, appropriately discard, and replace the three leaking gasoline storage tanks, gasoline dispensing units, and contaminated soils of the gas station; have new tanks satisfy current California Underground Leaking Tank and Santa Clara Water Valley regulations.
- Demolish and appropriately discard of the existing 350 square foot store building, and replace it with a 750 square foot building.
- Have all of the above work completed between October 4, 1997 and December 31, 1997 so that the store may be ready for operation from January 1, 1998.

Main Organizational Goals for Project

- Complete project goals with a minimum 5% profit from our fixed bid.
- Complete project goals with great enough quality that our firm gets an enhanced reputation and similar projects in the area.

Subcontracting

As mentioned, many of the tasks needed to complete the above goals contain risks concerning the safety of the gasoline contaminated tanks, dispensers, and soil. One way to mitigate some of these risks is through the use of contracts with subcontractors and consultants. The tradeoff to this action is that with every task that we subcontract, we lose an opportunity to use our expertise and control to maximize profits. A key issue, then, for determining the success of this project for our firm is to balance the safety of subcontracting the risk with the profitability of assuming the risk ourselves.

There are certain specialty tasks that our company simply cannot perform:

- Soil compaction testing
- Soil contamination testing
- Installation of the utilities for the new convenience store
- Hauling the contaminated materials from the site (we do not want to be responsible for the waste once it leaves the site)
These tasks will have to be subcontracted. We are capable of performing the remainder of the project ourselves, but need to decide if it is prudent to do so. I argue that although there is a hazardous materials safety danger on this project, this is a very straight-forward, uncomplicated excavation and remediation. Thus it is my opinion that we should excavate and replace the tanks, soils and dispensers ourselves. The specifications for the new convenience store call for a 750 square foot concrete block building with only two counters. I believe that we should take advantage of this simplicity and do the foundation enlargement and the framing of the concrete block walls ourselves. Work done ourselves allows us to eliminate the mark-up of a subcontractor and thus be more competitive in the bidding. It also allows us to find an efficient method of work and make more than our target percentage of profit. What is more, it gives us control of any slack time in the schedule: we can decide whether it is better for our firm to press ahead as quickly as possible at a more expensive rate or to slow and work more cheaply. Should the organization accept the above scenario, the needed subcontractors are listed below:

- Truckers: bring in tanks and building materials, remove contaminated soil and demolition materials
- Soil testers: determine limits of soil contamination
- Roofers: new building
- Plumbers: new building
- Electricians: new building
- Surveyors: survey as-builts

Subcontracting Relationships

From a schedule control point of view, the ideal contractual approach for the necessary accelerated scheduling would be to engage all of the above subcontractors on a cost-plus basis. This arrangement would allow the most scheduling flexibility and would thus probably produce the shortest completion time. However, such an arrangement would also leave the subcontractors with no financial risk for the project; our organization, with the fixed-bid contract to the owner, would bear the entire financial risk for the undertaking. As this degree of risk is unacceptable, a better alternative is fixed-bid contracts with all of the subcontractors. The finite payment will provide incentive to each subcontractor to complete the job as quickly and cheaply as possible and will pass a degree of financial and quality risk to each. Very importantly, our organization will have to supervise and manage carefully to insure quality work and a timely phased schedule under these conditions.

Project Organization and Personnel Resources

Because no mention of an architect is made in any of the project specification sheets, our organization is presumably responsible for the design of the new convenience store building. Our organization can provide the design resources in-house to design the small, relatively simple new
building. The overall set-up will thus be one of design-build. The personnel resources that our organization must provide for design-build:

- Project manager to coordinate the entire project with the subcontractors and owner
- Superintendent to continuously oversee the site
- Site engineer to oversee the technical work of the subcontractors
- Architect/designer for the new building
- Labor crews that will physically perform the in-house work.

This set-up will minimize the impact of a construction-neophyte owner on the project, and will give our organization, which bears the brunt the risk of the time pressure and work specifications, maximum amount of control over that risk. A schematic of the organization is shown in Figure 1, page 13.

Final Scope of Work For Our Firm
When we account for all of the work done by the subcontractors and our jobs in supervising them, we arrive at the following scope of work for our organization over the course of this project:

1) Obtaining permits
   - Determine applicable permits for contaminated soil stockpiling and removal.
   - Obtain applicable permits for contaminated soil stockpiling and removal.
   - Obtain building permit for new store building.

2) Excavation, stockpiling and removal of the old tanks and soil
   - Fence the site and excavate tanks, soils, dispensers, and associated pipes
   - Supervise soil tester in determining the limits of excavation.
   - Supervise trucking subcontractor in removal of tanks, soil, and demolished retaining wall.

3) Placement and backfill of new tanks and soil
   - Supervise the trucking subcontractor in the delivery of backfill soil.
   - Determine the amount of new backfill soil needed.
   - Place the new tanks, dispensers, and pipes.
   - Supervise survey crew in completing as-built survey.
   - Backfill, grade, and asphalt site.

4) Demolition and removal of old store structure
   - Demolish and stockpile old building.
   - Supervise the trucking sub contractor the removal of the waste from the building.

5) Construction of new store building
   - Produce constuctible plan for new store building.
   - Secure building permit.
• Enlarge foundation for new building.
• Frame the new building with concrete blocks.
• Supervise plumbers and electricians.
• Supervise finishing and painting of new building.
• Meet with owners to determine if final goals have been met and payment secured.

Key Points Concerning Scope
In terms of mitigating the three main risks, a couple of the above tasks have priority. First, the contaminated soil should be over-excavated to make sure that none remains. A little over-excavation at the beginning will be far better than repeated tests and excavations. Second, every safety measure possible should be followed from the time that the contaminated materials are exposed until the time that they are loaded for transport and no longer our responsibility. These actions should be enough to ensure that the odds of a set-back in safety or excavation schedule are minimal. This document focuses now on lowering the chances of a schedule overrun due to the weather. The most important element of this focus is producing a schedule with the most slack possible for the rain.

Section 2: Scheduling
• Task Division
• Total Project Duration

Task Division
Task division is shown most easily by the critical-path diagram of the project shown in Figure 2, page 14. As shown, the two main parts of the project, the replacement of the gas tanks and the replacement of the building, are divided into tasks with two different levels of detail. The replacement of the tanks is scheduled according to the tasks listed in Section 1. Because the building has no plans prepared and has such general specifications given, durations are approximated for the overall building process, and not given for the individual tasks of framing, roofing, etc. As the plans for the building evolve, the schedule can become more detailed. The building schedule is given with very conservative duration estimates because of this generality.

All of the task durations are given in Figure 2. The durations for mobilization, ordering the pumps, ordering the tanks, supervising the soil testing, and demolishing the current building were found from consultation with Ashok Gopinath, and the new building construction was found from consultation with Martin Fischer. The duration for getting the excavation permits was given as an assumption in the original specifications. All other durations were taken from Means Building Construction Costs, 1997. (Means index numbers for the given tasks can be found in the cost section of this document.) The durations were calculated using an 8 hour-per-day, 5 days-per-
week schedule. Such a schedule allows the option of overtime later in the project if needed, as will be discussed later.

The resources used to calculate the durations are as follows:

(A standard crew is one foreman, one heavy-equipment operator, one piece of heavy equipment, and four laborers. Although the specific piece of heavy equipment may change from a back hoe to a small bulldozer, etc., each piece will be of comparable size and cost.)

- Mobilization: Standard crew, electrician, plumber
- Excavation permits: project manager, superintendent
- Tank and soil excavation: Standard crew w/ 1 cy tracked back hoe
- Removal of soil and tanks: Trucking subcontractor
- Soil testing: Soil-testing sub
- Tank replacement: Standard crew w/ 1 cy tracked back hoe
- Backfill: Standard crew w/ small bulldozer and a rolling compactor
- Pump replacement: Standard crew w/ 1 cy tracked back hoe
- As-builts: surveyor and rodman subcontractors
- Grading and asphaltling: Standard crew w/ small bulldozer and small asphalt roller
- Building plans: architect
- Demolition of old building: Standard crew w/ 1 cy tracked back hoe
- Removal of old building: Trucking subcontractor
- New store building: Standard crew; plumbing, electrician, and painting subcontractors
- Ordering pumps and tanks: project manager, site engineer, superintendent

Total Project Duration

Given the resources and durations listed above, the total project will be completed by December 12, as shown in Figure 2, page 14. The schedule as given runs the replacement of the tanks in parallel with the replacement of the store. This early completion time calls for a crew to be working on both activities at the same time, so two standard crews could be needed at certain times. Alternative schedules could coordinate tasks between the two main activities so that the minimum amount of personnel is needed. The cost of the project would decrease with this coordination, but at the expense of time. As this firm is trying to schedule as much accommodation for the weather as possible into the maximum three month duration, the extra crew is worthwhile.

Should weather-related or other events transpire that force the given schedule to be accelerated, two courses of action are possible. The first course is to start overtime work on those tasks for which
we are responsible. The work day can be extended to a maximum of 10 hours in Palo Alto, or Saturdays can be worked. Such flexibility in the schedule validates the decision to do a good deal of the work ourselves, for the more work we do directly the more we control slack time. The second possible way to decrease the overall schedule duration is to add more crews to our jobs. This option is more expensive than overtime, but will produce immediate results. However, because the site is relatively small, the returns from extra personnel will diminish rapidly. Thus it does not make sense to add more than one extra crew to either the tanks removal/replacement or the building.

Section 3: Cost

- Cost Organization
- Cost Estimate
- Discussion of Costs

Cost Organization

This document has so far dealt with mitigating the major risks of scope and schedule for this project, and it has proposed responses to those risks that our company can make as needed. The final step in approaching this project is to determine the cost of the project given those responses. The most logical way to organize the costs is to first divide expenses into in-house expenses and expenses paid to subcontractors. This way, the entire amount of money subcontracted can be easily marked up for estimated subcontractor profits. The in-house costs divide logically into those expenses for field equipment and personnel and costs concerning the actual construction labor.

Assumptions of the cost organization include:

- Duration of project is 3 months or 12 weeks, which includes time before mobilization for obtaining permits.
- All unit prices taken from Means Construction Cost Data 1997 unless noted; the index number is given for these items.
- All unit prices are average values unless noted, and all unit prices have been multiplied by San Francisco cost index of 1.25.
- Prices include overhead expenses, not just bare costs.
- Costs are more general for convenience store replacement for reasons discussed above in schedule.
- The cost of the convenience store is calculated using a square foot estimate. As part of the work is in-house and part is being subcontracted, costs were split in half between in-house and subcontracted work.
<table>
<thead>
<tr>
<th>Item</th>
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<th>Quantity</th>
<th>Unit Cost</th>
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<td><strong>IN-HOUSE COSTS</strong></td>
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<tr>
<td>Indirect</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Field Trailer 015-900-0250</td>
<td>month</td>
<td>3</td>
<td>$200.00</td>
<td>$600.00</td>
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<tr>
<td>Office Supplies 010-034-0120</td>
<td>month</td>
<td>3</td>
<td>$114.38</td>
<td>$343.13</td>
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<tr>
<td>Telephone Bill 010-034-0140</td>
<td>month</td>
<td>3</td>
<td>$316.25</td>
<td>$948.75</td>
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<tr>
<td>Field Trailer Utilities 010-034-0160</td>
<td>month</td>
<td>3</td>
<td>$118.13</td>
<td>$354.38</td>
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<tr>
<td>Superintendent 010-036-0260</td>
<td>week</td>
<td>12</td>
<td>$2343.75</td>
<td>$28,125.00</td>
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<tr>
<td>Field Engineer 010-036-120</td>
<td>week</td>
<td>12</td>
<td>$1537.50</td>
<td>$18,450.00</td>
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<tr>
<td>Project Manager 010-036-0200</td>
<td>week</td>
<td>4</td>
<td>$2481.25</td>
<td>$9925.00</td>
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<tr>
<td>Architect 010-004-0060</td>
<td>%</td>
<td>--</td>
<td>10% of building cost</td>
<td>$19,612.50</td>
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<tr>
<td>Permits 010-070-010</td>
<td>%</td>
<td>--</td>
<td>1% of total project cost</td>
<td>$5000.00</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>$83,360.00 (a)</td>
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**Direct:**

- **Excavation, stockpiling, and removal of the old tanks and soil**
  - 5' chain link fence installed
    - 015-304-010
    - If 300
    - $11
    - $3300.00

- **Leaking tank excavations**
  - 020-880-0190
  - tank 3
  - $1162.50
  - $3487.50
<table>
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<th>Unit</th>
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<th>Unit Cost</th>
<th>Total</th>
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<tr>
<td>Excavate contaminated soil</td>
<td>cy</td>
<td>500</td>
<td>$2.04</td>
<td>$1018.75</td>
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<tr>
<td>Placement and Backfill of New Tanks and Soil</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6,000 gallon Fiberglass double-walled gas tanks</td>
<td>tank</td>
<td>3</td>
<td>$12,125.00</td>
<td>$36,375.00</td>
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<tr>
<td>Double-walled gas pipe-3&quot; diameter</td>
<td>lf</td>
<td>150</td>
<td>$9.25</td>
<td>$1387.50</td>
</tr>
<tr>
<td>Assorted couplings</td>
<td></td>
<td></td>
<td>--</td>
<td>$1000.00</td>
</tr>
<tr>
<td>Installation of tanks</td>
<td>tank</td>
<td>3</td>
<td>$581.25</td>
<td>$1743.75</td>
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<tr>
<td>Buy structural fill for backfilling</td>
<td>cy</td>
<td>500</td>
<td>$17.44</td>
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<tr>
<td>Mass backfill</td>
<td>cy</td>
<td>500</td>
<td>$.45</td>
<td>$225.00</td>
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<td>Roller compacting</td>
<td>cy</td>
<td>500</td>
<td>$4.60</td>
<td>$2300.00</td>
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<tr>
<td>Fine grading</td>
<td>sy</td>
<td>65</td>
<td>$3.68</td>
<td>$238.88</td>
</tr>
<tr>
<td>Asphalt installation-2&quot;</td>
<td>sy</td>
<td>65</td>
<td>$29.38</td>
<td>$1909.38</td>
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<tr>
<td>Demolition and Removal of Old Store Structure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building demolition including 20 mi haul</td>
<td>day</td>
<td>4</td>
<td>$1870.00</td>
<td>$7480.00</td>
</tr>
<tr>
<td>Construction of New Store Building</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forms in place for concrete pump island</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>031-186-2500</td>
<td>each</td>
<td>2</td>
<td>$687.50</td>
<td>$1375.00</td>
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<tr>
<td>Installed concrete to enlarge old foundation and form new pump island</td>
<td>cy</td>
<td>20</td>
<td>$132.50</td>
<td>$2650.00</td>
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9
<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Quantity</th>
<th>Unit Cost</th>
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<tr>
<td>Fuel dispensers, installed (average value according to Means Assembly Cost Data)</td>
<td>each</td>
<td>4</td>
<td>$20,625.00</td>
<td>$82,500.00</td>
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<tr>
<td>Convenience store building (Means Assembly Cost Data) - 50%</td>
<td>sf</td>
<td>750</td>
<td>$144.00</td>
<td>$54,000.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$209,710.00 (b)</td>
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COSTS THROUGH SUBCONTRACTOR BY PHASE

Excavation, stockpiling, and removal of the old tanks and soil

Tanks to certified salvage dump - 100 mile round trip 020-880-1020 | tank | 3 | $750.00 | $2250.00 |
OSHA testing for contaminated soil 020-890-0100 | day | 5 | $350.00 | $1750.00 |
Lab tests of samples | each | 12 | $200.00 | $2400.00 |
Haul contaminated soil - 20 mi round trip in 12 cy dump truck 022-266-0560 | cy | 500 | $28.75 | $14,375.00 |
Disposal of contaminated soil at Class I landfill | cy | 500 | $312.50 | $156,250.00 |
Placement and Backfill of New Tanks and Soil
Compaction testing - 6" lifts 014-108-4400 | each | 20 | $60.00 | $1200.00 |
Survey As-builts 013-306-1100 | day | 1 | $743.75 | $743.75 |
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<th>Item</th>
<th>Unit</th>
<th>Quantity</th>
<th>Unit Cost</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haul in fill dirt- 20 mi 022-266-0560</td>
<td>cy</td>
<td>500</td>
<td>$28.75</td>
<td>$14,375.00</td>
</tr>
</tbody>
</table>

**Construction of New Store Building**

Convenience store building (Means Assembly Cost Data).-50% | sf  | 750      | $144.00   | $54,000.00 |

$247,350.00 (c)

Subcontractor subtotal (c):
Subcontractor markup: x 1.10

Subcontractor total: $272,090.00 (d)

In-house indirect (a): $83,360.00
In-house direct (b): $209,710.00

In-house total $293,070.00 (e)

Project subtotal (d) + (e): $565,160.00
Contingency factor x 1.15
Our mark-up x 1.05

Project total: $683,000.00 (f)

**Discussion of Cost Estimate**

This cost estimate is not highly precise, as evidenced by the 15% contingency factor. The greatest uncertainty in the price comes from the construction of the new building. Without plans for the building, only the most broad estimate of cost could be determined. The model building used in this determination was a gas service station with a bay door and brick outer wall covering the specified concrete block. The costs saved in not including these features on the actual building should account for any extra money needed to paint the new structure up to Palo Alto City code.
Should our organization proceed with this project, the precision of the cost estimate can be increased by developing the building plans and by finding historical data for comparisons.

Another uncertainty in the cost estimate exists because of the uncertain weather. Weather delays, even if they don't push the project past the completion date and become extremely expensive, still increase the price of the project because of the lost time. Hopefully, such increases will be covered by the contingency factor, but they should still be considered. Despite the cost estimate's shortcomings, it is an accurate guide to project magnitude and can be used to determine the amount of capital that we will need to move ahead on the project.

Conclusions
While working with contaminated materials and working on a time-pressure project under threat of bad weather are not ideal project conditions, this document has shown that the risks posed by both of these conditions are manageable. I believe that if the project is approached and subcontracted in the manner described above, it will be a profitable venture for this firm. Also, the odds are high that our firm can emerge from this project with a sterling reputation in the area, and there are surely many sights similar to this one. I recommend that this firm develop more detailed plans and be prepared to bid on this project roughly in the amount of $683,000.00.
Figure 1 - Organization of Project

Owners

Project Manager

Superintendent

Architect
Foreman
Site Engineer

Our firm-GC

Laborers

Various Subcontractors
Figure 2 - Critical Path Schedule