

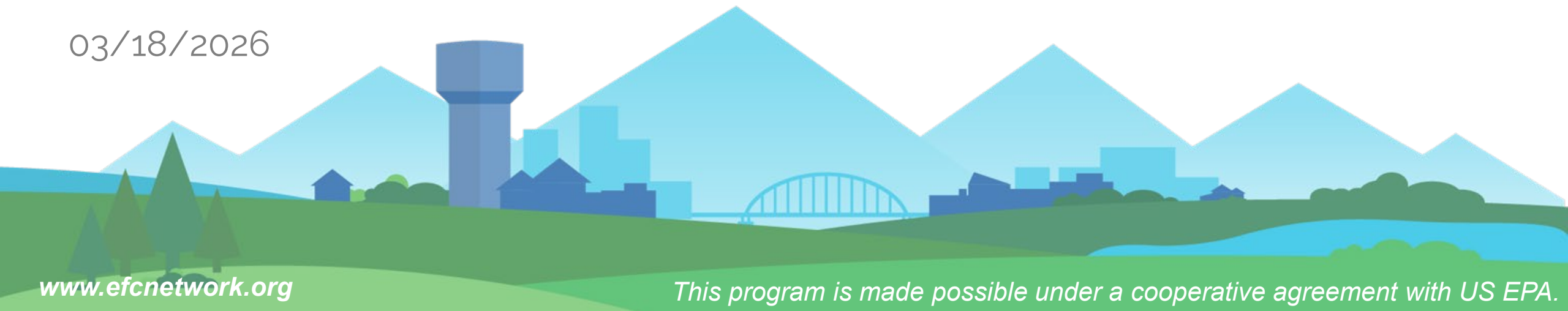


SOUTHWEST
ENVIRONMENTAL
FINANCE CENTER

US Territories Water Operator Training Series

Session 18: Distribution Systems 1: Hydraulics, Pipe Types, Selection, Installation, and Water Quality

03/18/2026



Trainer



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Water Utility Trainer & Specialist
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This training series is funded by the US EPA

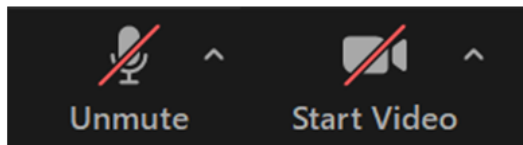
Zoom Logistics

Asking a Question

Audio/Webcam Settings

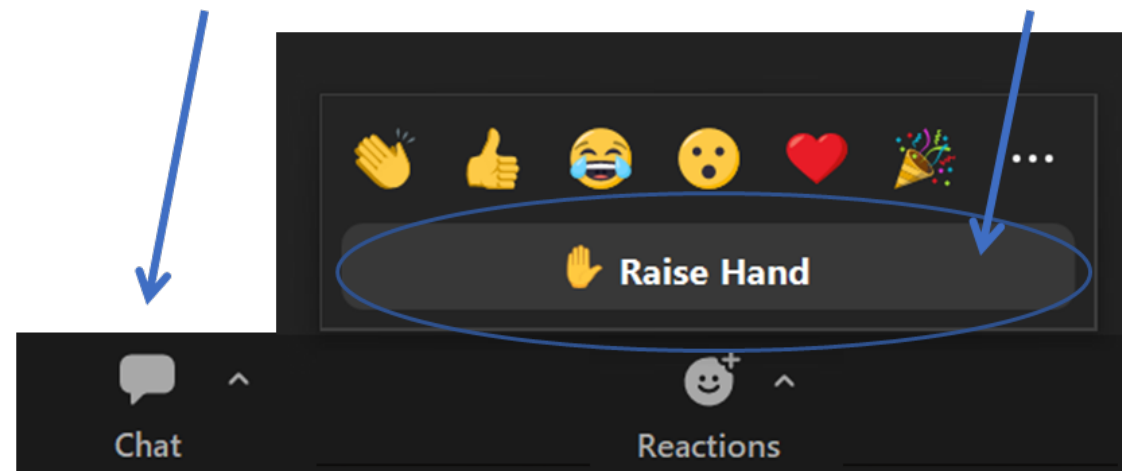
Mute, Unmute, select your audio source, or test audio settings.

Turn webcam on or off



Type questions into the chat box any time throughout the session

If you would like to **unmute** to ask a question, please **raise your hand** under the **Reactions** tab.



Schedule for 2026:

Date	Topic
1/22/2026	Alternative Treatment Processes (e.g. fluoridation, ion exchange, RO...)
2/5/2026	Drinking Water Treatment Math & Concept Review
2/19/2026	Safety Program Basics (including personal safety, equipment safety, facility safety)
3/5/2026	Lead & Copper Rule, Corrosion Control
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4/2/2026	Distribution Systems 2: Valves, Hydrants, Meters, and Service Connections
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4/30/2026	O&M: Pumps, Main, and Appurtenance Maintenance (including pressure monitoring, valve exercising, and flushing)
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Links to recordings and material are available on our website at <https://swefc.unm.edu/home/op-cert-trainings/>



Pacific Island Territories Operator Certification Trainings

This page is a repository of Wastewater and Drinking Water Operator Certification (Op Cert) Training Webinars offered by the SW EFC for systems in the Pacific Territories. Below you will find the **training webinar schedules (wastewater, then drinking water)** followed by a **training webinar recordings library**.

Jump to Wastewater Trainings ↓

Jump to Drinking Water Trainings ↓

Wastewater Training Schedule

Please note all times are local to CNMI and Guam. The times in American Samoa are one day earlier at 11 am.

Session	Date	Training Topic & Link to Recording (click to view)	Supporting Materials (click to download)
1	6/25/2025	Program Overview, Test Format, Study & Test Tips	PPT slides
2	7/9/2025	Treatment Overview	PPT slides
3	7/23/2025	WW Math Part 1 (Areas & Volumes)	PPT slides
4	8/6/2025	WW Math Part 2 (Flow Rates & Detention Times)	PPT slides
5	8/20/2025	Collection Systems – Gravity systems	PPT Slides

Sign in for every session to ensure you get credit for attending



**US Territories Water & Wastewater Operator Certification
Virtual Training Series Group Attendance Sheet**

Session Title: _____

Session Date: _____

Training Location: _____

Attendee Name	Attendee Signature	Arrival Time	Departure Time

I hereby certify that the individuals listed above attended the referenced training session.

Name: _____
Signature: _____
Title: _____
Date: _____

Please scan this sheet after each training session and email it to swefc@unm.edu with the subject line: "US Territories Op Cert Attendance Sheet"

Agenda: Distribution Systems

- 01** Hydraulic Basics
- 02** Pipe Types
- 03** Pipe Selection
- 04** Pipe Installation
- 05** Pipes & Water Quality

Poll Question

Why is excessive water pressure to residential homes undesirable?

- A. Increases particulate matter reaching the customer
- B. Causes erosion of the copper plumbing due to the high velocities, giving the water a metallic taste
- C. Decreases the life of water heaters and other water-using appliances
- D. Causes foaming from faucets

Poll Question

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Hydraulic Basics

Force

- Push of water against confining surfaces (lbs)

Pressure

- Force per unit area (lbs/sq. in.) (psi), which increases with water height and acts equally in all directions

Velocity

- The speed at which a particle of a substance is moving expressed as distance traveled over time (ft/sec, fps)

Flow Rate

- Speed at which a unit of volume is moving expressed as distance traveled per unit time (gal/min, ft³/sec, MGD- million gallons per day)

Major Hydraulic Concerns

Will the water
flow?

What
direction?

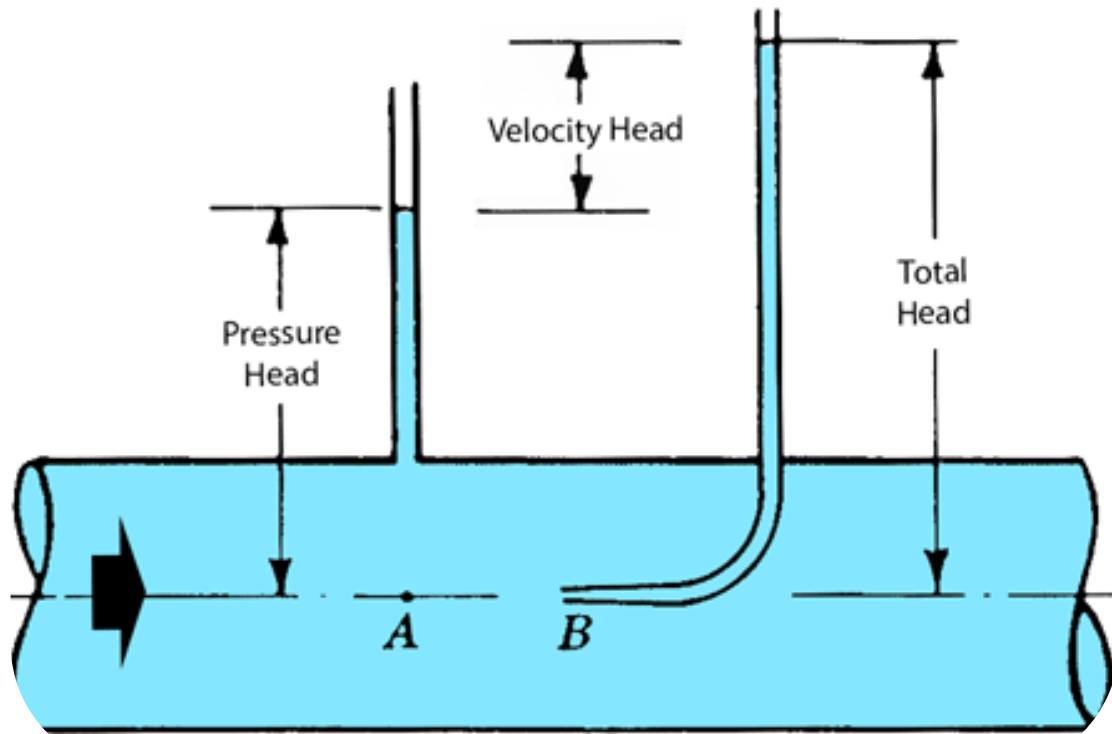
What
pressure?

Major Hydraulic Concerns

What pressure?

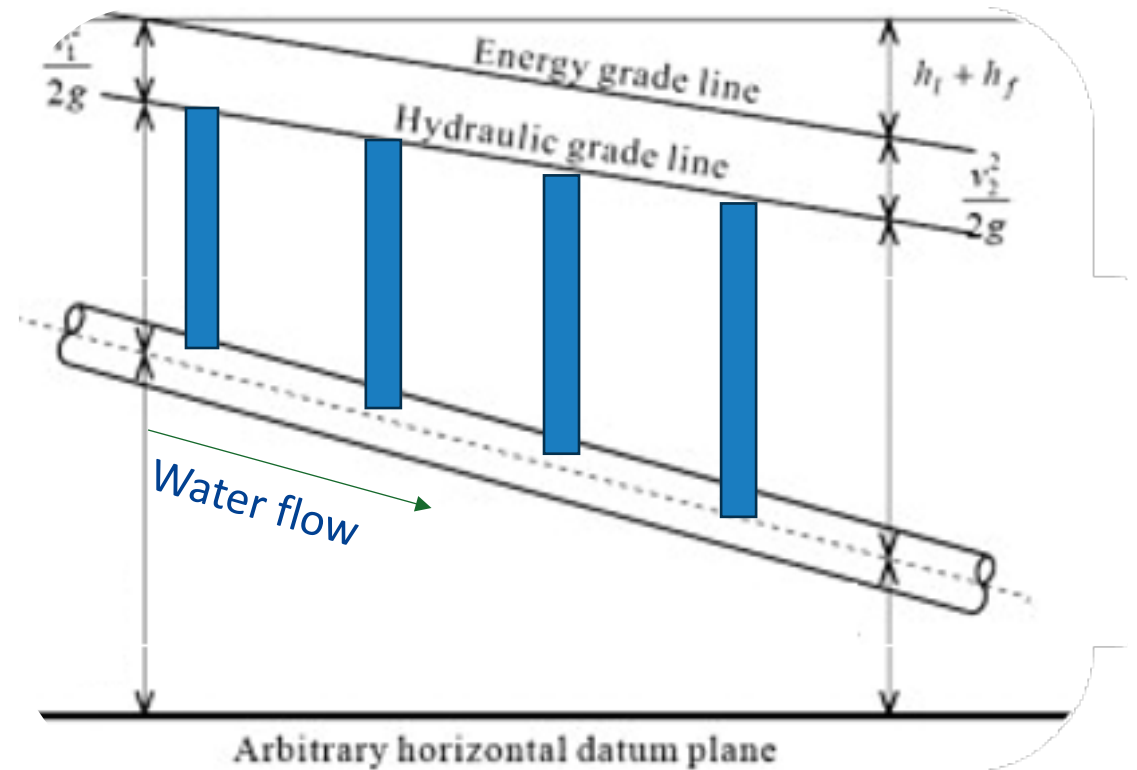
- Too low: Backflow
- Too high: Causes Damage

Head and Hydraulic Grade Lines



Pressure head

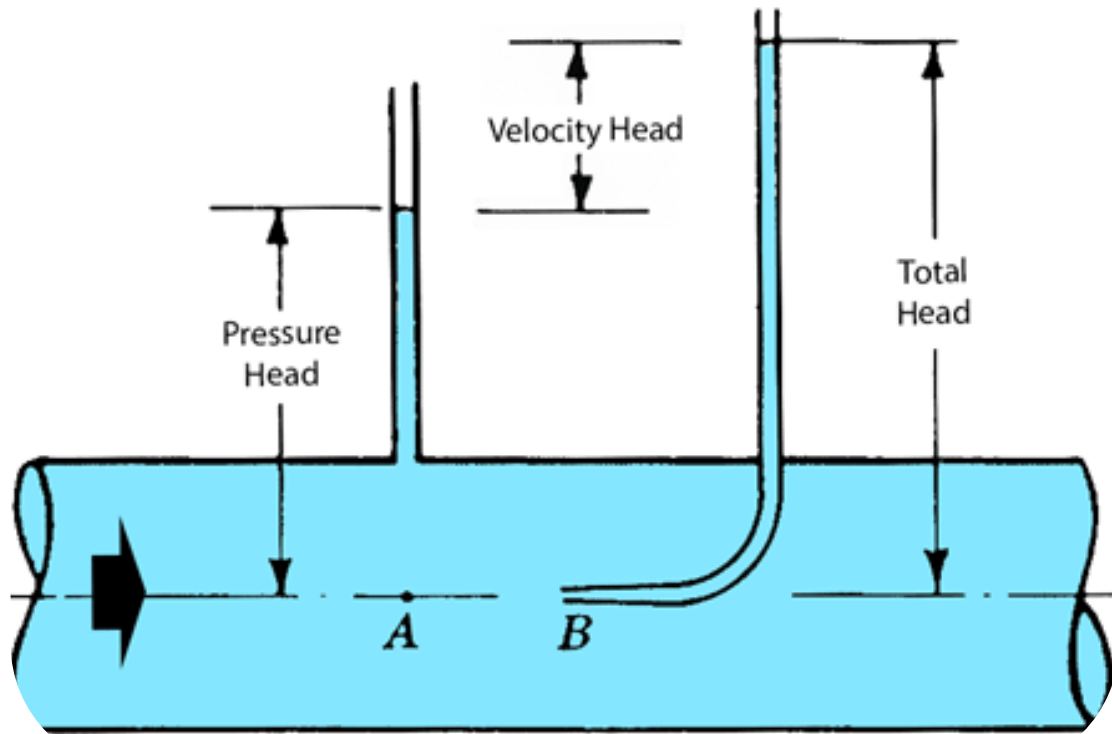
- If you drill a hole in the top of the pipe and attach a vertical pipe, the water would rise to the distance equal to the pressure head



Hydraulic grade line (HGL)

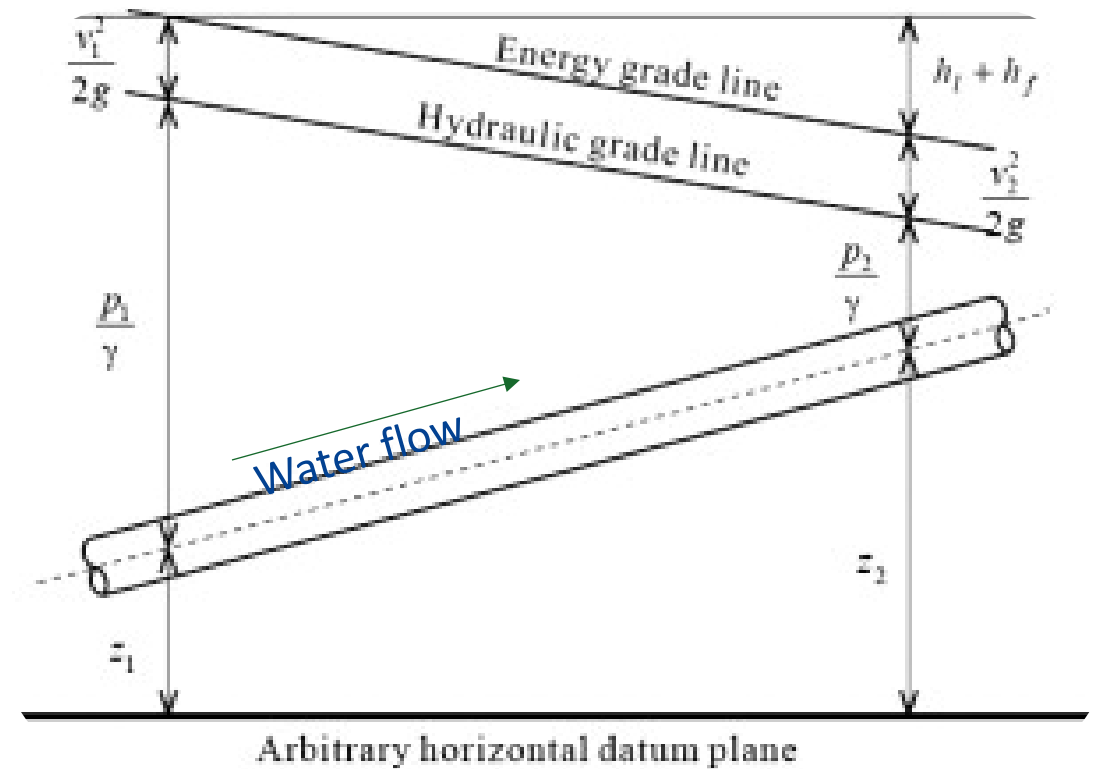
- The line connecting the top of the water in each tube. Always slopes downward in the direction of flow, regardless of the slope of the pipe

Head and Hydraulic Grade Lines



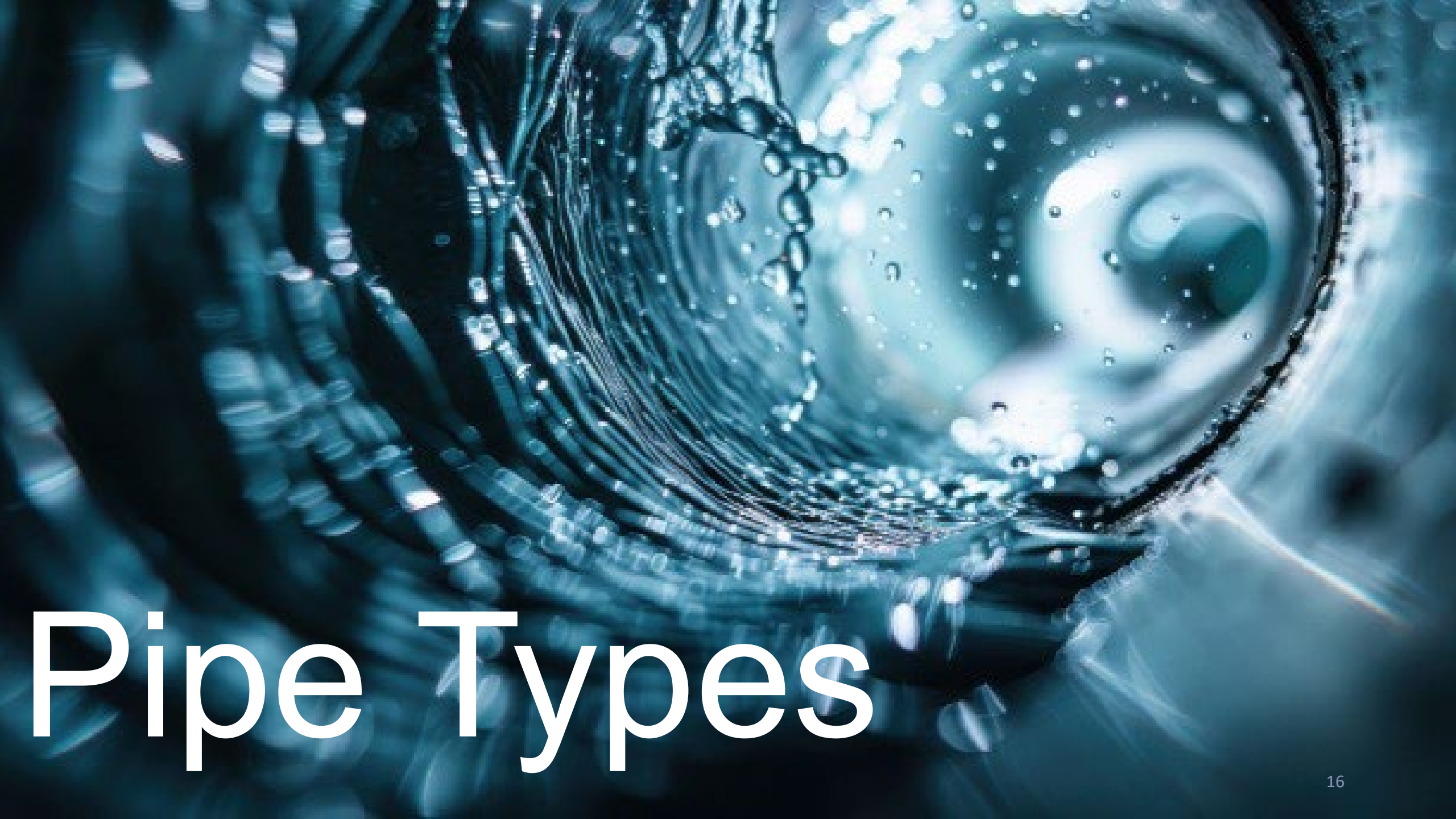
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Hydraulic grade line (HGL)

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Pipe Types

Pipe Types



Ductile Iron



Steel



Concrete



Plastic



Asbestos
Cement (AC)



Other

Cast Iron Pipe (CIP)

Background

- Introduced into the United States in 1817

Limitations

- Subject to corrosion
- Brittle pipe
- Now obsolete



Ductile Iron Pipe (DIP)

Background

- Introduced in 1955
- Life Span: 100+ years

Common Uses

- Transmission lines, distribution lines, in plant piping

Advantages

- High strength and load bearing capacity; Handles stress well, withstands high pressure
- Easily drilled and tapped for service lines



Ductile Iron Pipe (DIP)

Limitations

- Heavy (harder to handle)
- Corrosion concerns – requires lining on inside(cement)

Joint Type

- Flanged joints above-ground
- Bell/spigot or mechanical joint below ground with rubber ring

Standards

- ANSI/AWWA A21.51/C151
- Cement lining: ANSI/AWWA C104/A21.4



Concrete Pipe

Background

- Types: Prestressed Steel Cylinder (PCCP), Non-Prestressed Steel Cylinder, and non cylinder, non prestressed
- Life Span: 100+ years

Common Uses

- Distribution, transmission storm drains, sewer, road crossings

Advantages

- Long life, durable, good corrosion resistance, low maintenance, easily installed
- Strong (can vary)
- In large sizes (240 in) – it is less expensive
- Good for low water table situations (won't float)



Concrete Pipe

Limitations

- Heavy to install and handle, hard to tap, needs special fittings, and can deteriorate in corrosive soils

Joint Types

- May need special fittings
- Modified bell and spigot,

Standard

- Project specific, depends on type used



Steel Pipes (ST)

Background

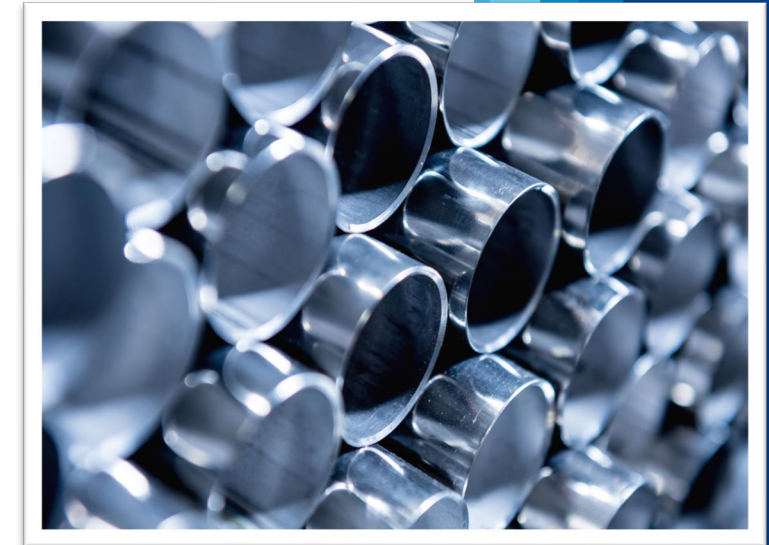
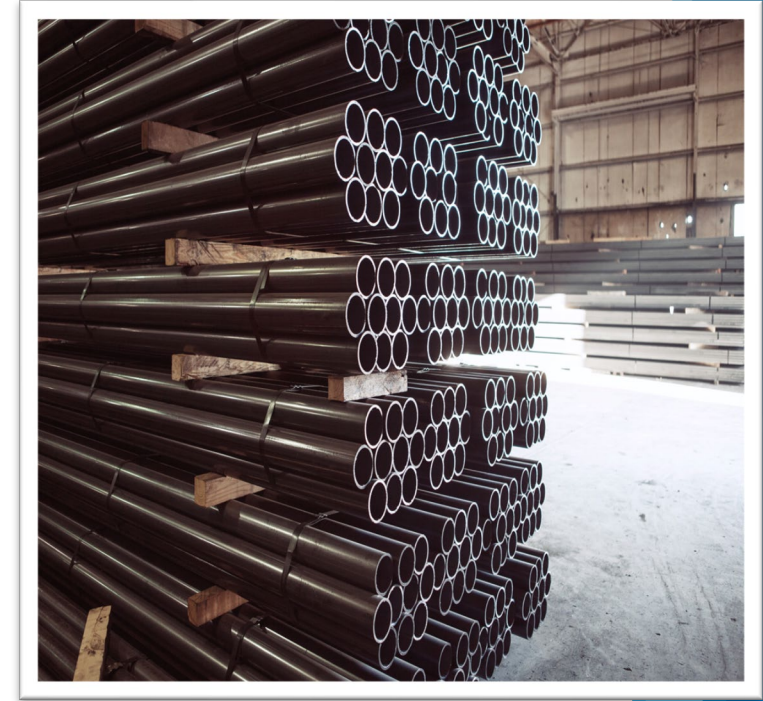
- Introduced in 1800s
- Life span: ~50 yrs

Common Uses

- Transmission Lines
- Used in areas with high operating pressures

Advantages

- Lighter, easier to handle, more flexible than DIP
- Easily installed and jointed



Steel Pipes (ST)

Limitations

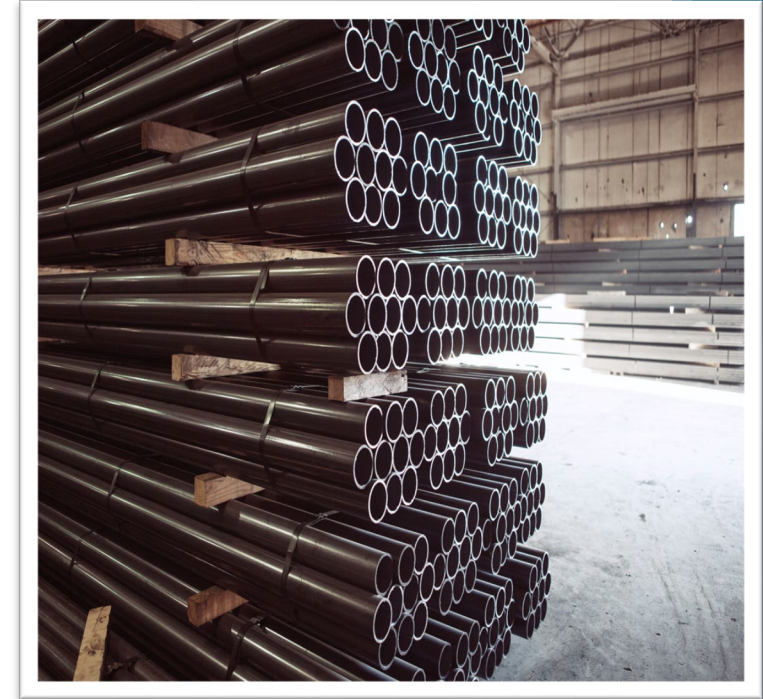
- Subject to corrosion/rusting - requires coatings
- Lower bearing strength - can collapse under vacuum

Joint Types

- Same as DIP or threaded
- Many styles – rigid vs flexible connections

Standard

- AWWA C200
- Coating: ANSI-A21.4 and AWWA C104
(Bituminous asphalt coating for potable water)



Asbestos Cement Pipe (AC)

Background

- Life span = 70 years

Common Uses

- Water distribution, sewer systems, storm drains

Advantages

- Less expensive, lighter, easier to install & tap than DIP
- Resists corrosion & tuberculation
- Wont burn or deteriorate



Asbestos Cement Pipe (AC)

Limitations

- Some concerns related to asbestos in water
- Not used as much anymore due to handling concerns
- Brittle, cracks under trench loads
- Need to thaw frozen pipes

Joint Types

- Sleeved couplings and rubber rings

Standards

- AWWA C400



Plastic Pipes

Background

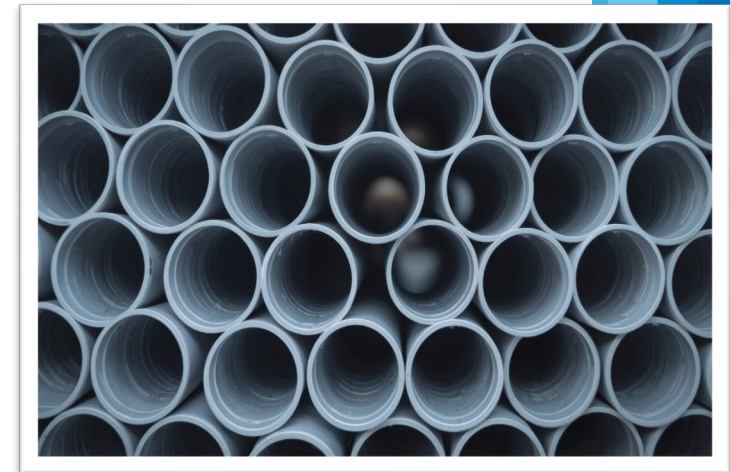
- Polyvinyl Chloride Pipe (PVC), Polyethylene (PE/HDPE), Polybutylene (PB)
- Life Span: ~50-100 years

Common Uses

- Used for distribution mains, service lines, and road crossings

Advantages

- Light weight; easy handling & repairing, less cost
- Less subject to corrosion due to low pH conditions



Plastic Pipes

Limitations

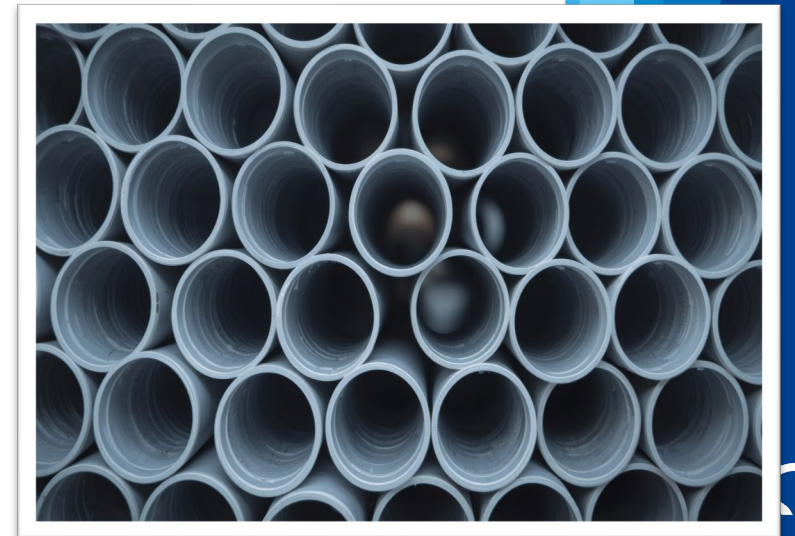
- Issues related to vinyl chloride leaching
- Susceptible to thermal expansion (lengthwise)
- More fragile (dependent on backfill material)

Joint Type

- Vary depending on material
- vent weld, bell and spigot joints, gasketed joint, etc.
- Threading is not recommended

Standard

- ANSI/AWWA C900-07



Pipe Types



Other

- Clay
- Wood



Service Pipes

- Brass
- Copper
- Plastic
- Iron
- Steel
- Asbestos Cement

Pipe Selection

Pipe Selection - Terminology

Water head loss

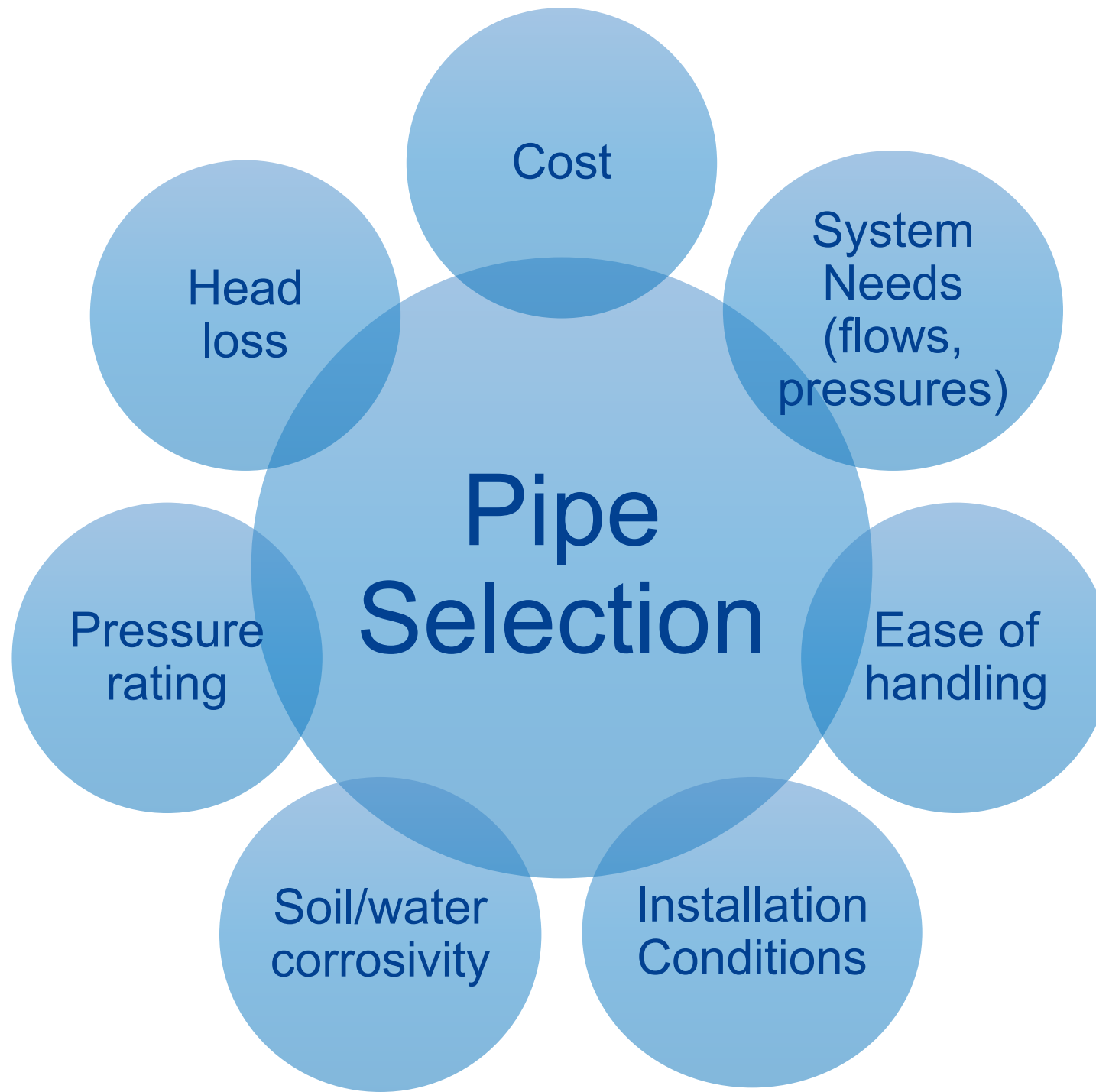
- C-factor – Coefficient of Friction, indicates how much friction is caused by the pipe (slows down the flow)
- Higher C-factor = smoother pipe = faster flow

Pressure Rating

- Measured in psi – pounds per square inch
- Four classes of pressure ratings
 - 100, 150, 200, 250 psi

Pipe Schedule

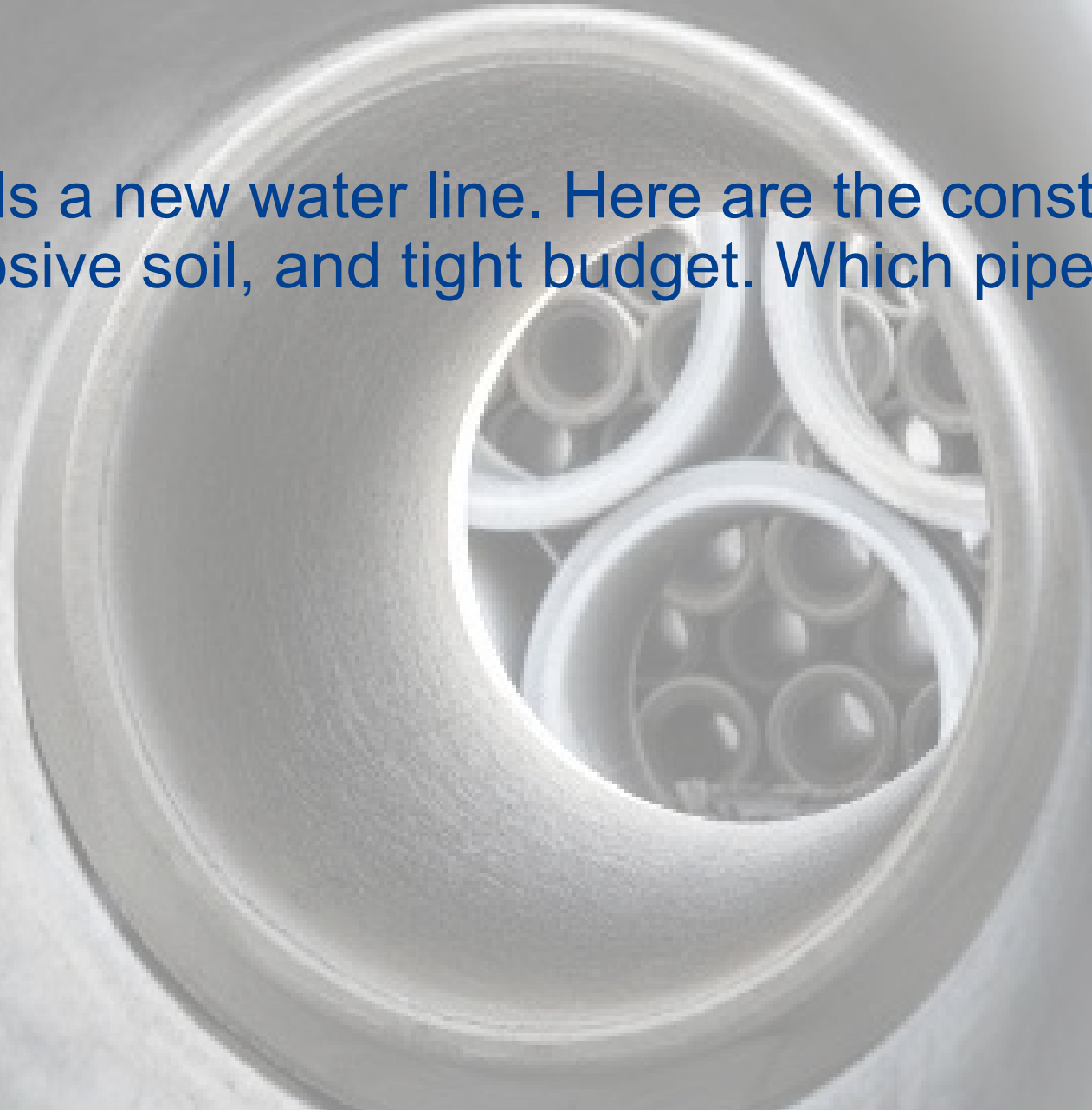
- The wall thickness of the pipe – higher number, thicker pipe
 - Schedule 40, Schedule 80, etc.



Poll Question

A small town needs a new water line. Here are the constraints: cold climate, corrosive soil, and tight budget. Which pipe would you choose?

- A. PVC/HDPE
- B. Ductile Iron
- C. Steel



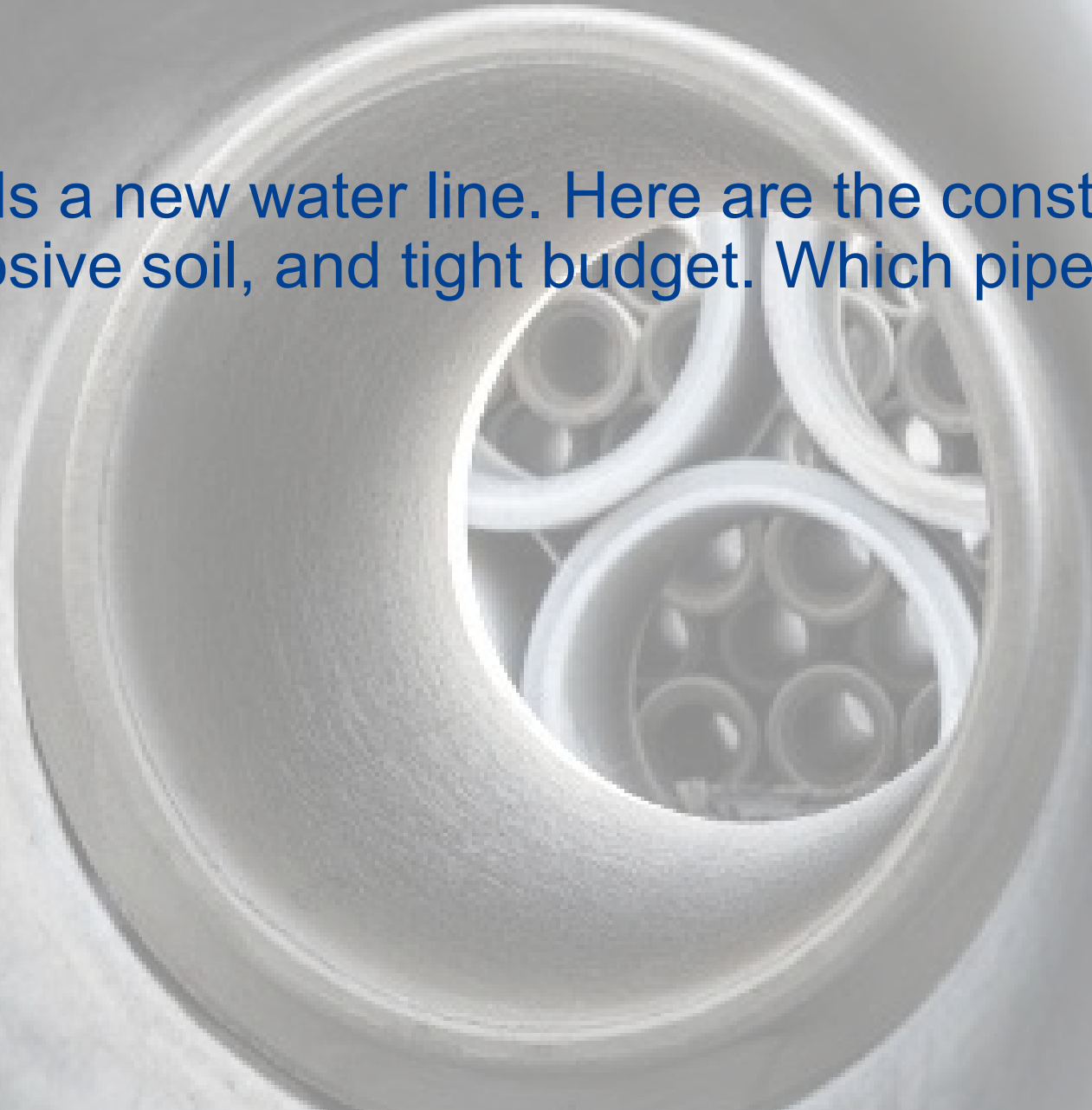
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C. Steel





Pipe Installation

Pipe Installation Considerations



Before placing pipe:

- Locate nearby utility lines (water, sewer, gas – call 811, power, telephone, cable, storm drains)
- Check the soil – if it looks or smells different
- Think of separation of water and sewer lines
- Inspect the pipe for damage and debris
- Spray/scrub inside with a strong chlorine solution and wash or flushed out.

These precautions will save time and expenses

Dirty joints and gasket are the most common reason for joint failure

Pipe Installation Considerations



Trench Depth

- Deep enough to protect from freezing, traffic, erosion, and future possible changes
- Water mains = 30in of cover over the top
- Rock should be excavated to 6in below grade line of the pipe bottom
- Must be protected if above frost line



Trench Width

- Generally, 1 foot wider on each side
- Follow local conditions
- Can depend on the grade line

General Trench Width Guide

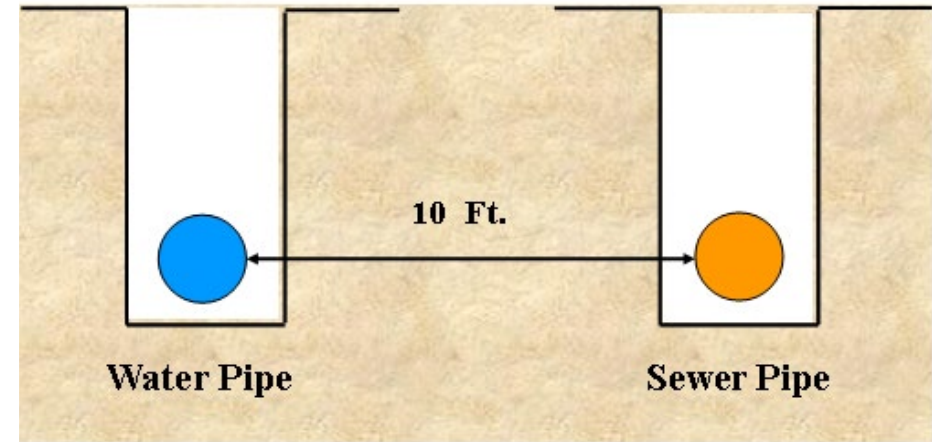
Pipe Size	Trench Width	Pipe Size	Trench Width	Pipe Size	Trench Width
3	27	14	38	36	60
4	28	16	40	42	66
6	30	18	42	48	72
8	32	20	44	54	78
10	34	24	48	60	84
12	36	30	54	64	88

All sizes are in inches. Guidelines only, follow codes/laws.

Separation Distances (horizontal/parallel)

Separation Distances - To prevent cross-connections or contamination of potable water

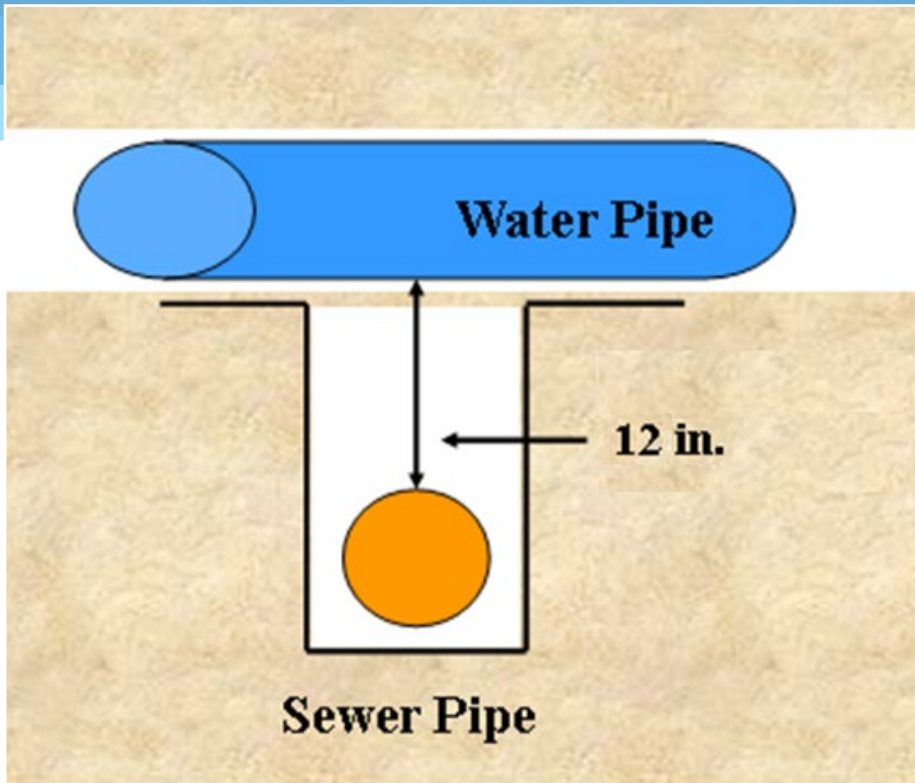
Verify separation distances with local codes, laws.



Horizontal

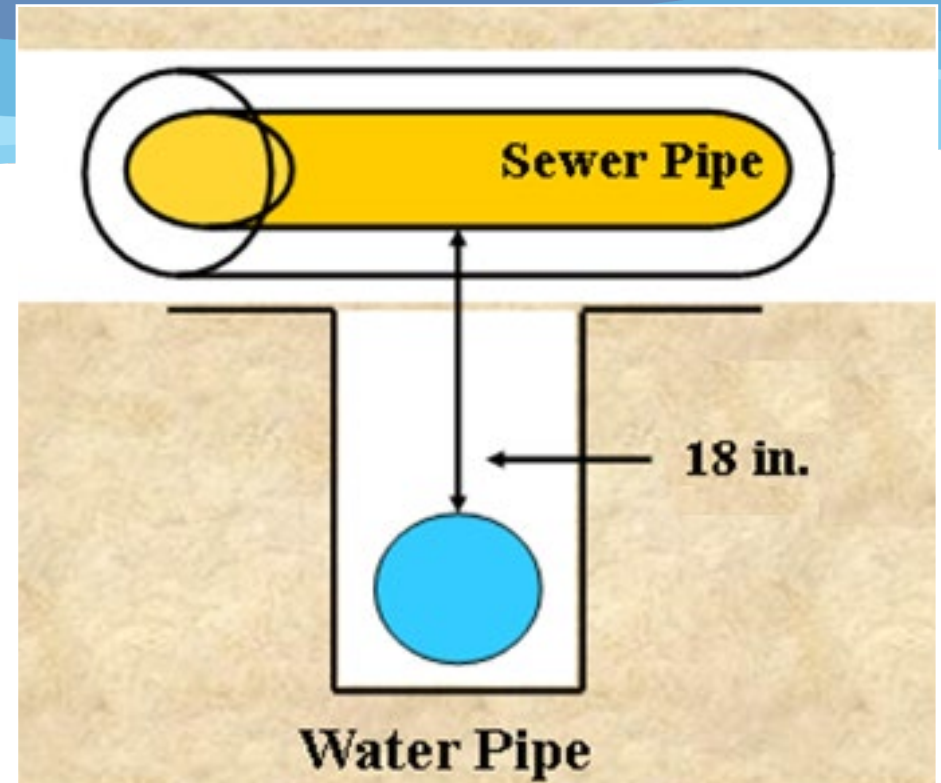
10 ft, edge to edge

Separation Distances (vertical)



Vertical – water above sewer

12 inches, edge to edge



Vertical - sewer above water

18 inches, edge to edge

Pipe Installation Considerations



While working:

- Make sure you go as far ahead of pipe laying as necessary
- Excavated rock and unstable material should be hauled away and not used for backfill
- Keep area between trench and spoils clear of loose material
- Keep spoil away from edge or trench
- Benching/Sloping, shoring, trench box
- Bedding – proper soil
- Lay pipes in trench, don't let it drop

Pipe Installation Considerations

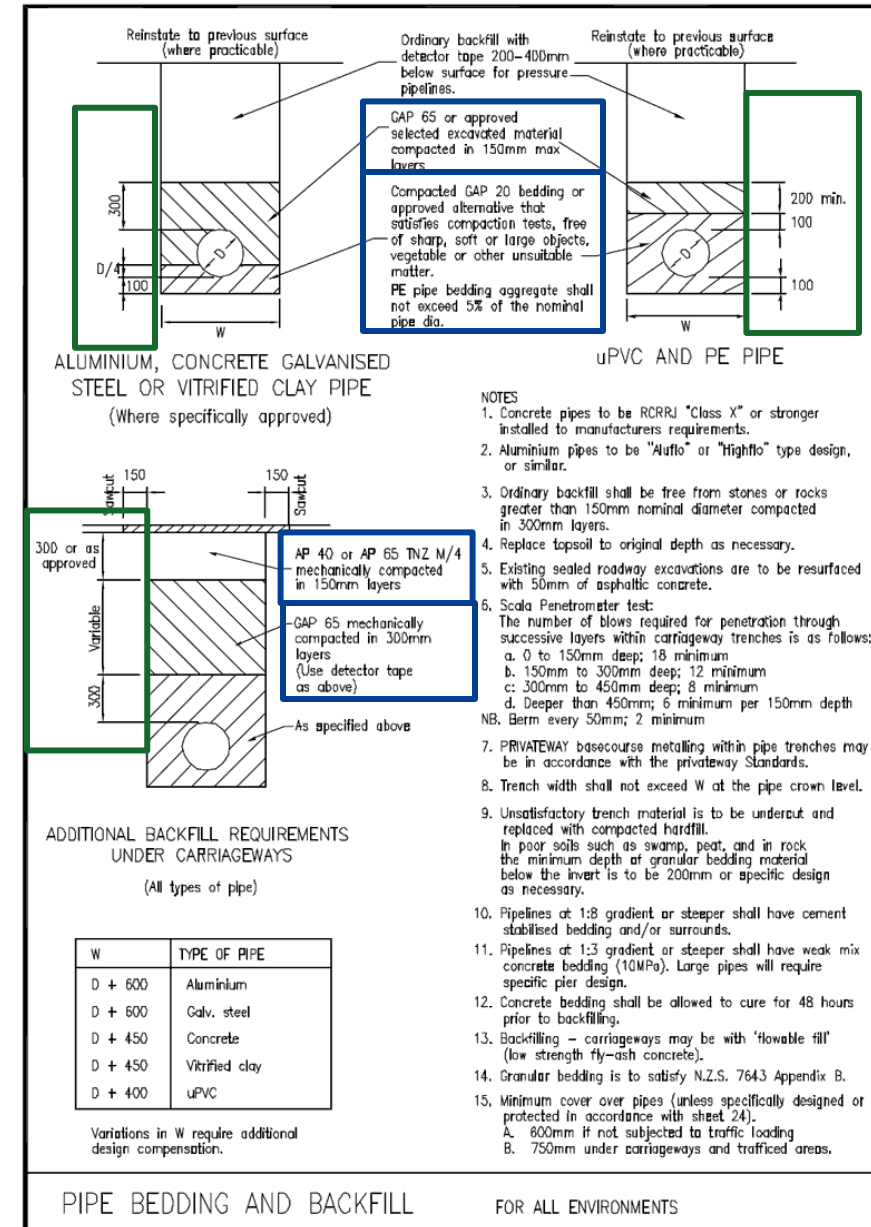


Backfill

- Purposes: fill the trench, protect the pipe and provide support along and under it.
- Type of material is important, sand preferred
- Compaction may be required
- Material should be free of abrasive, sharp edges
- Engineer should specify lift height and when tamping should occur

Bedding and Backfill – Specifications and Drawings

- “Backfilling is one of the most important phases of water main construction, and careful attention to its proper execution cannot be overstressed.” – Ductile Iron Pipe Research Association



Force of Flowing Water

Flowing water creates thrust on flexible pipe joints

Thrust can open joints near bends, elbows, tees, and dead-ends

Thrust increases with:

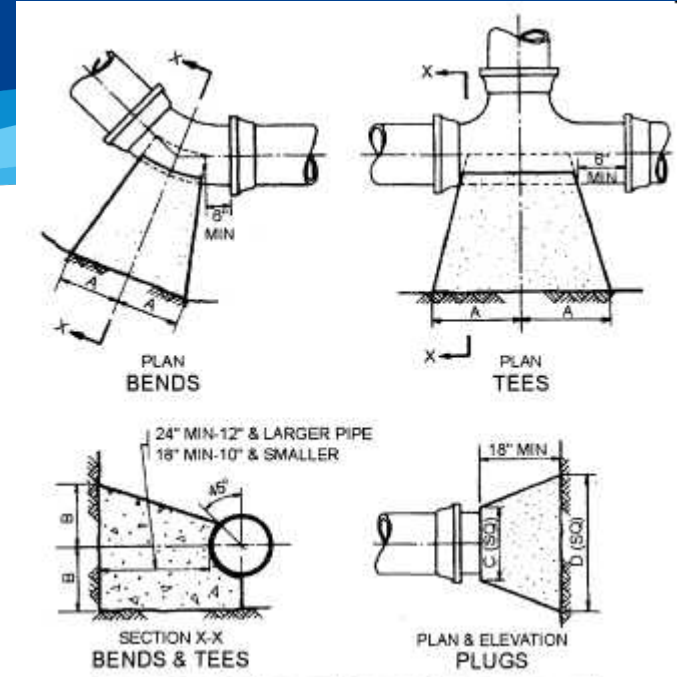
- Bend angle
- Pipe diameter
- Internal pressure
- Sudden changes in flow (water hammer)

Water hammer = rapid pressure spikes caused by valves opening/closing too quickly

Controlling Thrust Forces

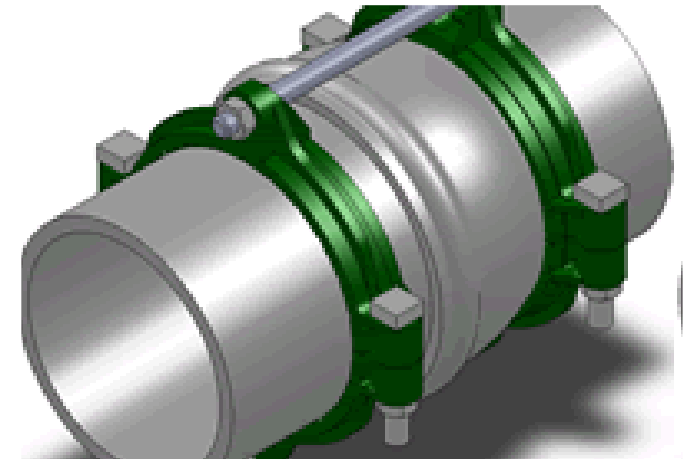
Thrust Block

- Concrete block placed in trench to resist thrust forces
- Prevents joint separation
- Placement depends on thrust direction and fitting type
- Force is transferred into surrounding soil



Thrust Restraint

- Added to pipe joints to overcome the force of the thrust
- Holds sections together to overcome thrust



Other Considerations

Steel Conduit Sheath – Encasing Pipes

Protects pipe (esp. plastic) from vibration & stress loadings (under railroads, highways)

Easier to repair, replace

Metal Marking Tape – “Tape Detect”

Marks location of plastic line for metal detection

Installed after tamping last lift, before last fill

New Distribution Piping



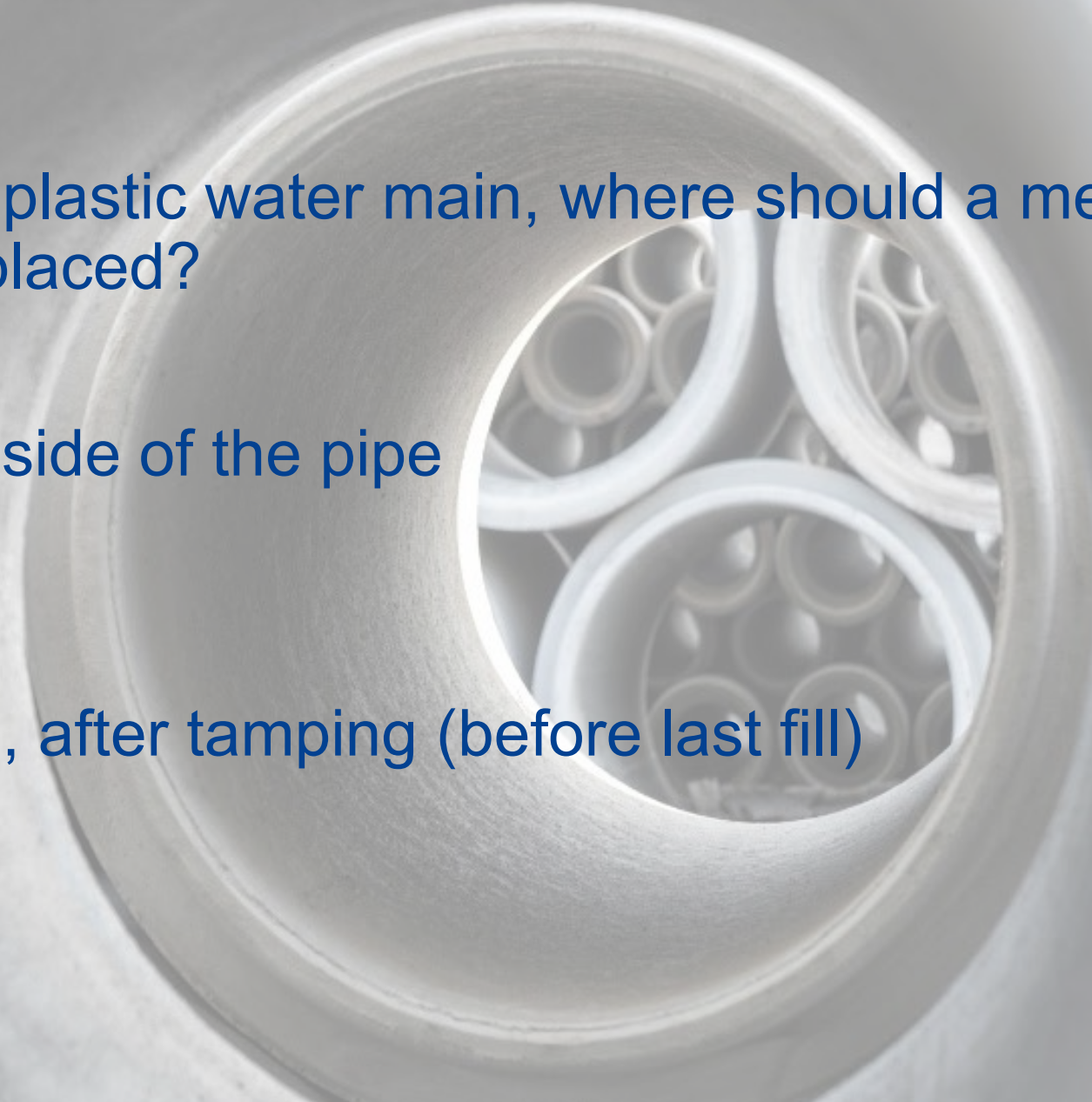
After installation and prior to putting the new line in service:

- Fill water line slowly from the low end to the high end to release air
- Pressure test and inspect for leaks
- Disinfect line according to AWWA Standard for Disinfection Water Mains
 - Dose → contact time → flush
 - Collect coliform samples and verify results
- Place in service

Poll

When installing a plastic water main, where should a metal marking tape be placed?

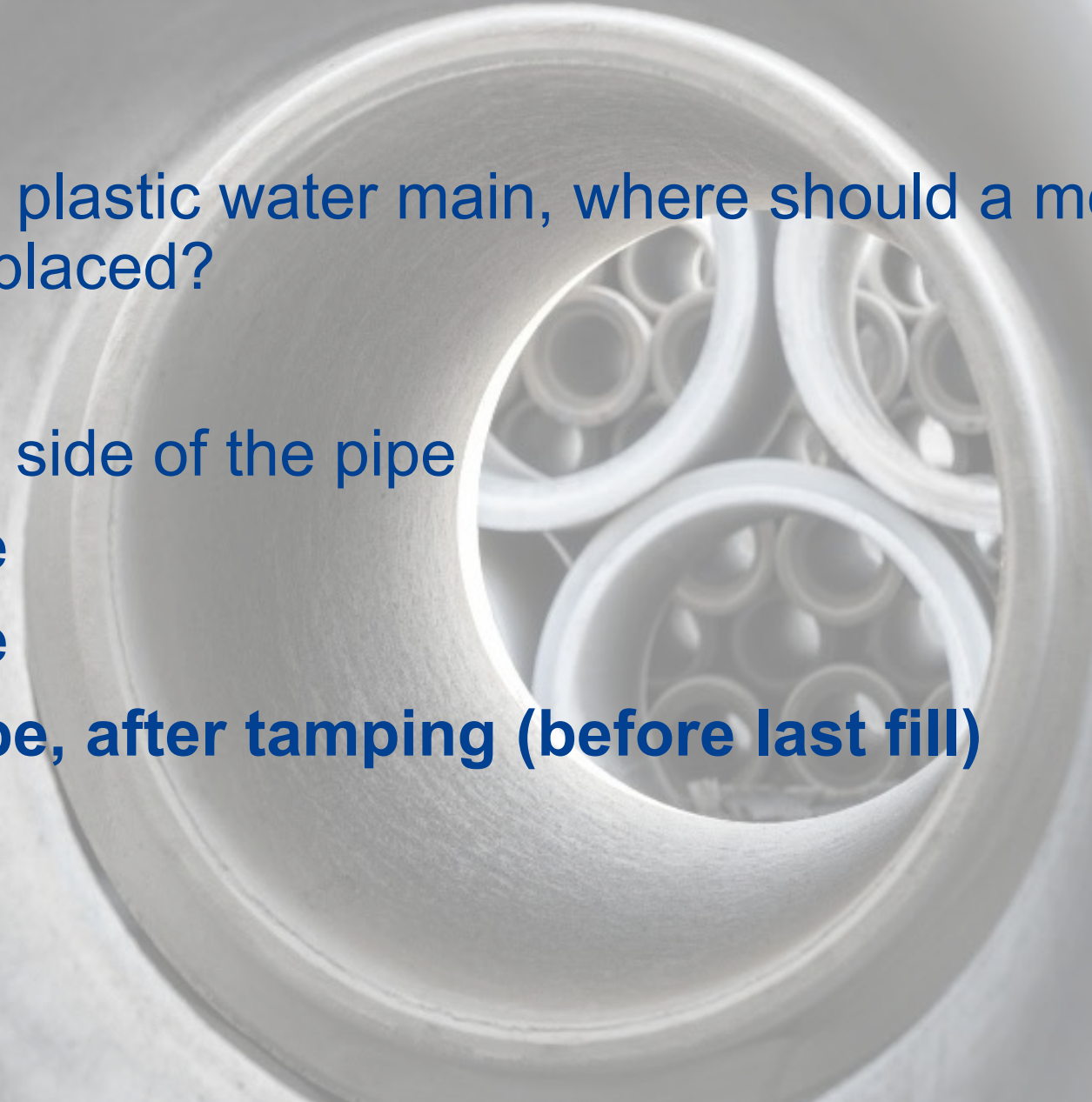
- A. Directly on the side of the pipe
- B. Below the pipe
- C. Inside the pipe
- D. Above the pipe, after tamping (before last fill)



Poll

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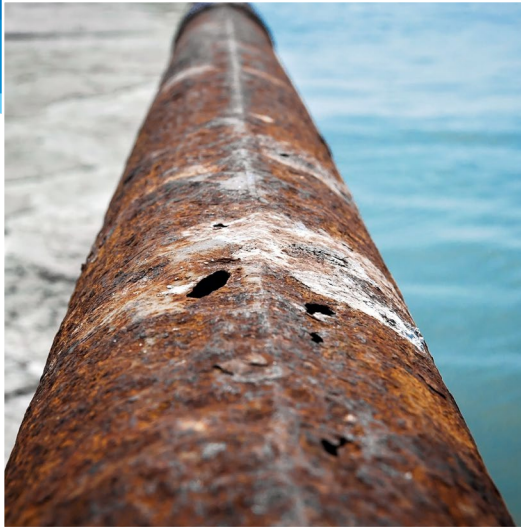
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Pipes & Water Quality

Pipes Affect on Water Quality – Corrosion



Corrosion

- Leads to decreased water quality
- More chlorine needed to effectively treat water
- Lead and copper increases
- Changes in pH affects corrosion in the pipes

Tuberculation

- Increases roughness of inside of pipe through to corrosion (rust)
- Increased water pressures
- Reduced water flows (friction)
- Bottlenecks in the distribution



Dead Ends

Dead ends

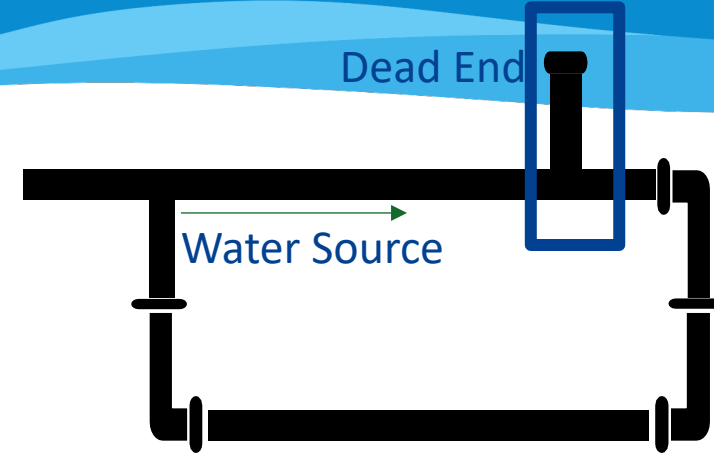
- Water mains that terminate without being looped

Impacts

- Taste and odor issues, increased water age
- Decrease in chlorine residual (high demand)
- Increase in disinfection by-products (DBPs) (trihalomethanes)

Solution

- Install hydrants, flushing valve or blowoffs
- Use looping systems
- Implement routine or auto flushing programs



Water Leaks

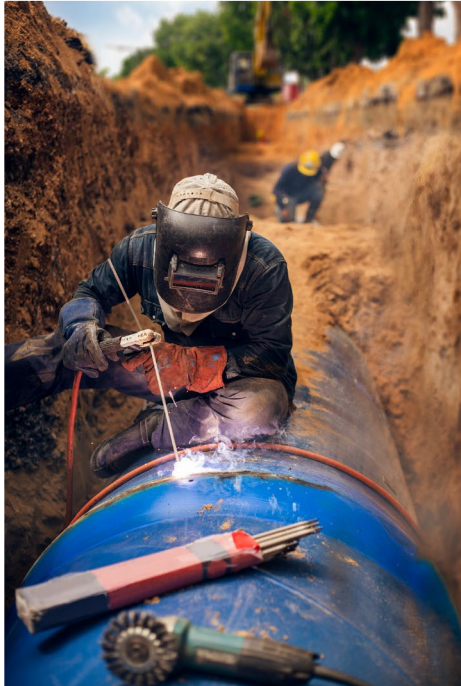
Water leaks

- Introduce contaminants into the distribution system
- Backflow due to backsiphonage
- Organic matter will increase chlorine demand

Water Loss Audit

- Used to discover water leaks in distribution
- Compare how much water is produced and how much is sold.
- Leaks may be present if there is a high volume of unaccounted for water or high amount of non-revenue water

Breaks and Repairs



Steps to take after locating a line break:

- Locate and close appropriate isolation valves
- Keep excavation dry and main pressurized
- Prevent contamination from entering system
- Repair break and check for leaks
- Disinfect as needed and return to service

Poll

What is the primary health risk of trihalomethanes?

- A. Cancer
- B. Liver damage
- C. Pancreas disorders
- D. Nervous system damage



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Thank You!



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Questions?

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