Milwaukee Regional Medical Center uses CFRP to Increase Life of PCCP Pipes by 20 Years

Amber Wagner, Ph.D., PE
Brian Wimberger

AEGION®
Stronger. Safer. Infrastructure.®

FYFE®

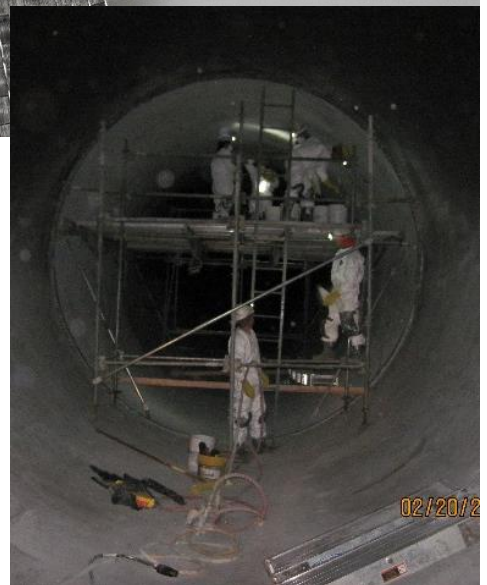
Insituform

OUTLINE

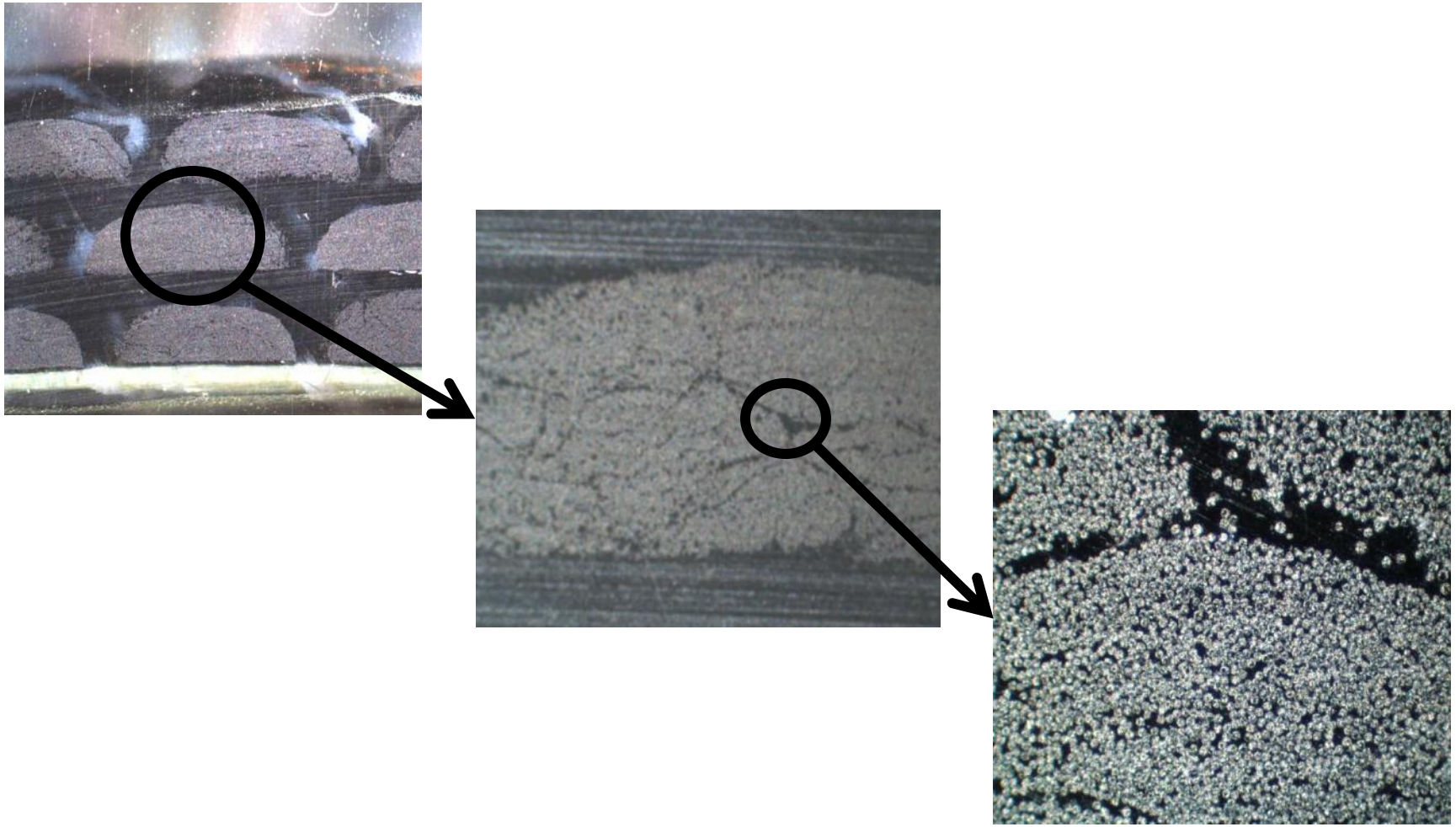
- Introduction to FRP
- Project Background
- Design
- Installation
- Inspection
- Conclusion

INTRODUCTION TO FRP

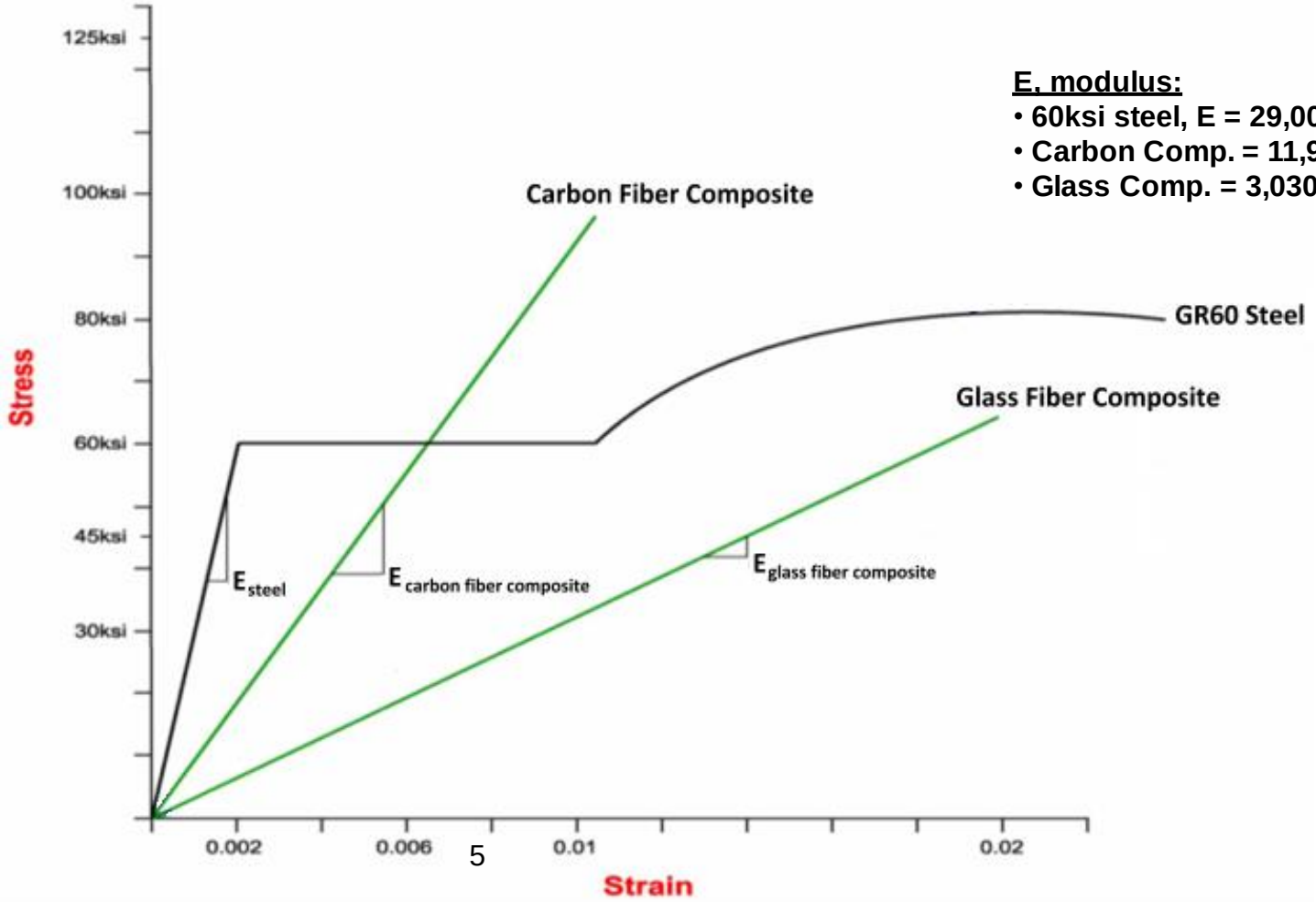
- Carbon Fiber Reinforced Polymers (CFRP)
- Glass Fiber Reinforced Polymers (GFRP)



CARBON FIBER REINFORCED POLYMER (CFRP): UP-CLOSE



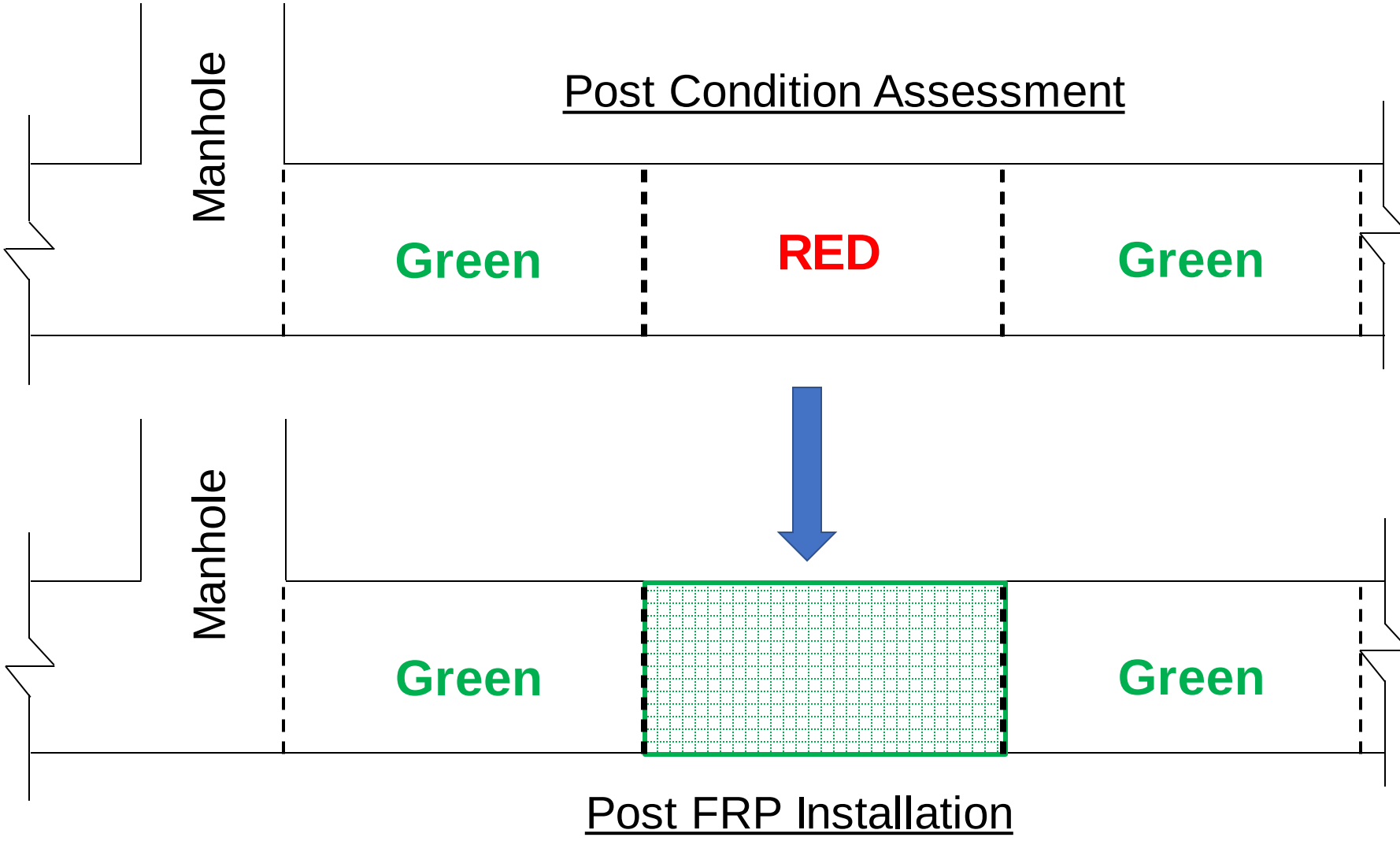
COMPARISON OF MECHANICAL PROPERTIES



E, modulus:

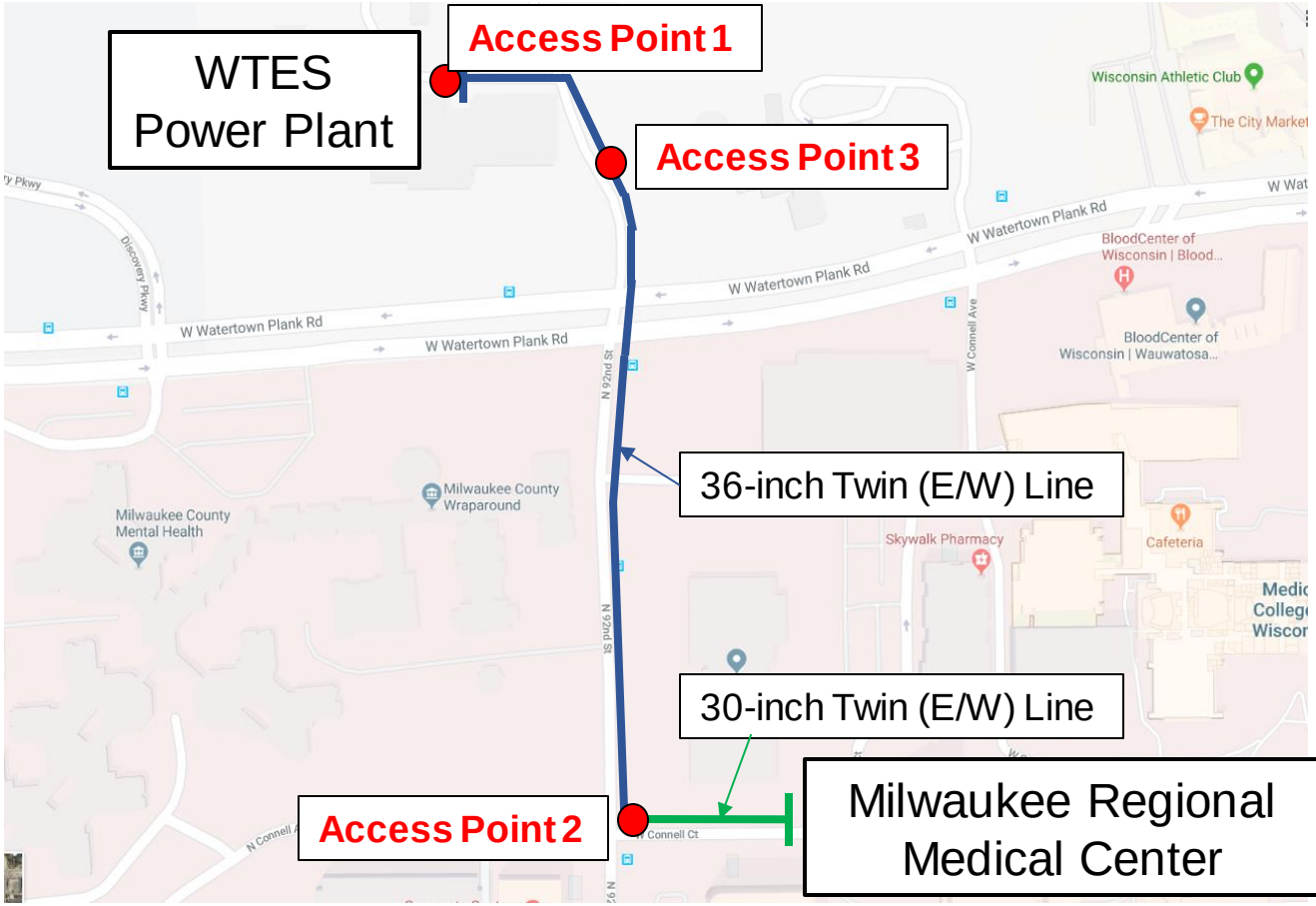
- **60ksi steel, E = 29,000ksi**
- **Carbon Comp. = 11,900ksi**
- **Glass Comp. = 3,030ksi**

OVERVIEW OF PROJECT PROGRESSION

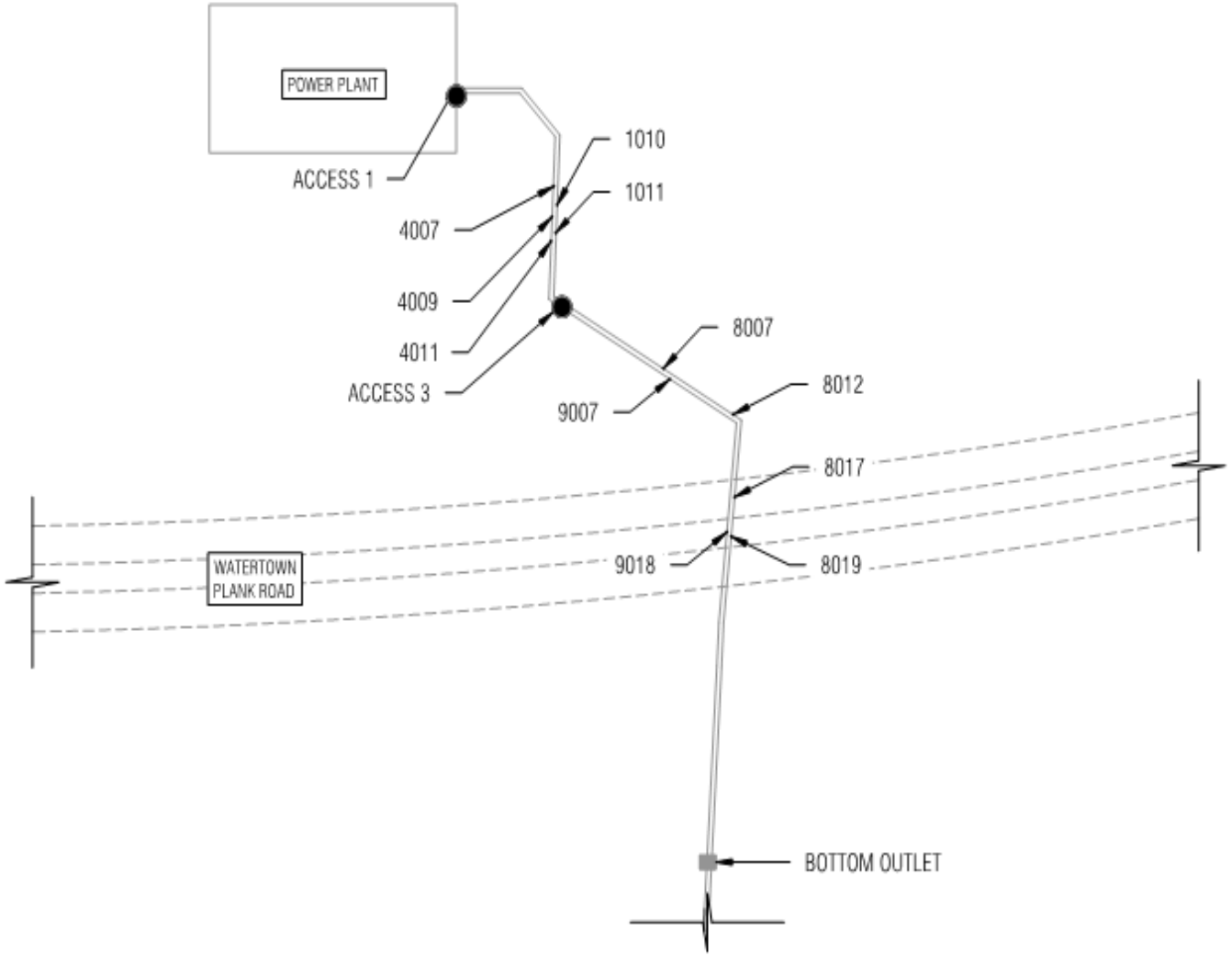


PROJECT BACKGROUND

1. Both Lines Required Assessment
2. Timely Repair Required
3. Not enough in budget for complete replacement



POST CONDITION ASSESSMENT

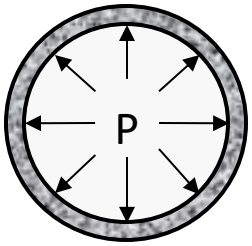


DESIGN PARAMETERS

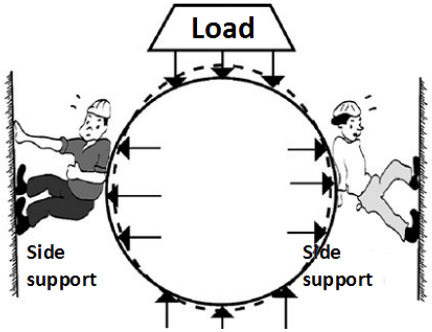
Design Requirement	Value
• Pipe Diameter	36 inches
• Pipe Type	PCCP
• Working Pressure	125 psi
• Soil Height	12 feet
• Water Height	12 feet
• Live Loading	AASHTO HS-20
• Design Life	20 years
• Design Standard	AWWA C305

AWWA C305 DESIGN REQUIREMENTS

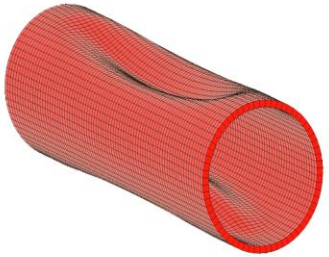
Hoop Direction



Burst Pressure

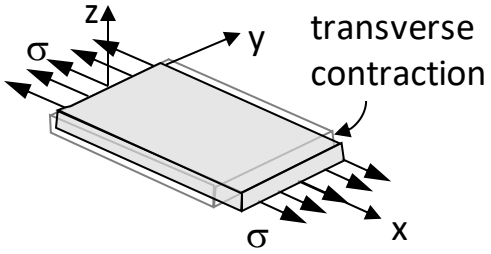


Pipe Deflection

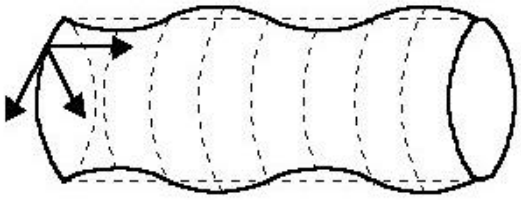


Constrained Buckling

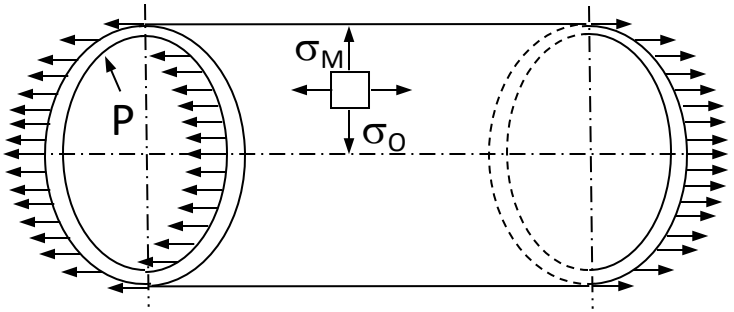
Longitudinal Direction



Poisson's Effect



Temperature Change



Thrust Loading

FRP INSTALLATION VIDEO

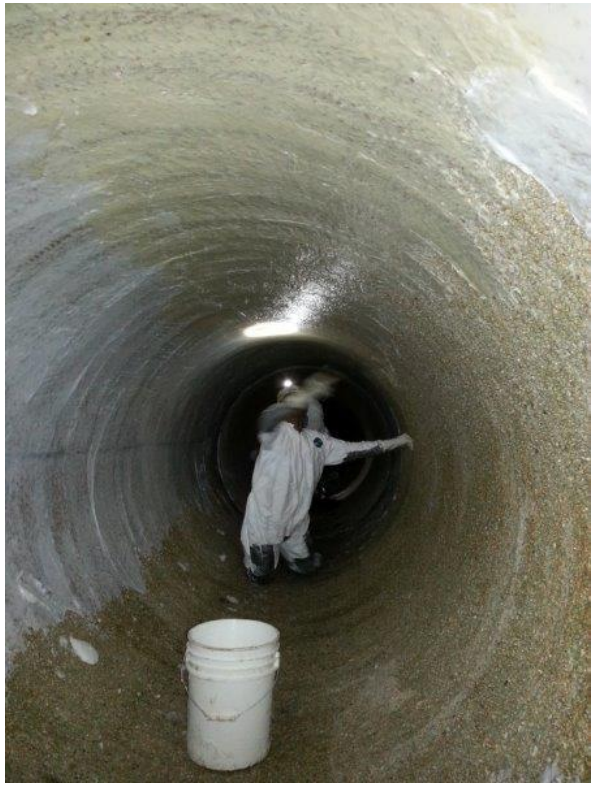
STEP 1: SURFACE PREPARATION

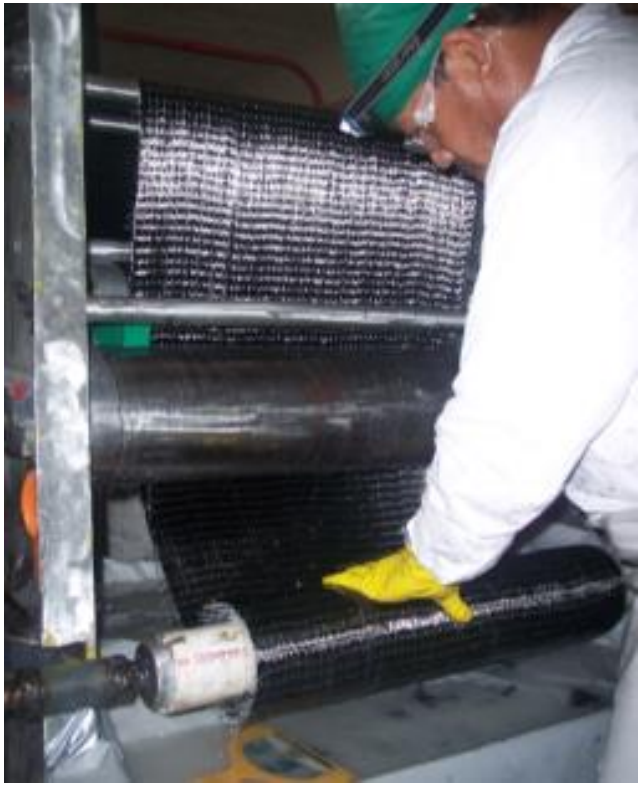
Sand Blasting Equipment

Finished Surface - Concrete

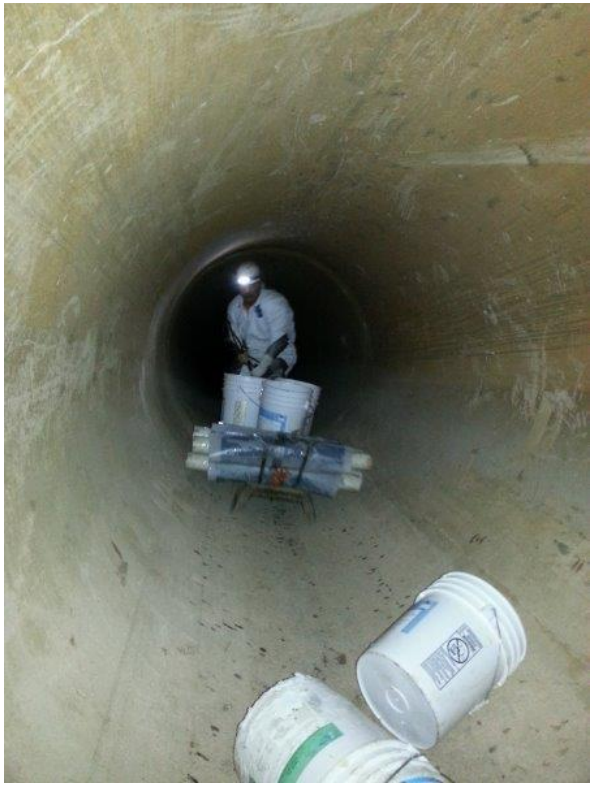
STEP 2: PRIMER / SATURATION

Surface Primer



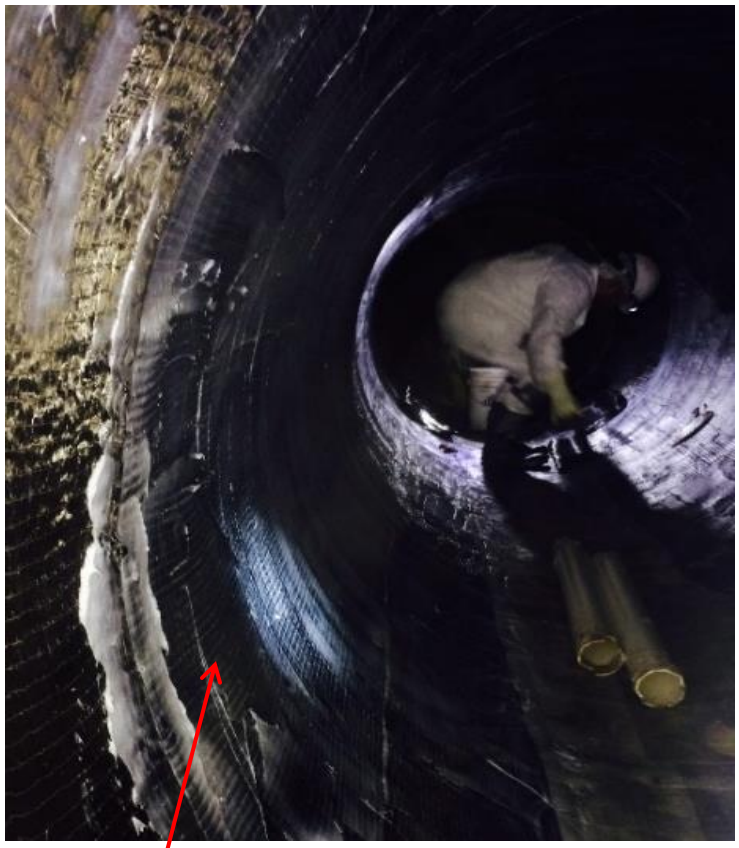


Material Transport



CFRP Impregnation

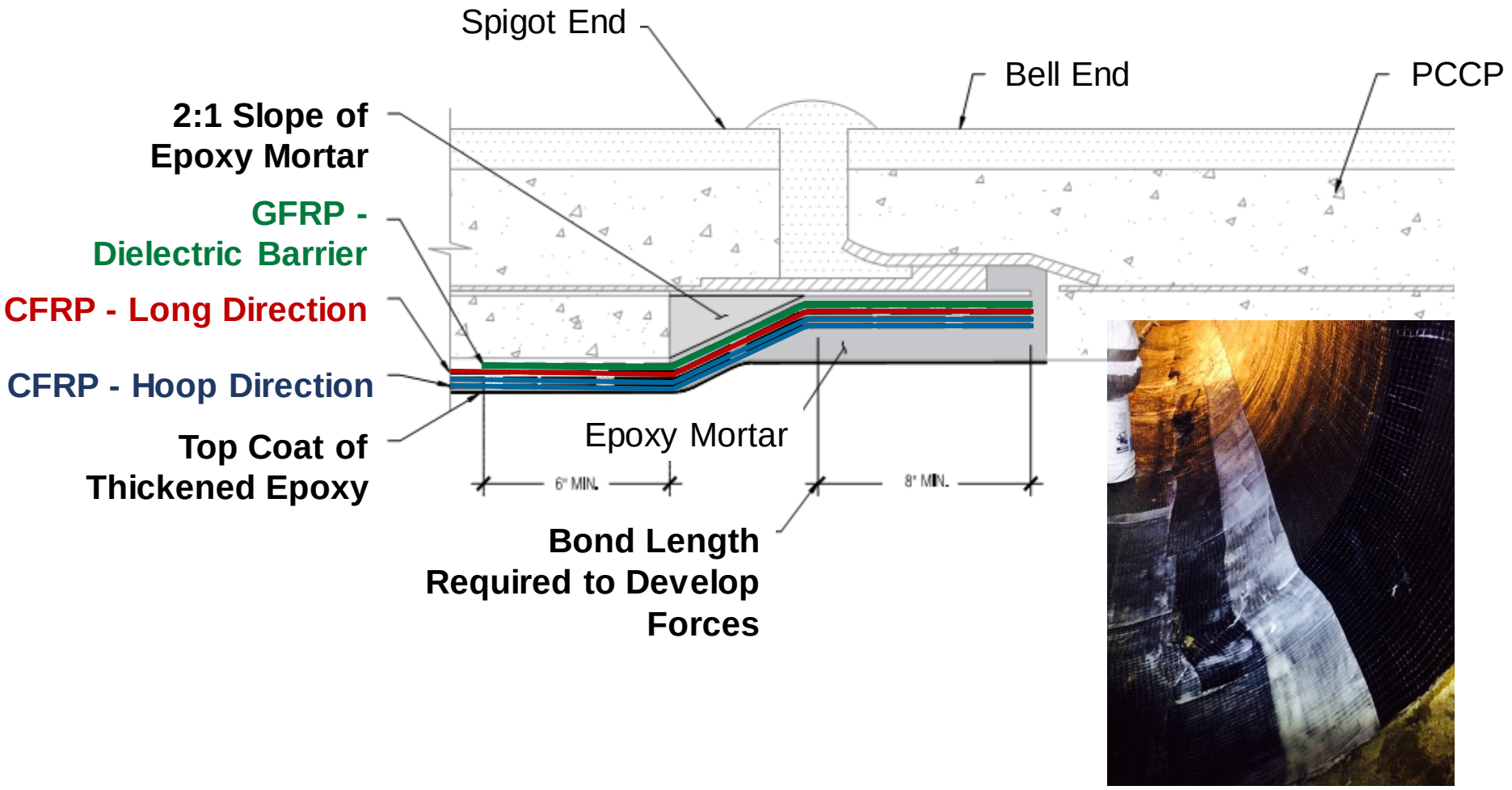
STEP 3: FRP SYSTEM INSTALLATION



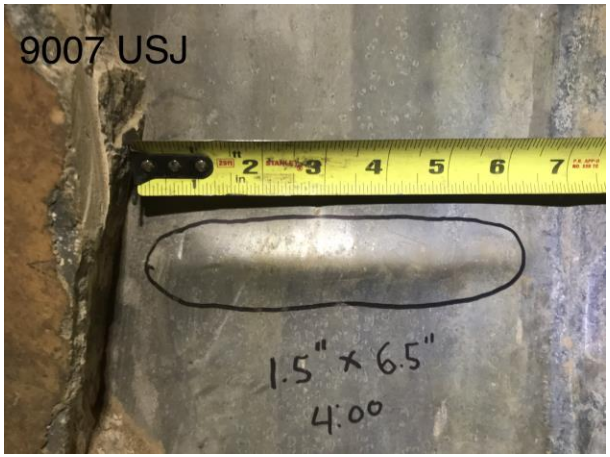
Circumferential layer

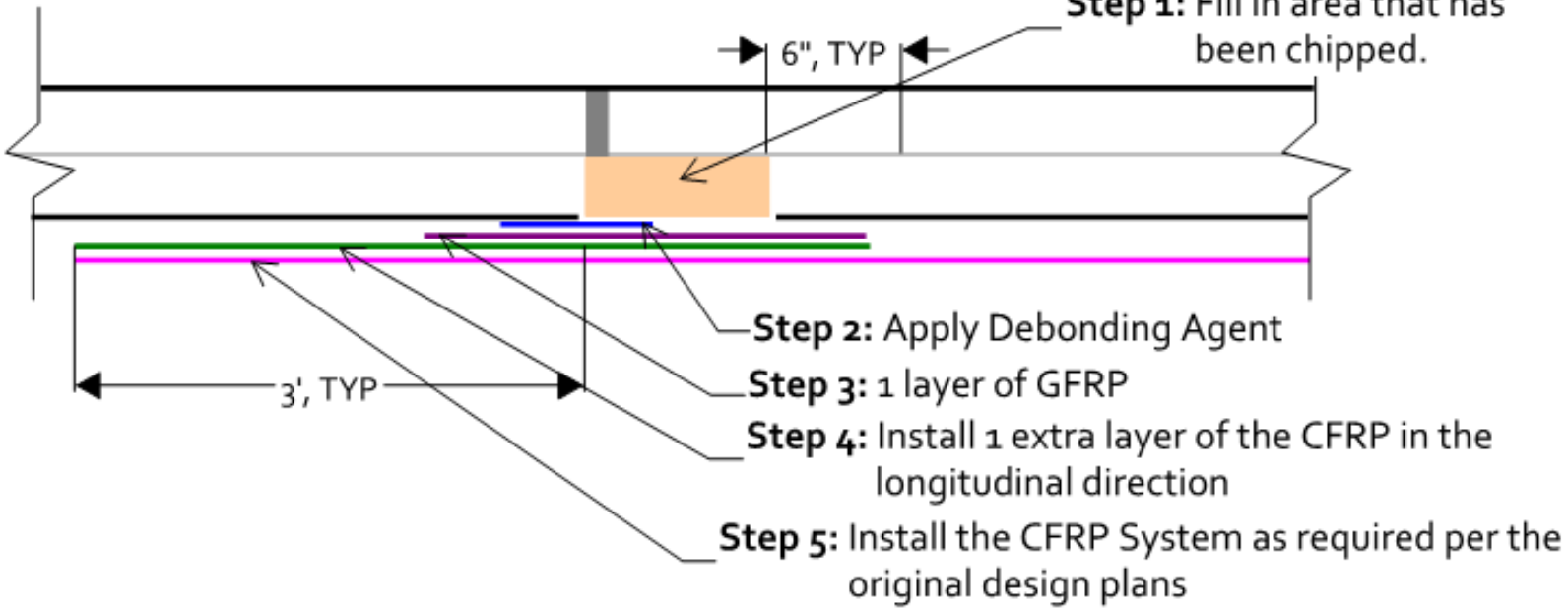
Completely Installed FRP System

STEP 4: TYPICAL TERMINATION DETAIL

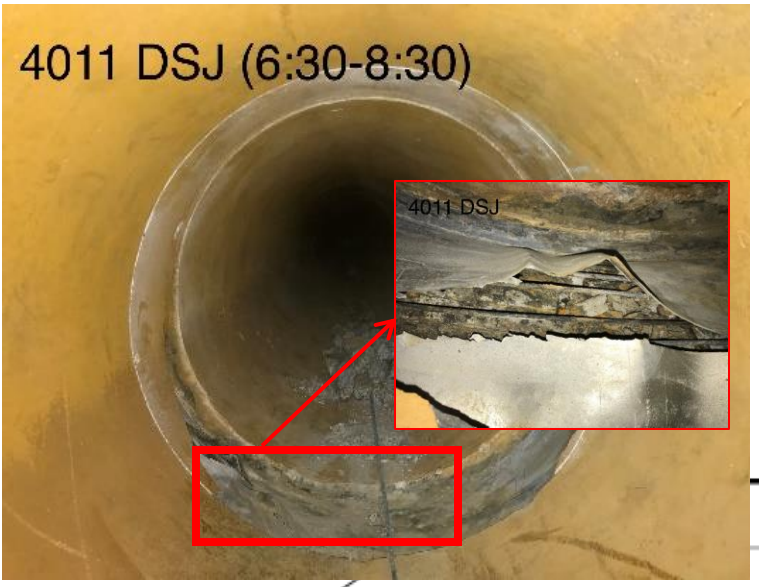


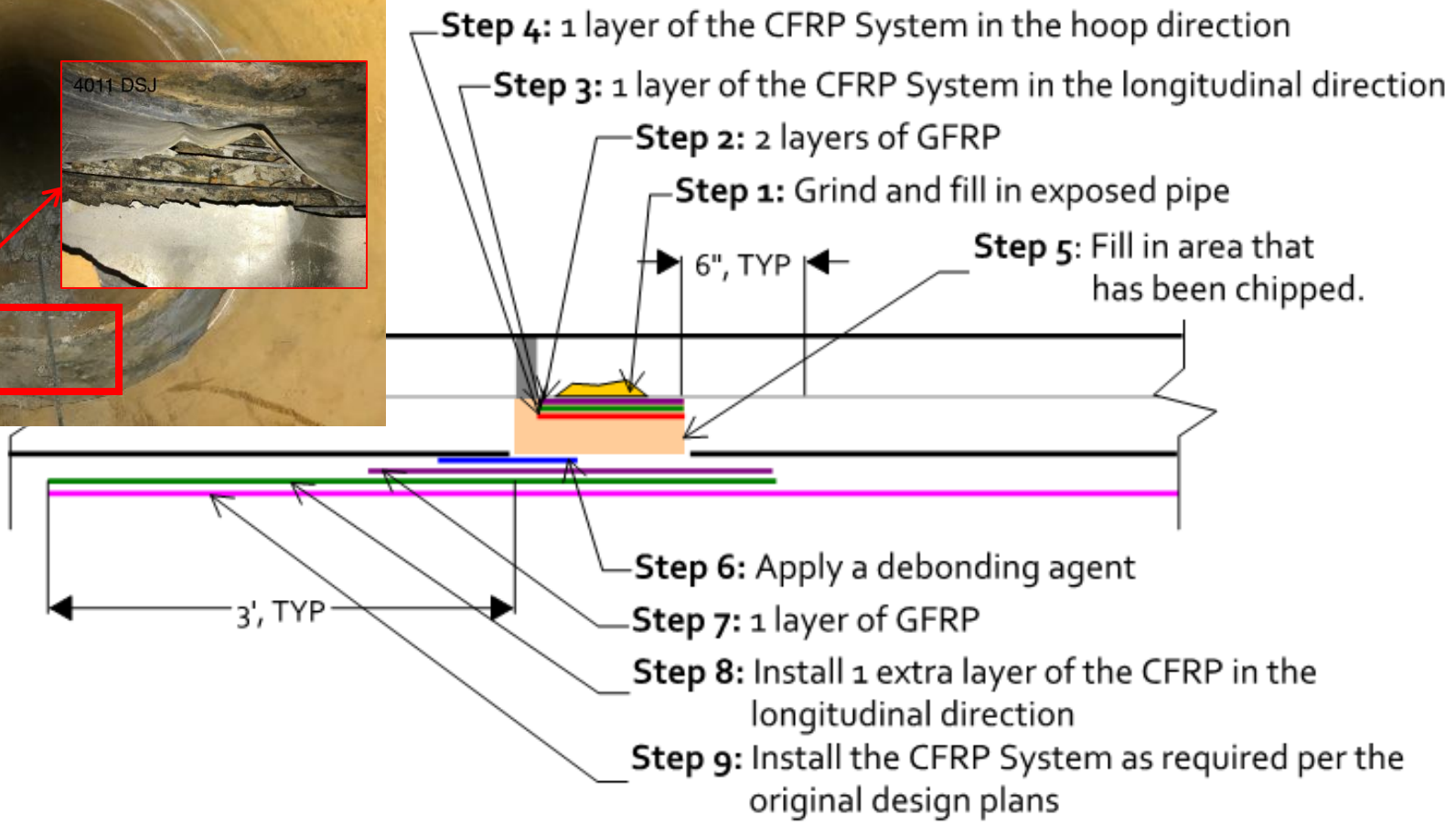
STEP 4: MODIFIED TERMINATION DETAILS





STEP 4: MODIFIED TERMINATION DETAILS





FIELD QC – MOCK-UP PANEL TESTING

- Minimum (3) 2 ft. x 2 ft. panels on adjacent non-repair pipes
- Prepared and tested by Installer (ASTM D4541)
- Witnessed by Inspector
- >200 psi required for at least 3 tests per panel

TESTING OF WITNESS PANELS

- Prepared by the Installer, witnessed by the Inspector, tested by the Independent Testing Agency
- Typically two-panels per day per work shift
- Typically two-layers unless otherwise specified
- Preparation of panels spread throughout construction
- Mean tensile strength and modulus obtained per ASTM D3039 should be greater than the characteristic values used in design

CONCLUSION

30” and 36” PCCP Chilled Water Lines Rehab

11 Pipe Segments Repaired

Completed On-Time and Under Budget

Increased Life of Line by 20 Years