TANK INDUSTRY CONSULTANTS

EVALUATION OF THE

350,000 GALLON STEEL STANDPIPE

"RICE HILL TANK"
BOSTON, NEW YORK

FOR

ERIE COUNTY WATER AUTHORITY
BUFFALO, NEW YORK

October 16 and 17, 2016

16.081.L614.010

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November 9, 2016

SUBJECT:

The subject of this report is the field evaluation of the 350,000 gallon steel standpipe in Boston, New York. The tank was operated by the Erie County Water Authority and was known as the "Rice Hill Tank." The field evaluation was performed on October 16 and 17, 2016 by Gregory P. Cannon, NACE Coating Inspector Level 3—Certified, Certificate No. 10339, Bradlee A. Sipe, NACE Coating Inspector Level 2—Certified, Certificate No. 6704, and Eugene Dube of Tank Industry Consultants. The Owner's representatives on the site at the time of the field evaluation were Jay Meyers and Ted Czosnyka. The stiffener-supported roof tank was of welded steel construction. According to information on the tank nameplate, the tank was constructed by Advance Tank and Construction Company in 1998 under contract number 4998. The tank nameplate also stated the tank had a capacity of 350,000 gallons, a diameter of 31 ft, and a shell height of 61 ft.

OBJECTIVE:

The purpose of this washout and evaluation was to determine the condition of the tank interior, exterior, exposed foundation, and accessories. The purpose of this report is to present the findings of the evaluation and to make recommendations for recoating, repairing, corrosion protection, and maintenance. Budget estimates for the work, anticipated life of the coating and the structure, and the replacement cost of the tank are also included.

AUTHORIZATION:

This washout, evaluation, and report were authorized in the PSA dated March 24, 2016 and signed by Earl L. Jann, Chairman.

EXECUTIVE SUMMARY:

Most of the coating on the interior surfaces of the tank appeared to be in fair condition. However, deep metal loss, including a hole, had occurred in the floor and shell. The hole in the floor as well as any other areas of deep metal loss found in the floor or lower shell should be repaired as soon as possible, and the overflow inlet should be rewelded to the shell. The entire interior should then be recoated within the next year before the metal loss on the upper shell worsens. The exterior coating system appeared to be in good overall protection to the majority of the steel surfaces and should not need to be repainted within the next 5 years from a corrosion standpoint.

ANSI/OSHA and Safety-Related Deficiencies: There were OSHA and safety-related deficiencies observed on this tank. These deficiencies included:

- the paint on the exterior ladder safe-climbing device may prevent its proper operation,
- the misaligned sections of the exterior ladder safe-climbing device would prevent the sleeve from sliding freely along it,
- the ball valve penetrating the roof manhole neck restricted the access through the manhole,
- the roof manhole cover opened toward the center of the roof, and
- the roof access was not equipped with safety railing to deter personnel from inadvertently falling from the roof (29 CFR 1910.23(c)(1)).

If the Owner wishes to fully comply with OSHA and safety-related standards, it is recommended that these deficiencies be rectified.

AWWA and Operational Deficiencies: There were sanitary and operating deficiencies observed on this tank as well. These deficiencies included:

- one roof coupling was open,
- the roof vent was not of clog-resistant design,
- the overflow pipe was not completely attached to the shell, and
- holes were located in the floor.

These deficiencies should be corrected.

The safety-related, sanitary, and operating deficiencies listed above are not intended to be a complete list of deficiencies on this tank. The Owner should refer to the complete report text and accompanying photographs for a complete account of all observed deficiencies.

This evaluation and the reporting of the condition of this tank do not warrant the original structural condition of the tank or any of the original design for seismic loadings. Likewise, recommendations for this tank do not include modifications which may be required for compliance with present structural codes.

PHOTOGRAPHS:

Color photographs were taken of the visible portions of the foundation, the tank interior and exterior and are included as a part of this report. The significant photographs are keyed to the observations.

NOMENCLATURE:

The terms used in describing the various components of water tanks are unique to the industry. In fact, the terms vary from firm to firm and from person to person. In an attempt to define the terms used in this report, a sketch of the general type of tank covered is included at the end of the narrative portion of this report. Each horizontal row of steel plates on the tank is referred to as a "shell ring" or "ring." To

aid in referencing the shell rings, the bottom ring is referred to as shell ring 1 and the top ring is shell ring 8. **Warning: Some appurtenances on this tank may be referred to as erection or rigging attachments, lugs, or brackets. This does not mean that they are safe for rigging. Each attachment for each tank should be evaluated on an individual basis by a structural engineer or an experienced rigger before being used. These devices may have been intended for only the original erectors and painters to use with specialized equipment.**

ADHESION TESTS:

All adhesion tests performed during this evaluation were done in general accordance with ASTM D3359. The results are reported herein using the ASTM scale. The ASTM scale is a relative scale to rate adhesion from 0 to 5 with 5 being the best. A table of adhesion test results classification is included with this report following the sketch of the tank.

HEAVY METALS TESTS:

Samples of the exterior and interior coating systems were sent to a laboratory for inductively coupled plasma-atomic emission spectrometry analyses. The test results were as follows:

	Cadmium		Chromium		Lead	
	mg/kg	percent	mg/kg	percent	mg/kg	percent
Exterior	< 0.52	< 0.000052%	2.8	0.00028%	4.4	0.00044%
Interior	< 0.39	< 0.000039%	29	0.0029%	7.1	0.00071%

Tank Industry Consultants performs this test only to determine if there is lead, cadmium, or chromium present in the coating samples. To limit damage to the existing coating, only small areas were tested. The small number of samples taken and the difficulty of retrieving all primer from the steel profile may cause the tests performed to not accurately represent the total coating system. Variations in thickness, types of coatings applied, and the interim cleaning and painting operations will also affect the actual readings. The reliability of the results is also dependent on the amount of primer included in the sample. Additional testing to determine the amount of leachable contaminants present in the spent cleaning debris will need to be performed following cleaning operations at the time of repainting. Results from the laboratory analysis are included following the adhesion tables.

ULTRASONIC THICKNESS MEASUREMENTS:

(all readings were taken through coating)

Roof Plates:	
Cap:	0.356 in. to 0.367 in.
Finger:	0.347 in. to 0.356 in.
Shell:	
Ring #8:	0.411 in. to 0.423 in.
Ring #7:	0.426 in. to 0.442 in.
Ring #6:	0.421 in. to 0.438 in.
Ring #5:	0.422 in. to 0.431 in.
Ring #4:	0.428 in. to 0.432 in.
Ring #3:	0.474 in. to 0.483 in.
Ring #2:	0.556 in. to 0.567 in.
Ring #1:	0.679 in. to 0.683 in.
Bottom Plate Projection:	0.294 in. to 0.298 in.
Floor:	0.319 in. to 0.328 in.

OBSERVATIONS:

A. Foundation and Site

SITE:
Size: approx. 80 ft x 105 ft
Fence: none
Gate:
Location: site entrance, northwest corner of site
Width: 26 ft
Locked: yes

Nearest Structures:
Type: building
Direction: north
Distance: approx. 12 ft

Type: building
Direction: northeast
Distance: approx. 110 ft

Type: residences
Direction: south
Distance: approx. 600 ft

Nearest Overhead Power Lines:
Direction: east
Distance: approx. 15 ft

FOUNDATION:
Type: concrete ringwall
Projection Above Grade:
North: 10 in. to 18 in.
South: 10 in. to 15 in.
East: 8-1/2 in. to 12 in.
West: 10 in. to 13 in.
Grout: 3/4 in. to 1-3/4 in.
Sealant: polyurethane

1. **Site Location**: The tank was located off of Zimmerman Road in Boston, New York. The site was located in a wooded area. Residences were located to the south. Overhead power lines were located to the east. (See photos 3-6)

2. **Site Conditions**: The tank site was covered with grass. The site was flat but it appeared to be graded to provide adequate drainage away from the foundation. The tank site was not fenced. However, a locked gate extended across the site access from Zimmerman Road. Two buildings were located on the site. Antenna cables extended under an ice bridge from one of the buildings to the tank. A hydrant was located adjacent to the site access. A T-handle for a valve stem was located adjacent to the overflow pipe storm drain on the site. (See photos 1-2, 7, 12)

3. **Foundation**: The tank foundation appeared to be a concrete ringwall. No significant areas of chipping, cracking, and or spalling were noted in the exposed surface of the foundation. The foundation exhibited and/or exceeded the AWWA recommended 6 in. to 12 in. projection above grade. The top surface of the foundation had been coated, and the coating appeared to be in good condition. A bracket was bolted to the top of the foundation. (See photos 8-10)

4. **Grout and Sealant**: There was a pad of grout between the tank bottom plate and the concrete foundation. The grout was not visible due to the polyurethane sealant located around the bottom plate-to-foundation interface. The sealant appeared to be in fair overall condition. Isolated areas of cracking and disbonding were observed in the sealant. (See photos 8, 10)

B. Exterior Surfaces

DESCRIPTION:
Construction: welded steel
Diameter: approx. 31 ft 9-1/2 in.
Shell Height: approx. 61 ft
Shell Rings: 8
Roof Type: stiffener-supported

NAMEPLATE:

Location: adjacent to shell manhole on northeast side of shell

Advance Tank and Construction Co.			
Wellington, CO	**Perris, CA**	**Plainfield, IL**	**Pell City, AL**
AWWA	**D100**	**APP -**	
1998	**4998**	**NO**	
Year	**Contract**	**Heat Treatment**	
31'-0	**61'-0**	**Rings**	
Dia.	**Height**	**1 - 8**	
350,000 Gal.		**A36**	
Capacity		**Material**	

ANCHOR BOLTS:

Number: 12
Size: 1-1/2 in. diameter
Chairs:
Width: 5-1/2 in. (i/s – i/s)
Height: 12 in.
Top Plates: 5 in. x 7 in. x 1/4 in.
Side Plates: 1-1/4 in. to 5 in. x 10 in. x 1/2 in. thick

BOTTOM PLATE PROJECTION: 1-7/8 in. to 3-3/4 in. from shell

SHELL MANHOLES:

Number: 2
Locations: northeast and southwest sides of shell ring #1
Type: flanged and bolted
Size: 29-3/4 in. diameter
Neck: 6-3/4 in. projection from shell x 1/2 in. thick
Flange: 38-1/2 in. diameter x 3/4 in. thick
Bolts:
Number: 42
Size: 3/4 in. diameter x 3 in. long
Cover Plate:
Size: 38-3/4 in. diameter x 3/4 in. thick
Hinged: yes, exterior

OVERFLOW PIPE:

Size: 6 in. diameter
Visible Air Break: approx. 1 ft
Protective Screen: 16 x 16 mesh
Brackets:
Size: 5 in. x 1-3/4 in., channel
Spacing: approx. 8 ft
Storm Drain: 3 ft square x 6 ft 11 in. deep

SHELL LADDER:
- Number of Rungs: 47
- Distance From Top of Foundation to Lowest Rung: approx. 15 ft 2 in.
- Width: 16 in.
- Side Rails: 2-1/2 in. x 3/8 in., flat bar
- Rung Size: 3/4 in. diameter
- Spacing: 12 in. on center
- Toe Room: 9 in.
- Brackets:
  - Construction: welded ladder
  - Size: 3 in. x 3/8 in., flat bar
  - Spacing: approx. 8 ft
- Safe-Climbing Device: notched-tubular rail
- Safety Cage:
  - Depth: 27-1/4 in.
  - Width: 27-1/2 in.
  - Vertical Bars:
    - Size: 2 in. x 1/4 in., flat bar
    - Spacing: 8-3/4 in.
  - Horizontal Bars:
    - Size: 2 in. x 1/4 in., flat bar
    - Spacing: 42 in.
- Vandal Deterrent:
  - Type: hinged door at base of safety cage
  - Locked: yes

ROOF SAFETY RAILING: none

ROOF OPENINGS:
- Manhole:
  - Size: 24 in. square
  - Type: hinged
  - Curb: 8 in.
  - Welded: exterior only
  - Overlap: 2 in.
  - Locked: yes

- Roof Vent:
  - Neck Height: 5 in.
  - Neck Size: 24 in. square
  - Screen:
    - Orientation: vertical
    - Size: 16 x 16 mesh and expanded metal
  - Cover: 24 in. diameter x 18-1/4 in. tall

EXTERIOR COATING AND METAL CONDITION:

	Coating Thickness		Approx. % Failure to		Adhesion	Metal Loss	
	Range	Typical	Underlying Coating	Rust		Typical	Deepest
Shell	6.5 mils to 14 mils	9 mils	Neg.	Neg.	4 S	Neg.	Neg.
Roof	6 mils to 10.5 mils	8.5 mils	1%	< 1/2%	4 S	Neg.	Neg.

Key to Table

Adhesion 5 (very good)
4 (good)
3 (fair)
2 (poor)
1 (very poor)
0 (very poor)

T = Topcoat to Underlying Coating

S = Primer to Steel

Neg. = negligible

1. **Exterior Coating Condition**: The coating on the exterior of the tank appeared to be in good overall condition with no significant corrosion noted. The exterior coating exhibited good adhesion to the steel.

2. **Bottom Plate**: The tank bottom plate extension appeared to be in nearly its original condition at the time of the field evaluation. Random spots of corrosion were located along the perimeter of the bottom plate. (See photos 8, 10)

3. **Anchor Bolts and Chairs**: The tank was equipped with twelve anchor bolts and chairs. Minor amounts of debris were observed within the chairs. Corrosion was observed on a few of the bolts. The bolts were not equipped with washers, and gaps were located at the top plate-to-nut interfaces. (See photos 11-12)

4. **Shell Condition**: The contour of the tank shell was good with no significant discontinuities observed. The coating appeared to be in good overall condition as no significant corrosion was noted. The coating had been touched-up in areas. Overspray, runs, and minor amounts of debris were present in the coating. The coating had chalked and faded, and it exhibited good adhesion to the steel. A tank nameplate was located on the northeast side of the shell on the reinforcing pad for the shell manhole. (See photos 14, 16-17, 24-25)

5. **Shell Manholes**: The tank was equipped with two flanged and bolted circular manholes located on the northeast and southwest sides of the tank. The shell plate around each of the manholes was equipped with a reinforcing plate. Open weep holes were located in the reinforcing plates. The manhole covers were equipped with hinged supports located on the exterior of the tank. A hand hold was located on the shell above each manhole. Corrosion and metal loss were located on the interior of the manhole necks. (See photos 13-15)

6. **Overflow Pipe:** The overflow pipe exited through the top shell ring and extended down the shell before discharging above a grate-covered storm drain. The discharge end of the pipe was equipped with protective screening to prevent the ingress of insects into the tank. The pipe was equipped with welded steel brackets which appeared to be in their original structural condition at the time of this field evaluation. (See photos 12, 17-18)

7. **Exterior Shell Ladder: There were safety deficiencies noted: (1) the misaligned sections of the safe-climbing device would prevent the sleeve from sliding freely along it, and (2) the safe-climbing device was painted.** A ladder provided access from near grade to the roof. The ladder was equipped with a notched-tubular safe-climbing device. However, two of the rail sections were misaligned and the presence of paint on the device would prevent the sleeve from sliding freely along it. The exterior ladder was equipped with a safety cage constructed of welded flat bar members. The base of the safety cage was flared. A flexible conduit, grounding cable, and coaxial cable were clamped to one side of the safety cage, and a PVC pipe was clamped to the other side of the safety cage. The flexible conduit had been coated although the coating had peeled in widespread areas. The exterior ladder was welded to brackets which were welded to the shell. The exterior ladder and brackets appeared to be in nearly their original structural condition at the time of this field evaluation. The base of the ladder was equipped with a hinged door-type vandal deterrent. The vandal deterrent was locked prior to and after the field evaluation. Two antennas were attached to the safety cage at the roof access. A grate step was located at the roof access. (See photos 19-23, 26-27)

8. **Roof Safety Railing: There was a safety-related or OSHA deficiency noted: the roof access was not equipped with safety railing to deter personnel from inadvertently falling from the roof.**

9. **Roof Condition: There was a sanitary deficiency noted: one coupling was open**. The contour of the roof appeared adequate with no significant discontinuities noted. The roof coating appeared to be good overall condition. A few areas of peeled coating and corrosion were located near the perimeter. The coating had chalked, faded, and weathered. The roof coating exhibited good adhesion to the steel. Ten couplings were located near the roof perimeter. Nine of these were threaded and plugged while the tenth was open. Four lugs were located on the upper finger plates. **The lugs should not be used for rigging purposes.** (See photos 25, 30-33)

10. **Roof Manhole: There were safety-related deficiencies noted: (1) the ball valve penetrating the manhole neck restricted personnel access through the manhole, and (2) the manhole cover opened toward the center of the roof.** The roof was equipped with one hinged cover manhole. The roof manhole was locked prior to and after this evaluation. The roof manhole was welded on the exterior only. Corrosion was observed on the interior surfaces of the roof manhole. A 3 in. diameter PVC pipe penetrated the manhole neck and extended into the manhole opening before ending in a ball valve. (See photos 27-29)

11. **Roof Vent: There was a sanitary, AWWA, and operational deficiency noted: the roof vent was not of clog-resistant design.** The roof was equipped with a vent attached to a flanged opening in the approximate center of the roof. The flanged connection appeared to have a gasket. The vent was equipped with fine mesh screening which was shielded from wind-driven dust and debris. Expanded metal screening was located at the base of the vent cover. Corrosion was observed on the vent neck and flange. (See photos 34-35)

C. Interior Surfaces

ROOF SUPPORT SYSTEM:
- Radial Stiffeners:
  - Number: 20
  - Size: 3 in. x 2 in. x 1/4 in., angle
- Center Hub Stiffener:
  - Diameter: approx. 8 ft
  - Size: approx. 4 in. x 4 in. x 3/8 in., angle

TOP SHELL ANGLE:
- Size: 3 in. x 3 in. x 3/8 in.
- Orientation: leg out

INTERIOR LADDER: none

CATHODIC PROTECTION: none

OVERFLOW:
- Inlet Type: funnel
- Location: estimated approx. 8 in. below the roof-to-shell connection

INTERIOR PIPING:
- Inlet Pipe:
  - Size: 6 in. diameter
  - Projection: 8 ft 5 in. above floor
- Drain Pipe:
  - Size: 6 in. diameter
  - Sump: 18 in. diameter x 10-1/4 in. deep
- Outlet Pipe:
  - Size: 6 in. diameter
  - Projection: 12-3/4 in.
  - Protective Cover: none

INTERIOR COATING AND METAL CONDITION:

	Coating Thickness		% Failure to		Adhesion	Metal Loss	
	Range	Typical	Primer	Rust		Typical	Deepest
Roof	8 mils to 12 mils	10 mils	Neg.	4 S	2 S	Neg.	Neg.
Shell	9 mils to 13 mils	11 mils	Neg.	< 1/2%	4 S	1/16 in.	7/32 in.
Floor	9 mils to 19.5 mils	13.5 mils	Neg.	< 1/2%	4 S	1/8 in.	Holes

Key to Table

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5 (very good)
4 (good)
3 (fair)
2 (poor)
1 (very poor)
0 (very poor)

T = Topcoat to Underlying Coating

S = Primer to Steel

Neg. = negligible

1. **Interior Coating Condition**: The coating on the interior surfaces of the tank appeared to be in fair condition. Metal loss, including a hole, had occurred in the floor and shell. The coating on the interior surfaces of the tank exhibited poor to good adhesion to the steel.

2. **Roof Condition**: The coating on the roof plates appeared to be in fair to poor overall condition. Corrosion and rust staining were noted along the top of the roof stiffeners, along the roof plate lap seams, along the stiffener edges, and around the roof vent opening. The interior roof support structure consisted of intermittently welded radial stiffeners and a center hub stiffener. Metal loss was located along the stiffener flanges. Daylight was present at an open coupling in the roof. (See photos 36-42)

3. **Shell Condition**: The coating on most of the shell interior appeared to be in fair overall condition although corrosion had allowed metal loss to occur. Metal loss measurements taken during this evaluation indicated a typical pit depth of 1/16 in., and the deepest pit found measured 7/32 in. deep. The shell coating was discolored slightly due to mineral staining from the water. A top shell angle was located around the roof-to-shell connection, and widespread corrosion was located in this area. Rust staining had streaked down from the roof-to-shell connection and roof stiffener ends onto the upper shell surfaces. (See photos 42, 46-49)

4. **Overflow Pipe**: **There was an operational deficiency: the overflow pipe was not completely attached to the shell.** The overflow included a funnel-type inlet. It appeared the location of the overflow inlet was such that the top capacity level was below the shell-to-roof connection. However, the overflow pipe was broken from the shell, and large gaps were located between the pipe and shell. Corrosion was observed on the pipe adjacent to its penetration and on the shell surfaces around the pipe opening. (See photos 43-45)

5. **Bottom Plate Condition**: **There was an operational deficiency: holes were located in the floor.** The coating on the tank bottom appeared to be in fair overall condition. Corrosion had allowed deep metal loss and a hole to occur in the floor. The metal loss typically measured 1/8 in. deep. A lug was located on the floor. **The lug should not be used for rigging purposes.** (See photos 50-53)

6. **Interior Piping**: The inlet pipe projected approximately 8 ft 5 in. above the floor. The outlet pipe projected above the floor. The inlet pipe appeared to have constructed of stainless steel. The outlet pipe ended with a flanged opening and was not equipped with a protective cover. A drain pipe was located in a sump in the floor. Corrosion was located in the sump. (See photos 54-56)

RECOMMENDATIONS:

A. Foundation and Site

1. **Site Maintenance**: The site should be maintained so that the top of the foundation projects a minimum of 6 in. to a maximum of 12 in. above grade and so that proper drainage away from the foundation continues. Site maintenance should be performed with the mower discharge directed away from the base of the tank to prevent rock chips in the coating and the accumulation of grass on the bottom plate.

2. **Tank and Site Security**: Water tanks have been defined by some courts under certain circumstances as attractive nuisances. As such, there may be a significant potential liability to the Owner for injury to persons on the tank and tank site, even if access is not authorized. Recent events have prompted the entire water industry to consider measures that inhibit intentional acts that could threaten the water supply. A review of the security requirements for the tank and site is recommended to confirm that the existing measures are consistent with the Owner's security requirements for their water system. Primary tank and site security should be focused on eliminating, preventing, and detecting unauthorized access to the tank. Such security measures might include routinely and periodically verifying all manholes and gates are locked, and all exterior ladders have suitable deterrents. Other security measures might include installing no-trespass signs, site lighting, surveillance cameras, motion detectors, installing alarms on gates and tank manholes, and arranging more frequent site visits by law enforcement agencies. At a minimum, a chain link fence topped with barbed wire and equipped with a locked gate should be installed around the entire site.

3. **Foundation**: When the tank exterior is repainted, any unsound concrete should be chipped to sound material and the concrete should be brush-off blasted. Any deteriorated areas or voids found should have a bonding agent and a vinyl emollient modified concrete patching mortar applied to build up the surface to its original contour. The concrete should then be painted with a concrete sealer.

4. **Grout Maintenance**: All loose grout should be chipped away to solid material when the tank is empty. Any shim plates which can be easily removed should be taken out. Any voids in the grout should be filled with a nonshrinking, nonstaining, structural grout material. The grout should be placed as far back under the bottom plate as possible and squared off vertically with the edge of the bottom plate. Any gap between the steel bottom plate and the grout should be filled with a flexible sealant.

5. **Sealant Maintenance**: When the exterior repainting is performed, the existing sealant located between the bottom plate and the foundation should be removed and replaced with a flexible polyurethane sealant.

6. **Overhead Power Lines: All overhead power lines within 40 ft of the tank should be relocated underground in order to prevent potential electrical shock to personnel working on the**

tank. The relocation of the power lines should be performed in accordance with the National Electric Code (NEC) guidelines.

B. Exterior Surfaces

1. **Life of the Exterior Coating**: The exterior coating system appeared to be in good overall protection to the majority of the steel surfaces. Tank Industry Consultants believes that the exterior of the tank should not need to be repainted within the next 5 years from a corrosion standpoint. However, the exterior should be reevaluated in 3 to 5 years, in accordance with AWWA recommendations, to determine a more precise recoating schedule. Due to the good adhesion of the existing exterior coating, spot cleaning and topcoating appears to be an option. The exterior coating system should be evaluated immediately prior to preparing specifications to determine if the coating adhesion is still adequate to accept a topcoat.

2. **Coating Testing**: Prior to preparation of specifications for the cleaning and coating of the exterior of the tank, samples of the exterior coating system should be subjected to laboratory analysis to test for ingredients which may at that time be subject to regulations concerning their handling and disposal.

3. **Cleaning**: When the exterior is to be cleaned, all varieties of containment should be investigated. Containment of the wind-blown debris will be required, and containment of paint droplets will be required.

4. **Recommended Coating System**:

a. **Spot Clean and Topcoat**: If the exterior is to be repainted within the next few years, then spot cleaning and topcoating the tank appears to be the recommended option. The typical life of a spot cleaned and topcoated system is approximately 7 to 8 years, but is highly dependent on previous surface preparation and the condition of the underlying coating system.

b. **Coating Application**: The entire exterior surfaces of the tank should be high-pressure washed to remove chalked coating, mildew, and contaminants. After washing, the damaged and rusted areas should be spot cleaned to the equivalent of an SSPC-SP 6, Commercial Blast Cleaning, or SSPC-SP 11, Power Tool Cleaning to Bare Metal. All areas of excessive coating thickness and runs in the coating should be cleaned to the equivalent of an SSPC-SP 7, Brush-Off Blast Cleaning, to remove the excessive mils. The spot cleaned areas should receive a spot prime coat compatible with the present coating system. The entire exterior surfaces should then be intermediate coated and topcoated with a compatible coating system.

5. **Alternative Coating System**:

a. **Complete Cleaning and Repainting**: The optimum long-life coating system presently available for this site is an epoxy-polyurethane coating system. Properly formulated and applied polyurethanes have good resistance to condensation, mildew, and chipping. The polyurethanes also have excellent color and gloss retention and the longest expected service life of any of the common exterior tank coatings. The typical life of a properly applied epoxy-

polyurethane coating system is approximately 15 to 20 years. These coatings are also presently manufactured to meet current VOC requirements.

b. **Coating Application**: The entire tank exterior should be cleaned to the equivalent of an SSPC-SP 6, Commercial Blast Cleaning and have an epoxy-primed, epoxy intermediate and polyurethane finish coating system applied. However, care must be taken during the application of this particular coating system because this coating does have poor dry-fall characteristics, and potential damage to the surrounding property must be taken into consideration. The polyurethane coatings also require close monitoring of temperature and humidity during application.

6. **Effective Service Life**: Tank Industry Consultants defines the life of a coating as the amount of time before repainting becomes necessary due to coating failure and corrosion. During the coating life the Owner should expect the coating to lose its gloss, start to chalk, show signs of weathering, and possibly some rust staining. Future touch-up may be required on isolated coating failures. If aesthetics are a concern, the Owner may have to topcoat the repainted tank prior to the end of the expected service life. However, future topcoating would be less expensive than complete cleaning and recoating and could delay the next complete cleaning and repainting for many years.

7. **Other Systems**: With air emission volatile organic compounds (VOC) restrictions being put in place around the nation, alternative coating systems may become available which would be viable options for this tank. The Owner should review the available systems prior to preparing specifications for the recoating project.

8. **Coating Curing**: It would be more economical to paint the tank exterior at the same time the interior is painted, since the tank must be drained while the exterior is painted, and the applied coatings cure. This will also reduce mobilization and observation costs.

9. **Rehabilitation Schedule**: To obtain the lowest possible prices for the work outlined in the recommendations, the Owner should have the specifications prepared and the work bid in the spring, with the work scheduled to start in early summer (if possible).

10. **Grinding and Bracket Removal**: Any unused brackets or erection lugs should be removed prior to the exterior repainting. Any weld burrs, weld spatter, or erection scars should be ground off to provide a smooth surface for the application of the coating.

11. **Nameplates**: The tank nameplates should be removed for the cleaning and coating of the tank. The nameplates should be cleaned and reattached to the tank using new brackets.

12. **Anchor Bolts**: After abrasive blast cleaning, the anchor bolts, chairs, and nuts should be examined for deterioration. If deterioration is found and the anchor bolts are mild steel, the deteriorated areas of the anchor bolts should be repair welded as necessary. Dirt, debris, and grass clippings can accelerate corrosion and should not be allowed to accumulate in the anchor bolt chairs. The gaps at the nut-to-top plate interfaces should be eliminated with washers.

13. **Electrical Apparatus**: All unused electrical conduit, antennas, fixtures, electrical metering equipment, and control cabinets should be removed from the tank and tank site. All required equipment should be repaired and maintained in accordance with the National Electric Code (NEC).

14. **Existing Shell Manholes**: At the time of recoating and repairs, the gaskets for the shell manholes should be replaced. The unplugged weep holes should be tapped and plugged.

15. **Exterior Ladder**: The painted and misaligned safe-climbing device should be replaced. A safety cage is not required on a ladder with a safe-climbing device. To reduce cleaning and painting costs and future maintenance costs, the shell ladder cage could be removed. The exterior ladder not include slip-resistant rungs. Slip-resistant rungs are required for all ladders constructed after March 1991 by the OSHA Construction standards. However, slip-resistant rungs are not required by the OSHA General Industry standards for ladders or by AWWA D100.

16. **Vandal Deterrent**: If the existing safety cage is removed, a new vandal deterrent should be installed.

17. **Roof Safety Railing**: Safety railing which meets current OSHA dimensional requirements should be installed at the roof access and adjacent to the roof manhole.

18. **Clog-Resistant Vent**: The tank was not equipped with a clog-resistant vent. AWWA Standards recommend that all vents with screening against insects be designed to ensure "fail-safe" operation if the insect screens become occluded. Inadequate ventilation could cause a tank collapse if the tank is rapidly drained while the screen is occluded or frosted over. Therefore, a clog-resistant vent should be installed near the center of the roof. The vent should be designed so that it is removable in order to act as a second means of access to the tank interior.

19. **Roof Manhole**: The roof manhole cover should be rotated 90 degrees so it does not open toward the center of the roof. The pipe penetration with the ball valve should be relocated so it does not interfere with personnel use of the manhole.

20. **Roof Coupling**: The open roof coupling should be equipped with a plug.

C. Interior Surfaces

1. **Life of the Interior Coating**: Most of the coating on the interior surfaces of the tank appeared to be in fair condition. However, deep metal loss, including a hole, had occurred in the floor and shell. The hole in the floor as well as any other areas of deep metal loss found in the floor or lower shell should be repaired as soon as possible, and the overflow inlet should be rewelded to the shell. Tank Industry Consultants recommends the entire interior should then be recoated within the next year before the metal loss on the upper shell worsens. It is recommended that when the interior is completely cleaned and repainted, an epoxy coating system should be used.

2. **Coating Testing**: Prior to preparation of specifications for the cleaning and coating of the interior of the tank, samples of the interior coating system should be subjected to laboratory analysis to test for ingredients which may at that time be subject to regulations concerning their handling and disposal.

3. **Spot Cleaning and Spot Coating**: The areas of deep metal loss in the shell and floor should be repaired and spot cleaned to the equivalent of an SSPC-SP 10, Near-White Blast Cleaning. A two-component epoxy coating system should then be applied. This coating system should meet the

certification criteria of ANSI/NSF 61 and state department of health regulations. Any welded steel patch plates installed at the holes should be touched-up as well.

4. **Recommended Interior Coating System:**

a. **Epoxy Coating System**: The optimum long-life coating system presently available for the interior of water tanks is a two-component epoxy coating system. A 100% solids epoxy system is recommended for the interior of this tank. This coating system should meet the certification criteria of ANSI/NSF 61 and state department of health regulations.

b. **Coating Application**: When the interior is to be repainted, the entire tank interior should be cleaned to the equivalent of an SSPC-SP 10, Near-White Blast Cleaning and an epoxy coating system applied.

c. **Service Life**: The typical life of a properly formulated and applied epoxy coating system is approximately 12 to 15 years in immersion service. Tank Industry Consultants defines the life of a coating as the expected service life before repainting becomes necessary due to coating failure and corrosion. The Owner could extend the service life of the coating by installing, properly maintaining and operating a cathodic protection system to help protect the steel surfaces in areas which have experienced coating failure.

5. **Cathodic Protection**: When the tank is rehabilitated the brackets and fittings should be installed for the future installation of a cathodic protection system.

a. **Type**: When the cathodic protection system is installed, an ice-resistant cathodic protection system which features long-life anodes, automatic potential and current control should be specified.

b. **Scheduling**: After the interior is completely cleaned and recoated, the cathodic protection system should not be energized until after the First Anniversary Evaluation. The Owner should conduct washouts and evaluations approximately every 3 years to monitor the need for cathodic protection. As the interior coating begins to show signs of failure, the cathodic protection system should be energized to aid in minimizing corrosion below the top capacity level.

c. **Maintenance**: Cathodic protection, if used and maintained properly, will control active corrosion below the water level and extend the useful life of a coating system. It should be noted that maintenance as recommended by the cathodic protection manufacturer is required for the cathodic protection system to work properly. Without proper monitoring, the cathodic protection system may operate too high and cause the coating to blister, or the system may operate too low and not adequately protect the exposed steel surfaces.

6. **Pit Welding and Pit Filling**: After initial cleaning, all significant pitting which is found should be welded, and all pitting with rough edges that would make the pitting difficult to coat properly should be filled with a solventless epoxy seam sealer. (It was estimated that approximately 25 square inches of pits will require welding, and approximately 2 gallons of seam sealer will be required for pit repair.) The existing hole and any other holes found in the floor should be covered with welded steel patch plates.

7. **Seam Sealing**: The existing roof manhole and existing roof vent intersections should be sealed with an epoxy seam sealer at the time of the interior recoating.

8. **Flexible Sealant**: The unwelded lapped roof seams should be sealed with a flexible sealant or seal welded at the time of the interior recoating.

9. **Rough Edges**: All unused brackets should be removed from the interior and exterior surfaces at the time of the next recoating. Any weld burrs, spatter, scars or rough edges in the steel should be ground smooth to provide a better surface for coating. (It was estimated that approximately 30 man-hours of grinding will be required on the interior of the tank.)

10. **Overflow**: The overflow inlet should be rewelded to the shell as soon as possible.

11. **Roof Support Structure**: After abrasive blast cleaning, the roof support structure should be carefully evaluated as metal loss repairs may be necessary at areas where the metal loss was not previously visible.

12. **Inlet Pipe**: The inlet pipe appeared to be constructed of stainless steel, and this should be confirmed. If it is stainless steel, it is recommended the pipe be replaced with a plastic or carbon steel pipe to prevent accelerated rates of corrosion due to dissimilar metals.

ECONOMIC FACTORS:

Item	Cost	Life in Years
Replacement of tank with a new one	$ 700,000[1]	75+

The following is a complete list of repairs and estimated costs for their respective recommendations found in the RECOMMENDATION section of this report.

Item	Sanitary & Safety	Scheduled Maintenance Repairs
Clean and Paint Exterior:		
Spot Repair and Topcoat		$ 100,000
Containment		100,000
SP 6, Complete Clean, Epoxy/Polyurethane System		150,000
Containment		120,000
Clean and Paint Interior:		
SP 10, 100% Solids Epoxy System		250,000
Spot Clean and Spot Coat Interior		40,000
Cathodic Protection System		12,000
Miscellaneous Chipping and Grinding		3,000
Seam Sealing		5,000
Pit and Hole Repair		10,000
Grout Repair		1,000
Foundation Repair		2,000
Repair Overflow Inlet		5,000
Replace Exterior Ladder Safe-Climbing Device	$ 4,000	
Replace Vandal Deterrent	2,000	
Install Roof Safety Railing	4,000	
Modify Roof Manhole Cover	2,000	
Install Clog-Resistant Vent	8,000	
Install Anchor Bolt Washers	1,000	
Contingency Items	10,000	12,000

Estimates are believed to be a high average of bids that would be received in 2017.

[1] The replacement estimate includes costs associated with new tank fabrication and erection, foundation, painting, and engineering. The budget estimate given does not include costs associated with tank demolition, site acquisition, and distribution interruptions.

The following economic factors include only those work items that the Engineer believes to be the minimum to properly maintain this tank from an operational standpoint. Other items related to safety and risk management should be evaluated by the Owner.

Item	Cost
Clean and Paint Exterior:	
Spot Repair and Topcoat	$ 100,000
Containment	100,000
Clean and Paint Interior:	
SP 10, 100% Solids Epoxy System	250,000
Spot Clean and Spot Coat Interior	40,000
Miscellaneous Chipping and Grinding	3,000
Seam Sealing	5,000
Pit and Hole Repair	10,000
Grout Repair	1,000
Foundation Repair	2,000
Repair Overflow Inlet	5,000
Replace Exterior Ladder Safe-Climbing Device	4,000
Replace Vandal Deterrent	2,000
Install Roof Safety Railing	4,000
Modify Roof Manhole Cover	2,000
Install Clog-Resistant Vent	8,000
Install Anchor Bolt Washers	1,000
Contingency Items	15,000
Total of Engineer's Recommendations	**$ 552,000**

Tank Industry Consultants has no control over the cost of labor, materials, or equipment, or over the contractors' methods of determining prices, or over competitive bidding, or the market conditions. Opinions of probable cost, as provided for herein, are to be made on the basis of our experience and qualifications and represent our best judgment as design professionals familiar with the design, maintenance, and construction of concrete and steel plate structures. However, Tank Industry Consultants cannot and does not guarantee that proposals, bids, or the construction cost will not vary from opinions of probable cost prepared for the Owner.

Due to the numerous potential scopes of work which exist, the Owner should obtain an updated budget estimate once the final scope of work has been determined. This would enable the Owner to accurately budget monies for additional mobilization costs and damaged coating rehabilitation costs.

Engineering and resident observation costs are not included in the Total of the Engineer's Recommendations because these fees are dependent upon the scope of work to be performed. Tank Industry Consultants performs all facets of the engineering services which would be required for this project. Estimated fees for engineering and resident observation will be furnished upon request.

CLOSURE:

Brief Summation: The Erie County Water Authority operates a 350,000 gallon standpipe in Boston, New York. Most of the coating on the interior surfaces of the tank appeared to be in fair condition. However, deep metal loss, including a hole, had occurred in the floor and shell. The hole in the floor as well as any other areas of deep metal loss found in the floor or lower shell should be repaired as soon as possible, and the overflow inlet should be rewelded to the shell. Proper maintenance after completing the recommendations herein would include periodic washouts and evaluations approximately every 3 to 5 years in accordance with AWWA recommendations, and the installation and proper maintenance of a new ice-resistant cathodic protection system with long-life anodes.

Contractor Selection: The work should be performed by a competent bonded contractor, chosen from competitive bids taken on complete and concise specifications. The coatings used should be furnished by an experienced water tank coating manufacturer, supplying the field service required for application of technical coatings.

Standards for Repairs and Coatings: All work done and coatings applied should be applied in accordance with NACE, ANSI/NSF Standard 61, the manufacturer's recommendation, AWWA D100 and AWWA D102 (latest revisions), and the SSPC: The Society for Protective Coatings.

Observation of Work: Observation of the work in progress by experienced personnel will offer additional assurance of quality protective coating application. Observations can be performed on a continuous basis or spot (critical phase) basis. The actual cost of observation may be less using spot as opposed to full-time resident observation; however, with spot observation it is often necessary for work to be redone to comply with the specifications. This somewhat lowers the quality of the finished product, lengthens the job, and is frequently a cause of conflict between the contractor, Owner, and field technician. Resident full-time observation minimizes the amount of "rework" required.

Anniversary and Maintenance Evaluations: An anniversary evaluation should be conducted prior to the end of the one year bonded guarantee. Washouts and coating, structural, sanitary, safety, and corrosion evaluations should be conducted not less than every 3 to 5 years.

Time Frame: If the work is not performed within the next 6 months, the structure should be reevaluated prior to the preparation of specifications and solicitation of bids.

Specifications and Bidding Documents: The recommendations in this report are not intended to be specifications on which a contractor can bid. Complete bidding documents must include general and special conditions, detailed technical specifications, and other information necessary for the competitive bidding process. To properly protect the interests of the Owner, Contractor, and Engineer; the initial evaluation, the technical specifications, legal portions of the contract documents, and the observation should be performed by the same firm or with close coordination of all parties involved.

Limitations of Evaluation: It is believed that the conditions reported herein reflect the condition of the tank as observed on the date of the evaluation, using reasonable care in making the observations, and safety in gaining access to the tank. Should latent defects be discovered during the cleaning of the structure, they should be brought to the attention of the Owner and the Engineer.

Seismic and Wind Loadings: This tank is located in or near a region of moderate seismic activity. This evaluation and the reporting of the condition of this tank do not warrant the structural condition of the tank or any of the original design for seismic loadings. Likewise, recommendations for this tank do not include modifications which may be required for compliance with present structural codes. It is possible the tank was erected in compliance with pre-existing industry standards which have since been replaced by more restrictive standards.

Hazardous Materials in Coatings: It should be taken into consideration that Federal, State, and local environmental agencies have placed stricter controls on the removal of lead-based and other heavy-metal based coatings from steel structures by the use of conventional abrasive blasting techniques. The paint and blast residue may be considered to be hazardous waste depending on the concentration of lead or other particles in residue.

Please contact Tank Industry Consultants if you have any questions or comments.

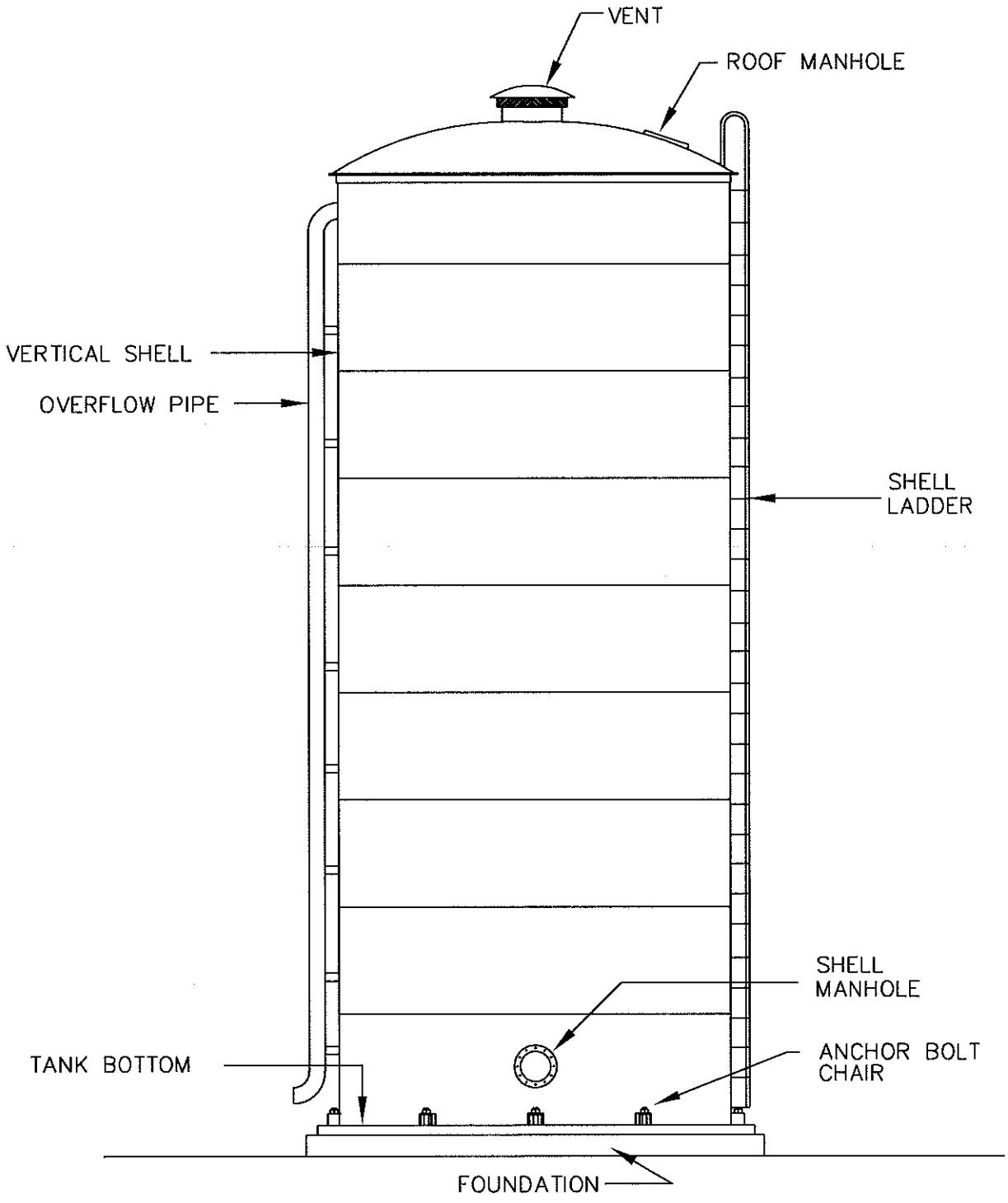
Respectfully submitted,

Tank Industry Consultants

Jennifer Coon, CHMM, CET

Gregory R. "Chip" Stein, P.E.
Managing Principal

STANDPIPE



NOMENCLATURE

Classification of Adhesion Test Results

Method A – X Cut Tape Test Approx. 1.5 in. long cuts at 30 deg. to 45 deg. apart.	Surface	Classification
No peeling or removal.		5
Trace peeling or removal along incisions.		4
Jagged removal along incisions up to 1/16 in. (1.6mm) on either side.		3
Jagged removal along most of incisions up to 1/8 in. (3.2mm) on either side.		2
Removal from most of the area of the X under the tape.		1
Removal beyond the area of the X.		0

Method B – Lattice Cut Tape Test Six parallel cuts at 2mm apart.	Surface	Classification
The edges of the cuts are completely smooth; none of the squares of the lattice are detached.	No Failure	5
Small flakes of the coating are detached at intersections; less than 5% of the lattice is affected.		4
Small flakes of the coating are detached along edges and at intersections of cuts. The area affected is 5% to 15% of the lattice.		3
The coating has flaked along the edges and on parts of the squares. The area affected is 15% to 35% of the lattice.		2
The coating has flaked along the edges of cuts in large ribbons and whole squares have detached. The area affected is 35% to 65% of the lattice.		1
Flaking and detachment worse than grade 1.		0

ASTM 3359 Standard Test Methods for Measuring Adhesion by Tape Test

Tank Industry Consultants

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10/27/2016

The following analytical report covers the analysis performed on samples submitted to EMSL Analytical, Inc. on 10/21/2016. The results are tabulated on the attached data pages for the following client designated project:

16.081.L614.010

The reference number for these samples is EMSL Order #161619504. Please use this reference when calling about these samples. If you have any questions, please do not hesitate to contact me at (317) 803-2997.

Approved By:

Doug Wiegand, Laboratory Manager

EMSL Analytical, Inc.
2001 East 52nd St., Indianapolis, IN 46205
Phone/Fax: (317) 803-2997 / (317) 803-3047
http://www.EMSL.com indianapolislab@emsl.com

EMSL Order: 161619504
CustomerID: TICO62
CustomerPO:
ProjectID:

Attn: **Julie Perkins**
Tank Industry Consultants
7740 West New York Street
Indianapolis, IN 46214

Phone: (317) 271-3100
Fax: (317) 271-3300
Received: 10/21/16 11:00 AM
Collected: 10/16/2016

Project: **16.081.L614.010**

Analytical Results

Client Sample Description 1 Ext East Shell ***Collected:*** 10/16/2016 ***Lab ID:*** *0001*

Method	*Parameter*	*Result*	*RL*	*Units*	*Prep Date*	*Analyst*	*Analysis Date*	*Analyst*
3050B/6010C	Cadmium	ND	0.52	mg/Kg	10/27/2016	TD	10/27/2016	TD
3050B/6010C	Chromium	2.8	1.3	mg/Kg	10/27/2016	TD	10/27/2016	TD
3050B/6010C	Lead	4.4	1.3	mg/Kg	10/27/2016	TD	10/27/2016	TD

Client Sample Description 2 Int North ***Collected:*** 10/16/2016 ***Lab ID:*** *0002*

Method	*Parameter*	*Result*	*RL*	*Units*	*Prep Date*	*Analyst*	*Analysis Date*	*Analyst*
3050B/6010C	Cadmium	ND	0.39	mg/Kg	10/27/2016	TD	10/27/2016	TD
3050B/6010C	Chromium	29	0.98	mg/Kg	10/27/2016	TD	10/27/2016	TD
3050B/6010C	Lead	7.1	0.98	mg/Kg	10/27/2016	TD	10/27/2016	TD

Definitions:

ND - indicates that the analyte was not detected at the reporting limit
RL - Reporting Limit (Analytical)

1. Tank and site.

2. Tank and site.

3. Surrounding area.

4. Surrounding area.

5. Surrounding area.

6. Surrounding area.

7. Site access.

8. Tank foundation, sealant, and bottom plate projection.

9. Tank foundation, flexible conduit, bracket, and PVC pipe.

10. Tank foundation, sealant, bottom plate projection, anchor bolt, and chair.

11. Anchor bolt and chair. Note gap at nut-to-top plate interface.

12. Overflow pipe discharge above storm drain. Note T-handle behind storm drain.

13. Shell manhole.

14. Shell manhole and tank nameplate.

15. Corrosion and metal loss in shell manhole neck.

16. Shell exterior.

17. Overflow pipe.

18. Overflow pipe and bracket.

19. Vandal deterrent at base of exterior ladder.

20. Exterior ladder, conduit, cables, safe-climbing device, PVC, and safety cage.

21. Flexible conduit, cable, and coaxial cable on safety cage.

22. PVC pipe bolted to ladder safety cage.

23. Misaligned notched-tubular rail sections.

24. Shell exterior.

25. Top shell angle and threaded and plugged roof coupling.

26. Roof access.

27. Roof access.

28. Corrosion on roof manhole.

29. Piping extending into roof manhole.

30. Roof exterior.

31. Peeled coating and corrosion along roof perimeter.

32. Open roof coupling.

33. Lug on roof.

34. Roof vent.

35. Roof vent.

36. Roof interior and support structure.

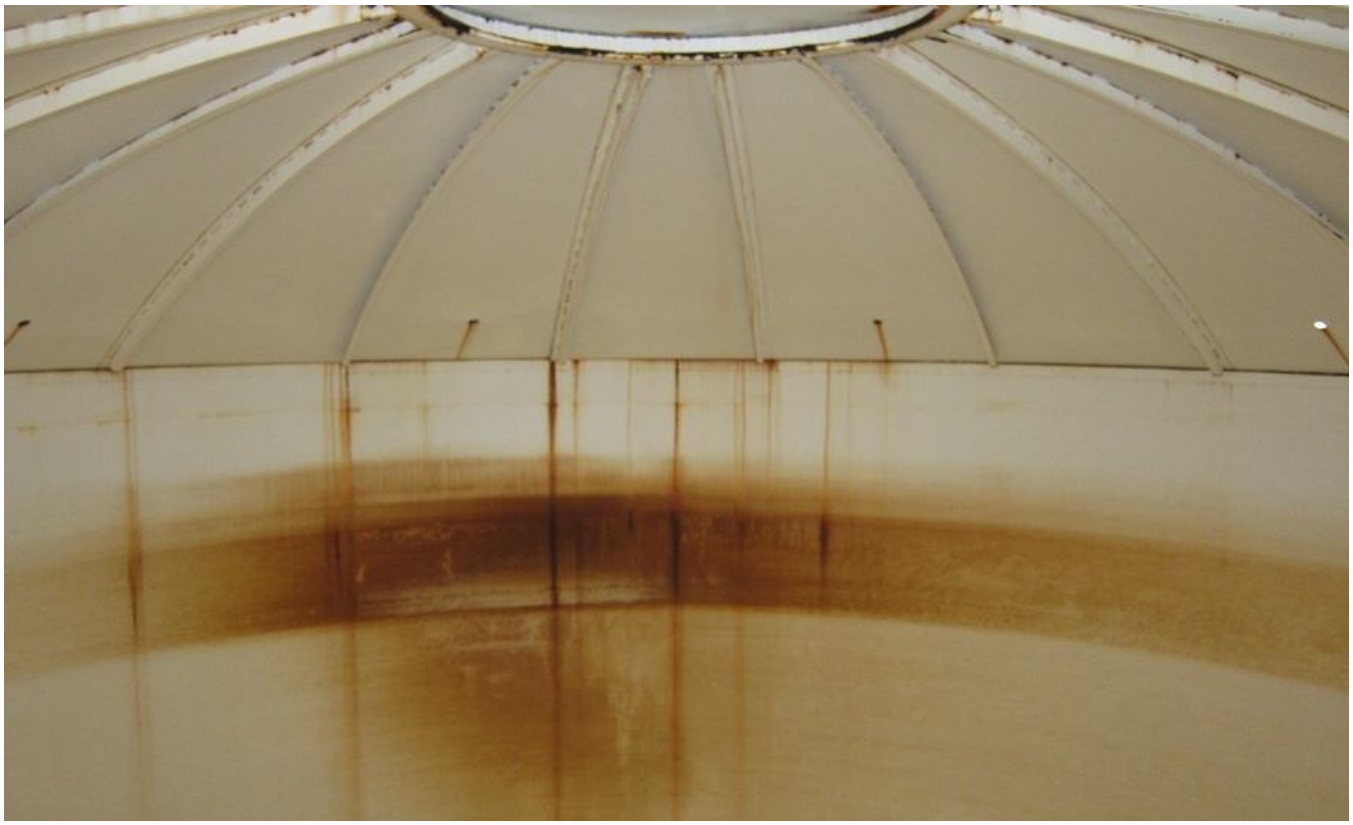
37. Roof interior and support structure.

38. Corrosion on roof stiffeners.

39. Corrosion and metal loss along roof stiffeners and around roof vent opening.

40. Corrosion along roof stiffener. Note daylight at coupling opening.

41. Corrosion along roof stiffener.



42. Roof and rust staining on upper shell.

43. Overflow pipe no longer attached to shell.

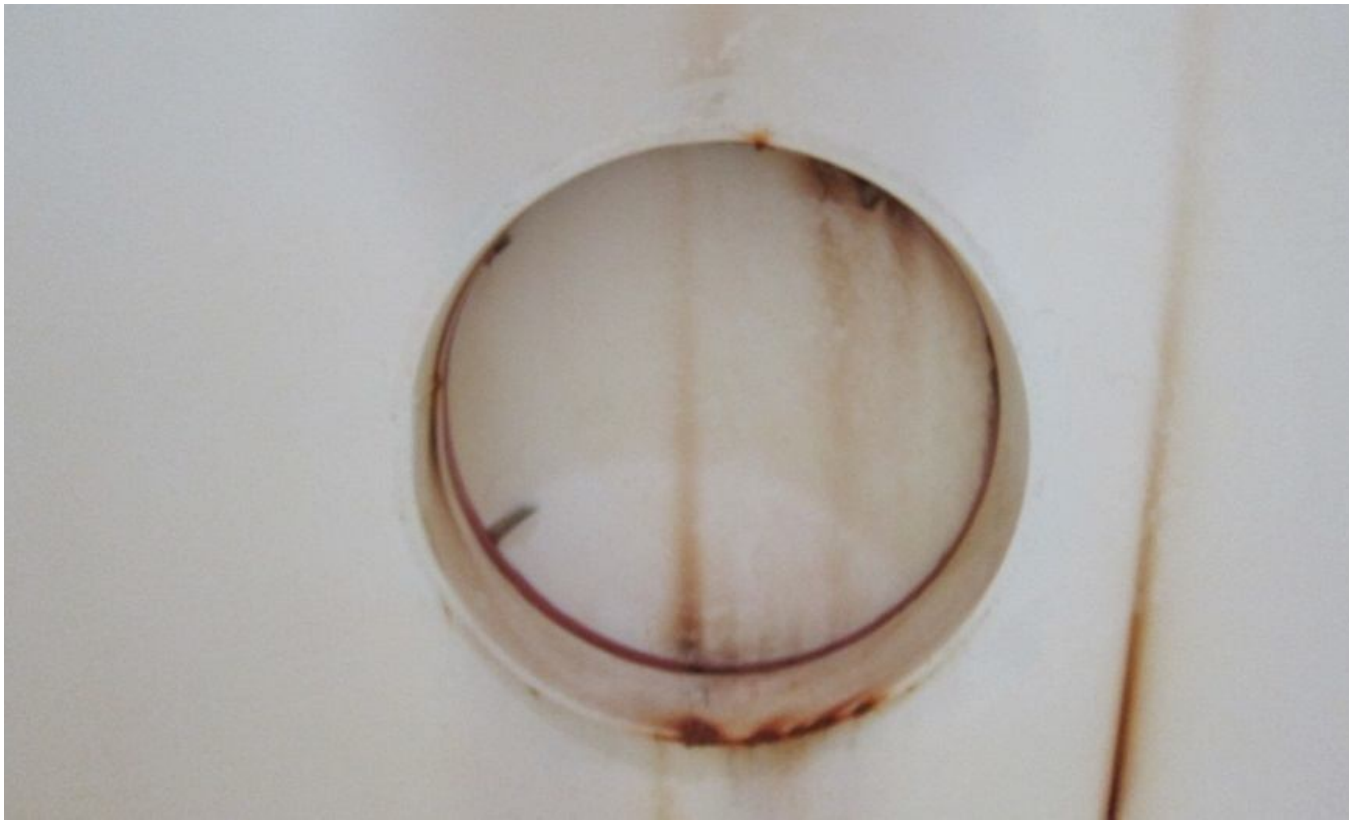
44. Overflow pipe no longer attached to shell.

45. Overflow pipe no longer attached to shell.

46. Corrosion on shell.

47. Corrosion along shell horizontal seams.

48. Corrosion and metal loss in shell.



49. Shell manhole interior.

50. Lug on floor.

51. Metal loss in floor.

52. Metal loss in floor.

53. Hole in floor.

54. Inlet pipe.

55. Outlet pipe.

56. Drain pipe in sump.