California Rural Water Association

Memorandum

Alleghany Tank Inspection

To: Alleghany County Water District
PO Box 860
Alleghany, CA 95910

From: Nathan Thomas P E
CRWA Senior Engineer
1234 N Market Blvd
Sacramento, CA 95834

December 22, 2022

Background:

The Alleghany County Water District (ACWD) is registered as a community water system with the State Water Resources Control Board (SWRCB) with water system number CA4600012. The ACWD owns a tank built in 2018 that has begun to leak. A tank inspection was performed by Coating Specialists and Inspection Services, Inc. (CSI) on June 3, 2022. Nathan Thomas PE, project engineer for the SAFER Alleghany Feasibility Analysis and Technical Evaluation (Project), attended the inspection and has prepared this Memorandum of findings for the State, ACWD, and other stakeholders.

The tank at 105 Hell's Half Acre Road began to leak shortly after construction was completed. The Project intent is to identify and characterize the leak to facilitate proper repairs, restore the tank to service, and promote a reasonable service life of 25 to 40 years. The ACWD system includes only one 150,000 gallon storage tank. The tank was replaced by a new bolted steel tank constructed by Thompson Tank and manufactured by CST Industries, inc. The new tank was placed in service in December 2018 and partially inspected by CSI in January 2020. The inspection noted rusting bolts at the base of the tank and repair work was performed on the defects in June 2020 by Thompson Tank. In October 2021 ACWD reported that the tank was leaking from the bottom. The tank was removed from service in November 2021 and remained empty until July 2022. CRWA is providing technical assistance to ACWD via the State SAFER program including project management and engineering expertise to identify the cause of the tank's premature failure and recommend steps toward providing adequate, reliable storage to ACWD.

Onsite Observations:

The tank was completely drained and fully accessible for the inspection. While onsite June 3, 2022, CRWA noted that the tank exterior generally appears to be in good condition. The exterior showed no signs of degradation beyond normal wear and tear. There were only two electronic items noted on the tank, a coaxial cable to a roof mounted radio antenna and a PVC conduit that carries the wire for the level transducer that hangs near the roof hatch. The transducer was hanging inside the tank low enough to touch the floor at the time of the inspection.

Inside the tank there were notable signs of corrosion mostly at the bolts and appurtenances. Also noted were several areas of pitting located in the steel bottom panels near the aluminum internal ladder. Some pits still had paint (coating) bridging over them with only a small hole in the coating. The holes in the steel underneath were approximately the size of a nickel and a few penetrated through the bottom plates. Additional pitting was noted on the floor panels at the location of the level gauge float attachment cables. In at least one location the subgrade below leaking area(s) has apparently washed away leaving void spaces below the tank bottom. The floor flexes up and down several inches with changes in loading. Throughout the lower portions of the tank there are numerous bolts that are exhibiting corrosion. There was additional corrosion at the tank inlet and outlet pipes and notable coating defects at the manway. The coating at the manway had previously been repaired but was chipping and peeling with rust forming on the bare metal. The corrosion on the bolts was widely dispersed and most prevalent near the ladder and in the level gauge float attachment area. There was also corrosion of significance at the connection between the shell and the cross beam that supports the roof. Photos of onsite observations are attached.

The inside tank bottom had substantial quantities of black sediment particles in the puddles of remaining water. The sealant at the tank seams appears to be the source of the black sediment on the bottom. The sealant throughout the tank interior is crumbly and easily disintegrates into similar black powder when touched. The sealant on the tank outside was hard and intact and not crumbly like the same substance on the inside. It is not known whether this sealant was intended to harden or remain more flexible.

Subsequent Findings:

The ACWD reported the tank was partially repaired prior to being put in service for fire season while the inspection results were being compiled. Temporary repairs were carried out by Thompson Tank on June 27, 2022. Three patches were installed over the largest holes near the ladder and many bolts were covered and sealed. Additional interior surface sealant material was added at the chine where the wall meets the floor in at least one location. Other rust spots were covered with sealant. Isolation washers were installed on the ladder at the stainless steel bolted connections. ACWD personnel reported that only some ladder connections were isolated and

the harder to access locations were not included in the repairs. The tank was then disinfected and filled for use.

The sealant chalking on the inside the tank is of concern. The degradation on the inside may be caused by defective sealant material used in construction, imperfect curing (possibly due to temperature or disinfection chemicals), or a slow degradation over time due to reaction with stored water. The most likely cause is defective construction materials because the product was selected for use in contact with chlorinated water. The sealant material may have been poorly formulated or stored improperly, but the cause of failure must be determined by further analysis. On August 23, 2022, the tank was confirmed by ACWD to be leaking from the seams of the sidewalls (shell). The risk of leaking from sealant failure was noted in an email from CSI dated August 9, 2022:

> *"A secondary issue, which has not yet manifested into a catastrophic issue, but could impact water quality and the tank's ability to hold water is the sealant, which is entirely uncured, everywhere probed."*

The sealant failure adds a new line of inquiry that must be resolved to ensure the tank functions as intended. Based on a photo taken during construction (attached below), the sealant used is Manus Bond 75 AM. The labeling on the box in the photo appears to be the 'USDA accepted' product type, not the NSF 61 certified type as required by CA regulations. Better documentation of the sealant used during construction was not available. The manufacturer's data sheets for the sealant are attached.

Summary and Comments on CSI Inspection:

CRWA contracted with CSI in May 2022 to have the tank coating inspected. The tank inspection was performed on June 3, 2022, by Steve Metcalf of CSI. CRWA was onsite at the time of the inspection. CSI rendered a report on the 2022 inspection merged with the previous report of inspection they had performed on the tank dated January 28, 2020. CRWA was unaware that the previous report existed until the 2022 report was submitted in July 2022. CRWA repeatedly requested a standalone report with a recommended repairs and a cost estimate for the repair work. However, CSI did not provide the estimate or the separate report. The merged CSI report is attached. Sealant samples provided to CSI by ACWD at the time of the 2022 inspection were analyzed by spectrometer. The sealant analysis results are attached with the CSI report.

The interior tank coating especially the floor was not inspected closely during the 2020 inspection because the tank was not fully drained. Only surfaces near the manway were accessible at the time. The first inspection did result in some repairs in June 2020 as noted above. The current findings on the interior coating did identify three holes in the floor near the interior ladder. Galvanic corrosion was identified there and confirmed by electronic test during the inspection. CSI observations indicate galvanic corrosion being the main problem leading to the floor leaks. Galvanic corrosion is caused by two conditions: (1) coating defects and (2) dissimilar metals or uninsulated electronics. When these conditions exist, they cause a localized

circuit to form in the water that destroys the weaker metal where exposed. The aluminum, interior ladder not being isolated from the carbon steel tank shell caused the most severe corrosion and the floor leak. Similar pitting corrosion in the floor panels is occurring where the stainless steel cables that tether the level gauge float connect to the floor. From the inspection report:

> "*Epoxies have a typical service life of 25 to 35 years, and after just one year [21 months] of service, the lining has failed, leading to breaches in the tank bottom.*"

CSI also noted that rapid galvanic corrosion is occurring on some bolted connections because the bolts are dissimilar metal to the shell materials being joined. In these cases, the coating was likely damaged during assembly.

CSI made the following recommendations:

- Spot repair on exterior surfaces as needed.
- Examination of interior surfaces to identify and electrically isolate all dissimilar metals with detailed repair work of all corroded surfaces including grinding, welding, surface preparation, and recoating as needed.
- A maintenance plan per AWWA standards with periodic repairs.

CSI made no recommendations regarding the sealant in the report. The sealant leak began after the CSI inspection.

Conclusion and Recommendations:

Throughout the tank design and construction many layers of oversight could have prevented the ladder from not being electrically isolated. But had that occurred, the tank would have failed early outside the warranty period due to coating defects not detected or corrected prior to acceptance. The ACWD tank now requires repair to remain serviceable. There are at least two potential approaches to the repair work:

1. Replace limited panels in the floor and make spot repairs and modifications to the interior on other items as needed based on subsequent inspection results.
2. Replace the entire tank floor and shell (this is a preliminary possibility pending subsequent inspection results).

Option 1 is predicated on the assumption that the tank is over all a reliable product and will perform for the design life with reasonable modifications and repairs. Option 2 assumes the tank has too many defects and will cause an operation and maintenance burden during its design life in excess of the cost of replacement now. Prior to selecting a course of action, CRWA strongly recommends that additional testing and documentation be conducted to determine whether the sealant is serviceable and will remain intact for the tank design life. If the sealant is found defective throughout the structure, CRWA recommends Option 2, replacing the tank floor and shell with new panels while implementing higher quality control during assembly and acceptance.

Recommended actions applicable to both Options:

- Close professional oversight and project documentation by independent engineering consultant on all work performed.
- Install a fiberglass interior ladder using hardware isolation techniques as employed on the tank panels.
- Hang the pressure transducer up off floor to prevent forming a galvanic circuit or chipping coating.
- Verify the chemicals and concentrations used in tank disinfection and compare to the sealant limitations for chemical exposure.
- Add passive cathodic protection near ladder and level gauge float connections below the tank inlet height.
- Pay an independent consultant to perform a holiday test on the entire interior surface prior to placing in service or signing off on repairs. Repair contractor to pay for repairs and retesting on test failure.

Additional Option 1 recommended actions:

- Replace panels with significant corrosion or pitting.
- Repair interior coating at roof beam / shell interface.
- Repair defects in interior coating at all lower locations including bolts, manway, ladder, float, pipe inlet, and all holidays.
- Replace subgrade where washed out under tank bottom panels.
- Install dielectric isolation on the float support structure (and ladder connections if keeping the aluminum ladder).
- Repair sealant as necessary, based on subsequent analysis.

Additional Option 2 recommended actions:

- Review and optimize sealant and hardware selections to minimize risk of corrosion and premature failure.
- Observe and verify manufacturer's tests for coating quality control.
- Maintain strict oversight, documentation, and quality control during reassembly, testing, sanitizing, and acceptance.

The next step necessary for either Option is to characterize the tank sealant condition. This work needs to be conducted by an independent consultant. The consultant should be vetted for preexisting relationships with the stakeholders. After the sealant conditions and characteristics are understood, a cost / benefit analysis can be conducted comparing the Options to remedy both the galvanic corrosion and the sealant in a single project.

Cost estimates and schedules for Options 1 and 2 are not provided due to the limited amount of data available to determine the scope of either project. It is not reasonable to render cost

opinions or timelines for the tank repair or replacement prior to making a more detailed quantification of parts that need to be repaired / replaced. The range of work required will be better defined by subsequent inspection and material analysis. The cost of repairs (Option 1) can then be weighed against the cost of tank replacement (Option 2).

Photos

Aluminum ladder with rust at connections and at seam on wall

Tank floor with black sediment

Transducer on floor, rust pits dispersed around and at foot of the ladder

Close up of a rust pit on floor

Close up of black sediment

Corrosion at connection of level gauge float support structure

Exterior of the tank

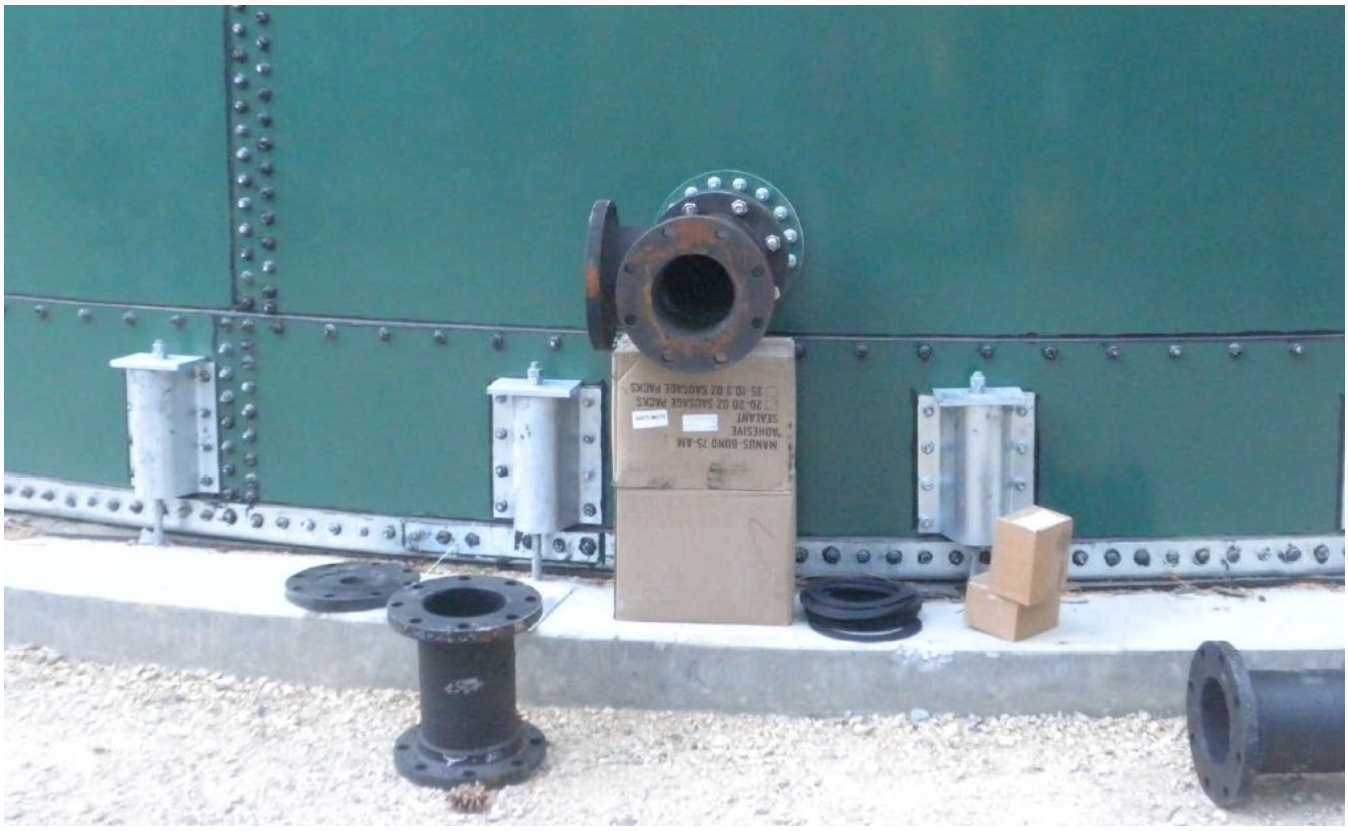

Photo provided by ACWD of sealant box during construction.

Close up of box.

Manus 75 Bond AM Product Data

HI-COMPRESSION TAPES
ADHESIVES • SEALANTS
SPECIAL INDUSTRIAL PAINTS
CUSTOM MECHANICAL EQUIPMENT

SALES • SERVICE ENGINEERING
CONSULTING ENGINEERING
NEW PRODUCT DESIGN

TECHNICAL DATA

MANUS-BOND 75-AM

INDUSTRIAL GRADE
HIGH PERFORMANCE POLYETHER ADHESIVE/SEALANT

1. PRODUCT DESCRIPTION:

Manus-Bond 75-AM Industrial Grade exhibits excellent adhesion to many substrates including aluminum, brass, steel, Kynar®, Galvalume®, painted surfaces, vinyl, glass, granite, marble, wood and many plastics. Cures fast, even at low temperatures. 75-AM Industrial Grade is highly weather resistant and can be painted with most paints. Manufactured from high grade polyether technology 75-AM contains no solvents or isocyanates and is non-yellowing. Conforms to ASTM C920, Type S, Grade NS, Class 50, Use T, NT, I, G and A. AAMA 802.3 Type II Back Bedding Compound. USDA accepted.

2. TECHNICAL DATA:

Tack Free Time	Less than an hour @ 77˚F/50% RH
Skin Time	Less than 30 minutes @ 77˚F/50% RH
Sag	Non-sagging
Tensile Strength	225 psi
Lap Shear (shear rate = 1”/min)	275 psi
Elongation	275%
High Temperature Resistance	Up to 300˚F for short periods
Low Temperature Flexibility	Properties retained to -75˚F
Hardness	45 - 50
UV Ratings	After 2000 hours UV-A no change in appearance or physical properties (ASTM G26)
Corrosive Properties	Non-corrosive
Staining	Non-staining

3. COLORS:

White, aluminum gray, black. Other colors available upon request.

4. PACKAGING:

10.1 fl. oz. cartridges, 10 & 20 fl. oz. sausage packs, 1, 5, & 55 gallon containers.

5. SURFACE PREPARATION:

Apply to clean, dry surfaces free of contaminants that can adversely affect adhesion.
Remove all old sealant before applying 75-AM. Some substrate materials may not be compatible with this product.
Testing substrate compatibility with this product before full application is recommended.

6. PAINTING:

Cured 75-AM may be painted with most industrial & consumer paints.
Testing prior to painting is recommended.

7. STORAGE LIFE:

For maximum shelf life, store unopened product at or below 80˚F.
12 months = cartridges and sausage packs
6 months = 1, 5 and 55 gallon containers

8. PRECAUTIONS:

Some applications may not be compatible with this product. Some cleaners, solvents may not be compatible with this product. Testing suitability for intended application before proceeding with full application is recommended. Use with adequate ventilation. Inhalation of vapor during application and cure may cause slight eye or throat irritation. In case of contact with eyes, lips, or mouth, flush thoroughly with water. If irritation persists, consult a physician. Avoid repeated, prolonged contact with skin. See MSDS for additional information. **Keep out of reach of children.**

9. TECHNICAL SERVICE:

Manus technical representatives are always available to provide assistance. Please contact our Technical Service Department with your questions or requests for specific applications.

10. LIMITED WARRANTY:

Any goods proved defective will be replaced or the purchase price refunded. The limited warranty described herein is in lieu of any other warranty, expressed or implied, including any implied warranty of merchantability or fitness for a particular use. The user shall determine suitability of the product for its intended use. Liability for any incidental or consequential damage or loss is excluded. The user assumes all risks of the product's use, handling and storage.

Distributed by

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NAPLES, FL • CHASKA, MN

Section 1 - PRODUCT AND COMPANY IDENTIFICATION

Material Name
MANUS-BOND 75-AM INDUSTRIAL GRADE
Product Use
Adhesives. Sealant.
Restrictions on Use
None known.
Details of the supplier of the safety data sheet
Manus Products, Inc.
866 Industrial Blvd. West
Waconia, MN 55387
Phone: (952) 442-3323
Emergency Phone #: (800) 424-9300

Section 2 - HAZARDS IDENTIFICATION

Classification in accordance with paragraph (d) of 29 CFR 1910.1200.
Acute Toxicity - Oral - Category 4
Serious Eye Damage/Eye Irritation - Category 2A
Carcinogenicity - Category 1A
Reproductive Toxicity - Category 1B
Specific Target Organ Toxicity - Single Exposure - Category 1 (central nervous system)
Specific Target Organ Toxicity - Repeated Exposure - Category 1 (respiratory system)
Specific Target Organ Toxicity - Repeated Exposure - Category 2 (bladder)
GHS Label Elements
Symbol(s)

Signal Word
Danger
Hazard Statement(s)
Harmful if swallowed.
Causes serious eye irritation.
May cause cancer.
May damage fertility or the unborn child.
Causes damage to organs.
Causes damage to organs through prolonged or repeated exposure.
May cause damage to organs through prolonged or repeated exposure.
Precautionary Statement(s)
Prevention
Obtain special instructions before use.
Do not handle until all safety precautions have been read and understood.
Wear eye protection/face protection.
Do not breathe dust/fume/gas/mist/vapors/spray.

Wash thoroughly after handling.
Do not eat, drink or smoke when using this product.

Response

If exposed: Call a POISON CENTER or doctor/physician.
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
If eye irritation persists: Get medical advice/attention.
IF SWALLOWED: Call a POISON CENTER/doctor if you feel unwell.
Rinse mouth.
Get medical advice/attention if you feel unwell.
Specific treatment (see label).

Storage

Store locked up.

Disposal

Dispose of contents/container in accordance with local/regional/national/international regulations.

Statement(s) of Unknown Acute Toxicity

Oral 71.91% of the mixture consists of ingredient(s) of unknown acute toxicity.

Section 3 - COMPOSITION / INFORMATION ON INGREDIENTS

CAS	Component Name	Percent
1317-65-3	Calcium carbonate	30-60
471-34-1	Carbonic acid, calcium salt (1:1)	15-40
13463-67-7	Titanium dioxide (White, Gray, Beige and Neutral only)	1-5
2768-02-7	Organosilane	1-5
818-08-6	Dibutyltin oxide	0.1-1
28553-12-0	Diisononyl phthalate	15-40
1333-86-4	Carbon black (*used in Black only)	0.05-<0.1

Section 4 - FIRST AID MEASURES

Inhalation

IF INHALED: If breathing is difficult, remove person to fresh air and keep at rest in a position comfortable for breathing Call a POISON CENTER or doctor/physician if you feel unwell.

Skin

IF ON SKIN Wash with plenty of soap and water If skin irritation or rash occurs: Get medical advice/attention Take off contaminated clothing and wash before reuse

Eyes

IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists: Get medical advice/attention

Ingestion

IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician Do NOT induce vomiting

Most Important Symptoms/Effects

Acute

Harmful if swallowed. Causes serious eye irritation.

Delayed

May cause cancer. May damage fertility or the unborn child. Causes damage to organs. Causes damage to organs through prolonged or repeated exposure. May cause damage to organs through prolonged or repeated exposure.

Section 5 - FIRE FIGHTING MEASURES

Extinguishing Media

Suitable Extinguishing Media

Use carbon dioxide, regular dry chemical, regular foam or water.

Unsuitable Extinguishing Media

Do not use high-pressure water streams.

Special Hazards Arising from the Chemical

Upon decomposition, this product emits carbon monoxide, carbon dioxide and/or low molecular weight hydrocarbons.

Hazardous Combustion Products

Upon decomposition, this product emits carbon monoxide, carbon dioxide and/or low molecular weight hydrocarbons.

Advice for firefighters

Heating may cause an explosion. Containers may rupture or explode.

Fire Fighting Measures

Keep away from sources of ignition - No smoking Move material from fire area if it can be done without risk Avoid inhalation of vapors or combustion by-products. Dike for later disposal. Stay upwind and keep out of low areas.

Special Protective Equipment and Precautions for Firefighters

A positive-pressure, self-contained breathing apparatus (SCBA) and full-body protective equipment are required for fire emergencies.

Section 6 - ACCIDENTAL RELEASE MEASURES

Personal Precautions, Protective Equipment and Emergency Procedures

Wear personal protective clothing and equipment, see Section 8.

Methods and Materials for Containment and Cleaning Up

Keep unnecessary people away, isolate hazard area and deny entry. In case of spillage, stop the flow of material and block any potential routes to water systems. Only personnel trained for the hazards of this material should perform clean up and disposal.

Environmental Precautions

Do not flush into sanitary sewer systems, drains or surface water. Avoid release to the environment.

Section 7 - HANDLING AND STORAGE

Precautions for Safe Handling

Do not handle until all safety precautions have been read and understood. Keep away from all ignition sources. Avoid contact with eyes and skin. Do not eat, drink or smoke when using this product. Always wear recommended personal protective equipment. Wear personal protective clothing and equipment, see Section 8. Take precautionary measures against static discharge.

Conditions for Safe Storage, Including any Incompatibilities

Store locked up.

Store in a cool dry place. Store in a well-ventilated area. Keep separated from incompatible substances. Keep container tightly closed. Empty containers may contain product residue. Store and handle in accordance with all current regulations and standards. Avoid contact with temperatures above 120 C.

Incompatible Materials

Strong oxidizer. strong acids.

Section 8 - EXPOSURE CONTROLS / PERSONAL PROTECTION

Component Exposure Limits

Calcium carbonate	**1317-65-3**
NIOSH:	10 mg/m3 TWA total dust ; 5 mg/m3 TWA respirable dust
OSHA (US):	15 mg/m3 TWA total dust ; 5 mg/m3 TWA respirable fraction
Mexico:	10 mg/m3 TWA VLE-PPT
	20 mg/m3 STEL [PPT-CT]
Carbonic acid, calcium salt (1:1)	**471-34-1**
NIOSH:	10 mg/m3 TWA total dust ; 5 mg/m3 TWA respirable dust
Titanium dioxide	**13463-67-7**
ACGIH:	10 mg/m3 TWA
NIOSH:	2.4 mg/m3 TWA (CIB 63) fine ; 0.3 mg/m3 TWA (CIB 63) ultrafine, including engineered nanoscale
	5000 mg/m3 IDLH
OSHA (US):	15 mg/m3 TWA total dust
Mexico:	10 mg/m3 TWA VLE-PPT as Ti
	20 mg/m3 STEL [PPT-CT] as Ti
Carbon black	**1333-86-4**
ACGIH:	3 mg/m3 TWA inhalable particulate matter
NIOSH:	3.5 mg/m3 TWA ; 0.1 mg/m3 TWA (Carbon black in presence of Polycyclic aromatic hydrocarbons) as PAH
	1750 mg/m3 IDLH
OSHA (US):	3.5 mg/m3 TWA
Mexico:	3.5 mg/m3 TWA VLE-PPT
	7 mg/m3 STEL [PPT-CT]

ACGIH - Threshold Limit Values - Biological Exposure Indices (BEI)
There are no biological limit values for any of this product's components.

Engineering Controls
Ventilation equipment should be explosion-resistant if explosive concentrations of material are present. Provide local exhaust or process enclosure ventilation system.

Individual Protection Measures, such as Personal Protective Equipment
Eye/face protection
Wear splash resistant safety goggles with a faceshield.
Respiratory Protection
Selection and use of respiratory protective equipment should be in accordance in the USA with OSHA General Industry Standard 29 CFR 1910.134; or in Canada with CSA Standard Z94.4.
Glove Recommendations
Wear appropriate chemical resistant gloves.
Protective Materials
Wear appropriate chemical resistant clothing.

Section 9 - PHYSICAL AND CHEMICAL PROPERTIES

Appearance	paste	**Physical State**	solid
Odor	mild	**Color**	black , white , gray
Odor Threshold	Not available	**pH**	Not available
Melting Point	Not available	**Boiling Point**	Not available
Boiling Point Range	Not available	**Freezing point**	Not available
Evaporation Rate	Not available	**Flammability (solid, gas)**	Not available
Autoignition Temperature	Not available	**Flash Point**	93.3 °C (>200 °F)
Lower Explosive Limit	Not available	**Decomposition temperature**	Not available
Upper Explosive Limit	Not available	**Vapor Pressure**	Not available
Vapor Density (air=1)	Not available	**Specific Gravity (water=1)**	1.3 - 1.7
Water Solubility	(Slightly soluble)	**Partition coefficient: n-octanol/water**	Not available
Viscosity	Not available	**Kinematic viscosity**	Not available
Solubility (Other)	Not available	**Density**	Not available
Physical Form	paste	**Molecular Weight**	Not available

Section 10 - STABILITY AND REACTIVITY

Reactivity
No reactivity hazard is expected.
Chemical Stability
Stable at normal temperatures and pressure.
Possibility of Hazardous Reactions
Will not polymerize.
Conditions to Avoid
Avoid heat, flames, sparks and other sources of ignition. Avoid contact with incompatible materials. Avoid contact with temperatures above 120 C.

Incompatible Materials
Strong acids. Strong oxidizer.
Hazardous decomposition products
Upon decomposition, this product emits carbon monoxide, carbon dioxide and/or low molecular weight hydrocarbons.

Section 11 - TOXICOLOGICAL INFORMATION

Information on Likely Routes of Exposure
Inhalation
May be harmful if inhaled.
Skin Contact
May cause skin irritation.
Eye Contact
Causes serious eye irritation.
Ingestion
Harmful if swallowed.
Acute and Chronic Toxicity
Component Analysis - LD50/LC50
The components of this material have been reviewed in various sources and the following selected endpoints are published:
Carbonic acid, calcium salt (1:1) (471-34-1)
Oral LD50 Rat 6450 mg/kg
Titanium dioxide (13463-67-7)
Oral LD50 Rat >10000 mg/kg
Organosilane (2768-02-7)
Oral LD50 Rat 7340 µL/kg
Dibutyltin oxide (818-08-6)
Oral LD50 Rat 44.9 mg/kg
Diisononyl phthalate (28553-12-0)
Oral LD50 Rat >9750 mg/kg
Inhalation LC50 Rat >4.4 mg/L 4 h (no deaths occurred)
Carbon black (1333-86-4)
Oral LD50 Rat >15400 mg/kg
Product Toxicity Data
Acute Toxicity Estimate

Oral	1261.241 mg/kg

Immediate Effects
Harmful if swallowed. Causes serious eye irritation.
Delayed Effects
May cause cancer. May damage fertility or the unborn child. Causes damage to organs. Causes damage to organs through prolonged or repeated exposure. May cause damage to organs through prolonged or repeated exposure.
Irritation/Corrosivity Data
Causes serious eye irritation.
Respiratory Sensitization
No information on significant adverse effects.
Dermal Sensitization
No information on significant adverse effects.
Component Carcinogenicity

Titanium dioxide	**13463-67-7**
ACGIH:	A4 - Not Classifiable as a Human Carcinogen
IARC:	Monograph 93 [2010] ; Monograph 47 [1989] (Group 2B (possibly carcinogenic to humans))
DFG:	Category 3A (could be carcinogenic for man ;inhalable fraction with the exception of ultra small particles)
OSHA:	Present
NIOSH:	potential occupational carcinogen
Carbon black	**1333-86-4**
ACGIH:	A3 - Confirmed Animal Carcinogen with Unknown Relevance to Humans
IARC:	Monograph 93 [2010] ; Monograph 65 [1996] (Group 2B (possibly carcinogenic to humans))
DFG:	Category 3B (could be carcinogenic for man ;inhalable fraction)
OSHA:	Present
NIOSH:	potential occupational carcinogen

Results of a DuPont epidemiology study showed that employees who had been exposed to titanium dioxide pigments were at no greater risk of developing lung cancer than were employees who had not been exposed to titanium dioxide pigments. No pulmonary fibrosis was found in any of the employees and no associations were observed between titanium dioxide pigment exposure and chronic respiratory disease or lung abnormalities. Based on the results of this study, DuPont concluded that titanium dioxide pigment will not cause lung cancer or chronic respiratory disease in humans at concentrations experienced in the workplace.

Germ Cell Mutagenicity
No information on significant adverse effects.

Tumorigenic Data
No information on significant adverse effects.

Reproductive Toxicity
May damage fertility or the unborn child.

Specific Target Organ Toxicity - Single Exposure
Central nervous system.

Specific Target Organ Toxicity - Repeated Exposure
Respiratory system. Bladder.

Aspiration hazard
No information on significant adverse effects.

Medical Conditions Aggravated by Exposure
No data available.

Section 12 - ECOLOGICAL INFORMATION

Ecotoxicity
May cause long lasting harmful effects to aquatic life.

Component Analysis - Aquatic Toxicity

Diisononyl phthalate	**28553-12-0**
Fish:	LC50 96 h Brachydanio rerio >100 mg/L [semi-static]; LC50 96 h Lepomis macrochirus >0.14 mg/L [flow-through]; LC50 96 h Lepomis macrochirus >0.17 mg/L [static]; LC50 96 h Pimephales promelas >0.19 mg/L [flow-through]; LC50 96 h Pimephales promelas >0.14 mg/L [static]
Algae:	EC50 72 h Desmodesmus subspicatus >500 mg/L IUCLID ; EC50 96 h Pseudokirchneriella subcapitata >1.8 mg/L [static] EPA
Invertebrate:	EC50 48 h Daphnia magna >500 mg/L IUCLID ; EC50 48 h Daphnia magna >0.06 mg/L [Static] EPA

Section 13 - DISPOSAL CONSIDERATIONS

Disposal Methods
Dispose in accordance with all applicable federal, state/regional and local laws and regulations.
Component Waste Numbers
The U.S. EPA has not published waste numbers for this product's components.

Section 14 - TRANSPORT INFORMATION

US DOT Information:
Further information: Not regulated as dangerous goods

IATA Information:
Further information: Not regulated as dangerous goods

ICAO Information:
Further information: Not regulated as dangerous goods

IMDG Information:
Further information: Not regulated as dangerous goods
International Bulk Chemical Code
This material contains one or more of the following chemicals required by the IBC Code to be identified as dangerous chemicals in bulk.

Titanium dioxide	**13463-67-7**
IBC Code:	Category Z (slurry)

Section 15 - REGULATORY INFORMATION

U.S. Federal Regulations
None of this product's components are listed under SARA Sections 302/304 (40 CFR 355 Appendix A), SARA Section 313 (40 CFR 372.65), CERCLA (40 CFR 302.4), TSCA 12(b), or require an OSHA process safety plan.
SARA Section 311/312 (40 CFR 370 Subparts B and C) reporting categories
Carcinogenicity; Acute toxicity; Reproductive Toxicity; Serious Eye Damage/Eye Irritation; Specific Target Organ Toxicity

U.S. State Regulations

The following components appear on one or more of the following state hazardous substances lists:

Component	CAS	CA	MA	MN	NJ	PA
Calcium carbonate	**1317-65-3**	No	Yes	Yes	Yes	Yes
Titanium dioxide	**13463-67-7**	No	Yes	Yes	Yes	Yes
Carbon black	**1333-86-4**	Yes	Yes	Yes	Yes	Yes

California Safe Drinking Water and Toxic Enforcement Act (Proposition 65)

WARNING

This product can expose you to chemicals including Titanium dioxide, Diisononyl phthalate, Carbon black , which are known to the State of California to cause cancer. For more information go to www.P65Warnings.ca.gov.

Titanium dioxide	**13463-67-7**
Carc:	carcinogen , 9/2/2011 (airborne, unbound particles of respirable size)
Diisononyl phthalate	**28553-12-0**
Carc:	carcinogen , 12/20/2013
Carbon black	**1333-86-4**
Carc:	carcinogen , 2/21/2003 (airborne, unbound particles of respirable size)

Canada Regulations

Canadian WHMIS Ingredient Disclosure List (IDL)

Components of this material have been checked against the Canadian WHMIS Ingredients Disclosure List. The List is composed of chemicals which must be identified on MSDSs if they are included in products which meet WHMIS criteria specified in the Controlled Products Regulations and are present above the threshold limits listed on the IDL

Dibutyltin oxide	**818-08-6**
	1 %
Carbon black	**1333-86-4**
	1 %

Component Analysis - Inventory

Calcium carbonate (1317-65-3)

US	CA	EU	AU	PH	JP - ENCS	JP - ISHL	KR KECI - Annex 1	KR KECI - Annex 2	KR - REACH CCA	CN	NZ	MX	TW	VN (Draft)

Yes	NSL	EIN	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes

Carbonic acid, calcium salt (1:1) (471-34-1)

US	CA	EU	AU	PH	JP - ENCS	JP - ISHL	KR KECI - Annex 1	KR KECI - Annex 2	KR - REACH CCA	CN	NZ	MX	TW	VN (Draft)
Yes	DSL	EIN	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes

Titanium dioxide (13463-67-7)

US	CA	EU	AU	PH	JP - ENCS	JP - ISHL	KR KECI - Annex 1	KR KECI - Annex 2	KR - REACH CCA	CN	NZ	MX	TW	VN (Draft)
Yes	DSL	EIN	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes

Organosilane (2768-02-7)

US	CA	EU	AU	PH	JP - ENCS	JP - ISHL	KR KECI - Annex 1	KR KECI - Annex 2	KR - REACH CCA	CN	NZ	MX	TW	VN (Draft)
Yes	DSL	EIN	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	No	Yes	Yes

Dibutyltin oxide (818-08-6)

US	CA	EU	AU	PH	JP - ENCS	JP - ISHL	KR KECI - Annex 1	KR KECI - Annex 2	KR - REACH CCA	CN	NZ	MX	TW	VN (Draft)
Yes	DSL	EIN	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	No	Yes	Yes

Diisononyl phthalate (28553-12-0)

US	CA	EU	AU	PH	JP - ENCS	JP - ISHL	KR KECI - Annex 1	KR KECI - Annex 2	KR - REACH CCA	CN	NZ	MX	TW	VN (Draft)
Yes	DSL	EIN	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes

Carbon black (1333-86-4)

US	CA	EU	AU	PH	JP - ENCS	JP - ISHL	KR KECI - Annex 1	KR KECI - Annex 2	KR - REACH CCA	CN	NZ	MX	TW	VN (Draft)
Yes	DSL	EIN	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes

Section 16 - OTHER INFORMATION

NFPA Ratings
Health: 2 Fire: 1 Reactivity: 0
Hazard Scale: 0 = Minimal 1 = Slight 2 = Moderate 3 = Serious 4 = Severe

Summary of Changes
Section 2 - HAZARDS IDENTIFICATION. Section 11 - TOXICOLOGICAL INFORMATION. Section 15 - REGULATORY INFORMATION. California Safe Drinking Water and Toxic Enforcement Act (Proposition 65).

Preparation Date
8/10/2018

Key / Legend
ACGIH - American Conference of Governmental Industrial Hygienists; ADR - European Road Transport; AU - Australia; BOD - Biochemical Oxygen Demand; C - Celsius; CA - Canada; CA/MA/MN/NJ/PA - California/Massachusetts/Minnesota/New Jersey/Pennsylvania*; CAS - Chemical Abstracts Service; CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act; CFR - Code of Federal Regulations (US); CLP - Classification, Labelling, and Packaging; CN - China; CPR - Controlled Products Regulations; DFG - Deutsche Forschungsgemeinschaft; DOT - Department of Transportation; DSD - Dangerous Substance Directive; DSL - Domestic Substances List; EC – European Commission; EEC - European Economic Community; EIN - European Inventory of (Existing Commercial Chemical Substances); EINECS - European Inventory of Existing Commercial Chemical Substances; ENCS - Japan Existing and New Chemical Substance Inventory; EPA - Environmental Protection Agency; EU - European Union; F - Fahrenheit; F - Background (for Venezuela Biological Exposure Indices); IARC - International Agency for Research on Cancer; IATA - International Air Transport Association; ICAO - International Civil Aviation Organization; IDL - Ingredient Disclosure List; IDLH - Immediately Dangerous to Life and Health; IMDG - International Maritime Dangerous Goods; ISHL - Japan Industrial Safety and Health Law; IUCLID - International Uniform Chemical Information Database; JP - Japan; Kow - Octanol/water partition coefficient; KR KECI Annex 1 - Korea Existing Chemicals Inventory (KECI) / Korea Existing Chemicals List (KECL); KR KECI Annex 2 - Korea Existing Chemicals Inventory (KECI) / Korea Existing Chemicals List (KECL) , KR - Korea; LD50/LC50 - Lethal Dose/ Lethal Concentration; LEL - Lower Explosive Limit; LLV - Level Limit Value; LOLI - List Of LIsts™ - ChemADVISOR's Regulatory Database; MAK - Maximum Concentration Value in the Workplace; MEL - Maximum Exposure Limits; MX – Mexico; Ne- Non-specific; NFPA - National Fire Protection Agency; NIOSH - National Institute for Occupational Safety and Health; NJTSR - New Jersey Trade Secret Registry; Nq - Non-quantitative; NSL – Non-Domestic Substance List (Canada); NTP - National Toxicology Program; NZ - New Zealand; OSHA - Occupational Safety and Health Administration; PEL- Permissible Exposure Limit; PH - Philippines; RCRA - Resource Conservation and Recovery Act; REACH- Registration, Evaluation, Authorisation, and restriction of Chemicals; RID - European Rail Transport; SARA - Superfund Amendments and Reauthorization Act; Sc - Semi-quantitative; STEL - Short-term Exposure Limit; TCCA – Korea Toxic Chemicals Control Act; TDG - Transportation of Dangerous Goods; TLV - Threshold Limit Value; TSCA - Toxic Substances Control Act; TW – Taiwan; TWA - Time Weighted Average; UEL - Upper Explosive Limit; UN/NA - United Nations /North American; US - United States; VLE - Exposure Limit Value (Mexico); VN (Draft) - Vietnam (Draft); WHMIS - Workplace Hazardous Materials Information System (Canada).

Other Information

Disclaimer:

Supplier gives no warranty whatsoever, including the warranties of merchantability or of fitness for a particular purpose. Any product purchased is sold on the assumption the purchaser shall determine the quality and suitability of the product. Supplier expressly disclaims any and all liability for incidental, consequential or any other damages arising out of the use or misuse of this product. No information provided shall be deemed to be a recommendation to use any product in conflict with any existing patent rights.

CSI Report and Sealant Analysis Results

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Providing Quality Technical Services to the Coating Industry

July 15, 2022 *Via E-mail:* nthomas@calruralwater.org

Nathan Thomas, PE
California Rural Water Association
1234 North Market Blvd.
Sacramento, CA 95834

Subject: Final Report (Addenda) – Coating Evaluation

Re: Alleghany Tank, Cal Rural Water Association

Dear Nathan:

In January of 2020, CSI prepared a report entitled *Warranty Inspection*, after a site visit by CSI's Mr. Tim Grady on 09JAN20. This site inspection found no determinative flaws or defects associated with the tank, but Mr. Grady was unable to enter the tank due to the three feet of standing water within it at that time. Since that 2020 inspection, CSI's Mr. Steve Metcalf has revisited the site (2022) and was able to make entry for the purpose of a more detailed examination of the interior surfaces. This report amends the prior with additional information about the interior surfaces, which were unknown due to access constraints in 2020.

Please find attached the Final Report for the inspection that was completed on the above referenced storage tank. Please let us know if you have any questions or if you have any further needs. I can be reached through e-mail at ttendler@CSIServices.biz or by cell at 818.216.1979.

Sincerely,

Todd C. Tendler

CSI Services, Inc.
Todd Tendler
Project Manager

P.O. Box 801357, Santa Clarita, CA 91380
877-274-2422

Final Report
Warranty Inspection
Alleghany Bolted Tank
California Rural Water Association

Prepared for:
Nathan Thomas, PE
California Rural Water Association
1234 North Market Blvd.
Sacramento, CA 95834

Prepared by:
CSI Services, Inc.

Todd Tendler
NACE Certified Inspector No.4581

July 15, 2022

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Appendix

- CSI Chart 1 – General Description of Conditions
- CSI Chart 2 – Rust Grade Criteria
- CSI Chart 3 – Corrosion Grade Criteria
- CSI Chart 4 – Coating Chalking Criteria
- CSI Chart 5 – Coating Adhesion Criteria
- CSI Chart 6 – Coating Blistering Criteria

Introduction

Under an agreement with California Rural Water Association, CSI Services, Inc. (CSI) conducted an inspection on the Alleghany bolted tank located within Alleghany, CA. The tank is a bolted potable water storage tank manufactured by CST with an identification number of 18-8547. This report documents the findings of the 2020 inspection and the 2022 inspection and includes recommendations for maintenance work, where applicable. In January 2020, the tank area had recently endured a snowstorm at the time of the inspection which had the effect of obscuring the roof surfaces from view. Additionally, the water within the tank could not be completely drained prior to the inspection, which limited the examination to the areas within immediate proximity to the shell manway. Since then, CSI has returned to the site to document the interior surfaces closeup.

CSI is a third-party independent consulting engineering firm that specializes in tank evaluations with specific expertise in protective coatings and linings. CSI provides many different services including failure analysis, expert witness, evaluations, in-process inspection, and testing. Mr. Todd Tendler of CSI was assigned to manage the project. Mr. Tendler is a NACE International Certified Coating Inspector (No. 4581) and has over 25 years of extensive experience evaluating tanks. The field-work was performed by Mr. Tim Grady, NACE International Certified Coating Inspector (No. 4688) on Thursday, January 9, 2020. The inspection was made to all accessible areas of the tanks after they had been partially drained. The second inspection, which focused on the interior surfaces, was performed by Mr. Steve Metcalf. This dry inspection revealed at least three through penetrations in the tank bottom.

Summary

The exterior paint system is in excellent condition. The adhesion of the paint system was determined to be excellent, and chalking was nonexistent, commensurate with a paint system that is three years old.

The interior lining overall is in good condition in the areas above the highest water level (HWL) and in fair condition below the HWL with the main defects being highly localized spot corrosion associated with the galvanic process. During the inspection it was noted that the tank ladder is not electrically isolated from the carbon steel, and this has led to accelerated corrosion including up to three through penetrations in the tank bottom.

Epoxies have a typical service life of 25 to 35 years, and after just one year of service, the lining has failed, leading to breaches in the tank bottom.

Background

The Alleghany tank is a bolted above ground storage tank with a diameter of 31 feet and a shell height of 29 feet with a nominal capacity of 145,853.00 gallons. The bolted tank is understood to have been constructed in 2019 and is a vertical structure with a flat bottom and a bridge supported roof (i.e. no columns, rafters, etc.). Access to the tank interior is afforded by a roof hatch with both interior and exterior aluminum ladder and two ground level shell manways. The bolted tank is of a cylindrical design comprised of six horizontal shell courses comprised of carbon steel and the internal tank surface is lined with a fusion bonded thin film epoxy. The exterior of the bolted tank appears to have a fusion bonded polyurethane paint system. No internal or external cathodic protection systems were identified on the structure.

Field Evaluation

The evaluation involved visual observations (both with and without magnification), non-destructive testing, and destructive testing. Photos were taken and are included in a Photo Summary. For survey purposes, the tank has been segmented into defined areas: primarily the interior and exterior surfaces. Furthermore, the interior of the tank has been segmented into roof, shell and tank bottom. A rating system has been developed to quantify the condition of the various tank areas. Each of the rating criteria is found in the Appendix (Charts 1 through 6).

The condition of the paint systems was rated as being poor, fair, good, or excellent (Chart 1). The extent of any rust defects identified within each of the areas were generally determined using the guidelines set forth in ASTM D610 “Standard Test Method for Evaluating the Degree of Rusting of Painted Steel Surfaces” (Chart 2). Where applicable, the characteristic or stage of corrosion was determined according to CSI Corrosion Grade criteria (Chart 3). The degree of chalking was determined in accordance with ASTM D4214 “Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films,” Test Method D659, Method C (Chart 4). Coating adhesion was assessed in accordance with ASTM D3359 “Standard Test Method for Evaluating Adhesion by Tape Test, modified Method A and ASTM D6677 “Standard Test Method for Evaluating Adhesion by Knife” (Chart 5). Any blistering that may have been present was rated in accordance with ASTM D714 “Standard Test Method for Evaluating the Degree of Blistering in Paints” (Chart 6). Dry film thickness (DFT) measurements were obtained using a Positector 6000 Type II gage in accordance with ASTM D7091 "Standard Test Method for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals" and the applicable requirements of SSPC-PA2 "Procedure for Determining Conformance to Dry Coating Thickness Requirements".

Close-up visual observation of the exterior paint system was made to all accessible roof and shell surfaces. The exterior paint system is in excellent condition with minimal chalking (ASTM D4214, No. 8) and negligible spot rust (CSI Grade 1) in areas. The paint adhesion was estimated to be satisfactory (modified, ASTM D6677). The film thickness on the exterior surfaces ranged from between 6.3 and 11.4 mils. The only notable rust was located on the edges of appurtenances and the exterior edge of the shell manway. Significant corrosion in the form of advanced metal loss was observed with this item.

The lining on the roof, which includes the roof support structure is in good condition with no discernible corrosion. The lining on the interior shell and floor is in overall good condition with minimal corrosion or coating defects observed. Rust is showing on the inlet pipe and the drain pipe, shell manway, and on numerous bolts connecting the floor plate to the starter ring at the shell chime. Rust colored material was also present on the internal surfaces of the shell, weeping from isolated shell plate connection bolts. The DFT on the interior was found to range between 6.3 and 8.9 mils.

Discussion

The paint system on the exterior was found to be relatively thin and in excellent condition on the roof, shell, and tank accessories.

Overall, the internal linings in the tank were found to be in good condition yet there are at least three through penetrations at the tank bottom which are a result of galvanic corrosion. The inspection of the interior lining in 2020 was limited to the surfaces as viewed from the manway due to the tank still bearing up to three feet of water upon arrival. At that time, the only internal item of note was some small rust nodules developing around the galvanized bolts, mainly at the tank chime, but also at isolated areas within the tank shell. It was suspected that the stand-alone bolted connection points are corroding due to the damage sustained during pneumatic bolt tightening and the chipping of the coating resulting in the electrolytic connection between carbon steel and galvanized steel substrates (galvanic corrosion). The resulting connection between the exposed carbon steel bolt hole and the galvanized bolt results in aggressive corrosion due to dissimilar metals. The internal ladder, however, is a more destructive force as it is a combination of (more noble) stainless steel and aluminum mated directly to the carbon steel without isolation. During the inspection of 2022, a simple check of conductivity was performed with a multi-meter and found that the ladder structure is indeed a part of the electric circuit and therefore is not isolated. These conditions must be remedied prior to returning the tank to service.

There are also areas of mechanical damage that were not adequately repaired prior to the tank going into service initially. These areas are focused at edges of accessories and what appears to be impact damage at the tank bottom related to the initial erection.

Rust is a result of ferrous metal essentially converting itself back to its original state, iron ore. It takes a tremendous amount of energy to convert an ore into a usable metal. These metals then try to naturally release this energy through the development of rust. Corrosion is a more generic term for a condition that has resulted in a substrate that has reacted with its environment. With respect to the stages of the rust or corrosion of steel, the process initiates itself as light-colored orange surface rust. As the corrosion process continues, the rust becomes darker in color until it eventually results in advancing forms of metal loss. Metal loss can take the form of pitting, which is a localized corrosion cell that results in cavities or holes developing in the metal.

Isolated corrosion pits can develop within a coating system that may have only a few small breaks that were not corrected through periodic maintenance repairs. If the remaining, adjacent coating has excellent adhesion, it will inhibit undercutting corrosion. As a result, the corrosion forces will have a tendency to concentrate on the exposed bare metal, which results in pitting. Pitting can be critical in some instances. The maximum corrosion rate for steel in fresh water is typically no more than 30 mils per year (MPY). As a result, the pitting can develop into a perforation if not repaired. If a thru-hole develops within a tank bottom, the isolated issue can develop into a much larger corrosion problem. Corrosion requires oxygen to advance, and the underside of the tank bottoms are considered a dead-air space. As a result, the bottom of tank floors are typically not coated. A perforation or thru-hole with even a small trickle of water will reintroduce oxygen into the environment creating active corrosion that is difficult to identify until the steel floor plate requires replacement.

Pinpoint rusting can develop from a coating film thickness being too thin to provide a proper barrier or from pinholes/holidays in the film. If the coating was applied to thin or has thinned from degradation, the peaks of the substrates profile extend through the film and rust. Rusting pinholes are commonly isolated to localized spots of a coating system that did not receive proper coverage and are most commonly located at irregular surfaces.

Recommended Work

The following activities are recommended for remedial work:

1. At exterior surfaces, spot repair the paint system at locations of mechanical damage.

2. At interior surfaces, a thorough examination of the relationships of dissimilar metals is encouraged. Electrically isolate stainless steel, aluminum and zinc from the carbon steel. As part of the lining repair work, include a plan to make some localized grinding and weld repairs to the more severely corroded areas.

3. Place the tank on a 5-year maintenance inspection cycle as recommended by AWWA while continuing to make underwater repairs to rust spots with an NSF epoxy.

Photo Summary

Photo 1 – Exterior (Jan 2020) – Overview of the Allegheny Bolted Tank

Photo 2 – Exterior (Jan 2020) – View of the six shell courses.

Photo 3 – Exterior (Jan 2020) – View of the lower shell courses and anchorage to the concrete foundation.

Photo 4 – Exterior (Jan 2020) – Tank manufacturer's nameplate.

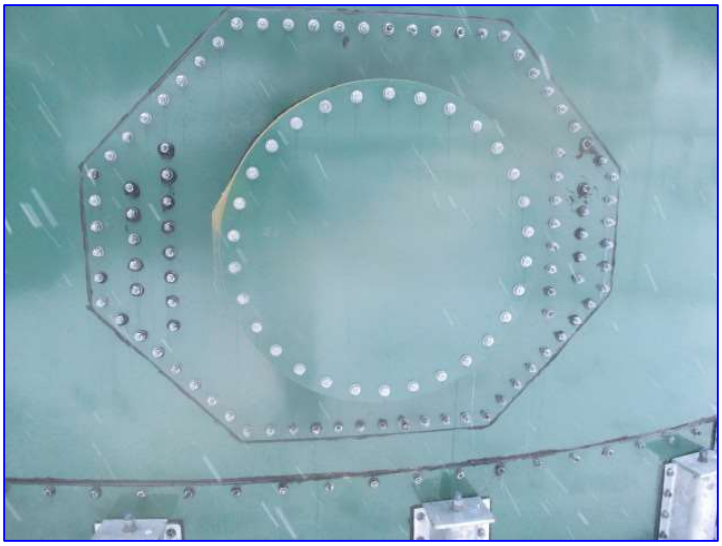


Photo 5 – Exterior (Jan 2020) – View of the tank shell manway (1 of 2)

Photo 6 – Exterior (Jan 2020) – Roof surfaces were covered with snow at the time of the inspection.

Photo 7 – Exterior (Jan 2020) – View of perimeter roof vent.

Photo 8 – Exterior (Jan 2020) – View of the aluminum center vent.

Photo 9 – Exterior (Jan 2020) – View of the roof center vent.

Photo 10 – Exterior (Jan 2020) – View of tank accessories.

Photo 11 – Interior (Jan 2020) – Shell manway exhibits spot rust at flange mating surfaces.

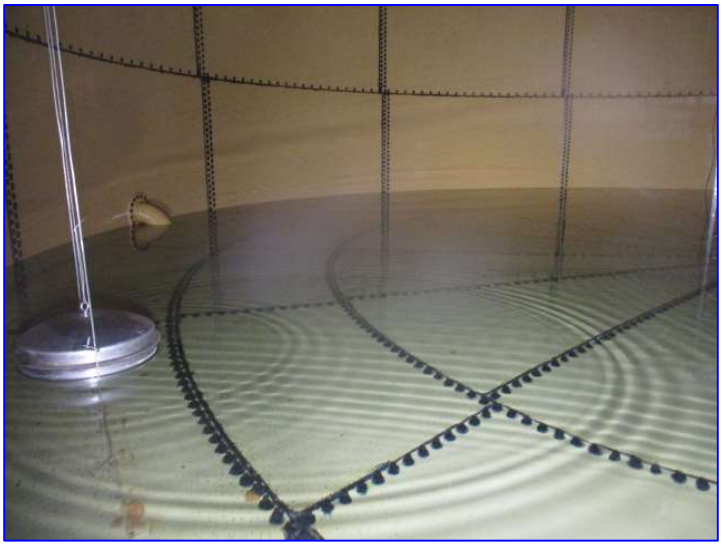


Photo 12 – Interior (Jan 2020) – A the time of the inspection, the tank was partially drained which prohibited entry, yet in this view the shell, floor, and water level mechanism appear in good condition.

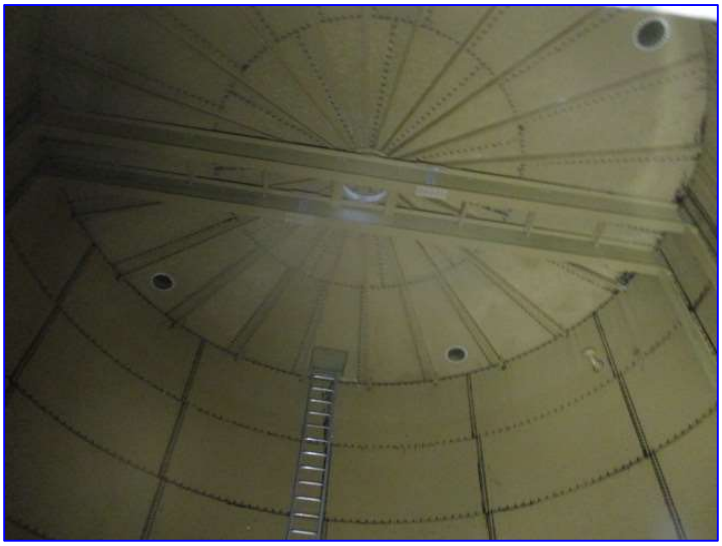


Photo 13 – Interior (Jan 2020) – Overview of the bridge supported roof structure.

Photo 14 – Interior (Jan 2020) – Overview of the interior shell

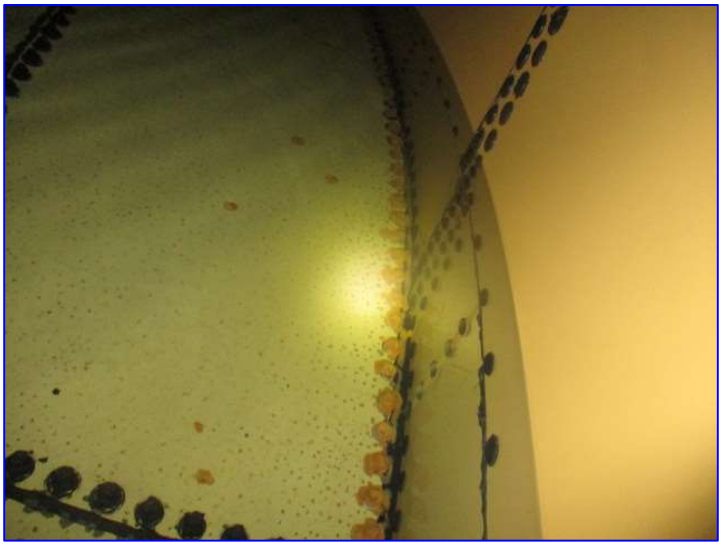


Photo 15 – Interior (Jan 2020) - View of the tank chime where rust nodules have developed around galvanized bolts.

Photo 16 – Interior (Jan 2020) – View of isolated shell bolts where rust has developed.

Photo 17 – Interior (Jan 2020) – View of rust nodules at the shell manway.

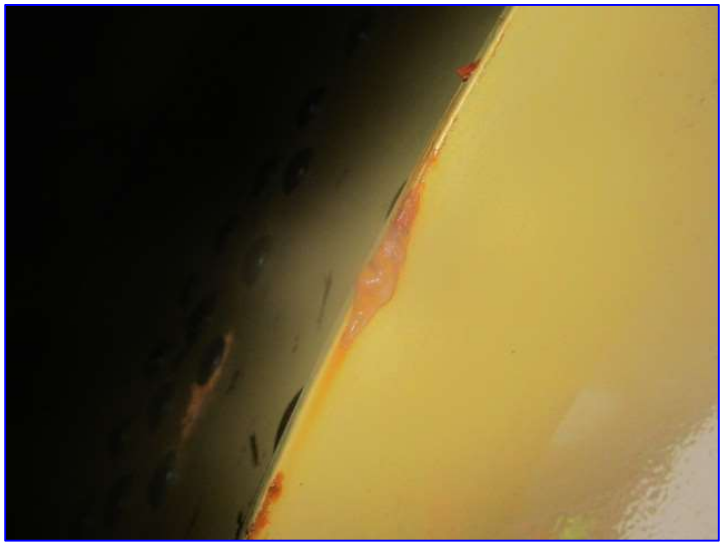


Photo 18 – Interior (Jan 2020) – View of spot rusting at the edges of the shell manway.

Photo 19 – Interior (Jan 2020) – View of the tank chime where bolts connecting the floor plate to the shell starter ring have developed rust nodules due to the galvanic corrosion between the bolt and the chipped coating at the bolt hole.

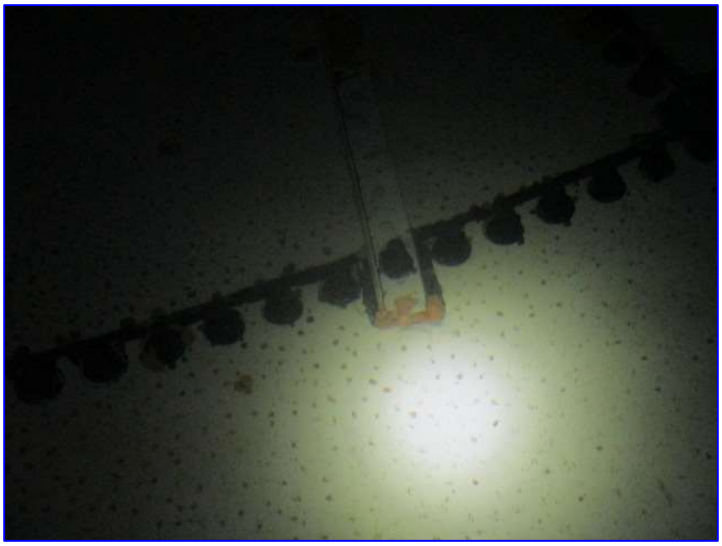


Photo 20 – Interior (Jan 2020) – View of rust forming at the edge of the bolt channel.

Photo 21 – Interior (June 2022) – View of the interior bridge supported roof structure.

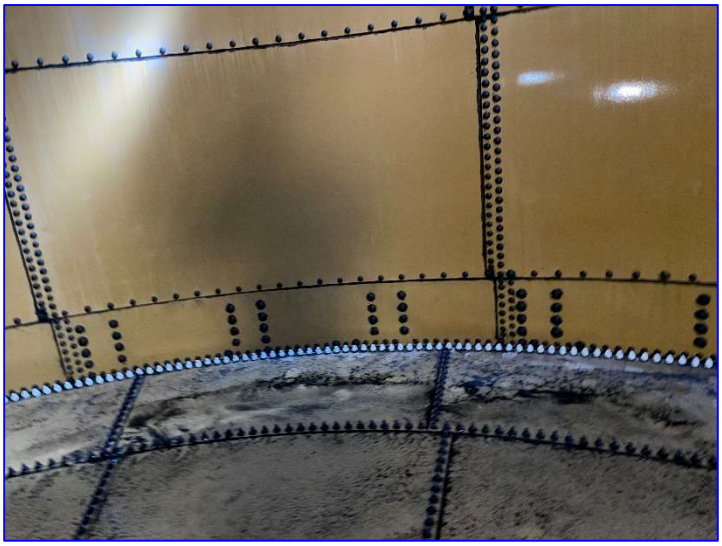


Photo 22 – Interior (June 2022) – Overview of the shell and tank bottom.

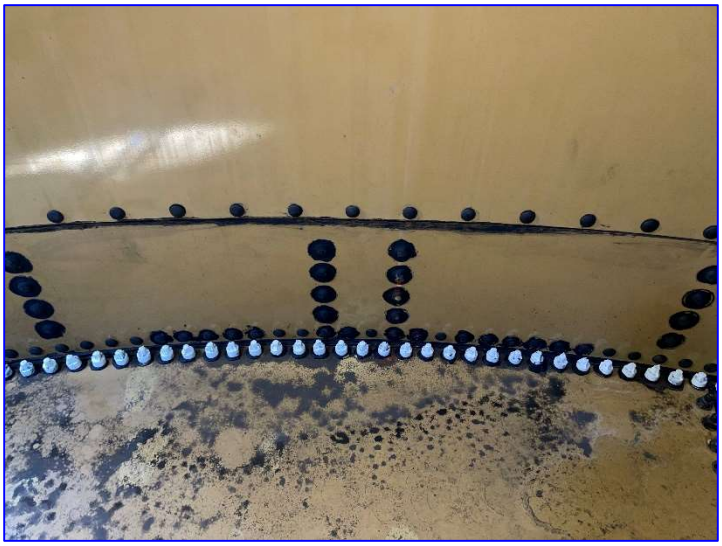


Photo 23 – Interior (June 2022) – View of the shell and tank bottom.

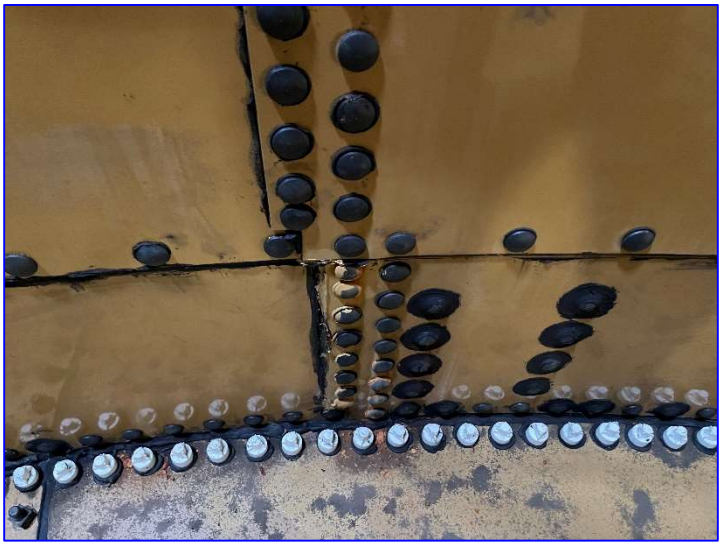


Photo 24 – Interior (June 2022) – View of rust forming at the edges of some capped bolts.

Photo 25 – Interior (June 2022) – Overview of the shell and tank bottom.

Photo 26 – Interior (June 2022) – View of a caulked plate seam where rust has formed.

Photo 27 – Interior (June 2022) – View of a lining repair that appears to have failed.

Photo 28 – Interior (June 2022) – View of a plate lap segment of the shell where sealant appears to be performing properly.

Photo 29– Interior (June 2022) – View of minor staining at the edge of a shell plate lap.

Photo 30 – Interior (June 2022) – View of rust forming at the edges of some capped bolts.

Photo 31 – Interior (June 2022) – View of rust forming at the edges of some capped bolts.

Photo 32 – Interior (June 2022) – View of rust forming at the edges of some capped bolts.

Photo 33– Interior (June 2022) – View of the ladder where stainless steel fasteners mate aluminum to carbon steel and the resulting galvanic corrosion.

Photo 34 – Interior (June 2022) – View of the ladder where stainless steel fasteners mate aluminum to carbon steel and the resulting galvanic corrosion.

Photo 35 – Interior (June 2022) – View of rust forming at the edges of the ladder stand-offs.

Photo 36 – Interior (June 2022) – View of rust weeping from faying surfaces at the ladder.

Photo 37 – Interior (June 2022) – View of residue wiped from the surfaces of the sealant.

Photo 38 – Interior (June 2022) – View of a through penetration of the tank bottom.

Photo 39 – Interior (June 2022) – View of a site at the tank bottom where a rust nodule has been removed leaving behind deep pitting in the carbon steel.

Photo 40– Interior (June 2022) – View of areas of spot rust at the tank bottom, likely caused by mechanical damage.

Photo 41 – Interior (June 2022) – View of the sealant used at the tank bottom plate laps.

Photo 42– Interior (June 2022) – View of the tank bottom at the center of the tank.

Photo 43 – Interior (June 2022) – View of rust forming at bolt holes of a tank accessory.

Photo 44 – Interior (June 2022) – View of rust staining from metallic debris.

Photo 45 – Interior (June 2022) – View of rust forming at sharp edges of the manway.

Photo 46 – Interior (June 2022) – View of rust forming at an area of incomplete sealant application

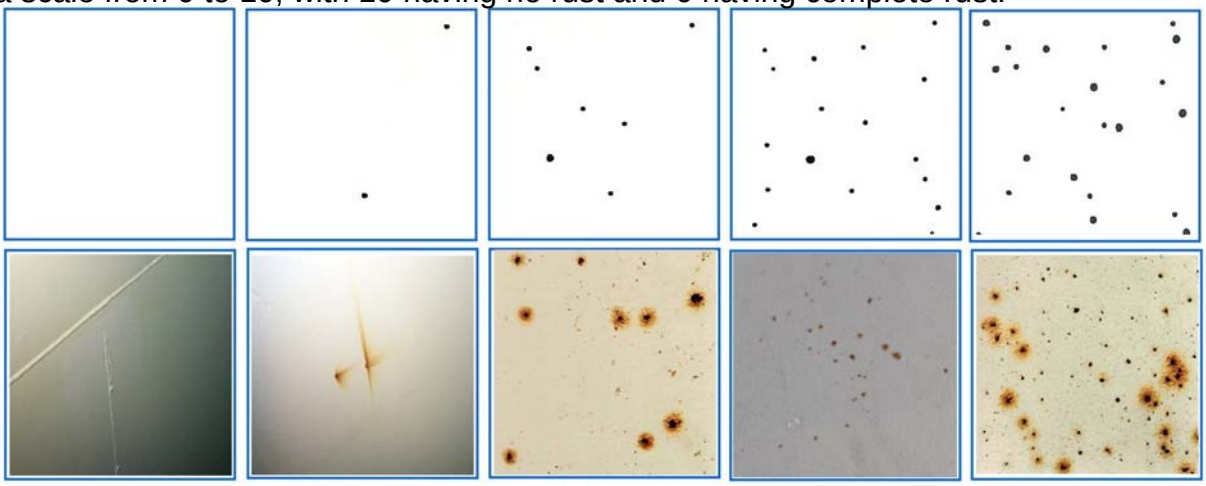
Photo 47 – Interior (June 2022) – View of rust forming at the edges of some capped bolts, accessory flange and piping.

Photo 48 – Interior (June 2022) – View of rust forming at the edges of some capped bolts.

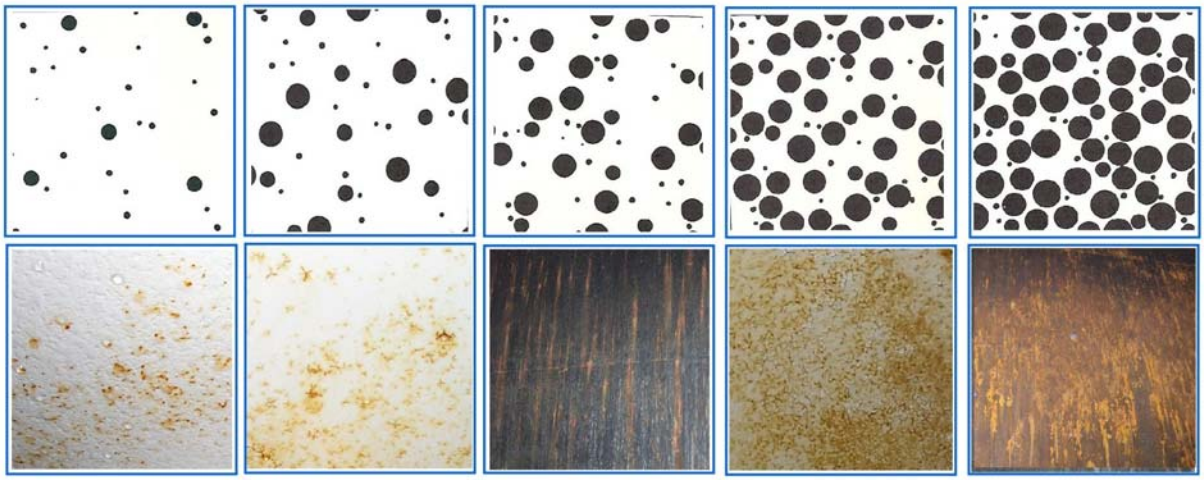
Chart 1 - Condition Rating The table below gives a basic description of the four different categories that CSI Services, Inc. uses to provide a general depiction of the condition of each defined area of a structure. The categories are Poor, Fair, Good, or Excellent. The development of these categories is based on historical knowledge and experience of various paint and lining systems over given periods of time in certain service environments. Basically, the rating is determined based on what should be expected of the paint or lining system at that point in its life cycle. As a result, different determinations are made for maintenance inspection versus warranty inspections. A detailed description of each rating with relative consideration addressed follows:

Rating	General Description of Conditions	
	Maintenance Inspection	**Warranty Inspection**
Poor	This condition is usually prioritized for rework in the short-term. Typically, these surfaces have considerably more coating defects and/or corrosion than what is expected for the age of the system.	This condition identifies an area with wholesale coating defects or corrosion concerns that will typically require significant removal and replacement of the coatings in the area.
Fair	Typically, these surfaces have a level of coating defects and/or corrosion that is slightly worse than what should be expected for the age of the system. This condition is placed on a short-term monitoring schedule.	This condition identifies an area with partial coating defects or corrosion concerns that will require significant rework.
Good	This condition is rated for areas without any considerable coating defects or corrosion. These surfaces are in a condition that is typical for the age of the coating system.	This condition identifies areas with coating defects or corrosion that is typically seen in one-year warranty inspections. Typically, only minor spot repairs are required.
Excellent	This condition is for areas without any considerable coating defects or corrosion. Typically, these surfaces are in a condition that is better than expected for the age of the system.	This condition identified areas that typically are in perfect condition and require no repair work.

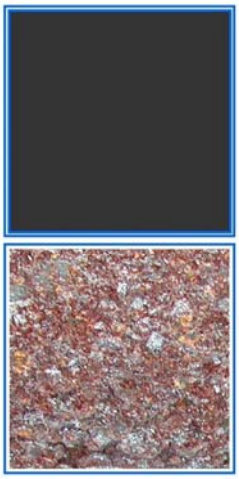
Chart 2 -Rust Grade The black and white figures below depict the standards referenced in ASTM D610 “Standard Test Method for Evaluating Degree of Rusting on Painted Surfaces.” Below each standard is a photographic depiction of each level of corrosion, as used by CSI Services, Inc. The standards depict the percentage of rust on a scale from 0 to 10, with 10 having no rust and 0 having complete rust.



Rust Grade 10 Rust Grade 9 Rust Grade 8 Rust Grade 7 Rust Grade 6



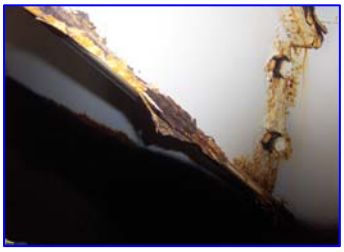
Rust Grade 5 Rust Grade 4 Rust Grade 3 Rust Grade 2 Rust Grade 1



Rust Grade 0

Rust Grade	Description
10	No rusting or less than 0.01% of surface rusted
9	Minute rusting, less than 0.03% of surface rusted
8	Few isolated rust spots, less than 0.1% of surface rusted
7	Less than 0.3% of surface rusted
6	Excessive rust spots, but less than1% of surface rusted
5	Rusting to the extent of 3% of surface rusted
4	Rusting to the extent of 10% of surface rusted
3	Approximately one-sixth of the surface rusted
2	Approximately one-third of the surface rusted
1	Approximately one-half of the surface rusted
0	Approximately 100% of the surface rusted

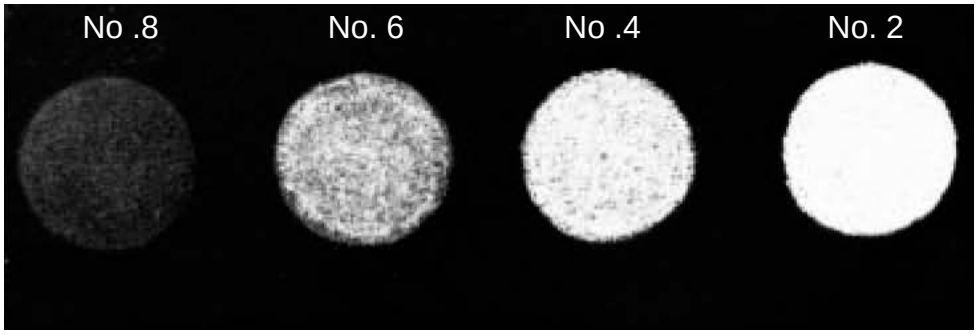
Chart 3 - Corrosion Grade The figure below depicts the photographic standards referenced by CSI Services, Inc. in the determination of the characteristics and stages of corrosion progression. This standard is used to better quantify the level of corrosion once it has progressed to Rust Grades 3, 2, 1, or 0 (see Chart 2). When applicable, CSI classifies an area as one or more of the five different Corrosion Grades. Corrosion Grades 1 through 5 are described below:

Grade	Description	Photo Examples
1	Light Rust - This condition involves relatively light colored rust that does not have any significant metal loss.	 
2	Dark Rust -This condition involves relatively dark colored, thicker rust that is progressing towards the next phase, significant metal loss.	 
3	Pitting - This condition involves isolated or widespread deep spot corrosion (pitting).	
4	Scale - Also known as lamellar or exfoliation corrosion. The edges of the affected area are leaf like and resemble the separated pages of a wetted book.	 
5	Structural Loss - This condition involves metal loss or failure where components will require structural consideration	 

The photos depicted are examples and were not taken on this project.

Chart 4 - Chalking The figure below depicts the photographic standards referenced in ASTM D4214 “Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films,” Method D659, Method C. Generally speaking, chalking is the degradation of a paint’s binder leaving behind loose pigments as the binder reacts with the environment, primarily ultraviolet light and oxygen. Evaluating chalking is a means to measure the performance of a coating system and its life cycle projection. It is also important to quantify for consideration of future overcoating options. This test uses these pictorial standards to quantify the amount of chalking present on paint films. The depictions below represent the mount of colored chalk removed onto a cloth during the test. The scale ranges from 2 to 8 with the rating 2 having the most chalk.

Light Colored Paints



Dark Colored Paints

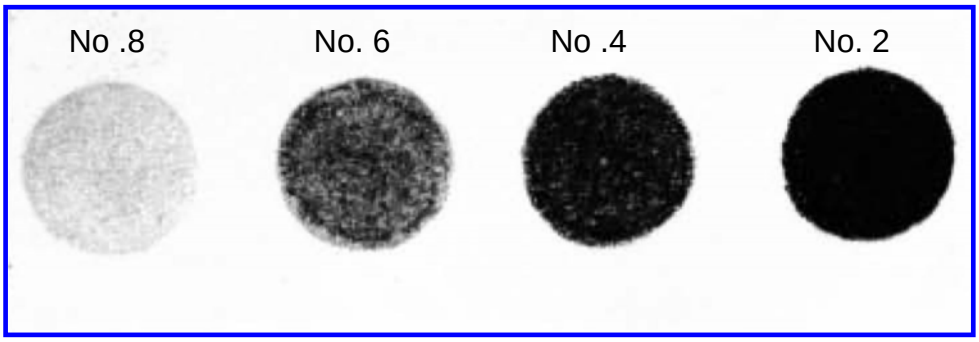
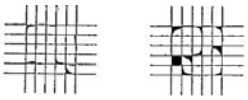
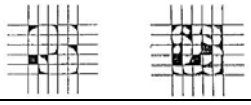
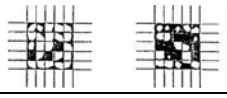
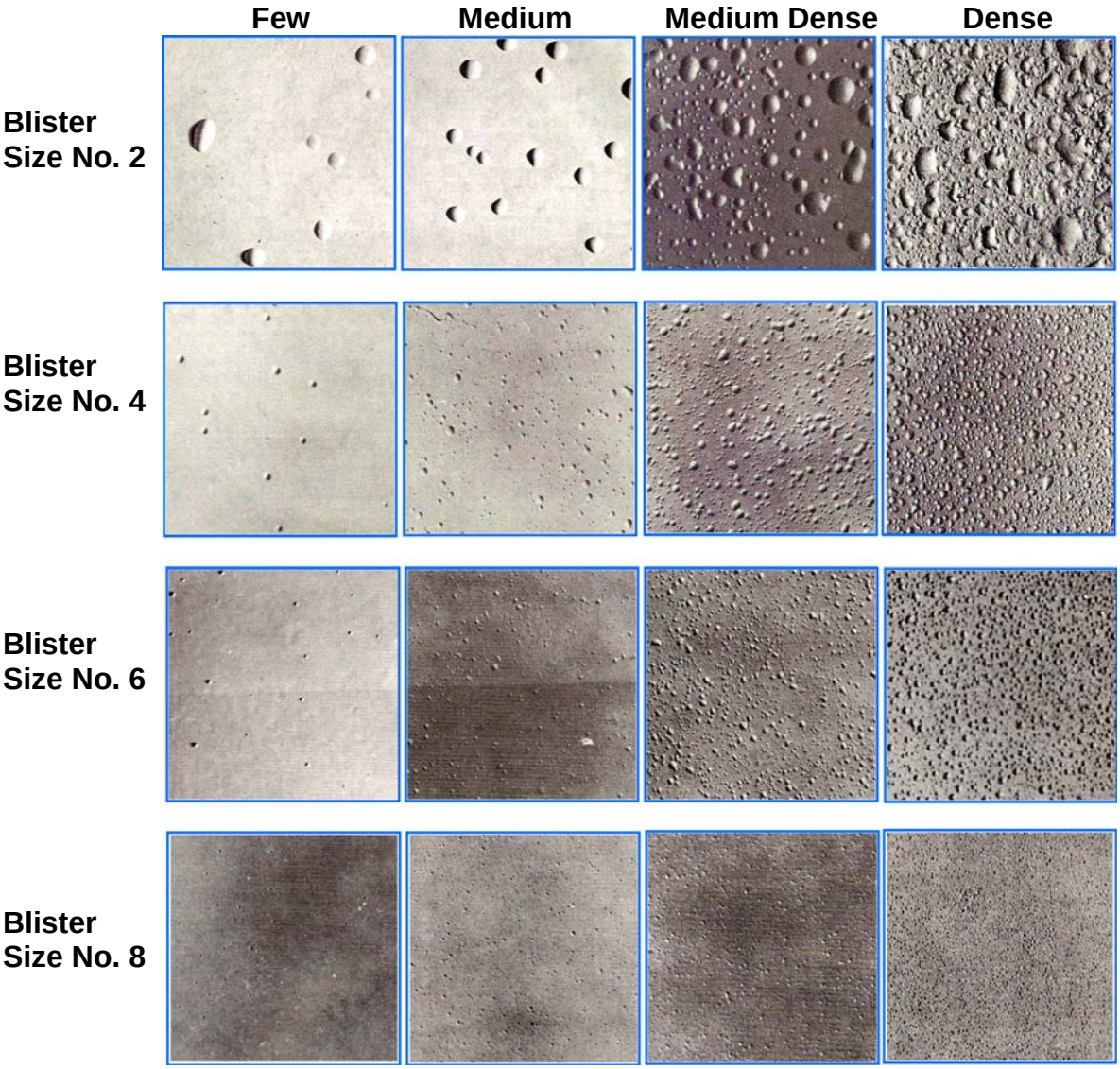


Chart 5 - Adhesion Rating The figures below depict the photographic standards and criteria referenced in ASTM D3359 "Standard Test Method for Evaluating Adhesion by Tape Test" and ASTM D6677 "Standard Test Method for Evaluating Adhesion by Knife." Both Standards are used to assess the condition of a paint system for life-cycle projections. It is also used to evaluate an existing paint system's ability to withstand the added stress that any overcoating strategies can create. Depending upon the thickness of the paint system, ASTM D3359 has two different test methods. The rating criteria for both standards follow:

ASTM D3359					
Method A			Method B		
Rating	**Observation**	**Surface of X-cut from which flaking/peeling has occurred**	**Rating**	**Percent Area Removed**	**Surface of cross-cut area from which flaking has occurred for six parallel cuts and adhesion range by percent**
5A	No peeling or removal	None	5B	0% none	
4A	Trace peeling or removal along incisions or their intersection		4B	Less than 5%	
3A	Jagged Removal along incisions up to 1/16" on either side		3B	5 – 15%	
2A	Jagged removal along most of incisions up to 1/8" on either side		2B	15 – 35%	
1A	Removal from most of the area of the X under the tape		1B	35-65%	
0A	Removal beyond the area of the X		0B	Greater than 65%	

ASTM D6677	
Rating	Description
10	Fragments no larger than $\frac{1}{32}$" x $\frac{1}{32}$" can be removed with difficulty
8	Chips up to $\frac{1}{8}$" x $\frac{1}{8}$" can be removed with difficulty
6	Chips up to $\frac{1}{4}$" x $\frac{1}{4}$" can be removed with slight difficulty
4	Chips larger than $\frac{1}{4}$" x $\frac{1}{4}$" can be removed with slight pressure
2	Once coating removal is initiated by knife, it can be peeled at least $\frac{1}{4}$"
0	Coating can be peeled easily to length greater than $\frac{1}{4}$"

Chart 6 – Blistering Rating The figure below depicts the photographic standards referenced in ASTM D714 “Standard Test Method for Evaluating Degree of Blistering of Paints”. This test uses these pictorial standards to quantify both the size and density of blisters that may develop in linings. Although the standard uses a blister size scale of 0 to 10 this chart uses the most common sizes of blisters found in the field. The standard does not use a reference for the size of each of the blisters depicted. CSI used this scale as a means for further quantification by qualifying the largest blister depicted as being 1 inch in width (Blister Size No. 2) and the smallest blister being 1/32 of an inch in width (Blister Size No. 8).



Testing Report

Project ID: L091202
Report Date: 9/20/2022
Client: CSI Services, Inc.
Client Contact: Randy Gordon

Scope of Work:
Nine samples that were removed from various locations of a tank were received for analysis. Per client request, four of the samples labeled as internal ring samples were compared to the sample labeled "Foundation Ring Exterior" to see if different sealing products were used on the inside versus the outside of the tank.

Samples:

Sample IDs	Date Received	Description
AD25886	9/12/22	Foundation Ring, Ring #1, Inside
AD25887	9/12/22	Ring #2 (Not Tested)
AD25888	9/12/22	Ring #3
AD25889	9/12/22	Ring #4 (Not Tested)
AD25890	9/12/22	Ring #5
AD25891	9/12/22	Ring #6 (Not Tested)
AD25892	9/12/22	Ring #7
AD25893	9/12/22	Foundation Ring, Exterior
AD25894	9/12/22	Tank Bottom Outer Sheet (Not Tested)

Test Method:
Infrared Spectroscopy was performed using a Perkin Elmer Frontier Fourier Transform Infrared Spectrometer equipped with an Attenuated Total Reflectance (ATR) attachment. Spectra were collected at a resolution of 4 cm^{-1} and are the accumulation of 16 scans.

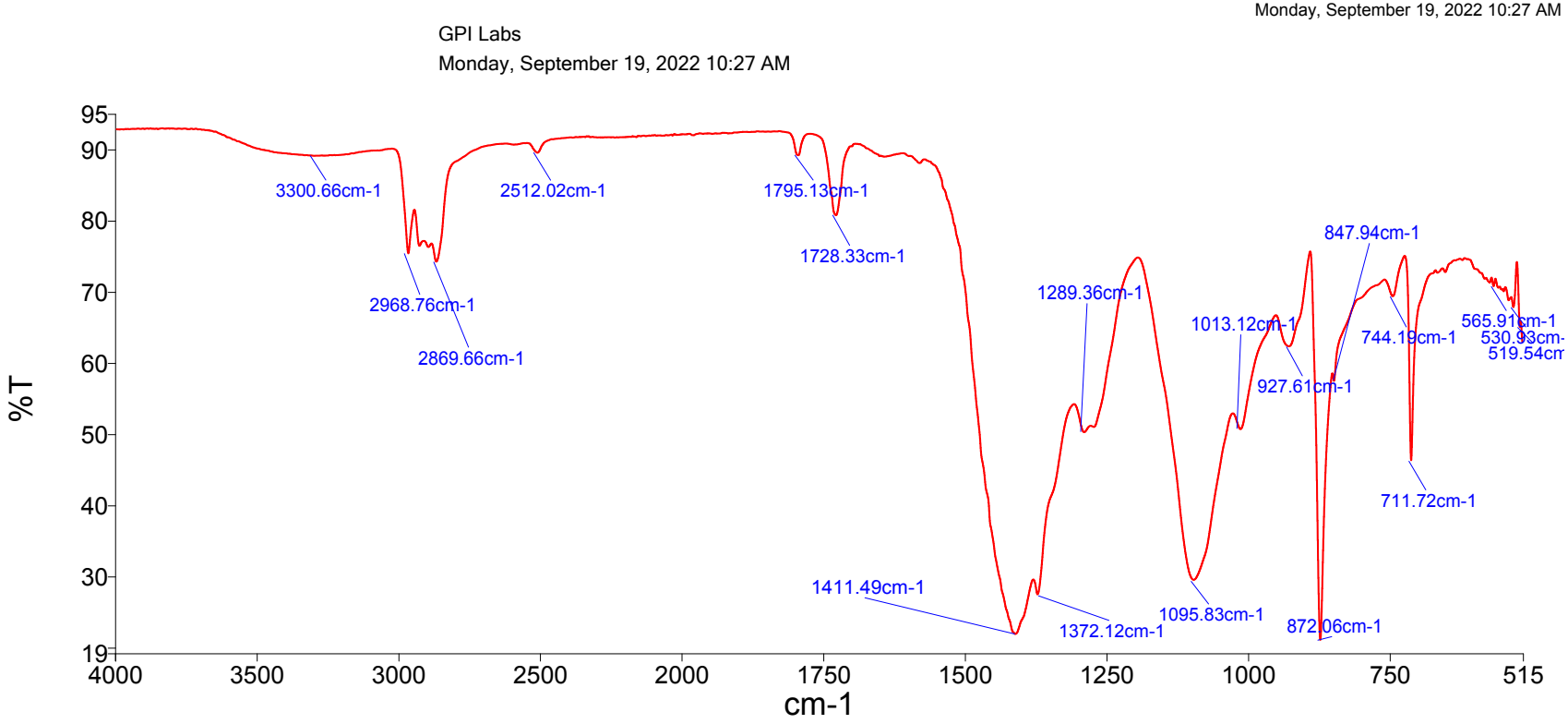
FTIR Results:
The spectra which were obtained are included in Appendix A of this report. Briefly, the analysis revealed that all five samples that were analyzed displayed spectra that were consistent with each other. The lack of definition in the spectrum on AD25890 may indicate a higher degree of degradation compared to the other sample. All the samples analyzed are consistent with urethanes, with a cluster of characteristic peaks centered near 2900 cm^{-1}, and further peaks near 1730, 1100, 870, and 710 cm^{-1}.

Reviewed by:

GPI Laboratories, Inc. 4403 Donker Court S.E., Grand Rapids, MI 49512 Tel: (616) 940-3112

Appendix A: FTIR Spectra

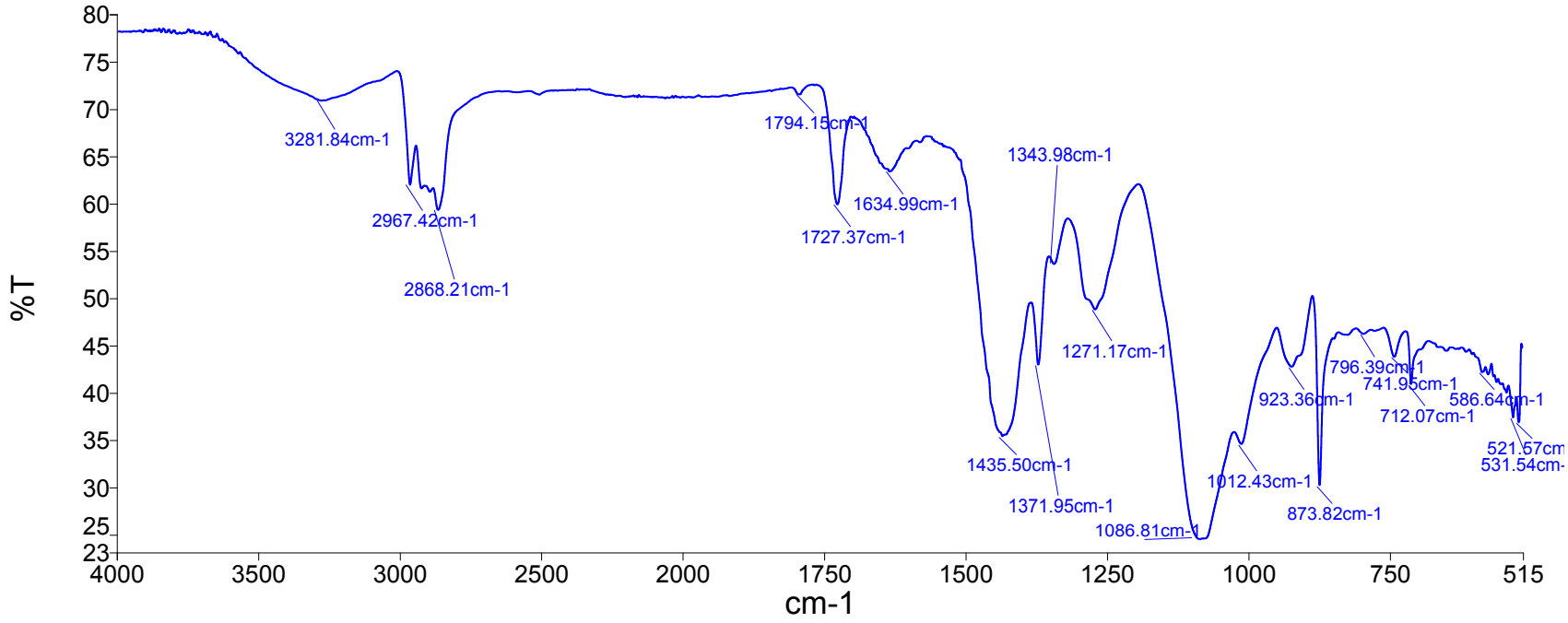
PerkinElmer Spectrum Version 10.03.09
Monday, September 19, 2022 10:27 AM



Sample Name	Description	Method	Project ID	Analyst
AD25886	Foundation Ring, Ring #1 (Inside)	ATR	L091202	JRB

PerkinElmer Spectrum Version 10.03.09
Monday, September 19, 2022 10:28 AM

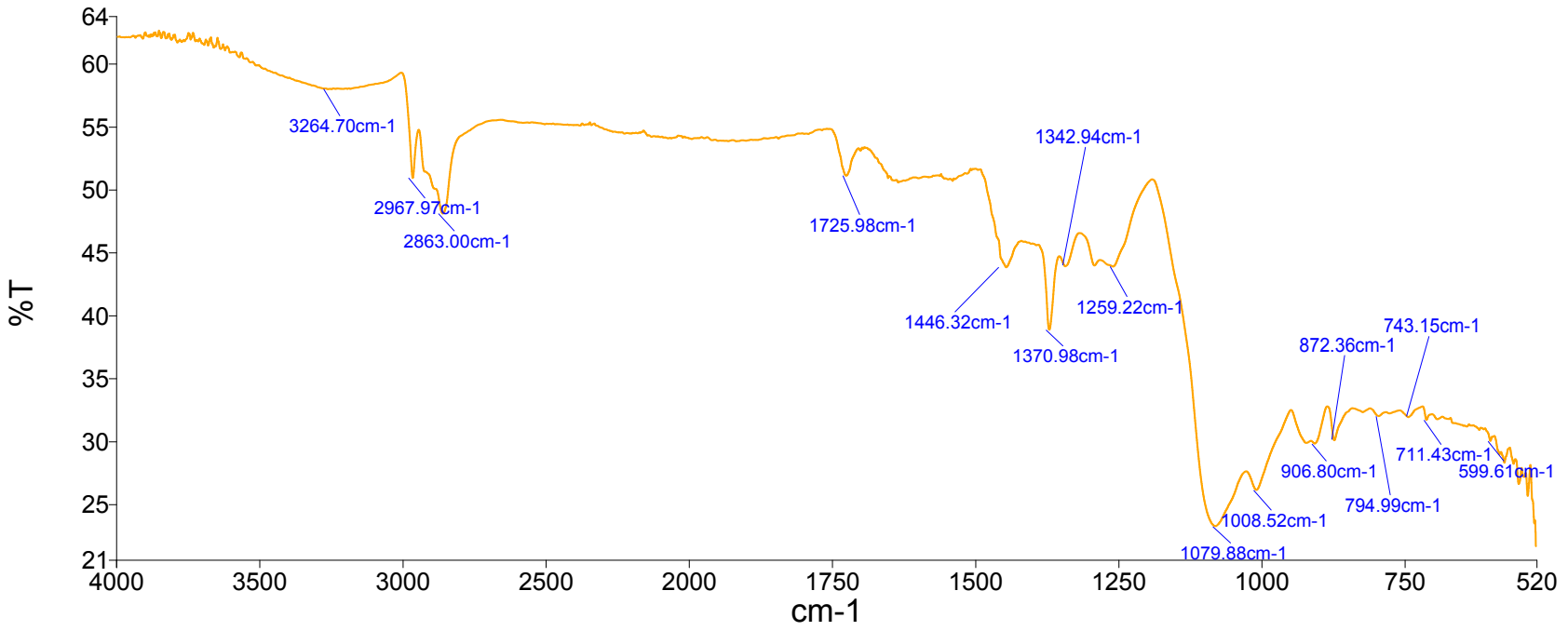
GPI Labs
Monday, September 19, 2022 10:28 AM



Sample Name	Description	Method	Project ID	Analyst
AD25888	Ring #3	ATR	L091202	JRB

PerkinElmer Spectrum Version 10.03.09
Monday, September 19, 2022 10:39 AM

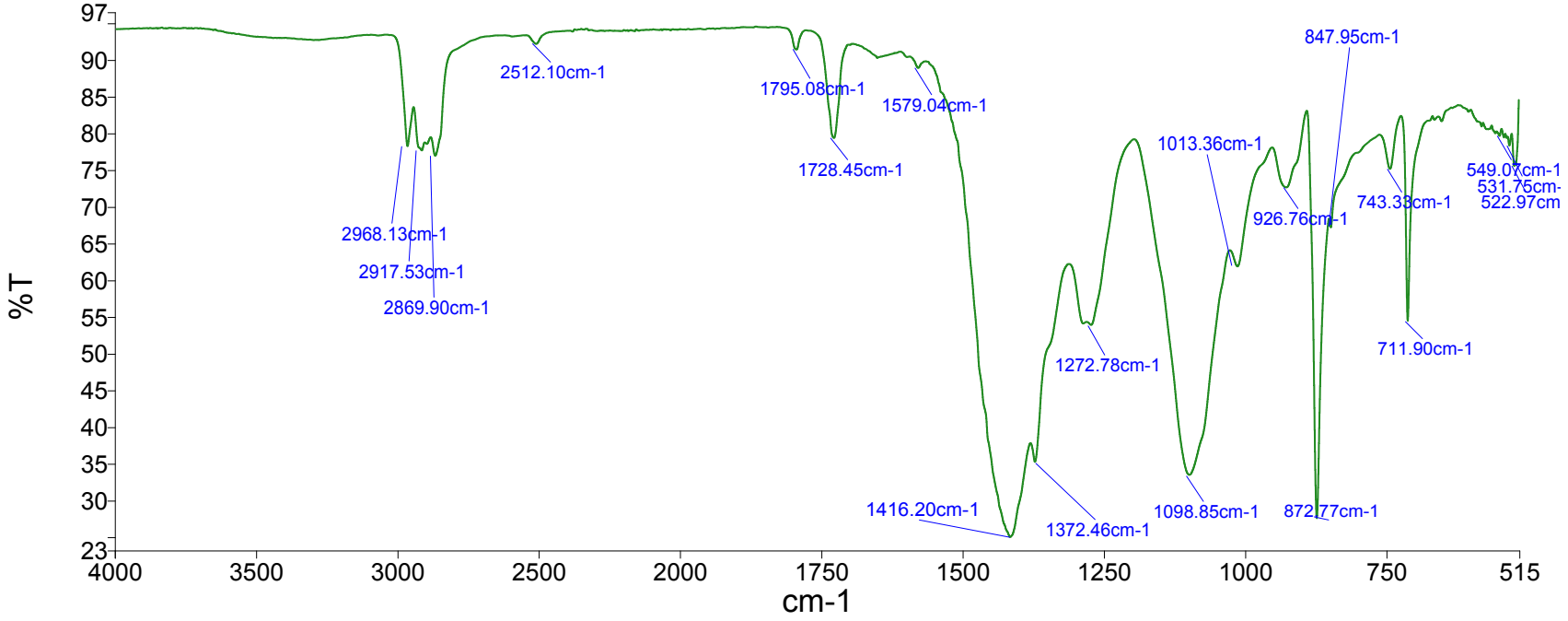
GPI Labs
Monday, September 19, 2022 10:39 AM



Sample Name	Description	Method	Project ID	Analyst
AD25890-2	Ring #5	ATR	L091202	JRB

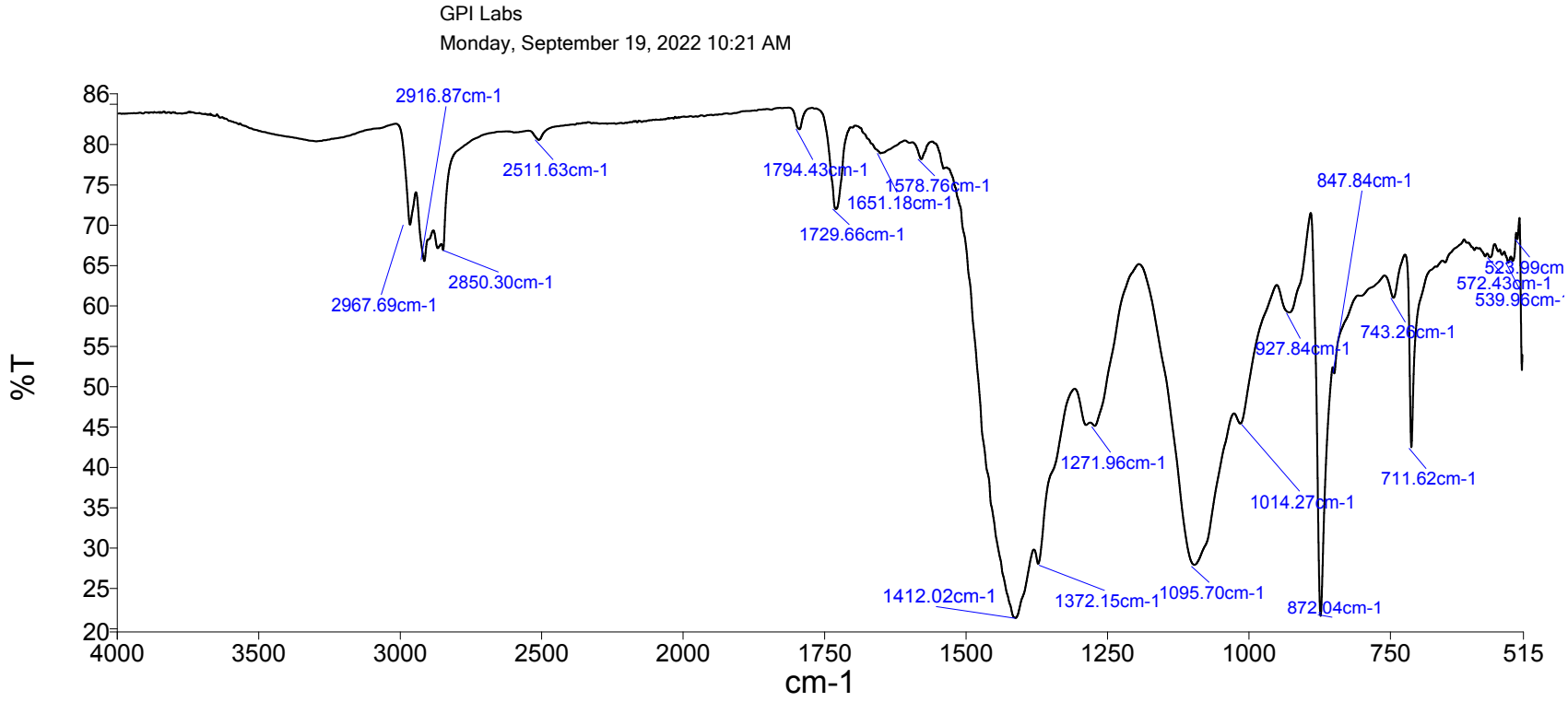
PerkinElmer Spectrum Version 10.03.09
Monday, September 19, 2022 10:35 AM

GPI Labs
Monday, September 19, 2022 10:35 AM



Sample Name	Description	Method	Project ID	Analyst
AD25892	Ring #7 Above Liquid Zone	ATR	L091202	JRB

PerkinElmer Spectrum Version 10.03.09
Monday, September 19, 2022 10:21 AM



Sample Name	Description	Method	Project ID	Analyst
AD25893	Foundation Ring Exterior	ATR	L091202	JRB