ESTIMATING EXCAVATION
REVISED

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Get Started Right

Construction cost estimating is demanding work, no matter what type of construction is involved. But I think estimating earthwork is the hardest of all. Why? For two reasons: First, excavation has more variables and unknowns — you don't know what's down there until you start digging; second, you have to rely on information from many sources — some of which may not be accurate.

That's why every earthwork estimator needs special skills:

- The ability to read plans and specifications
- An understanding of surveying and engineering practice
- A facility with mathematical calculations
- The ability to anticipate environmental and legal issues
- An abundance of good common sense

If you can bring common sense to the task, this manual will show you how to do the rest. I'll help you develop all the skills every good earthwork estimator needs.

Of course, I can't cover everything on every type of job. But I'll include the information most earthwork estimators need on most jobs. Occasionally, you'll have a job that requires special consideration. But if you understand the principles I'll explain here, you should be able to handle anything but the most bizarre situations.

A couple of subjects I think are important to cover here are the "by hand" approach to many earthwork problems, as well as the basics of computer earthwork estimating software. Both are meaningful topics for the earthwork estimator today. I've met many younger estimators who do earthwork take-offs with a computer who can't even describe what the existing or proposed surfaces of the project would look like in the real world. Finding the centerline of a sloping surface in a basement requires knowledge based on the experience of doing "by hand" or manual earthwork take-offs. Those who've calculated earthwork take-offs on paper will make better use of their software. So, even though computers are used more and more for earthwork project take-offs, having a background in the math involved in project calculations will improve your capabilities when using a computer program. While computer programs generally don't make mistakes, it's very common for a mistake to be made by the person feeding the data into the computer. If you haven't a reasonable idea of what the result should be, you won't know if the software has given you a completely wrong answer. No software is a substitute for good judgment and sound estimating experience.

In this first chapter, I won't do much more than touch on a few important points you should understand:

1. why you have to estimate quantities
2. the importance of plans and specs
3. working accurately
4. keeping good records

After making these points in this chapter, I'll describe a step-by-step estimating system, from making the site survey to writing up the final cost summary. I'll teach you a process for making consistently accurate earthwork estimates. Part of this process is calculating the cubic yards to be moved. That's the heart of every earthwork estimate. I'll cover quantity estimating in detail. Then I'll explain how to find labor and equipment costs per unit. We'll also consider soil and rock properties and how the equipment you use affects bid prices.

Why Calculate Quantities?

In the past, many smaller dirt jobs were bid on a lump-sum basis rather than by the cubic yard. Dirt contractors based their bids on guesses: What equipment will I need and how long should it take? Making estimates this way overcame a big problem for many of these excavation contractors — they didn't know *how* to estimate soil and rock quantities.

I think those days are over. Today, fuel and labor costs are too high and the competition is too intense to risk "seat-of-the-pants" guesses. A few mistakes and a couple of surprises and you're going to be looking for some other type of work. Only the best survive for long in this business. And most of the survivors know how to make accurate bids by the cubic yard. Fortunately, making good quantity estimates isn't too hard once you've mastered a few simple skills. I hope that's why you're reading this book.

I've found that all good earthwork estimators are also good at calculating earthwork quantities. Here's why:

No one's going to do it for you. You have to do it yourself or it's not going to get done right. Many engineers, architects, and even some builders know how to figure soil and rock quantities, but few take the trouble to do it. Instead, they depend on the earthwork estimator to do it. If the engineer calculates quantities, he'll give the numbers in cubic yards, but won't specify what types of cubic yards are being presented. I've know some engineers who don't understand the concepts of soil swell and shrinkage. They simply give the cubic yards based on length × width × depth calculations and leave it up to the estimator to convert those quantities into loose and compacted cubic yards for the cut and fill quantities, respectively. I've also found that engineers make mistakes in calculating the quantities. There's an old estimator's saying: "An engineer does not an estimator make." These are two totally different professions.

Today, most owners, engineers and architects request excavation bids based on the cubic yards moved. That's now the accepted procedure for most projects, from single-family homes to roads and commercial jobs. Some projects are still bid lump sum, but those are the exceptions. It's common for the actual amount of dirt moved to be more or less than expected, so the best way to protect your business is to bid by the cubic yard. If it turns out you have to move more dirt than the plans show, instead of having to eat the extra cost, you'll get paid for it. It's as simple as that.

General and Special Quantities

If you agree that excavation bids should be based on quantity estimates, the next step should be obvious. Every estimate must start by figuring the quantity of soil to be moved.

I recommend you begin any project estimate, no matter how large or small, by dividing the excavation into two categories: general quantities and special quantities.

General quantities include any work where you can use motorized equipment such as scrapers, hoes and loaders at their designed production rate.

Special quantities include anything that requires special care or lower production rates. Examples are most rock excavation, nearly all hand excavation, and backhoe work around sewer lines, underground utilities, or existing structures. Naturally, prices for special quantities are higher than prices for general quantities.

Keeping these two quantities separate protects you. Most excavation contracts have a clause that covers extra work. Unanticipated rock deposits, special soil problems and unusual trenching problems are extra work that you should be paid extra for. If you've bid a higher price for special quantities, you'll get paid at that price per cubic yard for the additional work. Otherwise you could end up chipping out rock at the price of moving sand.

Calculating Cubic Yard Cost

Here's the basic formula for costs per cubic yard: Labor and equipment cost per hour multiplied by the hours needed to complete the work, divided by the cubic yards of material to be moved, or

$$\text{Cost per CY} = \frac{\text{Cost per Hour} \times \text{Total Hours}}{\text{Total Cubic Yards}}$$

Does that seem simple? It's not. You may know your hourly labor and equipment costs right down to the last penny. But estimating the time needed is never easy. And calculating volumes for sloping and irregular surfaces is very demanding work.

Here are a few things about the formula for computing costs per cubic yard that you should take note of.

1. It's based on labor and equipment costs for your business. That's important and I'll have more to say about it later.
2. It assumes you know the quantity of soil or rock to be moved. That's going to take some figuring.
3. Even after you've calculated the cost per hour and quantity of soil, you're not finished. You need to estimate the time needed. Usually that's the hardest part. To do that, you have to decide on the equipment (method) to use.

Of course, the quantity of material (yardage) is a very important part of our cost formula. But the excavation method (type of equipment) also has a major influence on cost. The most expensive equipment (cost per hour) will usually be the most productive (move soil at the lowest cost). But the machine with the largest capacity isn't always the best choice for every outhaul. I'll explain why later. For now, just understand that making good equipment selections helps reduce costs.

Reading Plans and Specifications

Many excavation projects let out for bid are based on a set of plans. Plans are scale drawings that show the finished project. Plans are supplemented with written descriptions called specifications (or specs). Specs explain in words what the plans can't or don't show. Ideally, the plans and specs, read together, should answer every question about the job. They shouldn't leave anything up to interpretation. The better the job done by the engineer or designer, the more likely the plans will be clear and complete.

Plan reading is an important skill for every earthwork estimator. But this isn't a book on plan reading. If you need help with reading plans or you don't understand the plans and drawings in this book, pay a visit to your local library or search the internet. You'll find there are several manuals that explain basic plan reading.

Look for Notes on Special Problems or Conditions

As an excavation estimator, you're expected to understand every detail in the plans and specs for the jobs you bid. Read these documents completely. They're worth careful study. Note everything that affects your excavation work. Some engineers and architects aren't very well organized. They can put instructions and notes almost anywhere on the plans. Read every page carefully, regardless of what you think it's about. Use a yellow highlighter and mark anything in the specifications that affects your work, such as the type of compaction required for the fill material. That'll make it easier to find later if you need to look it up.

Utility Lines

Pay particular attention to notes that spell out the contractor's responsibility. For example, you may find a note somewhere on the plans that relieves the engineer or architect of responsibility for damage to utility lines. It may say something like this:

> NOTE: While every precaution has been taken to show existing utilities in their proper location, it is the contractor's responsibility to determine their actual location. No assumption should be made that no other utility lines fall within the limits of construction.

That means that if you break a pipe, such as a water main or a gas line that wasn't marked on the plans, it's entirely your fault and you have to shoulder the costs. So if you suspect utility lines may be a problem, ask the utility companies to locate their lines for you. Most will be happy to do that at no cost. But they may want ample advance notice.

Changed Conditions

Also pay attention to notes on natural obstacles (such as rock) or anything that's buried on the site. Is there an abandoned underground storage tank or old basement in the area to be excavated? The plans may also mention drainage problems and unsuitable soil deposits, probably in the cross-section drawings or special provisions of the specs.

A.I.A. contracts, and most federal government contracts, spell out what happens if you encounter *changed conditions* at the jobsite. An example of changed conditions would be if the soil type isn't what was indicated in the contract documents, or isn't normal for the type of work you're doing. In that case, you're entitled to extra pay for dealing with those changed conditions.

Owners and engineers have written volumes of contract language excusing themselves from liability for test borings and other information they provide to bidders. Some contracts even say that you're responsible for conditions at the site, if those conditions aren't as indicated in the bidding documents. That's ridiculous. To protect your business, be sure there's a *changed conditions clause* in the contract so you'll get extra pay if conditions aren't what the test borings showed, or conditions are very unusual for the type of work being done.

Other Costs

Search the plans and specs for everything that may affect cost. That's always your starting place. But it's not the end of your search. Many cost items won't show up in either the plans or specs. For example, you'll have to find out from the city or county building department what permits will be required. Also, city, county or federal law may set minimums for wages, employee benefits and insurance coverage.

Here's another pitfall to watch for: Who pays to have the project staked out by a surveyor or engineer? In most cases, the designer will pay for surveying — the first time. If you knock over any survey stakes during actual work, you'll probably have to replace them at your own expense. Work as carefully around the stakes as possible. But if job layout makes it impossible to avoid moving stakes, allow enough in your bid to pay for another survey.

Make sure you understand how you'll be paid. On larger projects, you're usually paid per cubic yard, based on the difference between the original soil cross section and the cross section when work is finished. We'll talk more about cross sections later in this book.

On many smaller projects, your payment may be based on the engineer's estimate of yardage. If that's the case, look for a provision in the specs that gives you an option to have final cross sections made at your own expense. Experience will help you decide if a final set of cross sections is to your advantage. But I recommend that you always take off quantities yourself. Don't assume the plans are right. Anyone can make a mistake, but you could end up paying the price.

Undercutting

Undercutting is removing additional dirt from an area below the finished grade line. There are several situations where this is necessary. The most common is where clay or a rock ledge is close to, but not above, the finished grade line. Figure 1-1 shows a typical situation with a rock ledge below the surface. Most structures can't be built directly on rock. If the rock weren't there, you would excavate to the finished grade line and be done. But because the rock is just below finished grade, you have to cut deeper. That's the undercut. Then you have to backfill the undercut with a suitable material, such as select sand. The sand provides a buffer between the rock and the foundation.

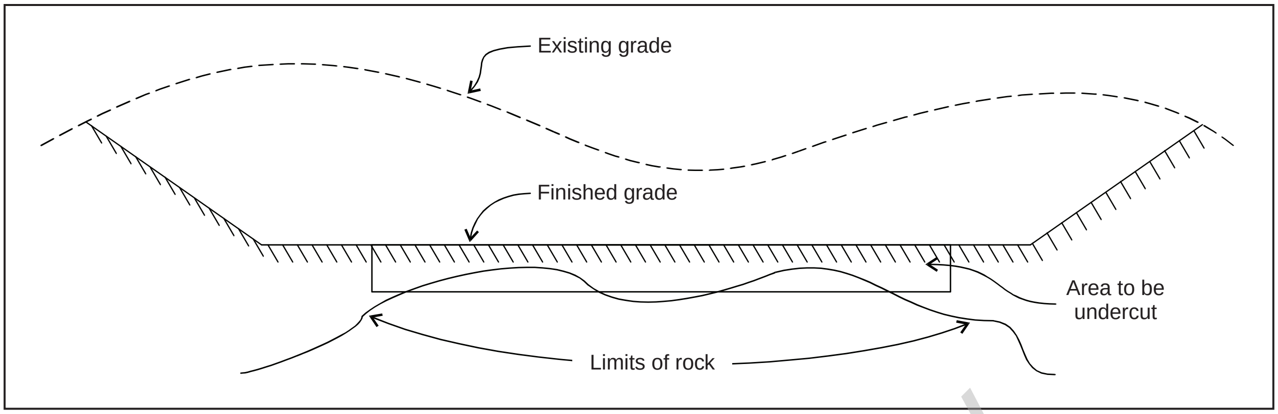

Figure 1-1
Undercutting for rock

There's probably nothing in the specifications that gives you the right to collect for undercutting and backfill. But it's expensive work and the cost shouldn't come out of your pocket. Where undercutting may be necessary, include it in your bid as a separate item on a per cubic yard measure.

Undercutting is also needed when trenching for underground utilities, such as storm drains and sanitary sewer lines. The undercut makes room for bedding material to be placed under the pipe. Most plans will show only a designated flow line elevation. But based on the plans and your good judgment, you'll have to decide how much and what type of bedding to install below the pipe. Each cubic yard of bedding requires a cubic yard of undercutting. Some engineers specify this, and others don't. Figure 1-2 shows an example. Undercutting may also be required on roads, parking lots and sidewalks — anywhere there's a load on the soil.

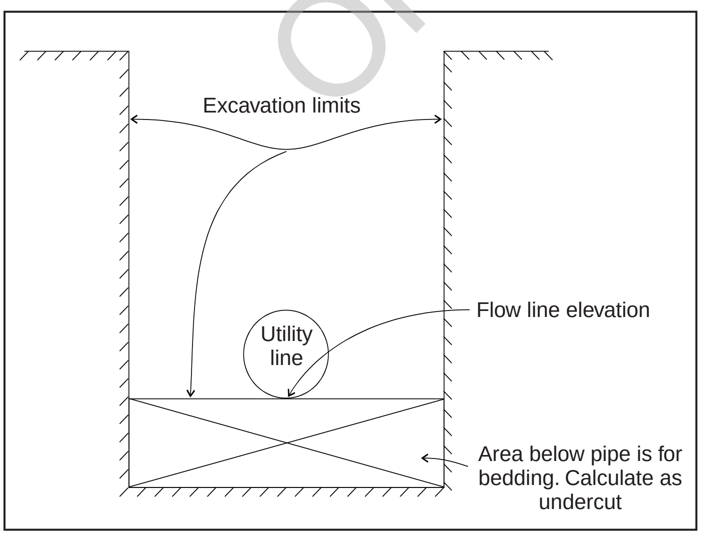

Figure 1-2
Undercutting for pipe bedding

Overfilling is the opposite of undercutting. When backfilling a large area, you can usually bring the backfill right to grade without cutting away excess backfill. But in a small area, it's usually easier to bring the area above the final grade line by 2 to 4 inches, then cut off the excess. This is still called undercutting. Of course, you can't expect to get paid for removing the 2- to 4-inch excess. But it's still a cost of the job.

Accuracy Is Essential

Accuracy is the essence of estimating. If you can't work accurately, you're in the wrong business. But don't get me wrong. I don't mean that you have to account for every spadeful of soil on every estimate. On small projects, there are times when you can ignore small differences in elevation. On most jobs these small plus and minus areas will average out to almost nothing. But a 1-inch mistake in elevation over the whole job can cost you thousands of dollars. Even a $^{1}/_{16}$-inch error over a few acres can hurt you.

Here's an example. Assume you're bringing in fill on a city lot measuring 125 feet by 150 feet. Because of a mistake in grade, your estimate of imported soil is wrong. It leaves the entire site 1 inch below the specified finished grade. How much more soil will be needed to correct the 1-inch mistake?

Here's the formula for volume:

Volume (in cubic feet) = Length (in feet) × Width (in feet) × Depth (in feet)

In this example, you know the length and width in feet, but the depth is only 1 inch. To use the formula, convert 1 inch to a decimal part of a foot. You can either refer to the conversion chart (see Figure 1-3) or divide 1 by 12, since 1 inch = $^{1}/_{12}$ foot. Either way, you'll find that 1 inch equals 0.0833 feet.

Now you're ready to use the formula for volume:

$$\text{Volume (CF)} = 125 \times 150 \times 0.0833$$
$$= 1{,}561.88$$

How many cubic yards is that? Since there are 27 cubic feet in a cubic yard, divide the cubic feet by 27:

$$\text{Volume (CY)} = \frac{1{,}561.88}{27}$$
$$= 57.8$$

Trucking in almost 58 cubic yards of soil won't be cheap. If imported soil costs you $25 a cubic yard, your 1-inch mistake is a $1,450 error. That could make the difference between profit and loss on this job.

Inches	Decimal feet	Inches	Decimal feet
1/16	0.0052	7/8	0.0729
1/8	0.0104	15/16	0.0781
3/16	0.0156	1	0.0833
1/4	0.0208	2	0.1667
5/16	0.0260	3	0.2500
3/8	0.0313	4	0.3333
7/16	0.0365	5	0.4167
1/2	0.0417	6	0.5000
9/16	0.0469	7	0.5833
5/16	0.0521	8	0.6667
11/16	0.0573	9	0.7500
3/4	0.0625	10	0.8333
13/16	0.0677	11	0.9167

Figure 1-3
Inches to decimal feet conversion chart

Your Estimating Procedure

The more organized and logical your estimating procedure, the more accurate your estimates will be. If you have the tools, papers and information you need close at hand, you're off to a good start. Then you can focus your attention and concentration on producing an accurate estimate. If you're cramped for space in an uncomfortable office with poor lighting, and trying to work without all the equipment and information you need, errors are almost inevitable.

Work Area and Equipment

Start by organizing an efficient work area. It should be large enough so you can lay out all the plans on a table and still have room to write and calculate. Provide enough light to make reading comfortable, and keep the work area free of shadows. This is especially important when working with transparent overlays or other light-duty paper where you might mistake shadows for lines.

Although it's not essential, I like using a light table. You can place a drawing on it, overlay it with another paper, and see through both of them. It's great for working with plan and profile sheets, overlays on grid, or take-off sheets. It's a good idea to tape a sheet of drafting paper over a site plan. You can set up a grid and write all your calculations on the paper and file it away after the take-off is done. That way, you won't be marking up the drawings if you have to return them to the engineer. You don't want the engineer or anyone else to see how you did your take-off.

A large wall-mounted marker board is useful for showing, studying, or sharing an equation or idea, and can be a very handy addition to your work area.

A good calculator is a must. I recommend buying a calculator with both a digital and a paper printout. You need the printout to check your figures. Make sure you have an engineer's scale and drafting triangles for checking and drawing lines, a small magnifying glass, tape for holding overlays, and the normal collection of pencils, pens, erasers, and paper.

Later in the book we'll talk about using a planimeter to take off quantities. Although it's relatively expensive, a good planimeter will soon pay for itself. Take care to select one that's sturdy and has all the needed instructions and attachments.

A computer is even more expensive, but there are few estimators now who aren't using one. There are programs on the market that can handle anything from simple calculations to a complete estimating program, with cross sections, quantities and printouts. But no program is a substitute for a good estimator who understands estimating procedures and practices — which is the purpose of this book.

There are two advantages to using a computer. The first is time, an estimator's most valuable asset. A computer can help make your time more productive. Second, a computer makes it easier to keep cost figures for equipment and labor. Records from past projects and estimates can make current estimates more accurate.

If you don't currently use a computer in your work, don't jump in without first doing some research. There's tons of estimating software, thousands of different computers on the market, and hundreds of dealers. Take the time to make yourself familiar with the options. Talk to dealers. More important, talk to other estimators who use computers in their estimating. Read trade magazines, especially the ads for estimating software. And don't go out and buy a computer and then look for estimating programs to run on it. First, choose the estimating program you like, and then buy the computer that will run that program. Otherwise, you may find the computer you bought won't run the program you like.

The Work Process

When you've got your work area and equipment set up to work efficiently, you're on the path to accurate estimates. To stay on that path, it's important to approach the work with a logical and organized procedure. That speeds up the work and reduces mistakes. Let me describe the method that works for me. I think it'll work for you, too.

When starting a project, first read all documents describing the job. Take notes on any situation that's not a normal work requirement. Are there utilities that must not be disturbed? Do the documents indicate specialized material types from soil boring logs? Do they stipulate any arrangement for rock on the site? Watch carefully for the compaction and testing requirements. Testing is expensive and your project could be delayed while testing is being performed. Look for any special provisions set out by the designer. Then head out for a field visit. You'll find details about the site visit in the next chapter.

After returning from the field, review the documents again, looking for unusual situations that the site visit brought to your attention. Then make a complete written outline of all work that needs to be done, in the order in which it will be performed. Set up files for each separate section. Make a list of additional data such as quad sheets, local conditions, and any other information you need to gather.

Here's the order I usually use.

1. Consider any drainage, traffic or work zone protection that needs to be done. Are there any onsite streams that must remain open, or roadways to maintain? These would probably be lump sum items, not items you'd take off quantities for. Just make sure you don't miss any of these special items.

2. After studying the plans and the site, you should have a good idea if there's enough fill on the site, or if you'll need a borrow pit. Will you need a place to put excess material offsite? Begin now to make arrangements for needed borrow and storage sites, sampling of material for approval by the engineer, and purchase of any material that's needed. Also, check with heavy equipment dealers in the area to make sure any specialized equipment you'll need to do the project is available for rent. I've even heard of contractors who take a risk and rent equipment in advance in order to keep the competing contractors from getting the equipment.

3. Now consider the topsoil requirements. Review the material sample, the requirements for replacement, and availability of storage area on the site. Calculate the amount of usable material and the amount of waste that must be disposed of.

4. Will there be any special excavation, like rock work or the removal of existing structures or facilities? Make sure you include all work and any special equipment you'll need. Will you need to rent equipment? What about rock drills and saws, blasting material, or cranes?

5. Begin calculating the general quantities with the cut or fill work over the entire project. Start in the same place and proceed throughout the project the same way for every estimate. One way to make sure you cover the entire project is to set up a grid system with a corresponding file system. As you finish work in each grid, mark it off, file it, and move on to the next grid.

6. Next, calculate all the utility lines, keeping the figures for each area separate. Be especially careful in estimating the tie-in between new and existing lines. Allow a little extra time for lines that aren't exactly where the plans show them to be.

7. Then consider the roads, parking lots, and paved or special drainage ditches. Again, keep the quantities for each separate. One note of caution: Remember to consider the base and sub-base when figuring final elevations.

8. Buildings, basements, sidewalks and other similar structures are next. After you've calculated each structure separately, add them all together to get a structure total.

9. Finally, calculate the topsoil. And don't forget that if you've used a borrow pit, you may have to place topsoil there also.

10. Now you're ready to start putting together all that information to come up with a realistic quantity total for the complete project. Fill out the final quantities sheet. Remember to attach all worksheets, scratch paper and calculator printouts so you can recheck your totals.

Review your final sheet, looking for potential problem areas. If possible, have someone else check all your calculations and extensions. If that's not possible, set the estimate aside and go through it again a few days later. You'll have a fresh approach that may spot errors or omissions.

The last step is to go through all the documents and make sure they're in order. Then file them. Don't throw anything away — not even the scrap paper. Why are those records valuable? Keep reading; that's next.

Record Keeping

Once you've learned to read plans carefully and work accurately, there's still one more important step in good estimating practice: record keeping.

Think of your estimates as accumulated wisdom. Treasure them. Keep them handy. Make sure they're easy to understand. They should show how each figure was developed. Why? There are at least four reasons.

First, planning the work is a big part of every estimator's job. You can't estimate any type of earthwork without making decisions about equipment. Once you've selected equipment for estimating purposes, document your choice on the estimate worksheets.

If your bid is accepted, you'll probably want to do the work with the same equipment assumed in the estimate. What if months have gone by and you can't remember how the figures were developed? You have to start selecting equipment and estimating costs all over again. If the equipment assumed in your estimate isn't the same as the equipment actually used, comparison of estimated and actual costs may be meaningless.

Second, you're going to refer to most estimates many times over months or even years. You shouldn't have to guess about how each figure was developed. That wastes time and can exhaust your patience. I've seen estimators who should know better use

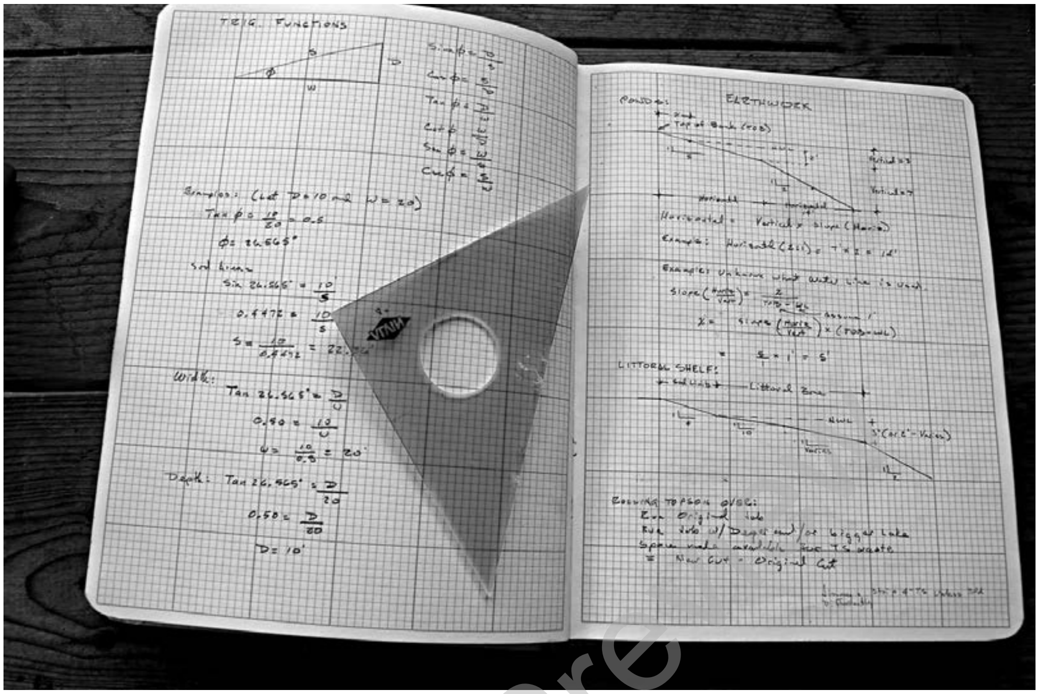

Figure 1-4
Formula book

the back of an envelope to figure special quantities. After entering the final cost, they discard the envelope. Later, if there's a question about the estimate, how can they verify the figures? They're gone!

When you write a calculation or create a drawing for possible future use, take the time to clearly describe the calculation and label each drawing very clearly. Over the years, I've created good ways to solve problems, and then later discovered that I didn't know how I came up with those solutions so I could duplicate them. Because I didn't make good notes or include well-labeled drawings, my solutions were one-time successes that I couldn't carry forward for future work. Now, whenever I find calculations that are needed over and over on different projects, I carefully draw diagrams and write out the equations, and then place them in a special book for future reference. (See Figure 1-4.)

Third, old estimates are invaluable when compiling new estimates. Every estimate, especially if you actually did the work, provides a frame of reference for future jobs — even if labor and equipment costs have changed.

Fourth, every estimator makes mistakes. That's no embarrassment. But repeating mistakes is both foolish and expensive. The best way to avoid repeating mistakes is to preserve every scrap of estimating evidence — in a neat, tidy, well-organized file. Make notes on what worked and what didn't. Review those estimates and notes when estimating similar jobs.

Save everything. Good record keeping can come in handy as backup to justify a claim for extra work or as a means of proving your claim in court if a dispute goes into litigation. Also, someday you may want to write a book. I saved my notes and estimates and wrote a book. You're reading it.

Use Public Records

To the professional estimator, there's no such thing as too much cost information. Collect all the estimating data you can. It helps if you know where to look for it. I canvass city and county engineering departments, public works departments and maintenance departments for whatever information they can provide. They know about bid prices, soil conditions, abandoned streets, utility lines, sewer, and water problems. Use the resources available from your city and county government.

Aerial maps at the county tax office and contour maps from the United States Geological Survey offer clues to possible water and soil problems. There are USGS offices in most states. They're often located in the capitol, or in cities with universities. Check your local phone book or local engineering groups for the address of the nearest office. City, state and county highway departments will have information on soil problems they've found under highways in the area.

Understanding Plan or Drawing Measurements

There are three scenarios you may encounter with plans or drawings that will make your job as an earthwork estimator more difficult. They are: drawings that have been enlarged or reduced; a drawing that has only a measurable area; and being forced to measure a plan drawn in an engineering scale with a common ruler. Let's look quickly at how to deal with these three situations.

Determining the Actual Scale of a Plan

When a print has been reduced or enlarged, you can still use the given scale to measure plan dimensions accurately. The factor by which the plan scale has been reduced or enlarged can be determined by the following formula:

$$\text{Scale Factor} = \frac{\text{Printed Plan Dimension}}{\text{Scaled Dimension (using original scale)}}$$

Example: You are given an original scale of 1" = 20'. Find the scale factor if a given plan dimension of 250 feet measures 55 feet at the original scale of 1" = 20':

$$\text{Scale Factor} = \frac{250'}{55'}$$

$$= 4.545$$

You'll need to multiply any dimension scaled at 1" = 20' by 4.545 in order to obtain the correct length. Note: Never apply the factor to a printed dimension entered directly into your calculator. Apply the factor only to dimensions measured with your scale.

Some computer programs have a "compensate scale" feature that automatically determines the correct scale to use on any enlarged or reduced drawing; however, you can check your accuracy in setting the compensate scale feature by using the following formula:

$$\text{Actual Scale} = \frac{\text{Printed Dimension} \times \text{Original Scale}}{\text{Measured Dimension (using original scale)}}$$

Example: Determine the actual scale of the drawing discussed in the previous example.

$$\text{Actual Scale} = \frac{250' \times 20'}{55'}$$

$$= 90.91 \text{ feet per inch}$$

Determining Plan Scale When Only Area is Given

In this situation you have a grading plan with a plan scale of 1" = 40'. The engineer has also given you the dimensions of the site, with an area of 5.76 acres. However, no other dimensions are given on the plan, not even a scale bar. Using the given plan scale provided, the work area measures 18.3 acres. Obviously, the plan has been reduced, making the given scale incorrect. What scale should you use to produce the correct results? Use the following equation to solve the problem:

$$\text{Correct Scale} = \frac{\text{Given Scale} \times \sqrt{\text{Given Area}}}{\sqrt{\text{Site Perimeter Area}}}$$

$$= \frac{40 \times \sqrt{5.76}}{\sqrt{18.3}}$$

$$= 22.44 \text{ feet per inch}$$

When You Have the Wrong Measuring Tool

Years ago, while visiting a friend, I was asked to measure the length of a line on a plan drawn at an engineering scale of 1" = 40', and all my friend had to measure the line with was a common ruler. The line measured at $3\frac{3}{16}$ inches long. To convert the length to the correct scale, I expressed my measured length as a decimal equivalent of inches and multiplied the result by the plan scale. The decimal equivalent of $3\frac{3}{16}$ inches is 3.1875 inches, so my calculation was:

3.1875 inches × 40 feet = 127.5 feet

To apply this principle to areas, convert each area dimension to its engineering dimension and multiply them together. For example, if an area measured with a ruler is $3\frac{1}{2}$ inches by $1\frac{1}{4}$ inches on a plan drawn at 1" = 40', it has actual dimensions of 3.5 and 1.25 inches in decimal form. Convert these dimensions to engineering scale dimension:

3.5 inches × 40 feet per inch = 140 feet

1.25 inches × 40 feet per inch = 50 feet

So the actual area at a 40-foot scale is:

140 feet × 50 feet = 7,000 square feet

What If You Don't Have Plans?

Up to this point, we've assumed that you're bidding the job from plans and specs provided by an architect or engineer. But you may be asked to bid on a small job that wasn't designed by an engineer or architect. Then you'll have to create your own plan. It may also be up to you to determine quantities and prepare a contract.

In any case, always figure soil quantities and get a written contract on every job, large or small. The responsibilities and liabilities are all yours, so plan and execute your bid with care. Use the procedures and guidelines in this book — even if there are no plans.

If the owner doesn't have a plan prepared by an architect or engineer, collect as much information as possible from the owner. Does he or she know of any soil problems at the site? Is it your responsibility to request the survey and staking? Are any permits needed? When should the job be completed? Where are the utility lines? What conditions might delay the work?

Whether the job is big or small, whether you've got no plan or a very complete plan prepared by the best engineering firm in the state, make a visit to the site as part of your estimating procedure. That's important — important enough to be the subject of an entire chapter. And that's the next chapter in this book.

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Practical References for Builders

Excavation & Grading Handbook Revised

The foreman's, superintendent's and operator's guide to highway, subdivision and pipeline jobs: how to read plans and survey stake markings, set grade, excavate, compact, pave and lay pipe on nearly any job. Includes hundreds of informative, on-the-job photos and diagrams that even experienced pros will find invaluable. This new edition has been completely revised to be current with state-of-the-art equipment usage and the most efficient excavating and grading techniques. You'll learn how to read topo maps, use a laser level, set crows feet, cut drainage channels, lay or remove asphaltic concrete, and use GPS and sonar for absolute precision. For those in training, each chapter has a set of self-test questions, and a Study Center CD-ROM included has all 250 questions in a simple interactive format to make learning easy and fun. **512 pages, 8½ x 11, $42.00**

CD Estimator

If your computer has *Windows*™ and a CD-ROM drive, CD Estimator puts at your fingertips over 135,000 construction costs for new construction, remodeling, renovation & insurance repair, home improvement, framing & finish carpentry, electrical, concrete & masonry, painting, and plumbing & HVAC. Monthly cost updates are available at no charge on the Internet. You'll also have the *National Estimator* program — a stand-alone estimating program for *Windows*™ that *Remodeling* magazine called a "computer wiz," and *Job Cost Wizard*, a program that lets you export your estimates to QuickBooks Pro for actual job costing. A 60-minute interactive video teaches you how to use this CD-ROM to estimate construction costs. And to top it off, to help you create professional-looking estimates, the disk includes over 40 construction estimating and bidding forms in a format that's perfect for nearly any *Windows*™ word processing or spreadsheet program. **CD Estimator is $108.50**

Markup & Profit: A Contractor's Guide, Revisited

In order to succeed in a construction business, you have to be able to price your jobs to cover all labor, material and overhead expenses, and make a decent profit. But calculating markup is only part of the picture. If you're going to beat the odds and stay in business — profitably, you also need to know how to write good contracts, manage your crews, work with subcontractors and collect on your work. This book covers the business basics of running a construction company, whether you're a general or specialty contractor working in remodeling, new construction or commercial work. The principles outlined here apply to all construction-related businesses. You'll find tried and tested formulas to guarantee profits, with step-by-step instructions and easy-to-follow examples to help you learn how to operate your business successfully. Includes a link to free downloads of blank forms and checklists used in this book. **336 pages, 8½ x 11, $47.50**

Construction Estimating Reference Data

Provides the 300 most useful manhour tables for practically every item of construction. Labor requirements are listed for sitework, concrete work, masonry, steel, carpentry, thermal and moisture protection, doors and windows, finishes, mechanical and electrical. Each section details the work being estimated and gives appropriate crew size and equipment needed. Includes a CD-ROM with an electronic version of the book with *National Estimator*, a stand-alone *Windows*™ estimating program, plus an interactive multimedia video that shows how to use the disk to compile construction cost estimates. **432 pages, 11 x 8½, $39.50**

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552 pages, 8½ x 11, $72.75. Revised annually

Paper Contracting: The How-To of Construction Management Contracting

Risk, and the headaches that go with it, have always been a major part of any construction project — risk of loss, negative cash flow, construction claims, regulations, excessive changes, disputes, slow pay — sometimes you'll make money, and often you won't. But many contractors today are avoiding almost all of that risk by working under a construction management contract, where they are simply a paid consultant to the owner, running the job, but leaving him the risk. This manual is the how-to of construction management contracting. You'll learn how the process works, how to get started as a CM contractor, what the job entails, how to deal with the issues that come up, when to step back, and how to get the job completed on time and on budget. Includes a link to free downloads of CM contracts legal in each state. **272 pages, 8½ x 11, $55.50**

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Basic Engineering for Builders

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