Tank Coatings and Maintenance:

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Advanced Solutions

Overview:

Introduction

Proactive vs Reactive

- **What is Asset Management**
- **Risk Analysis**
- **Cost Effectiveness**

Steel Tanks:

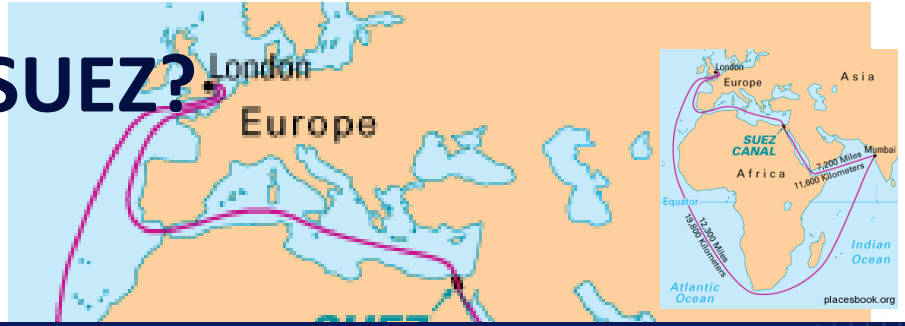
- **Common Coatings and Material Selection**
- **Common Failures**

Concrete Tanks:

- **Basics of Concrete**
- **Problems**
- **Maintenance of Concrete Structures**
  - Why Coat Concrete?
- **Concrete Coating Options**
- **Case Studies**

Who is SUEZ?

Our History: The SUEZ Canal Company



- **SUEZ Canal Company** formed in 1858
- Used **innovative coal and steam-powered technology to** build canal
- **SUEZ Canal** opened in 1869

Today:

- Present in 70 countries
- 80,990 employees
- 323,000 Municipal and Industrial customers
- $ 18+ billion revenue annually

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SUEZ' HISTORY IN NORTH AMERICA

1869 — Founded as Hackensack Water Company

1974 — Integration of Infilco by Degremont

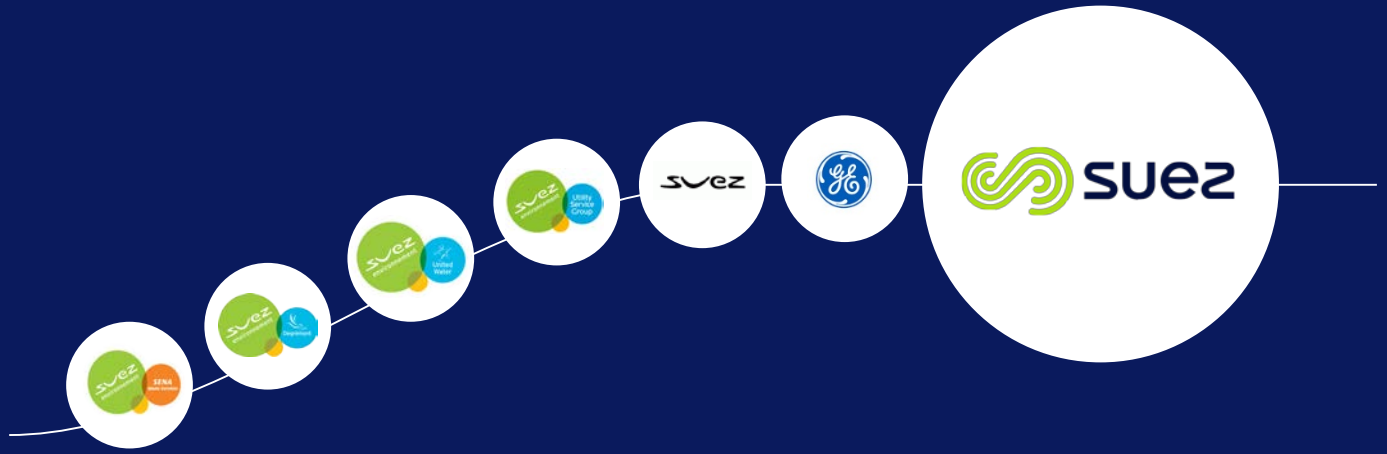
2000 — Integration of United Water

2008 — Integration of Utility Service Group

2011 — Integration of SENA Waste Services

2017 — Acquisition of GE Water & Process Technologies

SUEZ' HISTORY IN NORTH AMERICA



Suez Advanced Solutions Offerings

Water Wells

- Condition assessment
- Maintenance program
- Pumps services
- Rehabilitation
- Drilling

Water Quality

- Asset chemical cleaning
- Mixers
- THM removal
- Ice Pigging
- Filter media replacement

Steel Water Tanks

- Condition assessment
- Maintenance program
- Rehabilitation
- Drone inspections

Concrete Structures

- Condition assessment
- Maintenance program
- Rehabilitation
- Water, wastewater and storm water assets

Network assets & Meters

- Maintenance program with AMI
- Advanced Network management (Aquadvanced)
- Network condition assessment and rehabilitation

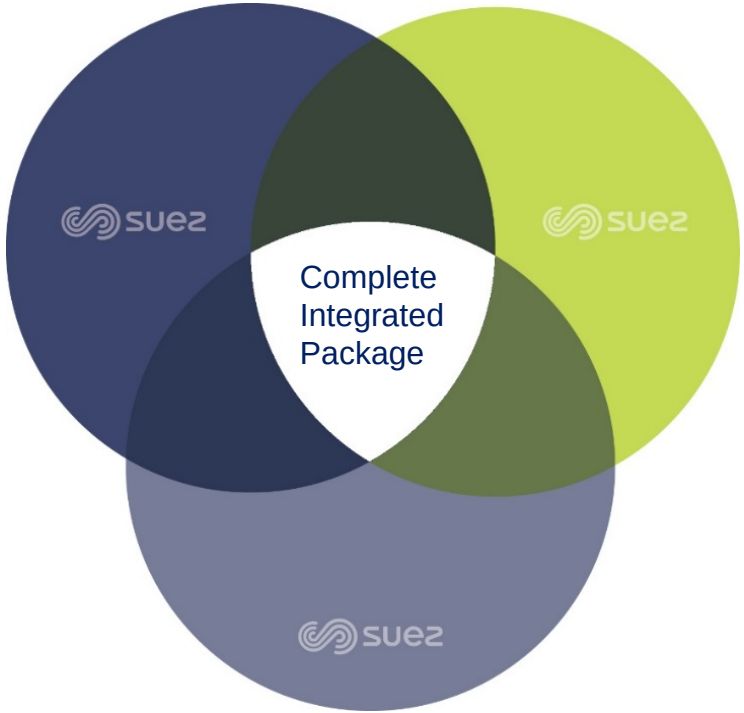
The Challenge:

increasing regulation | shrinking resources | pressure on operational costs | aging infrastructure

Infrastructure maintenance

- Rehabilitate
- Maintain
- Back-up short-staffed internal teams

Extend
life of asset



New Technologies

- Do more with existing assets to meet new regulations

Lower capital costs

SUEZ can provide water utilities with an integrated solution.

Smart Asset Management

- Increased efficiency
- Optimized operations

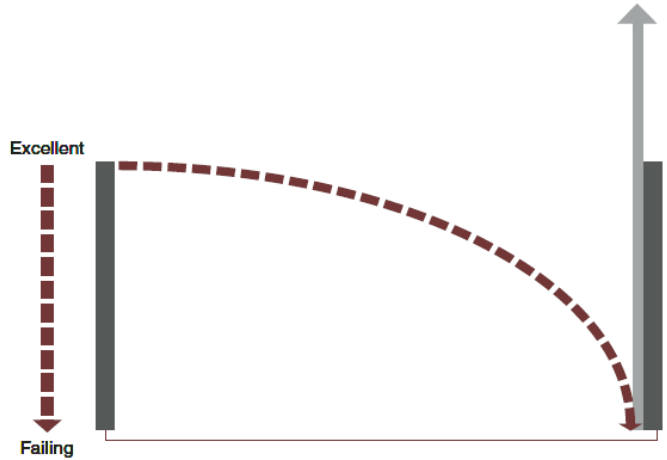
Lower operating expenses

What is Preventive Maintenance & Asset Management?

Water System Maintenance Programs are Designed to Extend the Useful Life of Assets

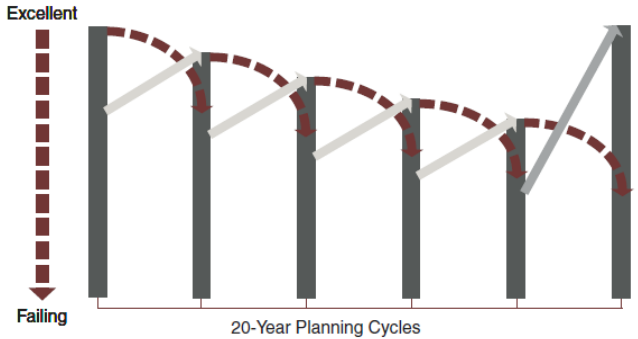
Run-to-Failure Management Model

Sewer system assets that are not regularly maintained usually deteriorate faster than expected and lead to higher replacement and emergency response costs.



Peak Condition
Asset Decay
Rehab/Replacement Cost

Cost-effective!



Peak Condition
Asset Decay Rate
O&M Cost
Rehab/Replacement Cost

Asset Management Model

Components are regularly maintained over long planning cycles, and finally replaced when deterioration outweighs the benefit of further maintenance. Costs are well-distributed over the life of the asset.

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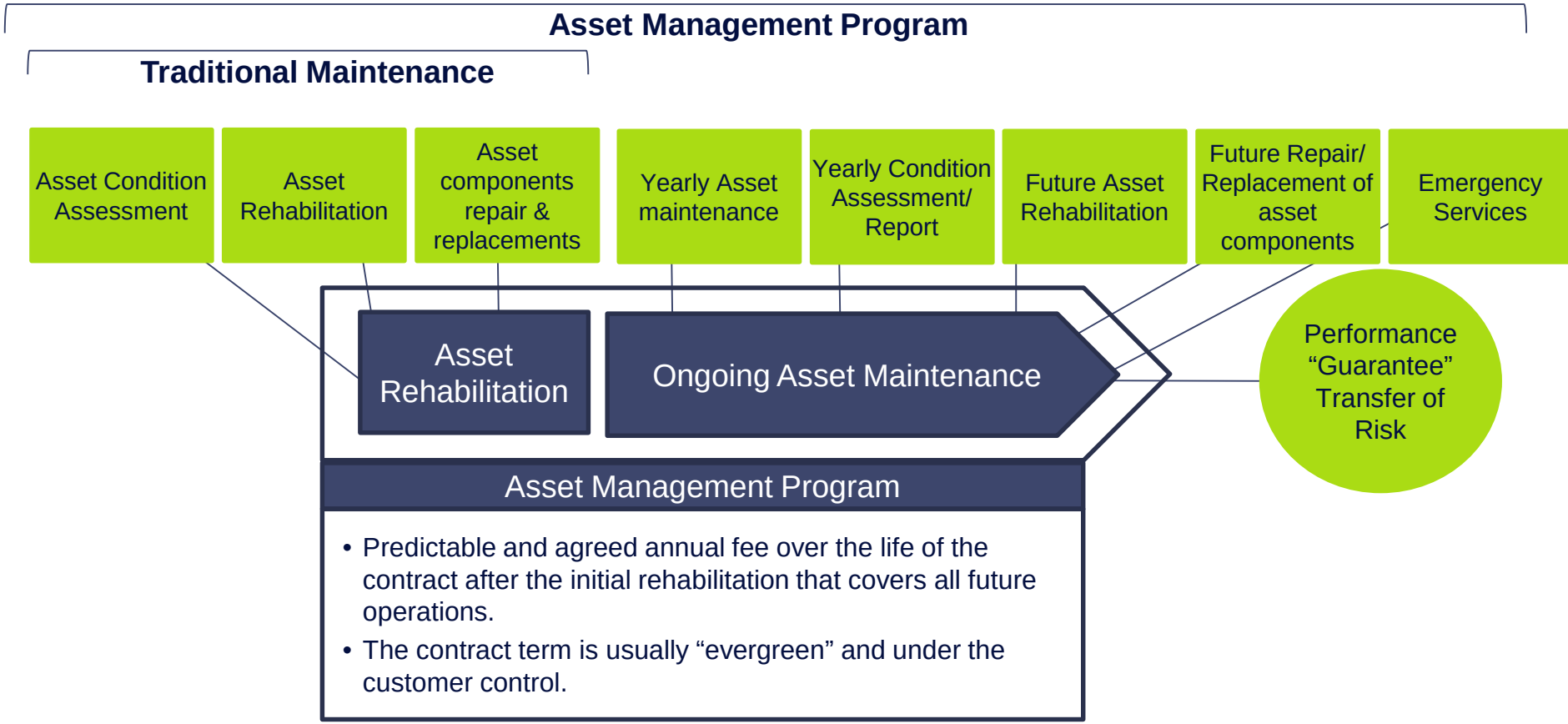
Water Asset Maintenance



Tank Coatings and Maintenance: Steel Tanks

- Proactive vs Reactive

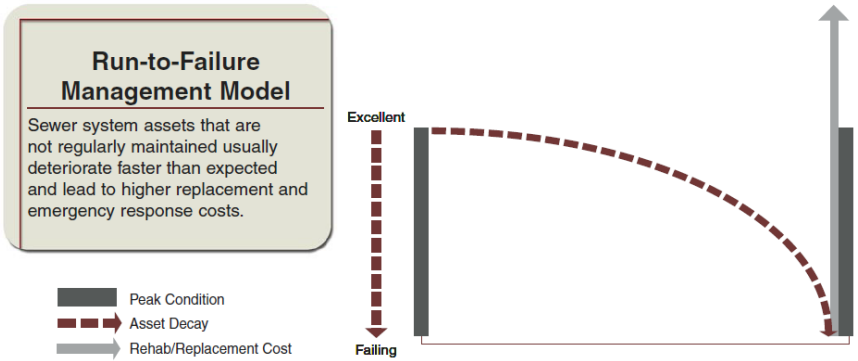
Life Cycle

How long will the coating system last?

- **Depends on the user's approach to, and philosophy of, maintenance.**
  - Appearance
  - Corrosion protection
  - Water Quality

Typical Maintenance Practices

- **Original Painting**
- **Spot Touch-Up and Repair**
  - Usually more prep required
- **Maintenance Repaint (spot prime and full coat)**
  - If adhesion is still good and prep is limited
- **Full Repaint (total coating removal and replacement)**



Tank Coatings and Maintenance: Steel Tanks

- Risk Analysis

Risk of Delayed Maintenance

Risk of Delayed Maintenance

Risk of Delayed Maintenance

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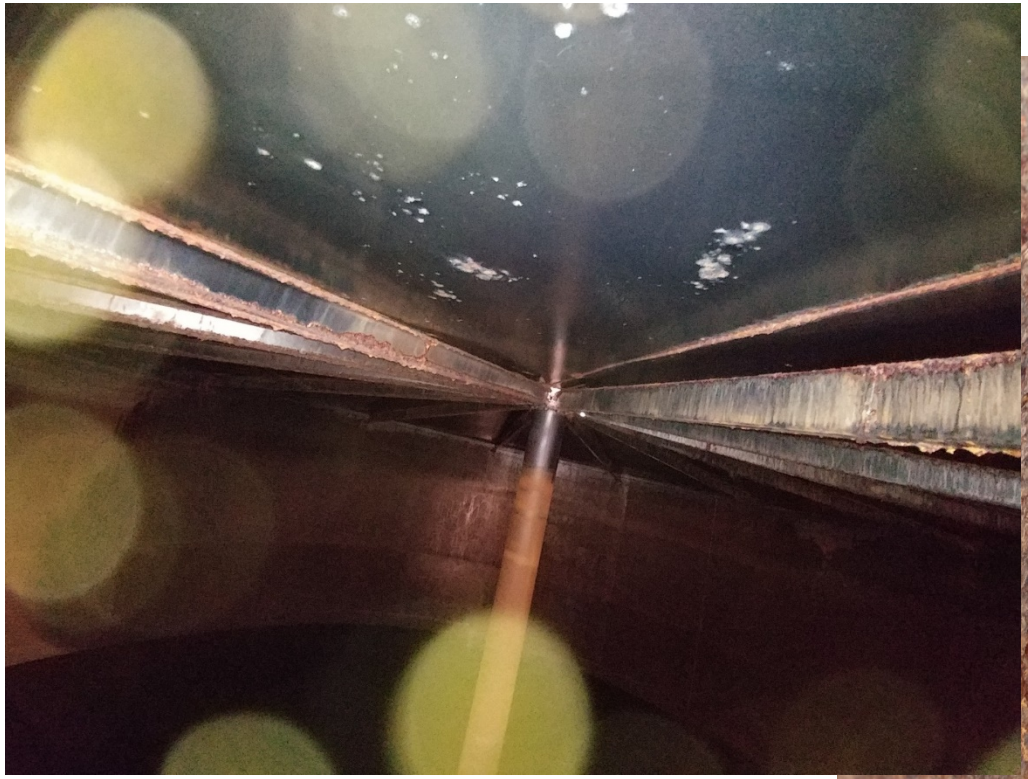
Risk of Deferred Maintenance

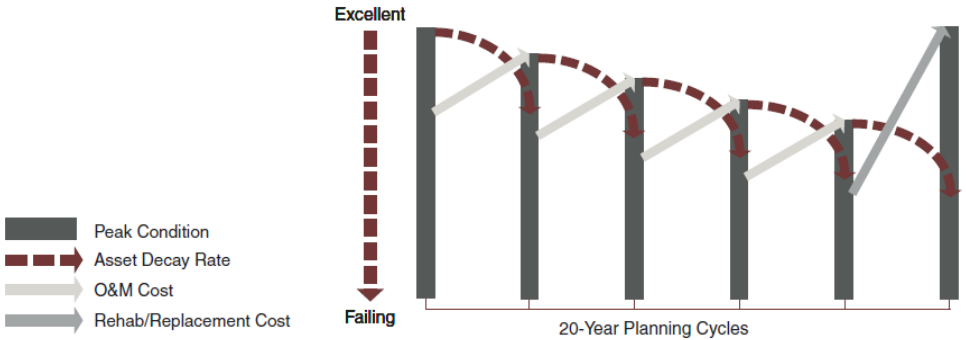


Tank Coatings and Maintenance: Steel Tanks

- Preventative

Water System Maintenance Programs are Designed to Extend the Useful Life of Assets

Cost-effective!



Asset Management Model

Components are regularly maintained over long planning cycles, and finally replaced when deterioration outweighs the benefit of further maintenance. Costs are well-distributed over the life of the asset.

Preventative Maintenance Practices

- Original Renovation and Repairs
- Regular Interior and Exterior Inspections
- Spot Touch-Up and Repairs
- Regular Overcoats to reduce surface prep (spot prime and full coat) and protect adhesion
- Regular interior coatings replacement (prevent steel loss)
- Full Repaint only when needed over prolonged period

Why Preventative Maintenance?

AWWA M42: Steel Water Storage Tanks (1998):

- " A good, comprehensive preventative maintenance program can extend the life of an existing tank (as well as that of a new tank) INDEFINITELY"

- " Many thousands of dollars can be saved and complaints from citizens can be eliminated if a planned approach to tank maintenance is adopted."

- " Small outlays for maintenance can substantially delay or eliminate the need to replace a utilities large capital investment in tanks

Why Preventative Maintenance?

AWWA "Steel Water Storage Tanks" (2010) Chapter 10, Page 381:

"Why have a maintenance program? The answer is simple: **Preventive maintenance has been, and always will be, less expensive than crisis maintenance**."

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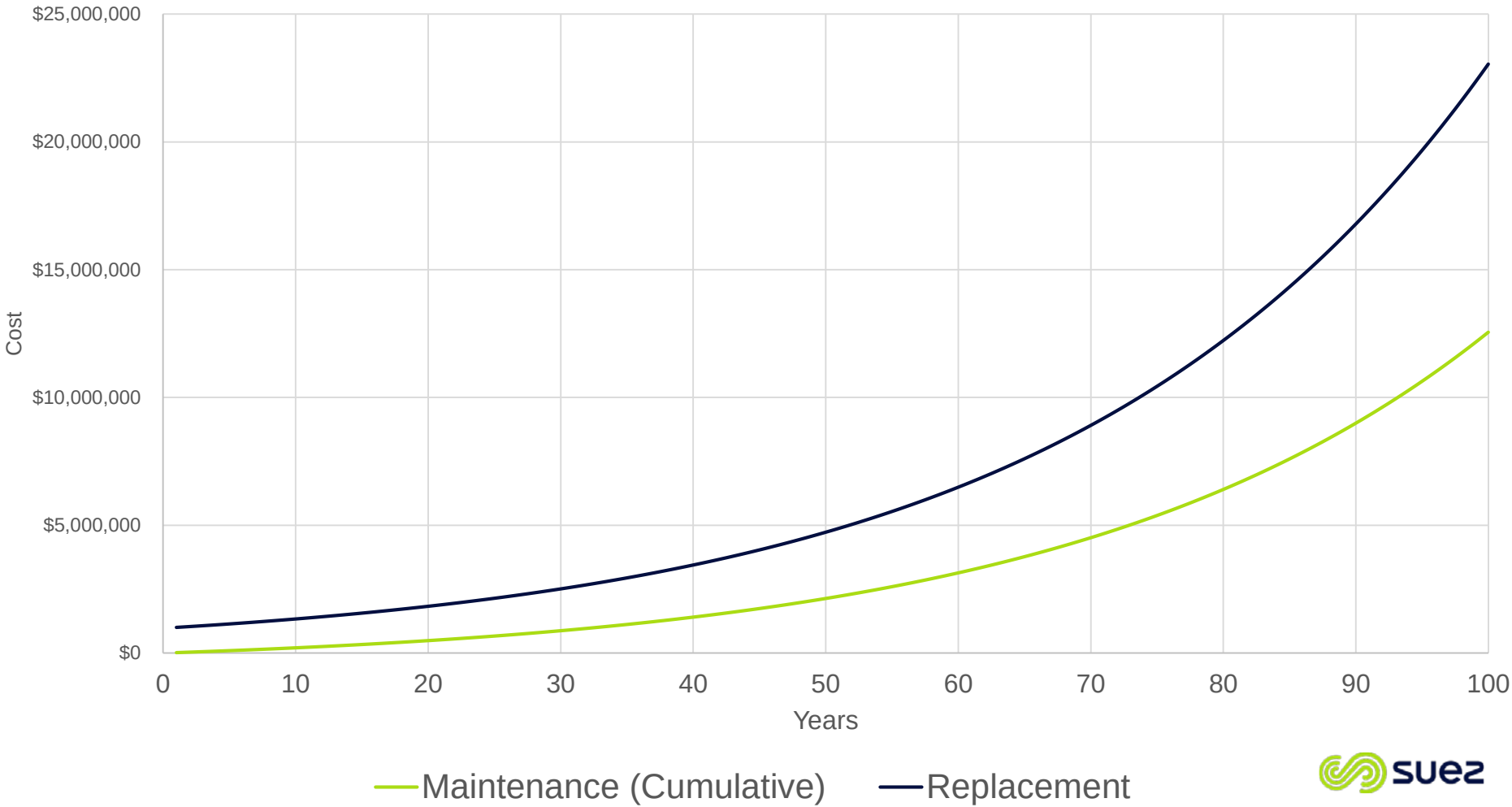
Benefits of Proactive Maintenance

Asset Management = Preventative = Proactive

- **Extends the useful life of the water asset**
- **Ensure the asset operates in case of an emergency**
- **Lower costs for operations and maintenance**
- **Budgeting based on sustained performance**
- **Defensible decision-making**
- **Improved public confidence**
- **Improved regulatory compliance**

Replacement vs Maintenance: 500,000 Gallon Tank



Tank Coatings and Maintenance: Steel Tanks

- Common Coatings and Material Selection

AWWA D102-09 Coating Systems
EXTERIOR COATING SYSTEMS

- OCS No. 1 (three or four coat alkyd) Aluminum, Metallic, Alkyd, Silicone Alkyd
- OCS No. 2 (three coat) Moisture cured Polyurethane
- OCS No. 3 (three coat) Water-based Acrylic or Modified Acrylic
- OCS No. 4 (three coat) Zinc rich primer (organic or inorganic), Aliphatic Polyurethane, Aliphatic Fluorourethane
- OCS No. 5 (three coat) Epoxy primer, Epoxy intermediate, Aliphatic Polyurethane
- OCS No. 6 (three coat) Zinc rich primer (organic or inorganic), Epoxy intermediate, Aliphatic Polyurethane

AWWA D102-09 Coating Systems
INSIDE COATING SYSTEMS

- ICS No. 1 (two coat) Two component Epoxy
- ICS No. 2 (three coat) Two component Epoxy
- ICS No. 3 (three coat) Inorganic Zinc rich primer, two component Epoxy intermediate and finish coats (Non-immersed surfaces)
- ICS No. 4 (one coat) Thermoset Polymer, Polyurethane or Polyurea
- ICS No. 5 (three coat) Organic Zinc rich primer, two component Epoxy intermediate and finish coats (Immersed surfaces)

Older Coating Systems

Lead

- **Lasted a long time**
- **Removal is very costly**
- **Encapsulation may be better**
- **Must protect adhesion**

Older Coating Systems

Coal Tar

- **Long service life**
- **Not NSF**
- **Costly to remove**
  - Heavy blasting
  - Chipping (enamel)

Older Coating Systems

Clear Coats

- **Protects from UV**
- **Great for aesthetics**
- **Prevents organic growth**
- **Skipping**
- **Difficult to overcoat**

Tank Coatings and Maintenance: Steel Tanks

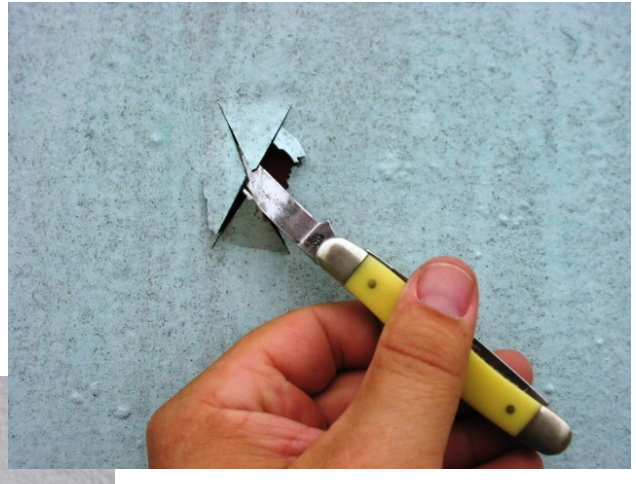
- Common Failures

Coatings Conditions

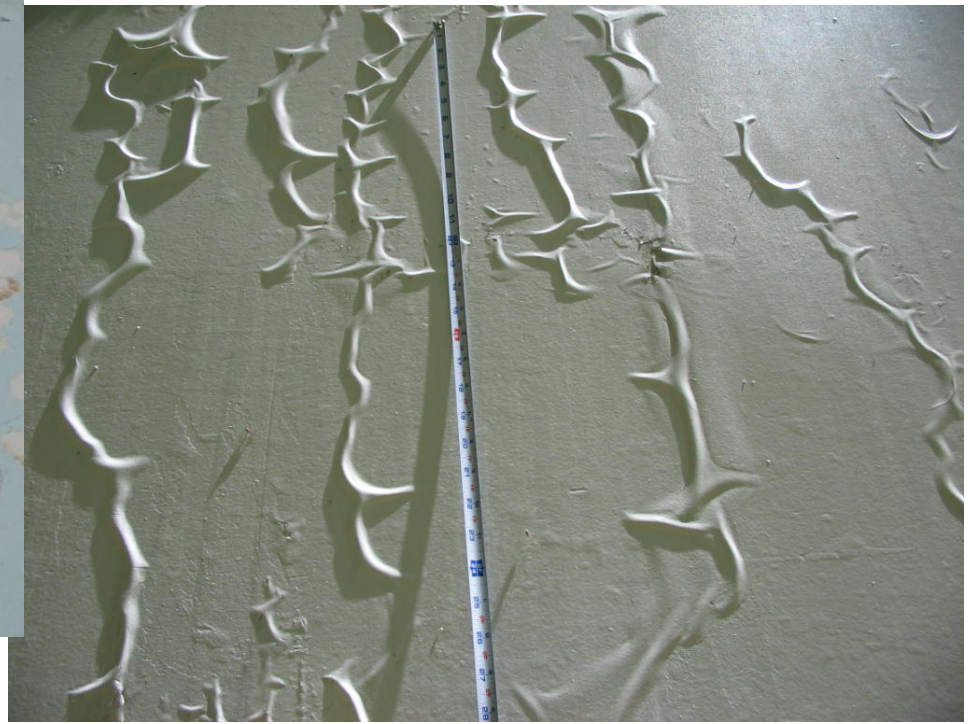
- Generic type and general condition
- Approximate percentage and type of coatings system failure
- Adhesion
- Coating System Thickness
- Extent of Pitting Damage
- Heavy Metal Presence

Coatings Conditions: Thickness

Coatings Conditions: Adhesion



Coatings Failure: Adhesion

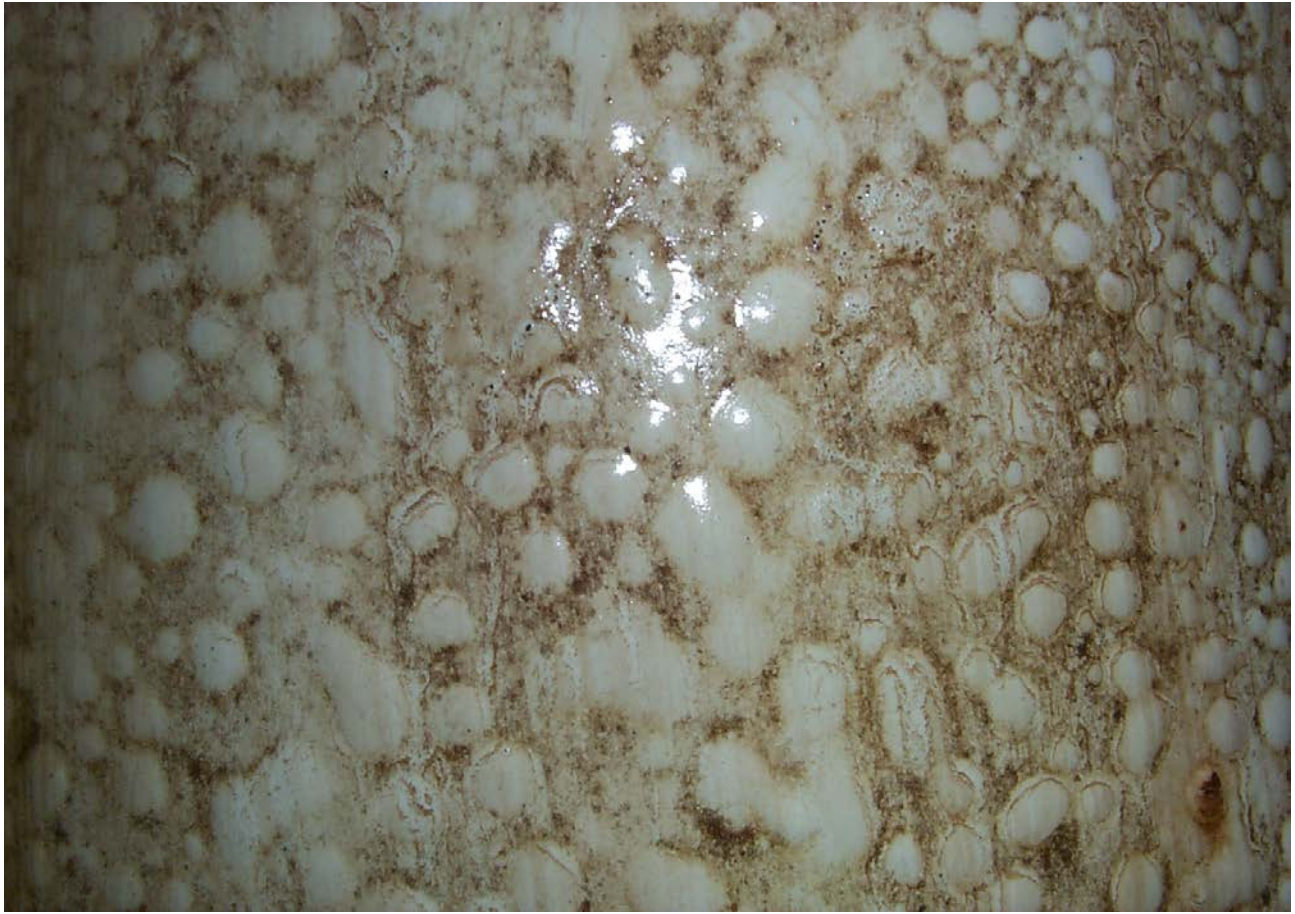


Coatings Failure: Adhesion

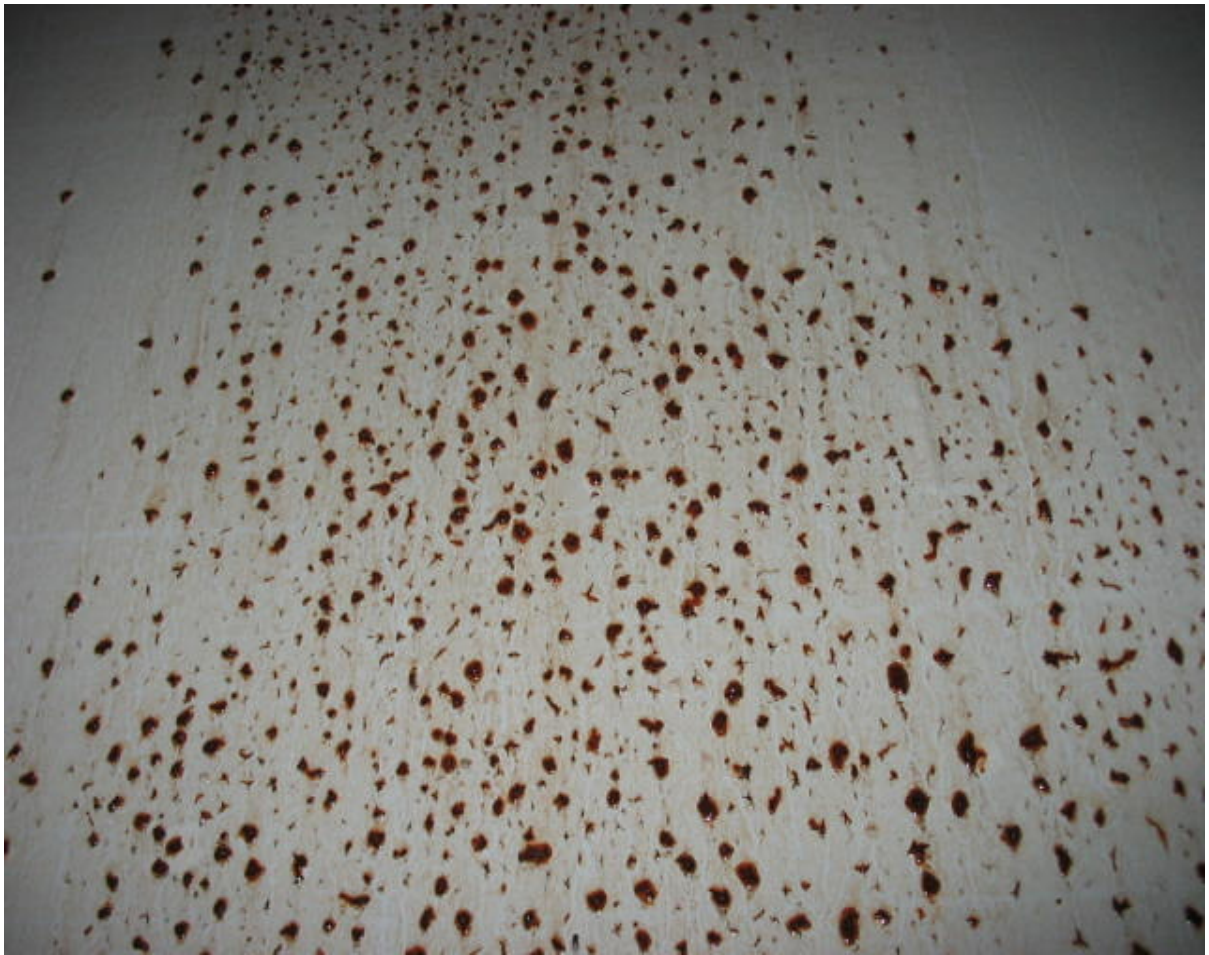
Coatings Failure: Corrosion

Coatings Failure: Corrosion

Coatings Failure: Blistering



Coatings Failure: Blistering



Coatings Failure: Steel Loss

Tank Coatings and Maintenance:

Concrete Coatings

Basics of Concrete

Basics of Concrete

What is Concrete?

- **Portland Cement**
- **Coarse & Fine Aggregate**
- **Water**
- **Admixtures (optional)**
  - Air-entraining
  - Water-reducing
  - Retarding
  - Accelerating
  - Superplasticizers
  - Corrosion-inhibiting

Basics of Concrete

Concrete is by far the most widely used construction material in the world.

In the water and wastewater market it represents 80-85% of the substrates with potential application for high performance coatings.

Much stronger in compression than in tension.

Problems Inherent with Concrete

Problems Inherent with Concrete

Concrete is not maintenance free.

- **Concrete cracks, spalls, and leaks.**
- **Two types of concrete:**
  - Concrete that has cracked
  - Concrete that is going to crack

Concrete is not all the same:

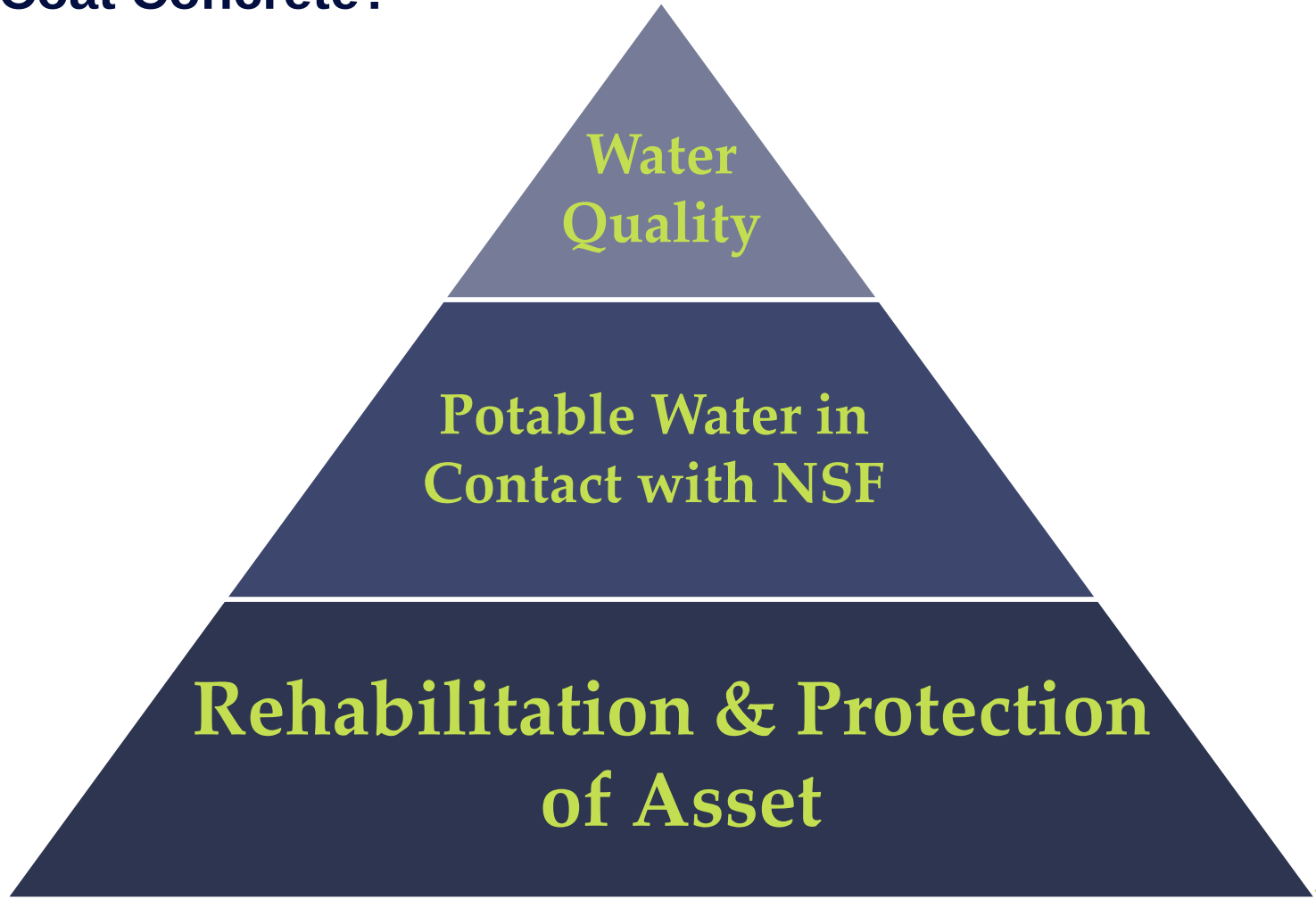
- **By definition concrete is a heterogeneous mixture.**
- **Different batches can have very different properties, even on construction of the one structure.**
- **Concrete as a substrate is not as predictable or stable as steel.**

Problems Inherent with Concrete

- Certain regions with high sulfur content in the water will experience rapid degradation of concrete above the high water line and on the underside of the roof. Roof replacements are common.
- Below grade tanks often have infiltration concerns.
- Concrete is typically marketed as “maintenance free” when in fact it is not.

Maintenance of Concrete Structures

Why Coat Concrete?



Preservation of the Asset:

Why Coat Concrete?

Preservation of the asset.

- Protect the concrete from acid and sulfate attack.
- Protect the rebar structure from corrosion and chlorides.

Reduction in water losses from cracks.

Aesthetics.

Protection of Asset

- Concrete structures are not Maintenance Free
- As part of a comprehensive Asset Management Program that includes coatings of all surfaces, the serviceable life of a concrete tank can be extended indefinitely
- Leaks (non-revenue water) can be minimized through proper maintenance
- Aesthetics of concrete tanks can be greatly improved with coatings

Do you prefer this maintenance approach?

Or this maintenance approach?

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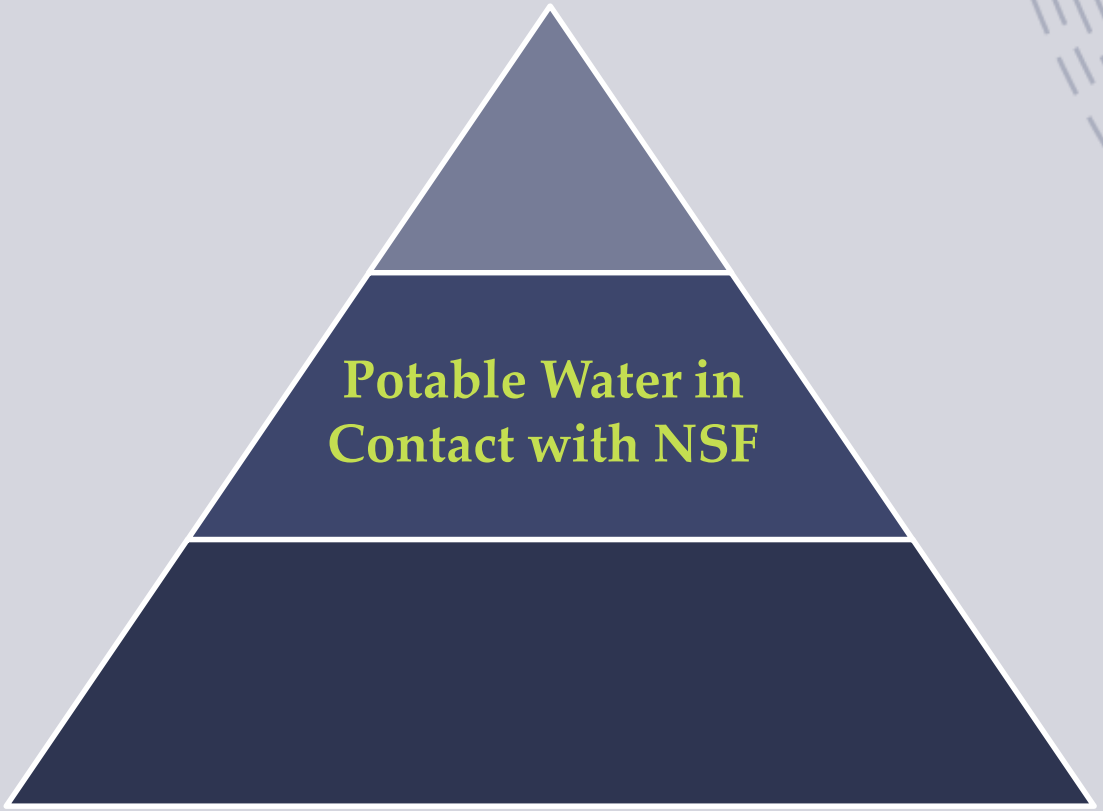
NSF/ANSI 61 Linings for Potable Water Contact:



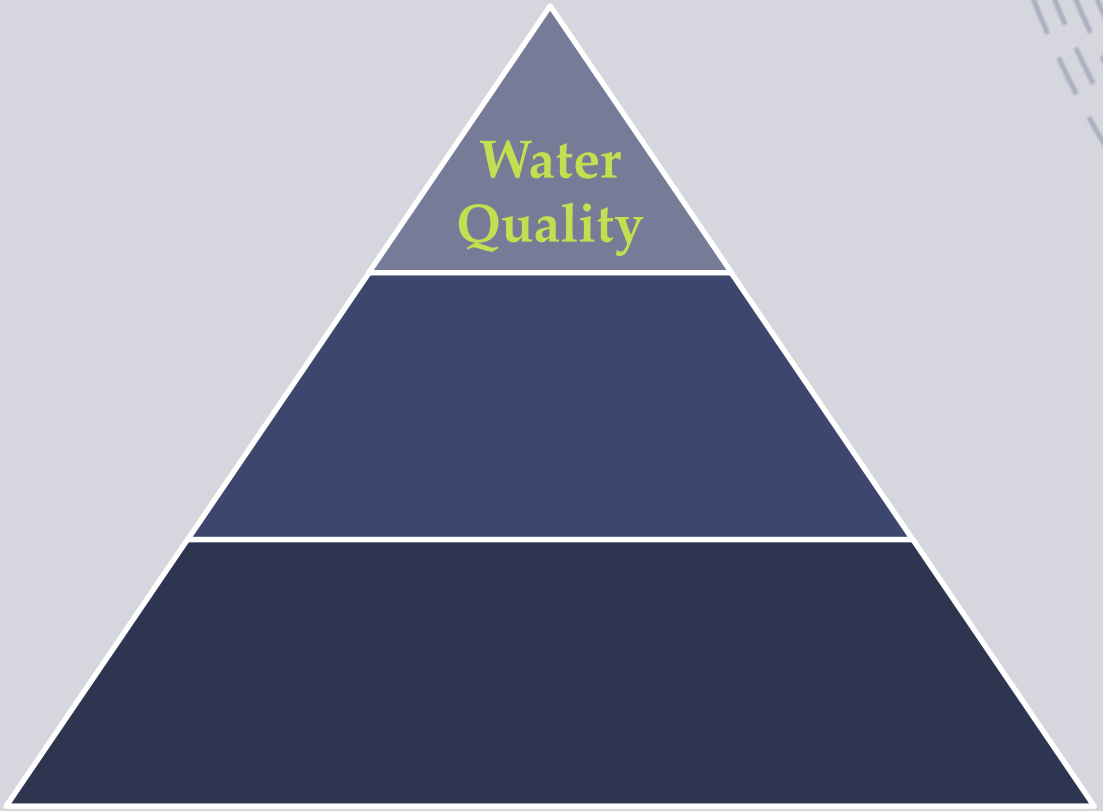
Why Coat Concrete?

- **Ensure the public water supply is in contact with an NSF 61 compliant material.**

Why NSF?

- **The professional application of an NSF certified coating system will ensure compliance for the community's potable water structures.**

Preservation of the Asset:



Why Coat Concrete?

Improve water quality

- **Reduce biofilm**
- **Protection from inflow of rain and groundwater.**

What is Biofilm?

- **Bacterial cells**
- **The colonies they form**
- **The polysaccharide slime they deposit for protection**

Associated Issues:

- **Harbor Problematic Organisms**
- **Nuisance and Pathogenic**
- **Promote Mineral Accumulation**
- **Require Additional Disinfection**
  - Increased DBP
- **Cause Taste & Odor Issues**

Water Quality: Control of Biofilms in Distribution System

Proactive Water Quality Protection

The Theory:

- **Biofilms like to form and grow on rough surfaces.**
- **Biofilms grow faster on rougher surfaces than smooth surfaces.**
- **Calcium (component of concrete) is an excellent food source for biofilms.**

↓

Lining the interior of potable water concrete tanks is a critical tool in combatting biofilms and disinfection byproducts in a water distribution system.

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Biofilm Test Matrix

Substrate

No Coating	15 mils Standard 67% Solids Epoxy	30-40 mils 100% Solids Epoxy
• Cast Concrete • Wooden float Finish Concrete • Light Broom Finish Concrete • Heavy Broom Finish Concrete • Steel	• Cast Concrete • Wooden float Finish Concrete • Light Broom Finish Concrete • Heavy Broom Finish Concrete • Steel	• Cast Concrete • Wooden float Finish Concrete • Light Broom Finish Concrete • Heavy Broom Finish Concrete • Steel

Results

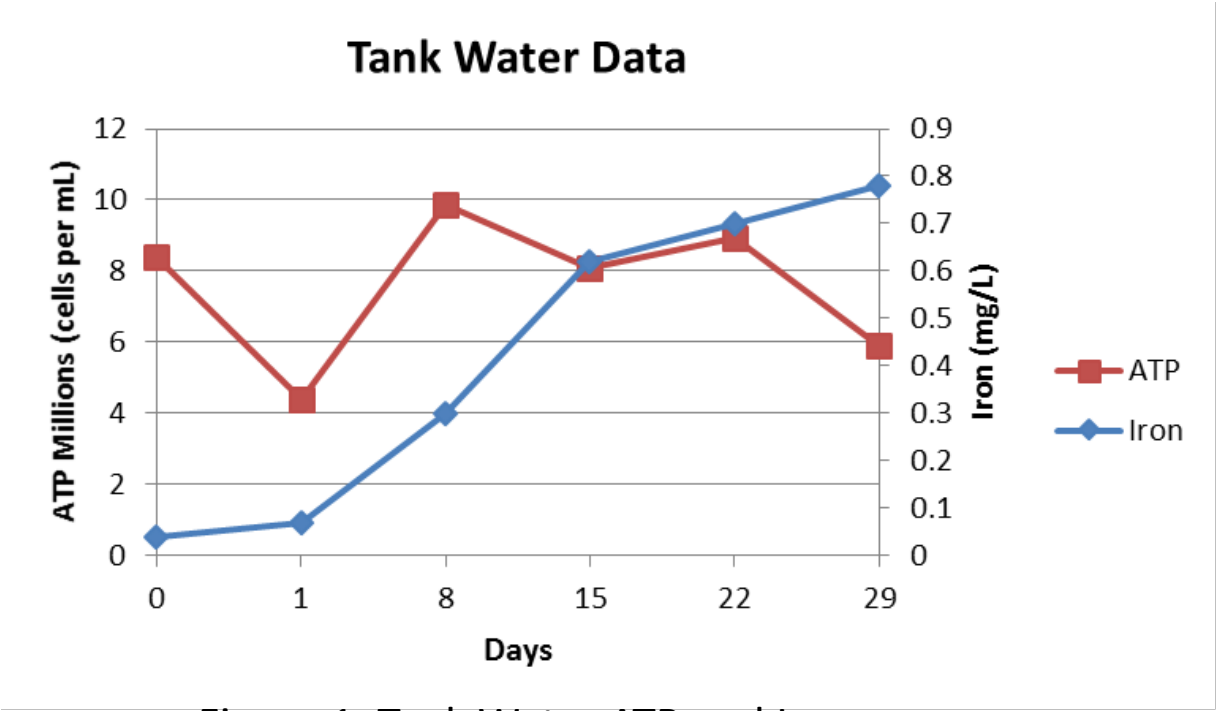

Figure 1. Tank Water ATP and Iron Levels over Time

Results (cont'd)

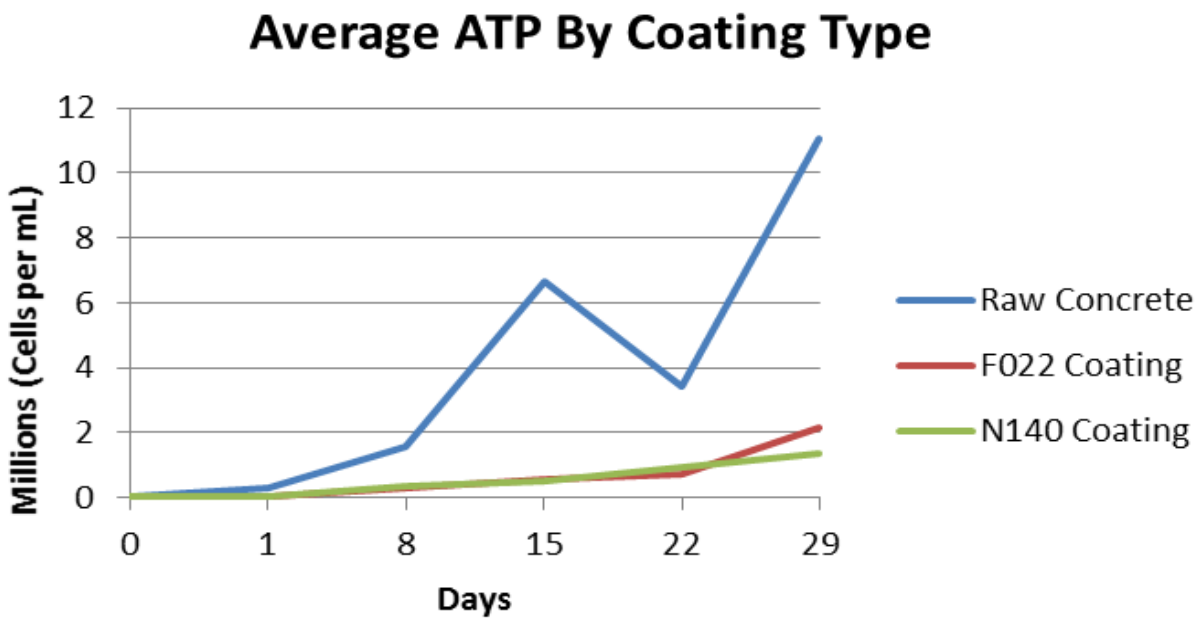

Figure 2. ATP Levels on Coated and Uncoated Coupons over Time

Conclusions of Biofilm Study

- Raw concrete coupons exhibited considerably higher levels ATP levels than either of the coated coupons.
- By the end of the 30 day project, the uncoated concrete had an overall difference of 6X more bacteria than the coated coupons.
- The type of paint (i.e. standard epoxy vs high performance 100% solids epoxy) did not appear to make a difference in the study. Both were equally effective in combating bacterial growth.

This research shows that raw, uncoated concrete surfaces are more susceptible to biofilm development and accumulation as compared to coated concrete surfaces.

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Concrete Coating Options

Interior Maintenance Options

Standard 70% Solids Epoxy

For Relatively Smooth Concrete, Less Protection Desired:

- Crack repair
- Sweep Blasting Surface Prep
- Apply Two Full Coats of 70% Solids Epoxy Paint

Pro's and Con's:

✓ No specialized equipment
✓ Less expensive upfront costsAll Crews Familiar with Technology
✓ Much Easier to Remove In Future If Required.
✕ Minimal Protection of Substrate
✕ Short Life Cycle = higher Maintenance Cost
✕ Longer Return to Service

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Interior Maintenance Options

100% Solids Epoxy

For Rough Concrete, More Protection Desired:

- Crack /Spall Repair
- SSPC SP13 Surface Prep
- Optional Parge Coat
- Apply One Coat of 100% Solids Epoxy

Pro's and Con's:

✓ Excellent Chemical Resistance
✓ Excellent Life = Low Maintenance Cost
✓ Minimal Surface Prep
✓ Excellent Structural Properties
✓ Goes on in One Coat
✓ Quick Return to Service
X Expensive
X Requires Specialized Equipment
X Less Flexible

Interior Maintenance Options

100% Solids Elastomeric Polyurethane System

For Rough Concrete, More Protection Desired

- Crack /Spall Repair
- Sweep Blasting Surface Prep
- Trowel Apply One Parge Coat of Surfacing Compound
- Apply One Full Coat of 70% Solids Epoxy
- Apply One Coat of 100% Solids Polyurethane at 40-80mils DFT

Pro's and Con's:

✓ Flexible
✓ Good Long Term System Due to Additional Surface Prep/Coatings
X Very Expensive
X Requires Specialized Equipment
X Multiple Coats
X Less Chemical Resistance
X Usually Black
X Not as Smooth as Epoxy = +Biofilm

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Case Studies

Avon, CT (Woodmont Tank)

Background:

- **Cast in place concrete tank;**
- **Life of existing exterior coating expired; significant cracking on exterior; freeze/thaw has deepened cracks.**
- **Interior has no protective coating; frequent cracking; rebar exposure; efflorescence visible in walls and roof.**

Avon, CT

Background (con’t)

- Exterior was pressure washed to remove all loose debris and efflorescence.
- All cracks and spalling areas were repaired as needed.
- The exterior roof received a 3-coat system consisting of high build epoxy, a high millage coat of polyurethane, and a top coat of polyester polyurethane;
- The exterior walls received two coats of latex.

Avon, CT

Background (con’t)

- The interior was pressure washed to remove any bio-film or sedimentation; all exposed rebar was abrasive blast cleaned to an SSPC SP-10 and coated with a zinc primer.
- All cracks and spalling areas were repaired as needed by utilizing repair mortar or grout injection, if necessary.
- Walls received a cementitious parge coat to provide a uniform surface.

Avon, CT

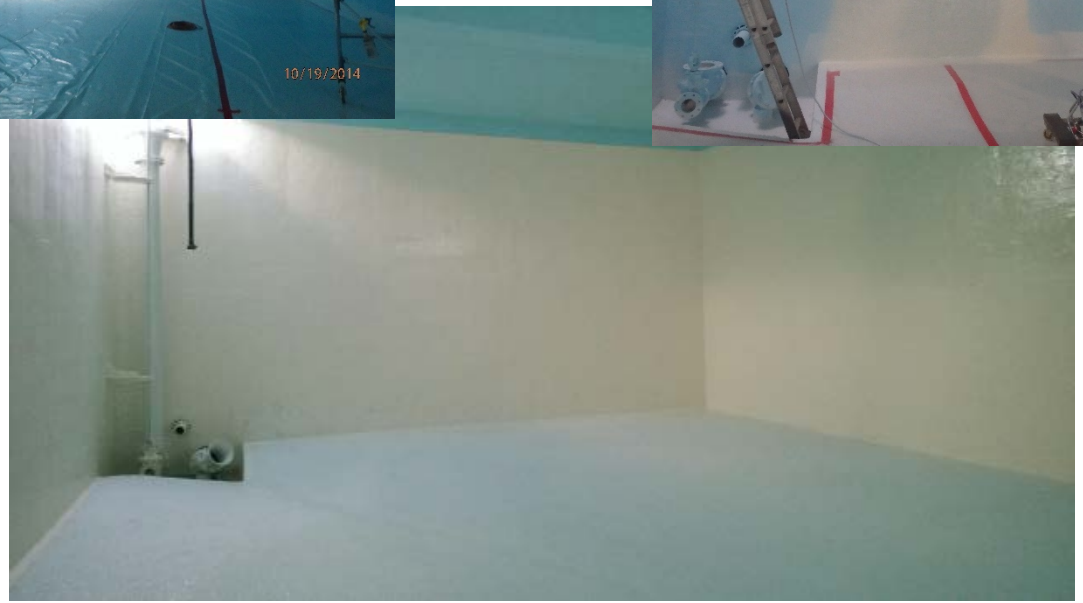
Background (con’t)

- Once the parge coat was applied to the walls, a coat of high build NSF-approved epoxy was applied to the walls, roof, and floor.
- Walls and floor were top coated with a high millage of NSF-approved polyurethane.

Avon, CT: Before

Avon, CT: Before

Avon, CT: After



Avon, CT: After

Ralls, TX

Background:

- **Clearwell - First full service MP sold on concrete tank.**
- **Exterior – cracks were previously repaired but repairs were failing.**
- **Interior – pinholes and hairline cracks in the walls.**
- **Exposed aggregate in the roof.**

Ralls, TX

Background (con't):

- **Customer has attempted to repair cracked surfaces with latex.**
- **Tank was leaking.**
- **Interior has never been coated.**
- **Exterior was pressure washed and overcoated with two coats of a modified waterborne acrylic paint.**
- **All cracks were filled with the paint prior to coating.**

Ralls, TX

Background (con't):

- **Complete concrete interior was pressure washed and chemical cleaned with muriatic acid and chlorine solutions.**
- **Interior piping was blast cleaned to an SSPC SP-10 and primed with organic zinc.**
- **All surfaces were sprayed with once coat of an NSF-approved 100% solids epoxy.**
- **Pinholes and small cracks were filled during the spraying process.**

Ralls, TX: Before

Ralls, TX: After

Thiele Kaolin, Sandersville, GA

Background:

- **Concrete holding tank deteriorating from low pH mineral slurry.**
- **Foundation was settling over time inducing cracking.**
- **Floor began to leak, causing contamination of the product.**
- **Tank needed to be repaired and coated.**

Thiele Kaolin, Sandersville, GA

Background:

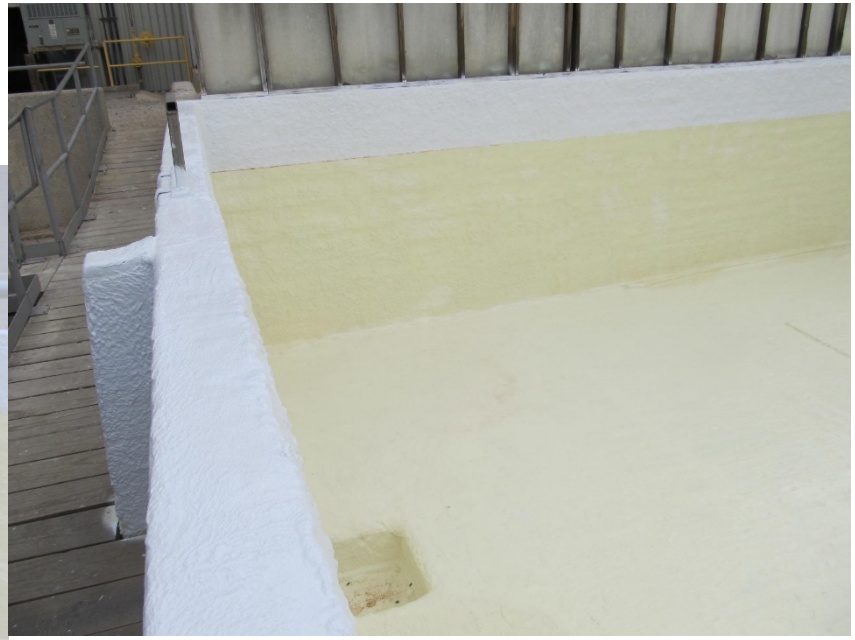
- **Crack Repairs - 100% solids epoxy mastic then covered with fiberglass screen mesh embedded with a coat of 100% solids epoxy.**
- **Protective Coating – Walls and floor sprayed with 100% solids epoxy at 250 mils.**
- **Areas exposed to sunlight were topcoated with an aliphatic urethane for UV protection.**

Thiele Kaolin: Before

Thiele Kaolin: Before

Thiele Kaolin: After

Thiele Kaolin: After



Wyandotte, MI Water Treatment Plant

Background:

- **Six deteriorating concrete filters.**
- **Protection of the asset was the purpose of the project.**
- **Walls were prepared and coated with high build 100% solids epoxy.**

Wyandotte, MI: Before

Wyandotte, MI: After

Treatment Plants

Aging Treatment Plant Infrastructure

Systems are Struggling to meet consumer demands and balance budgets.

- Concrete & plant infrastructure are in constant need of repair and/or replacement. These repairs can be costly, unpredictable, and cause a strain on plant operations.
- Time and money are limited – issues left unresolved and tend to snowball – assets are run to failure.
- Treatment facilities need asset protection through renovation: protective coatings, new media, control upgrades and better energy efficiency.
- Piping, equipment, controls need renovated or replaced.

Concrete & Plant Rehabilitation Services

Plant Rehabilitation Services

- Turnkey solution with single source responsibility for all scopes and trades and 3-5 year spreading of initial renovation costs
- Option for long-term AMP to maintain operational structures (e.g. clarifiers, basins, digesters, etc.)
- Future Energy audit (under development) with recommended upgrades & energy savings (blowers, aeration basins, LED, etc)

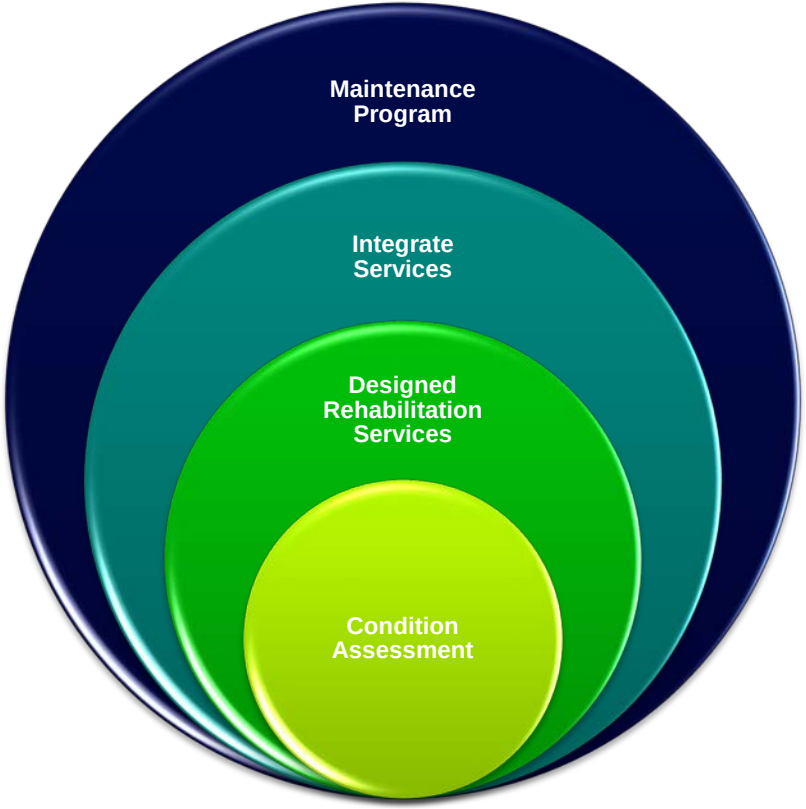
Plant Rehabilitation Services

Concrete Plant Rehabilitation services :

- Designed to provide an innovative and comprehensive approach to renovating concrete infrastructure and treatment plant assets.
- Designed around Upfront Renovation of concrete and steel structures utilizing high performance coatings on substrates prone to corrosion, coupled with specific design criteria to fulfill customer’s needs.

Maintenance Approach

- Thorough analysis of facility assets
- Provide Design Specific Rehabilitation Services
- Integrate Other Service
- Remove Risk through MP



Advantage

Value & Benefits

- Savings and reduced risk.
- Single Source Responsibility of safety, sanitary, coatings and security conditions.
- Balanced Allocation of maintenance funds; Flat Annual Fee with inflation cap.
- Spreading of UR costs.
- One year automatically renewable contract; cancelable by customer at anytime.
- Annual inspections; alternating visual and washouts with chemical cleaning.
- Decreased system interruptions.

Burning Questions?

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