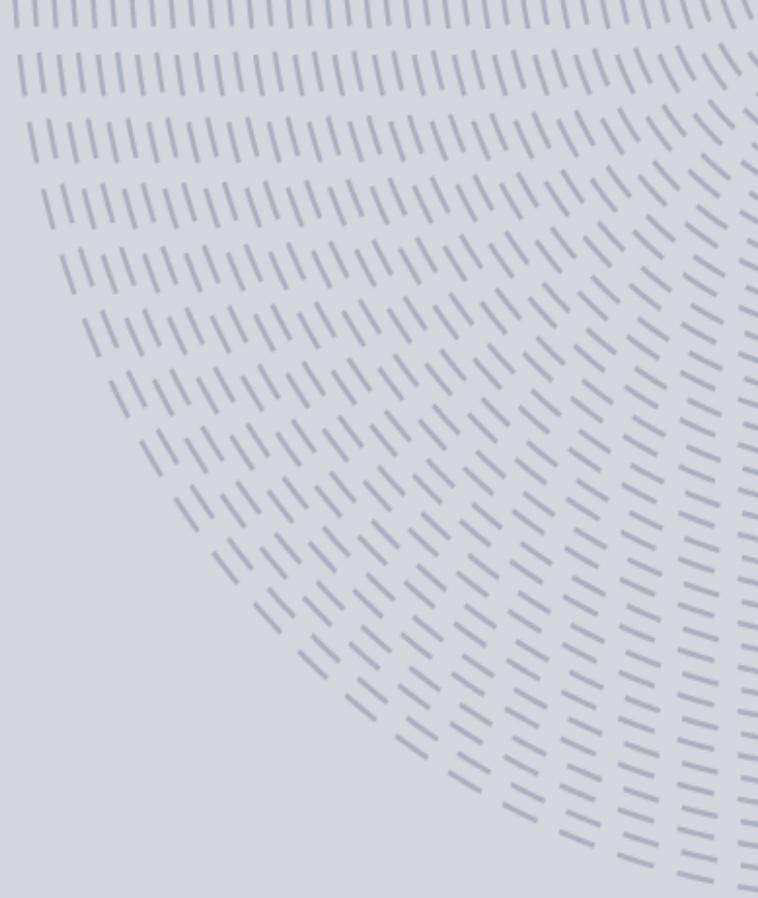


Why Coat Concrete Tanks?

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Advanced Solutions

Overview:

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



Basics of Concrete & Problems Inherent with Concrete



Basics of Concrete

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

- **Represents 80-85% of the substrates in water and wastewater with potential application for high performance coatings.**
 - Estimated 25,000 concrete potable water tanks in the U.S. and another 25,000 concrete clear wells.
 - Most municipalities are not actively maintaining their concrete assets.



Basics of Concrete

What is Concrete?

- **Portland Cement**
- **Coarse & Fine Aggregate**
- **Water**
- **Admixtures (optional)**
 - Air-entraining
 - Water-reducing
 - Retarding
 - Accelerating
 - Superplasticizers
 - Corrosion-inhibiting
- **Much stronger in compression than in tension.**



Problems Inherent with Concrete

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.

Concrete is not maintenance free.

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



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.**



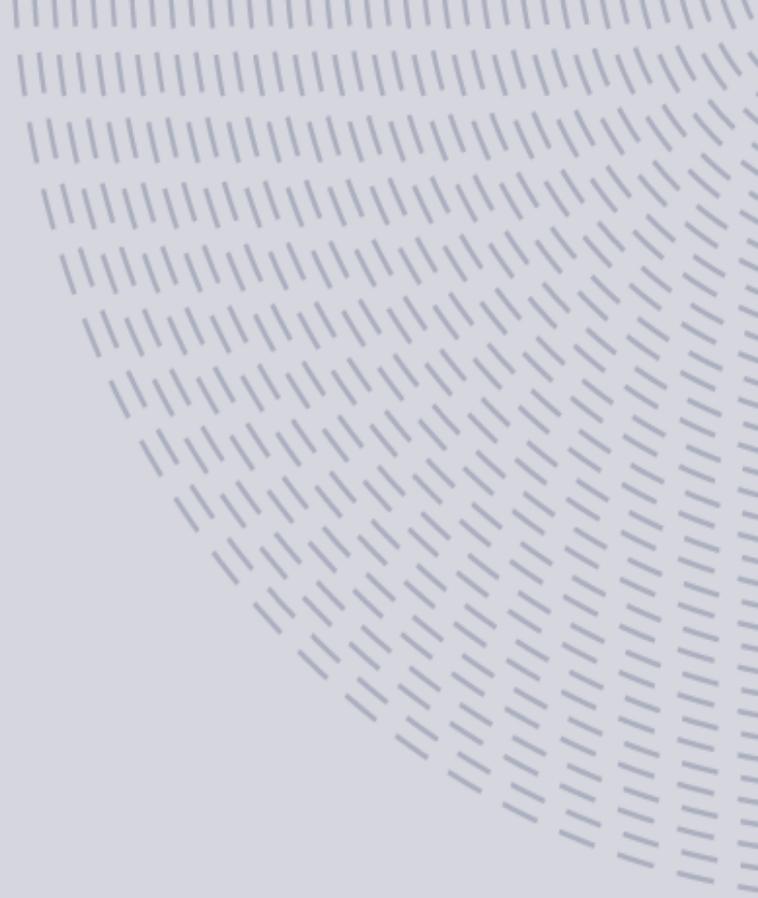
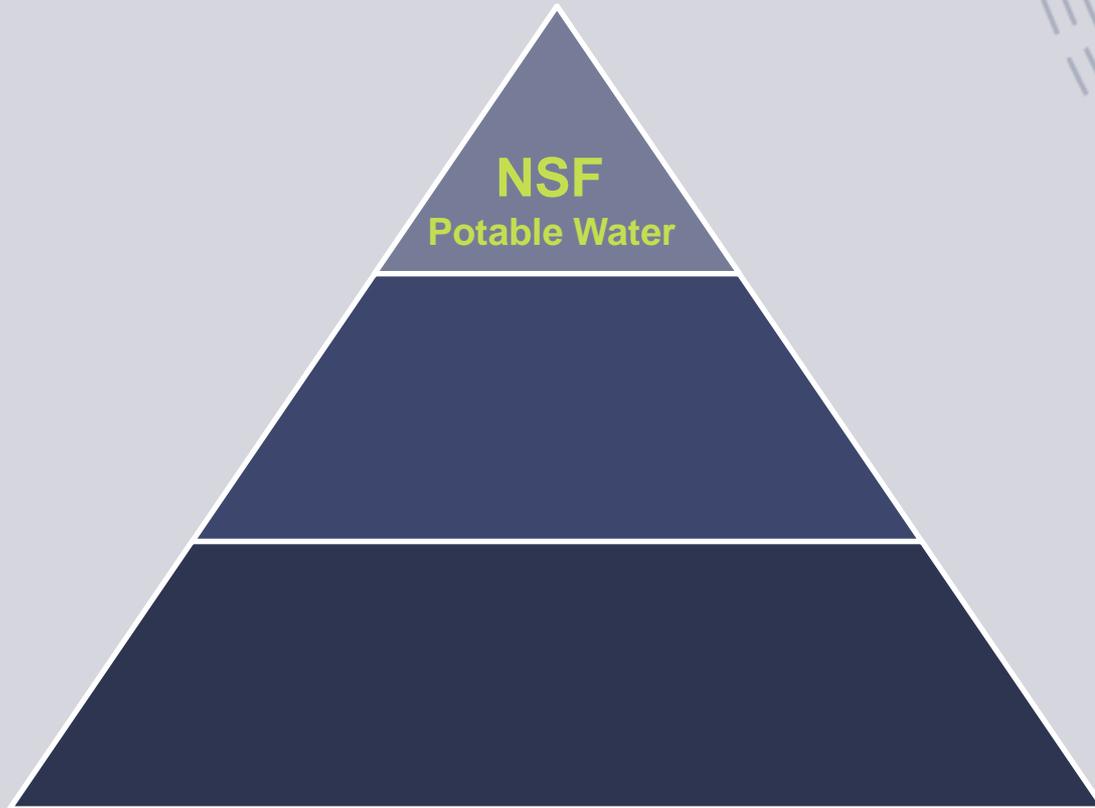
Maintenance of Concrete Structures



Why Coat Concrete?



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.**

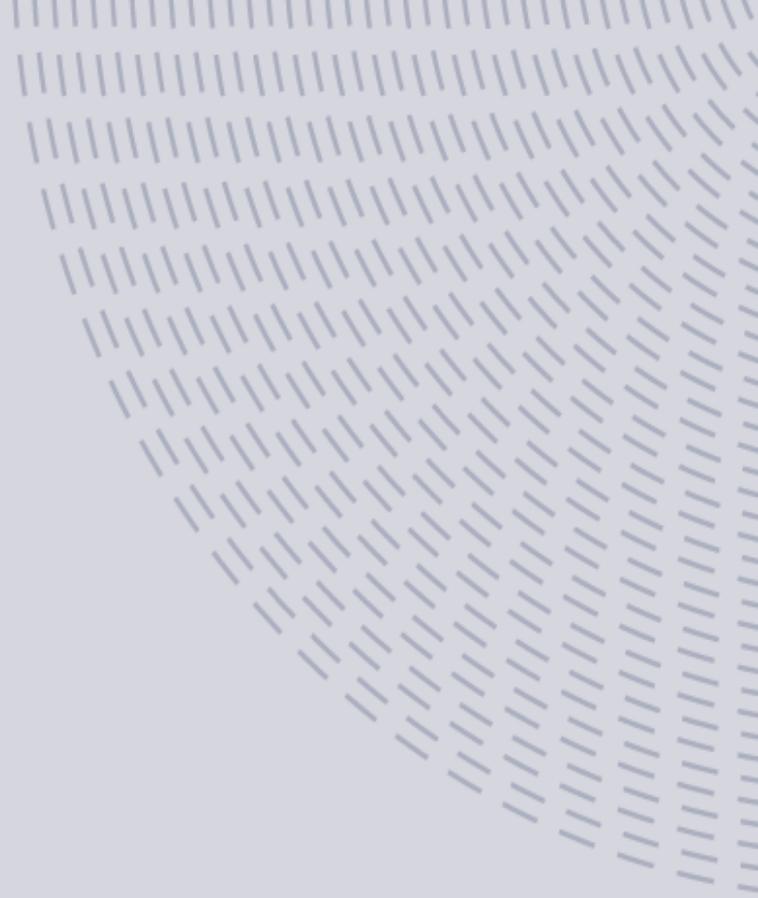
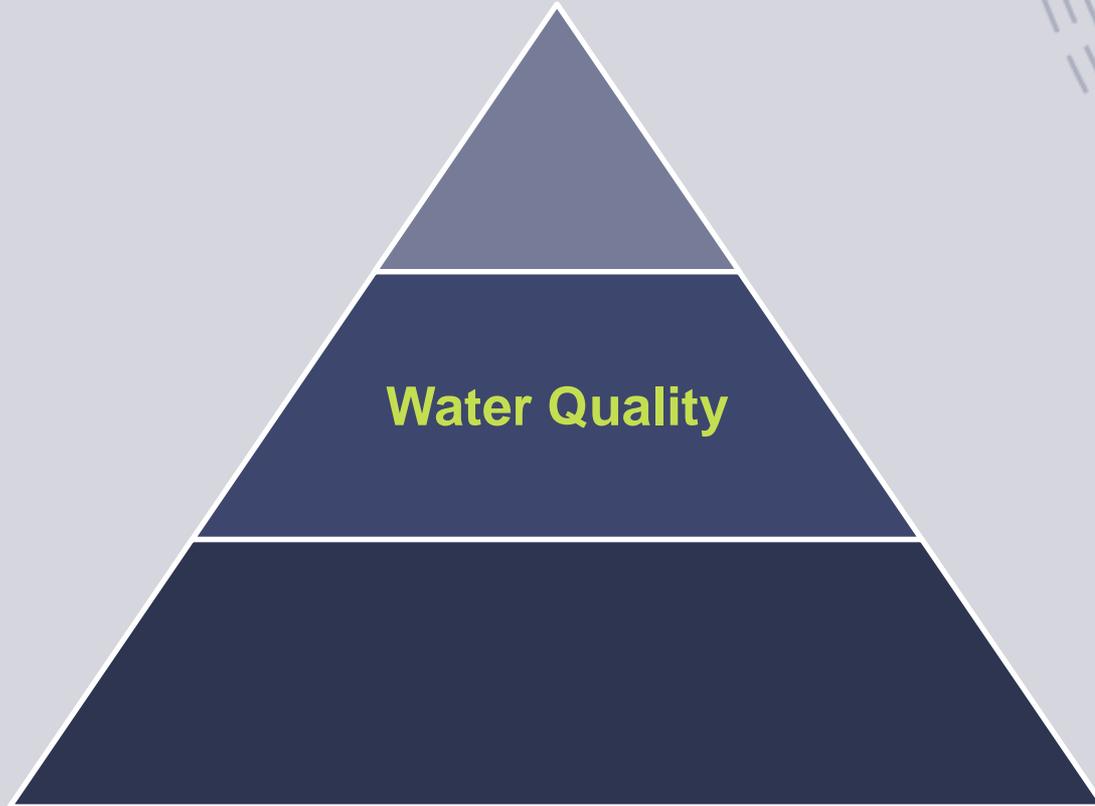


Why NSF?

- **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?

Biofilm is:

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



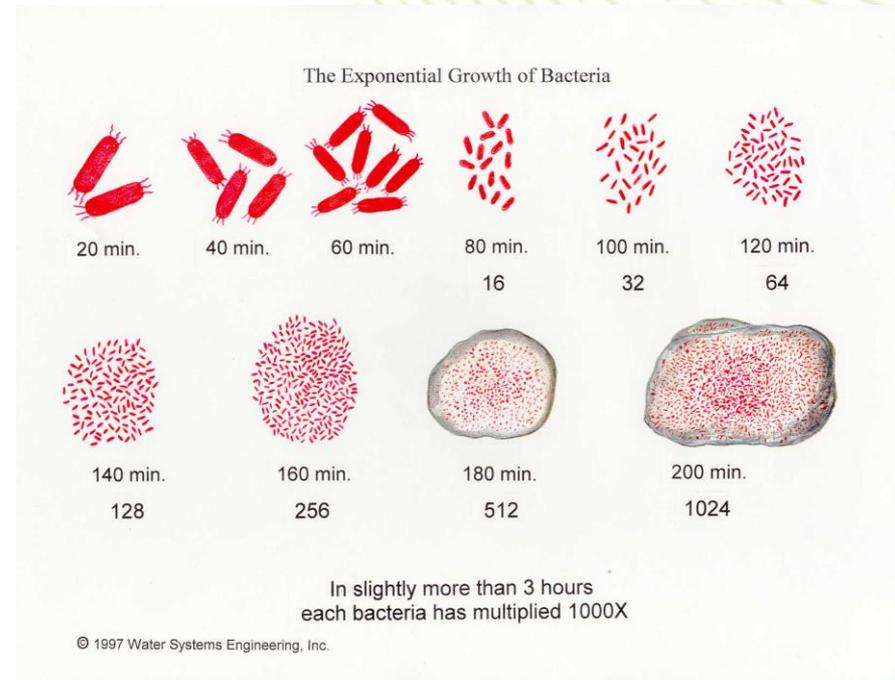
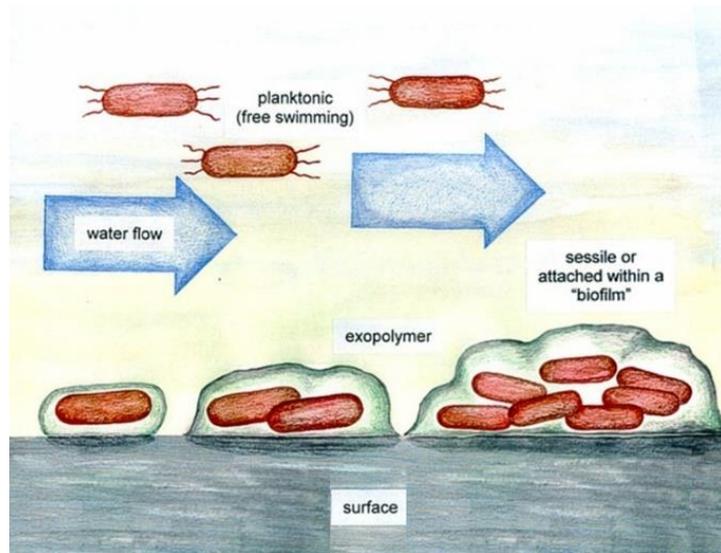
Biofilms Issues:

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



Biofilm Development

Adhere to surface, multiply through cell division, secrete exopolymer slime for protection and nutrient capture and incorporate mineral deposits into the matrix.



Biofilm Removal

Chemical Cleaning the Water Storage Tank:

Pressure washing alone will not remove bio-film, which is an ongoing source for chlorine consumption and DBP production.

Reactive Approach



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.

Proactive Water Quality Protection

This theory was tested as follows (cont'd):

- The concrete samples with different finishes were coated with two types of epoxy and one was left uncoated.
- Steel samples were also included in the experiment.

Substrate

No Coating

- Cast Concrete
- Wooden float Finish Concrete
- Light Broom Finish Concrete
- Heavy Broom Finish Concrete
- Steel

15 mils Standard
67% Solids Epoxy

- Cast Concrete
- Wooden float Finish Concrete
- Light Broom Finish Concrete
- Heavy Broom Finish Concrete
- Steel

30-40 mils 100%
Solids Epoxy

- Cast Concrete
- Wooden float Finish Concrete
- Light Broom Finish Concrete
- Heavy Broom Finish Concrete
- Steel

Test Procedure

- All samples were disinfected and immersed in a 200 gallon holding tank. Water was drawn and added at cycles to mimic an actual operating system.
- Samples raised and tested for Adenosine Triphosphate (ATP) and Iron (Fe) after the initial 24 hours and every 7 days thereafter for four weeks: 29 days total.



Results

Tank Water Data

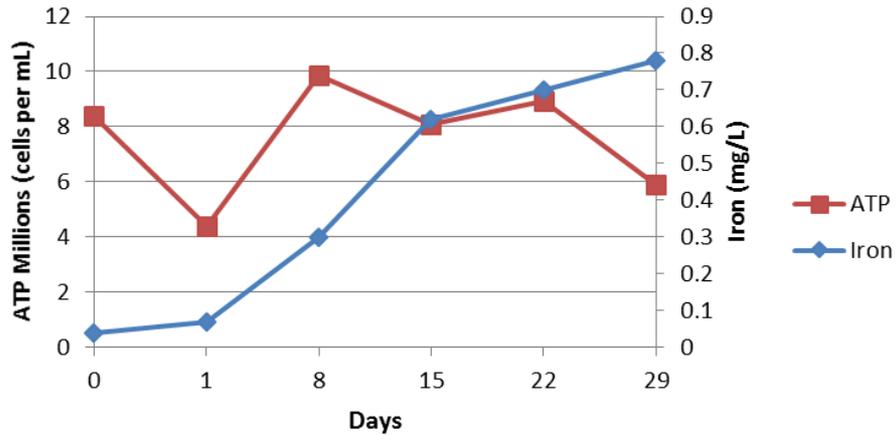


Figure 1. Tank Water ATP and Iron Levels over Time

Average ATP By Coating Type

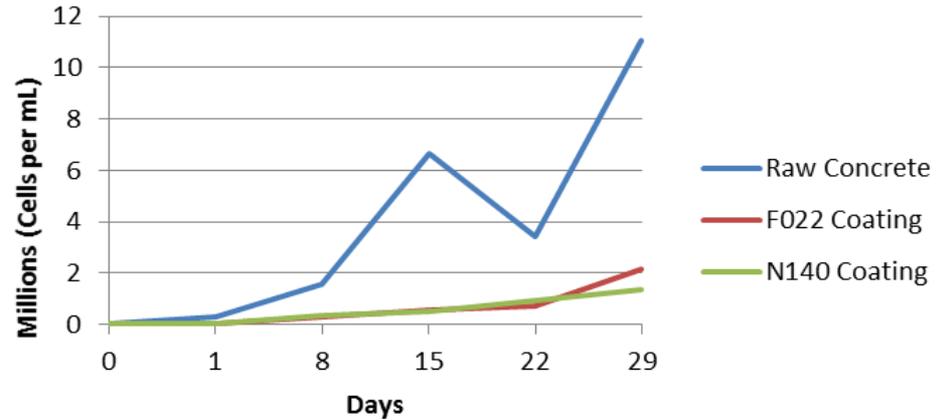


Figure 2. ATP Levels on Coated and Uncoated Coupons over Time

Conclusions of Biofilm Study

- **Raw concrete coupons exhibited considerably higher levels ATP levels than either of the coated coupons.**
 - 6X more bacteria than the coated coupons by the end of the 30 day project.
- **The type of paint (i.e. standard epoxy vs high performance 100% solids epoxy) did not appear to make a difference in the study.**



Uncoated concrete surfaces are more susceptible to biofilm development and accumulation compared to coated concrete surfaces.

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.

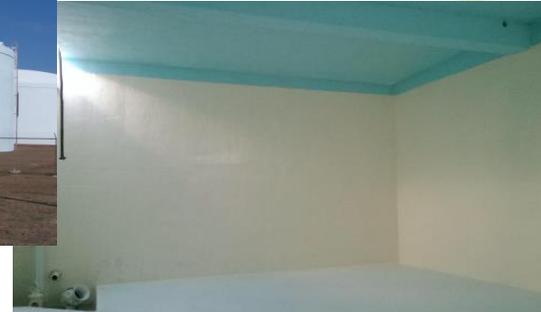


Protection of Asset

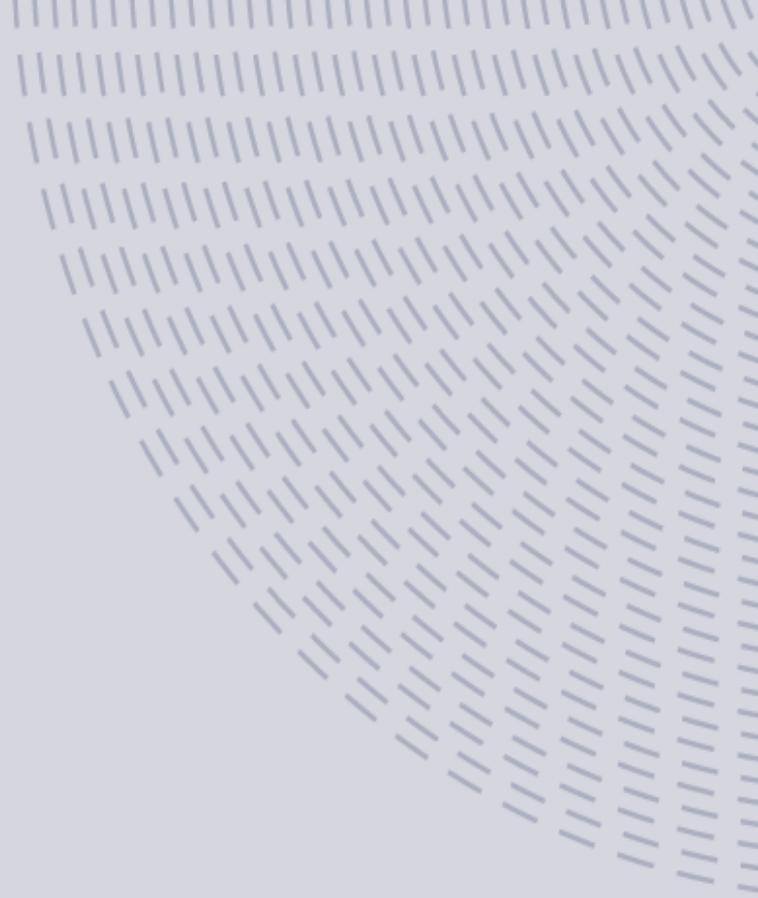
- Concrete structures are not Maintenance Free
- A comprehensive Asset Management Program that includes coatings of all surfaces can extend the serviceable life indefinitely
- Leaks (non-revenue water) can be minimized through proper maintenance
- Aesthetics of concrete tanks can be greatly improved



Do you prefer this maintenance approach? Or this maintenance approach?



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 costs
All 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

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

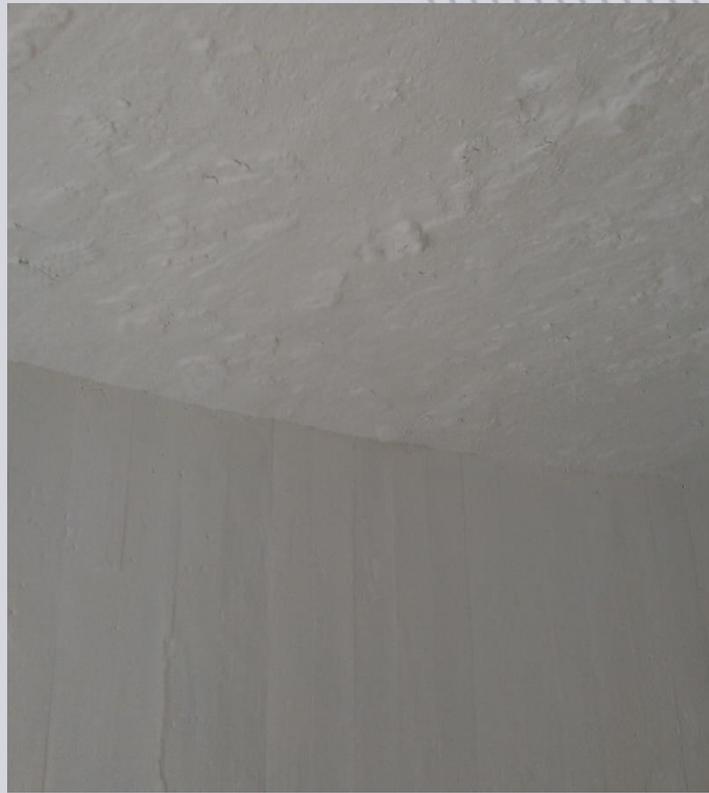
- Crack /Spall Repair
- Sweep Blasting Surface Prep
- Trowel Apply One Parge Coat of Surfacing Compound
- Apply One Full Coat of 70% Solids Epoxy
- Apply One Coat of 100% Solids Polyurethane at 40-80mils DFT



Pro's and Con's:

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

Case Studies



Avon, CT (Woodmont Tank)

Cast in place concrete tank:

- **Exterior**
 - Exterior coating failure
 - Significant cracking, freeze/thaw has deepened cracks.
- **Interior**
 - no protective coating
 - frequent cracking, rebar exposure
 - efflorescence visible in walls and roof.

Avon, CT: Before



Avon, CT: Before



Avon, CT

Exterior:

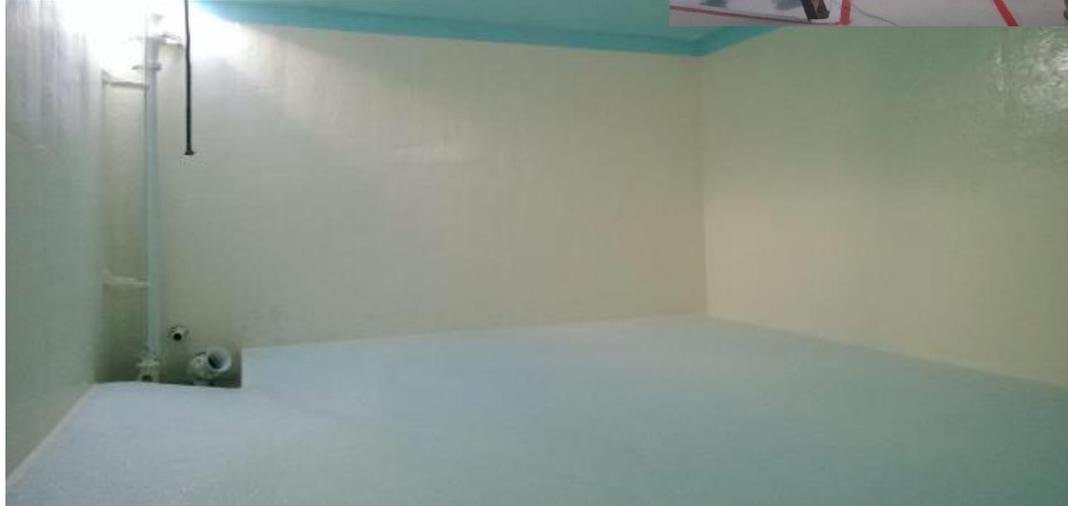
- **Pressure washed to remove loose debris and efflorescence.**
- **All cracks and spalling areas were repaired as needed.**
- **The exterior roof received a 3-coat system**
 - High build epoxy, a high millage coat of polyurethane, and a top coat of polyester polyurethane;
- **The exterior walls received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

Avon, CT

Interior:

- **Pressure washed**
- **All exposed rebar 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.**
- **High build NSF-approved epoxy applied to the walls, roof, and floor.**
- **Walls and floor were top coated with a high millage of NSF-approved polyurethane.**

Avon, CT: After



Avon, CT: After



Ralls, TX - Clearwell

Background:

- **Exterior – Cracks**
 - Customer previously attempted to repair cracked surfaces with latex. Repairs were failing.
- **Interior - never been coated**
 - Pinholes and hairline cracks in the walls.
 - Exposed aggregate in the roof.
 - Tank was leaking.



Ralls, TX

Repairs:

- Interior pressure washed and chemical cleaned
- 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.
- 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.

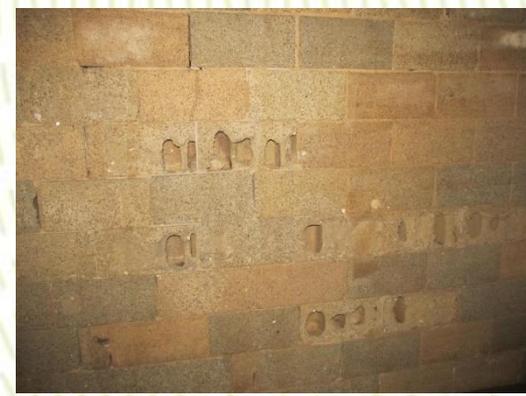
Ralls, TX: After



Fort Valley, GA

Background:

- **Concrete clearwell built in the 1920s.**
- **Additional chambers were built.**
- **Concrete is deteriorating; untreated water was leaking into tank.**
 - Leaking water came from rain water and untreated water that bypassed the chlorination process.
- **Vertical stress cracks along the perimeter walls and along the floors.**
- **Spalling concrete exposed rebar.**

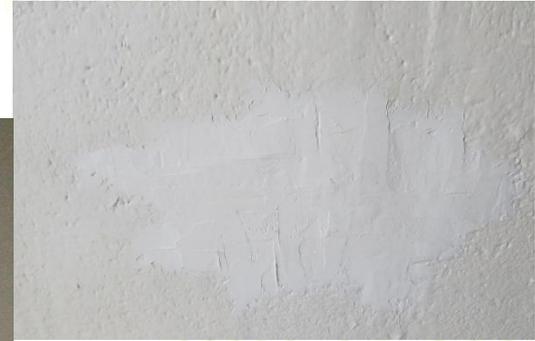


Fort Valley, GA

Background (con't):

- **Concrete walls and floor were pressure washed to remove loose concrete and biofilm.**
- **Tank was acid etched with muriatic acid to open the pores of the substrate.**
- **Large cracks were filled addressed as follows:**
 - Filled with 100% solids epoxy mastic.
 - Embedded mastic with fiberglass mesh for additional reinforcement.
 - Coated with the primary coating system.
- **All floors, walls, and small cracks were coated/filled with 100-125 mils DFT of 100% solids epoxy.**

Fort Valley, GA: After



Wyandotte, MI Water Treatment Plant

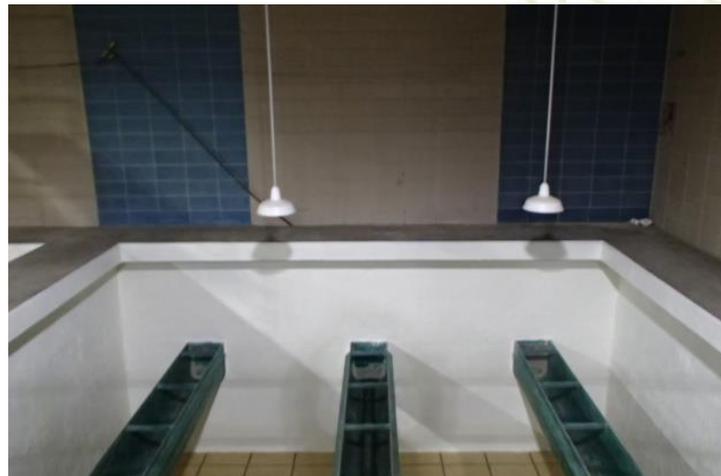
Background:

- **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



Burning Questions?

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