North Dakota Department of Health
Division of Waste Management

Landfill Operator Training
Maps, Plans and Math
Practice Book

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NORTH DAKOTA
DEPARTMENT *of* HEALTH

Introduction

This practice book is designed for you to use prior to attending the North Dakota Department of Health, Division of Waste Management's Landfill Operator Training. During Operator Training there will be several topics covered that deal with calculations and the math associated in the operation of a landfill. There are several objectives and goals you should work to accomplish prior to attending Landfill Operator Training. They are:

Objectives:

- Familiarize yourself with the mathematics that are associated with the operation of a landfill.
- Refresh and practice the math skills necessary to actively engage in working through the problems during the maps, plans and math presentations during Landfill Operator Training.
- Refresh and practice the math skills necessary to complete the Landfill Operator Training Certification Exam.

Goals

- Be familiar with the equations and formulas needed to perform specific calculations.
- Be comfortable reading a map and using a scale to determine actual distance, length or area.
- Be comfortable with the correct operation of a calculator and transferring numbers and operational functions from paper to the calculator.

Practice Book Structure

This practice book will be separated into several sections that deal with different aspects of mathematics. Some of these sections may be reviewed for you while some may not be. It is strongly recommended that you go through each section of this practice book and complete the work. Each section will introduce a concept and provide you with example problems and practice problems. Answers to all practice problems will be provided in the answer key at the end of the book.

The section of this practice book will be

- Formulas and Conversion Factors
- Calculator Operation
- Conversions
- Reading Maps and Converting Scales
- Reading Topographic Maps and Contour Lines
- Calculating Slope, Area and Volume
- Glossary
- Answer Key for Practice Problems

Section 1: Formulas and Conversion Factors

This section will be used primarily as a reference page. There will be frequent times throughout the remaining sections when you will be asked to provide a formula, equation or conversion factor to solve a problem. This section will provide you with all of the required information that you may need to complete the remainder of the practice book.

Formulas:

Formula		Long Hand	Short Hand
Area	=	Length x Width	$A = l \times w$
Volume	=	Length x Width x Height	$V = l \times w \times h$
Area of Trapezoid (excavation or berm)	=	$\frac{Width1 + Width2}{2} \times Height$	$A = \frac{W1 + W2}{2} \times h$
Volume of Trapezoid (excavation or berm)	=	$\frac{Width1 + Width2}{2} \times Height\ x\ Length$	$V = \frac{W1 + W2}{2} \times h \times l$
Slope (Ratio)	=	Run to Rise	S(Ratio) = Run: Rise
Slope (%)	=	$\frac{Rise}{Run} \times 100$	S(%) = $\frac{Rise}{Run} \times 100$
% Slope to Slope Ratio	=	$\frac{100}{\%Slope} = Run:1$	$\frac{100}{\%} = Run:1$
Slope Ratio to % Slope	=	$\frac{100}{Run} = \%Slope$	$\frac{100}{Run} = \%$

Conversion Factors:

Unit		Conversion	Conversion Factor
1 foot	=	12 inches	1 ft. = 12 in.
1 acre	=	43,560 square feet	1 acre = 43,560 ft.^{2}
1 cubic yard	=	27 cubic feet	1 yd.^{3}= 27 ft.^{3}
1 square foot	=	1 ft. x 1 ft.	1 ft.^{2} = 1 ft. x 1 ft.
1 cubic yard	=	1 yd. x 1 yd. x 1 yd.	1 yd.^{3} = 1 yd. x 1 yd. 1 yd.
1 yard	=	3 feet	1 yd. = 3 ft.
1 mile	=	5280 feet	1 mi. = 5280 ft.

Section 2: Calculator Operation

When performing calculations using a calculator, it is important that the information you are transferring from the paper to the calculator gets entered properly. In this section, you will be introduced to basic calculator operation as it applies to simple mathematical calculations such as multiplication and division. This section will assume that you will be using a simple calculator.

Multiplication:

Ex. Problem: 25 x 15 = 375

On your calculator, enter 25, then x, then 15, then = to get the answer of 375. With multiplication, the order of the numbers entered does not make a difference in the answer. You could have entered 15 x 25 = and still came up with 375.

PP1. What is 250 times 300?

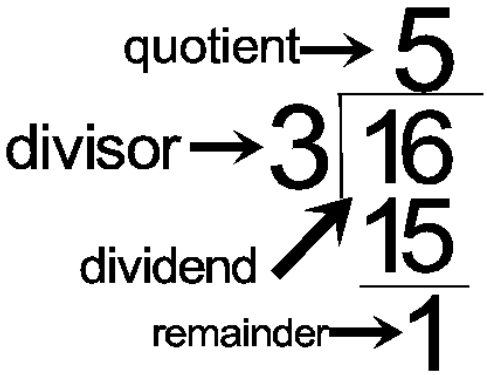
PP1 Answer:_____

Division:

When dividing using a calculator, **IT IS VERY IMPORTANT** that the information is entered in the correct order. If the information is not entered in the correct order, the answers will not be the correct answer.

From Long Division to Electronic Division: (the relationship and what the symbols mean)

In long division the problem consists of five items: the divisor, the dividend, the symbol, the quotient (answer), and the remainder. The problem below is: What is 16 divided by 3?



When dividing using a calculator you will lose the remainder, which will become the decimal portion of the quotient, and the symbols are changed. Instead of using the long division symbol ($\overline{)\quad}$) we will use either the obelus ($\div$) or the solidus (/) or fraction line ($-$) used in fractions.

So the above problem could be written as 16 $\div$ 3 =, or 16/3=, or $\frac{16}{3}$ =, all would be entered into the calculator the following way:

Enter 16
then $\div$
then 3
then = to get the answer of 5.3333

It is important to remember that the dividend is always entered into the calculator before the divisor.

Example: 35 divided by 5 could be written in the following four ways:

$5\overline{)35}$ or $35 \div 5$ or 35/5 or $\frac{35}{5}$. All of these problems would be entered into the calculator in the following sequence:

Enter 35
then $\div$
then 5
then = to get the answer of 7

When using a calculator to figure answers to division problems it is actually easier if the problem is written using $\div$ or / or $-$, since the numbers get entered into the calculator in the order they are written. When using the long division sign, the numbers must be entered in reverse order from how they are written.

It is also important to remember that you always enter the dividend first then the divisor, otherwise you will not get the correct answer.

Example: 48 divided by 6?

48 $\div$ 6 = 8 versus $6 \div 48$ = .125

PP2. What is 654 divided by 75? PP2 Answer:_____

PP3. What is 784 $\div$ 14? PP3 Answer:_____

PP4. What is 564/24? PP4 Answer:_____

Section 3: Conversions

Being able to convert numbers from one unit to another unit is essential for landfill operators for several reasons. First of all, most plans for landfills are drawn using a scale that is a different unit than the actual unit. For example, on a landfill plan, the length of a cell may be measured as 1.5 inches, the scale of the map may be 1 inch = 200 ft. To determine the actual length of the cell, you will need to be able to convert the measured distance to the actual distance using a conversion factor. Second, you may be required to convert different measures of volume from one to another, say from cubic feet to cubic yards. Also measurements of area may need to be converted from square feet to acres. All of these conversions can be calculated using a conversion factor.

What is a conversion factor?

A conversion factor is any fraction that is equal to 1. For example you know that 12 inches is equal to 1 foot. This information can be written in a fraction form to create a conversion factor, such as $\frac{12 inches}{1 foot}$ or $\frac{1 foot}{12 inches}$. You can see that each of these fractions is equal to 1. The number on the top (numerator) is the same as the number on the bottom (denominator) when you consider the units the numbers are given in. Obviously, 12 does not equal 1, but 12 INCHES is equal to 1 FOOT, therefore the conversion factor is equal to 1. There are several conversions listed in Section 1 that can be written in a fraction form to create a conversion factor.

How to use conversion factors (Factor-Label Method)

Any time you need to utilize a conversion factor, you will be changing the units that you are given to the units that you want to know.

Example: How many feet are equal to 144 inches?

In this example, the units you are given are inches, but you want to know the measurement in feet, so you need to use a conversion factor. To set up the following problem, we need to convert the problem from words to math in the following way:

How Many – means a blank line where your answer goes
Unit known – in this case feet
Are Equal – means an =
Units known – in this case inches

_____ ft. = 144 in.

Now we need to add a conversion factor that will allow us to remove the unit of inches. We will multiply the 144 in. by a conversion factor that includes the unit of inches in the denominator (the bottom number). The conversion factor we will want to use is $\frac{1 ft}{12 in}$. You can also see that this conversion factor contains the unit we want to convert to (feet) in the numerator (the top number). So the problem would continue to be written as follows:

_____ ft. = 144 in. x $\frac{1\,ft.}{12\,in.}$

Now that we have included a conversion factor that includes the units we want and the units we were given, we can eliminate the units that we were given and do not want anymore.

_____ ft. = 144 ~~in.~~ x $\frac{1\,ft.}{12\,\cancel{in.}}$ Now we are left with only the units that we are looking for, feet.

When inserting the conversion factor, ALWAYS put the number and units that you are converting to on the top and the number and units you want to eliminate on the bottom.

To complete the problem, simply do the math required. When using conversion factors, we always multiply the numbers on top (numerators) together and then we divide by all of the denominators. (Note: Any number that does not have a denominator written, the number 1 is the denominator. So 144 is the same as $\frac{144}{1}$).

To solve this problem we would enter the following into the calculator:

Enter 144
then x
then 1
then ÷
then 1
then ÷
then 12
then = to get the answer of 12 ft.

To check your answer, place the 12 ft. in the blank and make sure the equation is equal.

__12 ft.__ = 144 in. **(ALWAYS REMEMBER TO INCLUDE A NUMBER AND UNITS IN YOUR ANSWER)**

You can also see that in the above sequence of math operations, you didn't necessarily need to multiply by 1 and then divide by 1 as they cancel each other out. You could simply have taken 144 divided by 12 to get the same result.

Examples:

Units wanted

Units known

How many	yards	are equal to	670 feet?

Conversion Factor: units wanted on top, units known on bottom.

_____ yd. = 670 ft. $\times \frac{1\,yd.}{3\,ft.}$

_____ yd. = 670 ft. $\times \frac{1yd.}{3ft.}$

On your calculator:

Enter 670
Then ÷
Then 3
Then = to get your answer of 223.33 yd.

<u>223.33 yd.</u> = 670 ft. $\times \frac{1yd.}{3ft.}$

PP5: How many feet are equal to 6 inches?

PP5: Answer: _____

PP6: How many feet are equal to 455 yards?

PP6: Answer: _____

Section 4: Reading Maps and Converting Scales

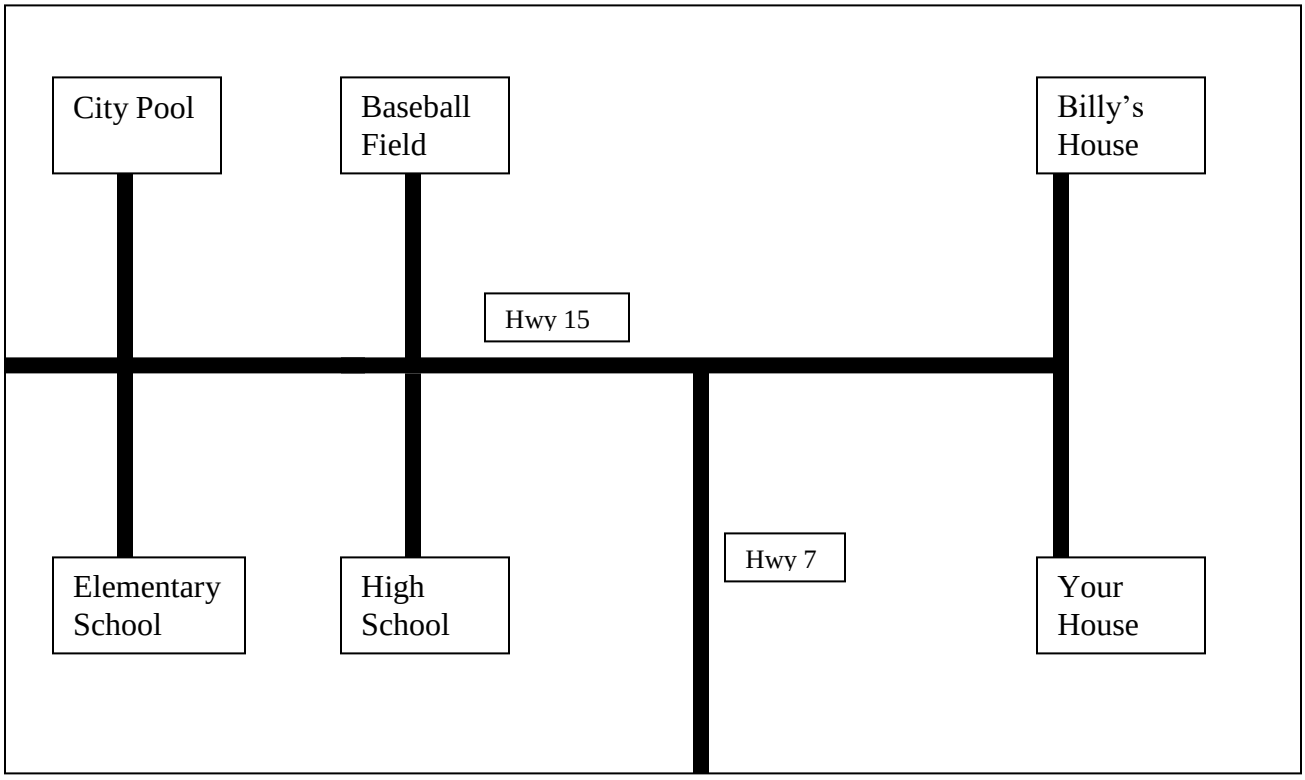
Many times in the operation of a landfill it is important to be able to read maps and plans. In order to properly know what the map or plan represents, it is also important to be able to convert measurements on the maps or plans to actual, physical measurements. In this section we will use a basic U.S. ruler with inches to convert measurements on maps and plans to actual, physical measurements.

Scale

Every map or plan that you look at will have some type of scale associated with it. A scale is a device used to tell you how many units of measurement on the map or plan are equal to the actual measurement. For example, the North Dakota Highway map has a scale in the upper right corner that reads "Scale: 1 inch = Approx. 15 miles". So the scale for this map would be 1 in = 15 miles. The scale on a map or plan can also be thought of as a conversion factor for that particular map or plan.

Converting using scales

Scale: 1 inch = .5 miles



Example Problem:

How far is it from Your House to Billy's House?

The first thing to consider is the scale, which for this map is 1 inch = .5 miles. Next we need to measure the map distance from Your House to Billy's House. You should have measured 2 inches. Now we can set up the problem similar to the conversion factors we did previously.

How many miles is equal to 2 inches?

$$_____ \text{ miles} = 2 \text{ in.} \times \frac{.5 miles}{1 in.}$$

Multiply 2 times .5 to get your answer of 1 mile. Remember, when converting using a scale, the scale is your conversion factor. Obviously .5 miles does not equal 1 inch in real life, but for this map it equals the same thing.

PP7: How far is it from the Elementary School to the Baseball Field?

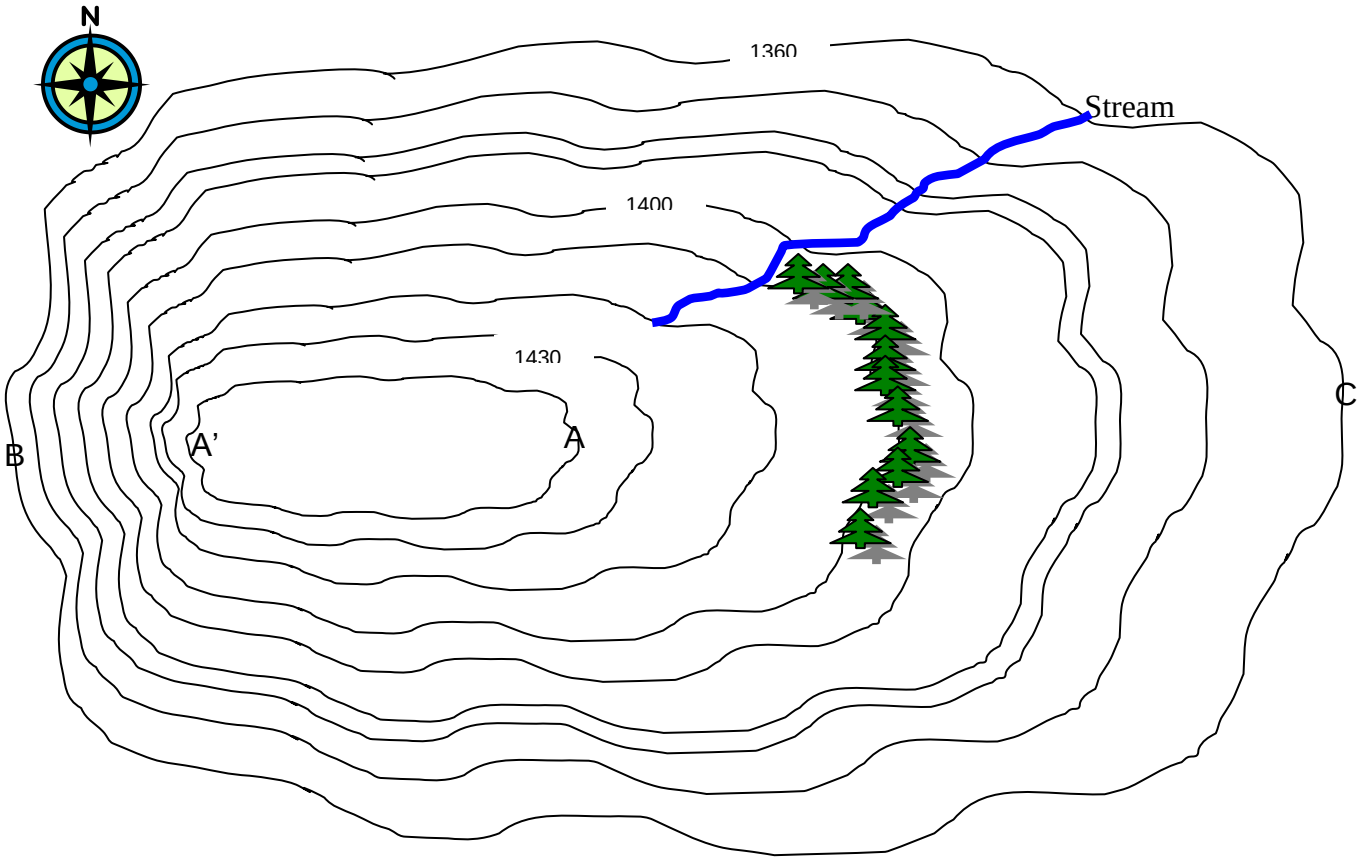
PP7: Answer: _____

PP8: How far is it from the Your House to the City Pool?

PP8: Answer: _____

Section 5: Reading Topographic Maps and Contour Lines

Similar to using a scale to determine distance on a map, reading topographic maps and contour lines will be useful to you in the operation of a landfill. You will use topographic maps to determine height of excavations and berms, depth of cells, etc. Topographic maps will also have scales to determine distances and they will also have a scale for the contour lines to determine elevations. Generally you will not need to convert the elevations on a topographic map as the contour lines represent actual change in elevation. An example is shown below. As you can see, this represents a hill that starts at an elevation of 1360 ft. and ends with an elevation of 1440 ft. Each contour line represents a change in elevation of 10 ft. We will assume the distance scale for this map is 1 inch = 1300 ft.



By utilizing the distance scale and the contour lines, we can determine several features of this area. For example, you can tell that the tree line is at an elevation of 1410 ft. To find this, locate the nearest contour line that is labeled. In this case it would be the contour line labeled 1400 ft. You can see that the next contour line in elevation is where the tree line is located; therefore the tree line is at an elevation of 1410 ft.

Example Problem: **What is the elevation of point A?**

To determine the elevation at point A, locate the nearest contour line that is labeled. This would be the contour line labeled 1430 ft. The next contour line closest to A would be 1440 ft. so the elevation of point A would be 1440 ft.

PP9: What is the elevation of point B? PP9 Answer: _____

PP10: What elevation does the stream begin at? PP10 Answer: _____

PP11: What side of the hill would be easier to climb (West or East)? PP11 Answer: _____

Section 6: Calculating Slope, Area and Volume

During the operation of a landfill, it is important for a landfill operator to be able to calculate slopes, area and volume. In this section, we will introduce you to each of these concepts.

Calculating Slope:

To calculate slope, you will need to know two terms: Rise and Run. The Rise is the difference in elevation between two points. The Run is the difference in distance between two points. By knowing the rise and run of a slope you will be able to calculate the slope ratio and the percentage slope. For our work in this book we will use a topographic map to determine both the rise and the run. There are other methods of determining these numbers which will be covered during operator training.

First we will work with the formulas to determine slope ratio and percentage slope without using a map to determine the measurements.

Example Problems:

1. If the run is 50 ft. and the rise is 10 ft. calculate the slope ratio and the % slope?

Run 50 ft., Rise 10 ft. so slope ratio would be 50:10 which can be reduced to 5:1. We will always want to express slope ratios as "something" to 1. We would say that this area has a slope of 5 to 1. This means for every 5 ft. of run, the elevation will go up 1 ft.

To determine % slope we use the formula $\frac{Rise}{Run} \times 100$. So we would have $\frac{10\,ft}{50\,ft.} \times 100$ = % slope.

To calculate this using your calculator:
Enter 10
Then ÷
Then 50
Then x
Then 100
Then = to get the answer of 20%. This area has a 20% slope.

2. If the run is 300 ft. and the rise is 50 ft. what is the slope ratio and % slope?

Run = 300 ft., Rise = 50 ft. So slope ratio is 300:50 which can be reduced to 6:1. (You can reduce the original slope by dividing 300 by 50 to get 6)

% slope = $\frac{Rise}{Run} \times 100$, so $\frac{50\,ft}{300\,ft} \times 100$ = 16.67 % slope

PP12: Calculate the slope ratio and % slope of an area that has a run of 300 ft. and a rise of 24 ft.

PP12 Answer: Slope Ratio: _____ % Slope: _____

We can also convert between % slope and slope ratios using the following two formulas:

For % Slope to Ratio

$$\frac{100}{\%Slope} = Run:1$$

For Ratio to % Slope

$$\frac{100}{Run} = \%Slope$$

Example Problems:

1. What is the slope ratio of a 20% slope?

Slope Ratio = $\frac{100}{\%Slope}$ so, $\frac{100}{20} = 5:1$

2. What is the % slope of an area that has a slope ratio of 4:1?

% Slope = $\frac{100}{Run}$ so, $\frac{100}{4}$ = 25% Slope

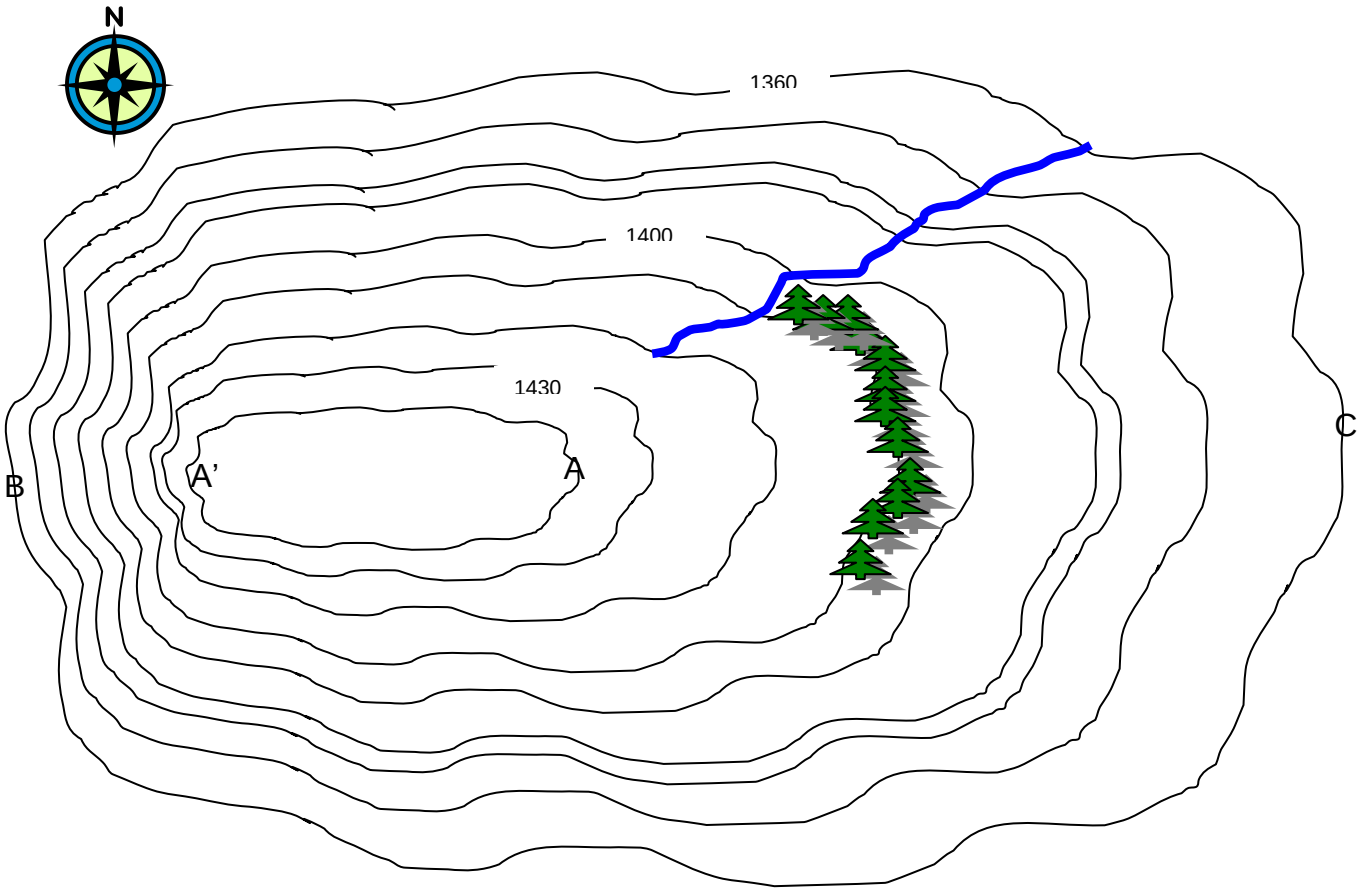
PP13: What is the % slope of an area with a slope ratio of 30:1?

PP13 Answer: _____

PP14: What is the slope ratio of an area with a 18% slope?

PP14 Answer: _____

Using maps to determine slope: (distance scale is 1 inch = 1300 ft.)



Example Problems:

1. What is the % slope from A to C?

- determine Run – measure from A to C and convert using the scale of 1 in = 1300 ft.
- determine Rise – determine elevation at A and subtract the elevation of C.

Run is $4in \times \frac{1300\ ft}{1in} = 5200\ ft$ ft. Rise is 1440 ft. – 1360 ft. = 80 ft.

% slope = $\frac{Rise}{Run} \times 100$

% slope = $\frac{80\ ft}{5200\ ft} \times 100$ = 1.54 % slope

2. What is the slope ratio from A to C?

- Use the formula Slope Ratio = $\frac{100}{\%Slope}$ so $\frac{100}{1.54\%}$ = 65:1.

PP15: What is the slope ratio from point B to point A'?

PP15 Answer: _____

PP16: What is the % slope from point B to point A'?

PP16 Answer: _____

Calculating Area:

Area is calculated using the formula A = *l* x *w*, where A = Area, *l* = length and *w* = width. The result of this calculation is always given in squared units or acres (square feet, square miles, acres).

Example Problems:

1. What is the area in square feet of a tabletop that measures 3 ft. x 4 ft.?

A = *l* x *w*, so A = 3 ft. x 4 ft., so A = 12 $ft.^2$

2. What is the area of a field that measures .5 miles x 1 mile?

A = *l* x *w*, so A = .5 miles x 1 mile, so A = .5 $miles^2$

PP17: What is the area of a slab of concrete that has a length of 100 feet and a width of 40 feet?

PP17 Answer: _____

PP18: What is the area of a football field that measures 120 yards by 53.3 yards?

PP18 Answer: _____

Converting from square feet to acres:

When operating a landfill, it may be more convenient and practical to talk about area in terms of acres rather than square feet or square miles. To convert a square foot measurement of area to acres we use the following conversion factor: 1 acre = 43,560 ft.^{2}

Example Problems:

1. How many acres are equal to 150,000 ft.^{2}?

_____ acres = 150,000 ft^2 $\times \dfrac{1 acre}{43{,}560\ ft.^2}$

To perform this calculation:

Enter 150,000
Then ÷
Then 43,560
Then = to get the answer of 3.44 acres

2. How many ft.^{2} are equal to 40.5 acres?

_____ ft.^{2} = 40.5 acres $\times \dfrac{43{,}560\ ft.^2}{1 acre}$

Take 40.5 x 43,560 = 1,764,180 ft.^{2}

PP19: How many acres are in an area of 250,000 ft.^{2}?

PP19 Answer: _____

PP20: How many ft.^{2} are in .25 acres?

PP20 Answer: _____

Calculating Volume:

In the operation of a landfill, it is important that you are able to perform calculations that determine volume. Volume is the amount of space an object takes up, for example an excavation of a cell has a specific volume of space. A storm water diversion berm will take a specific volume of fill dirt to construct. To calculate volume we use the formula V = *l* x *w* x *h*, where V = volume, *1* = length, *w* = width, and *h* = height (or depth). This formula can also be written as V = A x *h*, where A = area and *h* = height (or depth). Volume is expressed in cubic measurements such as cubic feet, cubic yards, or cubic inches.

Example Problems:

1. What is the volume of a dumpster that has a length of 6 feet, a width of 3 feet and a height of 4 feet?

V = *l* x *w* x *h*, so V = 6 ft. x 3 ft. x 4 ft., so V = 72 $ft.^3$

2. What is the volume of a trench with a length of 30 feet, a width of 5 feet and a depth of 8 feet?

V = *l* x *w* x *h*, so V = 30 ft. x 5 ft. x 8 ft., so V = 1200 $ft.^3$

PP21: What is the volume of an excavation that measures 40 ft. in length, 50 ft. in width and 25 ft. in depth?

PP21 Answer: _____

PP22: What is the volume of a trailer that is 15 feet long, 8 feet wide and 6 feet high?

PP22 Answer: _____

Converting to cubic yards:

During the operation of a landfill, it may be more practical to talk about volume in terms of cubic yards. Most volume measurements in the waste industry are discussed in these terms. To calculate a cubic feet measurement to cubic yards we will use the following conversion factor: 1 yd.^{3} = 27 ft.^{3}. We can perform the calculation that proves this conversion factor:

How many cubic feet are equal to one cubic yard?

_____ ft.^{3} = 1 yd.^{3} $\times \frac{3\,ft}{1yd.} \times \frac{3\,ft}{1yd} \times \frac{3\,ft.}{1yd.}$

3 x 3 x 3 is 27, so 27 ft.^{3} = 1 yd.^{3}

Example Problem:

1. How many yd^3 are equal to 75 ft.^{3}?

_____ yd.^{3} = 75 ft.^{3} $\times \frac{1yd^3}{27\,ft^3}$ 75 divided by 27 = 2.77 yd.^{3}

PP23: How many cubic feet are in an 8 cubic yard dumpster?

PP23 Answer: _____

PP24: How many cubic yards are equal to 324 ft.^{3}?

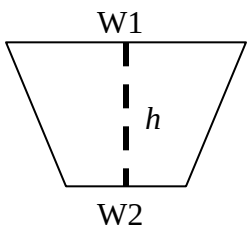
PP24 Answer: _____

Trapezoids:

Now that you are familiar with using the formulas for figuring area and volume, we can move on to figuring area and volume of trapezoids. A trapezoid is a shape with two parallel sides that are not the same length. The shape of most landfill cell excavations and fill areas are similar in shape to a trapezoid. Therefore it is important to be able to know how to calculate the area and volume of trapezoids. To calculate the area and volume, we will need to utilize two new formulas.

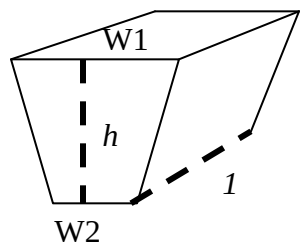
Area of Trapezoid

$$A = \frac{W1 + W2}{2} \times h$$



Volume of Trapezoid

$$V = \frac{W1 + W2}{2} \times l \times h$$



Where: W1 is one side's width
W2 is the other side's width
h is the height (or depth)
l is the length

Example Problems:

1. What is the area of a trapezoid with a top width of 2 ft. a bottom width of 1 ft. and a height of 10 ft.?

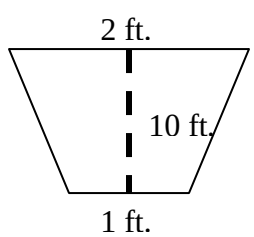
$$A = \frac{W1 + W2}{2} \times h$$

$$A = \frac{2\,ft. + 1\,ft.}{2} \times 10\,ft.,$$

$$A = \frac{3\,ft.}{2} \times 10\,ft.,$$

$$A = 1.5\,ft \times 10\,ft.$$

A = 15 ft.^{2}



2. What is the volume of an excavation that has a depth of 20 ft., a bottom width of 10 ft., a top width of 40 ft. and a length of 100 ft?

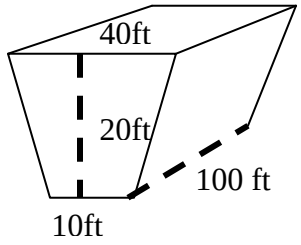
$$V = \frac{W1 + W2}{2} \times h \times l$$

$$V = \frac{10\ ft + 40\ ft}{2} \times 20\ ft. \times 100\ ft.$$

$$V = \frac{50\ ft.}{2} \times 20\ ft. \times 100\ ft.$$

$$V = 25\ ft \times 20\ ft. \times 100\ ft.$$

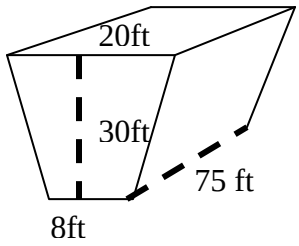
V = 50,000 ft.^{3}



PP25: What is the area of a trapezoid with a W1 of 5.5 ft., a W2 of 15 ft. and a height of 30 ft.?

PP25 Answer: _____

PP26: What is the volume of an excavation with the following measurements?



PP26 Answer: _____

Glossary

Acre	A common variable unit of land measure, now equal in the U.S. to 43,560 square feet.
Area	The quantitative measure of a plane or curved surface; two-dimensional extent.
Berm	A mound or bank of earth, used especially as a barrier.
Contour Lines	Contour lines are lines drawn on a map connecting points of equal elevation.
Conversion Factor	A numerical factor used to multiply or divide a quantity when converting from one system of units to another.
Cubic Foot	The volume of a cube with sides of 1 foot in length.
Cubic Yard	The volume of a cube with sides of 1 yard in length.
Denominator	That term of a fraction, usually written under the line, that indicates the number of equal parts into which the unit is divided; divisor.
Depth	A dimension taken through an object or body of material, usually downward from an upper surface, horizontally inward from an outer surface, or from top to bottom of something regarded as one of several layers.
Distance	The extent or amount of space between two things, points, lines, etc.
Dividend	A number that is to be divided by a divisor.
Divisor	A number by which another number, the dividend, is divided.
Elevation	The altitude of a place above sea level or ground level.
Excavation	A hole or cavity made by excavating.
Foot	A unit of length originally derived from the length of the human foot. It is divided into 12 inches and equal to 30.48 centimeters.
Height	Distance upward from a given level to a fixed point.
Inch	A unit of length, $^{1}/_{12}$ foot, equivalent to 2.54 centimeters.
Length	The longest extent of anything as measured from end to end.
Numerator	The term of a fraction, usually above the line, that indicates the number of equal parts that are to be added together.
Obelus	÷, the divide sign.
Percent Slope	The percent that a surface is inclined.
Quotient	The result of division.
Ratio	The relation between two similar magnitudes with respect to the number of times the first contains the second.
Remainder	The portion of the dividend that is not evenly divisible by the divisor.
Rise	Upward slope, as of ground or a road.
Run	The horizontal distance between two points.
Scale	A graduated line, as on a map, representing proportionate size.
Slope	An inclined surface.
Solidus	A punctuation mark (/) used to separate related items of information, in mathematical fractions means to divide.
Square Foot	A unit of area measurement equal to a square measuring one foot on each side.
Topographic Map	A map showing the relief features of the earth's surface, usually by means of contour lines to show changes in elevation.
Trapezoid	A quadrilateral plane figure having two parallel and two nonparallel sides.
Unit	Any division of quantity accepted as a standard of measurement or exchange.
Volume	The amount of space, measured in cubic units, that an object or substance occupies.
Width	Extent from side to side; breadth; wideness.

Answer Key for Practice Problems

PP1	**75,000** Solution: 250 x 300 = 75,000
PP2	**8.72** Solution: $654 \div 75 = 8.72$
PP3	**56** Solution: $784 \div 14 = 56$
PP4	**23.5** Solution: $564 \div 24 = 23.5$
PP5	**.5 ft.** Solution: $_____ ft. = 6in. \times \frac{1\,ft.}{12in.}$ Cross out like units (*in.*) and calculate 6 $\div 12$ = .5 ft. (include unit)
PP6	**1365 ft.** Solution: $_____ ft = 455\,yd. \times \frac{3\,ft.}{1yd}$ Cross out like units (*yd.*) and calculate 455 x 3 = 1365 ft. (include unit)
PP7	**1.75 miles** Solution: Measure from Elem. School to Baseball Field (3.5 in.) $_____ miles = 3.5in. \times \frac{.5miles}{1in.}$ Cross out like units (*in.*) and calculate 3.5 x .5 = 1.75 miles (include unit)
PP8	**3.5 miles** Solution: Measure from Your House to City Pool (7 in.) $_____ miles = 7in. \times \frac{.5miles}{1in.}$ Cross out like units (*in.*) and calculate 7 x .5 = 3.5 miles (include unit)

PP9	**1360 ft.** Solution: Notice that Point B is on the lowest contour line. Follow this line around the hill until you locate the label of 1360 ft.
PP10	**1420 ft.** Solution: Notice the location of the start of the stream is at the third contour line from the top. The second contour line is labeled 1430 ft. The nest contour line down would indicate an elevation of 1420 ft.
PP11	**East** Solution: Notice that the contour lines on the west side of the hill are spaced much closer together than those on the east side of the hill. The closeness of the lines indicates the steepness of the slope. The closer together the lines, the more the elevation changes in a shorter distance. Therefore the east side would have a much gentler slope and be easier to climb.
PP12	**Ratio - 12.5:1, % Slope – 8%** Solutions: Slope Ratio = Run to Rise, Run = 300 ft., Rise = 24 ft., Ratio = 300:24, we can reduce this by dividing 300 by 24 and getting 12.5. The slope ratio is then 12.5:1. % Slope = $\frac{Rise}{Run} \times 100$ % Slope = $\frac{24\,ft}{300\,ft} \times 100$ Cross out like units (*ft.*) and calculate 24 ÷ 300 = .08 Calculate .08 x 100 = 8 %
PP13	**3.33%** Solution: Slope Ratio to % Slope = $\frac{100}{Run}$ In the ratio 30:1, 30 is the run and 1 is the rise. Substitute 30 for *Run* in the equation Slope Ration to % Slope = $\frac{100}{30}$ and calculate $100 \div 30$ = 3.33%
PP14	**5.55:1** Solution: % Slope to Slope Ratio = $\frac{100}{\%Slope}$ = Run:1 Substitute in the percent slope of 18% into the equation: % Slope to Slope Ratio = $\frac{100}{18}$ and calculate $100 \div 18$ = 5.55:1

PP15	**16.25:1** Solution: Measure from point B to Point A' = 1 in. Calculate the actual distance: _____ $ft = 1in \times \frac{1300\ ft.}{1in.}$ Cross out like units (*in.*) and calculate 1 x 1300 = 1300 ft. This is the Run. Determine the rise from point B to Point A'. A' is at an elevation of 1440ft and Point B is at an elevation of 1360 ft. Subtract these numbers 1440 ft. – 1360 ft. = 80 ft. This is the Rise. So the Slope Ratio is 1300:80, reduce by dividing 1300 by 80 to get 16.25:1
PP16	**6.15%** Solution: Since we know the slope ratio already we can use the equation below: Slope Ratio to % Slope = $\frac{100}{Run}$, substitute in the run of 16.25 into the equation Slope Ratio to % Slope = $\frac{100}{16.25}$ and calculate 100 $\div$ 16.25 = 6.15%
PP17	**4000 ft.^{2}** Solution: $A = l \times w$, l = 100 ft., w = 40 ft., Calculate 100 ft. x 40 ft. = 4000 ft.^{2}
PP18	**6396 yd.^{2}** Solution: $A = l \times w$, l = 120 yd., w = 53.3 yd., Calculate 120 yd. x 53.3 yd. = 6396 yd.^{2}
PP19	**5.74 acres** Solution: _____ $acres = 250{,}000\ ft.^2 \times \frac{1acre}{43{,}560\ ft.^2}$ Cross out like units (*ft.*^{2}) and calculate 250,000 $\div$ 43,560 = 5.74 acres
PP20	**10,890 ft.^{2}** Solution: _____ $ft.^2 = .25acres \times \frac{43{,}560\ ft.^2}{1acre}$ Cross out like units (*acres*) and calculate .25 x 43,560 = 10,890 ft.^{2}
PP21	**50,000 ft.^{3}** Solution: $V = l \times w \times h$, where l = 40 ft., w = 50 ft. and h = 25 ft. Calculate V = 40 ft. x 50 ft. x 25 ft. = 50,000 ft.^{3}
PP22	**720 ft.^{3}** Solution: $V = l \times w \times h$, where l = 15 ft., w = 8 ft. and h = 6 ft. Calculate V = 15 ft. x 8 ft. x 6 ft. = 720 ft.^{3}

PP23	**216 ft.^{3}** Solution: $____\ ft.^3 = 8yd^3 \times \frac{27\ ft^3}{1yd.^3}$ Cross out like units ($yd.^3$) and calculate 8 x 27 = 216 ft.^{3}
PP24	**12 yd.^{3}** Solution: $____yd.^3 = 324\ ft^3 \times \frac{1yd^3}{27\ ft.^3}$ Cross out like units ($ft.^3$) and calculate $324 \div 27 =$ 12 yd.^{3}
PP25	**307.5 ft.^{2}** Solution: $A = \frac{W1 + W2}{2} \times h$, where *W1* = 5.5 ft., *W2* = 15 ft. and *h* = 30 ft. $A = \frac{5.5\ ft. + 15\ ft.}{2} \times 30\ ft.,$ $A = \frac{20.5\ ft.}{2} \times 30\ ft.$ $A = \frac{20.5\ ft.}{2} \times 30\ ft.$ $A = 10.25\ ft. \times 30\ ft.$ = 307.5 ft.^{2}
PP26	**31,500 ft.^{3}** Solution: $V = \frac{W1 + W2}{2} \times h \times l$, where *W1* = 20 ft., *W2* = 8 ft., *h* = 30 ft. and *l* = 75 ft. $V = \frac{20\ ft. + 8\ ft.}{2} \times 30\ ft. \times 75\ ft.$ $V = \frac{28\ ft.}{2} \times 30\ ft. \times 75\ ft.$ $V = 14\ ft. \times 30\ ft. \times 75\ ft.$ = 31,500 ft.^{3}