Pacific Tank & Pipe Co.

WATER PIPE · TANKS · CYANIDE PLANTS

SAN FRANCISCO, CAL.
LOS ANGELES, CAL.
PORTLAND, ORE.

C. L. CORY

The Number of this Book is

36

HYDRAULIC DATA

BY

H. D. COALE

CHIEF ENGINEER

PACIFIC TANK & PIPE COMPANY

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PRICE, TWO DOLLARS

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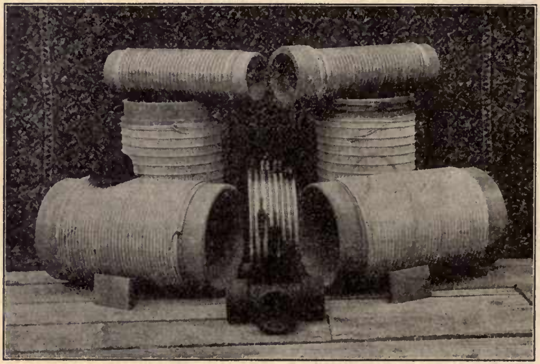
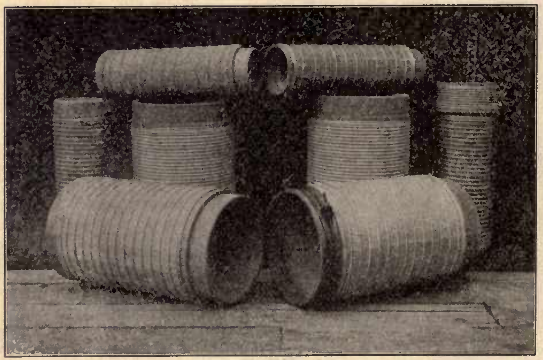




Types of Machine Banded Pipe

PREFACE

This book contains miscellaneous hydraulic information, useful engineering tables and a complete table showing the Flow of Water in WOOD PIPES of various sizes and under varying heads. It is designed not only for the use of the Engineer, but is also intended for a handy reference book for the Mayor and his Council, the Water Superintendent, the Irrigator, the Miner, in fact for anyone who has occasion to divert water from its natural channel for the purpose of domestic uses, power plants, irrigation, etc.

As a means of conveying water for all purposes, whether the quantity be merely a few gallons a minute or hundreds of cubic feet per second, WOOD PIPE is now conceded by advanced engineers and experienced laymen to be an engineering and economic success.

The flow of water in WOOD PIPE is greater, size for size, than in pipe constructed of any other kind of material.

The flow tables herein given are based as far as possible on results obtained by various experiments and may be assumed to be as nearly correct as is required in a calculation of this kind.

We have endeavored to make the tables in this book in such simple form that they can be readily understood, and in order to assist in such an understanding, examples and explanations are given where necessary.

PACIFIC TANK & PIPE COMPANY.

The Pacific Tank & Pipe Company has factories and offices at

Los Angeles, California,
San Francisco, California,
Portland, Oregon,

devoted exclusively to the manufacture and sale of

FIR AND REDWOOD PIPE,
FIR AND REDWOOD TANKS,
STEAM PIPE CASING.

Machine Banded Pipe may be purchased f. o. b. cars at our factories or f. o. b. cars at point of destination. Services of an experienced pipe foreman will be furnished if desired.

Continuous Stave Pipe may be purchased in knocked down form, or we will contract to install the pipe in place.

While this book is especially devoted to WOOD PIPE and hydraulic data, we wish to call the attention of our patrons to the fact that TANKS may be purchased in knocked down form, f. o. b. cars our factories, or f. o. b. cars at point of destination. Services of an experienced tank erector will be furnished if desired, or we will contract for the erection of both tanks and tank towers.

If interested in TANKS, STEAM PIPE CASING or WOOD PIPE, write for descriptive matter.

When writing for prices on pipe, kindly observe as closely as possible the outline on the following page, and always address our nearest office.

INFORMATION REQUIRED WITH INQUIRIES FOR MACHINE BANDED WOOD STAVE PIPE

1. The size or sizes of pipe you desire.

2. The length of each size.

3. Approximate head of each size, as follows:

Quantity	Size Pipe	Head Pressure
....	feet.........................	25 feet
....	feet.........................	50 feet
....	feet.........................	75 feet
....	feet.........................	100 feet
....	feet.........................	150 feet
....	feet.........................	200 feet
....	feet.........................	250 feet
....	feet.........................	300 feet
....	feet.........................	350 feet
....	feet.........................	400 feet

4. The quantity of water to be delivered.

5. Is your project to be a gravity, pumping or power system—what kind of pump or water wheel?

6. If possible send plans and profiles of system.

7. Name railway station at which freight is to be delivered.

INFORMATION REQUIRED WITH INQUIRIES FOR CONTINUOUS WOOD STAVE PIPE

1. The size or sizes of pipe you desire.

2. The length of each size.

3. Approximate heads of each size in variations of ten feet, and lengths for each head.

4. The quantity of water to be delivered.

5. Is your project to be a gravity, pumping or power system—what kind of pump or water wheel?

6. If possible send plans and profiles of system.

7. Name railway station at which freight is to be delivered.

TEN REASONS FOR USING WOOD PIPE

1. It is preserved by water and not rusted or corroded by it.

2. It is not corroded by sulphur, salt or mineral water and fumes.

3. It is not destroyed by acids or salts.

4. Its carrying capacity is 20% greater than cast iron pipe, and remains constant while metal pipe decreases with age.

5. It does not taint or affect fluids going through it.

6. It does not burst when frozen. The elasticity of the wood prevents bursting.

7. It requires less labor and experience to lay in place than metal pipe.

8. It can be laid in shallower ditches than metal pipe, for it is not easily affected by frosts.

9. It is cheaper than steel, wrought iron or cast iron pipe.

10. Its durability exceeds steel or wrought iron pipe, and is classed with cast iron pipe.

We manufacture Pipe and Tanks from both Douglas Fir and Redwood lumber, making a specialty of Fir at our Portland factory and Redwood at our San Francisco and Los Angeles factories.

OUR SPECIALTIES

In addition to manufacturing wooden water pipe we are manufacturers of tanks for all purposes, and other specialties enumerated below.

- Mining Tanks
- Oil Tanks
- Water Tanks
- Wine Tanks
- Solution Tanks
- Leaching Tanks
- Gold Storage Tanks
- Vacuum Settling Tanks
- Vacuum Clean-up Tanks
- Vacuum Tanks
- Sump Tanks
- Chlorination Tanks
- Rectangular Settling Tanks
- Conical Bottom Settling Tanks
- Pulp Thickener Tanks
- Agitating Tanks
- All Iron Bottom Discharge Doors
- All Iron Side Discharge Doors
- Plug Discharge Doors
- Zinc Lathes
- Improved Iron Zinc Boxes
- Wooden Zinc Boxes
- Mechanical Agitators
- Assayer's Cyanide Plants
- Small Experimental Cyanide Plants
- Cyanide Plants for both Sand and Slime Treatment
- Automatic Distributors
- Classifiers
- Cast Iron Drying Pans
- False Bottoms

Wood and Iron Towers for Elevated Tanks

COMPLETE CYANIDE PLANTS

If interested in mining or cyanide plant equipment, send for our mining catalog. This is fully illustrated and contains valuable information for the miner.

"A WORD TO ENGINEERS"

In locating wood pipe lines for irrigation, power plants, city water systems, etc., there are several points that it would be well for the engineer to consider carefully.

First—Pipe designed for heavy pressure requires a greater amount of metal than low pressure pipe thereby increasing the cost; but, in running out a ditch line, it is frequently more economical to run across a valley, gulley or even a slight depression with an inverted syphon rather than follow the contour with a ditch.

Second—As has been shown by years of experience, the life of wood pipe is materially prolonged by the saturation of the staves, we, therefore, deem it good engineering practice, in all cases where conditions will permit, to drop the grade of the pipe as quickly as possible from the intake to a grade of 25 feet, or nearly, beneath the hydraulic grade line. This insures a pipe constantly full of water and the saturation of the top staves as well as the bottom, under pressure, while at the same time it does not affect the quantity of metal and therefore does not increase the cost.

Third—At all summits in the pipe line air valves, or vents, should be placed. These may consist of automatic devices, a number of which are on the market and have proven satisfactory; or, if the pipe location is on side hill, a pipe of sufficient diameter may be laid up the hill to an elevation slightly above the hydraulic grade line, or, where necessary, above the line of static pressure.

It is especially important that an air vent be placed at the point where the pipe drops with increased gradient to reservoir or power plant so that, in case more water be drawn off at the outlet than the light gradient above can supply, a vacuum will not be caused and collapse of the pipe will thus be averted.

Fourth—In determining the pressure head for which a wood pipe shall be banded, ample allowance should be made for water hammer or surge due to pumping or rapid closing of valves. The factor of safety should be based on the maximum pressure to which the pipe can possibly be subjected. For example—a pumping line having a 45-foot lift or static head, may have a friction head of 15 feet and a possible additional head of 20 feet due to water hammer. The pipe in this case should be banded for 80-foot head.

Fifth—In drawing specifications remember that manufacturers have standard forms of construction that have been approved by engineers of ability and great experience. A deviation from standard means, usually, an increased cost and, most frequently, a product of inferior quality.

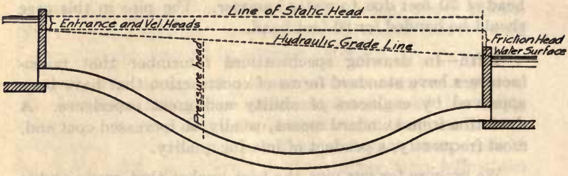
We procure for our pipe the best lumber that grows and is handled in the lumber market. The most carefully and rigidly drawn specifications cannot improve its quality.

The same is true of our other materials, steel rods, galvanized wire, cast iron, etc. They are manufactured of the best quality of raw material and are finished in the most suitable manner for the purpose for which they are intended.

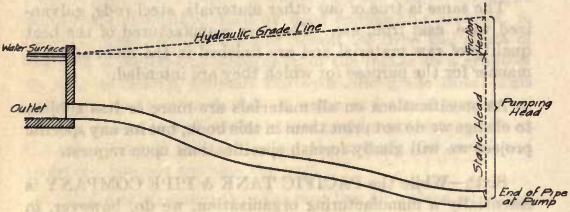
As specifications on all materials are more or less subject to change we do not print them in this book, but for any specific project we will gladly furnish specifications upon request.

Sixth—While the PACIFIC TANK & PIPE COMPANY is essentially a manufacturing organization, we do, however, in order to insure satisfaction to our customers, undertake to construct Continuous Stave Pipe in place or to lay Machine Banded Pipe in place under certain conditions, which are as follows:

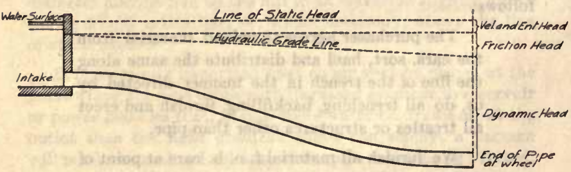
> The purchaser agrees to unload material from the cars, sort, haul and distribute the same along the line of the trench in the manner directed by us, do all trenching, backfilling, furnish and erect all trestles or structures other than pipe.
>
> We furnish all material f. o. b. cars at point of delivery and construct the pipe in place under contract, or furnish the material as above and an experienced man to superintend the construction work at a price per diem.



PROFILE OF INVERTED SYPHON



PROFILE OF LINE FOR PUMPING PLANT



PROFILE OF LINE FOR POWER PLANT

DEFINITIONS

For illustration of definitions see cuts on opposite page.

The following definitions are not, on account of space, sufficiently comprehensive to satisfy the requirements of the practicing engineer. They will, however, be of interest to those who have neither the time nor the inclination to study, more deeply, the mysteries of hydraulics.

HEAD.—The word Head as applied to pipe lines has a variety of meanings and is sometimes carelessly used by engineers and laymen. The several meanings are classified and described in the following ways:

STATIC HEAD.—The Static Head is the difference in elevation between the surface of the water at the intake and the elevation of any given point in the pipe line. From this vertical measurement, which is usually stated in feet, is obtained the internal pressure per square inch which is hereinafter described under the title of Pressure.

TOTAL HEAD.—The Total Head (sometimes called Total Fall) is the difference in elevation between the water at the intake and the surface of the water at the outlet and, in connection with gravity lines with an open end discharge, is the sum of three items, viz.: Friction Head, Velocity Head and Entrance Head, which are defined in order.

FRICTION HEAD.—Assuming a gravity line discharging into a reservoir with the discharge end under the surface of the water, the Friction Head is the difference in elevation between the surface of the water at the intake and the elevation of the water at the outlet after the sum of the Velocity Head and the Entrance Head shall have been deducted. Should the discharge pipe be above the surface of the water then the center of the discharge end should be considered rather than the surface of the water in the reservoir.

Friction Head, also known as Loss due to Friction, is the difference in pressure (resolved into feet head) between any two given points in a continuous line of pipe, the difference in pressure being due to the friction between the water and the interior surface of the pipe.

From the Friction Head is obtained the slope governing the flow of water in the pipe. This slope will be recognized under a definition given later as the Hydraulic Gradient.

VELOCITY HEAD.—The Velocity Head is a distance measured down from the surface of the water at the intake and is determined by the law of falling bodies. In order that the water in the pipe may flow with sufficient velocity to maintain the discharge for which it is designed a certain distance, or fall through space, must be utilized by the law of gravity in obtaining that velocity.

ENTRANCE HEAD.—The Entrance Head is generally assumed to be half of the Velocity Head and is due to the resistance caused by the eddies produced by the water entering the end of the pipe. This may be to a great extent overcome by using an enlarged or funnel shaped intake, but in most cases the velocity is not sufficiently great to make this item of moment. Especially is this true of long pipe lines where with a comparatively low velocity both the Entrance Head and the Velocity Head are so small that they can be omitted from consideration.

PRESSURE HEAD.—The Pressure Head is the difference in elevation between the surface of any confined body of water and any point in the container where it may be desired to ascertain the pressure. After the Pressure Head has been determined the pressure in pounds per square inch is obtained by multiplying the head in feet by .4335. The pressure in pounds per square inch at any given point is equivalent to the actual weight of a column of water one inch square and equal in height to the Pressure Head.

PUMPING HEAD.—The Pumping Head is the sum of the Static Head and the Friction Head necessary to discharge the given quantity of water.

DYNAMIC HEAD.—The Dynamic Head, or Head or Fall actually used in the production of power, is the difference in elevation between the point of discharge and the hydraulic gradient. In connection with turbine wheels the discharge point may be assumed to be the elevation of the tail water while in the case of tangential wheels the elevation of the center of the wheel should be considered.

In the design of a pipe line for a power system a certain amount of head is assumed to be lost, which is made up of the sum of the Friction Head, the Entrance Head and the Velocity Head. The remainder of the total head is the actual fall of water after all deductions have been made for the frictional and other losses and is the fall actually employed in producing power.

WORKING HEAD.—Working Head is a term frequently used and is generally misleading and therefore is not here defined.

HYDRAULIC GRADIENT OR HYDRAULIC GRADE LINE.—In the case of a pipe line having but one intake and one point of discharge, the Hydraulic Gradient is a theoretical line drawn from the surface of the water in the outlet to a point in the intake. This point is determined by measuring down from the surface of the water a distance corresponding to the sum of the Entrance Head and the Velocity Head. On the basis of the slope indicated by this line the velocity of the water is calculated.

The Hydraulic Gradient will be a broken line:

1.—If there be any change in the diameter of the pipe.

2.—If water be drawn off at a point or points other than the one point above mentioned.

3.—If any part of the pipe be constructed above a straight line drawn between the ends of the pipe.

This definition does not cover the various phases of the Hydraulic Gradient and for illustration we refer you to the drawings on page 10 and for still further information to the various engineering text books on the subject of Hydraulics.

SLOPE.—The Slope of the pipe line is obtained by dividing the Friction Head by the length of the pipe line. This result, in order to obtain the basis on which our table is calculated, must then be multiplied by 1000.

COEFFICIENT OF FRICTION or COEFFICIENT OF ROUGHNESS.—The term Coefficient of Friction as used in formulae relating to the flow of water in pipes or channels is a factor indicating the resistance due to friction caused by roughness of the surface in contact with the flowing water.

Were the element of roughness entirely eliminated, the water would fall, by its own weight, according to the natural laws of gravity. The coefficients used in the Flow Tables given in this book have been selected as representing as nearly as possible the actual condition of friction encountered in wooden pipes. It is well to bear in mind that after service of a year or two, the interior of wooden pipe is much smoother than when new, the amount of friction is correspondingly less and as a consequence the velocity and discharge are greater. On the contrary, the flow of water in metal pipe never is as great as in wooden pipe and after short service the metal pipe tuberculates and corrodes to such an extent as to greatly increase the friction and diminish the discharge.

MEAN RADIUS OR HYDRAULIC RADIUS.—The Mean (or Hydraulic) Radius is the quotient, in feet, obtained by dividing the area of wet cross-section in square feet, by the wet perimeter in feet. In pipes running full or exactly half full, and in semi-circular open channels running full, it is equal to one-fourth of the inner diameter.

WET PERIMETER.—The Wet Perimeter is the sum of the lengths, in feet, found by measuring across the channel, such parts of its sides and bottom as are in contact with the water.

EXAMPLE.—A channel 3 feet deep by 6 feet wide with water running 2 feet 6 inches deep, has a Wet Perimeter equal to 2 feet 6 inches plus 2 feet 6 inches plus 6 feet 0 inches $=$ 11 feet.

The area of wet cross-section is $2\frac{1}{2} \times 6 = 15$ square feet.

TABLE OF
SPECIFIC GRAVITIES

Water	1.00	Ivory	1.83
Sea Water	1.03	Sulphur	2.03
Alcohol	.84	Marble	2.70
Turpentine	.87	Chalk	2.50
Wine	1.00	Quartz	2.65
Milk	1.02	Glass	2.98
Cork	.24	Granite	2.72
Poplar	.38	Diamond	3.53
Cedar	.56	Zinc	7.00
Walnut	.67	Cast Iron	7.21
Cherry	.72	Tin	7.29
Maple	.75	Steel	7.83
Ash	.75	Brass	8.40
Mahogany	1.06	Copper	8.95
Oak	1.17	Silver	10.53
Ebony	1.33	Lead	11.37
Ice	.92	Mercury	13.55
Butter	.94	Gold	19.26
Coal (Anthracite)	1.50	Platinum	21.50
" (Bituminous)	1.30	Aluminum	2.56

EQUIVALENTS OF ELECTRICAL UNITS

1 Kilowatt = 1,000 watts.

1 Kilowatt = 1.34 horsepower.

1 Kilowatt = 44,240 foot-pounds per minute.

1 Kilowatt = 56.85 B. T. U. (British thermal units) per minute.

1 Horsepower = 746 watts.

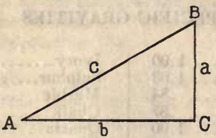
1 Horsepower = 33,000 foot-pounds per minute.

1 Horsepower = 42.41 B. T. U. per minute.

1 B. T. U = 778 foot pounds.

1 B. T. U. = 0.000293 K. W. hours.

SOLUTION OF RIGHT TRIANGLES



TO FIND A

Given	Formulae	Given	Formulae
a, b	$\tan A = \frac{a}{b}$	a, b	$\cot A = \frac{b}{a}$
a, c	$\sin A = \frac{a}{c}$	b, c	$\cos A = \frac{b}{c}$

TO FIND B

a, b	$\cot B = \frac{a}{b}$	a, b	$\tan B = \frac{b}{a}$
a, c	$\cos B = \frac{a}{c}$	b, c	$\sin B = \frac{b}{c}$

TO FIND a

A, b	$a = b \tan A$	B, c	$a = c \cos B$
A, c	$a = c \sin A$	B, b	$a = b \cot B$

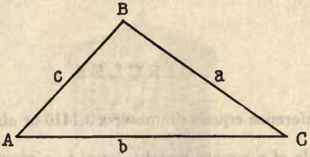
TO FIND b

A, c	$b = c \cos A$	B, c	$b = c \sin B$
A, a	$b = a \cot A$	B, a	$b = a \tan B$

TO FIND c

A, a	$c = \frac{a}{\sin A}$	B, a	$c = \frac{a}{\cos B}$
A, b	$c = \frac{b}{\cos A}$	B, b	$c = \frac{b}{\sin B}$

SOLUTION OF OBLIQUE TRIANGLES



TO FIND a, b, c

Given	Formulae	Given	Formulae
A, B, b	$a = \frac{b \sin A}{\sin B}$	C, c, a	$\sin A = \frac{a \sin C}{c}$
A, B, a	$b = \frac{a \sin B}{\sin A}$	A, a, b	$\sin B = \frac{b \sin A}{a}$
A, C, a	$c = \frac{a \sin C}{\sin A}$	A, c, a	$\sin C = \frac{c \sin A}{a}$

TO FIND A, B, C

Given	Formulae
b, c, s	$\sin \frac{1}{2} A = \sqrt{\frac{(s-c)\ (s-b)}{bc}}$
a, c, s	$\sin \frac{1}{2} B = \sqrt{\frac{(s-c)\ (s-a)}{ac}}$
a, b, s	$\sin \frac{1}{2} C = \sqrt{\frac{(s-a)\ (s-b)}{ab}}$

$$s = \frac{1}{2}(a + b + c)$$

CIRCLES

Circumference equals diameter x 3.1416 or about 3 1-7.

The side of a square equal in area to a given circle equals diameter x 0.8862.

The side of an inscribed square equals diameter x 0.7071.

The diameter of a circle equals the circumference divided by 3.1416.

The area of a circle equals the square of the diameter x 0.7854 or the square of the radius x 3.1416.

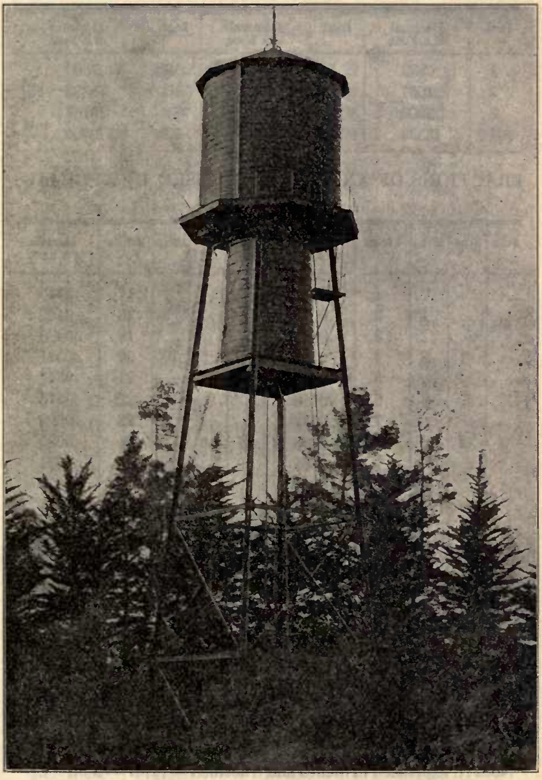
Lengths of arcs:

For 1 degree = Radius x .01745329 Log. = 8.2418774.
For 1 minute = Radius x .00029089 Log. = 6.4637261.
For 1 second = Radius x .000004848 Log. = 4.6855749.

Volume of a sphere = 4.188 x the cube of the radius, or 0.01689 x the cube of the circumference.

Area of surface of sphere:

Equals 3.1416 x the square of the diameter.
Equals 0.3183 x the square of the circumference.
Equals the diameter x the circumference.



30,000 Gallon Tank and 10,000 Gallon Secondary Tank
on 75 Foot Steel Tower

INCHES EXPRESSED IN DECIMALS OF A FOOT

Inch	Decimal of a Foot	Inch	Decimal of a Foot	Inch	Decimal of a Foot
1	.0833	5	.4167	9	.7500
2	.1667	6	.5000	10	.8333
3	.2500	7	.5833	11	.9167
4	.3333	8	.6667	12	1.0000

FRACTIONS OF AN INCH EXPRESSED IN DECIMALS OF A FOOT

4ths	8ths	16ths	32nds	Decimal of a Foot	4ths	8ths	16ths	32nds	Decimal of a Foot
....	....	....	1	.0026	....	....	....	17	.0443
....	....	1	2	.0052	....	....	9	18	.0469
....	....	....	3	.0078	....	....	....	19	.0495
....	1	2	4	.0104	....	5	10	20	.0521
....	....	....	5	.0130	....	....	....	21	.0547
....	....	3	6	.0156	....	....	11	22	.0573
....	....	....	7	.0182	....	....	....	23	.0599
1	2	4	8	.0208	3	6	12	24	.0625
....	....	....	9	.0234	....	....	....	25	.0651
....	....	5	10	.0260	....	....	13	26	.0677
....	....	....	11	.0286	....	....	....	27	.0703
....	3	6	12	.0313	....	7	14	28	.0729
....	....	....	13	.0339	....	....	....	29	.0755
....	....	7	14	.0365	....	....	15	30	.0781
....	....	....	15	.0391	....	....	....	31	.0807
2	4	8	16	.0417	4	8	16	32	.0833

EXAMPLES

3 9-32″ expressed in decimals of a foot = .2500 = 3 in.
.0234 = 0 9/32 in.
.2737 = 3 9/32 in.

.4662 ft. expressed in inches and fractions = .4167 = 5 in.
.0495 = 0 19/32 in.
.4662 = 5 19/32 in.

DECIMALS OF AN INCH FOR EACH 1/64TH

1/32ds	1/64ths	Decimal	Fraction	1/32ds	1/64ths	Decimal	Fraction
	1	.015625			33	.515625	
1	2	.03125		17	34	.53125	
	3	.046875			35	.546875	
2	4	.0625	1–16	18	36	.5625	9–16
	5	.078125			37	.578125	
3	6	.09375		19	38	.59375	
	7	.109375			39	.609375	
4	8	.125	1–8	20	40	.625	5–8
	9	.140625			41	.640625	
5	10	.15625		21	42	.65625	
	11	.171875			43	.671875	
6	12	.1875	3–16	22	44	.6875	11–16
	13	.203125			45	.703125	
7	14	.21875		23	46	.71875	
	15	.234375			47	.734375	
8	16	.25	1–4	24	48	.75	3–4
	17	.265625			49	.765625	
9	18	.28125		25	50	.78125	
	19	.296875			51	.796875	
10	20	.3125	5–16	26	52	.8125	13–16
	21	.328125			53	.828125	
11	22	.34375		27	54	.84375	
	23	.359375			55	.859375	
12	24	.375	3–8	28	56	.875	7–8
	25	.390625			57	.890625	
13	26	.40625		29	58	.90625	
	27	.421875			59	.921875	
14	28	.4375	7–16	30	60	.9375	15–16
	29	.453125			61	.953125	
15	30	.46875		31	62	.96875	
	31	.484375			63	.984375	
16	32	.5	1–2	32	64	1.	1

TABLE SHOWING DISCHARGE IN CUBIC FEET PER SECOND OF A GIVEN NUMBER OF U. S. GALLONS

Gallons	Cu. Ft. per Sec. Flowing 24 Hours	Cu. Ft. per Sec. Flowing 6 Hours	Cu. Ft. per Sec. Flowing 8 Hours	Cu. Ft. per Sec. Flowing 10 Hours	Cu. Ft. per Sec. Flowing 12 Hours
1,000,000	1.547	6.189	4.642	3.713	3.094
2,000,000	3.094	12.378	9.283	7.427	6.189
3,000,000	4.642	18.567	13.925	11.140	9.283
4,000,000	6.189	24.756	18.567	14.853	12.378
5,000,000	7.736	30.945	23.208	18.567	15.472
6,000,000	9.283	37.134	27.850	22.280	18.567
7,000,000	10.831	43.322	32.492	25.994	21.661
8,000,000	12.378	49.511	37.134	29.707	24.756
9,000,000	13.925	55.700	41.775	33.420	27.850

EXAMPLES

1. How many cubic feet of water per second will have to be discharged in order to give 35 million gallons in 24 hours?

Gals. in 24 hrs.		Cu. Ft. per Sec.
30,000,000	=	46.42
5,000,000	=	7.736
35,000,000	=	54.156 Cu. Ft. per Sec. Ans.

2. How many cubic feet of water per second will have to be discharged in order to give 72,560,000 gallons in eight hours?

Gals. in 8 hrs.		Cu. Ft. per Sec.
70,000,000	=	324.92
2,000,000	=	9.283
500,000	=	2.3208
60,000	=	.2785
72,560,000	=	336.8023 Cu. Ft. per Sec. Ans.

TABLE SHOWING DISCHARGE IN CUBIC FEET PER SECOND OF A GIVEN NUMBER OF CUBIC FEET

Cubic Feet	Cu. Ft. per Sec. Flowing 24 Hours	Cu. Ft. per Sec. Flowing 6 Hours	Cu. Ft. per Sec. Flowing 8 Hours	Cu. Ft. per Sec. Flowing 10 Hours	Cu. Ft. per Sec. Flowing 12 Hours
1000	.0116	.0463	.0347	.0278	.0231
2000	.0231	.0926	.0694	.0556	.0463
3000	.0347	.1389	.1042	.0833	.0694
4000	.0463	.1852	.1389	.1111	.0926
5000	.0579	.2315	.1736	.1389	.1157
6000	.0694	.2778	.2083	.1667	.1389
7000	.0810	.3241	.2431	.1944	.1620
8000	.0926	.3704	.2778	.2222	.1852
9000	.1042	.4167	.3125	.2500	.2083

EXAMPLE

How many cubic feet per second will give 425,800 cubic feet in six hours flow?

Cu. Ft. in 6 hours.		Cu. Ft. per sec.
400,000	=	18.52
20,000	=	.926
5,000	=	.231
800	=	.037
425,800	=	19.714 Cu. Ft. per Sec. Ans.

HYDRAULIC DATA

Gallons per day (24 hours) multiplied by .000001547 equals Cubic Feet per Second.

Cubic Feet per Second divided by .000001547 equals Gallons per day (24 hours).

A Cubic Foot of Water contains nearly 7½ gallons (7.48052) and weighs about 62½ pounds.

A Gallon of Fresh Water weighs 8.34 pounds and contains 231 cubic inches.

27154 Gallons of Water (3630 Cubic Feet) will cover one acre one inch deep.

The Miner's Inch has varying actual values in different states as follows:

One Second Foot equals 50 Miner's Inches in Utah, Idaho and Nevada.

One Second Foot equals 40 Miner's Inches in Montana and Arizona.

One Second Foot equals 38.4 Miner's Inches in Colorado.

Note.—The Miner's Inch given in the Flow Table in this book, is that generally spoken of as the California Inch, or 1/50 of one second foot, which is customarily used by miners in that State. The California statute, however, provides that the Miner's Inch shall equal 1½ cubic feet per minute, or one second foot equals 40 Miner's Inches.

One Acre Foot equals 43560 Cubic Feet = one second foot of water flowing for 12 hours and 6 minutes.

Doubling the diameter of a pipe multiplies its end area four times.

Theoretically water can be raised by suction 33 feet, but practically only 25 to 28 feet.

The amount of power developed by water flowing through a pipe may be ascertained by the following formula:

$$\text{Horse Power} = .1134HS$$

in which H equals the dynamic head in feet;

S equals the cubic feet of water per second.

This gives a strictly theoretical result and from it must be deducted from 20% to 30% to cover machine inefficiency.

Example.—50 second feet of water with 75 foot head: 75 times 50 times .1134=425. Deducting 20% for inefficiency will give 340 Horse Power.

TABLE OF EFFECTIVE FIRE STREAMS

Using 100 Feet of 2½-in. ordinary best quality rubber lined hose between nozzle and hydrant or pump.

Smooth Nozzles, Size	¾"						⅞"						1"					
Pressure at hydrants, lbs.	32	43	54	65	75	86	34	46	57	69	80	91	37	50	62	75	87	100
Pressure at nozzle, lbs...	30	40	50	60	70	80	30	40	50	60	70	80	30	40	50	60	70	80
Pres. lost in 100 ft. 2½" hose, lbs..............	2	3	4	5	5	6	4	6	7	9	10	11	7	10	12	15	17	20
Vertical height, feet.....	48	60	67	72	76	79	49	62	71	77	81	85	51	64	73	79	85	89
Horizontal distance, feet.	37	44	50	54	58	60	42	49	55	61	66	70	47	55	61	67	72	76
Gals. discharge per min..	90	104	116	127	137	147	123	142	159	174	188	201	161	186	208	228	246	263
Smooth Nozzles, Size	**1⅛"**						**1¼"**						**1⅜"**					
Pressure at hydrants, lbs.	42	56	70	84	98	112	49	65	81	97	113	129	58	77	96	116	135	154
Pressure at nozzle, lbs...	30	40	50	60	70	80	30	40	50	60	70	80	30	40	50	60	70	80
Pres. lost in 100 ft. 2½" hose, lbs..............	12	16	20	24	28	32	19	25	31	37	43	49	28	37	46	56	65	74
Vertical height, feet.....	52	65	75	83	88	92	53	67	77	85	91	95	55	69	79	87	92	97
Horizontal distance, feet.	50	59	66	72	77	81	54	63	70	76	81	85	56	66	73	79	84	88
Gals. discharge per min..	206	238	266	291	314	336	256	296	331	363	392	419	315	363	406	445	480	514

RELATIVE CAPACITY OF PIPES OF DIFFERENT DIAMETERS

This table is based on discharges of pipes having a friction head of one foot in one thousand feet as given in the Flow Table in this book.

For preliminary use only.

Dia. in ins.	2"	3"	4"	5"	6"	8"	10"	12"	14"	16"	18"	20"	22"	24"
2"	1.0	...	...	...	...	...	...	...	...	...	...	...	...	...
3"	3.0	1.0	...	...	...	...	...	...	...	...	...	...	...	...
4"	6.3	2.1	1.0	...	...	...	...	...	...	...	...	...	...	...
5"	11.0	3.9	1.8	1.0	...	...	...	...	...	...	...	...	...	...
6"	18.0	6.4	2.9	1.6	1.0	...	...	...	...	...	...	...	...	...
8"	40.0	13.0	6.2	3.5	2.1	1.0	...	...	...	...	...	...	...	...
10"	...	25.0	11.0	6.4	3.9	1.8	1.0	...	...	...	...	...	...	...
12"	...	40.0	18.0	10.0	6.2	2.9	1.6	1.0	...	...	...	...	...	...
14"	...	...	27.0	15.0	9.1	4.2	2.3	1.4	1.0	...	...	...	...	...
16"	...	...	37.0	21.0	12.0	6.0	3.2	2.0	1.4	1.0	...	...	...	...
18"	...	...	...	28.0	17.0	8.1	4.4	2.8	1.9	1.3	1.0	...	...	...
20"	...	...	...	37.0	22.0	10.0	5.8	3.6	2.5	1.8	1.3	1.0	...	...
22"	...	...	...	...	29.0	13.0	7.4	4.7	3.2	2.3	1.6	1.3	1.0	...
24"	...	...	...	...	36.0	17.0	9.3	5.9	4.0	2.8	2.1	1.6	1.2	1.0
26"	...	...	...	...	45.0	21.0	11.0	7.2	4.9	3.5	2.6	1.9	1.5	1.2
28"	...	...	...	...	...	25.0	14.0	8.7	5.9	4.2	3.1	2.3	1.8	1.4
30"	...	...	...	...	...	30.0	16.0	10.0	7.0	5.0	3.7	2.8	2.2	1.7
32"	...	...	...	...	...	35.0	19.0	12.0	8.3	5.9	4.3	3.3	2.6	2.0
34"	...	...	...	...	...	41.0	22.0	14.0	9.6	6.9	5.0	3.8	3.0	2.4
36"	...	...	...	...	...	47.0	26.0	16.0	11.0	7.9	5.8	4.4	3.5	2.8
38"	...	...	...	...	...	...	30.0	19.0	13.0	9.1	6.7	5.1	4.0	3.2
40"	...	...	...	...	...	...	34.0	21.0	14.0	10.0	7.6	5.8	4.5	3.6
42"	...	...	...	...	...	...	39.0	24.0	16.0	12.0	8.7	6.7	5.2	4.1
44"	...	...	...	...	...	...	44.0	27.0	18.0	13.0	9.9	7.5	5.9	4.7
46"	...	...	...	...	...	...	...	31.0	21.0	15.0	11.0	8.5	6.6	5.3
48"	...	...	...	...	...	...	...	34.0	23.0	16.0	12.0	9.4	7.3	5.9

To illustrate this table it may be seen that the discharge from one 10-inch pipe is equivalent to the discharge from eleven 4-inch pipes.

TABLE FOR WEIR MEASUREMENT

Computed from formula by Wm. Kent, A. M., M. E., 1899, giving Cubic Feet of Water per minute that will flow over a Weir one inch wide and from ⅛ to 20⅞ inches deep.

Depth in inches	cu. ft.	⅛" cu. ft.	¼" cu. ft.	⅜" cu. ft.	½" cu. ft.	⅝" cu. ft.	¾" cu. ft.	⅞" cu. ft.
0	.00	.01	.05	.09	.14	.19	.26	.32
1	.40	.47	.55	.64	.73	.82	.92	1.02
2	1.13	1.23	1.35	1.46	1.58	1.70	1.82	1.95
3	2.07	2.21	2.34	2.48	2.61	2.76	2.90	3.05
4	3.20	3.35	3.50	3.66	3.81	3.97	4.14	4.30
5	4.47	4.64	4.81	4.98	5.15	5.33	5.51	5.69
6	5.87	6.06	6.25	6.44	6.62	6.82	7.01	7.21
7	7.40	7.60	7.80	8.01	8.21	8.42	8.63	8.83
8	9.05	9.26	9.47	9.69	9.91	10.13	10.35	10.57
9	10.80	11.02	11.25	11.48	11.71	11.94	12.17	12.41
10	12.64	12.88	13.12	13.36	13.60	13.85	14.09	14.34
11	14.59	14.84	15.09	15.34	15.59	15.85	16.11	16.36
12	16.62	16.88	17.15	17.41	17.67	17.94	18.21	18.47
13	18.74	19.01	19.29	19.56	19.84	20.11	20.39	20.67
14	20.95	21.23	21.51	21.80	22.08	22.37	22.65	22.94
15	23.23	23.52	23.82	24.11	24.40	24.70	25.00	25.30
16	25.60	25.90	26.20	26.50	26.80	27.11	27.42	27.72
17	28.03	28.34	28.65	28.97	29.28	29.59	29.91	30.22
18	30.54	30.86	31.18	31.50	31.82	32.15	32.47	32.80
19	33.12	33.45	33.78	34.11	34.44	34.77	35.10	35.44
20	35.77	36.11	36.45	36.78	37.12	37.46	37.80	38.15

Example Showing the Application of the above Table.

Suppose the Weir to be 60 inches long, and the depth of water on it to be 5½ inches. Follow down the left-hand column of the figures in the table until you come to 5 inches. Then run across the table on a line with the 5, until under ½ on top line, and you will find 5.15. This multiplied by 60, the length of Weir, gives 309, the number of cubic feet of water passing per minute, and this multiplied by 7½ will give the gallons—2317½.

CONTENTS OF ROUND TANKS IN U. S. GALLONS AND CUBIC FEET

For One Foot in Depth

Dia. of Tanks	No. U. S. Gals.	Cubic Ft. and Area in Sq. Ft.	Dia. of Tanks	No. U. S. Gals.	Cubic Ft. and Area in Sq. Ft.	Dia. of Tanks	No. U. S. Gals.	Cubic Ft. and Area in Sq. Ft.
1 ft.	5.87	.785	4 ft.	94.00	12.566	9 ft.	475.89	63.62
1 in.	6.89	.922	1 in.	97.96	13.095	3 in.	502.70	67.20
2	8.00	1.069	2	102.00	13.635	6	530.24	70.88
3	9.18	1.227	3	106.12	14.186	9	558.51	74.66
4	10.44	1.396	4	110.32	14.748			
5	11.79	1.576	5	114.61	15.321	10	587.52	78.54
6	13.22	1.767	6	118.97	15.90	3	617.26	82.52
7	14.73	1.969	7	123.42	16.50	6	647.74	86.59
8	16.32	2.182	8	127.95	17.10	9	678.95	90.76
9	17.99	2.405	9	132.56	17.72			
10	19.75	2.640	10	137.25	18.35	11	710.90	95.03
11	21.58	2.885	11	142.02	18.99	3	743.58	99.40
						6	776.99	103.87
2	23.50	3.142	5	146.88	19.63	9	811.14	108.43
1	25.50	3.409	1	151.82	20.29			
2	27.58	3.687	2	156.83	20.97	12	846.03	113.10
3	29.74	3.976	3	161.93	21.65	3	881.65	117.86
4	31.99	4.276	4	167.12	22.34	6	918.00	122.72
5	34.31	4.587	5	172.38	23.04	9	955.09	127.68
6	36.72	4.909	6	177.72	23.76			
7	39.21	5.241	7	183.15	24.48	13	992.91	132.73
8	41.78	5.585	8	188.66	25.22	3	1031.50	137.89
9	44.43	5.940	9	194.25	25.97	6	1070.80	143.14
10	47.16	6.305	10	199.92	26.73	9	1110.80	148.49
11	49.98	6.681	11	205.67	27.49			
						14	1151.50	153.94
3	52.88	7.069	6	211.51	28.27	3	1193.00	159.48
1	55.86	7.467	3	229.50	30.68	6	1235.30	165.13
2	58.92	7.876	6	248.23	33.18	9	1278.20	170.87
3	62.06	8.296	9	267.69	35.78			
4	65.28	8.727	7	287.88	38.48	15	1321.90	176.71
5	68.58	9.168	3	308.81	41.28	3	1366.40	182.65
6	71.97	9.621	6	330.48	44.18	6	1411.50	188.69
7	75.44	10.085	9	352.88	47.17	9	1457.40	194.83
8	78.99	10.559						
9	82.62	11.045	8	376.01	50.27	16	1504.10	201.06
10	86.33	11.541	3	399.88	53.46	3	1551.40	207.39
11	90.13	12.048	6	424.48	56.75	6	1599.50	213.82
			9	449.82	60.13	9	1648.40	220.35

CONTENTS OF ROUND TANKS IN U. S. GALLONS AND CUBIC FEET

For One Foot in Depth

Dia. of Tanks	No. U. S. Gals.	Cubic Ft. and Area in Sq. Ft.	Dia. of Tanks	No U. S. Gals.	Cubic Ft. and Area in Sq. Ft.	Dia. of Tanks	No. U. S. Gals.	Cubic Ft. and Area in Sq. Ft.
17 ft.	1697.9	226.98	**23** ft.	3108.0	415.48	**29** ft.	4941.0	660.52
3 in.	1748.2	233.71	3 in.	3175.9	424.56	3 in.	5026.6	671.96
6	1799.3	240.53	6	3244.6	433.74	6	5112.9	683.49
9	1851.1	247.45	9	3314.0	443.01	9	5199.9	695.13
18	1903.6	254.47	**24**	3384.1	452.39	**30**	5287.7	706.86
3	1956.8	261.59	3	3455.0	461.86	3	5376.2	718.69
6	2010.8	268.80	6	3526.6	471.44	6	5465.4	730.62
9	2065.5	276.12	9	3598.9	481.11	9	5555.4	742.64
19	2120.9	283.53	**25**	3672.0	490.87	**31**	5646.1	754.77
3	2177.1	291.04	3	3745.8	500.74	3	5737.5	766.99
6	2234.0	298.65	6	3820.3	510.71	6	5829.7	779.31
9	2291.7	306.35	9	3895.6	520.77	9	5922.6	791.73
20	2350.1	314.16	**26**	3971.6	530.93	**32**	6016.2	804.25
3	2409.2	322.06	3	4048.4	541.19	3	6110.6	816.86
6	2469.1	330.06	6	4125.9	551.55	6	6205.7	829.58
9	2529.6	338.16	9	4204.1	562.00	9	6301.5	842.39
21	2591.0	346.36	**27**	4283.0	572.56	**33**	6397.6	855.30
3	2653.0	354.66	3	4362.7	583.21	3	6495.0	868.31
6	2715.8	363.05	6	4443.1	593.96	6	6593.0	881.42
9	2779.3	371.54	9	4524.3	604.81	9	6691.7	894.62
22	2843.6	380.13	**28**	4606.2	615.75	**34**	6791.3	907.92
3	2908.6	388.82	3	4688.8	626.80	3	6891.5	921.32
6	2974.3	397.61	6	4772.1	637.94	6	6992.5	934.82
9	3040.8	406.49	9	4856.2	649.18	9	7094.1	948.42

To find the capacity of tanks greater than the largest given in the table, look in the table for a tank of one-half of the given size, and multiply its capacity by 4, or one of one-third its size, and multiply its capacity by 9, etc.

PRESSURE OF WATER

Head in feet	Pressure in lbs. per sq. inch	Head in feet	Pressure in lbs. per sq. inch	Head in feet	Pressure in lbs. per sq. inch	Head in feet	Pressure in lbs. per sq. inch
1	0.43	42	18.21	83	35.98	124	53.75
2	0.87	43	18.64	84	36.41	125	54.19
3	1.30	44	19.07	85	36.85	126	54.62
4	1.73	45	19.51	86	37.28	127	55.06
5	2.17	46	19.94	87	37.72	128	55.49
6	2.60	47	20.37	88	38.15	129	55.92
7	3.03	48	20.81	89	38.58	130	56.36
8	3.47	49	21.24	90	39.02	131	56.79
9	3.90	50	21.68	91	39.45	132	57.22
10	4.34	51	22.11	92	39.88	133	57.66
11	4.77	52	22.54	93	40.32	134	58.09
12	5.20	53	22.98	94	40.75	135	58.52
13	5.64	54	23.41	95	41.18	136	58.96
14	6.07	55	23.84	96	41.62	137	59.39
15	6.50	56	24.28	97	42.05	138	59.82
16	6.94	57	24.71	98	42.48	139	60.26
17	7.37	58	25.14	99	42.92	140	60.69
18	7.80	59	25.58	100	43.35	141	61.12
19	8.24	60	26.01	101	43.78	142	61.56
20	8.67	61	26.44	102	44.22	143	62.00
21	9.10	62	26.88	103	44.65	144	62.43
22	9.54	63	27.31	104	45.08	145	62.86
23	9.97	64	27.74	105	45.52	146	63.29
24	10.40	65	28.18	106	45.95	147	63.73
25	10.84	66	28.61	107	46.39	148	64.16
26	11.27	67	29.05	108	46.82	149	64.59
27	11.70	68	29.48	109	47.25	150	65.03
28	12.14	69	29.91	110	47.69	151	65.46
29	12.57	70	30.35	111	48.12	152	65.89
30	13.01	71	30.78	112	48.55	153	66.33
31	13.44	72	31.21	113	48.99	154	66.76
32	13.87	73	31.65	114	49.42	155	67.19
33	14.31	74	32.08	115	49.85	156	67.63
34	14.74	75	32.51	116	50.29	157	68.06
35	15.17	76	32.95	117	50.72	158	68.49
36	15.61	77	33.38	118	51.15	159	68.93
37	16.04	78	33.81	119	51.59	160	69.36
38	16.47	79	34.25	120	52.02	161	69.79
39	16.91	80	34.68	121	52.45	162	70.23
40	17.34	81	35.11	122	52.89	163	70.66
41	17.77	82	35.55	123	53.32	164	71.10

PRESSURE OF WATER

Head in feet	Pressure in lbs. per sq. inch	Head in feet	Pressure in lbs. per sq. inch	Head in feet	Pressure in lbs. per sq. inch	Head in feet	Pressure in lbs. per sq. inch
165	71.53	207	89.73	249	107.93	290	125.71
166	71.96	208	90.15	250	108.37	291	126.14
167	72.40	209	90.60	251	108.80	292	126.58
168	72.83	210	91.03	252	109.23	293	127.01
169	73.26	211	91.46	253	109.67	294	127.44
170	73.70	212	91.90	254	110.10	295	127.88
171	74.13	213	92.33	255	110.53	296	128.31
172	74.56	214	92.76	256	110.97	297	128.74
173	75.00	215	93.20	257	111.40	298	129.18
174	75.43	216	93.63	258	111.83	299	129.61
175	75.86	217	94.06	259	112.27	300	130.05
176	76.30	218	94.50	260	112.71	305	132.22
177	76.73	219	94.93	261	113.14	310	134.39
178	77.16	220	95.37	262	113.57	315	136.55
179	77.60	221	95.80	263	114.01	320	138.72
180	78.03	222	96.23	264	114.44	325	140.89
181	78.46	223	96.67	265	114.87	330	143.06
182	78.90	224	97.10	266	115.31	335	145.22
183	79.33	225	97.53	267	115.74	340	147.39
184	79.77	226	97.97	268	116.17	345	149.56
185	80.20	227	98.40	269	116.61	350	151.73
186	80.63	228	98.83	270	117.04	355	153.89
187	81.07	229	99.27	271	117.47	360	156.06
188	81.50	230	99.70	272	117.91	365	158.23
189	81.93	231	100.13	273	118.34	370	160.40
190	82.37	232	100.56	274	118.77	375	162.56
191	82.80	233	101.00	275	119.21	380	164.73
192	83.23	234	101.43	276	119.64	385	166.90
193	83.67	235	101.86	277	120.07	390	169.07
194	84.10	236	102.30	278	120.51	395	171.23
195	84.53	237	102.73	279	120.94	400	173.40
196	84.97	238	103.16	280	121.38	410	177.74
197	85.40	239	103.60	281	121.81	420	182.07
198	85.83	240	104.03	282	122.24	430	186.41
199	86.27	241	104.46	283	122.68	440	190.74
200	86.70	242	104.90	284	123.11	450	195.08
201	87.13	243	105.33	285	123.54	460	199.41
202	87.56	244	105.76	286	123.98	470	203.75
203	88.00	245	106.20	287	124.41	480	208.08
204	88.43	246	106.63	288	124.84	490	212.42
205	88.85	247	107.06	289	125.28	500	216.75
206	89.30	248	107.50				

TABLE FOR DETERMINING THE VELOCITY OF WATER IN OPEN CHANNELS

Velocity in Feet per Sec. When Slope = .01 = 52.8 ft. per Mile.

Mean Radius	Coefficients "n" of roughness. .010	.011	.012	.013	.015	.017	.020	.025	.030	.035	0.40	Mean Radius
.1	3.00	2.62	2.34	2.08	1.70	1.45	1.14	.85	.66	.54	.44	.1
.15	4.06	3.60	3.21	2.90	2.40	2.01	1.62	1.20	.93	.77	.66	.15
.2	5.09	4.47	4.02	3.62	2.99	2.55	2.05	1.52	1.20	.98	.85	.2
.3	6.85	6.08	5.48	4.93	4.16	3.51	2.85	2.14	1.70	1.37	1.20	.3
.4	8.42	7.53	6.77	6.20	5.19	4.43	3.61	2.78	2.21	1.83	1.52	.4
.5	9.80	8.84	7.92	7.24	6.08	5.23	4.31	3.32	2.62	2.19	1.84	.5
.6	11.08	10.00	8.99	8.21	6.97	5.97	4.96	3.80	3.02	2.56	2.17	.6
.7	12.39	11.05	10.04	9.12	7.78	6.70	5.52	4.27	3.43	2.85	2.47	.7
.8	13.50	12.07	11.00	10.01	8.49	7.33	6.08	4.74	3.84	3.13	2.77	.8
.9	14.61	13.10	11.96	10.91	9.21	8.07	6.64	5.17	4.18	3.46	3.04	.9
1.0	15.60	14.10	12.80	11.70	9.90	8.70	7.20	5.60	4.50	3.80	3.30	1.0
1.1	16.68	15.00	13.64	12.48	10.59	9.30	7.72	6.03	4.88	4.09	3.48	1.1
1.2	17.63	15.88	14.45	13.25	11.17	9.86	8.21	6.46	5.26	4.38	3.77	1.2
1.5	20.21	18.25	16.66	15.31	13.11	11.51	9.68	7.59	6.25	5.27	4.53	1.5
2.0	24.18	21.92	20.08	18.38	15.84	14.00	11.73	9.33	7.78	6.50	5.66	2.0
2.5	27.83	25.14	23.08	21.26	18.34	16.20	13.68	10.91	9.01	7.67	6.69	2.5
3.0	31.00	28.06	25.80	23.90	20.61	18.19	15.41	12.30	10.22	8.83	7.79	3.0
4.0	36.80	33.40	30.80	28.40	24.60	21.80	18.60	15.20	12.60	11.00	9.60	4.0
6.0	46.53	42.37	39.18	36.25	31.59	28.16	24.25	19.84	16.65	14.45	12.73	6.0
10.0	61.98	56.92	52.49	48.69	43.00	38.26	33.20	27.19	23.40	20.55	18.34	10.0
20.0	91.23	83.63	77.37	72.00	63.95	57.24	50.09	41.59	35.78	31.75	28.62	20.0

See Table and Rule on next page.

TABLE OF SLOPES AND MULTIPLE

To be used in connection with opposite Table

Fall in 100 Feet.	Fall in 100 Feet.	Fall in 1000 Feet.	Fall in 1 Mile	Multiple
0.01 feet	⅛ inch	0.1 feet	0.53 feet	.100
0.02 "	¼ "	0.2 "	1.06 "	.141
0.03 "	⅜ "	0.3 "	1.59 "	.173
0.04 "	½ "	0.4 "	2.11 "	.200
0.05 "	⅝ "	0.5 "	2.64 "	.223
0.06 "	¾ "	0.6 "	3.17 "	.245
0.07 "	⅞ "	0.7 "	3.70 "	.265
0.08 "	1 "	0.8 "	4.22 "	.283
0.09 "	1⅛ "	0.9 "	4.75 "	.300
0.10 "	1¼ "	1.0 "	5.28 "	.316
0.12 "	1½ "	1.2 "	6.34 "	.346
0.14 "	1¾ "	1.4 "	7.40 "	.374
0.16 "	1⅞ "	1.6 "	8.45 "	.400
0.18 "	2⅛ "	1.8 "	9.50 "	.424
0.20 "	2⅜ "	2.0 "	10.56 "	.447
0.25 "	3 "	2.5 "	13.20 "	.500
0.30 "	3⅝ "	3.0 "	15.84 "	.548
0.35 "	4¼ "	3.5 "	18.48 "	.592
0.40 "	4¾ "	4.0 "	21.12 "	.632
0.45 "	5⅜ "	4.5 "	23.76 "	.671
0.50 "	6 "	5.0 "	26.40 "	.707

RULE.—Find the Mean Radius of the channel or flume by the method described under definitions of Mean Radius and Wet Perimeter.

Take from the table of velocities the number opposite the Mean Radius and under the suitable coefficient of roughness. This number must be multiplied by the multiple opposite the fall in the table of slopes. The result is the velocity in feet per second.

The quantity of water discharged is found by multiplying the area of the wet cross-section by the velocity.

EXAMPLE

A box flume has four foot straight sides and an inside width of five feet, the water being calculated to run 3.75 feet deep with a fall of 1½ inches per 100 feet.

The wet perimeter is found to be 3.75 plus 3.75 plus 5 = 12.5 feet.

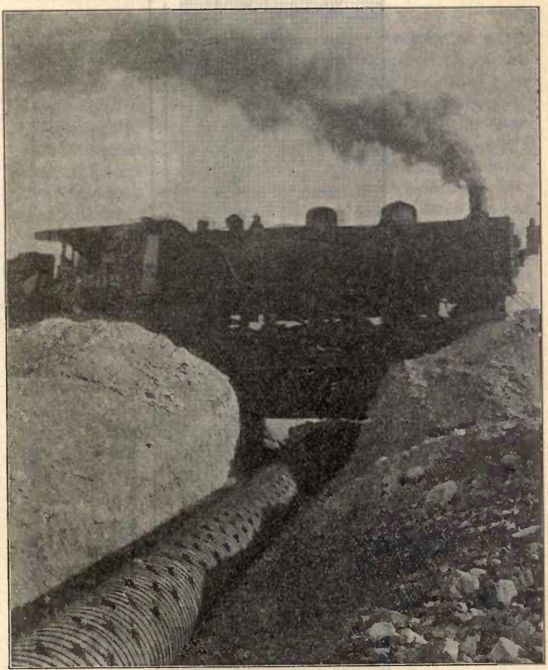
The area of the wet cross-section is 3.75 x 5 = 18.75 square feet.

The Mean Radius is therefor 18.75 ÷ 12.5 = 1.5.

Assuming that the coefficient in this case is .015, we refer to the table of velocities and under .015 and opposite 1.5 we find 13.11. Now refer to the table of slopes and opposite 1½" we find the multiple .346. Multiplying 13.11 by .346 we obtain 4.54, which equals the velocity in feet per second of the water in the flume. The quantity of water carried by the flume is found to be 18.75 x 4.54 = 85.1 cubic feet per second.

TABLE SHOWING QUANTITY OF WATER IN ONE FOOT OF PIPE IN CUBIC FEET AND IN U. S. GALLONS

Dia. of Pipe in Inches	Cu. Ft. of Water in 1 Foot of Pipe	U. S. Gals. in 1 Foot of Pipe	Dia. of Pipe in Inches	Cu. Ft. of Water in 1 Foot of Pipe	U. S. Gals. in 1 Foot of Pipe
½	0.0014	0.0102	58	18.348	137.3
¾	0.0031	0.0230	60	19.635	146.9
1	0.0055	0.0408	62	20.966	156.8
2	0.0218	0.1632	64	22.340	167.1
3	0.0491	0.3672	66	23.76	177.7
4	0.0873	0.6528	68	25.22	188.7
5	0.1364	1.020	70	26.73	200.0
6	0.1963	1.469	72	28.27	211.5
8	0.3491	2.611	74	29.87	223.4
10	0.5454	4.080	76	31.50	235.6
12	0.7854	5.875	78	33.18	248.2
14	1.069	7.997	80	34.91	261.1
16	1.396	10.44	82	36.67	274.3
18	1.767	13.22	84	38.48	287.9
20	2.182	16.32	86	40.34	301.7
22	2.640	19.75	88	42.24	316.0
24	3.142	23.50	90	44.18	330.5
26	3.687	27.58	92	46.16	345.3
28	4.276	31.99	94	48.19	360.5
30	4.909	36.72	96	50.27	376.0
32	5.585	41.78	98	52.38	391.8
34	6.305	47.16	100	54.54	408.0
36	7.069	52.88	102	56.75	424.5
38	7.876	58.92	104	58.99	441.2
40	8.727	65.28	106	61.28	458.4
42	9.621	71.97	108	63.62	475.9
44	10.559	78.99	110	66.00	493.7
46	11.541	86.33	112	68.42	511.8
48	12.566	94.00	114	70.88	530.2
50	13.635	102.00	116	73.39	549.0
52	14.748	110.3	118	75.94	568.0
54	15.904	119.0	120	78.54	587.5
56	17.104	128.0			



Continuous Stave Pipe Used as an Irrigation Syphon

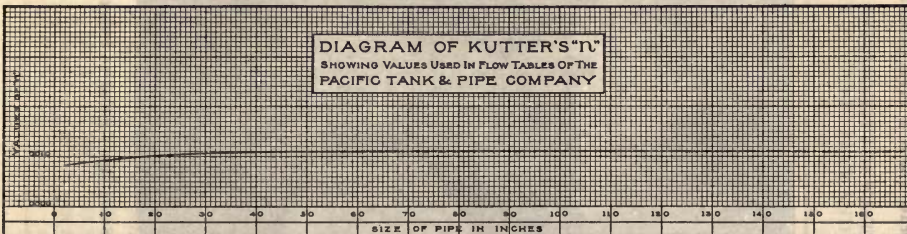


DIAGRAM OF KUTTER'S "n"
SHOWING VALUES USED IN FLOW TABLES OF THE
PACIFIC TANK & PIPE COMPANY
VALUES OF "n"
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
SIZE OF PIPE IN INCHES

TABLES FOR FLOW OF WATER THROUGH WOOD PIPE

In preparing the following tables for the flow of water through wooden pipes, such as are manufactured by us, we have given full consideration to all of the few tests that have been made from which intelligent deductions can be drawn. Unfortunately, most of the tests that have been made were with pipe constructed under unusual conditions or with greatly varying grades or curvature. It is our intention to show in these tables as nearly as possible the actual amount of water that will flow through wooden pipes with a minimum amount of curvature either vertical or horizontal. Should there be, in a long line of pipe, merely three or four curves of considerable radius, the flow would not be affected to any appreciable extent.

In preparing these tables we have used the "Kutter" formula and a changeable value of "n." The diagram on the opposite page shows the various values of "n" for all pipes from 2 inches up to 168 inches in diameter. It will be observed that the coefficient 0.011 is used for the larger diameters and that this valuation is slightly decreased for the smaller diameters. Many engineers calculate the flow of water in wood pipe with the valuation of "n" = 0.010. We believe that the valuation which we have given is safe and for reasonably straight pipes can be used without hesitancy.

We present a few examples of the use of this table which will readily explain how the size of pipe can be ascertained to deliver certain quantities of water, or how with the size given the frictional loss can be determined; in fact, the intelligent use of these tables can be made to do away entirely with the long tiresome calculations that are beyond the reach of the layman and are a tedious and complicated piece of work for the practicing engineer.

You wlll note that the first column represents the loss of head due to friction in 1,000 feet of pipe when discharging a given quantity of water. This frictional head can be applied to any length of pipe by multiplying by the number of thousand feet and fraction thereof, the result being the total frictional loss in the entire pipe. The second column shows the mean velocity in feet per second, an item which is rarely considered by the layman. The third column is the discharge of the pipe in cubic feet per second. The fourth gives the discharge in gallons per minute and the fifth gives the discharge in miner's inches. The miner's inch used herein is equivalent to one-fiftieth of a cubic foot per second.

In the last column is given the combined entrance and velocity heads. This figure represents the head of water which should stand over the top of the pipe at the intake in order to give the body of water in the pipe the velocity, and consequently, the discharge required. This item can be reduced nearly one-third provided that the intake end of the pipe is enlarged so as to eliminate the entrance friction. (See definition of Entrance Head.)

EXAMPLES

1. Pipe to be used as an Inverted Syphon.

Given
- Size of pipe......60 inches.
- Length of pipe...3200 feet.
- Discharge.......286 cubic feet per second.

Required—Total Head.

Turning to the table showing a diameter of 60″ we find opposite the discharge of 286 cubic feet per second, that 8 feet of head is required for friction in each 1000 feet of pipe. The friction in the entire line is therefore found by $3.2 \times 8 = 25.6$ feet. Glancing across the same line from which we obtained the friction head, we find that 4.9 feet is required for velocity and entrance head. This added to 25.6 equals 30.5 feet, which is the Total Head required to discharge the given quantity of water.

Should occasion occur in which the exact discharge required is not found in the table, the friction head as well as the velocity and entrance heads can be determined, sufficiently close, by comparison with adjoining discharges and heads either by the eye or by simple proportion.

Should the quantity of water given be stated in gallons per minute or in miner's inches, the calculation would be effected in the same manner.

2. Pipe to be used as an Inverted Syphon.

Given
- Length of pipe.............4800 feet.
- Discharge................. 92 sec. feet.
- Total Head................36.2 feet.

Required—Size.

As part of this Total Head will be taken up as velocity and entrance head, until we know the exact velocity, we can obtain only an approximate result. We therefore proceed to divide the Total Head by the number of thousands of feet of length: 36.2 divided by 4.8 equals 7.5 plus. Now let us assume that the .5 feet will be devoted to velocity and entrance head and the 7 feet to the friction head in 1000 feet of pipe. Referring to the table, and after examining several pages we find that under a diameter of 40 inches and opposite 7 feet is the required discharge, namely 92 sec. feet. We now multiply for the exact friction head: 7 x 4.8 equals 33.6 feet. To this add 2.6 for velocity and entrance head, giving a total of 36.2 feet. 40 inches is therefore the diameter required. In this example, it is sometimes necessary to make several trials before the correct result is obtained.

3. Pipe to be used as an Inverted Syphon.

Given
- Size...................... 20 inches.
- Length....................4260 feet.
- Total Head................ 22.16 feet.

Required—Discharge.

Divide 22.16 by 4.26 equals 5 plus. Assuming the friction head to be 5 feet, the total friction head will be 5 multiplied by 4.26 equals 21.30. To this add velocity and entrance head .86 feet equals a total head of 22.16 feet. From the table opposite a friction head of 5 feet per 1000 it is found that the discharge is 13.3 sec. feet, the answer sought.

4. A pipe supplying water for a Power Plant.

The size of pipe, the discharge and the friction, velocity and entrance heads may be determined as shown above but it must not be forgotten that the dynamic head is the important factor to be considered. From this alone power is developed. An increase in pipe diameter means less friction head and more dynamic head and consequently an increase in the number of horse power developed.

The economic size of pipe to employ should be given the careful study of a capable engineer.

5. A pipe used as a Pumping Line.

In pumping from a source of supply to a reservoir or ditch the water may be assumed to be lifted straight up in the air to such a height that it will, by gravity, flow to the point of discharge. For example, a pump is required to lift 3000 gallons per minute through 3500 feet of 16″ pipe to a reservoir having its water surface 43 feet above the pump. Referring to the table, it is found that in discharging 3000 gallons per minute through a 16″ pipe, there is 4 feet of friction head per 1000 feet of pipe, or 4 multiplied by 3.5 equals 14 feet in the entire line. The pump will therefore be compelled to work against a pumping head of 43 feet plus 14 feet equals 57 feet.

The diameter of pipe selected is governed largely by the cost of pumping and the experienced engineer should be called upon for an economic consideration of the subject.

DIAMETER—2 INCHES

Area 0.0218 sq. ft. $n = 0.0082$

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	0.194	0.004	1.90	0.20	0.00
0.2	0.275	0.006	2.70	0.30	0.00
0.3	0.337	0.007	3.30	0.35	0.00
0.4	0.389	0.008	3.80	0.40	0.00
0.5	0.435	0.009	4.30	0.45	0.01
0.6	0.476	0.010	4.70	0.50	0.01
0.7	0.515	0.011	5.10	0.55	0.01
0.8	0.550	0.012	5.40	0.60	0.01
0.9	0.584	0.013	5.70	0.65	0.01
1.0	0.615	0.014	6.00	0.70	0.01
1.5	0.753	0.017	7.40	0.85	0.01
2.0	0.870	0.019	8.50	0.95	0.02
3.0	1.07	0.023	10.5	1.15	0.03
4.0	1.23	0.027	12.1	1.35	0.04
5.0	1.38	0.030	13.5	1.50	0.05
6.0	1.51	0.033	14.8	1.65	0.05
7.0	1.63	0.036	16.0	1.80	0.06
8.0	1.74	0.038	17.0	1.90	0.07
9.0	1.85	0.040	18.1	2.00	0.08
10.0	1.95	0.042	19.1	2.10	0.09
12.0	2.13	0.046	20.9	2.30	0.10
14.0	2.30	0.050	22.5	2.50	0.12
16.0	2.46	0.054	24.1	2.70	0.14
18.0	2.61	0.057	25.6	2.85	0.16
20.0	2.75	0.060	26.9	3.00	0.18
22.0	2.88	0.063	28.2	3.15	0.19
24.0	3.01	0.066	29.5	3.30	0.21
26.0	3.14	0.068	30.7	3.40	0.23
28.0	3.26	0.071	31.9	3.55	0.25
30.0	3.37	0.074	33.0	3.70	0.27

Continued on page 83.

DIAMETER—3 INCHES

Area 0.0491 sq. ft. $n = 0.0084$

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	0.262	0.013	5.80	0.65	0.00
0.2	0.371	0.018	8.20	0.90	0.00
0.3	0.454	0.022	10.0	1.10	0.01
0.4	0.525	0.026	11.6	1.30	0.01
0.5	0.587	0.029	12.9	1.45	0.01
0.6	0.643	0.032	14.2	1.60	0.01
0.7	0.694	0.034	15.3	1.70	0.01
0.8	0.742	0.036	16.4	1.80	0.01
0.9	0.787	0.039	17.4	1.95	0.01
1.0	0.830	0.041	18.3	2.05	0.02
1.5	1.02	0.050	22.5	2.50	0.02
2.0	1.17	0.057	25.8	2.85	0.03
3.0	1.44	0.071	31.8	3.55	0.05
4.0	1.66	0.082	36.6	4.10	0.06
5.0	1.86	0.091	41.0	4.55	0.08
6.0	2.03	0.100	44.8	5.00	0.10
7.0	2.19	0.108	48.3	5.40	0.11
8.0	2.35	0.115	51.8	5.75	0.13
9.0	2.49	0.122	54.9	6.10	0.15
10.0	2.62	0.128	57.4	6.40	0.16
12.0	2.87	0.141	63.3	7.05	0.19
14.0	3.10	0.152	68.4	7.60	0.22
16.0	3.32	0.163	73.2	8.15	0.26
18.0	3.52	0.173	77.6	8.65	0.28
20.0	3.71	0.182	81.8	9.10	0.32
22.0	3.89	0.191	85.9	9.55	0.35
24.0	4.06	0.199	89.6	9.95	0.38
26.0	4.23	0.208	93.4	10.4	0.41
28.0	4.39	0.216	96.9	10.8	0.45
30.0	4.55	0.223	101.0	11.2	0.48

Continued on page 84.

DIAMETER—4 INCHES

Area 0.0873 sq. ft. n = 0.0086

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	0.321	0.028	12.6	1.40	0.01
0.2	0.454	0.040	17.8	2.00	0.01
0.3	0.556	0.048	21.8	2.40	0.01
0.4	0.641	0.056	25.1	2.80	0.01
0.5	0.717	0.063	28.1	3.15	0.01
0.6	0.786	0.069	30.8	3.45	0.01
0.7	0.848	0.074	33.2	3.70	0.02
0.8	0.907	0.079	35.6	3.95	0.02
0.9	0.963	0.084	37.4	4.20	0.02
1.0	1.013	0.089	39.7	4.45	0.02
1.5	1.24	0.108	48.6	5.40	0.04
2.0	1.43	0.125	56.0	6.25	0.05
3.0	1.76	0.154	68.9	7.70	0.07
4.0	2.03	0.177	79.5	8.85	0.10
5.0	2.27	0.198	89.0	9.90	0.12
6.0	2.48	0.216	97.3	10.8	0.14
7.0	2.68	0.234	105.0	11.7	0.17
8.0	2.87	0.251	113.0	12.6	0.19
9.0	3.04	0.265	119.0	13.3	0.21
10.0	3.21	0.280	126.0	14.0	0.24
12.0	3.51	0.307	138.0	15.4	0.29
14.0	3.79	0.331	149.0	16.6	0.33
16.0	4.06	0.355	159.0	17.8	0.38
18.0	4.30	0.375	168.0	18.8	0.43
20.0	4.54	0.396	178.0	19.8	0.48
22.0	4.76	0.415	187.0	20.8	0.53
24.0	4.97	0.434	195.0	21.7	0.57
26.0	5.17	0.452	203.0	22.6	0.62
28.0	5.36	0.468	210.0	23.4	0.67
30.0	5.56	0.486	218.0	24.3	0.72

Continued on page 85.

DIAMETER—5 INCHES

Area 0.1364 sq. ft. n = 0.0087

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	0.372	0.051	22.8	2.55	0.01
0.2	0.526	0.072	32.2	3.60	0.01
0.3	0.644	0.088	39.4	4.40	0.01
0.4	0.743	0.101	45.5	5.05	0.01
0.5	0.831	0.113	50.9	5.65	0.02
0.6	0.910	0.124	55.7	6.20	0.02
0.7	0.983	0.134	60.2	6.70	0.02
0.8	1.05	0.143	64.3	7.15	0.03
0.9	1.11	0.151	68.0	7.55	0.03
1.0	1.17	0.160	71.6	8.00	0.03
1.5	1.44	0.196	88.3	9.80	0.05
2.0	1.66	0.226	102.0	11.3	0.06
3.0	2.04	0.278	125.0	13.9	0.10
4.0	2.35	0.320	144.0	16.0	0.13
5.0	2.63	0.358	161.0	17.9	0.16
6.0	2.88	0.393	177.0	19.7	0.19
7.0	3.11	0.424	191.0	21.2	0.23
8.0	3.32	0.453	203.0	22.7	0.26
9.0	3.52	0.480	216.0	24.0	0.29
10.0	3.71	0.506	227.0	25.3	0.32
12.0	4.07	0.555	249.0	27.8	0.39
14.0	4.40	0.600	270.0	30.0	0.45
16.0	4.70	0.641	288.0	32.1	0.51
18.0	4.98	0.679	305.0	34.0	0.58
20.0	5.26	0.716	322.0	35.8	0.65
22.0	5.51	0.751	338.0	37.6	0.71
24.0	5.76	0.785	353.0	39.3	0.77
26.0	5.99	0.816	367.0	40.8	0.83
28.0	6.22	0.848	381.0	42.4	0.90
30.0	6.44	0.878	394.0	43.9	0.96

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DIAMETER—6 INCHES

Area 0.1963 sq. ft. n = 0.0088

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	0.422	0.083	37.2	4.15	0.01
0.2	0.596	0.117	52.5	5.85	0.01
0.3	0.731	0.144	64.6	7.20	0.01
0.4	0.844	0.166	74.3	8.30	0.02
0.5	0.944	0.185	83.2	9.25	0.02
0.6	1.03	0.202	90.8	10.1	0.02
0.7	1.12	0.220	98.7	11.0	0.03
0.8	1.19	0.234	105.0	11.7	0.03
0.9	1.27	0.249	112.0	12.5	0.04
1.0	1.33	0.262	117.0	13.1	0.04
1.5	1.64	0.322	145.0	16.1	0.06
2.0	1.89	0.371	167.0	18.6	0.08
3.0	2.31	0.454	204.0	22.7	0.12
4.0	2.67	0.524	235.0	26.2	0.17
5.0	2.98	0.585	263.0	29.3	0.21
6.0	3.26	0.642	288.0	32.1	0.25
7.0	3.53	0.693	311.0	34.7	0.29
8.0	3.77	0.740	332.0	37.0	0.33
9.0	4.00	0.785	353.0	39.3	0.37
10.0	4.22	0.828	372.0	41.4	0.42
12.0	4.62	0.907	407.0	45.4	0.46
14.0	4.99	0.980	440.0	49.0	0.58
16.0	5.34	1.05	472.0	52.5	0.66
18.0	5.66	1.11	498.0	55.5	0.75
20.0	5.97	1.17	526.0	58.5	0.82
22.0	6.26	1.23	552.0	61.5	0.91
24.0	6.54	1.28	576.0	64.0	1.0
26.0	6.80	1.34	602.0	67.0	1.1
28.0	7.06	1.39	624.0	69.5	1.2
30.0	7.31	1.44	646.0	72.0	1.3

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DIAMETER—8 INCHES

Area 0.3491 sq. ft. $n = 0.009$

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	0.506	0.177	79.3	8.85	0.01
0.2	0.716	0.250	112.0	12.5	0.01
0.3	0.877	0.306	137.0	15.3	0.02
0.4	1.01	0.352	158.0	17.6	0.02
0.5	1.13	0.394	177.0	19.7	0.03
0.6	1.24	0.433	195.0	21.7	0.04
0.7	1.34	0.467	210.0	23.4	0.04
0.8	1.43	0.499	224.0	25.0	0.05
0.9	1.52	0.531	238.0	26.6	0.05
1.0	1.60	0.558	251.0	27.9	0.06
1.5	1.96	0.684	307.0	34.2	0.09
2.0	2.26	0.789	354.0	39.5	0.12
3.0	2.77	0.967	434.0	48.4	0.18
4.0	3.20	1.12	502.0	56.0	0.24
5.0	3.58	1.25	562.0	62.5	0.30
6.0	3.92	1.37	615.0	68.5	0.36
7.0	4.23	1.48	664.0	74.0	0.42
8.0	4.53	1.58	711.0	79.0	0.48
9.0	4.80	1.68	753.0	84.0	0.54
10.0	5.06	1.77	794.0	88.5	0.60
12.0	5.54	1.93	868.0	96.5	0.72
14.0	5.99	2.09	940.0	104.5	0.82
16.0	6.40	2.23	1000.0	111.5	0.96
18.0	6.78	2.37	1060.0	118.5	1.1
20.0	7.16	2.50	1120.0	125.0	1.2
22.0	7.51	2.62	1180.0	131.0	1.3
24.0	7.84	2.74	1230.0	137.0	1.4
26.0	8.16	2.85	1280.0	142.5	1.5
28.0	8.47	2.96	1330.0	148.0	1.7
30.0	8.77	3.06	1380.0	153.0	1.8

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DIAMETER—10 INCHES

Area 0.5454 sq. ft. n = 0.0091

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	0.588	0.321	144	16.1	0.01
0.2	0.832	0.454	203	22.7	0.02
0.3	1.02	0.556	250	27.8	0.02
0.4	1.18	0.644	289	32.2	0.03
0.5	1.31	0.715	321	35.8	0.04
0.6	1.44	0.786	353	39.3	0.05
0.7	1.56	0.851	382	42.6	0.06
0.8	1.66	0.905	406	45.3	0.06
0.9	1.76	0.960	431	48.0	0.07
1.0	1.86	1.02	458	51.0	0.08
1.5	2.28	1.24	558	62.0	0.12
2.0	2.63	1.44	646	72.0	0.16
3.0	3.22	1.76	790	88.0	0.24
4.0	3.72	2.03	911	101.5	0.32
5.0	4.16	2.27	1020	113.5	0.40
6.0	4.56	2.49	1120	124.5	0.48
7.0	4.92	2.68	1210	134.0	0.56
8.0	5.26	2.87	1290	143.5	0.64
9.0	5.58	3.04	1370	152.0	0.72
10.0	5.88	3.21	1440	160.5	0.80
12.0	6.44	3.51	1580	175.5	0.97
14.0	6.96	3.80	1710	190.0	1.1
16.0	7.44	4.06	1820	203.0	1.3
18.0	7.89	4.30	1930	215.0	1.5
20.0	8.32	4.54	2040	227.0	1.6
22.0	8.72	4.76	2140	238.0	1.8
24.0	9.11	4.98	2230	249.0	1.9
26.0	9.48	5.18	2320	259.0	2.1
28.0	9.85	5.37	2410	268.5	2.3
30.0	10.2	5.56	2500	278.0	2.4

DIAMETER—12 INCHES

Area 0.7854 sq. ft. 1 Foot $n = 0.0093$

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	0.654	0.513	231	25.7	0.01
0.2	0.925	0.726	326	36.3	0.02
0.3	1.13	0.887	398	44.4	0.03
0.4	1.31	1.03	462	51.5	0.04
0.5	1.46	1.15	515	57.5	0.05
0.6	1.60	1.26	564	63.0	0.06
0.7	1.73	1.35	606	67.5	0.07
0.8	1.85	1.45	651	72.5	0.08
0.9	1.96	1.54	691	77.0	0.09
1.0	2.07	1.62	727	81.0	0.10
1.5	2.53	1.99	893	99.5	0.15
2.0	2.93	2.30	1030	115.0	0.20
3.0	3.58	2.81	1260	140.5	0.30
4.0	4.14	3.25	1460	162.5	0.40
5.0	4.62	3.63	1630	181.5	0.50
6.0	5.07	3.98	1790	199.0	0.60
7.0	5.48	4.30	1930	215.0	0.70
8.0	5.85	4.60	2060	230.0	0.80
9.0	6.21	4.88	2190	244.0	0.90
10.0	6.54	5.13	2310	256.5	1.0
12.0	7.16	5.63	2520	281.5	1.2
14.0	7.74	6.08	2730	304.0	1.4
16.0	8.28	6.50	2920	325.0	1.6
18.0	8.78	6.89	3100	344.5	1.8
20.0	9.25	7.26	3260	363.0	2.0
22.0	9.71	7.62	3420	381.0	2.2
24.0	10.1	7.96	3570	398.0	2.4
26.0	10.6	8.33	3740	416.5	2.6
28.0	11.0	8.64	3880	432.0	2.8
30.0	11.3	8.89	3990	444.5	3.0

DIAMETER—14 INCHES

Area 1.069 sq. ft. | 1 Foot 2 Inches | n = 0.0096

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	0.705	0.754	338	37.7	0.01
0.2	0.998	1.07	479	53.5	0.02
0.3	1.22	1.30	586	65.0	0.03
0.4	1.41	1.51	678	75.5	0.05
0.5	1.58	1.69	761	84.5	0.06
0.6	1.73	1.85	832	92.5	0.07
0.7	1.87	1.99	898	99.5	0.08
0.8	1.99	2.13	957	106.5	0.09
0.9	2.11	2.26	1010	113.0	0.10
1.0	2.23	2.38	1070	119.0	0.12
1.5	2.73	2.92	1310	146.0	0.17
2.0	3.15	3.37	1510	168.5	0.23
3.0	3.86	4.13	1860	206.5	0.34
4.0	4.46	4.77	2140	238.5	0.46
5.0	4.99	5.33	2400	266.5	0.58
6.0	5.46	5.84	2620	292.0	0.69
7.0	5.90	6.32	2830	316.0	0.81
8.0	6.30	6.74	3030	337.0	0.92
9.0	6.70	7.17	3220	358.5	1.1
10.0	7.05	7.54	3390	377.0	1.2
12.0	7.72	8.26	3710	413.0	1.4
14.0	8.35	8.94	4010	447.0	1.6
16.0	8.92	9.51	4280	475.5	1.9
18.0	9.46	10.1	4540	505.0	2.1
20.0	9.98	10.7	4790	535.0	2.3
22.0	10.5	11.2	5040	560.0	2.5
24.0	10.9	11.7	5240	585.0	2.8
26.0	11.4	12.1	5480	605.0	3.0
28.0	11.8	12.6	5670	630.0	3.2
30.0	12.2	13.1	5860	655.0	3.5

DIAMETER—16 INCHES

Area 1.396 sq. ft. 1 Foot 4 Inches $n = 0.0098$

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	0.756	1.06	474	53.0	0.01
0.2	1.07	1.49	671	74.5	0.03
0.3	1.31	1.83	822	91.5	0.04
0.4	1.51	2.10	947	105.0	0.05
0.5	1.69	2.36	1060	118.0	0.07
0.6	1.85	2.58	1160	129.0	0.08
0.7	2.00	2.79	1250	139.5	0.09
0.8	2.14	2.99	1340	149.5	0.11
0.9	2.27	3.17	1420	158.5	0.12
1.0	2.39	3.34	1500	167.0	0.13
1.5	2.93	4.09	1840	204.5	0.20
2.0	3.38	4.72	2120	236.0	0.27
3.0	4.14	5.78	2600	289.0	0.40
4.0	4.78	6.67	3000	333.5	0.53
5.0	5.35	7.47	3360	373.5	0.66
6.0	5.86	8.18	3670	409.0	0.80
7.0	6.32	8.82	3960	441.0	0.93
8.0	6.76	9.44	4240	472.0	1.1
9.0	7.17	10.0	4500	500.0	1.2
10.0	7.56	10.6	4740	530.0	1.3
12.0	8.28	11.6	5190	580.0	1.6
14.0	8.95	12.5	5610	625.0	1.9
16.0	9.57	13.4	6000	670.0	2.1
18.0	10.1	14.2	6330	710.0	2.4
20.0	10.7	14.9	6690	745.0	2.7
22.0	11.2	15.7	7010	785.0	2.9
24.0	11.7	16.4	7320	820.0	3.2
26.0	12.2	17.0	7630	850.0	3.5
28.0	12.7	17.7	7950	885.0	3.8
30.0	13.1	18.3	8220	915.0	4.0

DIAMETER—18 INCHES

Area 1.767 sq. ft. 1 Foot 6 Inches $n = 0.0099$

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	0.81	1.44	643	72.0	0.02
0.2	1.15	2.03	913	101.5	0.03
0.3	1.41	2.49	1120	124.5	0.05
0.4	1.62	2.86	1290	143.0	0.06
0.5	1.81	3.20	1440	160.0	0.07
0.6	1.99	3.52	1580	176.0	0.09
0.7	2.15	3.80	1710	190.0	0.11
0.8	2.29	4.05	1820	202.5	0.12
0.9	2.43	4.29	1930	214.5	0.14
1.0	2.56	4.53	2030	226.5	0.15
1.5	3.14	5.55	2490	277.5	0.22
2.0	3.63	6.42	2880	321.0	0.31
3.0	4.44	7.85	3520	392.5	0.46
4.0	5.13	9.07	4070	453.5	0.61
5.0	5.74	10.2	4560	510.0	0.76
6.0	6.28	11.1	4980	555.0	0.91
7.0	6.79	12.0	5390	600.0	1.1
8.0	7.24	12.8	5750	640.0	1.2
9.0	7.68	13.6	6100	680.0	1.3
10.0	8.10	14.3	6430	715.0	1.5
12.0	8.87	15.7	7040	785.0	1.8
14.0	9.59	16.9	7610	845.0	2.1
16.0	10.3	18.1	8180	905.0	2.5
18.0	10.9	19.2	8650	960.0	2.8
20.0	11.5	20.2	9130	1010.0	3.0
22.0	12.1	21.3	9610	1065.0	3.3
24.0	12.6	22.2	10000	1110.0	3.6
26.0	13.1	23.1	10400	1155.0	4.0
28.0	13.6	24.0	10800	1200.0	4.2
30.0	14.1	24.8	11200	1240.0	4.6

DIAMETER—20 INCHES

Area 2.182 sq. ft. 1 Foot 8 Inches $n = 0.010$

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	0.863	1.88	845	94.0	0.02
0.2	1.22	2.66	1190	133.0	0.03
0.3	1.49	3.25	1460	162.5	0.05
0.4	1.72	3.75	1680	187.5	0.07
0.5	1.92	4.19	1880	209.5	0.08
0.6	2.11	4.61	2070	230.5	0.10
0.7	2.28	4.98	2230	249.0	0.12
0.8	2.44	5.33	2390	266.5	0.14
0.9	2.58	5.63	2530	281.5	0.15
1.0	2.73	5.95	2680	297.5	0.17
1.5	3.34	7.29	3270	364.5	0.26
2.0	3.85	8.40	3770	420.0	0.35
3.0	4.72	10.3	4630	515.0	0.52
4.0	5.45	11.9	5340	595.0	0.69
5.0	6.10	13.3	5980	665.0	0.86
6.0	6.68	14.6	6550	730.0	1.0
7.0	7.22	15.8	7070	790.0	1.2
8.0	7.71	16.8	7550	840.0	1.3
9.0	8.18	17.8	8030	890.0	1.5
10.0	8.63	18.8	8460	940.0	1.7
12.0	9.45	20.6	9260	1030.0	2.1
14.0	10.2	22.3	10000	1115.0	2.4
16.0	10.9	23.8	10700	1190.0	2.7
18.0	11.6	25.2	11400	1260.0	3.1
20.0	12.2	26.6	11900	1330.0	3.5
22.0	12.8	27.9	12600	1395.0	3.8
24.0	13.4	29.1	13100	1455.0	4.2
26.0	13.9	30.3	13600	1515.0	4.5
28.0	14.4	31.5	14100	1575.0	4.8
30.0	14.9	32.6	14600	1630.0	5.2

DIAMETER—22 INCHES

Area 2.640 sq. ft. 1 Foot 10 Inches $n = 0.0101$

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	0.911	2.41	1080	120.5	0.02
0.2	1.29	3.41	1530	170.5	0.04
0.3	1.58	4.17	1870	208.5	0.06
0 4	1.82	4.80	2160	240.0	0.08
0.5	2.04	5.38	2420	269.0	0.10
0.6	2.23	5.89	2640	294.5	0.12
0.7	2.41	6.36	2860	318.0	0.14
0.8	2.58	6.81	3060	340.5	0.16
0.9	2.73	7.21	3240	360.5	0.17
1.0	2.88	7.60	3420	380.0	0.19
1.5	3.52	9.32	4170	466.0	0.29
2.0	4.07	10.8	4830	540.0	0.39
3.0	4.98	13.2	5910	660.0	0.58
4.0	5.76	15.2	6830	760.0	0.77
5.0	6.44	16.9	7640	845.0	0.97
6.0	7.06	18.7	8370	935.0	1.2
7.0	7.62	20.1	9040	1005.0	1.4
8.0	8.15	21.5	9670	1075.0	1.5
9.0	8.64	22.8	10300	1140.0	1.7
10.0	9.11	24.1	10800	1205.0	1.9
12.0	9.98	26.4	11800	1320.0	2.3
14.0	10.8	28.5	12800	1425.0	2.7
16.0	11.5	30.4	13600	1520.0	3.1
18.0	12.2	32.3	14500	1615.0	3.5
20.0	12.9	34.0	15300	1700.0	3.9
22.0	13.5	35.7	16000	1785.0	4.2
24.0	14.1	37.2	16700	1860.0	4.6
26.0	14.7	38.8	17400	1940.0	5.0
28.0	15.2	40.1	18000	2005.0	5.4
30.0	15.8	41.6	18700	2080.0	5.8

DIAMETER—24 INCHES

Area 3.142 sq. ft. 2 Feet $n = 0.0102$

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	0.96	3.02	1350	151.0	0.02
0.2	1.36	4.26	1920	213.0	0.04
0.3	1.66	5.22	2340	261.0	0.06
0.4	1.92	6.03	2710	301.5	0.08
0.5	2.14	6.72	3020	336.0	0.11
0.6	2.35	7.38	3320	369.0	0.13
0.7	2.54	7.98	3590	399.0	0.15
0.8	2.71	8.52	3820	426.0	0.17
0.9	2.88	9.05	4060	452.5	0.19
1.0	3.03	9.53	4280	476.5	0.21
1.5	3.71	11.7	5240	585.0	0.32
2.0	4.29	13.5	6060	675.0	0.43
3.0	5.25	16.5	7410	825.0	0.64
4.0	6.07	19.1	8570	955.0	0.85
5.0	6.78	21.3	9570	1065.0	1.1
6.0	7.44	23.4	10500	1170.0	1.3
7.0	8.03	25.2	11300	1260.0	1.5
8.0	8.57	26.9	12100	1345.0	1.7
9.0	9.10	28.6	12800	1430.0	1.9
10.0	9.60	30.1	13500	1505.0	2.1
12.0	10.5	33.0	14800	1650.0	2.6
14.0	11.4	35.7	16100	1785.0	3.0
16.0	12.1	38.2	17100	1910.0	3.4
18.0	12.9	40.4	18200	2020.0	3.8
20.0	13.6	42.6	19200	2130.0	4.3
22.0	14.2	44.7	20100	2235.0	4.7
24.0	14.9	46.7	21000	2335.0	5.1
26.0	15.5	48.6	21900	2430.0	5.6
28.0	16.1	50.4	22700	2520.0	6.0
30.0	16.6	52.2	23400	2610.0	6.4

DIAMETER—26 INCHES

Area 3.687 sq. ft. 2 Feet 2 Inches n = 0.0103

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	1.00	3.69	1660	184.5	0.02
0.2	1.42	5.22	2350	261.0	0.05
0.3	1.73	6.38	2860	319.0	0.07
0.4	2.00	7.37	3310	368.5	0.09
0.5	2.24	8.26	3710	413.0	0.12
0.6	2.45	9.03	4060	451.5	0.14
0.7	2.65	9.77	4390	488.5	0.16
0.8	2.83	10.4	4690	520.0	0.19
0.9	3.00	11.1	4970	555.0	0.21
1.0	3.16	11.7	5240	585.0	0.23
1.5	3.88	14.3	6430	715.0	0.35
2.0	4.47	16.5	7410	825.0	0.46
3.0	5.48	20.2	9080	1010.0	0.69
4.0	6.33	23.3	10500	1165.0	0.93
5.0	7.08	26.1	11700	1305.0	1.2
6.0	7.75	28.6	12800	1430.0	1.4
7.0	8.37	30.9	13900	1545.0	1.6
8.0	8.95	33.0	14800	1650.0	1.8
9.0	9.50	35.0	15700	1750.0	2.1
10.0	10.0	36.9	16600	1845.0	2.3
12.0	11.0	40.6	18200	2030.0	2.8
14.0	11.8	43.7	19500	2185.0	3.3
16.0	12.7	46.7	21000	2335.0	3.8
18.0	13.4	49.5	22200	2475.0	4.2
20.0	14.2	52.2	23500	2610.0	4.6
22.0	14.9	54.8	24700	2740.0	5.1
24.0	15.5	57.1	25700	2855.0	5.6
26.0	16.1	59.5	26700	2975.0	6.1
28.0	16.8	61.8	27800	3090.0	6.5
30.0	17.3	63.9	28700	3195.0	7.0

DIAMETER—28 INCHES

Area 4.276 sq. ft. 2 Feet 4 Inches $n = 0.0104$

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	1.04	4.46	2000	223.0	0.03
0.2	1.48	6.31	2840	315.5	0.05
0.3	1.81	7.72	3470	386.0	0.08
0.4	2.09	8.94	4010	447.0	0.10
0.5	2.33	9.96	4470	498.0	0.13
0.6	2.56	10.9	4910	545.0	0.15
0.7	2.76	11.8	5300	590.0	0.18
0.8	2.95	12.6	5660	630.0	0.20
0.9	3.13	13.4	6010	670.0	0.23
1.0	3.30	14.1	6340	705.0	0.25
1.5	4.04	17.3	7760	865.0	0.38
2.0	4.66	19.9	8940	995.0	0.50
3.0	5.71	24.4	10900	1220.0	0.76
4.0	6.60	28.2	12700	1410.0	1.0
5.0	7.38	31.6	14200	1580.0	1.3
6.0	8.08	34.6	15500	1730.0	1.5
7.0	8.73	37.3	16800	1865.0	1.8
8.0	9.34	39.9	17900	1995.0	2.0
9.0	9.90	42.3	19000	2115.0	2.3
10.0	10.4	44.6	20000	2230.0	2.6
12.0	11.4	48.9	21900	2445.0	3.0
14.0	12.4	52.8	23800	2640.0	3.5
16.0	13.2	56.4	25300	2820.0	4.0
18.0	14.0	59.9	26900	2995.0	4.6
20.0	14.8	63.1	28400	3155.0	5.1
22.0	15.5	66.1	29700	3305.0	5.5
24.0	16.2	69.2	31100	3460.0	6.1
26.0	16.8	72.0	32200	3600.0	6.7
28.0	17.5	74.6	33600	3730.0	7.1
30.0	18.1	77.3	34700	3865.0	7.6

DIAMETER—30 INCHES

Area 4.909 sq. ft. 2 Feet 6 Inches n = 0.0105

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	1.08	5.31	2380	265.5	0.03
0.2	1.52	7.46	3350	373.0	0.05
0.3	1.87	9.18	4120	459.0	0.08
0.4	2.16	10.6	4760	530.0	0.11
0.5	2.41	11.8	5310	590.0	0.13
0.6	2.64	13.0	5820	650.0	0.16
0.7	2.85	14.0	6280	700.0	0.19
0.8	3.05	15.0	6720	750.0	0.22
0.9	3.23	15.9	7120	795.0	0.24
1.0	3.41	16.7	7520	835.0	0.27
1.5	4.17	20.5	9190	1025.0	0.40
2.0	4.82	23.7	10600	1185.0	0.54
3.0	5.90	29.0	13000	1450.0	0.81
4.0	6.81	33.4	14900	1670.0	1.1
5.0	7.62	37.4	16800	1870.0	1.4
6.0	8.35	41.0	18400	2050.0	1.6
7.0	9.02	44.3	19900	2215.0	1.9
8.0	9.64	47.3	21200	2365.0	2.2
9.0	10.2	50.2	22500	2510.0	2.4
10.0	10.8	52.9	23800	2645.0	2.7
12.0	11.8	58.0	26000	2900.0	3.2
14.0	12.8	62.6	28200	3130.0	3.8
16.0	13.6	66.7	30000	3335.0	4.3
18.0	14.5	71.2	31900	3560.0	4.9
20.0	15.2	74.8	33500	3740.0	5.4
22.0	16.0	78.4	35200	3920.0	5.9
24.0	16.7	82.0	36800	4100.0	6.5
26.0	17.4	85.3	38300	4265.0	7.0
28.0	18.0	88.5	39700	4425.0	7.6
30.0	18.7	91.6	41200	4580.0	8.1

DIAMETER—32 INCHES

Area 5.585 sq. ft. 2 Feet 8 Inches n = 0.0106

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	1.11	6.20	2780	310.0	0.03
0.2	1.57	8.77	3930	438.5	0.06
0.3	1.93	10.8	4840	540.0	0.09
0.4	2.23	12.5	5590	625.0	0.11
0.5	2.49	13.9	6240	695.0	0.14
0.6	2.73	15.2	6850	760.0	0.17
0.7	2.95	16.5	7400	825.0	0.20
0.8	3.15	17.6	7900	880.0	0.23
0.9	3.34	18.7	8380	935.0	0.26
1.0	3.52	19.7	8830	985.0	0.29
1.5	4.31	24.0	10800	1200.0	0.43
2.0	4.98	27.8	12500	1390.0	0.58
3.0	6.10	34.1	15300	1705.0	0.87
4.0	7.04	39.3	17700	1965.0	1.2
5.0	7.88	44.0	19800	2200.0	1.4
6.0	8.64	48.3	21700	2415.0	1.7
7.0	9.32	52.1	23400	2605.0	2.0
8.0	9.97	55.7	25000	2785.0	2.3
9.0	10.6	59.0	26600	2950.0	2.6
10.0	11.1	62.2	27800	3110.0	2.9
12.0	12.2	68.1	30600	3405.0	3.5
14.0	13.2	73.6	33100	3680.0	4.0
16.0	14.1	78.7	35300	3935.0	4.6
18.0	14.9	83.4	37300	4170.0	5.2
20.0	15.8	88.0	39600	4400.0	5.8
22.0	16.5	92.3	41400	4615.0	6.3
24.0	17.3	96.5	43400	4825.0	7.0
26.0	18.0	100.3	45100	5015.0	7.5
28.0	18.7	104.2	46900	5210.0	8.1
30.0	19.3	107.8	48400	5390.0	8.7

DIAMETER—34 INCHES

Area 6.305 sq. ft. — 2 Feet 10 Inches — n = 0.0107

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	1.15	7.2	3260	360	0.03
0.2	1.63	10.3	4610	515	0.06
0.3	1.99	12.4	5640	620	0.09
0.4	2.30	14.5	6510	725	0.12
0.5	2.57	16.2	7280	810	0.15
0.6	2.81	17.7	7950	885	0.18
0.7	3.04	19.2	8610	960	0.22
0.8	3.25	20.5	9200	1025	0.25
0.9	3.45	21.8	9770	1090	0.28
1.0	3.63	22.9	10300	1145	0.31
1.5	4.45	28.1	12600	1405	0.46
2.0	5.14	32.4	14600	1620	0.61
3.0	6.29	39.7	17800	1985	0.92
4.0	7.26	45.8	20600	2290	1.2
5.0	8.13	51.3	23000	2565	1.5
6.0	8.90	56.1	25200	2805	1.8
7.0	9.62	60.7	27200	3035	2.1
8.0	10.3	64.8	29100	3240	2.5
9.0	10.9	68.7	30900	3435	2.8
10.0	11.5	72.4	32600	3620	3.0
12.0	12.6	79.3	35700	3965	3.7
14.0	13.6	85.7	38500	4285	4.3
16.0	14.5	91.6	41000	4580	5.0
18.0	15.4	97.2	43600	4860	5.6
20.0	16.3	102.5	46100	5125	6.1
22.0	17.1	107.5	48400	5375	6.7
24.0	17.8	112.2	50400	5610	7.3
26.0	18.5	116.8	52400	5840	8.0
28.0	19.2	121.2	54300	6060	8.6
30.0	19.9	125.5	56300	6275	9.2

DIAMETER—36 INCHES

Area 7.069 sq. ft. 3 Feet $n = 0.0108$

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	1.19	8.4	3780	420	0.03
0.2	1.68	11.8	5340	590	0.07
0.3	2.05	14.5	6510	725	0.10
0.4	2.37	16.7	7540	835	0.13
0.5	2.65	18.7	8430	935	0.16
0.6	2.90	20.5	9220	1025	0.19
0.7	3.13	22.1	9950	1105	0.23
0.8	3.35	23.7	10600	1185	0.26
0.9	3.55	25.1	11300	1255	0.29
1.0	3.75	26.5	11900	1325	0.33
1.5	4.59	32.4	14600	1620	0.49
2.0	5.29	37.4	16800	1870	0.65
3.0	6.49	45.9	20600	2295	0.97
4.0	7.50	53.1	23800	2655	1.3
5.0	8.38	59.3	26600	2965	1.6
6.0	9.18	65.0	29200	3250	2.0
7.0	9.93	70.2	31500	3510	2.3
8.0	10.6	75.1	33700	3755	2.6
9.0	11.3	79.6	35900	3980	3.0
10.0	11.9	84.2	37800	4210	3.3
12.0	13.0	91.9	41300	4595	3.9
14.0	14.0	99.0	44500	4950	4.6
16.0	15.0	106.0	47700	5300	5.2
18.0	15.9	112.5	50500	5625	5.9
20.0	16.8	118.6	53400	5930	6.5
22.0	17.6	124.4	56000	6220	7.2
24.0	18.4	129.8	58500	6490	7.9
26.0	19.1	135.3	60700	6765	8.5
28.0	19.8	140.3	62900	7015	9.1
30.0	20.5	145.3	65200	7265	9.8

DIAMETER—38 INCHES

Area 7.876 sq. ft. — 3 Feet 2 Inches — n = 0.0108

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	1.23	9.69	4350	484	0.04
0.2	1.73	13.6	6120	680	0.07
0.3	2.12	16.7	7500	835	0.11
0.4	2.45	19.3	8670	965	0.14
0.5	2.74	21.6	9700	1080	0.18
0.6	3.01	23.7	10700	1185	0.21
0.7	3.24	25.5	11500	1275	0.24
0.8	3.47	27.3	12300	1365	0.28
0.9	3.68	29.0	13000	1450	0.31
1.0	3.88	30.5	13700	1525	0.35
1.5	4.76	37.5	16800	1875	0.52
2.0	5.48	43.2	19400	2160	0.70
3.0	6.72	52.9	23800	2645	1.1
4.0	7.76	61.1	27500	3055	1.4
5.0	8.68	68.4	30700	3420	1.8
6.0	9.50	74.8	33600	3740	2.1
7.0	10.3	81.2	36400	4060	2.5
8.0	11.0	86.7	38900	4335	2.8
9.0	11.6	91.3	41000	4565	3.1
10.0	12.3	96.9	43500	4845	3.5
12.0	13.4	105.8	47400	5290	4.2
14.0	14.5	114.2	51300	5710	4.9
16.0	15.5	122.1	54800	6105	5.6
18.0	16.5	129.6	58400	6480	6 3
20.0	17.4	136.7	61600	6835	7.0
22.0	18.2	143.2	64400	7160	7.7
24.0	19.0	149.6	67200	7480	8.4
26.0	19.8	155.7	70000	7785	9.1
28.0	20.5	161.6	72600	8080	9.8

DIAMETER—40 INCHES

Area 8.727 sq. ft. 3 Feet 4 Inches n = 0.0109

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	1.26	11.0	4940	550	0.04
0.2	1.78	15.5	6980	775	0.07
0.3	2.18	19.0	8550	950	0.11
0.4	2.52	22.0	9880	1100	0.15
0.5	2.81	24.5	11000	1225	0.18
0.6	3.08	26.9	12100	1345	0.22
0.7	3.33	29.1	13100	1455	0.26
0.8	3.56	31.1	13900	1555	0.29
0.9	3.78	33.0	14800	1650	0.33
1.0	3.98	34.7	15600	1735	0.37
1.5	4.88	42.5	19100	2125	0.55
2.0	5.62	49.1	22000	2455	0.73
3.0	6.89	60.1	27000	3005	1.1
4.0	7.96	69.5	31200	3475	1.5
5.0	8.90	77.7	34900	3885	1.8
6.0	9.76	85.2	38300	4260	2.2
7.0	10.5	92.0	41200	4600	2.6
8.0	11.3	98.2	44300	4910	2.9
9.0	11.9	103.9	46600	5195	3.3
10.0	12.6	109.8	49400	5490	3.7
12.0	13.8	120.3	54100	6015	4.4
14.0	14.9	129.9	58400	6495	5.2
16.0	15.9	138.9	62300	6945	5.9
18.0	16.9	147.2	66300	7360	6.6
20.0	17.8	155.3	69800	7765	7.4
22.0	18.7	162.9	73300	8145	8.1
24.0	19.5	170.2	76500	8510	8.8
26.0	20.3	177.2	79700	8860	9.6

DIAMETER—42 INCHES

Area 9.621 sq. ft. | 3 Feet 6 Inches | n = 0.0109

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	1.30	12.5	5610	625	0.04
0.2	1.84	17.7	7950	885	0.08
0.3	2.25	21.6	9720	1080	0.12
0.4	2.60	25.0	11200	1250	0.16
0.5	2.91	27.9	12600	1395	0.20
0.6	3.19	30.7	13800	1535	0.24
0.7	3.44	33.1	14900	1655	0.28
0.8	3.68	35.4	15900	1770	0.31
0.9	3.90	37.5	16800	1875	0.35
1.0	4.11	39.6	17800	1980	0.39
1.5	5.04	48.5	21800	2425	0.59
2.0	5.82	56.0	25300	2800	0.79
3.0	7.13	68.6	30800	3430	1.2
4.0	8.23	79.2	35600	3960	1.6
5.0	9.20	88.5	39800	4425	2.0
6.0	10.1	97.1	43600	4855	2.4
7.0	10.9	104.7	47100	5235	2.8
8.0	11.6	111.8	50100	5590	3.1
9.0	12.3	118.7	53200	5935	3.5
10.0	13.0	125.2	56200	6260	3.9
12.0	14.3	137.5	61800	6875	4.7
14.0	15.4	148.1	66500	7405	5.5
16.0	16.5	158.4	71300	7920	6.3
18.0	17.5	168.4	75600	8420	7.1
20.0	18.4	177.1	79500	8855	7.9
22.0	19.3	185.5	83400	9275	8.8
24.0	20.2	194.4	87300	9720	9.5

DIAMETER—44 INCHES

Area 10.559 sq. ft. 3 Feet 8 Inches $n = 0.0109$

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	1.34	14.2	6373	710	0.04
0.2	1.89	20.0	8960	1000	0.08
0.3	2.32	24.5	11000	1225	0.13
0.4	2.68	28.3	12700	1415	0.17
0.5	3.00	31.7	14200	1585	0.21
0.6	3.28	34.6	15600	1730	0.25
0.7	3.55	37.5	16800	1875	0.29
0.8	3.79	40.0	18000	2000	0.34
0.9	4.02	42.4	19100	2120	0.38
1.0	4.24	44.7	20200	2235	0.42
1.5	5.19	54.8	24600	2740	0.63
2.0	5.99	63.2	28400	3160	0.83
3.0	7.34	77.5	34800	3875	1.3
4.0	8.48	89.5	40200	4475	1.7
5.0	9.48	100.2	44900	5010	2.1
6.0	10.4	109.6	49300	5480	2.5
7.0	11.2	118.4	53100	5920	2.9
8.0	12.0	126.5	56900	6325	3.4
9.0	12.7	134.3	60200	6715	3.8
10.0	13.4	141.4	63500	7070	4.2
12.0	14.7	155.2	69700	7760	5.0
14.0	15.9	168.0	75400	8400	5.8
16.0	17.0	179.6	80600	8980	6.7
18.0	18.0	190.0	85300	9500	7.5
20.0	19.0	200.8	90100	10040	8.4
22.0	19.9	209.8	94400	10490	9.2
24.0	20.8	219.3	98600	10965	10.0

DIAMETER—46 INCHES

Area 11.541 sq. ft. 3 Feet 10 Inches n = 0.0109

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	1.38	15.9	7150	795	0.05
0.2	1.96	22.6	10100	1130	0.09
0.3	2.39	27.6	12400	1380	0.13
0.4	2.77	32.0	14400	1600	0.18
0.5	3.09	35.7	16000	1785	0.22
0.6	3.39	39.1	17600	1955	0.27
0.7	3.66	42.2	19000	2110	0.31
0.8	3.91	45.1	20300	2255	0.36
0.9	4.15	47.9	21500	2395	0.40
1.0	4.37	50.5	22700	2525	0.44
1.5	5.36	61.8	27800	3090	0.67
2.0	6.18	71.3	32000	3565	0.89
3.0	7.58	87.5	39300	4375	1.3
4.0	8.75	100.9	45400	5045	1.8
5.0	9.78	112.9	50700	5645	2.2
6.0	10.7	123.6	55500	6180	2.7
7.0	11.6	133.5	60200	6675	3.1
8.0	12.4	142.8	64300	7140	3.6
9.0	13.1	151.4	67900	7570	4.0
10.0	13.8	159.7	71600	7985	4.4
12.0	15.2	175.4	78800	8770	5.3
14.0	16.4	188.8	85000	9440	6.2
16.0	17.5	202.0	90700	10100	7.1
18.0	18.6	214.0	96500	10700	8.0
20.0	19.6	226.0	101000	11300	8.9
22.0	20.5	236.6	106000	11830	9.8

DIAMETER—48 INCHES

Area 12.566 sq. ft. 4 Feet $n = 0.011$

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	1.40	17.6	7900	880	0.05
0.2	1.98	24.9	11200	1245	0.09
0.3	2.43	30.6	13700	1530	0.14
0.4	2.81	35.3	15900	1765	0.18
0.5	3.14	39.5	17700	1975	0.23
0.6	3.44	43.2	19400	2160	0.27
0.7	3.71	46.6	20900	2330	0.32
0.8	3.97	49.9	22400	2495	0.37
0.9	4.21	52.9	23800	2645	0.41
1.0	4.44	55.8	25100	2790	0.46
1.5	5.44	68.4	30700	3420	0.69
2.0	6.28	78.9	35400	3945	0.91
3.0	7.69	96.6	43400	4830	1.3
4.0	8.88	111.6	50100	5580	1.8
5.0	9.93	124.7	56000	6235	2.3
6.0	10.9	136.6	61500	6830	2.8
7.0	11.7	147.5	66000	7375	3.2
8.0	12.6	157.7	71100	7885	3.7
9.0	13.3	167.4	75100	8370	4.1
10.0	14.0	176.3	79000	8815	4.6
12.0	15.4	193.1	86900	9655	5.5
14.0	16.6	208.6	93700	10430	6.4
16.0	17.8	223.0	100000	11150	7.3
18.0	18.8	236.6	106000	11830	8.2
20.0	19.9	249.4	112000	12470	9.1
22.0	20.8	261.6	117000	13080	10.1

DIAMETER—50 INCHES

Area 13.635 sq. ft. 4 Feet 2 Inches n = 0.011

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	1.44	19.6	8820	980	0.05
0.2	2.04	27.8	12500	1390	0.10
0.3	2.50	34.1	15300	1705	0.15
0.4	2.88	39.3	17600	1965	0.19
0.5	3.22	43.9	19700	2195	0.24
0.6	3.53	48.2	21600	2410	0.29
0.7	3.82	52.2	23400	2610	0.34
0.8	4.08	55.6	25000	2780	0.39
0.9	4.33	59.0	26500	2950	0.44
1.0	4.56	62.3	27900	3115	0.49
1.5	5.59	76.2	34300	3810	0.73
2.0	6.45	87.9	39500	4395	0.97
3.0	7.92	108.0	48500	5400	1.5
4.0	9.13	124.5	55900	6225	2.0
5.0	10.2	139.1	62400	6955	2.5
6.0	11.2	152.3	68600	7615	2.9
7.0	12.1	164.8	74100	8240	3.4
8.0	12.9	175.9	79000	8795	3.9
9.0	13.7	186.5	83900	9325	4.4
10.0	14.4	196.8	88200	9840	4.9
12.0	15.8	215.6	96800	10780	5.8
14.0	17.1	232.8	105000	11640	6.8
16.0	18.3	248.9	112000	12445	7.8
18.0	19.4	264.1	119000	13205	8.7
20.0	20.4	278.2	125000	13910	9.7

DIAMETER—52 INCHES

Area 14.748 sq. ft. 4 Feet 4 Inches $n = 0.011$

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	1.48	21.8	9800	1090	0.05
0.2	2.09	30.8	13800	1540	0.10
0.3	2.56	37.8	16900	1890	0.15
0.4	2.96	43.6	19600	2180	0.20
0.5	3.31	48.8	21900	2440	0.25
0.6	3.62	53.4	24000	2670	0.30
0.7	3.91	57.7	25900	2885	0.36
0.8	4.18	61.7	27700	3085	0.41
0.9	4.44	65.5	29400	3275	0.46
1.0	4.68	69.0	31000	3450	0.51
1.5	5.72	84.2	37900	4210	0.76
2.0	6.62	97.6	43900	4880	0.99
3.0	8.11	119.6	53800	5980	1.5
4.0	9.36	138.0	62100	6900	2.0
5.0	10.5	154.1	69600	7705	2.5
6.0	11.5	168.8	76200	8440	3.0
7.0	12.4	182.4	82200	9120	3.6
8.0	13.2	195.0	87500	9750	4.1
9.0	14.0	206.8	92800	10340	4.6
10.0	14.8	218.0	98000	10900	5.1
12.0	16.2	238.9	107000	11945	6.1
14.0	17.5	258.0	116000	12900	7.1
16.0	18.7	275.8	124000	13790	8.1
18.0	19.8	292.6	131000	14630	9.1
20.0	20.9	308.5	138000	15425	10.2

DIAMETER—54 INCHES

Area 15.904 sq. ft. 4 Feet 6 Inches $n = 0.011$

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	1.52	24.2	10900	1210	0.05
0.2	2.15	34.2	15400	1710	0.11
0.3	2.63	41.8	18800	2090	0.16
0.4	3.03	48.2	21600	2410	0.21
0.5	3.39	53.9	24200	2695	0.27
0.6	3.72	59.2	26600	2960	0.32
0.7	4.01	63.8	28700	3190	0.37
0.8	4.29	68.2	30700	3410	0.43
0.9	4.55	72.4	32500	3620	0.48
1.0	4.80	76.3	34300	3815	0.53
1.5	5.87	93.3	41900	4665	0.80
2.0	6.79	108.0	48500	5400	1.1
3.0	8.33	132.5	59500	6625	1.6
4.0	9.62	152.9	68700	7645	2.2
5.0	10.7	170.7	76400	8535	2.7
6.0	11.8	187.0	84300	9350	3.2
7.	12.7	202.0	90700	10100	3.7
8.0	13.6	216.0	97100	10800	4.3
9.0	14.4	229.1	103000	11455	4.8
10.0	15.2	241.0	109000	12050	5.3
12.0	16.6	264.6	119000	13230	6.4
14.0	18.0	285.8	129000	14290	7.5
16.0	19.2	305.4	137000	15270	8.6
18.0	20.4	323.8	146000	16190	9.6

DIAMETER—56 INCHES

Area 17.104 sq. ft. 4 Feet 8 Inches n = 0.011

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	1.55	26.5	11900	1325	0.06
0.2	2.19	37.5	16800	1875	0.11
0.3	2.69	46.1	20700	2305	0.16
0.4	3.10	53.2	23800	2660	0.22
0.5	3.47	59.4	26700	2970	0.28
0.6	3.80	65.2	29200	3260	0.34
0.7	4.11	70.4	31600	3520	0.39
0.8	4.39	75.2	33700	3760	0.45
0.9	4.66	79.8	35800	3990	0.51
1.0	4.91	84.1	37700	4205	0.56
1.5	6.02	102.8	46300	5140	0.84
2.0	6.94	118.7	53300	5935	1.1
3.0	8.50	145.4	65300	7270	1.6
4.0	9.83	168.2	75600	8410	2.2
5.0	11.0	187.6	84600	9380	2.8
6.0	12.0	205.6	92300	10280	3.4
7.0	13.0	222.1	100000	11105	3.9
8.0	13.9	237.4	107000	11870	4.5
9.0	14.7	251.8	113000	12590	5.0
10.0	15.5	265.7	119000	13285	5.6
12.0	17.0	291.3	131000	14565	6.7
14.0	18.4	314.0	141000	15700	7.9
16.0	19.6	335.8	151000	16790	9.0
18.0	20.8	356.3	160000	17815	10.1

DIAMETER—58 INCHES

Area 18.348 sq. ft. 4 Feet 10 Inches $n = 0.011$

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	1.59	29.2	13100	1460	0.06
0.2	2.25	41.3	18500	2065	0.12
0.3	2.75	50.5	22600	2525	0.18
0.4	3.18	58.3	26200	2915	0.24
0.5	3.55	65.1	29300	3255	0.29
0.6	3.89	71.4	32000	3570	0.35
0.7	4.20	77.1	34600	3855	0.41
0.8	4.48	82.2	36900	4110	0.47
0.9	4.77	87.5	39300	4375	0.53
1.0	5.03	92.2	41400	4610	0.59
1.5	6.16	113.0	50700	5650	0.88
2.0	7.11	130.5	58700	6525	1.2
3.0	8.71	159.8	71800	7990	1.8
4.0	10.1	184.4	83200	9220	2.4
5.0	11.2	206.2	92300	10310	2.9
6.0	12.3	226.0	101000	11300	3.5
7.0	13.3	243.8	110000	12190	4.1
8.0	14.2	260.9	117000	13045	4.7
9.0	15.1	276.7	124000	13835	5.3
10.0	15.9	291.7	131000	14585	5.9
12.0	17.4	319.4	143000	15970	7.0
14.0	18.8	345.1	155000	17255	8.2
16.0	20.1	368.8	166000	18440	9.4

DIAMETER—60 INCHES

Area 19.635 sq. ft. 5 Feet $n = 0.011$

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	1.63	32.1	14400	1605	0.06
0.2	2.30	45.2	20300	2260	0.12
0.3	2.82	55.4	24900	2770	0.19
0.4	3.25	63.8	28700	3190	0.25
0.5	3.63	71.4	32000	3570	0.31
0.6	3.98	78.3	35100	3915	0.37
0.7	4.30	84.6	37900	4230	0.43
0.8	4.60	90.4	40600	4520	0.49
0.9	4.87	95.8	42900	4790	0.55
1.0	5.14	100.9	45400	5045	0.61
1.5	6.30	123.9	55600	6195	0.92
2.0	7.28	143.1	64200	7155	1.2
3.0	8.92	175.4	78700	8770	1.9
4.0	10.3	202.1	90900	10105	2.5
5.0	11.5	225.8	101000	11290	3.1
6.0	12.6	247.4	111000	12370	3.7
7.0	13.6	267.1	120000	13355	4.3
8.0	14.6	286.0	129000	14300	4.9
9.0	15.4	302.8	136000	15140	5.5
10.0	16.3	319.0	144000	15950	6.1
12.0	17.8	350.0	157000	17500	7.4
14.0	19.2	377.8	169000	18890	8.6
16.0	20.6	403.5	182000	20175	9.8

DIAMETER—66 INCHES

Area 23.76 sq. ft. **5 Feet 6 Inches** **n = 0.011**

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	1.73	41.1	2055	0.07
0.2	2.45	58.2	2910	0.14
0.3	3.00	71.3	3565	0.21
0.4	3.46	82.2	4110	0.28
0.5	3.87	91.9	4595	0.35
0.6	4.24	100.7	5035	0.42
0.7	4.58	108.8	5440	0.49
0.8	4.89	116.2	5810	0.56
0.9	5.19	123.3	6165	0.63
1.0	5.47	130.0	6500	0.70
1.5	6.70	159.2	7960	1.0
2.0	7.74	183.9	9195	1.4
3.0	9.48	225.2	11260	2.1
4.0	10.9	259.0	12950	2.8
5.0	12.2	289.9	14495	3.5
6.0	13.4	318.6	15930	4.2
7.0	14.5	344.0	17200	4.9
8.0	15.5	367.5	18375	5.6
9.0	16.4	390.3	19515	6.3
10.0	17.3	411.5	20575	7.0
12.0	19.0	451.4	22570	8.4
14.0	20.5	486.8	24340	9.8

DIAMETER—72 INCHES

Area 28.27 sq. ft. | 6 Feet | n = 0.011

Head in Feet required for Friction in 1000 Feet of Pipe	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	1.83	51.7	2585	0.08
0.2	2.59	73.2	3660	0.16
0.3	3.17	89.6	4480	0.23
0.4	3.66	103.5	5175	0.31
0.5	4.09	115.6	5780	0.39
0.6	4.49	127.0	6350	0.47
0.7	4.85	137.1	6855	0.55
0.8	5.18	146.5	7325	0.62
0.9	5.50	155.5	7775	0.70
1.0	5.79	163.7	8185	0.77
1.5	7.09	200.5	10025	1.2
2.0	8.20	231.8	11590	1.6
3.0	10.0	282.7	14135	2.3
4.0	11.6	327.7	16385	3.1
5.0	13.0	366.4	18320	3.9
6.0	14.2	401.5	20075	4.7
7.0	15.3	433.7	21685	5.5
8.0	16.4	463.7	23185	6.2
9.0	17.4	491.1	24555	7.0
10.0	18.3	518.0	25900	7.8
12.0	20.1	567.5	28375	9.4
14.0	21.7	612.7	30635	10.9

DIAMETER—78 INCHES

Area 33.18 sq. ft. 6 Feet 6 Inches $n = 0.011$

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	1.92	63.7	3185	0.09
0.2	2.72	90.3	4515	0.17
0.3	3.33	110.5	5525	0.26
0.4	3.85	127.8	6390	0.34
0.5	4.31	143.7	7185	0.43
0.6	4.72	156.6	7830	0.52
0.7	5.09	168.9	8445	0.60
0.8	5.45	180.8	9040	0.69
0.9	5.78	191.8	9590	0.78
1.0	6.09	202.2	10110	0.86
1.5	7.46	247.5	12375	1.3
2.0	8.62	286.0	14300	1.7
3.0	10.5	349.8	17490	2.6
4.0	12.2	403.8	20190	3.4
5.0	13.6	452.0	22600	4.3
6.0	14.9	495.4	24770	5.2
7.0	16.1	534.9	26745	6.0
8.0	17.2	571.8	28590	6.9
9.0	18.3	607.0	30350	7.8
10.0	19.3	639.1	31955	8.6
12.0	21.1	700.2	35010	10.3

DIAMETER—84 INCHES

Area 38.48 sq. ft. 7 Feet n = 0.011

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	2.02	77.7	3885	0.10
0.2	2.86	110.1	5505	0.19
0.3	3.49	134.3	6715	0.28
0.4	4.04	155.5	7775	0.38
0.5	4.52	174.1	8705	0.47
0.6	4.94	190.1	9505	0.57
0.7	5.34	205.5	10275	0.66
0.8	5.71	219.8	10990	0.76
0.9	6.06	233.2	11660	0.85
1.0	6.39	245.8	12290	0.95
1.5	7.82	301.0	15050	1.4
2.0	9.04	347.9	17395	1.9
3.0	11.1	427.1	21355	2.8
4.0	12.8	491.5	24575	3.7
5.0	14.3	549.2	27460	4.7
6.0	15.6	601.5	30075	5.7
7.0	16.9	650.0	32500	6.6
8.0	18.1	696.5	34825	7.6
9.0	19.2	737.5	36875	8.5
10.0	20.2	777.0	38850	9.5

DIAMETER—90 INCHES

Area 44.18 sq. ft. | 7 Feet 6 Inches | n = 0.011

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	2.11	93.2	4660	0.10
0.2	2.98	131.7	6585	0.21
0.3	3.65	161.3	8065	0.31
0.4	4.22	186.4	9320	0.41
0.5	4.72	208.5	10425	0.52
0.6	5.17	228.4	11420	0.62
0.7	5.58	246.5	12325	0.73
0.8	5.97	263.7	13185	0.83
0.9	6.33	279.7	13985	0.93
1.0	6.67	294.6	14730	1.0
1.5	8.17	360.9	18045	1.5
2.0	9.43	416.6	20830	2.1
3.0	11.6	510.3	25515	3.1
4.0	13.3	589.3	29465	4.1
5.0	15.0	662.7	33135	5.2
6.0	16.3	720.1	36005	6.2
7.0	17.7	782.0	39100	7.3
8.0	18.9	835.0	41750	8.3
9.0	20.0	883.6	44180	9.3

WOOD PIPE is easily tapped, under pressure, for house service connections.

DIAMETER—96 INCHES

Area 50.27 sq. ft. 8 Feet n = 0.011

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	2.19	110.1	5505	0.11
0.2	3.11	156.3	7815	0.22
0.3	3.81	191.5	9575	0.34
0.4	4.39	220.7	11035	0.45
0.5	4.92	247.3	12365	0.56
0.6	5.38	270.4	13520	0.67
0.7	5.81	292.0	14600	0.79
0.8	6.22	312.7	15635	0.90
0.9	6.59	331.3	16565	1.0
1.0	6.95	349.2	17460	1.1
1.5	8.52	428.0	21400	1.7
2.0	9.83	494.1	24705	2.2
3.0	12.0	604.7	30235	3.4
4.0	13.9	699.0	34950	4.5
5.0	15.5	781.1	39055	5.6
6.0	17.0	855.5	42775	6.7
7.0	18.4	923.9	46195	7.9
8.0	19.7	989.0	49450	9.0

DIAMETER—102 INCHES

Area 56.75 sq. ft. — 8 Feet 6 Inches — $n = 0.011$

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	2.28	129.4	6470	0.12
0.2	3.23	183.2	9160	0.24
0.3	3.95	224.1	11205	0.36
0.4	4.57	259.3	12965	0.49
0.5	5.10	289.4	14470	0.61
0.6	5.59	317.2	15860	0.73
0.7	6.04	342.7	17135	0.85
0.8	6.46	366.6	18330	0.97
0.9	6.85	388.7	19435	1.1
1.0	7.22	409.6	20480	1.2
1.5	8.85	500.8	25040	1.8
2.0	10.2	578.8	28940	2.4
3.0	12.5	708.2	35410	3.6
4.0	14.4	818.8	40940	4.9
5.0	16.1	915.3	45765	6.1
6.0	17.7	1004.5	50225	7.3
7.0	19.1	1083.8	54190	8.5
8.0	20.4	1158.8	57940	9.7

Water in WOOD PIPE is warmer in winter and cooler in summer than in metal pipe.

DIAMETER—108 INCHES

Area 63.62 sq. ft. 9 Feet n = 0.011

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	2.36	150.1	7505	0.13
0.2	3.34	212.5	10625	0.26
0.3	4.10	260.8	13040	0.39
0.4	4.73	300.9	15045	0.52
0.5	5.29	336.5	16825	0.65
0.6	5.79	368.3	18415	0.78
0.7	6.26	398.2	19910	0.91
0.8	6.69	425.6	21280	1.0
0.9	7.10	451.7	22585	1.2
1.0	7.48	476.0	23800	1.3
1.5	9.17	583.0	29150	1.9
2.0	10.6	672.4	33620	2.6
3.0	13.0	827.1	41355	3.9
4.0	15.0	954.3	47715	5.2
5.0	16.7	1064.3	53215	6.5
6.0	18.3	1166.1	58305	7.8
7.0	19.8	1259.6	62980	9.1

WOOD PIPE is not affected by acids and is the ideal pipe to use for transmitting mineralized water.

DIAMETER—114 INCHES

Area 70.88 sq. ft. 9 Feet 6 Inches $n = 0.011$

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	2.44	173.0	8650	0.14
0.2	3.46	245.3	12265	0.28
0.3	4.24	300.5	15025	0.42
0.4	4.89	346.6	17330	0.56
0.5	5.47	387.7	19385	0.70
0.6	5.99	424.6	21230	0.83
0.7	6.47	458.6	22930	0.97
0.8	6.92	490.5	24525	1.1
0.9	7.34	520.3	26015	1.3
1.0	7.73	548.2	27410	1.4
1.5	9.47	671.2	33560	2.1
2.0	10.9	774.7	38735	2.8
3.0	13.4	951.0	47550	4.2
4.0	15.5	1096.5	54825	5.6
5.0	17.3	1225.5	61275	7.0
6.0	18.9	1342.5	67125	8.3
7.0	20.5	1450.9	72545	9.7

If you desire prices, specifications or estimates, write us and we will gladly supply you.

DIAMETER—120 INCHES

Area 78.54 sq. ft. 10 Feet $n = 0.011$

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	2.52	197.9	9895	0.15
0.2	3.57	280.4	14020	0.30
0.3	4.37	343.2	17160	0.44
0.4	5.05	396.6	19830	0.59
0.5	5.64	443.0	22150	0.74
0.6	6.18	485.4	24270	0.89
0.7	6.68	524.7	26235	1.0
0.8	7.14	560.8	28040	1.2
0.9	7.57	594.6	29730	1.3
1.0	7.98	627.5	31375	1.5
1.5	9.78	768.1	38405	2.2
2.0	11.3	885.9	44295	3.0
3.0	13.8	1086.2	54310	4.4
4.0	16.0	1252.7	62635	5.9
5.0	17.9	1401.9	70095	7.4
6.0	19.6	1535.5	76775	8.9

WOOD PIPE is a non-conductor of heat or cold and does not, therefore, require as deep a covering of earth as metal pipe.

DIAMETER—126 INCHES

Area 86.59 sq. ft. 10 Feet 6 Inches n = 0.011

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	2.60	225.1	11255	0.16
0.2	3.68	318.7	15935	0.32
0.3	4.51	390.5	19525	0.48
0.4	5.20	450.3	22515	0.63
0.5	5.82	504.0	25200	0.80
0.6	6.37	551.6	27580	0.95
0.7	6.88	595.7	29785	1.1
0.8	7.36	637.3	31865	1.3
0.9	7.81	676.3	33815	1.4
1.0	8.23	712.6	35630	1.6
1.5	10.1	874.6	43730	2.4
2.0	11.6	1004.4	50220	3.1
3.0	14.2	1229.6	61480	4.7
4.0	16.4	1420.1	71005	6.2
5.0	18.4	1593.3	79665	7.9

DIAMETER—2 INCHES

Area 0.0218 sq. ft. Continued from Page 41 n = 0.0082

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
32.0	3.48	0.076	34.1	3.80	0.28
34.0	3.58	0.078	35.0	3.90	0.30
36.0	3.69	0.080	35.8	4.00	0.32
38.0	3.79	0.083	37.3	4.15	0.34
40.0	3.89	0.085	38.2	4.25	0.35
42.0	3.98	0.087	39.0	4.35	0.37
44.0	4.08	0.089	40.0	4.45	0.39
46.0	4.17	0.091	40.8	4.55	0.41
48.0	4.26	0.093	41.8	4.65	0.42
50.0	4.35	0.095	42.6	4.75	0.44

DIAMETER—132 INCHES

Area 95.03 sq. ft. 11 Feet n = 0.011

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	2.67	253.7	12685	0.17
0.2	3.78	359.2	17960	0.33
0.3	4.64	440.9	22045	0.51
0.4	5.35	508.4	25420	0.67
0.5	5.98	568.3	28415	0.84
0.6	6.55	622.4	31120	1.0
0.7	7.08	672.8	33640	1.2
0.8	7.57	719.4	35970	1.3
0.9	8.03	763.1	38155	1.5
1.0	8.46	804.4	40220	1.7
1.5	10.4	988.3	49415	2.5
2.0	12.0	1140.3	57015	3.4
3.0	14.6	1387.4	69370	5.0
4.0	16.9	1606.0	80300	6.7
5.0	18.9	1796.1	89805	8.3

DIAMETER—3 INCHES

Area 0.0491 sq. ft. Continued from Page 42 n = 0.0084

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
32.0	4.70	0.231	103.7	11.55	0.51
34.0	4.84	0.238	106.8	11.90	0.55
36.0	4.98	0.244	109.5	12.20	0.58
38.0	5.12	0.251	112.7	12.55	0.61
40.0	5.25	0.258	115.8	12.90	0.64
42.0	5.38	0.264	118.5	13.20	0.67
44.0	5.51	0.270	121.3	13.50	0.71
46.0	5.63	0.276	124.0	13.80	0.74
48.0	5.75	0.282	126.5	14.10	0.77
50.0	5.87	0.288	129.3	14.40	0.80

DIAMETER—138 INCHES

Area 103.87 sq. ft. 11 Feet 6 Inches n = 0.011

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	2.75	285.6	14280	0.18
0.2	3.89	404.1	20205	0.35
0.3	4.77	495.5	24775	0.53
0.4	5.50	571.3	28565	0.70
0.5	6.16	639.8	31990	0.89
0.6	6.74	700.1	35005	1.1
0.7	7.28	756.2	37810	1.2
0.8	7.78	808.1	40405	1.4
0.9	8.26	858.0	42900	1.6
1.0	8.70	904.2	45210	1.8
1.5	10.6	1101.0	55050	2.6
2.0	12.3	1277.6	63880	3.5
3.0	15.1	1568.4	78420	5.3
4.0	17.4	1807.3	90365	7.1
5.0	19.5	2025.5	101275	8.9

DIAMETER—4 INCHES

Area 0.0873 sq. ft. Continued from Page 43 n = 0.0086

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
32.0	5.74	0.501	225.0	25.05	0.77
34.0	5.91	0.516	232.0	25.80	0.81
36.0	6.08	0.531	238.0	26.50	0.86
38.0	6.25	0.546	245.0	27.30	0.91
40.0	6.41	0.560	251.0	28.00	0.96
42.0	6.57	0.574	257.0	28.70	1.0
44.0	6.72	0.587	264.0	29.35	1.1
46.0	6.88	0.601	270.0	30.05	1.1
48.0	7.02	0.613	275.0	30.65	1.2
50.0	7.16	0.625	281.0	31.25	1.2

DIAMETER—144 INCHES

Area 113.1 sq. ft. 12 Feet n = 0.011

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	2.82	318.9	15945	0.19
0.2	3.99	451.3	22565	0.37
0.3	4.89	553.1	27655	0.56
0.4	5.64	637.9	31895	0.74
0.5	6.32	714.8	35740	0.93
0.6	6.92	782.7	39135	1.1
0.7	7.47	844.9	42245	1.3
0.8	8.00	904.8	45240	1.5
0.9	8.47	958.0	47900	1.7
1.0	8.93	1010.0	50500	1.9
1.5	10.9	1232.8	61640	2.8
2.0	12.6	1425.1	71255	3.7
3.0	15.4	1741.7	87085	5.5
4.0	17.8	2013.2	100660	7.4
5.0	19.9	2250.7	112535	9.2

DIAMETER—5 INCHES

Area 0.1364 sq. ft. Continued from Page 44 n = 0.0087

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
32.0	6.64	0.906	407.0	45.30	1.0
34.0	6.84	0.934	419.0	46.70	1.1
36.0	7.04	0.961	431.0	48.05	1.2
38.0	7.24	0.988	444.0	49.40	1.2
40.0	7.43	0.013	455.0	50.65	1.3
42.0	7.61	1.038	466.0	51.90	1.4
44.0	7.79	1.062	477.0	53.10	1.4
46.0	7.96	1.086	488.0	54.30	1.5
48.0	8.14	1.111	499.0	55.55	1.5
50.0	8.30	1.132	508.0	56.60	1.6

DIAMETER—156 INCHES

Area 132.73 sq. ft. 13 Feet $n = 0.011$

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	2.96	392.9	19645	0.20
0.2	4.19	556.1	27805	0.41
0.3	5.13	680.9	34045	0.61
0.4	5.92	785.8	39290	0.82
0.5	6.62	878.7	43935	1.0
0.6	7.26	963.6	48180	1.2
0.7	7.84	1040.6	52030	1.4
0.8	8.38	1112.3	55615	1.6
0.9	8.89	1180.0	59000	1.8
1.0	9.37	1243.7	62185	2.0
1.5	11.5	1526.4	76320	3.1
2.0	13.2	1752.0	87600	4.1
3.0	16.2	2150.2	107510	6.1
4.0	18.7	2482.1	124105	8.1
5.0	21.0	2787.3	139365	10.3

DIAMETER—6 INCHES

Area 0.1963 sq. ft. Continued from Page 45 $n = 0.0088$

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
32.0	7.54	1.48	665.0	74.0	1.3
34.0	7.78	1.53	687.0	76.5	1.4
36.0	8.00	1.57	705.0	78.5	1.5
38.0	8.22	1.62	727.0	81.0	1.6
40.0	8.44	1.66	745.0	83.0	1.7
42.0	8.65	1.70	764.0	85.0	1.7
44.0	8.85	1.74	781.0	87.0	1.8
46.0	9.05	1.78	800.0	89.0	1.9
48.0	9.25	1.82	817.0	91.0	2.0
50.0	9.44	1.86	835.0	93.0	2.1

DIAMETER—168 INCHES

Area 153.94 sq. ft. 14 Feet $n = 0.011$

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
0.1	3.10	477.2	23860	0.22
0.2	4.38	674.3	33715	0.45
0.3	5.37	826.7	41335	0.67
0.4	6.20	954.4	47720	0.90
0.5	6.93	1066.8	53340	1.1
0.6	7.60	1170.0	58500	1.4
0.7	8.20	1262.3	63115	1.6
0.8	8.77	1350.1	67505	1.8
0.9	9.30	1431.6	71580	2.0
1.0	9.81	1510.2	75510	2.2
1.5	12.0	1847.3	92365	3.4
2.0	13.9	2139.8	106990	4.5
3.0	17.0	2617.0	130850	6.8
4.0	19.6	3017.2	150860	9.0
5.0	21.9	3371.3	168565	11.2

DIAMETER—8 INCHES

Area 0.3491 sq. ft. Continued from Page 46 $n = 0.009$

Head in Feet required for Friction in 1000 Feet of Pipe.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	Gallons per Minute.	Discharge in Miner's Inches.	Velocity and Entrance Head in Feet.
32.0	9.05	3.16	1418.0	158.0	1.9
34.0	9.34	3.26	1464.0	163.0	2.0
36.0	9.60	3.35	1504.0	167.5	2.1
38.0	9.86	3.44	1544.0	172.0	2.3
40.0	10.11	3.53	1585.0	176.5	2.4
42.0	10.36	3.61	1622.0	180.5	2.5
44.0	10.61	3.72	1670.0	186.0	2.6
46.0	10.85	3.79	1702.0	189.5	2.7
48.0	11.07	3.87	1737.0	193.5	2.8
50.0	11.30	3.95	1772.0	197.5	3.0

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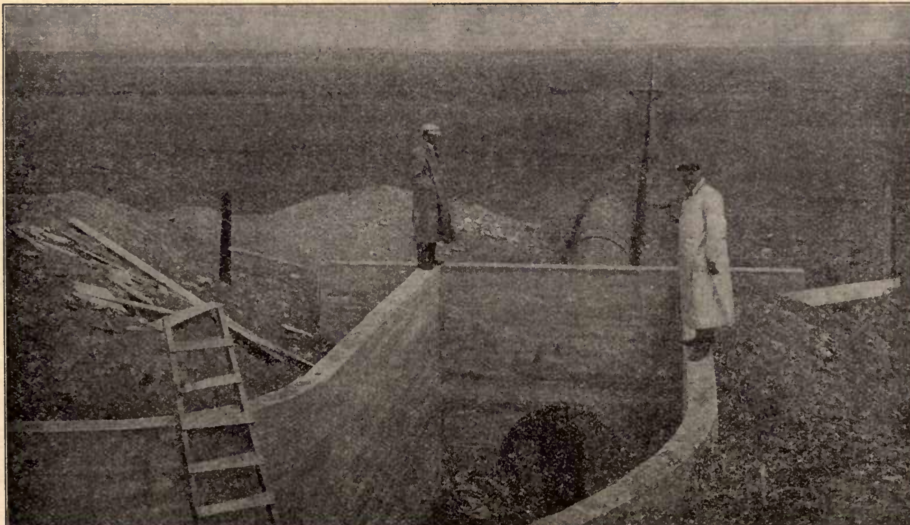

Continuous Stave Pipe—60 Inch Inside Diameter Pumping Line

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