# Estimating Highway Maintenance Work

## Fifth Edition

May 2008
SP-24-2008

compiled by

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# Estimating Highway Maintenance Work

Estimating amounts of materials, work done, size of crews, or number of trucks needed for road maintenance requires the skill of working with **NUMBERS** and **MEASUREMENTS**. By using addition, subtraction, multiplication, division and some basic rules, you can do some figuring ahead of time and make your crews look better. People feel better about themselves when they're doing a good job, their friends do too, and so does the motoring public.

**NUMBERS** play an important part in the everyday affairs of everybody. Ever since the beginning of the human race, people have been asking questions: How much? How many? How far? How long? and so on. To answer these questions, we need numbers and units of measurement.

**MEASURE** refers to standard values – 12 inches per foot, 2000 pounds per ton, 27 cubic feet per cubic yard. **MEASUREMENT** means the actual size of something – length, width, area, volume or weight. **RATE** involves two kinds of measurement – gallons per square yard, pounds per 2-lane mile, miles per gallon.

A pocket calculator saves the time involved in long-hand calculations and worrying about "why" things are true. A lot of "how" questions can be answered by doing things with numbers. To most of you these exercises will be easy but for others they may take more time and effort. If the latter is the case, an old saying may be comforting – "All things are difficult before they are easy".

An Appendix is provided to help with lengths, areas, volumes, rates, equivalents, and rules. You'll get acquainted with the **TABLES** and **RULES** as you run through the sample problems. The rules and tables used to solve the sample problems are listed in the left-hand margin. The table will help you change sizes or measurements into the same units before you punch the numbers into your calculator.

A number by itself does not have much meaning. Everyone should get in the habit of writing the units of measure with the numbers. Abbreviations are O.K.

## Problem Index

## STRAIGHT LINE MILAGE

1. How far is it between a point 0.3 of a mile east of Mile Marker 9 and another point 0.2 of a mile west of Mile Marker 7? (Give the answer in miles, feet and yards.)


$$Distance = 0.2 + 2 + 0.3\,mi. = \underline{\underline{2.5\,mi.}}$$

Table 3

$$2.5\,mi. \times \frac{5{,}280\ ft.}{mi.} = \underline{\underline{13{,}200\ ft.}}$$

$$\frac{13{,}200\ ft.}{3\ ft./yd.} = \underline{\underline{4{,}400\ yds.}}$$

## MOWING

2. A swath mile is considered to be 5 feet wide. How many <u>square feet</u> in a swath mile? How many acres?

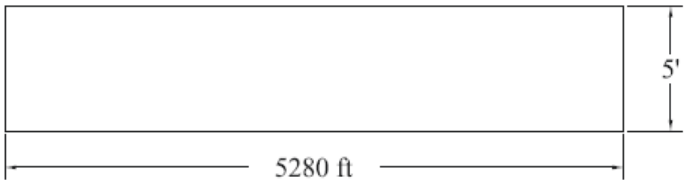



Table 3

$$Area = 5\ ft. \times 5{,}280\ ft. = \underline{\underline{26{,}400\,sq.\,ft.}}$$

Table 7

$$Acreage = \frac{26{,}400\,sq.\,ft.}{43{,}560\frac{sq.\,ft.}{acre}} = \underline{\underline{0.606\,acres}} = \underline{\underline{0.61\,acres}} = \underline{\underline{0.6\,acres}}$$

## MOWING

3. A highway worker mows from SLM 15.8 to SLM 24.7 and makes 4 passes with an 18 ft. wide gang mower. How many swath miles has he mowed? (Swath mile = 26,400 sq. ft. = 0.61 acres.)

$Length = SLM\ 24.7 - SLM\ 15.8 = 8.90\ mi.$

Table 3

$Width = 4 \times 18\ ft. = 72\ ft.$ $\qquad 8.9\ mi. \times \frac{5280\ ft.}{mi.} = 46{,}992\ ft.$

$Area = 72\ ft. \times 46{,}992\ ft. = 3{,}383{,}424\ sq.\ ft.$

$$\frac{3{,}383{,}424\ sq.\ ft.}{26{,}400\ {}^{sq.\ ft.}\!\!\diagup\!\!_{swath\ mi.}} = \underline{\underline{128.16\ swath\ mi.}}$$

## PRIME, TACK, SEAL COAT

4. How many gallons of liquid asphalt will be required to cover a pavement surface, 24 ft. wide, from SLM 4.55 to SLM 7.29 at a rate of 0.2 gal./sq. yd.?

$Length = SLM\ 7.29 - SLM\ 4.55 = 2.74\ mi.$

Table 3

$$2.74\ mi. \times 5{,}280 \frac{ft.}{mi.} = 14{,}467.2\ ft.$$

$Width = 24\ ft.$

Table 7

$$Area = 14{,}467.2\ ft. \times 24\ ft. = \frac{347{,}212.80\ sq.\ ft.}{9 \frac{sq.\ ft.}{sq.\ yd.}} = 38{,}579\ sq.\ yd.$$

$$Tack = 38{,}579.20\ sq.\ yd. \times \frac{0.2\ gal.}{sq.\ yd.} = \underline{\underline{7{,}715.84\ gal.}}$$

## PRIME, TACK, SEAL COAT

5. How many lane-miles (12 ft. X 1 mile) should a 1,000 gal. distributor cover at the rate of 0.2 gal./sq. yd.?

Rule 14

$$Coverage = 1{,}000\,gal. \div \frac{0.2\,gal.}{sq.yd.} = 5{,}000 sq.yd.$$

Table 3, 7

$$Lane\,mi. = 12\,ft. \times 5{,}280\,ft. = \frac{63{,}360\,sq.ft.}{9\frac{sq.ft.}{sq.yd.}} = 7{,}040\,sq.yd.$$

$$\#\,lane\,mi. = \frac{5{,}000\,sq.yd.}{7{,}040\,sq.yd./mi.} = \underline{\underline{0.71\,mi.}}$$

## COVER AGGREGATE

6. How many tons of cover aggregate will be required for a shoulder seal job, 4 ft. wide both sides, on a 2-lane project, 5.8 miles long? (Assume an application rate of 25 lbs./sq. yd.)

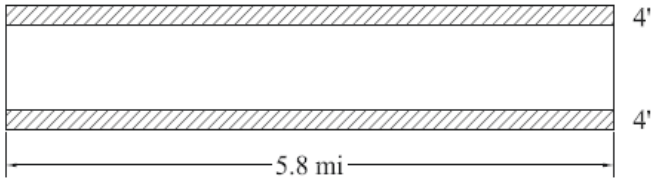



Table 3

$$Length = 5.8\,mi. \times 5{,}280\frac{ft.}{mi.} = 30{,}624\,ft.$$

$$Width = 2 \times 4\,ft. = 8\,ft.$$

Table 7

$$Area = 8\,ft. \times 30{,}624\,ft. = \frac{244{,}992\,sq.ft.}{9\frac{sq.ft.}{sq.yd.}} = 27{,}221.3\,sq.yd.$$

$$Cover\,Agg. = 27{,}221.3\,sq.yd. \times \frac{25\,lbs.}{sq.yd.} = 680{,}533.33\,lbs.$$

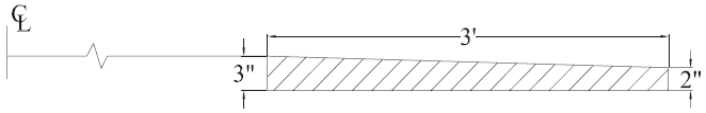
Table 5

$$\frac{680{,}533.33\,lbs.}{2{,}000\frac{lbs.}{ton}} = \underline{\underline{340.3\,ton}}$$

| | |
|---|---|
| | ROAD SALT APPLICATION |
| | 7. How many 2-lane miles of road will be covered by a truck load of salt treated sand weighing 8 tons with an application rate of 600 lbs. per 2-lane mile?<br><br>$Weight = 8\,tons \times 2{,}000\,\frac{lbs.}{ton} = 16{,}000\,lbs.$<br><br>$Application\,Rate = \frac{600\,lbs.}{2-lane\,mi.}$<br><br>$No.of\ lane\,miles = \frac{16{,}000\,lbs.}{600\,lbs./2-lane\,mi.} = \underline{\underline{26.7\,(2-lane\,mi.)}}$ |
| | ROAD SALT APPLICATION |
| Table 5 | 8. A truck applies salt at the rate of 600 lbs. per 2-lane mile from M.P. 2.2 to M.P. 32.0. How many tons of salt did he use?<br><br>$Length = M.P.32 - M.P.2.2 = 29.80\,mi.$<br><br>$\frac{600\,lbs.}{mi.} \times 29.80\,mi. = 17{,}880\,lbs.$<br><br>$\frac{17{,}880\,lbs}{2{,}000\,\frac{lbs.}{ton}} = \underline{\underline{8.94\,ton}}$ |

## BERM AGGREGATE

9. How many cubic yards of berm aggregate will be required to level up a berm from SLM 9.31 to SLM 7.18 in accordance with the following cross section? Change to tons using a rate of 2 tons per cu. yd.




$$\frac{3\,in.}{12\frac{in.}{ft.}} = 0.25\,ft. \qquad \frac{2\,in.}{12\frac{in.}{ft.}} = 0.167\,ft.$$

Rule 3

$$Area\,(Cross\,Section) = 3\,ft. \times \left( \frac{0.25\,ft. + 0.167\,ft.}{2} \right) = 0.626\,sq.\,ft.$$

$$Length = SLM\,9.31 - SLM\,7.18 = 2.13\,miles$$

$$2.13\,mi. \times \frac{5{,}280\,ft.}{mi.} = 11{,}246.4\,ft.$$

Rule 8

$$Volume = 11{,}246.4\,ft. \times 0.626\,sq.\,ft. = \frac{7{,}040.2\,cu.ft.}{27\frac{cu.ft.}{cu.yd.}} = \underline{\underline{260.7\,cu.\,yd.}}$$

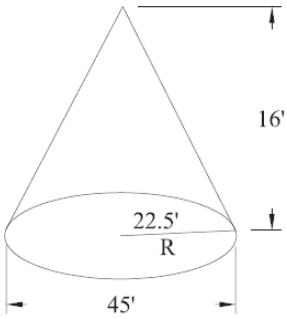
Table 4

$$Tonage = 260.7\,cu.\,yd. \times \frac{2\,ton}{cu.yd.} = \underline{\underline{521.4\,tons}}$$

## VOLUME – STOCKPILE

10. How many cu. yd. of stone in a cone-shaped stockpile that is 45 ft. in diameter and 16 ft. high?

Rule 9




$$Volume = \frac{3.14 \times r \times r \times h}{3}$$

$$Volume = \frac{3.14 \times 22.5\,ft. \times 22.5\,ft. \times 16\,ft.}{3}$$

$$= 8{,}478\,cu.\,ft.$$

Table 4

$$r = \frac{45\,ft.}{2} = 22.5\,ft.$$

$$\frac{8{,}478\,cu.\,ft.}{27\frac{cu.\,ft.}{cu.\,yd.}} = \underline{\underline{314\,cu.\,yd.}}$$

BLACKTOP

11. How many tons of asphalt concrete (blacktop) overlay will be needed to cover a section of road from SLM 4.55 to 7.29 that is 24 ft. wide and 1 in. thick? (1 cu. yd. of asphalt weighs 2 tons)

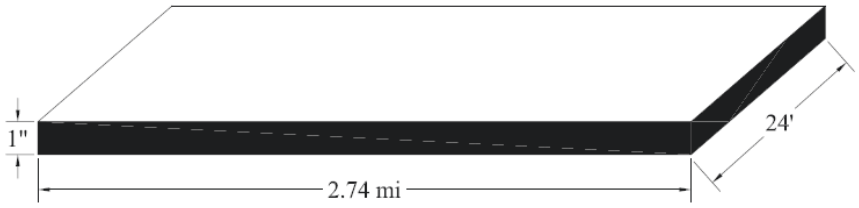



Table 3

$$Length = 2.74\,mi. \times \frac{5{,}280\,ft.}{mi.} = 14{,}467.20\,ft.$$

$$Thickness = \frac{1\,in.}{12\,in./ft.} = 0.0833\,ft.$$

Rule 6

$$Volume = 24\,ft. \times 14{,}467.20\,ft. \times 0.0833\,ft. = 28{,}922.83\,cu.\,ft.$$

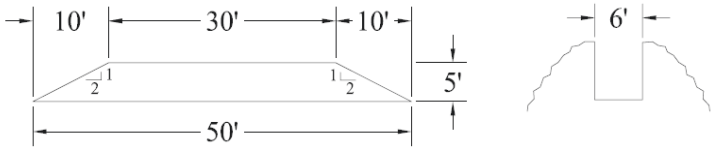
Table 4

$$\frac{28{,}922.83\,cu.\,ft.}{27\,\frac{cu.\,ft.}{cu.\,yd.}} = 1{,}071.22\,cu.\,yd.$$

$$1{,}071.22\,cu.\,yd. \times \frac{2\,ton}{cu.\,yd.} = \underline{\underline{2{,}142.4\,ton}}$$

## VOLUME – BACKFILL

12. How many cu. yd. of backfill would be required for a culvert trench that is 30 ft. wide from berm edge to berm edge, with a 2:1 slope (each side), 5 ft. deep and 6 ft. in length measured along the centerline? Disregard volume occupied by the pipe.




Rule 11

$$Slope\ 2:1 \sim 2 \times 5\ ft. = 10\ ft.(run\ on\ each\ side)$$

Rule 8

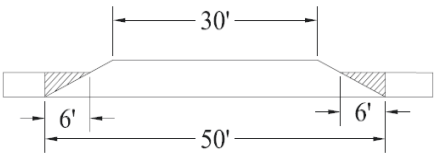
$$Volume = \frac{30\ ft. + 50\ ft.}{2} \times 5\ ft. \times 6\ ft. = 1{,}200\ cu.\ ft.$$

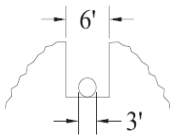
Table 4

$$Volume = \frac{1{,}200\ cu.\ ft.}{27\ cu.\ ft. / cu.\ yd.} = \underline{\underline{44.4\ cu.\ yd.}}$$

## VOLUME – PIPE

13. How much volume would be deducted for a 36-inch (outside diameter) pipe from the backfill calculated for the culvert trench in Problem No. 12.




$$Radius = \frac{3\ ft.}{2} = 1.5\ ft.$$

Rule 11

$$Slope\ 2:1 \sim 2 \times \frac{36\ in.}{12\ in. / ft.} = 6.0\ ft.$$

Rule 17

$$Volume\ of\ 50\ ft.\ Pipe = 3.14 \times 1.5\ ft. \times 1.5\ ft. \times 50\ ft. = 353.25\ cu.\ ft.$$

$$Deduct\ 2\ pieces\ of\ pipe\ near\ end =$$

$$2 \times \left[ \frac{1}{2} \times 3.14 \times 1.5\ ft. \times 1.5\ ft. \times 6\ ft. \right] = 42.39\ cu.\ ft.$$

$$Volume\ of\ Pipe\ Backfill = 353.25 - 42.39 = 310.86\ cu.\ ft.$$

Table 4

$$Volume\ (cu.\ yd.) = \frac{310.86\ cu.\ ft.}{27\ cu.\ ft. / cu.\ yd.} = \underline{\underline{11.51\ cu.\ yd.}}$$

## AREA – PIPE

14. What is the comparison of the area of two 12-inch pipes versus one 24-inch pipe? (Diameters are inside dimensions.)

Table 3

$D = 12\,in. = 1\,ft.$

$r = 6\,in. = 0.5\,ft.$

Rule 5

$Area\,(1-12\,in.) = 3.14 \times r \times r = 3.14 \times 0.5\,ft. \times 0.5\,ft. = 0.785\,sq.\,ft.$

$Area\,(2-12\,in.) = 2 \times 0.785\,sq.\,ft. = \underline{\underline{1.57\,sq.\,ft.}}$

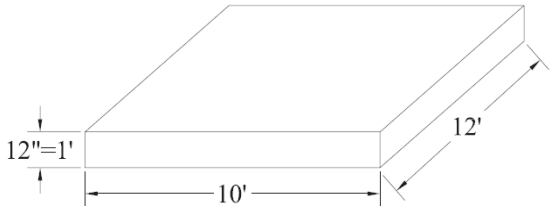
Rule 5

$Area\,(1-24\,in.) = 3.14 \times 1\,ft. \times 1\,ft. = \underline{\underline{3.14\,sq.\,ft.}}$

$Therefore, 1-24\,in.\ pipe\ has \cong twice\ the\ capacity\ of\ 2-12\,in.\ pipes$

## FULL – DEPTH PAVEMENT REPAIRS

15. How many cubic yards of concrete are required to make a 12 in. deep pavement repair, 10 ft. long and 12 ft. wide?




Rule 6

$Volume = 12\,ft. \times 10\,ft. \times 1\,ft. = 120\,cu.\,ft.$

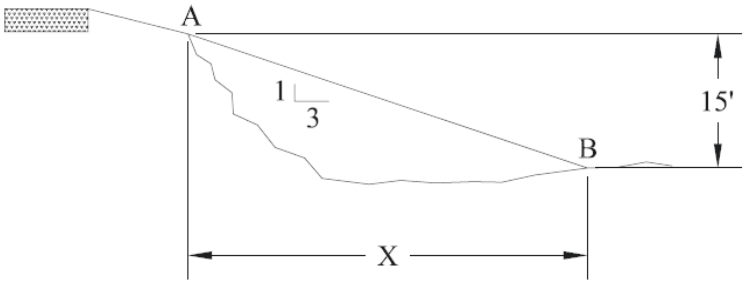
Table 4

$$\frac{120\,cu.\,ft.}{27\,\dfrac{cu.\,ft.}{cu.\,yd.}} = \underline{\underline{4.44\,cu.\,yd.}}$$

Rule 11

## SLOPE – ROADWAY

16. What is the HORIZONTAL distance from point "A" to point "B" in the following drawing using a 3:1 slope?




$X = 15\ ft. \times 3 = \underline{\underline{45\ ft.}}$

(or)

Using Ratio's

$\frac{1}{3} = \frac{15\ ft.}{X}$ $\qquad X = \frac{3 \times 15\ ft.}{1} = \underline{\underline{45\ ft.}}$

## SALT SPREADER CALIBRATION

17. A large sheet of canvas is slipped under the stream of salt for 5 turns of the auger shaft. The net weight of the salt is 87.3 pounds. What is the average amount of salt discharged per turn?

$$\frac{87.3\,lbs.salt}{5\,turns} = \underline{\underline{17.46\,\frac{lbs.salt}{turn}}}$$

## SALT SPREADER CALIBRATION

18. Determine the auger drive shaft speed in Revolutions Per Minute (RPM) when the shaft turns 5.6 times in 60 seconds.

$60\,seconds = 1\,\text{min}.$

$$\frac{5.6\,revolutions}{60\,\text{sec}.} = \frac{5.6\,rev.}{1\,\text{min}.} = \underline{\underline{5.6\,RPM}}$$

SALT SPREADER CALIBRATION

19. Determine the auger drive shaft speed in RPM when the shaft turns 6 times in 64 seconds.

$$\frac{64\,\text{sec.}}{60\,\frac{\text{sec.}}{\text{min.}}} = 1.067\,\text{min.}$$

$$\frac{6\,revolutions}{1.067\,\text{min.}} = \underline{\underline{5.625\,RPM}}$$

SALT SPREADER CALIBRATION

20. When the shaft speed equals 10.5 RPM and the average amount of salt is 9.5 pounds per turn, what is the salt output per minute?

$$10.5\,\frac{rev.}{\text{min.}} \times 9.5\,\frac{lbs.}{rev.} = \underline{\underline{99.75\,\frac{lbs.}{\text{min.}}}}$$

SALT SPREADER CALIBRATION

21. What is the salt output per mile (shaft speed = 20.2 RPM; pounds per turn = 9.5) and the truck speed is 20 miles per hour (MPH)?

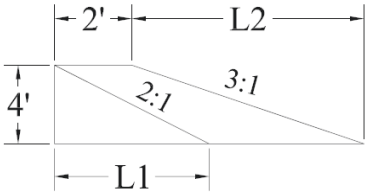
$$No.of\ Shaft\ Revolutions = 20.2\,\frac{rev.}{\text{min}} \times 60\,\frac{\text{min.}}{hr.} = \underline{\underline{1{,}212\,\frac{rev.}{hr.}}}$$

$$Amt.of\ Salt = 1{,}212\,\frac{rev.}{hr.} \times 9.5\,\frac{lbs.}{rev.} = \underline{\underline{11{,}514\,\frac{lbs.salt}{hr.}}}$$

$$Salt\ per\ mi. = 11{,}514\,\frac{lbs.}{hr.} \times \frac{1\,hr.}{20\,mi.} = \underline{\underline{575.7\,\frac{lbs.salt}{mile}}}$$

## SHOULDER FILL

22. You need to add 2 ft. and a 3:1 slope to a shoulder that is 4 ft. from the top of the pavement to the bottom of the ditch with a 2:1 slope. How many cubic yards of dirt will be needed for 1,000 linear ft. of pavement? (one side) (1 cu. yd. = 2 tons)




$L_1 = 4\,ft. \times 2 = 8\,ft.$

$L_2 = 4\,ft. \times 3 = 12\,ft.$

$$Total\ Area = (2\,ft. \times 4\,ft.) + \frac{1}{2} \times (4\,ft. \times 12\,ft.) = 32\,sq.\,ft.$$

$$Exisiting\ Area = \frac{1}{2}(4\,ft. \times 8\,ft.) = 16\,sq.\,ft.$$

$$Fill\ Area = 32 - 16 = 16\,sq.\,ft.$$

$$Volume = 16\,sq.\,ft. \times 1{,}000\,ft. = 16{,}000\,cu.\,ft.$$

$$\frac{16{,}000\,cu.\,ft.}{27\,cu.\,ft./cu.yd.} = \underline{\underline{592.6\,cu.\,yd.}}$$

$$592.6\,cu.\,yd. \times 2\frac{ton}{cu.\,yd.} = \underline{\underline{1{,}185.2\,ton}}$$

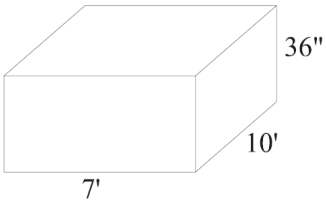
## TRUCK CAPACITY

23. How many cubic yards of material can a dump truck hold if the bed measures 10 ft. long by 7 ft. wide and is 36 inches high? (the bed is filled level) How many tons?

Table 3

Rule 6

$$Height = 36\,in. \div 12\,in./ft. = 3\,ft.$$




$$Volume = 10\,ft. \times 7\,ft. \times 3\,ft. = 210\,cu.\,ft.$$

$$\frac{210\,cu.\,ft.}{27\frac{cu.\,ft.}{cu.\,yd.}} = \underline{\underline{7.78\,cu.\,yd.}}$$

$$7.78\,cu.\,yd. \times 2\frac{ton}{cu.yd.} = \underline{\underline{15.6\,ton}}$$

## BLACKTOP

24. If one ton of 404 Asphalt will cover 162 sq. ft., how many tons of 404 will be needed to cover a stretch of road that is 20 ft. wide, from SLM 14.63 to SLM 15.50?

    Tack coat is applied at a rate of 0.07 gal. per sq. yd. How many gallons of tack will be needed to cover this pavement?

$$Length = SLM\,15.50 - 14.63 = 0.87\,mi.$$

Table 3

$$0.87\,mi. \times \frac{5{,}280\,ft.}{mi.} = 4{,}593.60\,ft.$$

Rule 1

$$Area = 20\,ft. \times 4{,}593.60\,ft. = 91{,}872\,sq.ft.$$

Table 7

$$Area\,(sq.yd.) = \frac{91{,}872\,sq.ft.}{9\,\frac{sq.ft.}{sq.yd.}} = 10{,}208\,sq.yd.$$

$$Asphalt\,(req'd) = 91{,}872\,sq.ft. \times \frac{1\,ton}{162\,sq.ft.} = \underline{\underline{567.1\,ton}}$$

$$Tack = 10{,}208\,sq.yd. \times \frac{0.07\,gal.}{sq.yd.} = \underline{\underline{714.56\,gal.}}$$

## VOLUME

25. How many cubic yards of stone would it take to fill a hole with a diameter of 6 ft. and a depth of 10 ft?

Rule 5

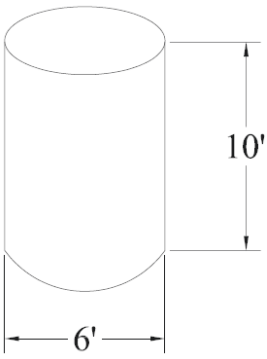
$$Area = \pi r^2 = 3.14 \times 3\,ft. \times 3\,ft. = 28.26\,sq.ft.$$

Rule 6

$$Volume = 28.26\,ft. \times 10\,ft. = 282.60\,cu.ft.$$

Table 4

$$\frac{282.60\,cu.ft.}{27\,\frac{cu.ft.}{cu.yd.}} = \underline{\underline{10.47\,cu.yd.}}$$



## BERM AGGREGATE

26. A section of roadway from SLM 6.43 to SLM 12.02 has just been resurfaced with 2 in. of 404 asphalt. You have to backup the new pavement with berm aggregate 2 ft. wide and the berm box can only pinch down to 1 in. on the outside edge. How many tons of berm aggregate will be needed if 1 cu. yd. weighs 3,800 lbs.? (both sides of the roadway must be done)


Table 3

$$Length = SLM\,12.02 - 6.43 = 5.59\,mi.$$

$$5.59\,mi. \times \frac{5{,}280\,ft.}{mi.} = 29{,}515.20\,ft.$$

$$\frac{1\,in.}{12} = 0.083\,ft. \qquad \frac{2\,in.}{12} = 0.167\,ft.$$

Rule 3

$$Area\,(1-side) = 2\,ft. \times \left( \frac{0.083\,ft. + 0.167\,ft.}{2} \right) = 0.25\,sq.\,ft.$$

$$Area\,(2-side) = 2 \times 0.25\,sq.\,ft. = 0.50\,sq.\,ft.$$

Rule 8

$$Volume = 29{,}515.20\,ft. \times 0.50\,sq.\,ft. = 14{,}757.6\,cu.ft.$$

Table 4

$$\frac{14{,}757.6\,cu.\,ft.}{27} = 546.58\,cu.\,yd.$$

$$Weight = 546.58\,cu.\,yd. \times \frac{3{,}800\,lbs.}{cu.\,yd.} = 2{,}077{,}004\,lbs.$$

$$2{,}077{,}004\,lbs. \div {}^{2{,}000\,lbs.}\!/_{ton} = \underline{\underline{1{,}038.5\,ton}}$$

## GRASS SEEDING

27. Side ditches are set back on a stretch of a roadway and you need to seed the bare slopes. If the area is 2 mi. long and 15 ft. wide, how many pounds of grass seed is needed? (Assume you will use 10 lbs. of grass seed per acre, and both sides of the road will be seeded).


Table 3

$$Length = 2\,mi. \times \frac{5{,}280\,ft.}{mi.} = 10{,}560\,ft.$$

Rule 1

$$Area = 10{,}560\,ft. \times 2\,sides \times 15\,ft. = 316{,}800\,sq.\,ft.$$

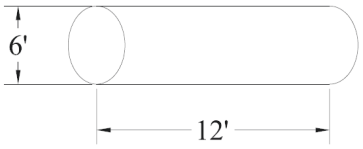
Table 7

$$\frac{316{,}800\,sq.\,ft.}{43{,}560\,\frac{sq.\,ft.}{acre}} = 7.27\,acres$$

$$Seed = 7.27\,acres \times \frac{10\,lbs.}{acre} = \underline{\underline{72.73\,lbs.}}$$

## VOLUME

28. How many gallons of water will a cylindrical tank hold that is 12 ft. long and 6 ft. in diameter?




$D = 6\,ft.$ $r = 3\,ft.$

Rule 5

$$End\,Area = \pi r^2 = 3.14 \times 3\,ft. \times 3\,ft. = 28.26\,sq.\,ft.$$

Rule 17

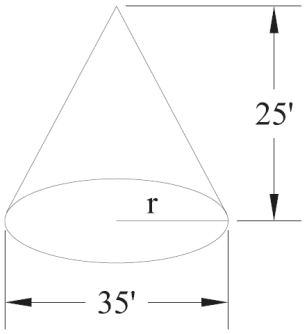
$$Volume = 28.26\,sq.\,ft. \times 12\,ft. = 339.12\,cu.\,ft.$$

Table 6

$$339.12\,cu.\,ft. \times \frac{7.5\,gal.}{1\,cu.\,ft.} = \underline{\underline{2{,}543.4\,gal.}}$$

## VOLUME

29. How many cubic yards are in a stockpile of stone with a base diameter of 35 ft. and a height of 25 feet?




$$r = \frac{35}{2} = 17.5\ ft. \qquad h = 25\ ft.$$

Rule 9

$$Volume = \frac{\pi r^2 h}{3}$$

$$= \frac{3.14 \times 17.5\ ft. \times 17.5\ ft. \times 25\ ft.}{3}$$

$$= 8{,}013.54\ cu.\ ft.$$

Table 4

$$\frac{8{,}013.54\ cu.\ ft.}{27\ \frac{cu.\ ft.}{cu.\ yd.}} = \underline{\underline{296.80\ cu.\ yd.}}$$

## MOWING

30. One person is mowing with a 7 ½-ft. swath mower on U.S. 33. In 2 days, he mows an area 15 ft. wide and 4 miles long on both sides of the road. How many swath miles will be mowed after 2 days of mowing?

Table 3

$$Length = 4\ mi. \times \frac{5{,}280\ ft.}{mi.} = 21{,}120\ ft.$$

Rule 1

$$Area = 15\ ft. \times 21{,}120\ ft. = 316{,}800\ sq.\ ft.$$

$$Swath\ mi. = 5{,}280\ ft. \times 5\ ft. = 26{,}400\ sq.\ ft.$$

$$Swath\ Miles = \frac{316{,}800\ sq.\ ft.}{26{,}400\ \frac{sq.\ ft.}{swath\ mi.}} = \underline{\underline{12.0\ swath\ mi.}}$$

Table 3

## GUARDRAIL REPAIR

31. How many guardrail panels (12'-6" long) and posts (6'-3" center to center) are required to repair a section of guardrail if an accident demolished 275 lineal ft. of TYPE 5 guardrail in the middle of a 1200 ft. run?

12'–6"=12.5' 6'–3"=6.25'

$$Panels = 275\ ft. \div {}^{12.5\ ft.}\!/_{panel} = 22 \qquad add\ (2) = \underline{\underline{24\ panels}}$$

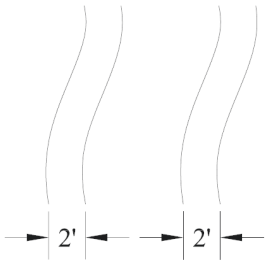
$$Posts = 275\ ft. \div 6.25\ ft. = 44 \qquad add\ (1) = \underline{\underline{45\ posts}}$$

## BLACKTOP

32. A section of roadway will be widened 2 ft. on both sides from SLM 14.10 to SLM 21.84. The depth of the asphalt widening will be 6 in. How many tons of 402 Asphalt will be needed? (Assume 1 cu. yd. of 402 weighs 4,000 lbs.)

$$Width = 2\ ft. \times 2\ sides = 4\ ft.$$

$$Depth = 6\ in. = \frac{6\ in.}{12\ {}^{in.}\!/_{ft.}} = 0.5\ ft.$$




$$Length = 21.84 - 14.10 = 7.74\ mi.$$

$$7.74\ mi. \times \frac{5{,}280\ ft.}{mi.} = 40{,}867.2\ sq.\ ft.$$

$$Volume = 4\ ft. \times 0.5\ ft. \times 40{,}867.2\ ft. = 81{,}734.4\ cu.\ ft.$$

$$= \frac{81{,}734.4\ cu.\ ft.}{27\ {}^{cu.\ ft.}\!/_{cu.yd.}} = \underline{\underline{3{,}027.2\ cu.\ yd.}}$$

## TRUCK CAPACITY

33. How many cubic yards of #8 stone can you legally haul if the maximum weight your single axle dump truck can scale is 30,000 lbs? How many tons? (Your truck weighs 12,000 lbs. empty)

$$\begin{array}{l} 30{,}000\,lbs.\ (total) \\ -\ \underline{12{,}000\,lbs.\ (truck)} \\ 18{,}000\,lbs.\ \ (load) \end{array}$$

Table 5

$$\frac{18{,}000\,lbs.}{2{,}000\,\dfrac{lbs.}{ton}} = \underline{\underline{9\,ton}}$$

## VOLUME

34. How many cu. yd. of stone would it take to fill a hole with a diameter of 12'-3" and a depth of 10'-9".

$12'\text{–}3'' = 12.25\ ft.$ $\qquad D = 12.25\ ft.$

$10'\text{–}9'' = 10.75\ ft.$ $\qquad r = 6.125\ ft.$

Rule 5 $\qquad End\ Area = \pi \times r \times r = 3.14 \times 6.125\ ft. \times 6.125\ ft. = 117.80\ sq.\ ft.$

Rule 17 $\qquad Volume = 117.80\ sq.\ ft. \times 10.75\ ft. = 1{,}266.35\ cu.\ ft.$

$$\frac{1{,}266.35\,cu.\ ft.}{27\,\dfrac{cu.\ ft.}{cu.\ yd.}} = \underline{\underline{46.90\,cu.\ yd.}}$$

## ROAD SALT APPLICATION

35. A snowplow operator's route covers 20 mi. one way. If the application is a salt/sand mixture at a rate of 400 lbs. per mile and his truck holds 8 tons of salt/sand, will the driver be able to make (1) complete round trip without reloading? How much salt/sand mixture will he driver use to cover his route one way?

Table 5

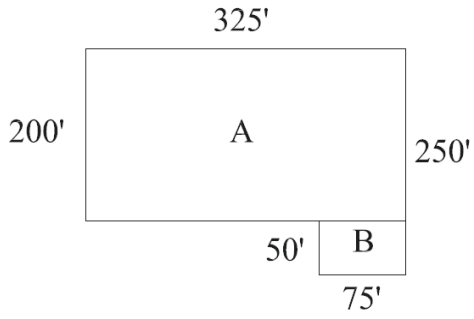
$$8\,ton \times \frac{2{,}000\,lbs.}{ton} = 16{,}000\,lbs.$$

$$a)\ 40\,mi. \times \frac{400\,lbs.}{mi.} = 16{,}000\,lbs. \Rightarrow \underline{\underline{yes}}$$

$$b)\ \frac{16{,}000\,lbs.}{2} = \underline{\underline{8{,}000\,lbs.}}$$

## GRASS SEEDING

36. How much grass seed would be required to cover the area shown below? Use an application rate of 3 lbs. per 1,000 sq. ft.




Rule 1

$$Area = Area"A" + Area"B"$$

$$= (200\,ft. \times 325\,ft.) + (50\,ft. \times 75\,ft.)$$

$$= 65{,}000\,sq.\,ft. + 3{,}750\,sq.\,ft. = 68{,}750\,sq.\,ft.$$

$$Seed = 68{,}750\,sq.\,ft. \times \frac{3\,lbs.}{1{,}000\,sq.\,ft.} = \underline{\underline{206.25\,lbs.}}$$

SHOULDER FILL

37. (a) A fill must be placed along the edge of the roadway to eliminate a sharp drop-off. Shoulders must be placed 10 ft. wide from the edge of pavement with a slope of 1-in. per ft. The fill will then be toed out at a slope of 4:1. If the ditch is to end up being 6 ft. below the edge of pavement, how far from the edge of pavement will the slope extend?

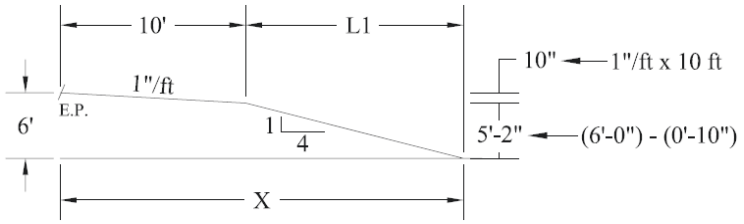


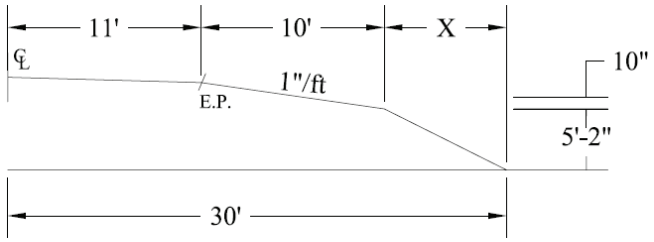

Table 3

$$5\ ft. - 2\ in. = \left( 5\ ft. + \frac{2\ in.}{12\ in./ft.} \right) = 5.167\ ft.$$

$$L_1 = 4 \times 5.167\ ft. = 20.67\ ft.$$

$$X = 10\ ft. + 20.67\ ft. = \underline{\underline{30.67\ ft.}}$$

(b) If the right-of-way will only permit putting the 6 ft. ditch 30 ft. from the centerline of the pavement, what would the slope be? (Pavement Width =22 ft.)



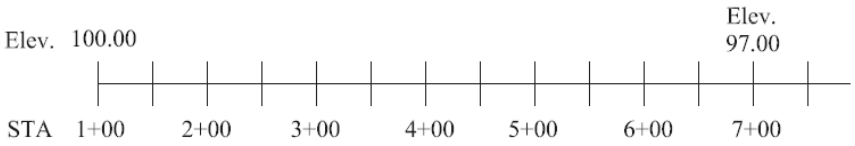

$$X = 30\ ft. - 10\ ft. - 11\ ft. = 9\ ft.$$

Rule 11

$$Slope = \frac{9\ ft.}{5\ ft. - 2\ in.} = \frac{9\ ft.}{5.167\ ft.} = \frac{1.74}{1} = \underline{\underline{1.74:1}}$$

## DITCH GRADE

38. What are the grade elevations at 50 ft. intervals for a 600 ft. ditch whose outlet end is 3 ft. lower than the inlet end? (Assume an elevation for one end of the ditch)




$$Grade = \frac{100-97}{600} = 0.005 \frac{ft.\ fall\ in\ elev.}{ft.\ of\ dist.}$$

$$Decrease\ in\ elev.\ every\ 50\ ft. = 50\ ft. \times 0.005 \frac{ft.}{ft.} = \underline{\underline{0.25\ ft.}}$$

| *STA* | | *Elev.* |
|---|---|---|
| 1 + 00 | | 100.00 *ft.* |
| 1 + 50 | 100 – 0.25 = | 99.75 *ft.* |
| 2 + 00 | 99.75 – 0.25 = | 99.50 *ft.* |
| 2 + 50 | 99.50 – 0.25 = | 99.25 *ft.* |
| 3 + 00 | 99.25 – 0.25 = | 99.00 *ft.* |
| 3 + 50 | 99.00 – 0.25 = | 98.75 *ft.* |
| 4 + 00 | 98.75 – 0.25 = | 98.50 *ft.* |
| 4 + 50 | 98.50 – 0.25 = | 98.25 *ft.* |
| 5 + 00 | 98.25 – 0.25 = | 98.00 *ft.* |
| 5 + 50 | 98.00 – 0.25 = | 97.75 *ft.* |
| 6 + 00 | 97.75 – 0.25 = | 97.50 *ft.* |
| 6 + 50 | 97.50 – 0.25 = | 97.25 *ft.* |
| 7 + 00 | 97.25 – 0.25 = | 97.00 *ft.* ← |

## CHIP & SEAL

39. If you are going to chip & seal 1.5 miles of shoulders 2.5 feet wide on both sides of the roadway, how many sq. yds. will you be treating? How many gallons of bituminous material will you need? How many cu. yds. of #8 stone will you need? How many tons of stone will you need? (Assume a bituminous material rate of 0.30 gal. per sq. yd. and a stone spread rate of 0.00083 cu. yd. per sq. yd.)


Table 3

$$Length = 1.5\,mi. \times \frac{5{,}280\ ft.}{mi.} = 7{,}920\ ft.$$

Rule 1

$$Area = 2.5\ ft. \times 7{,}920\ ft. = 19{,}800\,sq.\ ft.$$

$$\frac{19{,}800\,sq.\ ft.}{9\,\frac{sq.\ ft.}{sq.yd.}} = 2{,}200\,sq.\ yd.\ to\ be\ treated$$

$$Both\ /\ sides = 2{,}200\,sq.\ yd. \times 2 = \underline{\underline{4{,}400\ sq.\ yd.}}$$

$$Bit.\ Material = 4{,}400\,sq.\ yd. \times \frac{0.30\,gal.}{sq.\ yd.} = \underline{\underline{1{,}320\,gal.}}$$

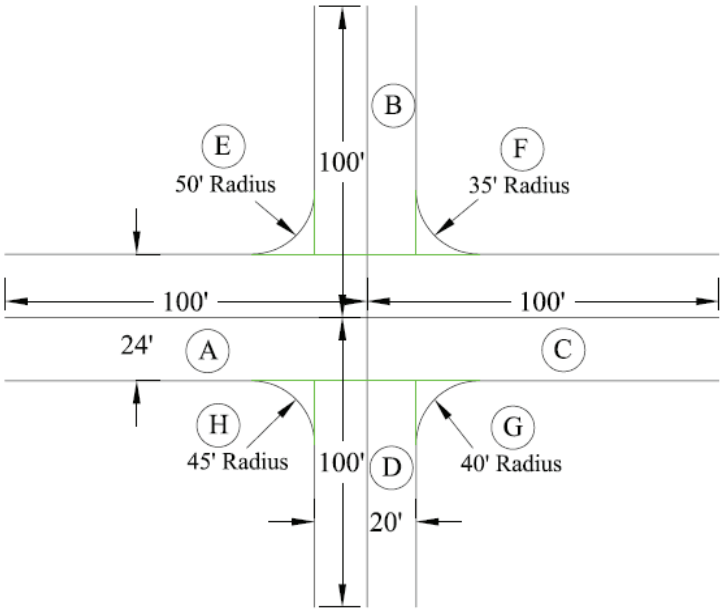
$$\#8\ stone = 4{,}400\,sq.\ yd. \times \frac{0.00083\,cu.\ yd.}{sq.\ yd.} = \underline{\underline{3.65\,cu.\ yd.}}$$

$$Weight = 3.65\,cu.\ yd. \times \frac{3{,}800\,lbs.}{cu.yd.} = 13{,}877.6\,lbs.$$

$$\frac{13{,}877.6\,lbs.}{2{,}000\,lbs./ton} = \underline{\underline{6.94\,ton}}$$

## AREA OF AN INTERSECTION

40. What is the total surface area of the intersection 100 ft. each way from the center? The east-west road is 24 ft. wide and the north-south road is 20 ft. wide.




Rule 1

$$Area_A = 100\,ft. \times 24\,ft. = 2{,}400\,sq.\,ft.$$

$$Area_B = (100\,ft. - 12\,ft.) \times 20\,ft. = 1{,}760\,sq.\,ft.$$

$$Area_C = 100\,ft. \times 24\,ft. = 2{,}400\,sq.\,ft.$$

$$Area_D = (100\,ft. - 12\,ft.) \times 20\,ft. = 1{,}760\,sq.\,ft.$$

Rule 1
Rule 5

$$Area_E = (50\,ft. \times 50\,ft.) - \frac{1}{4}(3.14 \times 50\,ft. \times 50\,ft.) = 537.50\,sq.\,ft.$$

$$Area_F = (35\,ft. \times 35\,ft.) - \frac{1}{4}(3.14 \times 35\,ft. \times 35\,ft.) = 263.38\,sq.\,ft.$$

$$Area_G = (40\,ft. \times 40\,ft.) - \frac{1}{4}(3.14 \times 40\,ft. \times 40\,ft.) = 344.00\,sq.\,ft.$$

$$Area_H = (45\,ft. \times 45\,ft.) - \frac{1}{4}(3.14 \times 45\,ft. \times 45\,ft.) = 435.38\,sq.\,ft.$$

$$\underline{\underline{Total = 9{,}900.26\,sq.\,ft.}}$$

## LIQUID CALCIUM CHLORIDE

41. Calcium chloride is stored in a tank to pre-wet truck loads of salt and/or grits. The net weight of material has to be converted to gallons for ODOT bookkeeping purposes. This is illustrated in solving the following problem:

    Five trucks hauling 8-tons of material each haul two loads during a storm. All the trucks were treated with a calcium chloride solution at the rate of 8 gallons per ton.

    If a 49,000 lb.-truck load of 30% solution @ 70° F was stored in the tank, how many gallons of solution are left after treating these truck loads of material? (Check rule 16 for Specific Gravity and Unit Weight of a gallon of solution)

$$5\,trucks \times \frac{2\,loads}{truck} = 10\,loads$$

$$10\,loads \times \frac{8\,ton}{load} = 80\,ton$$

$$80\,ton \times \frac{8\,gal.}{ton} = 640\,gal.$$

Rule 16

$$30\%\,Solution\,@\,70°F \Rightarrow Specific\,Gravity = 1.295 + 7(0.0003) = \underline{\underline{1.297}}$$

$$30\%\,Solution\,@\,70°F\,weighs\,1.297 \times 8.33 = \underline{\underline{10.80\,\frac{lbs.}{gal.}}}$$

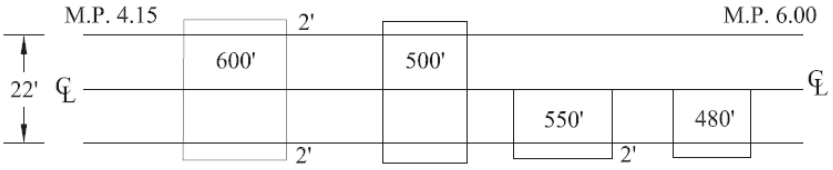
$$Gal.\,in\,truck = \frac{49{,}000\,lbs.}{10.80\,\frac{lbs.}{gal.}} = 4{,}537.04\,gal.$$

$$\#\,gal.\,remaining = 4{,}537.04\,gal. - 640\,gal. = \underline{\underline{3{,}897.04\,gal.}}$$

| | LIQUID CALCIUM CHLORIDE |
|---|---|
| | 42. Stockpiles of salt may be pre-wetted by injection with a 42% solution of calcium chloride. This material is delivered at 80° F. Lets work the same problem we just completed for the following two conditions:<br><br>1. Salt only<br>2. 50/50 mixture of salt and sand<br><br>Assume a 1,000 ton pile of salt has been treated with 48,000 lbs. of 42% solution at 80° F. Five trucks hauling 8 tons each make 2 trips. How many gallons should be deducted for each set of conditions? How many gallons are remaining in the stockpile? |
| Rule 16 | $42\%\,Solution@80°F \Rightarrow Specific\,Gravity = 1.438 - 3(0.0003)$<br><br>$= 1.437$<br><br>$Weight = 1.437 \times 8.33 \frac{lbs.}{gal.} = 11.97 \frac{lbs.}{gal.}$<br><br>$\frac{48{,}000\,lbs.}{11.97 \frac{lbs.}{gal.}} = 4{,}010.03\,gal.of\ 42\%\,solution\,used$<br><br>$and, \frac{4{,}010.03\,gal.}{1{,}000\,ton} = 4.010\,gal./ton$<br><br>$5\,trucks \times 2\,loads/truck \times 8\,tons/load = 80\,tons$<br><br>1. $Salt\,only - 80\,ton \times 4.01\,gal./ton = 320.80\,gal.$<br><br>$4{,}010.03\,gal. - 320.80\,gal. = \underline{\underline{3{,}689.23\,gal.}}$<br><br>2. $50/50\,mix - \frac{80}{2} = 40\,ton \times 4.01 \frac{gal.}{ton} = 160.40\,gal.$<br><br>$4{,}010.03\,gal. - 160.40\,gal. = \underline{\underline{3{,}849.6\,gal.}}$ |

## ASPHALT PATCHES

43. There are four bad areas between MP 4.15 and MP 6.00. Pavement is 22-ft. wide. Two of these patches are one-half width, 550 and 480 ft. long. Use 1-in. of 404 and tack the areas with 0.075 gal./sq. yd. with RS-2. How many tons of 404 asphalt (use 4,000 lbs./cu. yd.) and gallons of RS-2 will be needed? You will also need to calculate how many tons of berm stone it will take to do both sides of each full-width patch and one side of the half-width patches. Use 2-in. thick and 2-ft. wide for berm work. (Use 3,800 lbs. per cu. yd.)




Rule 3

*Asphalt*

$500\ ft. \times 22\ ft. = 11{,}000\ sq.\ ft.$
$600\ ft. \times 22\ ft. = 13{,}200\ sq.\ ft.$
$550\ ft. \times 11\ ft. = 6{,}050\ sq.\ ft.$
$480\ ft. \times 11\ ft. = 5{,}280\ sq.\ ft.$

*Berm Agg.*

$2 \times 500\ ft. = 1{,}000\ ft.$
$2 \times 600\ ft. = 1{,}200\ ft.$
$1 \times 550\ ft. = 550\ ft.$
$1 \times 480\ ft. = 480\ ft.$

Table 7

$$Sum = \frac{35{,}530\ sq.\ ft.}{9\ \frac{sq.\ ft.}{sq.\ yd.}} = 3{,}947.8\ sq.\ yd.$$

$Sum = 3{,}230\ ft.$

Rule 6
Table 4

*Asphalt*

$$35{,}530\ sq.\ ft. \times \frac{1\ in.}{12\ in./ft.} \times \frac{1}{27\ \frac{cu.\ ft.}{cu.\ yd.}} \times \frac{2\ ton}{cu.\ yd.} = \underline{\underline{219.3\ ton}}$$

*Tack*

$$3{,}947.9\ sq.\ yd. \times \frac{0.075\ gal.}{sq.\ yd.} = \underline{\underline{296.09\ gal.}}$$

Rule 6
Table 4

*Berm Agg.*

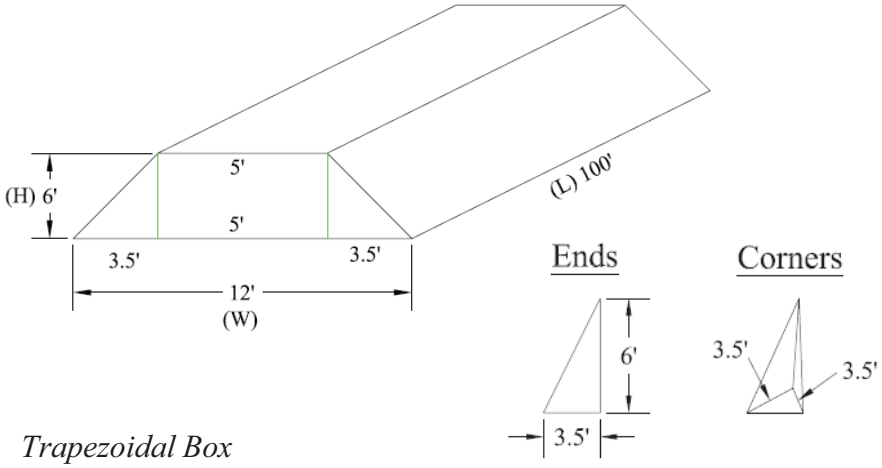
$$3{,}230\ ft. \times 2\ ft. \times \frac{2\ in.}{12\ in./ft.} = \frac{1{,}076.67\ cu.\ ft.}{27\ \frac{cu.\ ft.}{cu.\ yd.}} = 39.88\ cu.\ yd.$$

Table 5

$$39.88\ cu.\ yd. \times 3{,}800\ lbs. \times 1\ ton = \underline{\underline{75.77\ ton}}$$

## VOLUME OF STOCKPILE

44. A stockpile has a height of 6 ft. and a base of 12 ft. The width of the top is 5 ft. and the length of the stockpile is 100 ft. The slope of the ends is the same as the sides. Estimate the number of cubic yards of material in the stockpile.




*Trapezoidal Box*

Rule 8

$$Volume = \left( \frac{5\ ft. + 12\ ft.}{2} \right) \times 6\ ft. \times 100\ ft. = \underline{\underline{5{,}100\ cu.\ ft.}}$$

*Ends*

Rule 7

$$\frac{1}{2} \times 6\ ft. \times 3.5\ ft. \times 5\ ft. = 52.50\ cu.\ ft.$$

$$2\ ends \times 52.50\ cu.\ ft. = \underline{\underline{105.00\ cu.\ ft.}}$$

*Corners*

$$End\ Area = \frac{1}{2}(3.5\ ft. \times 3.5\ ft.) = 6.125\ sq.\ ft.$$

Rule 18

$$Volume = \frac{1}{3}(6.125\ sq.\ ft.) \times 6\ ft. = 12.250\ cu.\ ft.$$

$$4\ corners \times 12.250\ cu.\ ft. = \underline{\underline{49.00\ cu.\ ft.}}$$

*Total*

$$Volume = \frac{5{,}254.00\ cu.\ ft.}{27\ \frac{cu.\ ft.}{cu.\ yd.}} = \underline{\underline{194.59\ cu.\ yd.}}$$

*Note* :

*Figuring the ends and corners doesn't affect the answer much*!

## PERSON – DAYS

45. One PERSON – DAY is equivalent to eight (8) man – hours of work. How many PERSON – DAYS are represented by the following?

2 – men, 8 hours each, for one (1) day
1 – man, 3 hours each of two (2) days
3 – men, 2 hours each, for (1) day

$$2\times 8 = 16\,hr.$$
$$1\times 3\times 2 = 6\,hr.$$
$$3\times 2\times 1 = \underline{6hr.}$$
$$28\,hr.$$

$$\frac{28\,hr.}{8\,hr./PERSON-DAYS} = \underline{\underline{3.5\,PERSON-DAYS}}$$

## BRIDGE DECK REPAIR

46. A wooden bridge deck needs replaced. How many pieces of 3"x6"x20' strip floor will be required to replace the deck on a bridge, 20' wide and 30' long? Each strip will be placed on edge which is 2.5" wide.

*Assume no waste*

Rule 1

$$Deck\ Area = 20\ ft.\times 30\ ft. = 600\,sq.\ ft.$$

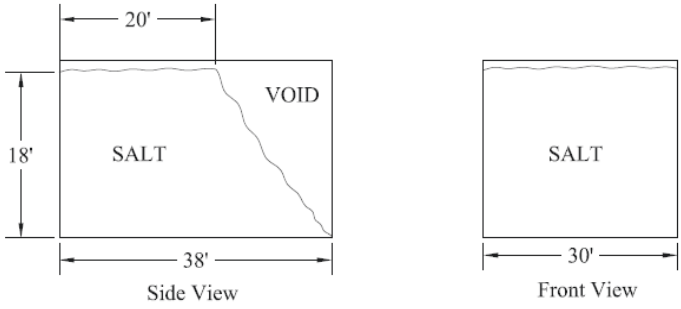
Table 3

$$Area\ per\ strip = \frac{2.5\,in.}{12\,in./ft.}\times 20\ ft. = 4.17\,sq.\ ft./strip$$

$$No.of\ strips = \frac{600\,sq.\ ft.}{4.17\,\frac{sq.\ ft.}{strip}} = 143.9 \qquad \underline{\underline{Use\ 144\,strips}}$$

## SALT SHED CAPACITY

47. What is the capacity, in tons, of the salt shed pictured below? Assume salt weighs one (1) ton per cubic yard.




Rule 7

$$Volume = \left(\frac{20\,ft. + 38\,ft.}{2}\right) \times \frac{18\,ft.}{1} \times \frac{30\,ft.}{1} \times \frac{1}{27} = 580\,cu.\,yd.$$

$$Capacity = 580\,cu.\,yd. \times {}^{1\,ton}\!/_{cu.\,yd.} = \underline{\underline{580\,ton}}$$

## CULVERT SIZES

48. Given the following combination of culvert sizes, arrange in order the culvert of combination of culverts with the largest flow capacity to the smallest.

a. 6 @ 12 in. diameter culverts
b. 2 @ 24 in. diameter culverts
c. 3 @ 18 in. diameter culverts
d. 1 @ 36 in. diameter culverts
e. 4 @ 15 in. diameter culverts

Rule 5

$$Area_a = \pi\left(\frac{12\,in.}{2}\right)^2 = 113.10\,sq.in. \times 6 = 678.6\,sq.in.$$

$$Area_b = \pi\left(\frac{24\,in.}{2}\right)^2 = 452.39\,sq.in. \times 2 = 904.8\,sq.in.$$

$$Area_c = \pi\left(\frac{18\,in.}{2}\right)^2 = 254.47\,sq.in. \times 3 = 763.4\,sq.in.$$

$$Area_d = \pi\left(\frac{36\,in.}{2}\right)^2 = 1{,}017.88\,sq.in. \times 1 = 1{,}017.88\,sq.in.$$

$$Area_e = \pi\left(\frac{15\,in.}{2}\right)^2 = 176.71\,sq.in. \times 4 = 706.8\,sq.in.$$

$$Answers: \underline{\underline{d, b, c, e, a}}$$

| | |
|---|---|
| | CRACK SEALER |
| Table 3 | 49. Convert seven (7) 60 lb. blocks of crack sealer to gallons when one gallon of crack sealer weighs 8.25 lb.<br><br>$Total\,Weight = 7 \times 60\,lbs. = 420\,lbs.$<br><br>$No.of\ gallons = \dfrac{420\,lbs.}{8.25\,lbs./gal.} = 50.91\,gal.$ $\quad \underline{\underline{Use\ 51\,gal.}}$ |
| | BERM CONDITIONING |
| | 50. Estimate the amount of material needed, in tons, for berm conditioning a 2 mile section of two – lane road. Use an average thickness of 2" and an average width of 3'. Assume a cubic yard of berm aggregate weighs 3,000 lb.<br><br>$Length = \dfrac{5{,}280\ ft.}{mi.} \times 2\,mi. = 10{,}560\ ft.$<br><br>$Thickness = \dfrac{2\,in.}{12\,in./ft.} = 0.16667\ ft.$<br><br>$\dfrac{5{,}280\,cu.\,ft.}{27\,\dfrac{cu.\,ft.}{cu.\,yd.}} \times 2\,(both\,sides) = 391.1\,cu.\,yd.$<br><br>$391.1\,cu.\,yd. \times 3{,}000\,\dfrac{lbs.}{cu.yd.} \times \dfrac{1\,ton}{2{,}000\,lbs.} = 586.7\,ton$ $\quad \underline{\underline{Use\ 587\,ton}}$ |

## MOWING

51. A highway worker mowed a 12 acre interchange using a 6 ft. mower. How many swath miles should be reported? (43,560 sq. ft. per acre – Table 7)

Problem #3

$$swath\,mile = 5{,}280\ ft. \times 5\ ft. = 26{,}400\,sq.\,ft.$$

Table 7

$$12\,acre \times 43{,}560\,\frac{sq.\,ft.}{acre} = 522{,}720\,sq.\,ft.$$

$$No.\,swath\,miles = \frac{522{,}720\,sq.\,ft.}{26{,}400\,sq.\,ft./swath\,mi.} = \underline{\underline{19.8\,swath\,mi.}}$$

## TANK CAPACITY

52. If a tank has a diameter of 6 feet and a length of 12 feet, how many gallons of liquid would it hold? Assume one cubic foot = 7.5 gallons.

Rule 17

$$Tank\,Volume = \pi\left(\frac{6\ ft.}{2}\right)^2 \times 12\ ft. = 339.29\,cu.\,ft.$$

$$No.\,of\ gal. = 339.29\,cu.\,ft. \times \frac{7.5\,gal.}{cu.\,ft.} = 2{,}544.69 \qquad \underline{\underline{Use\ 2{,}545\ gal.}}$$

CONCRETE BATCHING

53. The District Bridge Engineer would like to repair a concrete bridge and estimates that about 1.5 cubic yards of Class S concrete will be needed. Since this is a small job and will take a good bit of time to remove the deteriorated concrete and build forms, etc., it will be necessary to use a portable mixer. Mixer is designed to handle 1 sack batches. What would be the weights of material (cement, sand and limestone) needed for each batch. ODOT gives the following one (1) cubic yard batch:

(One sack = 94 lb. of cement)

Cement ---------- 715 lb.
Sand ---------- 1,260 lb.
Limestone ---------- 1,530 lb.
Water / Cement Ratio -------- 0.44

$$\frac{715\,lbs.}{94\,lbs./one-sack\,batch} = 7.6\,one-sack\,batches$$

$$Cement = \frac{715\,lbs.}{7.6\,one-sack\,batches} = \underline{\underline{94\,lbs.}}$$

$$Sand = \frac{1{,}260\,lbs.}{7.6\,one-sack\,batches} = \underline{\underline{166\,lbs.}}$$

$$Limestone = \frac{1{,}530\,lbs.}{7.6\,one-sack\,batches} = \underline{\underline{201\,lbs.}}$$

$$Water = \frac{0.44 \times 715\,lbs.}{7.6\,one-sack\,batches} = \underline{\underline{41\,lbs.}}$$

## DRAG PATCHING

54. You need to drag patch a piece of pavement that is 120' long and 10' wide with an average thickness of 2". How many tons of asphalt will you need? (One cu. yd. of asphalt weighs 2 tons)

Table 3

$$Thickness = \frac{2\,in.}{12\,in./ft.} = 0.1667\ ft.$$

Rule 6

$$Volume = 120\ ft. \times 10\ ft. \times 0.1667\ ft. = 200\,cu.\,ft.$$

Table 4

$$No.of\ cu.yd. = \frac{200\,cu.\,ft.}{27\,\frac{cu.\,ft.}{cu.\,yd.}} = 7.41\,cu.\,yd.$$

$$No.of\ tons = 7.41\,cu.\,yd. \times \frac{2\,ton}{cu.\,yd.} = 14.82\,ton \qquad \underline{\underline{Use\ 15\,ton}}$$

## CULVERT INSTALLATION

55. A 100-ft. long culvert is to be replaced at a one (1) percent grade where the inlet elevation is assumed to be 100.00 ft. What is the required outlet elevation using a lock level and ruler?

Rule 12

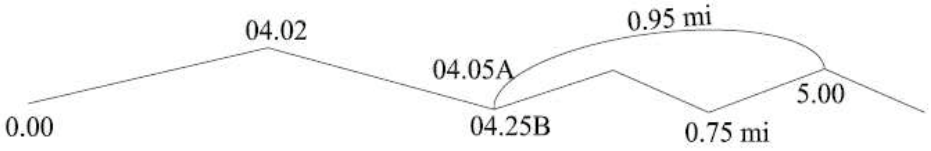
$$grade = 1\% = \frac{1}{100} = 0.01$$

$$change\ in\ elevation = 0.01 \times 100\ ft. = 1\ ft.$$

$$outlet\ elev. = 100.00\ ft. - 1.00\ ft. = \underline{\underline{99.00\ ft.}}$$

## STRAIGHT LINE MILEAGE

56. You want to calculate a mileage from the SLM book. What is the distance from Bridge No. 4.02 to a sign at SLM 5.00 when there is an equation of 4.25B = 4.05A?




$$0.23mi. + 0.95\,mi. = \underline{\underline{1.18\,mi.}}$$

This is done to keep from changing the SLM or Log Point of structures and poles, etc. At a future date, ODOT may re-inventory the road and eliminate the equation.

## EDGE LINE PAINTING

57. If it takes 16 gallons to paint one mile of 4-inch highway edge line and 6 pounds of reflective beads for each gallon of paint used, how many pounds of beads will be required for 18,480 feet of edge line?

Table 3

$$No.of\ miles = \frac{18{,}480\ ft.}{5{,}280\ \frac{ft.}{mi.}} = 3.5\,mi.$$

$$No.of\ gallons = 3.5\,mi. \times 16\,\frac{gal.}{mi.} = 56\,gal.$$

$$Pounds\ of\ beads = 56\,gal. \times 6\,\frac{lbs.}{gal.} = \underline{\underline{336\,lbs.}}$$

## ASPHALT QUANTITIES

58. You have received three tickets for asphalt placed on a driveway into the county garage. The tickets are for 20,000 lb., 24,000 lb., and 32,000 lb. Since it is a 404 gravel mix, we can assume there are 2 tons in each cubic yard of asphalt. How many cubic yards of material were placed on the driveway?

$$20{,}000 lbs. + 24{,}000 lbs. + 32{,}000 lbs. = 76{,}000 lbs.$$

$$76{,}000 lbs. \times \frac{1 ton}{2{,}000 lbs.} \times \frac{1 cu.yd.}{2 ton} = \underline{\underline{19 cu.yd.}}$$

## LANE CLOSURE

59. You need to close one lane of a 4-lane highway in a rural area. The lane is 12-ft wide and the posted speed limit is 65 mph. Determine the taper length (L) using the formula L = WS where:

W = Pavement lane width (ft.)
S = Speed (posted) in mph

$$Length = W \times S = 12\ ft. \times 65\ mph = \underline{\underline{780\ ft.}}$$

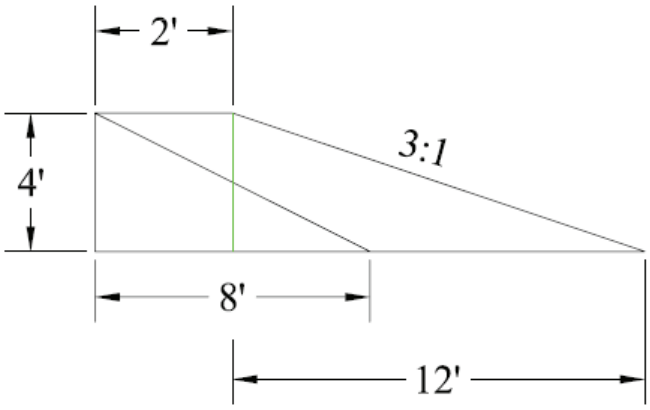
## CENTERLINE PAVEMENT MARKINGS

60. Determine the rate of application of double yellow centerline pavement markings to a pavement using the formula rate (R) = Gallons of paint (G) divided by distance of solid line in Miles (M) when 185 gallons of paint have been applied to 4.5 miles of road.

$$R = \frac{G}{M} = \frac{185 gal.}{4.5 mi.} = 41.1 \frac{gal.}{mi.} \qquad \underline{\underline{Use\ 41 \frac{gal.}{mi.}}}$$

## SHOULDER WIDENING

61. You want to add 2 feet and a 3:1 slope on to a shoulder that is 4 feet to top of ditch and a 2:1 slope now and this needs to be done for 1,000 feet. How many cubic yards of dirt will you need to make this improvement?




Rule 3

$$Total\ area = (2\ ft. \times 4\ ft.) + \frac{1}{2}(4\ ft. \times 12\ ft.) = 32\ sq.\ ft.$$

Rule 4

$$Existing = \frac{1}{2}(4\ ft. \times 8\ ft.) = 16\ sq.\ ft.$$

$$Fill = 32\ sq.\ ft. - 16\ sq.\ ft. = 16\ sq.\ ft.$$

Rule 6

$$Volume = \frac{16\ sq.\ ft. \times 1{,}000}{27\ \frac{cu.\ ft.}{cu.\ yd.}} = 593\ cu.\ yd.$$

## STRAIGHT LINE MILEAGE

62. Refer to Figure 1. (pg. 37) and Figure 2. (pg. 38) which is a map of the Cumberland area and a page from the SLM book for GUE-146. Using this information please answer the following questions:

    1. What is the SLM for the intersection of the SR 146 and the B&O Railroad? 3.91

    2. What is the distance in miles between the Corporation lines on SR 146? 1.13 mi.

    3. What is the width of the pavement surface between the Muskingum Co. line and SR 340? 20 ft.

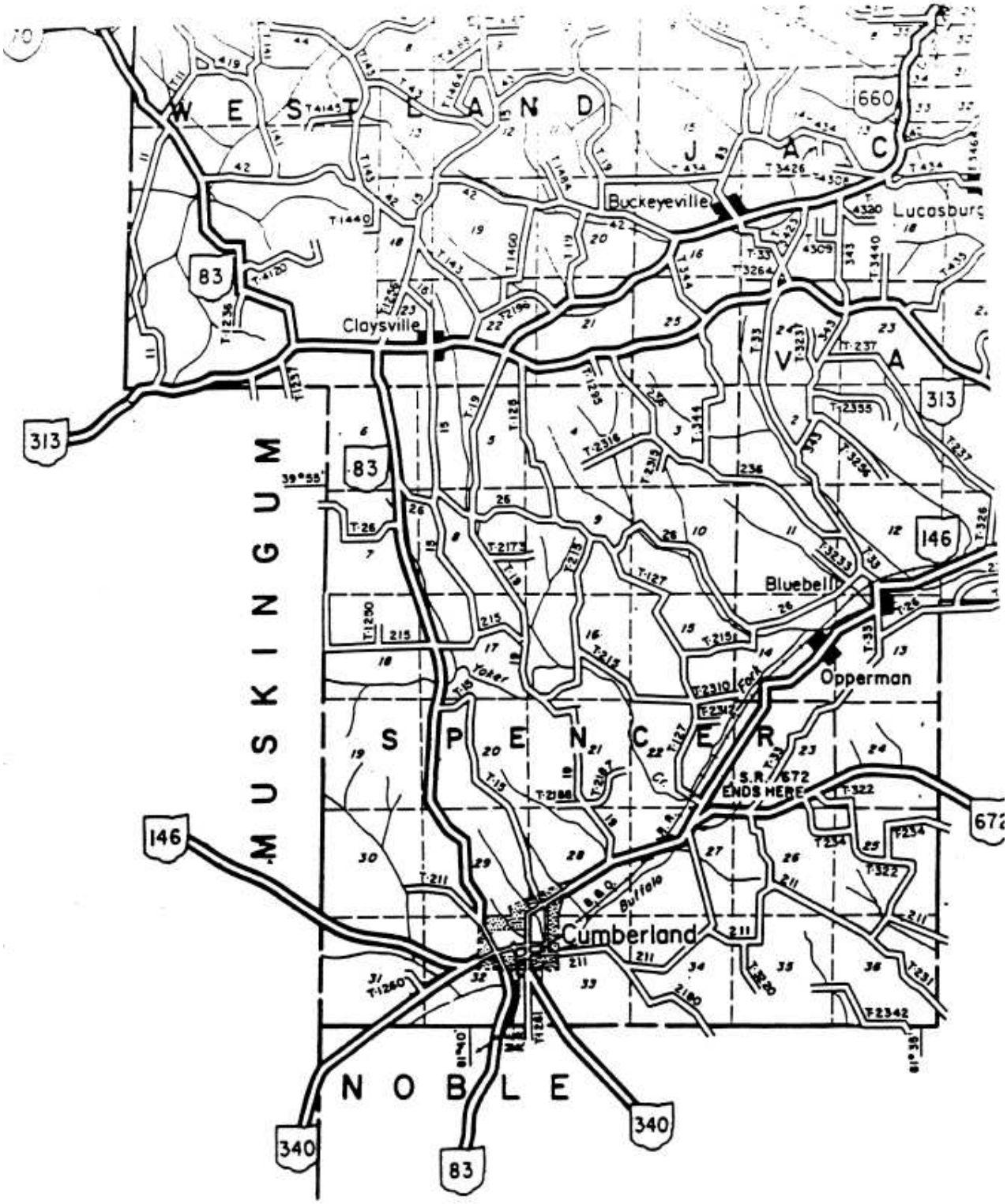
    4. What is the SLM for the intersection of SR 83 and SR 146? 1.87

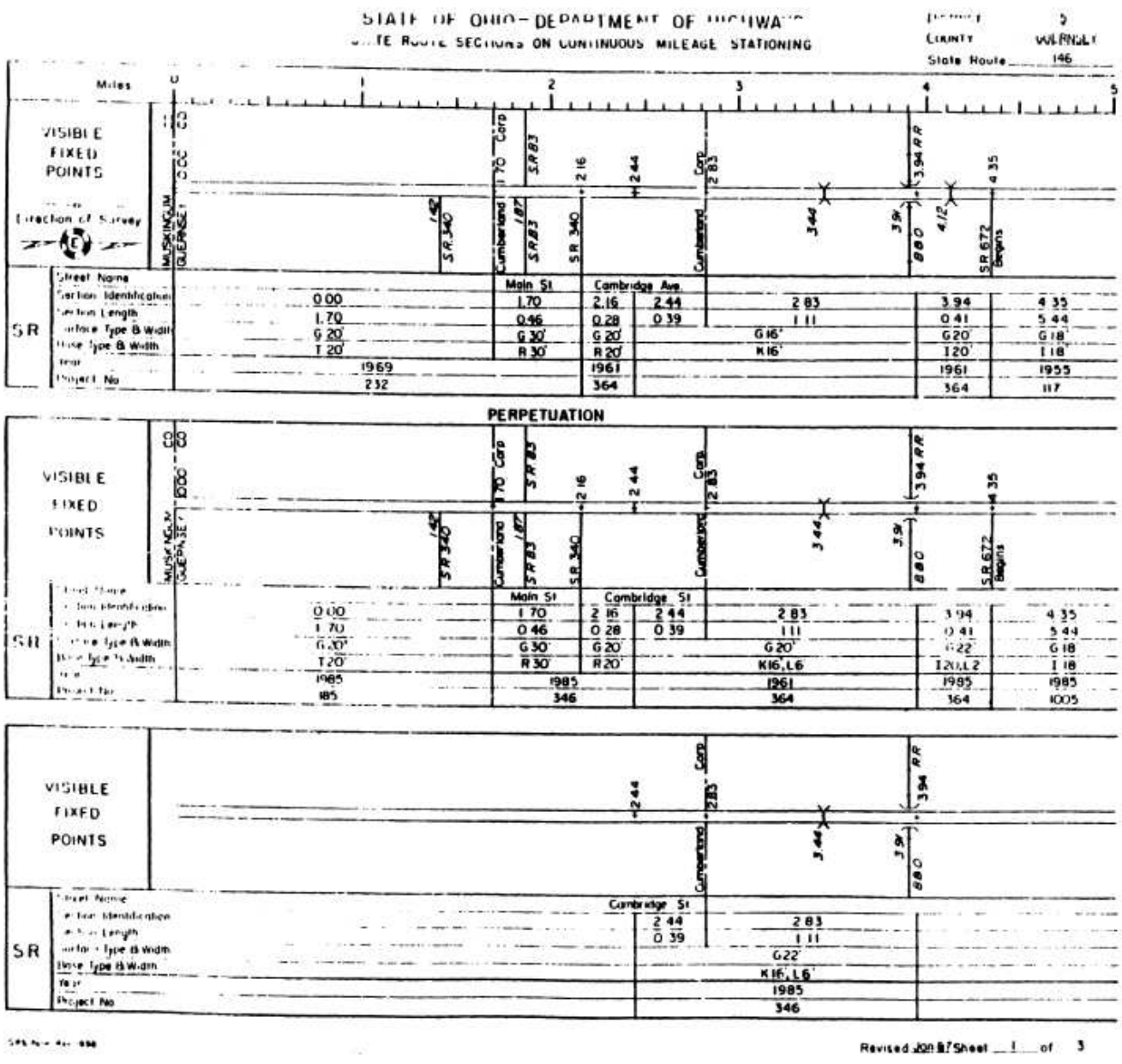
    5. What are the SLM limits for Section 0.00? 0.00 to 1.70

    6. What determines the SLM for a Section? Beginning SLM or Log Point

    7. What is the SLM of the bridge between the East Cumberland Corp. line and the B&O Railroad? 3.44

    8. Where do the 0.00 SLM's begin for East-West routes and North-South routes?
       Western most point E-W
       Southern most point N-S


WESTLAND
MUSKINGUM
SPENCER
NOBLE
Claysville
Buckeyeville
Lucasburg
Bluebell
Opperman
Cumberland
S.R. 672
ENDS HERE
Yoker
Buffalo
83
313
146
340
660
672


STATE OF OHIO – DEPARTMENT OF HIGHWAYS
STATE ROUTE SECTIONS ON CONTINUOUS MILEAGE STATIONING
County
State Route 146
Miles
VISIBLE FIXED POINTS
Direction of Survey
SR
Street Name
Section Identification
Section Length
Surface Type & Width
Base Type & Width
Year
Project No
Main St
Cambridge Ave
Cambridge St
PERPETUATION
Revised Jan 87 Sheet 1 of 3

| | |
|---|---|
| | DUMPED ROCK |
| Rule 6 | 63. Suppose you wanted to know how many tons of dumped rock you would need to fill a volume 800 feet long by 14 feet wide with an average depth of 8 feet. If the material you will use weighs about 3,700 lb a cu. yd., how many tons will be used?<br><br>$Volume = 800\,ft. \times 14\,ft. \times 8\,ft. = \dfrac{89{,}600\,cu.ft.}{27\,\dfrac{cu.ft.}{cu.yd.}} = 3{,}318.5\,cu.yd.$<br><br>$Tons = 3{,}318.5\,cu.yd. \times 3{,}700\,\dfrac{lbs.}{cu.yd.} \times \dfrac{1\,ton}{2{,}000\,lbs.} = 6{,}139.3\ tons$<br><br>$\underline{\underline{Use\ 6{,}139\,tons}}$ |
| | PURCHASE ORDER FOR ASPHALT CONCRETE |
| | 64. You have an open Purchase Order for 500 tons of asphalt concrete. If each of your trucks can haul 6 cubic yards, how many loads can you haul to complete the order? (Use conversion of 4,000 lb. a cu. yd.)<br><br>$6\,{cu.yd.}/{truck} \Rightarrow 6\,cu.yd. \times \dfrac{4{,}000\,lbs.}{cu.yd.} \times \dfrac{1\,ton}{2{,}000\,lbs.} = 12\,{ton}/{truck}$<br><br>$No.of\ trucks = \dfrac{500\,tons}{12\,\dfrac{tons}{truck}} = 41.67\,loads$<br><br>$\underline{\underline{Use\ 42\ loads}}$ |

# APPENDIX

The six most common types of measures used to estimate quantities for road work are:

- Length
- Area
- Space Volume (containers)
- Liquid Volume
- Weight
- Rate (as in gallons per square yard)

The TABLES and RULES are presented to help with the calculation of surface areas and volumes of containers or material that have three dimensions – length, breadth, and thickness. Terms such as width, height, depth, and base are also used.

# Table of Contents

APPENDIX (Pages A-1 through A-21)

# Table of Contents

APPENDIX (Continued)

# Table of Contents

APPENDIX (Continued)

## Table 1

| Abbreviations | | | |
|---|---|---|---|
| Add | + | Circumference | C |
| Subtract | - | Diameter | D |
| Multiply | × | Pi (π) | 3.14 |
| Divide | ÷ / | Radius | R |
| Ratio or Rate | / - | Length | L |
| Equal | = | Height | H |
| Percent | % | Width | W |
| Average | Avg. | Base, large | B |
| Approximate | ≈ | Base, small | b |

## Table 2

| Abbreviations | | | |
|---|---|---|---|
| Inches | in. or " | Square Inches | sq. in. |
| Feet | ft. or ' | Square Feet | sq. ft. or S.F. |
| Yards | yd. | Square Yards | sq. yd. or S.Y. |
| Miles | mi. | Acres | Ac. |
| Grams | gm. | Cubic Inches | cu. in. |
| Ounces | oz. | Cubic Feet | cu. ft. or C.F. |
| Pounds | lbs. | Cubic Yards | cu. yd. or C.Y. |
| Tons | Ton | Straight Line Mile | SLM |
| Gallons | gal. | Mile Post | MP |
| Hours | hr. | Log Point | LP |

**Table 3**

| Length Measures | | |
|---|---|---|
| Foot | Yard | Mile |
| 12 in | 36 in | 5280 ft |
| | 3 ft | 1760 yds |

**Table 4**

| Volume Measures | |
|---|---|
| Cubic Foot | Cubic Yard |
| 1728 cu. in. | 27 cu. ft. |

**Table 5**

| Weight Measures | | |
|---|---|---|
| Kilogram | Pound | Ton |
| 1000 gms | 16 oz | 2000 lbs |

**Table 6**

| Liquid Measures | |
|---|---|
| Cubic Foot | Gallon |
| 7.5 gals | 0.1337 cu. ft. |

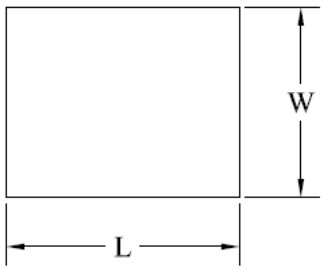
**Table 7**

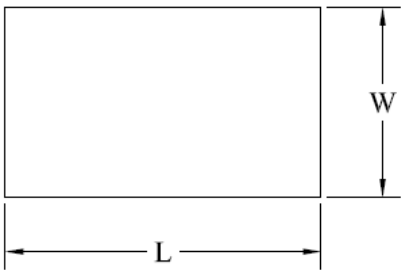
| Area Measures | | |
|---|---|---|
| Square Foot | Square Yard | Acre |
| 144 sq in | 9 sq ft | 43,560 sq ft |

**Table 8**

| Decimals | | |
|---|---|---|
| Places | Numbers | Expression |
| one | 0.1 | Tenth |
| two | 0.01 | Hundredth |
| three | 0.001 | Thousandth |
| four | 0.0001 | Ten-Thousandth |

# AREAS OF SURFACES

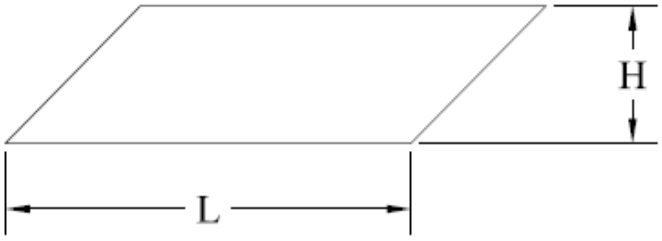



(Square or Rectangle)

Rule 1: The area (A) of a square or rectangle is calculated by multiplying the length (L) by the width (W). A = L x W

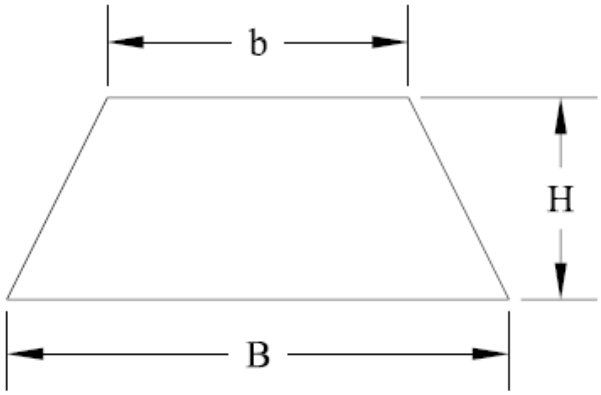
* * * * *




(Parallelogram)

Rule 2: The area (A) of a parallelogram is calculated by multiplying the length (L) times the height (H). A = L x H

# AREAS




(Trapezoid)

| Rule 3: The area (A) of a trapezoid is calculated by multiplying the height (H) times one-half the sum of the bases. A = H x ½ (B + b) |
|---|

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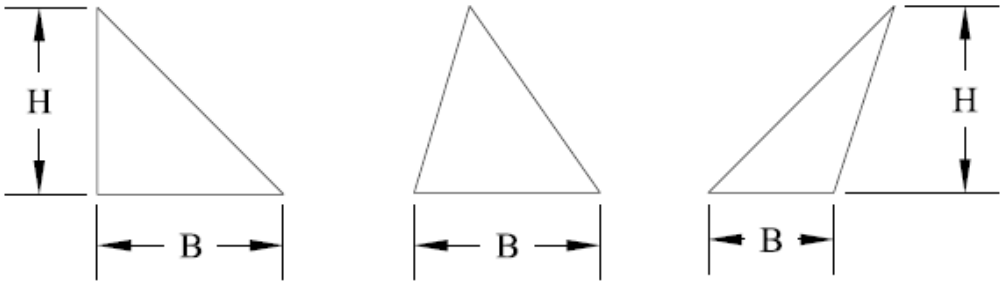
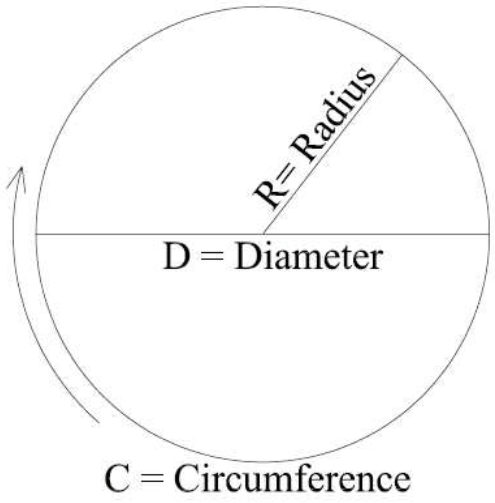



(Triangle)

| Rule 4: The area (A) of a triangle is calculated by multiplying the base (B) times the height (H) and dividing the answer by 2. A = ½ (B x H) |
|---|
| (Triangles are ½ a square, rectangle, or parallelogram.) |

# AREAS



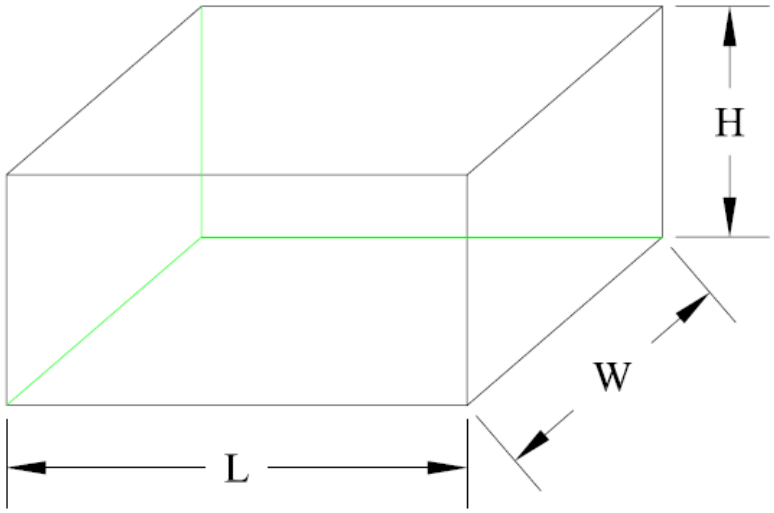

(Circle)

- Circumference is the distance around a circle
- Diameter is a straight line through the center of a circle
- Radius equals half the diameter
- Circumference = 3.14 x Diameter or 3.14 x 2 x R

Rule 5: The area (A) of a circle is calculated by multiplying 3.14 times the radius (R) times the radius (R). A = 3.14 x R x R also written as $A = 3.14R^2$ (R squared)

# VOLUMES

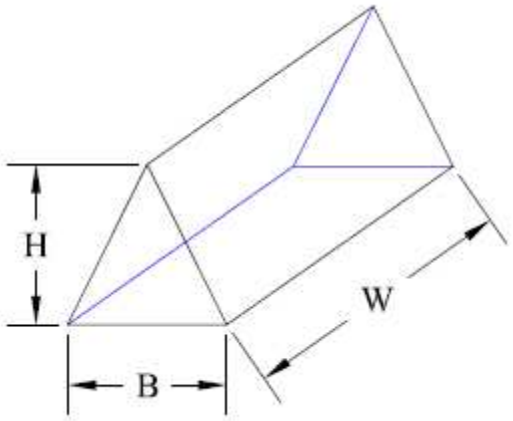
There are many shapes, the most common of which are boxes, cylinders, and cones. Rules for calculating the volumes or contents that are most used for highway maintenance and repair work are as follows:




(Rectangular Box)

Rule 6: The volume (V) of a rectangular box is calculated by multiplying the length (L) times the width (W) times the height (H). V = L x W x H. Using Rule 1 we could say the volume can be obtained by multiplying the area (L x W) x height (H).

# VOLUMES

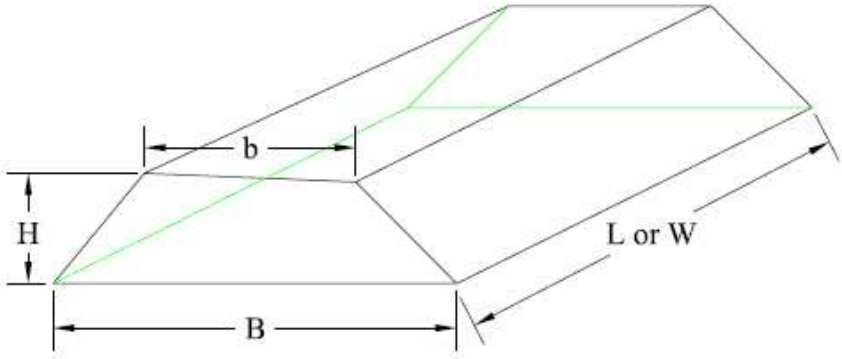



(Triangular Box)

Rule 7: The volume (V) of a triangular box is calculated by multiplying the base (B) times the width (W) and the height (H) and dividing this answer by 2.

$V = \frac{1}{2} (B \times W \times H)$

*  *  *  *  *

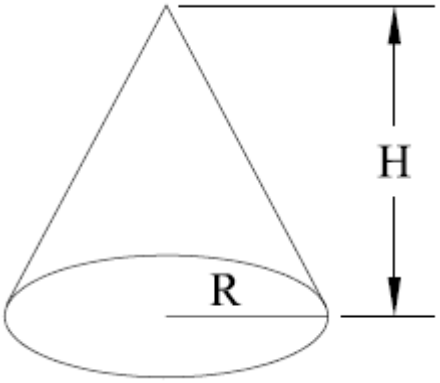



(Trapezoidal Box)

Rule 8: The volume (V) of a trapezoidal box is calculated by multiplying the area (A) of the trapezoidal side by the length (L) or width (W).

$V = \frac{1}{2} (B + b) \times H \times L$

# VOLUMES




(Cone)

Rule 9: The volume (V) of a cone is calculated by multiplying the area (A) of the base by the height of the cone and dividing by 3.

$V = 3.14 \times 1/3 (R \times R) \times H$ or

$V = 3.14 \times 1/3 (R^2) \times H$

Rule 10: $$\text{Average} = \frac{\text{Total of items added}}{\text{Number of items}}$$

Rule 11: $$\text{Slope ratio} = \frac{\text{Horizontal distance}}{\text{Vertical rise or fall}}$$

Slope ratios are expressed as 3:1, 4:1, etc., meaning 3 ft to 1 ft, 4 ft to 1 ft. The first number is the horizontal distance and the second number is the vertical distance.

Rule 12: $$\text{Percent grade} = \frac{\text{Vertical rise or fall}}{\text{Horizontal distance}} \times 100$$

Rule 13: Liquid asphalt application rate (in gallons per square yard)
$$= \frac{\text{Number of gallons used}}{\text{Area covered in square yards}}$$

Rule 14: Area covered by liquid asphalt in square yards
$$= \frac{\text{Number of gallons used}}{\text{Liquid ashpalt application rate (gal./sq.yd.)}}$$

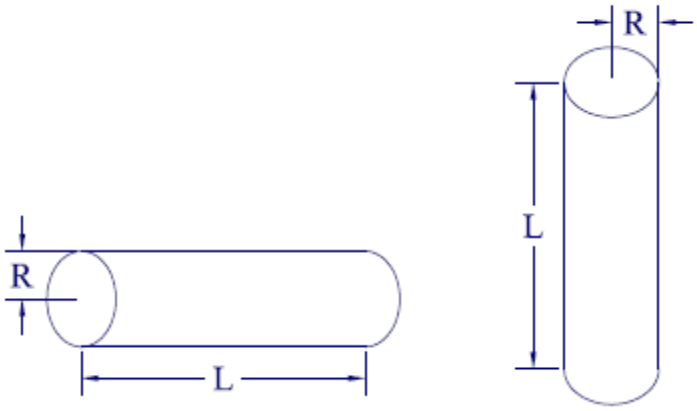
Rule 15: Area covered by deicers in square yards
$$= \frac{\text{Tons of salt x 2,000}}{\text{Salt/sand application rate (lbs./2 - lane mi)}}$$

| Rule 16: Liquid Calcium Chloride | | | | | |
|---|---|---|---|---|---|
| % Calcium Chloride Solution | Specific Gravity @ 77° F | WT lbs per Gal | % Calcium Chloride Solution | Specific Gravity @ 77° F | WT lbs per Gal |
| 30 (29.5-30.5) | 1.295 1.291-1.301 | 10.76 | 37 (35.6–37.4) | 1.379 1.374-1.384 | 11.46 |
| 31 (30.6-31.4) | 1.306 1.302-1.312 | 10.85 | 38 (37.5-38.5) | 1.391 1.385-1.397 | 11.56 |
| 32 (31.5-32.5) | 1.318 1.313-1.325 | 10.95 | 39 (38.6-39.4) | 1.403 1.398-1.408 | 11.66 |
| 33 (32.6-33.4) | 1.331 1.326-1.336 | 11.06 | 40 (39.5-40.5) | 1.415 1.409-1.421 | 11.76 |
| 34 (33.5-34.5) | 1.342 1.337-1.349 | 11.15 | 41 (40.6-41.4) | 1.426 1.422-1.431 | 11.85 |
| 35 (34.6-35.4) | 1.355 1.350-1.360 | 11.26 | 42 (41.5-42.5) | 1.438 1.432-1.444 | 11.95 |
| 36 (35.5-36.5) | 1.366 1.361-1.373 | 11.35 | | | |

NOTE: For temperatures above 77° F, subtract 0.0003 specific gravity units per degree F.

Weight = Specific Gravity x 8.33 lbs

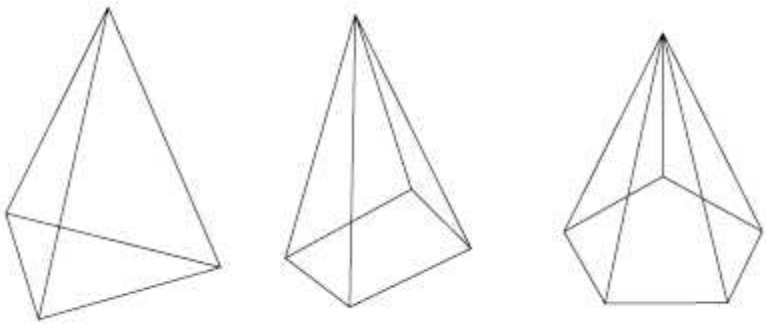
# VOLUMES




Rule 17: The volume (V) of a cylinder or tank is calculated by multiplying the area (A) of the base or end by the height (H) or length (L) of the object.

V = 3.14 x R x R x L

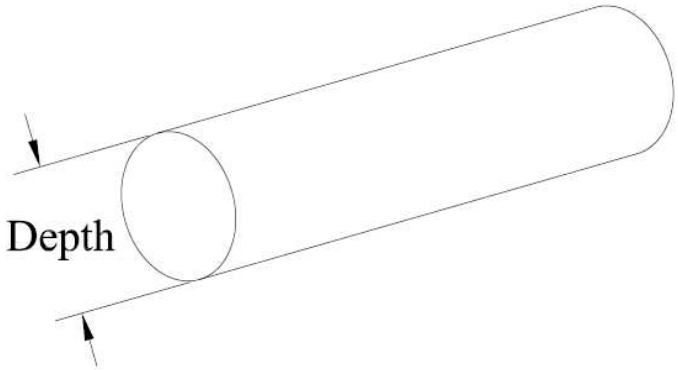
*  *  *  *  *



Rule 18: The volume of a pyramid is one-third its base area times its altitude.

| Rule 19: Estimating the number of gallons in a tank.<br>Gallons = Conversion Factor x Tank Capacity |
|---|

| Liquid Depth | Conversion Factor |
|---|---|
| 0.16D | 0.10 |
| 0.21D | 0.15 |
| 0.25D | 0.20 |
| 0.30D | 0.25 |
| 0.34D | 0.30 |
| 0.38D | 0.35 |
| 0.42D | 0.40 |
| 0.46D | 0.45 |
| 0.50D | 0.50 |
| 0.54D | 0.55 |
| 0.58D | 0.60 |
| 0.62D | 0.65 |
| 0.66D | 0.70 |
| 0.70D | 0.75 |
| 0.75D | 0.80 |
| 0.79D | 0.85 |
| 0.84D | 0.90 |
| 0.90D | 0.95 |




$$\text{LIQUID DEPTH} = \frac{\text{DEPTH FROM BOTTOM}}{\text{DEPTH OF TANK}}$$

Example: Capacity of the tank is 1,000 gallons. Depth is 4 ft. Level of liquid in the tank is 2 ft 3 in from the bottom of the tank. How many gallons are left in the tank?

Answer: Liquid depth is in terms of "D" = 2.25 ft /4 ft or 0.56D. Since we are estimating the gallons, we can use this chart two ways:

(1) 0.56D is between 0.54D and 0.58D so we use a Conversion Factor of 0.575. Gallons left in the tank = 0.575 x 1,000 or 575 gallons.

(2) Or, you could go to the nearest factor in the chart (0.60) and estimate that there are 0.60 x 1,000 or 600 gallons. If you chose to go to the lower factor of 0.55 you would get 0.55 x 1,000 or 550 gallons.

The exact answer is 576 gallons. So, you can make a good estimate by using this chart.

**Table 9**

| LINEAL FEET COVERED BY 1000 GALLON TANK | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Road Width (ft)** | **Gallons Per Square Yard** | | | | | | | |
| | **0.60** | **0.70** | **0.80** | **0.90** | **1.00** | **1.25** | **1.50** | **2.00** |
| 8' | 1,875 | 1,607 | 1,406 | 1,250 | 1,125 | 900 | 750 | 563 |
| 9' | 1,667 | 1,429 | 1,250 | 1,111 | 1,000 | 800 | 667 | 500 |
| 10' | 1,500 | 1,286 | 1,125 | 1,000 | 900 | 720 | 600 | 450 |
| 11' | 1,364 | 1,169 | 1,023 | 909 | 818 | 655 | 545 | 409 |
| 12' | 1,250 | 1,071 | 938 | 833 | 750 | 600 | 500 | 375 |
| 14' | 1,071 | 918 | 804 | 714 | 643 | 514 | 429 | 321 |
| 15' | 1,000 | 857 | 750 | 667 | 600 | 480 | 400 | 300 |
| 16' | 938 | 804 | 703 | 625 | 563 | 450 | 375 | 281 |
| 18' | 833 | 714 | 625 | 556 | 500 | 400 | 333 | 250 |
| 20' | 750 | 643 | 563 | 500 | 450 | 360 | 300 | 225 |
| 22' | 682 | 584 | 511 | 455 | 409 | 327 | 273 | 205 |
| 24' | 625 | 536 | 469 | 417 | 375 | 300 | 250 | 188 |
| 25' | 600 | 514 | 450 | 400 | 360 | 288 | 240 | 180 |
| 26' | 577 | 495 | 433 | 385 | 346 | 277 | 231 | 173 |
| 28' | 536 | 459 | 402 | 357 | 321 | 257 | 214 | 161 |
| 30' | 500 | 429 | 375 | 333 | 300 | 240 | 200 | 150 |

**Table 10**

| LINEAL FEET COVERED BY 1000 GALLON TANK | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Road Width (ft)** | **Gallons Per Square Yard** | | | | | | | | |
| | **0.10** | **0.15** | **0.20** | **0.25** | **0.30** | **0.33** | **0.35** | **0.40** | **0.50** |
| 8' | 11,250 | 7,500 | 5,625 | 4,500 | 3,750 | 3,375 | 3,214 | 2,813 | 2,250 |
| 9' | 10,000 | 6,667 | 5,000 | 4,000 | 3,333 | 3,000 | 2,857 | 2,500 | 2,000 |
| 10' | 9,000 | 6,000 | 4,500 | 3,600 | 3,000 | 2,700 | 2,571 | 2,250 | 1,800 |
| 11' | 8,182 | 5,455 | 4,091 | 3,273 | 2,727 | 2,455 | 2,338 | 2,045 | 1,636 |
| 12' | 7,500 | 5,000 | 3,750 | 3,000 | 2,500 | 2,250 | 2,143 | 1,875 | 1,500 |
| 14' | 6,429 | 4,286 | 3,214 | 2,571 | 2,143 | 1,929 | 1,837 | 1,607 | 1,286 |
| 15' | 6,000 | 4,000 | 3,000 | 2,400 | 2,000 | 1,800 | 1,714 | 1,500 | 1,200 |
| 16' | 5,625 | 3,750 | 2,813 | 2,250 | 1,875 | 1,688 | 1,607 | 1,406 | 1,125 |
| 18' | 5,000 | 3,333 | 2,500 | 2,000 | 1,667 | 1,500 | 1,429 | 1,250 | 1,000 |
| 20' | 4,500 | 3,000 | 2,250 | 1,800 | 1,500 | 1,350 | 1,286 | 1,125 | 900 |
| 22' | 4,091 | 2,727 | 2,045 | 1,636 | 1,364 | 1,227 | 1,169 | 1,023 | 818 |
| 24' | 3,750 | 2,500 | 1,875 | 1,500 | 1,250 | 1,125 | 1,071 | 938 | 750 |
| 25' | 3,600 | 2,400 | 1,800 | 1,400 | 1,200 | 1,080 | 1,039 | 900 | 720 |
| 26' | 3,462 | 2,308 | 1,731 | 1,385 | 1,154 | 1,038 | 989 | 865 | 692 |
| 28' | 3,214 | 2,143 | 1,607 | 1,286 | 1,071 | 964 | 918 | 804 | 643 |
| 30' | 3,000 | 2,000 | 1,500 | 1,200 | 1,000 | 900 | 857 | 750 | 600 |

**Table 11**

| SQUARE YARDS OF ROAD SURFACE FOR VARIOUS ROAD WIDTHS | | | |
|---|---|---|---|
| | Square Yards of Road Surface | | |
| Road Width | Per Linear Foot | Per 100 Feet | Per Mile |
| 6' | 0.67 | 66.67 | 3,520 |
| 7' | 0.78 | 77.78 | 4,107 |
| 8' | 0.89 | 88.89 | 4,693 |
| 9' | 1.00 | 100.00 | 5,280 |
| 10' | 1.11 | 111.11 | 5,867 |
| 11' | 1.22 | 122.22 | 6,453 |
| 12' | 1.33 | 133.33 | 7,040 |
| 13' | 1.44 | 144.44 | 7,627 |
| 14' | 1.56 | 155.56 | 8,213 |
| 15' | 1.67 | 166.67 | 8,800 |
| 16' | 1.78 | 177.78 | 9,387 |
| 17' | 1.89 | 188.89 | 9,973 |
| 18' | 2.00 | 200.00 | 10,560 |
| 20' | 2.22 | 222.22 | 11,733 |
| 22' | 2.44 | 244.44 | 12,907 |
| 24' | 2.67 | 266.67 | 14,080 |
| 25' | 2.78 | 277.78 | 14,667 |
| 26' | 2.89 | 288.89 | 15,253 |
| 28' | 3.11 | 311.11 | 16,427 |
| 30' | 3.33 | 333.33 | 17,600 |
| 32' | 3.56 | 355.56 | 18,773 |
| 34' | 3.78 | 377.78 | 19,947 |
| 36' | 4.00 | 400.00 | 21,120 |
| 38' | 4.22 | 422.22 | 22,293 |
| 40' | 4.44 | 444.44 | 23,467 |
| 50' | 5.56 | 555.56 | 29,333 |
| 60' | 6.67 | 666.67 | 35,200 |
| 70' | 7.78 | 777.78 | 41,067 |
| 75' | 8.33 | 833.33 | 44,000 |
| 80' | 8.89 | 888.89 | 46,933 |

**Table 12**

| NUMBER OF GALLONS IN A 1000 GALLON TANK (BASED ON PERCENT OF CAPACITY) | | | | | |
|---|---|---|---|---|---|
| **Percent of Depth** | **Percent of Capacity** | **Gallons** | **Percent of Depth** | **Percent of Capacity** | **Gallons** |
| 1 | 0.2 | 2 | 26 | 20.7 | 207 |
| 2 | 0.5 | 5 | 27 | 21.9 | 219 |
| 3 | 0.9 | 9 | 28 | 23.0 | 230 |
| 4 | 1.3 | 13 | 29 | 24.1 | 241 |
| 5 | 1.9 | 19 | 30 | 25.3 | 253 |
| 6 | 2.5 | 25 | 31 | 26.5 | 265 |
| 7 | 3.1 | 31 | 32 | 27.7 | 277 |
| 8 | 3.7 | 37 | 33 | 28.8 | 288 |
| 9 | 4.5 | 45 | 34 | 30.0 | 300 |
| 10 | 5.2 | 52 | 35 | 31.2 | 312 |
| 11 | 6.0 | 60 | 36 | 32.4 | 324 |
| 12 | 6.8 | 68 | 37 | 33.7 | 337 |
| 13 | 7.6 | 76 | 38 | 34.9 | 349 |
| 14 | 8.5 | 85 | 39 | 36.1 | 361 |
| 15 | 9.4 | 94 | 40 | 37.4 | 374 |
| 16 | 10.3 | 103 | 41 | 38.6 | 386 |
| 17 | 11.3 | 113 | 42 | 39.9 | 399 |
| 18 | 12.2 | 122 | 43 | 41.1 | 411 |
| 19 | 13.2 | 132 | 44 | 42.4 | 424 |
| 20 | 14.2 | 142 | 45 | 43.7 | 437 |
| 21 | 15.3 | 153 | 46 | 44.9 | 449 |
| 22 | 16.3 | 163 | 47 | 46.2 | 462 |
| 23 | 17.4 | 174 | 48 | 47.5 | 475 |
| 24 | 18.5 | 185 | 49 | 48.7 | 487 |
| 25 | 19.6 | 196 | 50 | 50.0 | 500 |

**Table 13**

| POUNDS OF AGGREGATE REQUIRED PER SQ.YD. FOR VARIOUS CUBIC YARD WEIGHTS | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pounds of Aggregate Per** | **Pounds of Compacted Aggregate Per Square Yard for Various Depths in Inches** | | | | | | | | | | | |
| | **1"** | **2"** | **3"** | **4"** | **5"** | **6"** | **7"** | **8"** | **9"** | **10"** | **11"** | **12"** |
| 1800 | 50 | 100 | 150 | 200 | 250 | 300 | 350 | 400 | 450 | 500 | 550 | 600 |
| 1900 | 53 | 106 | 158 | 211 | 264 | 317 | 369 | 422 | 475 | 528 | 581 | 633 |
| 2000 | 56 | 111 | 167 | 222 | 278 | 333 | 389 | 444 | 500 | 556 | 611 | 667 |
| 2100 | 58 | 117 | 175 | 233 | 292 | 350 | 408 | 467 | 525 | 583 | 642 | 700 |
| 2200 | 61 | 122 | 183 | 244 | 306 | 367 | 428 | 489 | 550 | 611 | 672 | 733 |
| 2300 | 64 | 128 | 192 | 256 | 319 | 383 | 447 | 511 | 575 | 639 | 703 | 767 |
| 2400 | 67 | 133 | 200 | 267 | 333 | 400 | 467 | 533 | 600 | 667 | 733 | 800 |
| 2500 | 69 | 139 | 208 | 278 | 347 | 417 | 486 | 556 | 625 | 694 | 761 | 833 |
| 2600 | 72 | 144 | 217 | 289 | 361 | 433 | 506 | 578 | 650 | 722 | 791 | 867 |
| 2700 | 75 | 150 | 225 | 300 | 375 | 450 | 525 | 600 | 675 | 750 | 825 | 900 |
| 2800 | 78 | 156 | 233 | 311 | 389 | 467 | 544 | 622 | 700 | 778 | 856 | 933 |
| 2900 | 81 | 161 | 242 | 322 | 403 | 483 | 564 | 644 | 725 | 806 | 886 | 967 |
| 3000 | 83 | 167 | 250 | 333 | 417 | 500 | 583 | 667 | 750 | 833 | 917 | 1000 |
| 3100 | 86 | 172 | 258 | 344 | 431 | 517 | 603 | 689 | 775 | 861 | 947 | 1033 |
| 3200 | 89 | 178 | 267 | 356 | 444 | 533 | 622 | 711 | 800 | 889 | 978 | 1067 |
| 3300 | 92 | 183 | 275 | 367 | 458 | 550 | 642 | 733 | 825 | 917 | 1008 | 1100 |
| 3400 | 94 | 189 | 283 | 378 | 472 | 567 | 661 | 756 | 850 | 944 | 1039 | 1133 |
| 3500 | 97 | 194 | 292 | 389 | 486 | 583 | 681 | 778 | 875 | 972 | 1069 | 1167 |
| 3600 | 100 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1100 | 1200 |

**Table 14**

| GALLONS OF ASPHALT REQUIRED PER MILE FOR VARIOUS RATES OF APPLICATION | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Road Width** | **Gallons Per Square Yard** | | | | | | | | | | | | | | | | |
| | **0.10** | **0.15** | **0.20** | **0.25** | **0.30** | **0.33** | **0.35** | **0.40** | **0.50** | **0.60** | **0.70** | **0.80** | **0.90** | **1.00** | **1.25** | **1.50** | **2.00** |
| 8' | 469 | 704 | 939 | 1173 | 1408 | 1564 | 1643 | 1877 | 2347 | 2816 | 3285 | 3755 | 4224 | 4693 | 5867 | 7040 | 9387 |
| 9' | 528 | 792 | 1056 | 1320 | 1584 | 1760 | 1848 | 2112 | 2640 | 3168 | 3696 | 4224 | 4752 | 5280 | 6600 | 7920 | 10560 |
| 10' | 587 | 880 | 1173 | 1467 | 1760 | 1956 | 2053 | 2347 | 2933 | 3520 | 4107 | 4693 | 5280 | 5867 | 7333 | 8880 | 11733 |
| 11' | 645 | 968 | 1291 | 1613 | 1936 | 2151 | 2259 | 2581 | 3227 | 3872 | 4517 | 5163 | 5808 | 6453 | 8067 | 9680 | 12907 |
| 12' | 704 | 1056 | 1408 | 1760 | 2112 | 2347 | 2464 | 2816 | 3520 | 4224 | 4928 | 5632 | 6336 | 7040 | 8800 | 10560 | 14080 |
| 14' | 821 | 1232 | 1643 | 2053 | 2464 | 2738 | 2875 | 3285 | 4107 | 4928 | 5749 | 6571 | 7392 | 8213 | 10267 | 12320 | 16427 |
| 15' | 880 | 1320 | 1760 | 2200 | 2640 | 2933 | 3080 | 3520 | 4400 | 5280 | 6160 | 7040 | 7920 | 8800 | 11000 | 13200 | 17600 |
| 16' | 939 | 1408 | 1877 | 2347 | 2816 | 3129 | 3285 | 3755 | 4693 | 5632 | 6571 | 7509 | 8448 | 9387 | 11733 | 14080 | 18773 |
| 18' | 1056 | 1584 | 2112 | 2640 | 3168 | 3520 | 3696 | 4224 | 5280 | 6336 | 7392 | 8448 | 9504 | 10560 | 13200 | 15840 | 21120 |
| 20' | 1173 | 1760 | 2347 | 2933 | 3520 | 3911 | 4107 | 4693 | 5867 | 7040 | 8213 | 9387 | 10560 | 11733 | 14667 | 17600 | 23467 |
| 22' | 1291 | 1936 | 2581 | 3227 | 3872 | 4302 | 4517 | 5136 | 6453 | 7744 | 9035 | 10325 | 11616 | 12907 | 16133 | 19360 | 25813 |
| 24' | 1408 | 2112 | 2816 | 3520 | 4224 | 4693 | 4928 | 5632 | 7040 | 8448 | 9856 | 11264 | 12672 | 14080 | 17600 | 21120 | 28160 |
| 25' | 1467 | 2200 | 2933 | 3667 | 4400 | 4889 | 5133 | 5867 | 7333 | 8800 | 10267 | 11733 | 13200 | 14667 | 18333 | 22000 | 29333 |
| 26' | 1525 | 2288 | 3051 | 3813 | 4576 | 5084 | 5339 | 6101 | 7627 | 9152 | 10677 | 12203 | 13728 | 15253 | 19067 | 22880 | 30507 |
| 28' | 1643 | 2464 | 3285 | 4107 | 4928 | 5476 | 5749 | 6571 | 8213 | 9856 | 11499 | 13141 | 14784 | 16427 | 20533 | 24640 | 32853 |
| 30' | 1760 | 2640 | 3520 | 4400 | 5280 | 5867 | 6160 | 7040 | 8800 | 10560 | 12320 | 14080 | 15840 | 17600 | 22000 | 26400 | 35200 |

**Table 15**

| TONS OF AGGREGATE REQUIRED PER MILE FOR VARIOUS RATES OF APPLICATION | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Width of** | **Pounds Per Square Yard** | | | | | | | | | | | | | | |
| **Area (ft)** | **3#** | **5#** | **7#** | **8#** | **10#** | **12#** | **15#** | **20#** | **25#** | **30#** | **35#** | **40#** | **45#** | **50#** | **100#** |
| 8' | 7.0 | 12 | 16 | 19 | 23 | 28 | 35 | 47 | 59 | 70 | 82 | 94 | 106 | 117 | 235 |
| 9' | 7.9 | 13 | 18 | 21 | 26 | 32 | 40 | 53 | 66 | 79 | 92 | 106 | 119 | 132 | 264 |
| 10' | 8.8 | 15 | 20 | 23 | 29 | 35 | 44 | 59 | 73 | 88 | 103 | 116 | 132 | 147 | 293 |
| 11' | 9.7 | 16 | 23 | 26 | 32 | 39 | 48 | 65 | 81 | 97 | 113 | 129 | 145 | 161 | 323 |
| 12' | 11 | 18 | 25 | 28 | 35 | 42 | 53 | 70 | 88 | 106 | 123 | 141 | 158 | 176 | 352 |
| 14' | 12 | 20 | 29 | 33 | 41 | 49 | 62 | 82 | 103 | 123 | 144 | 164 | 185 | 205 | 410 |
| 15' | 13 | 22 | 31 | 35 | 44 | 53 | 66 | 88 | 110 | 132 | 154 | 176 | 198 | 220 | 440 |
| 16' | 14 | 23 | 33 | 38 | 47 | 56 | 70 | 94 | 117 | 140 | 164 | 188 | 211 | 235 | 469 |
| 18' | 16 | 26 | 37 | 42 | 53 | 63 | 80 | 106 | 132 | 158 | 185 | 212 | 238 | 264 | 528 |
| 20' | 18 | 29 | 41 | 47 | 59 | 70 | 88 | 118 | 147 | 176 | 205 | 235 | 264 | 293 | 587 |
| 22' | 19 | 32 | 45 | 52 | 65 | 77 | 97 | 129 | 161 | 194 | 226 | 258 | 290 | 323 | 645 |
| 24' | 21 | 35 | 49 | 56 | 70 | 84 | 105 | 141 | 176 | 212 | 246 | 282 | 317 | 352 | 704 |
| 25' | 22 | 37 | 51 | 59 | 73 | 88 | 110 | 147 | 183 | 220 | 257 | 294 | 330 | 366 | 733 |
| 26' | 23 | 38 | 53 | 61 | 76 | 92 | 114 | 152 | 191 | 228 | 267 | 305 | 343 | 381 | 762 |
| 28' | 25 | 41 | 57 | 66 | 82 | 99 | 123 | 164 | 205 | 246 | 287 | 328 | 370 | 410 | 820 |
| 30' | 26 | 44 | 62 | 70 | 88 | 106 | 132 | 176 | 220 | 264 | 308 | 352 | 396 | 440 | 880 |

**Table 16**

| CUBIC YARDS OF MATERIAL REQUIRED PER 100 LINEAL FEET FOR VARIOUS LOOSE DEPTHS | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Width of** | **Cubic Yards of Loose Aggregate Required for Various Depths in Inches** | | | | | | | | | | | | | | |
| **Area (ft)** | **1/2"** | **3/4"** | **1"** | **1 1/2"** | **2"** | **2 1/2"** | **3"** | **3 1/2"** | **4"** | **4 1/2"** | **5"** | **6"** | **8"** | **10"** | **12"** |
| 8' | 1.2 | 1.9 | 2.5 | 3.7 | 4.9 | 6.2 | 7.4 | 8.6 | 9.9 | 11.1 | 12.3 | 14.8 | 19.8 | 24.7 | 29.6 |
| 9' | 1.4 | 2.1 | 2.8 | 4.2 | 5.6 | 6.9 | 8.3 | 9.7 | 11.1 | 12.5 | 13.9 | 16.7 | 22.2 | 27.8 | 33.3 |
| 10' | 1.5 | 2.3 | 3.1 | 4.6 | 6.2 | 7.7 | 9.3 | 10.8 | 12.3 | 13.9 | 15.4 | 18.5 | 24.7 | 30.9 | 37.0 |
| 11' | 1.7 | 2.5 | 3.4 | 5.1 | 6.8 | 8.5 | 10.2 | 11.9 | 13.6 | 15.3 | 17.0 | 20.4 | 27.2 | 34.0 | 40.7 |
| 12' | 1.9 | 2.8 | 3.7 | 5.6 | 7.4 | 9.3 | 11.1 | 13.0 | 14.8 | 16.7 | 18.5 | 22.2 | 29.6 | 37.0 | 44.4 |
| 14' | 2.2 | 3.2 | 4.3 | 6.5 | 8.6 | 10.8 | 13.0 | 15.1 | 17.3 | 19.4 | 21.6 | 25.9 | 34.6 | 43.2 | 51.9 |
| 15' | 2.3 | 3.5 | 4.6 | 6.9 | 9.3 | 11.6 | 13.9 | 16.2 | 18.5 | 20.8 | 23.1 | 27.8 | 37.0 | 46.3 | 55.6 |
| 16' | 2.5 | 3.7 | 4.9 | 7.4 | 9.9 | 12.3 | 14.8 | 17.3 | 19.8 | 22.2 | 24.7 | 29.7 | 39.5 | 49.4 | 59.3 |
| 18' | 2.8 | 4.2 | 5.6 | 8.3 | 11.1 | 13.9 | 16.7 | 19.4 | 22.2 | 25.0 | 27.8 | 33.3 | 44.4 | 55.6 | 66.7 |
| 20' | 3.1 | 4.6 | 6.2 | 9.3 | 12.3 | 15.4 | 18.5 | 21.6 | 24.7 | 27.8 | 30.9 | 37.0 | 49.4 | 61.7 | 74.1 |
| 22' | 3.4 | 5.1 | 6.8 | 10.2 | 13.6 | 17.0 | 20.4 | 23.8 | 27.2 | 30.6 | 34.0 | 40.7 | 54.3 | 67.9 | 81.5 |
| 24' | 3.7 | 5.6 | 7.4 | 11.1 | 14.8 | 18.5 | 22.2 | 25.9 | 29.6 | 33.3 | 37.0 | 44.4 | 59.3 | 74.1 | 88.9 |
| 25' | 3.9 | 5.8 | 7.7 | 11.6 | 15.4 | 19.3 | 23.1 | 27.0 | 30.9 | 34.8 | 38.6 | 46.3 | 61.7 | 77.2 | 92.6 |
| 26' | 4.0 | 6.0 | 8.0 | 12.0 | 16.0 | 20.1 | 24.1 | 28.1 | 32.1 | 36.1 | 40.1 | 48.1 | 64.2 | 80.2 | 96.3 |
| 28' | 4.3 | 6.5 | 8.6 | 13.0 | 17.3 | 21.6 | 26.0 | 30.2 | 34.6 | 38.9 | 43.2 | 51.9 | 69.1 | 86.4 | 103.7 |
| 30' | 4.6 | 6.9 | 9.3 | 13.9 | 18.6 | 23.1 | 27.8 | 32.4 | 37.0 | 41.7 | 46.3 | 55.6 | 74.1 | 92.6 | 111.1 |

# Updated Conversions

**Supplement added 2008**

## Linear and Conversions

12 inches = 1 foot
3 feet = 1 yard
5,280 feet = 1 mile
3,696 feet = 0.7 mile
3,168 feet = 0.6 mile
2,640 feet = 0.5 mile
2,112 feet = 0.4 mile
1,584 feet = 0.3 mile
1,056 feet = 0.2 mile
528 feet = 0.1 mile
264 feet = 0.05 mile
52.8 feet = 0.01 mile
9 square feet = 1 square yard

## Conversion Factors #1

1 centimeter = 0.39 inch
1 inch = 2.54 centimeters
1 meter = 39.37 inches
1 foot = 0.305 meter
1 meter = 3.28 feet
1 yard = 0.914 meter
1 meter = 1.094 yards
1 kilometer = 0.62 mile
1 mile = 1.609 kilometers

## Conversion Factors #2

1 milliliter = 0.034 fluid ounce
1 fluid ounce = 29.6 milliliters
1 U.S. quart = 0.946 liter
1 liter = 1.06 U.S. quarts
1 U.S. gallon = 3.8 liters
1 imperial gallon = 1.2 U.S. gallons = 4.5 liters

## Conversion Factors #3

1 short ton = 0.9 metric ton
1 metric ton = 1.1 short tons

## Other Conversion Factors

cubic feet x 0.03704 = cubic yards
cubic feet x 7.481 = gallons

cubic yards x 27= cubic feet
cubic yards x 202 = gallons

feet x 30.48 =centimeters
feet x 12 = inches
feet x 0.3048 = meters

gallons x 8 = pints
gallons x 4 = quarts

inches x 2.540 = centimeters

meters x 3.2808 = feet
meters x 39.37 = inches

meters x 1.0936 yards

miles x 5,280 = feet
miles x 1.6093 = kilometers
miles x 1760 = yards

pounds x 16 = ounces

square feet x 144 = inches
square feet x 1/9 = square yards

tons (long) x 2,240 = pounds
tons (short) x 2,000 = pounds

# U. S. - METRIC EQUIVALENTS

## LINEAR MEASURE

1 inch = 25.4 millimeters
= 2.54 centimeters

1 foot = 30.48 centimeters
= 0.3048 meter

1 yard = 0.9144 meter

1 mile = 1,609.3 meters
= 1.6093 kilometers

0.03937 inch = 1 millimeter

0.3937 inch = 1 centimeter

39.37 inches = 1 meter

3.2808 feet = 1 meter

1.0936 yards = 1 meter

3,280 feet = 1 kilometer

1,093.6 yards = 1 kilometer

0.62137 mile = 1 kilometer

# LIQUID MEASURE

1 fluid ounce = 29.573 milliliters

1 quart = 0.94635 liter

1 gallon = 3.7854 liters

33.814 fluid ounces = 1 liter

1.0567 quarts = 1 liter

## Length

### Metric System

1 millimeter = 1/1,000 meter
1 centimeter = 1/100 meter
1 kilometer = 1,000 meters

### American and British Units

1 inch = 1/36 yard = 1/12 foot
1 foot = 1/3 yard
1 yard (basic unit of length)
1 rod = 5 1/2 yards
1 mile = 1,760 yards = 5,280 feet

## Area

### American and British Units

1 square inch = 1/1,296 square yard = 1/144 square foot
1 square foot = 1/9 square yard
1 square yard (basic unit of area)
1 acre = 4,840 square yards = 160 square rods
1 square mile = 3,097,600 square yards = 640 acres

## Volume and Capacity (Liquid and Dry)

### American and British Units

1 cubic inch = 1/46,656 cubic yard = 1/1,728 cubic foot
1 cubic foot = 1/27 cubic yard
1 cubic yard (basic unit of volume)
1 U.S. fluid ounce = 1/128 U.S. gallon = 1/16 U.S. pint
1 pint = 1/8 gallon = 1/2 quart
1 quart = 1/4 gallon

## Weight (Mass)

### American and British Units: Avoirdupois

1 ounce = 1/16 pound
1 pound = 16 ounces (basic unit of weight or mass)
1 short ton = 2,000 pounds
1 long ton = 2,240 pounds

## ENGLISH TO SI (METRIC) CONVERSION FACTORS

### LENGTH

| SYMBOL | WHEN YOU KNOW | MULTIPLY BY | TO FIND | SYMBOL |
|---|---|---|---|---|
| in | inches | 25.4 | millimeters | mm |
| ft | feet | 0.3048 | meters | m |
| yd | yards | 0.9144 | meters | m |
| mi | miles | 1.609347 | kilometers | k |

### AREA

| SYMBOL | WHEN YOU KNOW | MULTIPLY BY | TO FIND | SYMBOL |
|---|---|---|---|---|
| $in^2$ | square inches | 645.16 | square millimeters | $mm^2$ |
| $ft^2$ | square feet | 0.09290304 | square meters | $m^2$ |
| $yd^2$ | square yards | 0.8361274 | square meters | $m^2$ |
| $mi^2$ | square miles | 2.589998 | square kilometers | $km^2$ |

### VOLUME

| SYMBOL | WHEN YOU KNOW | MULTIPLY BY | TO FIND$^2$ | SYMBOL |
|---|---|---|---|---|
| fl oz | fluid ounces | 29.57353 | milliliters | mL |
| gal | gallons | 3.785412 | liters | L |
| $ft^3$ | cubic feet | 0.02831685 | cubic meters | $m^3$ |
| $yd^3$ | cubic yards | 0.7645549 | cubic meters | $m^3$ |

## MASS

| SYMBOL | WHEN YOU KNOW | MULTIPLY BY | TO FIND² | SYMBOL |
|---|---|---|---|---|
| oz | ounces | 28.34952 | grams | g |
| lb | pounds | 0.4535924 | kilograms | kg |
| T | 2000 pounds | 0.9071847 | metric tons | t |

## TEMPERATURE

| SYMBOL | WHEN YOU KNOW | MULTIPLY BY | TO FIND² | SYMBOL |
|---|---|---|---|---|
| ºF | Fahrenheit | C = (F-32)/1.8 | Celsius | ºC |
| ºC | Celsius | F = 1.8C + 32 | Fahrenheit | ºF |

## SI (METRIC) TO ENGLISH CONVERSION FACTORS

### LENGTH

| Symbol | When You Know | Multiply By | To Find | Symbol |
|---|---|---|---|---|
| cm | centimeters | 0.3937 | Inches | in |
| mm | millimeters | 0.03937 | inches | in |
| m | meters | 3.28084 | feet | ft |
| m | meters | 1.093613 | yards | yd |
| km | kilometers | 0.62137 | miles | mi |

### AREA

| Symbol | When You Know | Multiply By | To Find | Symbol |
|---|---|---|---|---|
| $mm^2$ | square millimeters | 0.00155 | square inches | $in^2$ |
| $m^2$ | square meters | 10.76391 | square feet | $ft^2$ |
| $m^2$ | square meters | 1.19599 | square yards | $yd^2$ |
| $m^2$ | square meters | 0.000247 | acres | ac |
| $km^2$ | square kilometers | 0.3861 | square miles | $mi^2$ |

### VOLUME

| Symbol | When You Know | Multiply By | To Find | Symbol |
|---|---|---|---|---|
| mL | milliliters | 0.033814 | fluid ounces | fl oz |
| L | liters | 0.264172 | gallons | gal |
| $m^3$ | cubic meters | 35.31466 | cubic feet | $ft^3$ |
| $m^3$ | cubic meters | 1.30795 | cubic yard | $yd^3$ |

### MASS

| Symbol | When You Know | Multiply By | To Find | Symbol |
|---|---|---|---|---|
| g | grams | 0.035274 | ounces | oz |
| kg | kilograms | 2.204622 | pounds | lb |
| t | metric tons | 1.1023114 | 2000 pounds | T |

# WEIGHTS AND MEASURES

## U. S. SYSTEM METRIC SYSTEM

| LINEAR MEASURE | LINEAR MEASURE |
|---|---|
| 12 inches = 1 foot | 10 millimeters = 1 centimeter |
| 3 feet = 1 yard | 10 centimeters = 1 decimeter |
| 5.5 yards = 1 rod | 10 decimeters = 1 meter |
| | |
| **SQUARE MEASURE** | **SQUARE MEASURE** |
| 144 sq. inches = 1 sq. ft. | 100 sq. millimeters = 1 sq. centimeter |
| 9 sq. feet = 1 sq. yd. | 100 sq. centimeters = 1 sq. decimeter |
| 640 acres = 1 sq. mi. | 100 sq. decimeters = 1 sq. meter |
| | |
| **CUBIC MEASURE** | **CUBIC MEASURE** |
| 1,278 cu. in. = 1 cu. Ft. | 1,000 cu. millimeters = 1 cu. centimeter |
| 27 cu. ft. = 1 cu. yd. | 1,000 cu. centimeters = 1 decimeter |
| | 1,000 cu. decimeters = 1 cu. meter |
| | |
| | |
| **LIQUID MEASURE** | **LIQUID MEASURE** |
| 2 pts. = 1 qt. | 10 milliliters = 1 centiliter |
| 4 quarts = 1 gal. | 10 centiliters = 1 deciliter |
| 31 ½ gal. = 1 barrel | 10 deciliters = 1 liter |
| | 10 liters = 1 decaliter |
| | |
| **DRY MEASURE** | |
| 2 pts = 1 qt. | |
| 8 qt. = 1 peck | |
| 4 pecks = 1 bu. | |
| | |
| **FLUID MEASURE** | |
| 16 fl. ounces = 1 pt. | |
| 2 pts. = 1 qt. | |
| 4 qts. = 1 gal. | |
| | |
| | |
| **WEIGHTS** | **WEIGHTS** |
| 12 ounces = 1 pound | 10 milligrams = 1 centigram |
| | 10 centigrams = 1 decigram |
| | 10 decigrams = 1 gram |
| | 10 grams = 1 decagram |

## Examples: **Calculation Aids**

1) You are pouring a slab that is 30' by 30' and 6" thick and three footings that are 20' by 12" by 12".

First you need to put all the dimensions in the same units. I am going to choose feet. Thus the slab dimensions in feet are 30 by 30 by $^1/_2$. Hence the volume of concrete in the slab is $30 \times 30 \times {}^1/_2 = 450$ cubic feet.

One yard is three feet so a cubic yard is three feet by three feet by three feet. $3 \times 3 \times 3 = 27$ and hence 1 cubic yard is 27 cubic feet.

Thus the volume of concrete in the slab is $^{450}/_{27} = 16.7$ cubic yards.

In a similar fashion each footing has a volume of $20 \times 1 \times 1 = 20$ cubic feet

which is $^{20}/_{27} = 0.74$ cubic yards.

Thus you need $16.7 + 3 \times 0.74 = 18.92$ cubic yards.

2) Swath mile conversion for mowing operations:

If an odd shaped field is mowed, such as an infield, the swath miles can be determined by using dimensions found on the construction plans.

Area measured in acres can be converted to swath miles by multiplying the acreage by 1.65*.

For example, if a mowed field has an area of 12.68 acres, the number of swath miles would be 12.68 x 1.65 = 20.9 or 21 swath miles.

If the number of acres of a given area must be determined in the field, multiply length time width of the area to calculate number of square feet.

Divide this figure by 43,560 square feet (the number of square feet in 1 acre) to calculate the acreage of the given area. Acreage x 1.65, as in the previous example, converts to swath miles.

****Note:*** *Conversion from acres to swath miles:*
1 swath mile = .61 acre
or . . . . 1 acre = 1.65 swath mile

#3) There is a limit to how much salt can be stored in a given area. From certain facts about salt's physical characteristics, we can determine in advance how much space a known amount will occupy.

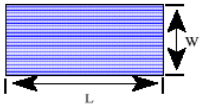
When deicing salt falls freely into a pile, it forms a cone with sides that slope at an angle of 32 degrees, salt's natural angle of repose.

The density of deicing salt ranges from 72 pounds per cubic foot loose to 84 pounds compacted. When calculating storage space requirements, use the figure 80 pounds per cubic foot or 2,160 pounds per cubic yard. Thus, a ton of salt would require 25 cubic feet of storage space.

## Area Calculations

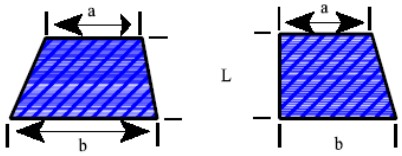
### Rectangular Area

Area (square feet) = Length (feet) x Width (feet)
To change to square yards, divide by 9



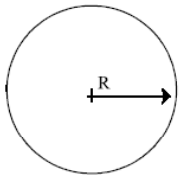

### Trapezoid Area

Width is the average of base "a" and base "b"
Width (feet) = ½ [a (feet) + b (feet)]
Area (square feet) = Length (feet) x Width (feet)
To change to square yards, divide by 9



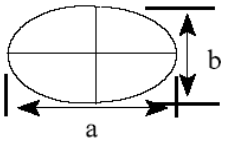

### Circular Area

The radium "R" is the imaginary line that runs from the center of the circle to the rim. To find the area of a circle in square feet, radius (feet) x radius (feet) x 3.14.
To change to square yards, divide by 9.



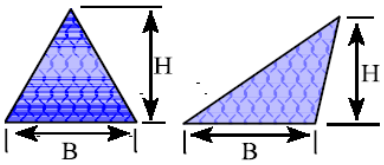

### Oval Area

Area (square feet) = ½ Length "a" (feet) x ½ Length "b" (feet) x 3.14.
To change to square yards, divide by 9.




### Triangular Area

Area (square feet) - ½ Base (feet) x Height (feet)
To change to square yards, divide by 9.



# Formula for geometric figures

## Perimeter formula

Square = 4 * side
Rectangle = 2 * (length + width)
Parallelogram = 2 * (side1 + side2)
Triangle = side1 + side2 + side3
Circle = 2 * pi * radius

## Area formula

Square = $side^2$
Rectangle = length * width
Triangle = base * height / 2
Circle = pi * $radius^2$
Cone (surface) = pi * radius * side

## Volume formula

Cube = $side^3$
Rectangular Prism = side1 * side2 * side3
Cone = (1/3) * pi * $radius^2$ * height
Pyramid = (1/3) * (base area) * height