Municipal Wastewater Infrastructure Lining and Rehabilitation

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Learning Objectives

- Causes of Deterioration of Concrete and Steel in Wastewater Treatment and Sewer Collection Environments
- Preventing Substrate Corrosion
- Rehabilitation of Substrate Corrosion

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Causes of Deterioration

- Structural Fatigue
- Corrosive Gases
- Microbiological Induced Corrosion (MIC)

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Structural Fatigue

- Caused by:
  - Traffic Loading
  - Freeze/Thaw Cycling
  - Soil Movement
  - Erosion or Cavitation

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Corrosive Gases

- Hydrogen Sulfide – H_2S
  - Corrosive to metal
  - Reduces the pH level concrete
  - Converts to sulfuric acid when it comes in contact with Sulfur Reducing Bacteria (SRB's)

Corrosive Gases

- Carbon Dioxide
  - Slow deterioration of the substrate
  - Naturally occurring
  - Acts to reduce pH of the substrate
  - Carbonated concrete

Microbiological Induced Corrosion

- This form of corrosion is a process that takes place in 4 distinct phases and is the largest contributor to corrosion in sewer collection and wastewater environments.

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Microbiological Induced Corrosion

- Phase 1
  - Sulfur reducing bacteria (SRB) break down sulfates in the waste stream and produce hydrogen sulfide (H_2S) and carbon dioxide CO_2.

Microbiological Induced Corrosion

- Phase 2
  - The acidic gases H_2S and CO_2 act to reduce the pH of concrete from approximately 12 to as low as 9.
  - Sulfur oxidizing bacteria (SOB's) attach to the surface as sulfates are produced.

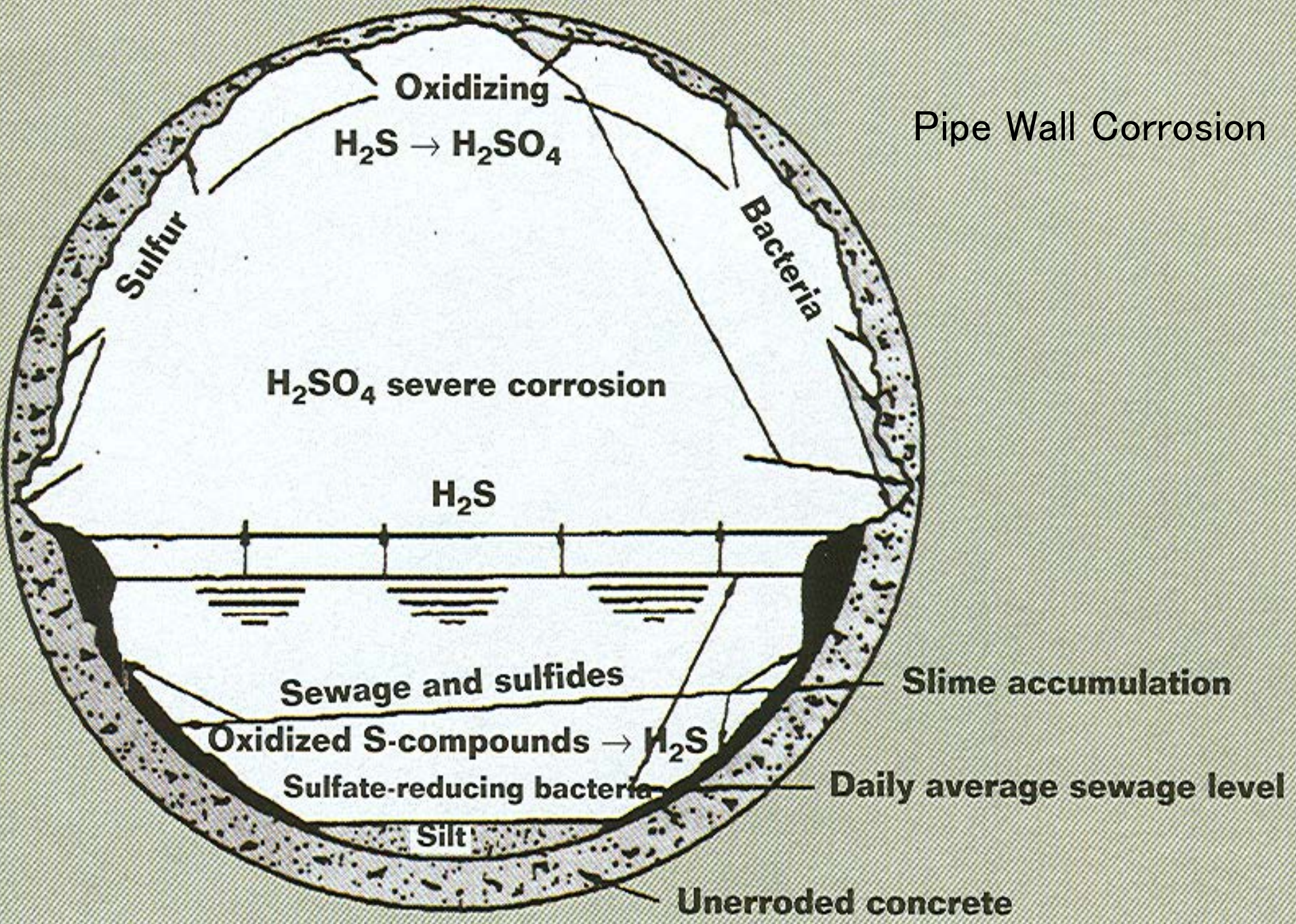
Microbiological Induced Corrosion

- Phase 3
  - The SOB's are known as Thiobacillus Thioxidans. They consume H_2S and discharge sulfuric acid H_2SO_4
  - The pH continues to drop and microbial growth accelerates creating more H_2SO_4

Microbiological Induced Corrosion

- Phase 4 – Final Phase
  - Acid attack of the concrete creates a layer of gypsum (calcium sulfate). As organisms reproduce, additional acid is produced.
  - Eventual structural failure

Pipe Wall Corrosion



Controlling Corrosion

1. Change design parameters.

(Minimize slow flow or stagnant conditions in treatment stream)

2. Different materials of construction.

(Use of vitrified clay, plastics, anti-microbial concrete)

3. Modification of sewage environment.

(Raise pH above 9 temporarily to kill SRB; sulfate reducing bacteria)

4. Installation of barrier coatings!

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Controlling Corrosion

- High performance coatings and linings offer the most cost effective means of barrier protection to isolate a substrate from its corrosive environment.

- Global cost of Corrosion is US $2.2 Trillion annually or over 3% of the world's GDP

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Controlling Corrosion

- Types of Substrates
  - Concrete
    - Prepare per Industry Standards – SSPC, NACE and ICRI (SSPC SP13/NACE No.6 & ICRI 0310.2)
  - Steel
    - Prepare per Industry Standards – SSPC, NACE, ISO, BS, Swedish Standards (SIS).
  - Ductile Iron
    - Prepare per Industry Standards - NAPF

Controlling Corrosion

- Acceptable Generic Coating Chemistries
  - High Build Amine Cured Epoxy Linings
    - Capable of film builds in excess of 1.5 mm DFT
  - High Build Aromatic Polyurethane Linings
    - Capable of film builds in excess of 1.5 mm DFT
  - Thin Film Reinforced Amine Cured Epoxy Linings
    - Capable of film builds in excess of 375 microns DFT

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Controlling Corrosion

- Important Features and Benefits of the Selected Product
  - Permeability of Coating Film
    - More Densely Cross-Linked Film or Flake Filled Reinforced Film
  - Elongation
    - Elastomeric properties or highest % elongation to resist cracking due to substrate movement
  - Chemical Resistance
    - Able to Resist H_2S, H_2S0_4, Fats, Oils and Greases

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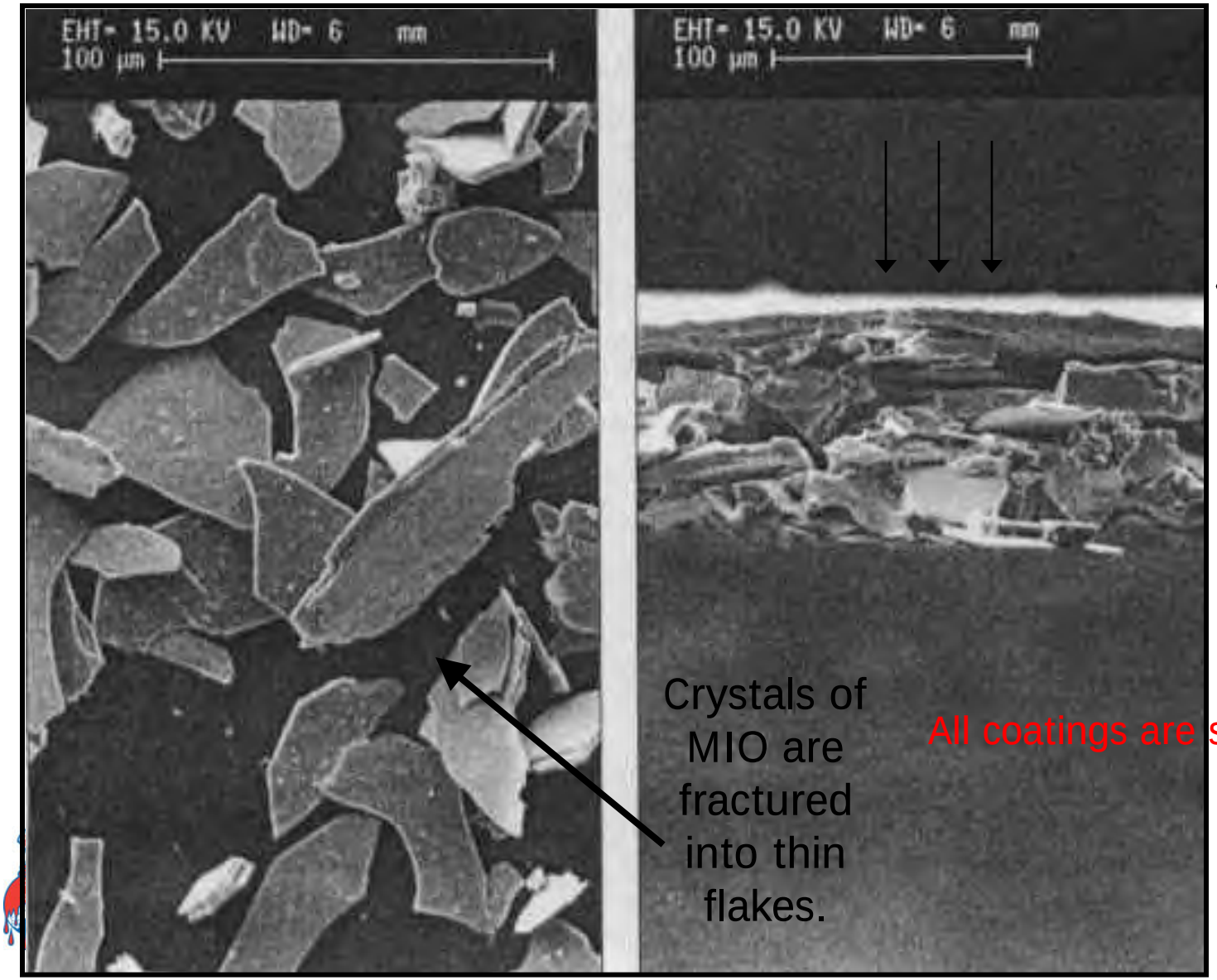
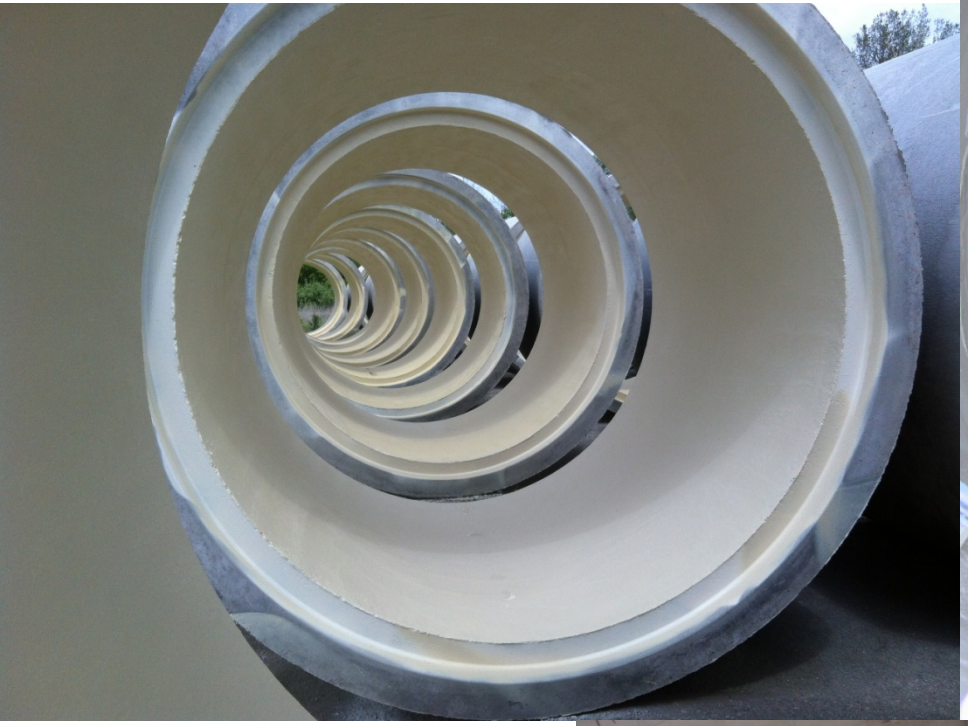
Controlling Corrosion

- Flake Filled Reinforced Films
  - Act to reduce the permeability of a semi-permeable film by increase the distance that liquids must pass through to reach the substrate.
    - Flake Fillers (List in order of least to most effective)
      - Mica
      - Micaeous Iron Oxide (MIO)
      - Treated Glass or Graphite (Resistance to Halogenated Acids)

Addition of Flake Filler





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Structural Rehabilitation

- Rehabilitation is facilitated by the lack of corrosion control measure during new construction.
- Extends the useful life of a structure.
- Increases the total project cost for completion of work.
- Creates downtime of critical assets within your wastewater infrastructure.

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Structural Rehabilitation

- Work requires more aggressive surface preparation, stopping any water infiltration, restoring the surface to a level or original plane, and the installation of a corrosion resistant barrier coating or lining.

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Surface Preparation

- Requires removal and disposal of greater amounts of the original substrate to ensure that you have sound surface to bond to.
- May require surface preparation or replacement of structural reinforcing members.

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Stopping Water Infiltration

- Water Infiltration should be classified into two categories.
  - Minor Leaks – Weeping or Trickling Water
  - Major Leaks – Gushing or Flowing Water
- Minor Leaks Can be stopped with the use of hydraulic cements
- Major Leaks will require the use of a hydro activated polyurethane grout.

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Restore the Surface

- Restoration of a deteriorated surface will take time and should be specified per one of the following:
  - Restore the surface to a level plane
    - No concern of structural integrity and the surface needs to be smooth for the application of the coating or lining system.
  - Restore the surface to its original plane
    - Concerned with structural integrity and the surface needs to be restore to the original wall thickness to provide required service life after application of coating or lining system

Corrosion Resistant Coatings & Linings

- Provide a longer life cycle for the substrate to which they have been applied
- Provide an excellent infiltration and exfiltration barrier
- Available chemistries include:
  - Epoxy
  - Polyurethane

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Corrosion Resistant Coatings & Linings

- Epoxy Coating and Linings
  - Industry Standard
  - Satisfies most project requirements
  - Not the fix for every situation
  - Consider based on the structure, location, use, and environment during application.

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Chemical Resistant Coatings & Linings

- Sherwin-Williams Sher-Glass FF Epoxy Corrosion Protection Coating
  - 75% Solids, Amine Cured Epoxy, Capable of being applied up to 500 Microns DFT in a single coat.
  - May be applied to a Surface Saturated Dry (SSD) Substrate.
  - The glass flake reinforced film offers lower permeability and improves chemical resistance at lower dry film thicknesses.

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Chemical Resistant Coatings & Linings

- Sherwin-Williams Cor-Cote SC “SewerCote” Plus Epoxy Corrosion Protection Coating
  - 100% Solids, Amine Cured Epoxy, Capable of being applied >1.5 mm DFT in a single coat.
  - May be applied to a Surface Saturated Dry (SSD) Substrate.
  - The product offers well balanced physical performance characteristics for use in municipal wastewater streams.

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Chemical Resistant Coatings & Linings

- Sherwin-Williams Cor-Cote SC “SewerCote” Plus Epoxy Mortar Corrosion Protection Lining
  - 100% Solids, Amine Cured Epoxy, Capable of being applied up to 5 mm DFT in a single coat.
  - May be applied to a Surface Saturated Dry (SSD) Substrate.
  - The product offers well balanced physical performance characteristics for use in municipal wastewater streams.

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Chemical Resistant Coatings & Linings

- Sherwin-Williams SherFlex Elastomeric Polyurethane Corrosion Protection *Flexible* Lining
  - 100% Solids, Aromatic, Polyurethane, Capable of being applied >5 mm DFT in a single coat.
  - Primer required for application to concrete and application to a Surface Saturated Dry (SSD) substrate.
  - The product offers a flexible liner capable of bridging a 3 mm crack. It will withstand severe traffic loading and may be used as a chimney seal.

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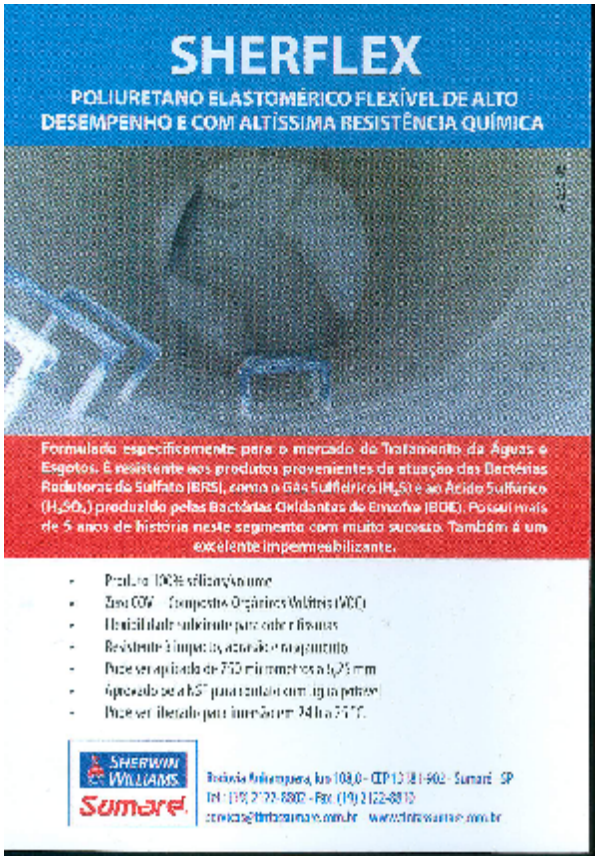
SherFlex



More information in Portuguese in the folder.

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Summary

- Protection of wastewater and sewer collection structures is required to achieve the desired in-service life cycle.
- There are two thought processes for maximizing service life of these assets (Protection and Rehabilitation).
- Sherwin-Williams understands your problems and offers the most complete line of products for the lining and rehabilitation of all of your municipal wastewater and sewer collection systems.

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Case History

New Construction Wet Well

In service for 6 months

In service for 4 ½ years

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Case History

Rehabilitated Wet Well

In service for 3 years

In service for 7 years

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Questions?

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New Products for NTS 036 (Sabesp)

Sumaflex Tar Free

Sumadur Hydro Branco

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