



**Northwest Pipe
Company**

Performance-Based Design

Engineered Steel Water Pipe Systems

Key Design Details of Engineered Steel Water Pipe

Performance-Based Design

Steel pipe is designed to withstand internal pressures and resist external loads utilizing American Water Works Association (AWWA) Steel Pipe Design Manual M11 and AWWA Standards. Steel pipe's strength and versatility enable customized performance-based designs to meet even the most demanding criteria.

High Strength with Low Weight for Safety and Economy

Delivering tensile strength of 60,000 psi and higher, operating pressures from 150 to more than 850 psi, and bursting strengths commonly exceeding three times design working pressure, steel pipe offers unequalled safety and light weight.

Ductility and Reliability Under Stress

AWWA steel pipe typically delivers elongations well in excess of 20%. With its high toughness, steel pipe can withstand stresses and strains without fracturing under shocks from surge, water hammer, earthquakes, cave-ins, washouts, extreme temperature changes, traffic vibrations, unstable foundations, and blasting.

High Carrying Capacity for Increased Performance

Steel water pipe provides exceptionally high working pressure capability. AWWA compliant linings protect steel pipe from corrosion and ensure its ability to maintain its high flow capacity over the life of the pipeline.

Bottle-Tight Joints Eliminate Water Loss

Steel pipe joints do not depend on perfect trench grading or soil stability to maintain their watertight integrity. The resilient nature of steel pipe allows it to absorb soil stresses without affecting joint soundness.

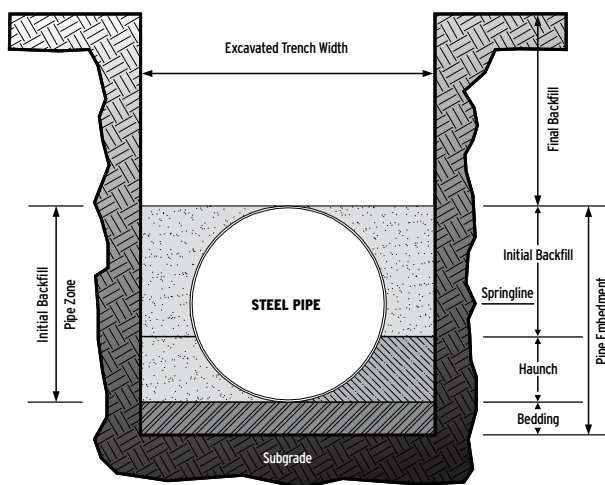
Adaptability for Ease in Engineering and Installation

Steel pipelines include a wide range of fittings and fully custom fabricated components to meet all special requirements.

Economy in Installation and Maintenance

Steel pipe's lower weight and smaller outside diameter not only reduce transportation and handling costs, but minimize excavation and backfill. Pipe sections as long as 60 feet minimize the number of field joints and reduce installation costs.

Bedding and Backfill / Trench Cross Section



Types of Recommended Joints

Rolled Groove Rubber Gasket Joint



Restrained Bell & Spigot Lap-welded Joint



Trench width shall be adequate to assure elimination of voids in the haunch area and/or proper placement and compaction of initial backfill materials.

Pipe embedment materials may be SC1, SC2, SC3 or as specified. Materials shall be placed evenly on both sides of pipe and compacted to a minimum of 75% standard proctor density per AASHTO T 99 or as specified.

Subgrade may need to be replaced or modified if trench bottom materials are unacceptable or unstable.

It's crucial. Every job you do
must use the highest quality
components available.
Northwest Pipe Company delivers.





Modulus of Soil Reaction, E' (psi)^a

Soil Stiffness Category	Soil Type ^b	AASHTO Soil Groups ^c	Depth of Cover in Feet	Compaction Level ^d			
				85%	90%	95%	100%
SC1	Clean, coarse-grained soils: SW, SP, GW, GP, or any soil beginning with one of these symbols with 12% or less passing a No. 200 sieve	A1, A3	2 - 5	700	1000	1600	2500
			5 - 10	1000	1500	2200	3300
			10 - 15	1050	1600	2400	3600
			15 - 20	1100	1700	2500	3800
SC2	Coarse-grained soils with fines: GM, GC, SM, SC, or any soil beginning with one of these symbols more than 12% fines. Sandy or gravelly fine-grained soils: CL, ML (or CL-ML, CL/ML, ML/CL) with more than 25% retained on a No. 200 sieve	A-2-4, A-2-5, A-2-6, or A-4 or A-6 soils with more than 25% retained on a No. 200 sieve	2 - 5	600	1000	1200	1900
			5 - 10	900	1400	1800	2700
			10 - 15	1000	1500	2100	3200
			15 - 20	1100	1600	2400	3700
SC3	Fine-grained soils: CL, ML (or CL-ML, CL/ML, ML/CL) with 25% or less retained on a No. 200 sieve	A-2-7, or A-4 or A-6 soils with 25% or less retained on a No. 200 sieve	2 - 5	500	700	1000	1500
			5 - 10	600	1000	1400	2000
			10 - 15	700	1200	1600	2300
			15 - 20	800	1300	1800	2600

Use $E' = 3000$ for compacted crushed rock or use $E' = 1000$ for dumped or slightly compacted crushed rock per U.S. Bureau of Reclamation Table 1A. For Soil Types SC1, SC2 or SC3 that are dumped or slightly compacted (<85% ^d) see Table 1A for E' values.

^a Derived from Hartley, James D. and Duncan, James M., "E' and Its Variation with Depth." Journal of Transportation, Division of ASCE, Sept. 1987.

^b ASTM D 2487, Standard Classification of Soils for Engineering Purposes.

^c AASHTO M 145, Classification of Soils and Soil Aggregate Mixtures.

^d Standard Proctor Densities in accordance with AASHTO T 99 are used with this table.

Performance-Based Pipe Design

Allowable fill - over top of pipe

Nominal Diameter (Available from 6 to 156 inches)	Pressure (psi)	Type 1 (E'= 700)	Type 2 (E'=1000)	Type 3 (E'=1200)	Type 4 (E'=1400)	Type 5 (E'=1600)	Type 6 (E'=2000)	Type 7 (E'=3000)
20	150	22	29	33	38	42	51	51
	200	22	29	33	38	42	51	73
	225	22	29	33	38	42	51	73
	250	23	29	34	38	43	51	73
	300	24	30	34	39	43	52	74
24	150	19	26	30	35	39	48	70
	200	19	26	30	35	39	48	68
	225	19	26	30	35	39	48	70
	250	20	27	31	35	40	49	71
	300	21	28	32	36	41	50	72
30	150	17	24	28	32	37	45	68
	200	17	24	28	33	37	46	68
	225	18	24	29	33	38	47	69
	250	19	25	30	34	38	47	69
	300	19	26	30	35	39	48	70
36	150	17	23	28	32	37	45	67
	200	17	23	28	32	37	45	68
	225	17	24	28	33	37	46	68
	250	18	24	29	33	38	46	68
	300	19	25	30	34	39	47	69
42	150	17	23	28	32	37	45	68
	200	17	23	28	32	37	46	68
	225	17	24	28	33	37	46	68
	250	18	25	29	34	38	47	69
	300	19	26	30	35	39	48	70
48	150	17	23	28	32	37	45	67
	200	17	23	28	32	37	45	68
	225	17	24	28	33	37	46	68
	250	18	25	29	33	38	46	68
	300	19	25	30	34	39	48	70
54	150	16	23	27	32	36	45	67
	200	17	23	28	32	36	45	67
	225	17	24	28	33	37	46	68
	250	18	24	28	33	37	46	68
	300	19	25	29	34	38	47	69
60	150	16	23	27	32	36	45	67
	200	17	23	27	32	36	45	67
	225	17	24	28	32	37	45	67
	250	17	24	28	33	37	46	68
	300	18	25	29	34	38	47	69
66	150	16	23	27	32	36	45	67
	200	17	23	27	32	36	45	67
	225	17	23	28	32	36	45	67
	250	17	24	28	32	37	46	68
	300	18	25	29	33	38	47	69
72	150	16	23	27	32	36	45	67
	200	16	23	27	32	36	45	67
	225	17	23	28	32	36	45	67
	250	17	24	28	32	37	45	68
	300	18	25	29	33	38	47	69

Steel pipe is adequate for the rated working pressures indicated for each nominal size plus an additional surge allowance of 50% of the working pressure. Working pressures far in excess of those listed are available, as are diameters up to 156 inches. E' is determined from Table 1. Varying soil types and compactive efforts can be utilized to develop the soil stiffness parameters (E'). Design based on use of steel meeting AWWA M11 requirements. Allowable fill based on cement-mortar lined and flexible-coated steel pipe with a vertical deflection limit of 3%. Manufacture of the pipe per all applicable AWWA Standards. Normal minimum depth of cover is 3 feet for HS-20 legal loads. Inquire when subject to off-road equipment or non-routine installations.

Suggested Specification of Steel Pipe for Water Transmission

Steel pipe shall be designed and manufactured in accordance with the latest edition of AWWA C200, AWWA M11 Steel Pipe Design Guidelines and other applicable AWWA Standards.

- Steel pipe shall be designed for a minimum _____ psi working pressure and _____ psi surge allowance (or project requirements whichever is greater).
- External load design shall be per AWWA M11 utilizing an E' of _____. Pipe shall be installed with bedding and backfill as detailed in AWWA C604.
- All pipe shall be designed with a minimum depth of cover of _____ (or project requirements whichever is greater).

Pipe and fittings shall be cement-mortar lined to AWWA C205 and coated with a three-layer tape coating per AWWA C214, or polyurethane coating per AWWA C222 or cement-mortar per AWWA C205. Above-ground or exposed pipe shall be coated with a liquid epoxy per AWWA C210 or polyurethane per AWWA C222. If specified, rubber gasketed joints shall be bonded to assure electrical continuity. After installation of the joint bonding wires and test leads, AWWA C214 and AWWA C222 coated pipe shall have joints wrapped with heat-shrink sleeves per AWWA C216. Cement-mortar coated pipe shall have joints completed with a cement-mortar diaper per AWWA C205.

Non-restrained joints shall be roll-grooved gasketed per AWWA C200 requirements. Restrained joints shall be single-lap welded per AWWA C206 or mechanical per AWWA C200 and or AWWA M11.

Fittings and specials shall be manufactured per AWWA C208. Flanges shall be steel slip-on per AWWA C207.

Pipe shall be studded, shipped, stored and handled to minimize coating damage and assure roundness.

Steel pipe, coatings, linings and fabrication shall be the product of one manufacturer that has not less than 5 years successful experience manufacturing large diameter steel water pipe in the USA and be certified to ISO-9001 or SPFA Certified Quality Assurance Program requirements.

Shop drawings shall be submitted to the engineer for approval and should include the following:

- Pipeline layout showing stations and elevations
- Details of standard pipe, specials and fittings
- Calculations for pipe design and fittings reinforcement and or test data
- Welder certifications and qualifications
- Details of studding and shipping packaging

Manufacturer shall furnish certified affidavit of compliance for all pipe and appurtenances supplied under this section including steel mill test reports, hydrostatic test reports and results of production test welds.

All pipe, fittings and accessories shall be installed and tested in accordance with the latest revision of AWWA Standard C604.

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