Seismic Resilience of Two Water Lines: Case Studies in Everett, WA

Jeff Blakely
Sr. Sales Engineer
AMERICAN Pipe

Richard Hefti, P.E.
Sr. Engineer
City of Everett

May 2, 2019

EVERETT
WASHINGTON

AMERICAN
THE RIGHT WAY

Agenda

Project Overview

ISO 16134

ERDIP Products

Design Considerations

Lessons Learned

Questions

EVERETT
WASHINGTON

International Organization for Standardization
ISO

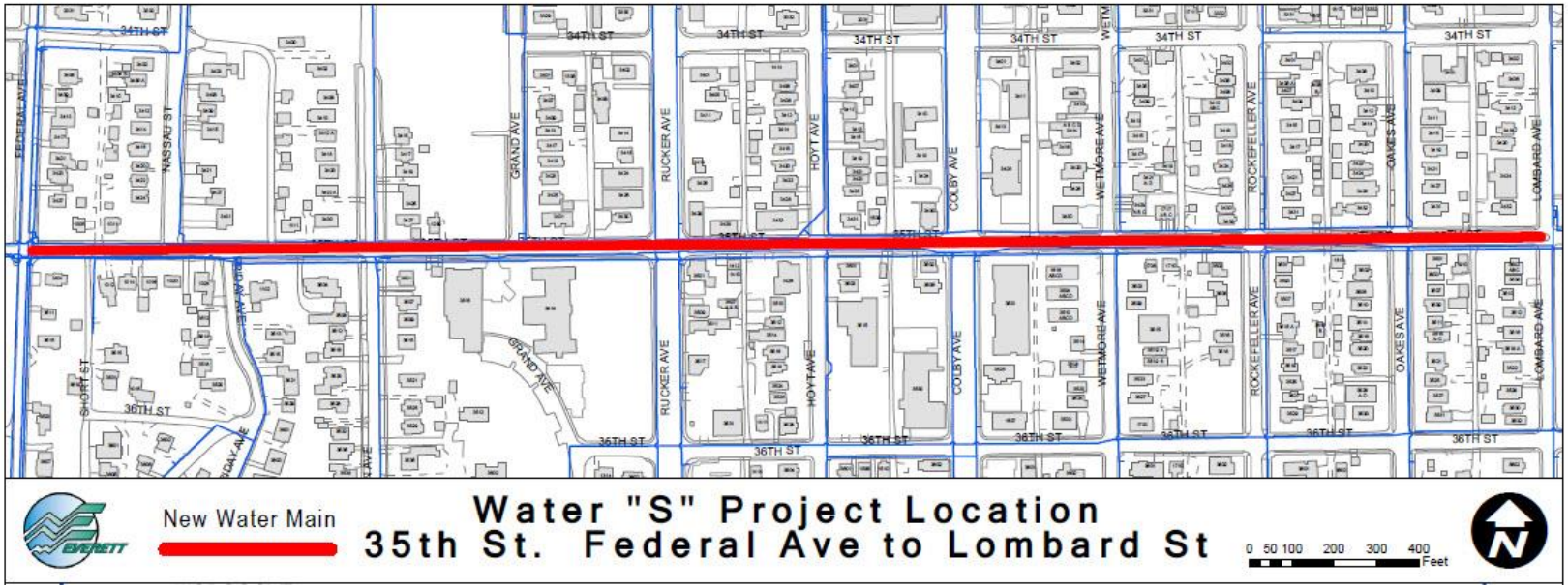
PROJECT OVERVIEW

Project Background

EVERETT WASHINGTON

35th Street

- 3,500 lf of 12" pipe that is main feed to Intermediate Pressure Zone
  - Replaces 1958 12" cast iron main with repair history

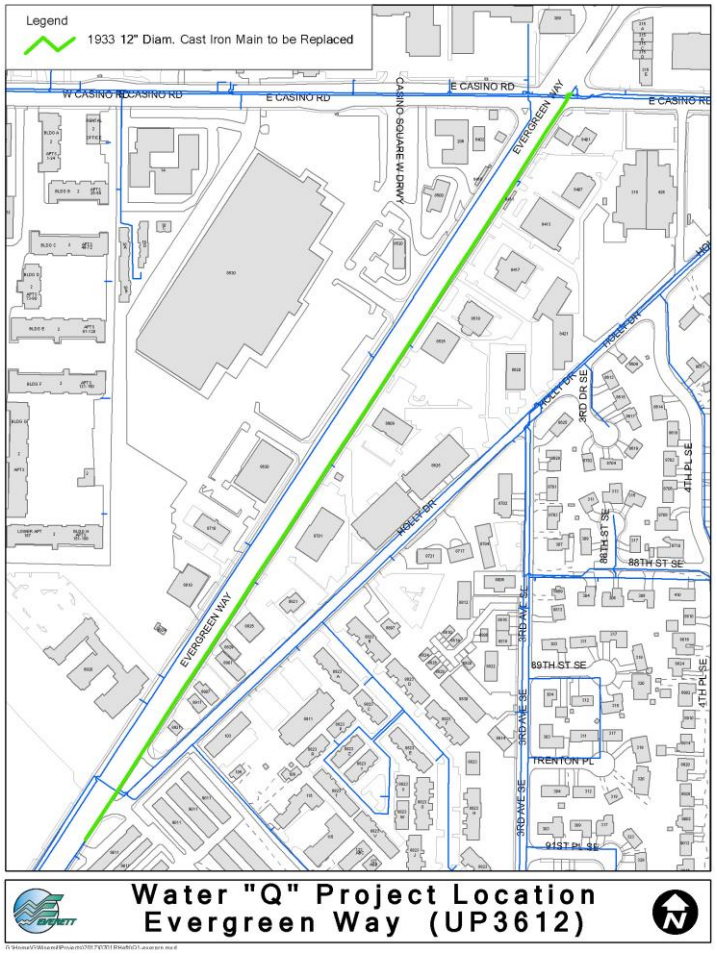


Project Background

EVERETT WASHINGTON

Evergreen Way

- 2,500 LF of 12" Pipe
- Main Feed to Commercial Areas South of Boeing Freeway
- Replaces 1933 12" Unlined Cast Iron



Seismicity / Geotech

EVERETT WASHINGTON

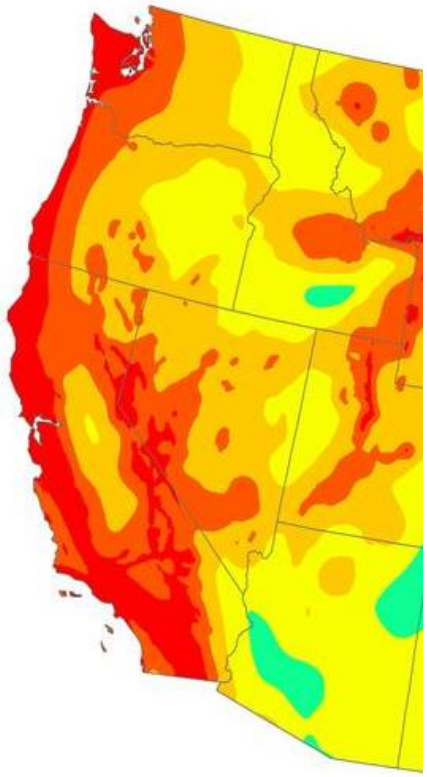
Liquefaction and Amplification Low

- Dense Glacial Sediments
- Lack of Groundwater

USGS Earthquake Maps

- Site Class "C"

Criteria	Value
S_s	1.346g
S_{ms}	1.346g
S_{ds}	0.897
S_1	0.511g
S_{m1}	0.664g
S_{d1}	0.443g
F_a	1.0
F_v	1.3

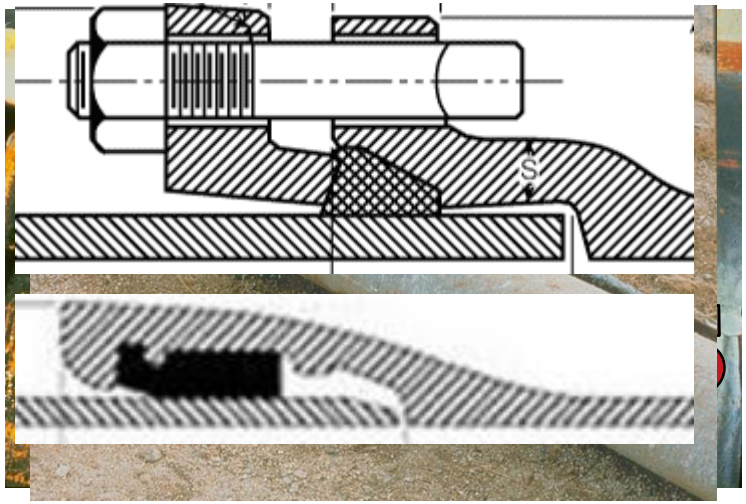


ISO 16134
ERDIP Design

ISO 16134

History

- Japanese Earthquake Forensics
  - Cast Iron / AC = Brittle
  - PVC / Steel = Barrel & Joint
  - DIP – Failure @ % Joints

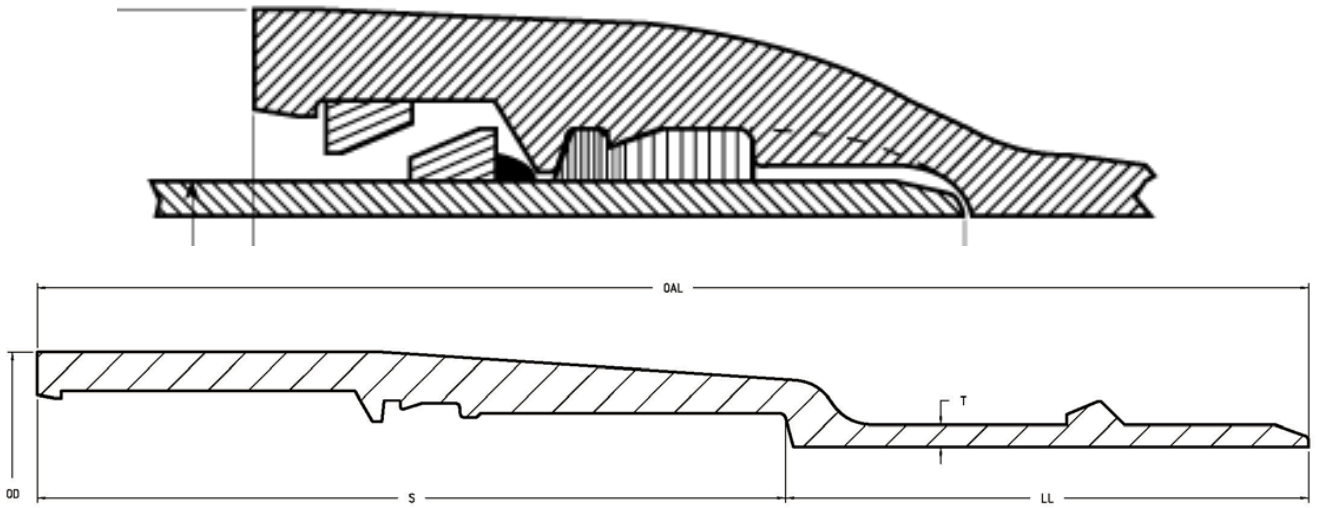


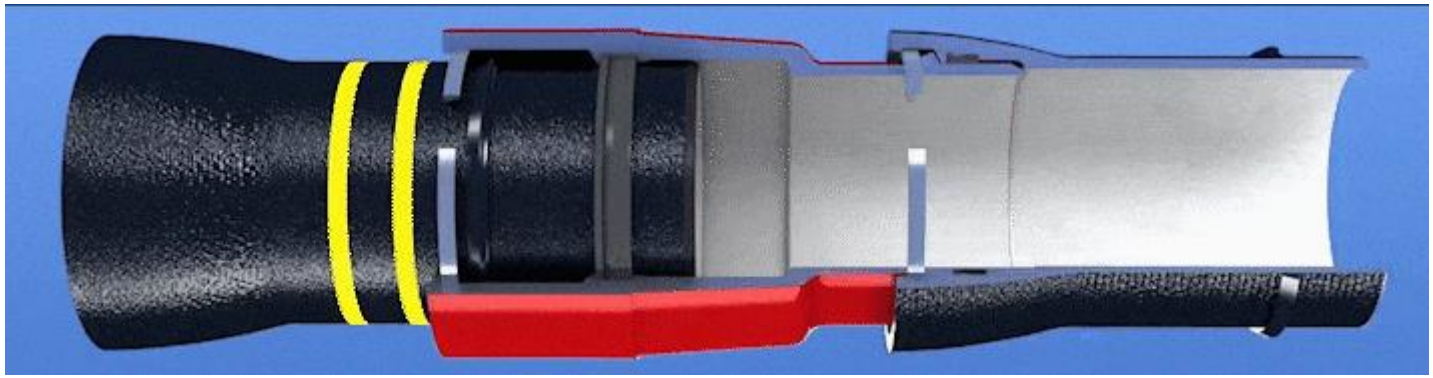
- Improve DIP Joint
  - Pull-Out Strength
  - Deflection
  - Strain Relief

Parameter	Class	Component performance
Expansion/contraction performance	S-1	± 1 % of *L* or more
	S-2	± 0,5 % to less than ± 1 % of *L*
	S-3	Less than ± 0,5 % of *L*
Slip-out resistance	A	3 *d* kN or more
	B	1,5 kN to less than 3 kN
	C	0,75 kN to less than 1,5 kN
	D	less than 0,75 *d* kN
Joint deflection angle	M-1	± 15° or more
	M-2	± 7,5° to < 15°
	M-3	Less than ± 7,5°
L is the component length, in millimetres (mm) *d* is the nominal diameter of pipe, in millimetres (mm)		

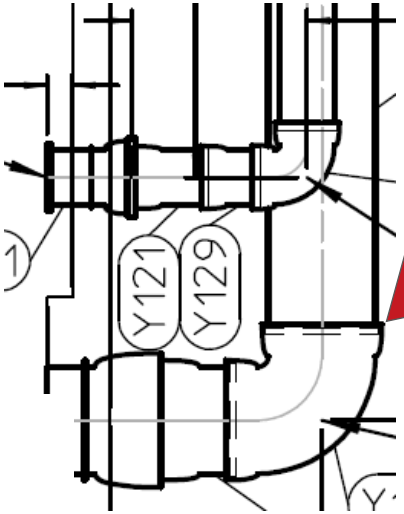
EARTHQUAKE RESISTANT DUCTILE IRON PIPE PRODUCTS

Earthquake Resistant DIP

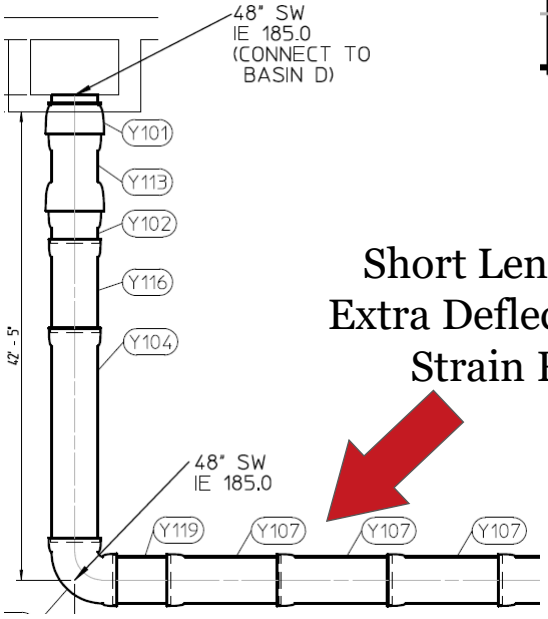




Earthquake Resistant DIP

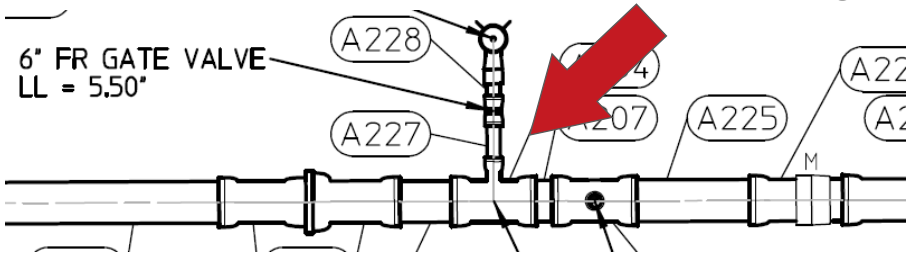


Pipe Rotation
In Fitting

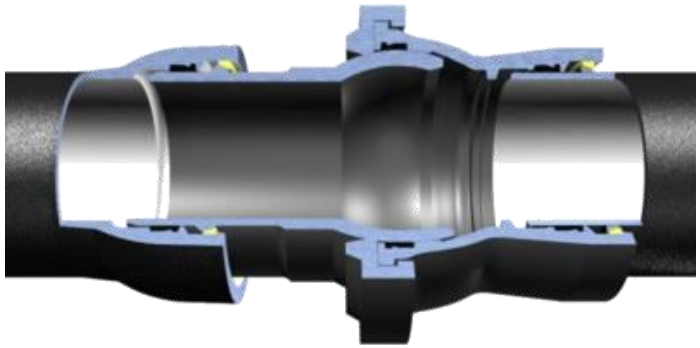


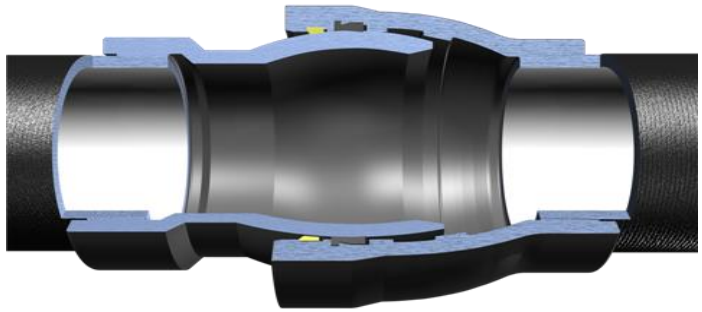
Short Lengths for
Extra Deflection and
Strain Relief

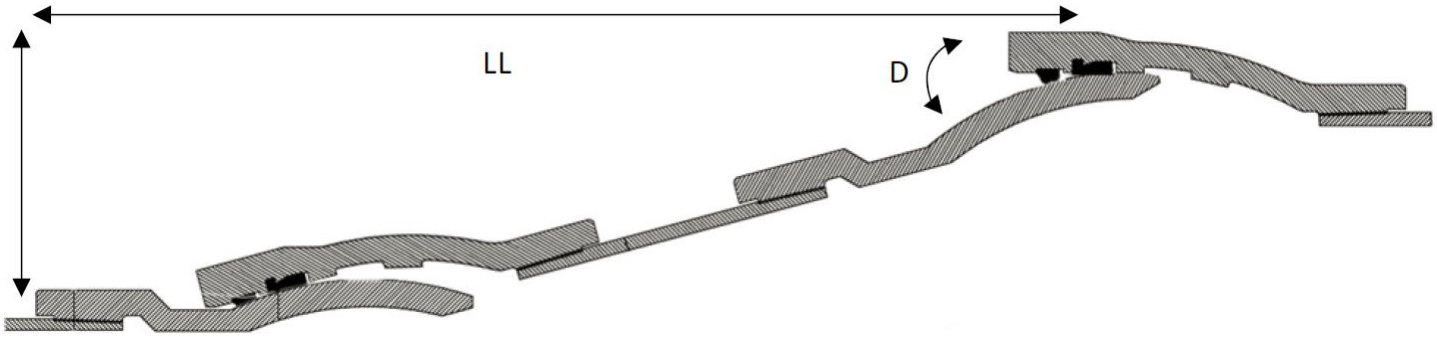
FR Gate Valve
And Fittings

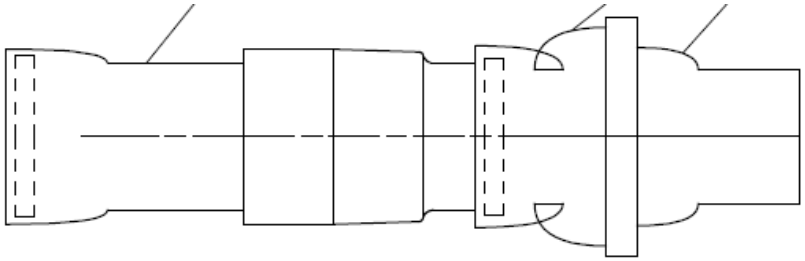


Earthquake Resistant DIP

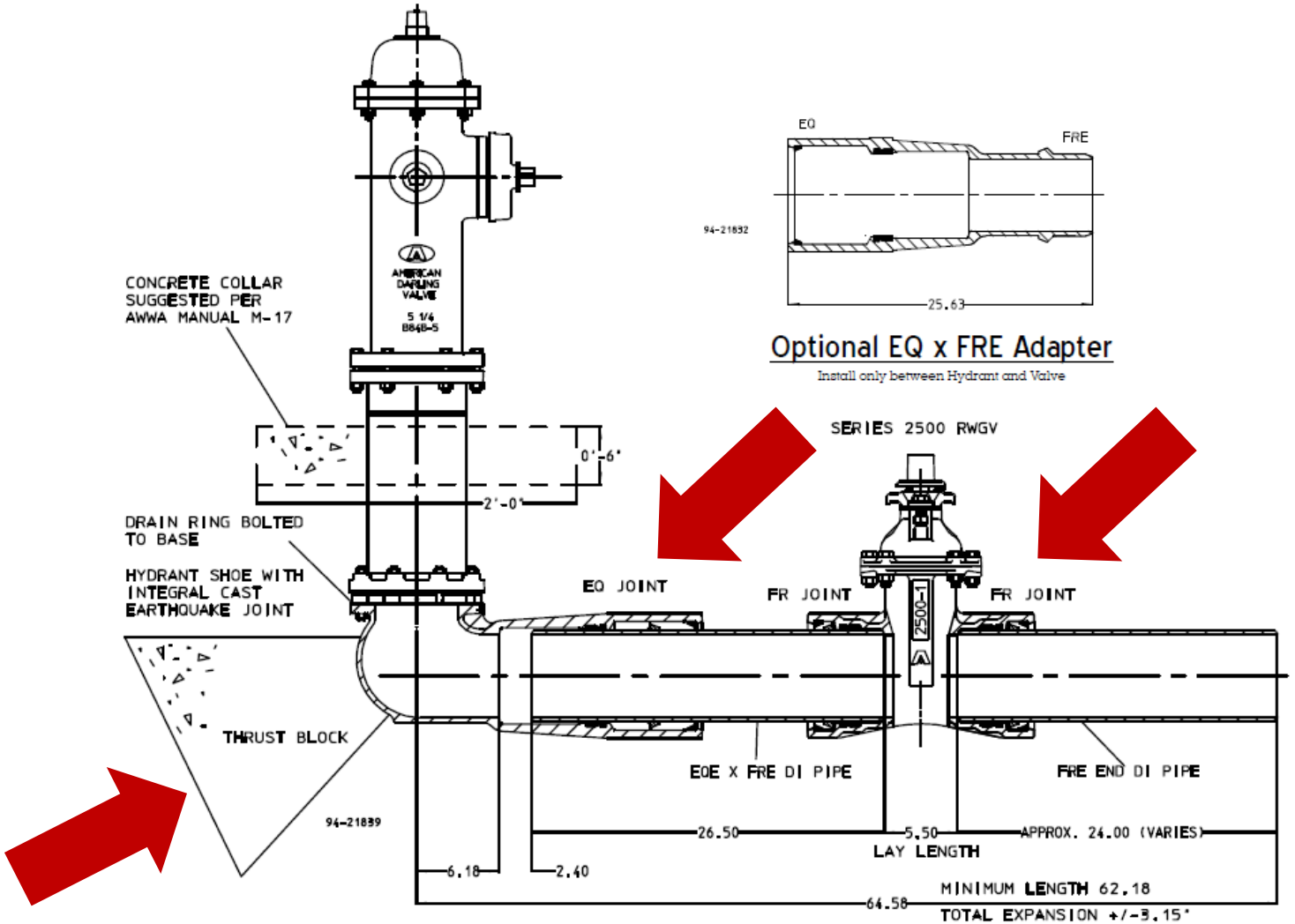








Earthquake Resistant DIP

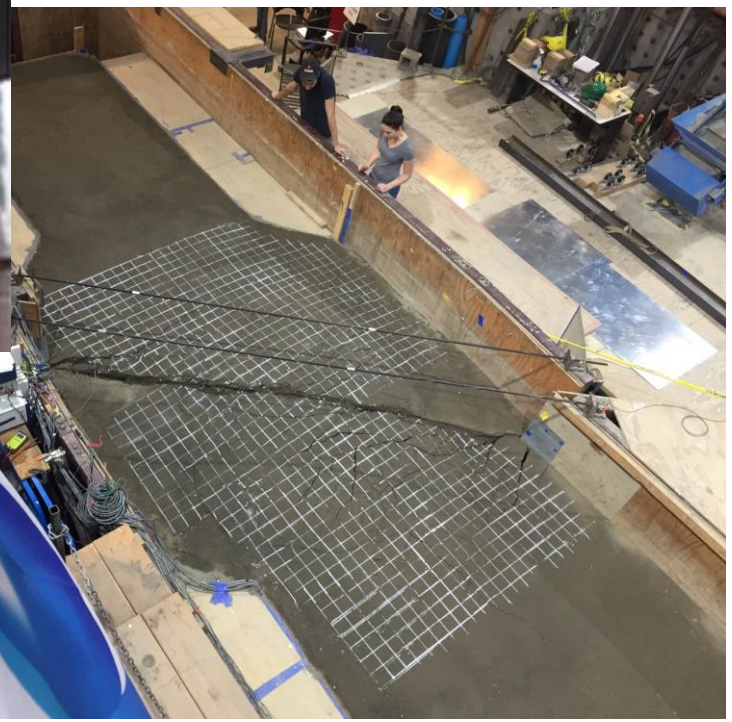


Standard Earthquake Joint Configuration

Optional EQ x FRE Adapter

Install only between Hydrant and Valve

Earthquake Resistant DIP - Testing



DESIGN CONSIDERATIONS

Design Considerations

Valve Vaults

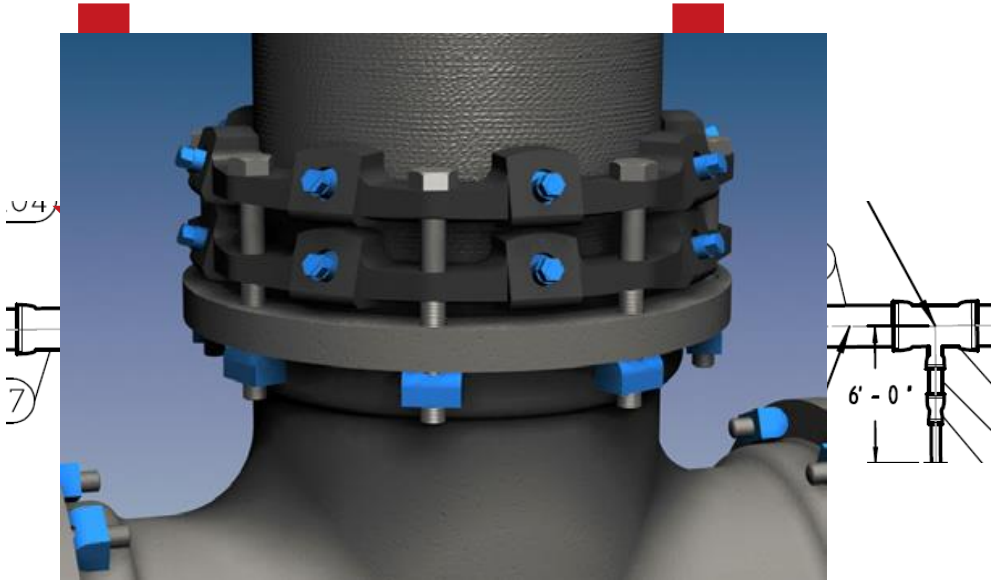
- Float/Sink/Twist

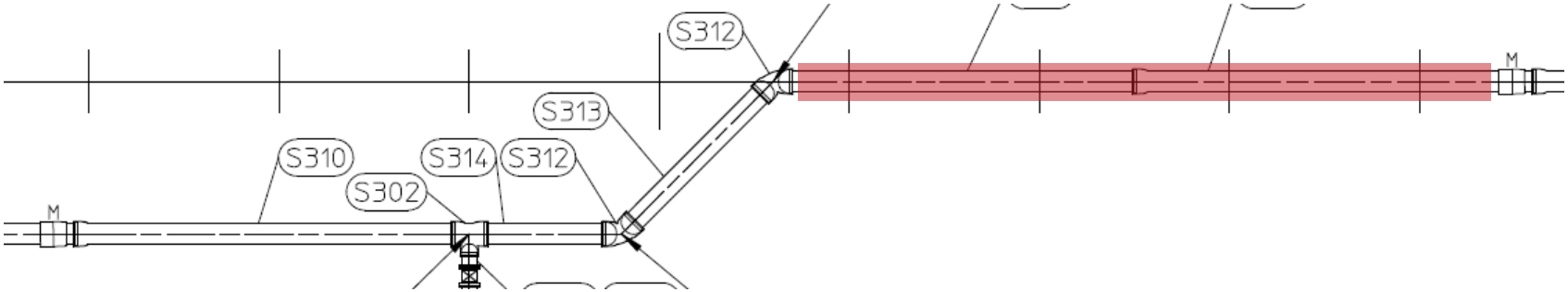
Thrust Forces

Connections

Future Work

- Red Wrap and Locator Tape



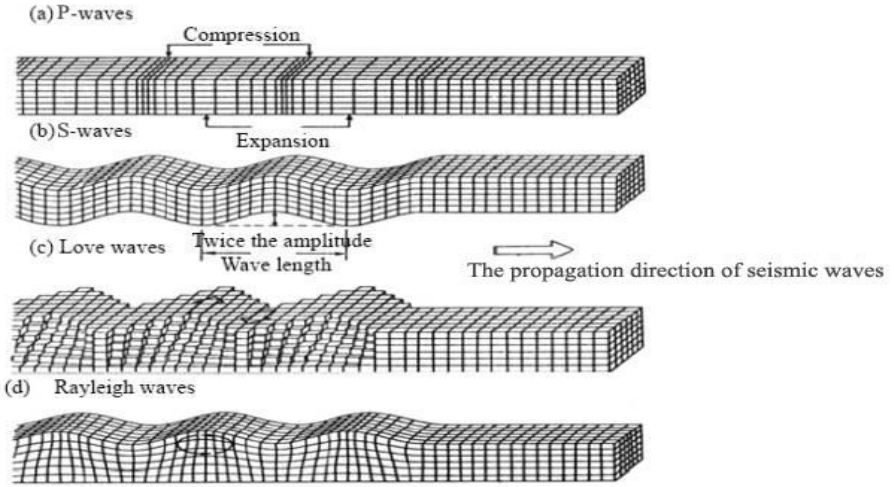


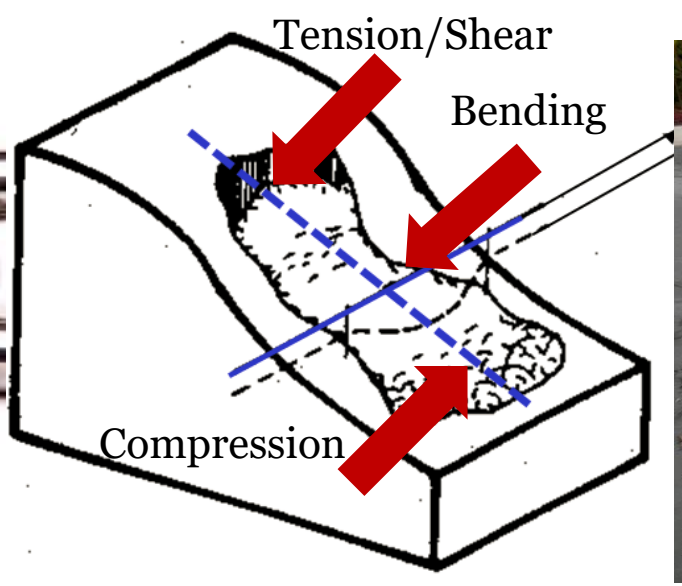
Design Considerations

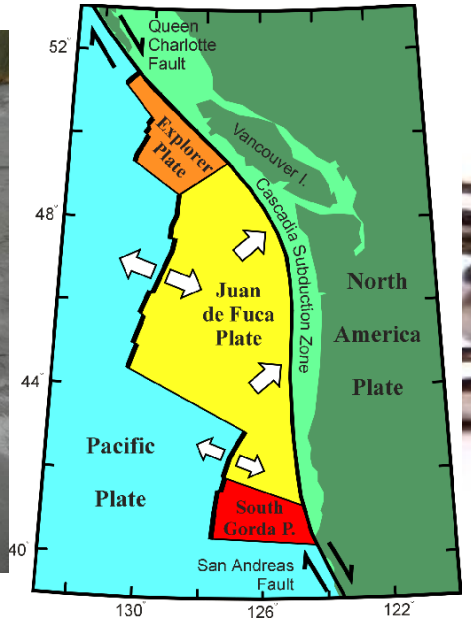
Each Location/Demand is Unique

- Wave Propagation
- Liquefaction
- Fault / Lateral Spread

System Components = Chain







Design Considerations

Earthquake Resistant Components

Parameter	Class	Component performance
Expansion/contraction performance	S-1	± 1 % of *L* or more
	S-2	± 0,5 % to less than ± 1 % of *L*
	S-3	Less than ± 0,5 % of *L*
Slip-out resistance	A	3 *d* kN or more
	B	1,5 kN to less than 3 kN
	C	0,75 kN to less than 1,5 kN
	D	less than 0,75 *d* kN
Joint deflection angle	M-1	± 15° or more
	M-2	± 7,5° to < 15°
	M-3	Less than ± 7,5°

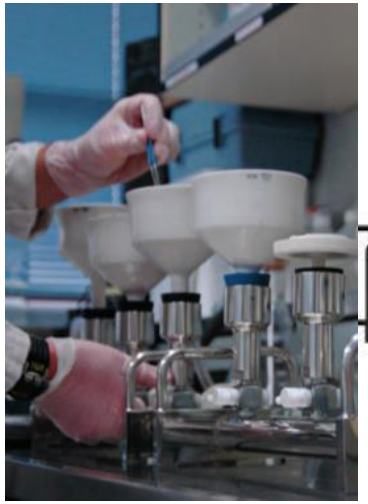
L is the component length, in millimetres (mm)
d is the nominal diameter of pipe, in millimetres (mm)

LESSONS LEARNED

Lessons Learned

Sticker Shock

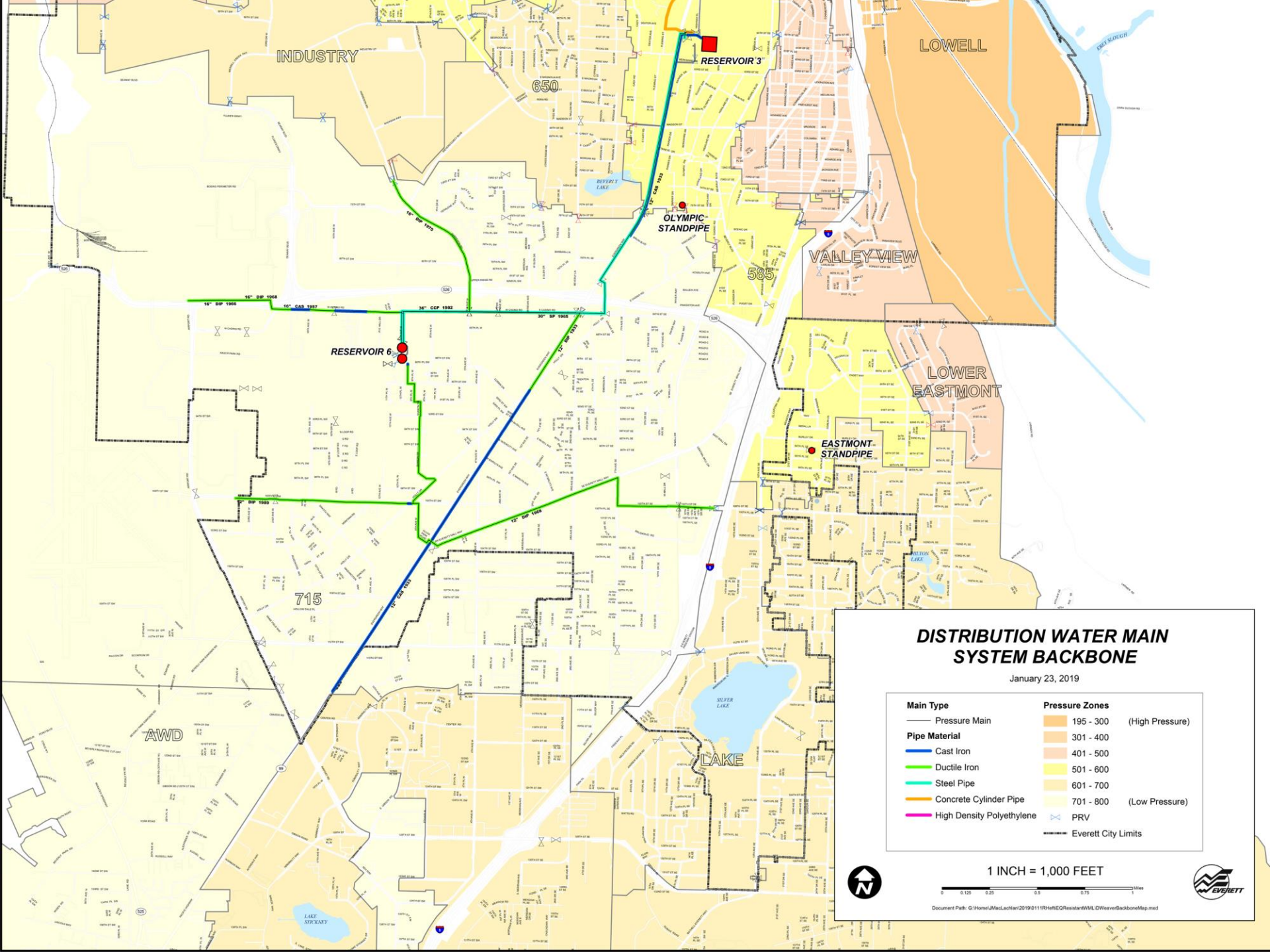
- **Cost**
  - City Standard: 12” Cl 52 DI, Push-on Joint
  - Avg. Bid Price Since 2011 Adjusted for Inflation = $92.62/lf
- **12” ERDIP**
- **Water S Bid price = $185.00/lf**
  - Water Q Bid price = $206.00/lf
- **Increase to Project**
  - 25% for Water S
  - 29% for Water Q
- **Circumstances**
  - New Product: Contractor Risk
  - Night Installation - Water Q
- **Cost/Benefit: Public Health & Safety**



Lessons Learned

Installation

- Site Conditions
- Assembly Methods
- Field Adaptability
- Installation Crew Training


INDUSTRY
650
RESERVOIR 3
LOWELL
OLYMPIC STANDPIPE
VALLEY VIEW
585
LOWER EASTMONT
EASTMONT STANDPIPE
RESERVOIR 6
715
AWD
LAKE
16" DIP 1970
16" DIP 1966
16" CAS 1957
36" CCP 1982
30" SP 1965
12" CAS 1923
12" DIP 1933
12" DIP 1968
DIP 1989
12" CAS 1923
DISTRIBUTION WATER MAIN SYSTEM BACKBONE
January 23, 2019
Main Type
Pressure Main
Pipe Material
Cast Iron
Ductile Iron
Steel Pipe
Concrete Cylinder Pipe
High Density Polyethylene
Pressure Zones
195 - 300 (High Pressure)
301 - 400
401 - 500
501 - 600
601 - 700
701 - 800 (Low Pressure)
PRV
Everett City Limits
1 INCH = 1,000 FEET
Document Path: G:\Home\JMacLachlan\2019\0111\RHefti\EQResistantWML\DWeaverBackboneMap.mxd


QUESTIONS?
CAT
CAT
315F
EVERETT
WASHINGTON
AMERICAN
THE RIGHT WAY