Barnstable, Massachusetts

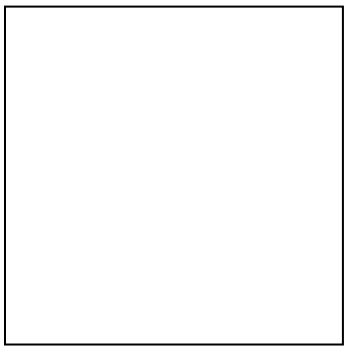
Hyannis Water System

Inspection, assessment and recommendations of the Mary Dunn 1 Water Storage Tank

June 2008

Weston&Sampson
ENGINEERS, INC.

Report



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ASSESSMENT OF THE MARY DUNN NO. 1 WATER STORAGE TANK FOR THE HYANNIS WATER SYSYTEM

Introduction

The need for this assessment arises from the events, which occurred On Saturday November 10, 2007. On this day, the Hyannis Water System issued a boil-order for all their customers. Repeat coliform samples taken at the Mary Dunn 1 Water Storage Tank had come back confirmed with E-coli. By chlorinating the water storage tank and the entire distribution system together with daily consecutive coliform sampling the Department of Environmental Protection lifted the order on Monday November 12, 2007. The bacteria detections were contained to the tank and were never detected in the distribution system.

The need for the issuance of the boil order was based on the fact that the Hyannis Water System has only two water storage tanks, one of them was off line for repair, and the Hyannis Fire Department requirements regarding fire fighting capacity combined with pump control and SCADA issues meant that the Mary Dunn 1 Water Storage Tank could not be isolated.

At this point the large water storage tank, Mary Dunn 2, is repaired and back in service. The small water storage tank, Mary Dunn 1 was taken off line in December 2007, emptied, cleaned and field inspected.

This report consists of a thorough inspection and assessment of all tank components, a repair and capital improvement plan for the tank and a water storage tank management plan for the Hyannis Water System.

PART I

Weston & Sampson Assessment and Recommendations

Introduction

This section of the report includes information on the rules, regulations and guidance documents that water professionals should follow with respect to water storage structures. The assessment of the Mary Dunn 1 and to some extent the Mary Dunn 2 water storage tanks includes an evaluation of existing conditions and whether the tanks and operations meet these rules and regulations.

The assessment includes the site, the tank itself, the operations of the water system related to the tank, and other related issues. At the end of this section are recommended improvements and estimates of probable costs to complete improvements necessary to

return the tank to service immediately and to maintain the tank in service for one, three, five and ten year periods.

Rules and Regulations

The regulations governing storage tanks are primarily from the Massachusetts Department of Environmental Protection. Additional guidance is provided by the American Water Works Association. The pertinent information from these sources can be found below.

The *2001 Massachusetts Department of Environmental Protection Guidelines and Policies for Public Water Systems, Chapter 8, Finished Water Storage* has been edited to include the issues applicable to the Hyannis water system's steel standpipe type finished water storage structures:

Protection

All finished water storage structures shall have suitable watertight roofs that exclude birds, animals, insects, and excessive dust.

Protection from Trespassers

Fencing, locks on access manholes, and other necessary precautions shall be provided to prevent trespassing, vandalism, and sabotage.

Drains

No drains on a water storage structure may have a direct connection to a sewer or storm drain. Drainage shall be directed to an area where flooding and erosion will not occur.

Overflow

All water storage structures shall be provided with an overflow that is brought down to an elevation between 12 and 24 inches above the ground surface, and discharges over a drainage inlet structure or a splash plate. No overflow may be connected directly to a sewer or storm drain. All overflow pipes shall be located so that any discharge is visible.

1. The overflow of a ground-level structure shall open downward and be screened with 24-mesh noncorrodible screen installed within the pipe at a location least susceptible to damage by vandalism.
2. The overflow pipe shall be of sufficient diameter to permit waste in excess of the filling rate.

Access

Finished water storage structures shall be designed with a reasonably convenient access to the interior for cleaning and maintenance. Manholes above the waterline:

1. Shall be framed at least 4 inches, and preferably 6 inches, above the surface of the roof at the opening.
2. Shall be fitted with a solid watertight cover which overlaps the framed opening and extends down around the frame at least 2 inches.
3. Should be hinged at one side.
4. Shall have a locking device.

Valve Pit

A valve pit with necessary valves, gauges, and sampling tap to collect a representative sample shall be installed. A corporation stop between tank and valve to allow the injection of chlorine shall be installed.

Vents

Finished water storage structures shall be vented. Overflows shall not be considered as vents. Open construction between the sidewall and roof is not permissible. Vents:

1. Shall prevent the entrance of surface water and rainwater.
2. Shall exclude birds and animals.
3. Should exclude insects and dust, as much as this function can be made compatible with effective venting, for elevated tanks and standpipes, four-mesh non-corrodible screens may be used.

Roof and Sidewall

The roof and sidewalls of all structures must be watertight with no openings except properly constructed vents, manholes, overflows, risers, drains, pump mountings, control ports, or piping for inflow and outflow.

1. Any pipes running through the roof or sidewall of a finished water storage structure must be welded, or properly gasketted in metal tanks.
2. Valves and controls should be located outside the storage structure so that the valve stems and similar projections will not pass through the roof or top of the reservoir.

Roof Drainage

The roof of the storage structure shall be well drained. Downspout pipes shall not enter or pass through the reservoir. Parapets, or similar construction which would tend to hold water and snow on the roof, will not be approved unless adequate waterproofing and drainage are provided.

Safety

The safety of employees must be considered in the design of the storage structure. As a minimum, such matters shall conform to pertinent laws and regulations of the area where the reservoir is constructed.

1. Ladders, ladder guards, balcony railings, and safety located entrance hatches shall be provided where applicable.
2. Elevated tanks with riser pipes over 8 inches in diameter shall have protective bars over the riser openings inside the tank.

Freezing

All finished water storage structures and their appurtenances, especially the riser pipes, overflows, and vents, shall be designed to prevent freezing that will interfere with proper functioning.

Silt Stop

The discharge pipes from all reservoirs shall be located in a manner that will prevent the flow of sediment into the distribution system. Removable silt stops should be provided where feasible.

Grading

The area surrounding a ground-level structure shall be graded in a manner that will prevent surface water from standing within 50 feet of the structure.

Painting

Proper protection shall be given to metal surfaces using paints or other protective coatings.

1. Paint systems shall meet appropriate AWWA specification. After proper curing, the coating shall not transfer any substances to the water that will be toxic or cause tastes or odors. The tank shall be flushed, disinfected, filled with water, and sampled for coliform and volatile organic compounds prior to going back into service.

Disinfection

Finished water storage structures shall be disinfected after construction, repair, or maintenance operations in accordance with current AWWA Standards. Representative samples shall indicate microbiologically satisfactory water before the facility is placed in operation.

Maintenance

The exterior and interior of tank should be cleaned and inspected annually by qualified personnel. A thorough structural and coating inspection should be conducted every 5 years.

The following section of the *AWWA D101-53 (R86), Standard for Inspecting and Repairing Steel Water Tanks, Standpipes, Reservoirs, and Elevated Tanks for Water Storage*, has been edited to cover standards for Routine Operation and Maintenance for the Hyannis water storage tanks.

Tanks need to be operated properly and maintained and inspected on a regular basis to maintain their structural and sanitary integrity. Routine operation and maintenance performed by water system operators represents a crucial component to the professional tank inspections. Routine tank operation typically consists of the daily monitoring of the automated systems designed to level out supply and demand. Tanks fill when supply exceeds demand and empty into the system when demand exceeds supply, typically maintaining water pressure between 35 and 100 psi. However, many other factors must be taken into account in the day-to-day operation of a water distribution system. Another important aspect of tank operation is the prevention of freezing problems in tanks.

Energy Management

A significant amount of energy can be saved by proper management of the distribution system, including storage. Since pumps are generally more efficient when they pump against lower head levels, it is more efficient to allow tank levels to fluctuate rather than to always keep the tanks full. A water utility can also achieve significant savings by using the most efficient pumps first and by replacing worn parts that may decrease the pump efficiency. Variable-rate pumps should be used at the highest possible speed, at which their efficiencies are usually greatest.

Another consideration involves minimizing energy cost savings by avoiding peak rate charges. If the storage capacity is sufficient, the pumping times can be modified to take advantage of off-peak energy charges.

Controls

The controls used in automated distribution systems require periodic inspection and maintenance to ensure trouble-free operation. Without regular inspection of the controls, potential breakdowns would not be discovered and more emergency repairs would be required.

Condition Assessment

The current condition of the Mary Dunn No. 1 Tank is good overall. There are several deficiencies, which require immediate attention in order to ensure the continued integrity and safety of the tank. These deficiencies and recommended improvements are presented in sections below.

Access/Site

The site where the two water storage tanks are located is a relatively remote area. Access to the tanks is gained from Mary Dunn Road via a long dirt road, which is generally in good condition, however the position of the access road limits entrance of larger vehicles and equipment from one direction only. In addition, adjacent tree cover may cause minor obstruction to large vehicles. It is recommended that periodic maintenance and trimming of vegetation be performed. The site is surrounded by a heavy tree line along the entire tank perimeter. The tree line should be maintained at a minimum distance of 6-8 feet outside the perimeter fence. However a larger cut back distance of 15 feet or more to the tree line would allow for more sun to reach the tanks resulting in less mildew growth and paint failure.

Both tanks are contained within a eight-foot high chain link fence perimeter security fence. There is at least 9.5-feet between the perimeter fence and the Mary Dunn No. 1 Tank and a larger distance between the two tanks. These areas provide sufficient room for both containment equipment and moderate to large blasting equipment and painting equipment. There is an additional large staging area outside the perimeter security fence, which will provide ample room for large equipment and vehicles. A double wide access locked chain link fence gate provides entry into the secured site, which is relatively level and covered with a uniform layer of gravel. There are two heavy traffic roadways within approximately 200-feet of the tank site, but no homes or other structures are located nearby. There is both electric and water available on site.

The control valves for both tanks are located in the area between the tanks. The valve boxes are raised several inches above the ground. It is recommended that markers be placed in the ground near each valve box. An identifier, (tank fill, tank drain, etc.), can be placed on the markers. This action can facilitate valve location at night and during snow events.

There is cell phone utility equipment located adjacent to the Mary Dunn No. 2 Tank foundation. It is recommended that is equipment be relocated before tank maintenance,

such as painting, is scheduled to occur. An effort should be made to permanently relocate the cellular phone company equipment to outside the perimeter fence at least 30 feet from the tanks.

The ladder terminates approximately 25-feet above ground level. This height is within the OSHA regulations. This height makes it difficult for an unauthorized person to access the ladder from the ground. A fall prevention system consisting of a flexible cable attached to a fall arrest anchor is installed on the access ladder. This provides additional protection in addition to the ladder cage. The ladder also has a lockable protective cover so that the ladder can only be accessed with a key. The protective cover ensures that the ladder cannot be accessed by simply transporting another ladder to the site.

Operations Assessment

Current Operations

The tanks are currently operated by Whitewater, Inc., under contract with the town of Barnstable. The tank levels are controlled by the groundwater well pumps and treatment plant pumps. The allowable maximum water level is 97.9 feet. During the winter months, the tanks are typically allowed to drop 3- feet before selected well pumps are turned on to fill the tanks. The maximum allowable tank drop during the winter is 4 to 5 feet. During the summer, the tanks are typically allowed to drop 2-feet before the first pump is turned on. The maximum allowable tank drop during the summer is 6 to 7 feet. The lowest level the tanks typically reach is 91-feet. Weston & Sampson recommends that the tanks be allowed to fluctuate between 85-100 feet during the winter months. This level will still allow for adequate pressure in the distribution system as well as help the water to turn over and not stagnate in the tanks. During the summer, the tanks should fluctuate between 90-100 feet. Under the current operation the water age in the tank is not optimized and the water is not adequately turning over.

Under summer, winter, and fire demands the Maher finished water pumps are the first pumps to turn on to fill the tanks. These three pumps are the lead pumps and at least two wells are usually running at any given time. The next pumps in the sequence to be turned on are the Hyannisport or Simmons Pond well pumps. The Straightway well pump is turned on as needed and the three active Mary Dunn well pumps are used as backup. The Airport well is used infrequently. Most of the wells are on for a brief period each day with the Maher wells being the most heavily used. The tanks typically fill during the night when the system demand is low. During the day, as the system demands increase and the tank level decreases, a new pump is turned on after every ½-foot drop in tank level. After three wells are on and the tank level continues to drop, the wells are turned on after a 1-foot drop in tank level. Weston & Sampson recommends that the tank levels should be allowed to drop more than ½-foot before the next pump is turned on. Allowing the tank to drop 1 full foot between each additional pump and a total of 15 feet before all the pumps are turned on will allow the water to turn over and provide for better mixing.

In the event of a power loss at the tank site, a battery backup system provides 30 minutes of service. After 30 minutes, the SCADA system sends out a reading of 0-feet for the tank levels. In this situation all of the pumps will automatically turn on. This configuration results in a high potential for a tank overflow. An operator then needs to reset the pumps so that not all of them continue to run. Weston & Sampson recommends that the battery backup power system be upgraded to provide at least four hours of service. The SCADA should also be reconfigured so that no more than one or two pumps turn on in the event of a power loss.

There are currently no flow meters for the tanks. Most communities that are similar in size to the Hyannis Water System do not have flow meters. Weston & Sampson does not recommend that a flow meter be installed for each tank. This would be an unnecessary expense for the Town without a real added benefit. Currently, the operator is able to determine the flow rate based on the tank level rise or drop over a measured period of time. This is an acceptable and typical method of estimating flow rate.

Each tank has a shut off gate valve. The Mary Dunn No. 2 Tank has a vault, which acts as a combined vault for both tanks. The RTU and piping is contained in this vault. There are two sample taps located outside the tank vault, one for each tank. Weston & Sampson recommends that a chlorine injection point be provided for the tanks. DEP mandates that each tank should be separately sampled and that the chlorine injection point be separate from the sample tap, therefore requiring a minimum of three points.

A pressure transmitter is located in the vault approximately 100-feet from the tanks, on the distribution side of the tank gate valves. This transmitter reads the pressure at both tanks (which are relatively the same at any given time). If one tank is taken offline, the transmitter can still read the pressure at the other tank. There are no altitude valves on the tanks.

Water Quality

The chlorine residual level at the tanks average 0.2 mg/L. The typical range is 0.2-0.5 mg/L. Due to their close proximity, the Mary Dunn Wells would have the highest effect on chlorine levels in the tanks. However these wells are not used frequently to fill the tanks. The tanks are located away from the majority of the water system so the effect of chlorine residuals due to the tanks in the distribution system is low. Taste and odor issues mostly occur in areas with low water demand or dead ends in the system. If the tanks are not mixed well or allowed to turn over, lower or variable chlorine residuals in the system could result in leading to taste and odor problems, especially in areas of low water demand. Straightway Well is known to have high manganese content and the water from this well causes most manganese issues. There are no iron and manganese problems related to the tanks.

Tank Freezing

Freezing problems have not been reported for either of the tanks. It is important to ensure that the water in the tanks is adequately circulated and mixed so that freezing does not occur. The normal winter operating range of 3 to 5 feet is not sufficient to ensure that freezing does not occur. Weston & Sampson recommends that the tank levels be fluctuated 10 to15 feet during the winter months.

Tank Cleaning

As water is held in the tank, suspended solids settle out of the water onto the tank bottom. Without regular interior cleaning, tanks may accumulate large amounts of sediment. Sediment and deposits on tank walls decrease the effectiveness of disinfectant use. In addition, proper inspections cannot be conducted if sediment covers the bottom of the tank. Tanks should be cleaned and inspected annually. The operators or a maintenance company can perform these cleanings.

Before work crews are scheduled to clean a tank, turn the necessary valves to block the tank off from the system and then drain the tank. The tank can be cleaned with low-volume, moderate-pressure (2,400 psi) pumps, fire fighting equipment, or other means. The water should be sprayed on all surfaces to remove as much residue as possible. If sedimentation is a problem or if local environmental regulations apply, it may be desirable to isolate the sediment and washout water and properly dispose of it, instead of allowing it to enter a storm sewer or the groundwater. In addition, care should be taken to prevent large amounts of sediment from entering the tank piping because pipes could be clogged, leading to valve damage.

The disinfection of water storage facilities should be done in accordance with *AWWA C652, Standard for the Disinfection of Water-Storage Facilities*. This standard offers three chlorination methods by which the disinfection can be accomplished.

Coliform Sampling and Exceedances

On Saturday November 10, 2007 the Hyannis Water System issued a boil-order for all their customers. Repeat coliform samples taken at the Mary Dunn No. 1 Water Storage Tank had come back confirmed with E-coli. By chlorinating the water storage tank and the entire distribution system together with daily consecutive coliform sampling the Department of Environmental Protection lifted the order on Monday November 12, 2007. The bacteria detections were contained to the tank and were never detected in the distribution system.

The need for the issuance of the boil order was based on the fact that the Hyannis Water System has only two water storage tanks, one of them was off line for repair, and the Hyannis Fire Department requirements regarding fire fighting capacity combined with

pump control and SCADA issues meant that the Mary Dunn 1 Water Storage Tank could not be isolated.

The Mary Dunn No. 2 tank is currently repaired and back in service. The smaller water storage tank, Mary Dunn No.1 was taken off line in December 2007, emptied, cleaned and field inspected.

Mixing and Circulation

We recommend that a mixing system be added to the tank. A mixing system will maximize circulation in the tank and minimize the water age. In the interim, the operating protocol for tank filling can be modified so that better mixing and circulation of the water in the tank will occur. Although the scenario has not been modeled, we expect that daily fluctuations of the tank levels by 10 to 15 feet will allow the water to turn over while still maintaining the required system pressure. A mixing system will result in more uniform and consistent results than a change in operating protocol alone. Mixing and/or better operating protocol will also reduce the risk of a bacterial contamination by minimizing any stagnation within the tank. There are several methods of mixing available. Active systems include mechanical mixing and are not frequently used. Passive systems are more frequently used and are recommended.

We recommend that installing a mixing system in the Mary Dunn No. 1 Tank be assessed in 3 years when the tank is next recommended to be taken out of service for repairs. The decision to install a mixing system should be dependent on the status of constructing a new tank in the system. The need for a mixing system for the Mary Dunn No. 2 Tank should be assessed when the tank is next taken out of service for repairs or maintenance.

There are several systems by various manufacturers that are available. Attached in Appendix B is an option provided by Tideflex Technologies for a mixing system for each tank. With the Tideflex model, the tank drawdown required is 3-4 feet. This same tank fluctuation without a mixing system will not provide sufficient mixing and water turn over.

Corrosion control

The corrosion of steel in aqueous solutions is an electrochemical process in which a current flows and a chemical reaction occurs. Cathodic protection systems are used to prevent or retard the corrosion that would naturally occur in a steel water tank. These systems prevent or slow corrosion by altering the electrochemical environment so that the submerged tank shell becomes the cathode of a corrosion cell. Since the cathode of a cell does not corrode, the submerged metallic tank shell is protected.

The March 2008 tank inspection revealed that the interior of the Mary Dunn No. 1 Tank is experiencing a small amount of rusting and corrosion. Rusting ranges between a medium to heavy grade, however it is quite infrequent with less than 1% of the entire shell surfaces affected. The pitting ranges from .100-.200-inches in depth. The majority

of the pitting was adequately sealed by the exiting paint system. Significant past metal loss was noted, with the majority of new corrosion resulting along the edges of the past deterioration. Overall the adhesion of the existing coatings is very good to excellent.

Evaluation of the current condition of the tank indicates that a cathodic protection system is not necessary. The protective coating appears to be functioning adequately resulting in only a small amount of corrosive activity. It is estimated that the existing coatings should provide, at a minimum, at least another four to five more years of an acceptable level of protection without any substantial furtherance in overall degradation of the existing coatings.

Security and SCADA

Security

The current security for the water storage facilities includes a perimeter fence with a locked double wide gate. Although not mandated by DEP, barbed wire can be installed on the fence for additional security around the site. Weston & Sampson recommends that a pole be installed inside the fence with a floodlight and a motion sensor. The SCADA antenna should be mounted on this pole and removed from its current location on a fence post. An alarm should be installed on the access ladder and the tank hatch. This would prevent any unauthorized access by the cell phone companies or another third party.

Security cameras at the site are not recommended due to the increased effort and cost to keep them maintained, hidden, and protected from vandals. With the appropriate motion sensors and alarms, the site can be secure and protected from intruders without the additional cost of cameras.

In the past, cellular phone companies had their own access key to the tank site. However, currently only Hyannis Water System personnel have keys to the site. Cellular phone companies need to call the Water System's emergency phone number and wait for someone to come to the site so they can gain access. In addition to the current key system, Weston & Sampson recommends that Hyannis Water System personnel remain on site while any cellular phone work is done on the tanks to ensure that no damage to the tanks occur while a third party is working on the site. Only the specified Water System operations personnel should have access to the tank site. Other town employees should be accompanied by the authorized Water System personnel if they need access to the tank site. The general public should not be allowed to access the tank site.

ATV and motorbike traffic is another security concern at the tank site. During daily and monthly inspections, the water system personnel should ensure that no break-ins or vandalism have occurred at the site. If the recreational traffic begins to pose a greater concern, "no trespassing" signs can be placed around the site.

SCADA Controls

The Telekey SCADA software is a DOS based system located at the water department office and is at least 20 years old. They system was recently upgraded and contains backup capabilities to prevent loss of historical data.

The current SCADA system is physically large and contains outdated technology. As compared to the newer technology this unit has limited capabilities. A large uninterrupted power source (UPS) battery system is located in a back room and serves as the backup power supply for the system. The UPS runs for a half hour then a 10KW generator is used for backup power. The SCADA system must be run by on-site operation only and cannot be controlled remotely.

While the current SCADA System is operable and does function on a daily basis, the system is proprietary by design. Specific components and/or programs contained within the system remain the property of the manufacturer. Obtaining technical assistance for repair or operation can be very limited and will have increased limitation in the future. The same problem will apply to obtaining various system components. The current system has exceeded the anticipated life span and has been modified to maintain operation.

A new SCADA system would require less room and maintenance. The newer programs are significantly improved in function and efficiency. They can be configured to provide countless control strategies and have better data acquisition and superior historical archiving capabilities. We recommend that a new SCADA system upgrade be designed and installed. The new upgrade should be a modular system and have web based remote access.

There is currently only one vault with a temperature sensor and an unauthorized entry sensor for the combined/Mary Dunn No. 2 tank vault. Weston & Sampson does not recommend the construction of another tank vault for the Mary Dunn No. 1 Tank since this riveted tank near the end of its useful life.

The current SCADA antenna at the tank site is located on a fence post. The antenna should be moved to a sturdy pole located inside the fence for increased security. The new antenna pole should also be equipped with a floodlight and a motion sensor.

We recommend that additional backup power, beyond the existing 30 minute supply, be provided for control, telemetry and security equipment. The additional power can be supplied to the site via battery or a solar panel. A portable generator can also be brought to the site in case of a power outage.

Cellular Phone Companies

There are currently two cellular phone companies with leases at the tank site. These two companies are AT&T/Cingular and Sprint-Nextel. The Massachusetts Department of

Environmental Protection issued a policy to define the position of the Drinking Water Program regarding the installation of antennae and/or other appurtenances on, or adjacent to, water storage tanks.

The *Guidance for Public Water Systems For Use With Policy DWSG98-01: Antennae And/Or Other Appurtenances Attached To Public Drinking Water Storage Tanks Or Constructed On Water Supply Land* states the following:

Sanitary, Safety, and Structural

a) Openings cut into tanks compromise the safety of the water in the tank, as well as damage the structural integrity of the tank

b) Cables and antenna brackets or devices that are improperly mounted to ladders, across access openings, or on platforms create safety and OSHA deficiencies. These can also obstruct or hamper access to vents and manholes.

c) Brackets or mounting devices screwed directly into tubular columns can cause interior as well as exterior column corrosion and possible structural failure.

d) Improperly designed brackets can crumple during high winds.

Future Maintenance

Improper (or unperformed) "touch up" painting after the antenna or brackets are installed can lead to premature coating failure on the interior and exterior of the tank.

Cables, antennae, and mounting devices placed too close to tanks can make it difficult if not impossible to clean or paint behind them.

Other

Improperly mounted devices or antennae can create a potential liability should high winds, ice loading, seismic activity, electrical storms or other similar events cause the installation to fail, damage the tank or surrounding support structures, or endanger nearby people.

Any surface preparation and/or touch up painting of impacted areas in or outside of the tank will comply with tank manufacture or tank construction contractor, AWWA and other pertinent industry standards.

The cell phone antennas on the Mary Dunn No. 2 tank impair general maintenance of the tank. The antenna company's ground equipment installation does not allow for complete access around the tank and the antenna cables impair access to the shell ladder. Hyannis Water Supply Division should consider having the cell phone companies relocate their ground equipment to at least 30-feet from the tank and outside the fenced area. Due to

the potential loss of revenue for the Town, Weston & Sampson does not recommend that the cellular phone companies be required to have their own pole and antennas. Instead, the Water System should gain the right to move or shut down cellular phone company equipment as needed while performing tank maintenance. The Town of Barnstable should also maintain the right to order the cellular phone companies to move off site. Future lease contracts should take into account these items.

As previously stated, any cellular phone company that wishes to gain access to the tank site must first notify the Hyannis Water System personnel so that the gate may be unlocked. Under no circumstances should the employee of a cellular phone company be given free access or keys to the tank site. All OSHA regulations must be followed when cellular phone companies are on site and performing any maintenance to their equipment. The phone companies must be required to use the recommended fall prevention system to be installed with the ladder. The Hyannis Water System personnel will also need to disarm the alarm recommended for the ladder.

Compliance: Future Regulations

The DEP has not indicated that future regulations or modifications to the existing policies are imminent. Costs associated with any future regulations need to be determined through further study at the time the regulations are issued.

Recommendations

The following sections provide recommendations and costs associated with placing the Mary Dunn No. 1 Tank back into service and having the tank remain in service for a number of years. It is important to note that Weston & Sampson recommends the construction of a new tank in Hyannis to help mitigate the current storage deficiencies within the Hyannis Water System. The following improvements should be implemented while balancing the costs and benefits for constructing a new tank.

<u>Immediate Improvements</u>

In order to return the Mary Dunn No. 1 Tank back to immediate active service improvements to assure that water, insects and animals cannot enter the tank and that water will not leak out. The following are necessary to complete the following work:

- Reseal the juncture between the roof and shell rim to prevent an entry for insects.
- Re-seal shell manhole with a new gasket to ensure that the manhole properly seals.
- Seal the lap seams and center post on the roof covering.
- Disinfect interior of the tank in accordance with AWWA C652.

The estimated cost for this work is approximately $8,000.

Year 1 Improvements

The following improvements and recommendations are all exterior to the tank and will improve the structure, safety, security, ad operability. They should be implemented within the first year after the tank is returned to active service:

- Repair the three severely deteriorated anchor bolt assemblies.
- Clean and paint the remaining anchor bolt assemblies.
- Install new chlorine injection point.
- Install barbed wire on the perimeter fence.
- Relocate the SCADA antenna to a new pole inside the perimeter fence.
- Install a floodlight and motion sensor on the pole.
- Provide additional battery backup power
- Place markers near the valve boxes.
- Install alarm on the access ladder and tank hatch.
- Provide minimum15-foot cutback to the tree line around the perimeter fence.

The estimated cost for this work is approximately $28,500.

3 Year Improvements

The following improvements and recommendations should be made during a routine tank cleaning within the next three years. They involve repairs to the coating system to prevent uncontrolled corrosion. They will extend the remaining life of the tank and possibly postpone the later repainting of the tank.

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- Spot weld, clean, and paint pits on tank floor.
- Clean and seal rivets noted to have pitting and metal loss.
- Install mixing system (dependent on status of new tank construction)

The estimated cost for this work is approximately $25,500.

5 Year Improvements

In order to ensure the Mary Dunn No. 1 Tank is in compliance and capable of remaining in active service beyond 5 years it will be necessary to make more substantial repairs to the foundation, and thoroughly repaint the roof structure, rim angles, ladder structure and various metal components. A 5 year inspection should be completed first to verify the need for the work. If a new tank is completed near this time, then these improvements could be avoided, as the Mary Dunn 1 Tank would be removed from service. The anticipated repairs include:

- Replace rigging post in the center of the roof in its entirety
- Replace the top 4” x 8” x ¼” overflow support bracket
- Repair both the handles on the shell manhole cover

- Remove all loose material on the foundation surface, resurface the cracked and spalled areas with a cementitious patching material, and apply a sealer material over all exposed surfaces.
- Abrasive blast clean to an SSPC-SP #10 all steel roof support structure surfaces as well as the center rigging assembly (inclusive of the exterior pipe surfaces), the lateral bracing and the shell rim angle.
- Apply (2) coats of an NSF approved high-build, high solids epoxy to a minimum dry film thickness of 16.0 mils.
- All steel surfaces exhibiting a 30% or more reduction in thickness or dimension should be replaced or reinforced as necessary
- Replace all anchor bolts as well as clean and paint the bolt and chair assemblies.
- Disinfect in accordance with AWWA DC652 standards and reseal the bottom manholes utilizing new gaskets.
- Abrasive blast clean and repaint the access ladder assembly
- Perform a professional tank inspection

The estimated cost for this work is approximately $70,000.

10 Year Improvements

In order to ensure the tank is in compliance and capable of remaining in active service beyond 10 years it is recommended to replace the roof and perform a complete replacement of the interior and exterior paint systems.

- Complete a 5 year periodic professional inspection
- Replace the entire roof and roof support structure with a new steel aluminum or fiberglass roof.
- Perform a complete rehabilitation and repainting of both the interior and exterior surfaces

The estimated cost for this work is approximately $320,000

Tank Management Plan

Management of the tank into the future should include periodic inspections of the tanks to assure that the tanks and the site are secure and that accidental or intentional contamination is prevented. It should also include modifications to the water system operations to improve water quality.

Inspection of the tanks and site are recommended daily, monthly, yearly and at 5-year intervals. The specific recommendations are described below and suggested forms to log the results of the inspections are provided.

Recommended Inspections

The following describes the variety of inspections required to maintain the operational and construction control over the drinking water storage tank section of the Hyannis Water System. Items the operator should bring during an inspection include the required inspection form, writing utensil, cell phone, camera, and binoculars.

Daily water system operator site visits and inspections.

Daily water system operator site visits and inspections should include visual inspection of the following:

- perimeter fence
- locks
- unauthorized access to the property
- leakage
- overflow

All problems should be promptly reported to a supervisor.

A sample daily inspection form is attached in Appendix A.

Monthly Inspections.

The following items should be inspected by the water system operators at least once per month.

Foundations

The foundations and surrounding earth should be examined for any signs of settlement. The concrete should also be observed for crumbling, deep cracking, and exposed reinforcing steel. If any of these conditions are found, the tank should be professionally inspected at the earliest opportunity.

Leaks

The exterior of the water-bearing surfaces should be examined, and any leaks-or rust streaking that could have been caused by tank leaks-should be reported. (Corrosion products often seal leaks, leaving only rust streaks as evidence of the leak.) The tank should be inspected by a professional structural engineer familiar with water tank construction as soon as possible after the leak is discovered. Although some leaks may not cause structural problems, potential catastrophic tank failures can be avoided if the visible leaks are properly investigated and repaired.

Exterior Corrosion

Any exterior corrosion, especially where metal loss is apparent, should be evaluated by a professional engineer familiar with the construction of water storage tanks. If the operator notices a change or severe worsening of the exterior corrosion patterns, he or she should bring this to the attention of the engineer. Special areas to observe are anchor bolts and nuts, rods, and rod pins and clevises.

Vandalism

The locks on ladders and access doors should be checked to prevent vandalism.

Ladders, Platforms, and Lighting

As the tank is accessed, the ladders and any ladder platforms should be inspected for noticeable metal loss. Any such metal loss should be inspected professionally. The ladder extending up the exterior of the tank should be checked for stability. Proper operation of the locked ladder guard to prevent unauthorized access to the tank exterior and roof should be checked.

Insect Problems

The site should be monitored for any insect problems such as a bee or wasp infestation. The water system operators should arrange for an exterminator to control any insect problems at the site. Non-toxic methods should be used. Tank inspections should not be avoided due to the presence of insects at the tank site.

Overflow

In order to keep insects, birds, and animals from entering the tank, the overflow screen must be in place and must seal tightly. The overflow brackets should also be inspected to uncover any broken or cracked brackets or welds. Tanks should not be regularly overflowed, and the overflow should not be used as a visual control for pipes and valves. Trickling overflow water can freeze and obstruct the overflow pipe.

Hatches

Hatch locks should be equipped with locks to prevent unauthorized entry into the tank. Shell manholes should be checked for proper seals to prevent leakage.

Vents

Vent screens should be in place and fit properly to prevent the entry of insects and birds. If an operator suspects that the tank vents have a tendency to become clogged or frozen over, the problem should be addressed by an engineer familiar with water tank vent design.

A sample monthly inspection log form is attached in Appendix A.

Annual Inspections

Annual inspections should include evaluation of all the items mentioned for the monthly inspections as well as the following:

Wind or Earthquake Damage

If any tornado, hurricane, major windstorm, or earthquake hits a tank, the tank should be professionally inspected to ensure that no damage occurred to the structure. If any damage is observed, the tank should be professionally inspected.

Five (5) Year Professional Examination

General

Every steel water storage tank, standpipe, or reservoir should be carefully inspected prior to repair and/or repainting and at anytime when leakage or some other apparent deterioration is observed. In any event, all water tanks should be thoroughly inspected at intervals of not more than five years. The standard for painting steel water storage tanks, AWWA D102, includes as an option a first anniversary inspection to be performed by the tank painting contractor. Defective areas should be repaired annually.

Inspection Service

Inspection service shall be provided only by organizations or individuals who are properly qualified to do such work. Those so qualified are:

1. An engineering organization whose principals are registered professional engineers, specializing in inspection service and having at least five years' experience in the inspection of steel structures.
2. Independent engineers, licensed in the state in which the structure is located, whose practice has included substantial or major attention to steel construction.
3. Inspection or safety agencies of the state in which the structure is located, if such agencies are empowered to render inspection service and, further, if such inspection services involve the employment of personnel experienced in steel construction and maintenance.

In all of the above classes of qualified inspection agencies, the inspector or inspectors assigned to the work in the field shall have been properly trained by the organization so qualified and shall have no interest, other than that of a competent inspector, in the performance of any work under consideration at the time the inspection is made.

Components of the Inspection

The tank should be evaluated from several standpoints to provide an accurate evaluation of its condition. Individuals entering the tank should comply with Occupational Safety and Health Administration (OSHA) and state regulations concerning entry into confined spaces.

Foundation

Sufficient information should be gathered to determine the structural integrity of the foundation. The foundation should be checked for visible concrete deterioration as well as hollow-sounding areas. Evidence of foundation settling should be noted and its cause evaluated. The following components of the foundation should be inspected.

1.Exterior foundation surface

2. Grout/ caulking

3. Anchor bolts

4. Anchor plates

5. Interior floor surface

6. Inlet and outlet supply pipe.

7. Silt ring

Tank Shell

The following components of the tank shell, interior and exterior should be inspected:

Exterior:

1. Exterior shell surface

2. Exterior laps and joints

3. Exterior joint plates

4. Exterior rivets

5. Access hatches, ground level

Interior:

1. Interior shell surface

2. Interior laps and joints

3. Interior joint plates

4. Interior rivets

5. Overflow weir box

Roof

The interior and exterior of the roof must be inspected.

Interior:

1. Interior structural trusses
2. Interior structural decking material
3. Interior caulking and seals
4. Interior vent openings and screens
5. Interior access hatches
6. Interior rigging hubs

Exterior:

1. Roofing material
2. Exterior vents, openings and screens
3. Exterior caulking and seals
4. Exterior access hatches
5. Exterior rigging hubs
6. Exterior roof overhang and caulking
7. Roof walkway
8. Roof guard rail

Appurtenances

The following appurtenances should be inspected:

1. exterior ladder including security gate
2. ladder and supports
3. safety cage
4. safety climb system
5. safety balcony
6. handrails
7. overflow structure
8. weir box
9. overflow drain pipe
10. bottom opening screen
11. splash pad

All vents, rigging hubs, lights and the general tank area including grounds and vegetation, fences and gates, security, and third party access should also be inspected.

Coatings

The condition of coatings on the tank should be evaluated. To accurately determine a coating or recoating schedule, it is necessary to estimate the remaining effective life of the coating system. Factors to consider may include rust, peeling, chalking, or graffiti.

Tank Maintenance Engineer

As long as the Town of Barnstable follows the recommendations presented in this report and performs the recommended inspection and maintenance procedures outlined, it is not necessary for the Town to retain a tank maintenance engineer.

PART II

Merithew, Inc. Tank Inspection Report

MERITHEW, INC.
INSPECTION SERVICES
P.O. BOX 177
RAYNHAM CENTER, MASSACHUSETTS 02768

POTABLE WATER AND OIL STORAGE TANK INSPECTION
DRY / WET / REMOTE EVALUATIONS
CLEANING / PAINTING INSPECTION – CODE COMPLIANCE

THE MARY DUNN #1
370,000 GALLON STANDPIPE
BARNSTABLE, MASSACHUSETTS
MARCH 11 & 13, 2008

INFO@MERITHEWINC.COM
TELEPHONE (508) 279-9965
FAX (508) 279-9948
WWW.MERITHEWINC.COM

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QUALITY OF SERVICES

April 8, 2008

Dear Mr. Adams,

Enclosed is the inspection report for the above referenced project. This report contains summary data for the tank, a description of the project background, procedures used, the detailed findings of the inspection and the recommendations associated with those findings. In addition, detailed measurement data, additional photographs and narrated video of the inspection are included, if applicable. The report is comprised of the visual observations made during an inspection as well as information obtained from utility personnel, the tank information plate as well as any additional reports, diagrams or other materials provided.

The information contained herein is as accurate as could be obtained by Merithew, Inc personnel at the time of the inspection. No other assurance or warranty is expressed or implied. We assume no responsibility for any errors or omissions in this report, but will attempt to resolve concerns with the content of this report upon request.

Any estimates or opinions with respect to tank rehabilitation provided by Merithew, Inc in this report are based on Merithew's experience and qualifications as a consultant and represent its best judgment as an experienced and qualified consultant familiar with the construction industry. Since Merithew, Inc. has no control over costs of labor, materials, equipment or services furnished by others or over competitive bidding or market conditions, it cannot guarantee that proposals, bids or actual project costs or construction costs will not vary from any estimates or opinions of costs prepared by Merithew, Inc.

Since the condition of the storage facility will change over time, the accuracy of the condition of the storage facility described herein will decrease with time. This report can no longer be considered accurate when the date for re-evaluation specified in the recommendations has been reached. The storage facility should be re-inspected to determine the current conditions at that time.

Thank you for your attention in this matter.

Sincerely,

Merithew, Inc.

David L. Merithew, President
DLM/elm

TANK DATA

TANK NAME: The Mary Dunn #1 370,000 Gallon Standpipe

DATE: March 11 & 13, 2008 **INSPECTED BY:** David Merithew & Chad Merithew

PREPARED FOR:

Mr. Bruce Adams
Weston & Sampson Engineers
5 Centennial Drive
Peabody, MA 01960

TANK LOCATION:
Street: Mary Dunn Rd
City: Barnstable
State: MA

TANK SIZE:
Diameter: 25'
Height: 100'
Capacity: 370,000 gallons

Aerial Photograph from MS Virtual Earth

CONSTRUCTION:
Number of Shell Rings: Twenty 5' rings.
Type of Structure: Riveted standpipe.
Type of Roof: Flat wood roof with asphalt covering.
Type of Foundation: Concrete ringwall.
Cathodic Protection: None.
Grounded: No separate grounding straps evident.
Interior Ladder: None.
Exterior Ladder: Fixed shell w/ cage.
FAA Lights: No obstruction lighting present.

DATE CONSTRUCTED: 1911 **BY:** N/A **CONTRACT NO:** N/A

DATE LAST PAINTED: **Exterior:** 1996-97 **Paint System:** Zinc/Epoxy/Urethane
Interior: 1996-97 **Paint System:** Epoxy/Modified Polyurethane

DATE LAST INSPECTED: **Interior**: N/A **Exterior:** N/A

SUMMARY

EXTERIOR SURFACES

The roof is comprised wood planks covered with ten rows of asphalt rolled roofing material, which remains intact but heavily weathered. The sections of rolled roofing are sealed with a mastic sealant, which also seals the nails anchoring the asphalt roofing material to the wood roof. In some areas, the sealer is cracked and split at the lap points. The deterioration of the sealer, as well as scattered tearing at the nails is allowing portions of the asphalt roofing material to begin to lift. Separation at these laps appears to have allowed at least some water to penetrate through the lapped joints and the nailed areas.

The protective coatings along the exterior surfaces of the shell were noted to be in very good to excellent condition with at least 95% of the coatings still intact and providing sound protection to the underlying steel surfaces. There was however, evidence of excessive weathering along the red paneled sections of the checkerboard design. This weathering has resulted in thinning of the finish coat of paint and the exposure of the intermediate coat which was noted to be intact with no further degradation evident at this time. Isolated areas of topcoat delamination were also observed along the checkerboard area which has resulting in the exposure of a grey coat of paint. This condition is very minor and appears to be affecting less than 0.5% of the checkerboard surfaces.

The remaining surfaces were exhibiting scattered areas of blistered coating which in some areas has fractured resulting in the exposure of the steel substrate. This deterioration appears to be localized to rivet heads and lap seams, as well as surfaces immediately adjacent to these areas, and may be the result of seepage emanating from the interior of the tank when filled. Please be advised that the seepage observed is not uncommon for riveted structures especially one of this age. In addition, there are also localized areas of crazed cracked coating primarily along rivet heads as further detailed within this report.

The exterior attachments are exhibiting varying degrees of coating degradation and rust formation however the area of primarily concern is the anchor bolt assemblies. Excessive metal loss due to current corrosive activity was observed along at least three anchor bolt assemblies. This metal loss has resulted in loss of structural integrity of the three anchor bolts, as further detailed within this report, and should be addressed as soon as feasible to do so and certainly before the tank is returned to service.

Exterior paint samples were procured and submitted to Groundwater Analytical for the purpose of performing metals testing (5 RCRA). The results of this testing indicated that at least (2) samples indicated a lead content in excess of 600-mg/Kg (ppm) which is typically considered lead bearing and therefore require special considerations during the removal and disposal process.

However please be advised that during the last maintenance operations the exterior surfaces of the tank were completely abrasive blast cleaned to an SSPC-SP #6 Commercial blast grade followed by the application of a zinc/epoxy/urethane coating. Therefore, the vast majority of the previously applied coatings were removed leaving only trace elements of the old coating around rivets, lap seams and other difficult to clean areas. The samples procured during this evaluation were collected from such areas and appear to represent some of the trace elements of the older coating systems. Nevertheless if and when

this tank is next maintained, it will be necessary to institute strict containment methodologies at least during the coating removal phase of the work to ensure the collection of any nuisance dust. Please refer to the attached laboratory reports for the entire list of test results.

INTERIOR SURFACES

The wood planks that comprise the roof structure were found to be in generally very good to excellent condition with no significant damage or rot evident at this time. The coating on the underside of the roof planks also appears to be in good condition, with no significant failure taking place. The junctions with the roof and venting hatches also appear to be in very good condition, with no significant deterioration noted.

The bar joists supporting the wood roof planks is exhibiting varying stages and degrees of deterioration as further outlined in this report. Structural repairs will be required in the near future in order to ensure continued serviceability of the roof structure.

The protective coatings along the shell surfaces are in generally very good to excellent condition with at least 99% of the coatings still intact and providing a sound corrosion barrier. The remaining surfaces area exhibiting scattered areas of failure which has resulted in the exposure of the steel substrate and subsequent medium to heavy rust formation as well as isolated areas of pitting as further detailed within this report.

The coating along the floor surfaces is also in very good to excellent condition with at least 98% of the coating intact and providing sound protection to the steel substrate. The remaining surfaces are exhibiting localized areas of minor blistering as well as minor rust formation resulting from the fracturing of some of the referenced blisters. In addition, there are also a few areas of coating failure which have resulted in a more aggressive degree of corrosion as well as metal loss in the form of pitting. There also a few isolated areas of top coat delamination resulting in the exposure of the base coat of primer which still appears to be intact and providing adequate protection to the steel substrate.

Interior paint samples of the epoxy coating as well as the elastomeric sealer were also procured and submitted to Groundwater Analytical for the purpose of performing metals testing (5 RCRA). The results of the testing indicated only trace elements of lead in (2) samples which were well below the level of 600-mg/Kg (ppm) which is typically used as the threshold for coatings to be considered lead bearing. Please refer to the attached laboratory reports.

STRUCTURAL

The overall structural integrity of the subject tank still appears to be good however there are several deficiencies which require immediate attention in order to ensure the continued integrity and safety of the tank.

Exterior:

1. At this time at least (3) of the anchor bolts are exhibiting 50% or greater metal loss and should be replaced as soon as possible. The base of the (3) bolts should be sufficiently exposed so as to reveal full thickness of the bolts, then cut and tapered so as to allow new bolts to be welded back in place. These new bolts should be of the same dimension as the original bolts and once replaced should be secured with new retention nuts. Prior to re-installing the referenced bolts the interior surfaces of the anchor bolt chair assemblies should be abrasive blast cleaned to an SSPC-SP #5 White metal grade followed by the application of a (3) coat Zinc/Epoxy/Urethane coating system. Prior to installation the bolts themselves should also be cleaned to an SSPC-SP #5 White metal grade and coated with at least the Zinc primer, with the exception of the welding points. Once installed the bolts should be re-cleaned and coated as necessary. Due to the presence of metal loss along all of the bolts, and the extreme difficulty in properly maintaining these bolts due to the very tight confines of the anchor bolt chairs, consideration should be given to replacing all of the anchor bolts as previously indicated for the (3) bolts. The installation of new anchor bolt and chair assemblies between the existing anchor assemblies should also be considered. This decision should be based on the anticipated service life of the tank.

2. The outer edge of the wood roof structure sits atop the steel rim angle of the shell as referenced in this report. The wood structure does not lie evenly along the top of the rim angle therefore leaving various sized gaps between the wood and rim angle throughout a large percentage of the roof perimeter. Past attempts to seal these gaps have been made using what appears to be an elastomeric sealer. It was noted however, that there are voids in the application of the sealer and that it appears that the sealer has pulled away from the rim angle along additional areas. This has resulted in small gaps between the wood and rim angle which appear to range from less than a 0.250” to as much as 0.700” as measured along accessible areas. These areas appear to be the primary points of entry for various insects which were reported to have been found when the tank was cleaned out. There are also larger spaces between the lower edge of the asphalt roofing material and the wood framework measuring as much as 1.0”-1.5” which may allow for accelerated degradation of these areas. Arrangements should be made to re-seal these areas in order to protect the exposed wood and steel from the elements as well as prevent entry of insects.

3. The rigging post in the center of the roof still appears to be structurally capable of supporting at least light loads however evidence of metal loss along the interior surfaces would suggest the structural integrity has been compromised. Furthermore the center post is secured in place by additional structural steel attached to the bar joists which support the roof. This structure is exhibiting substantial corrosive activity and metal loss as further detailed in the “Interior Roof” section of this report. At such time as the subject tank is scheduled for either interior or exterior rehabilitation, or at such time as the roof is replaced, it will be necessary

to replace this rigging structure in its entirety. Meanwhile anyone attempting to rig from this point should be informed as to the existing conditions and cautioned accordingly.

4. Overall, the roof surfaces appear to be well protected, however, evidence of deterioration of the outer covering and lifting at the lap joints and the center post of the roof suggests repairs to the asphalt roof and mastic sealer should be performed before infiltration of rain water, deterioration of the underlying wood or further deterioration of the roof covering itself takes place. It appears that at a minimum addition nailing and sealing of the lap seams as well as sealing of the juncture with the center rigging post is required.

5. The top 4" x 8" x ¼" overflow support bracket is exhibiting areas of excessive thinning as well as complete penetrations due to past and current metal loss. This metal loss is localized primarily to one side of the bracket and the bracket is currently structurally sound and a viable point of attachment to the overflow. However, at such time as the subject is scheduled for maintenance consideration should be given to replacing this item.

6. One handle on the original shell manhole cover is exhibiting extensive corrosive activity which has resulted in moderate to severe metal loss with as much as a 30% reduction in size noted while the other handle is exhibiting as much as a 10% reduction in size. The continued corrosion of these handles will render them unsafe therefore these items should be repaired as should as feasible to do so.

7. There is evidence of degradation in the form of cracked and spalling concrete along the vertical face of the foundation. This condition does not appear to have significantly progressed since our last inspection of 1997 however should be corrected in order to prevent any significant furtherance in degradation of the original foundation surfaces. At a minimum, consideration should be given to removing all loose material, re-surfacing these areas with a cementitious patching material then applying a sealer material over all exposed surfaces.

Interior:

1. There is as much as a 30-40% reduction in dimensional size of various components of the center post, channel beams and adjacent joist surfaces as well as slight to moderate metal loss, representing 10-20% reduction in dimensional size of the outer joist surfaces particularly were they rest atop the shell rim angle. Furthermore the ends of some of the joists are bent and some of the smaller bracing between the joists are also damaged. The majority of the bent joists and damaged bracing however appears to be a pre-existing condition as evidenced by intact coating along the majority of these surfaces. Consideration should be given to cleaning of all areas of heavy corrosion, re-assessing the extent of metal loss and establishing a scope of repair to the items in question. It is anticipated that sectional replacement of the joists as well as reinforcement of other areas will be required in order to ensure the continued structural integrity of the center rigging point as well as the joists and roof structure.

2. Two rivet heads on the shell plates are currently exhibiting metal loss in the form of pitting which has compromised the edge of the rivet head resulting in what appears to be exposure of the rivet hole and shank portion of the rivet. It may be advantageous to clean and seal these

areas prior to returning the tank back to active service so as to prevent any significant metal loss until such time as the interior surfaces are scheduled for complete rehabilitation.

3. There are (4) active pits along the floor surfaces. This pitting measures approximately 0.250 to 0.50" in diameter and 0.050 to 0.080" in depth. Consideration should be given to spot welding these pits so as to bring the pits flush with the original plate surfaces. In order to preserve the floor surfaces until the interior surfaces are scheduled for complete rehabilitation these areas, as well as the additional areas of corrosion along the floor and the rounded rigging lug, should then be at least power tool cleaned to an SSPC-SP #11 followed by the application of (1) coat of AquataPoxy A-6 at 10 mils.

4. There is a rectangular rigging lug along the floor surfaces which is exhibiting evidence of past metal loss as well as questionable attachment to the floor surfaces. Consideration should be given to removing this lug at such time as the tank is next maintained.

SITE

The site is located in a remote area, surrounded by a heavy tree line along the entire tank perimeter. There are two heavy traffic roadways within approximately 200' of the tank site, but no homes or other structures are located nearby. There is a second larger welded standpipe located on site, both contained within the same perimeter security fence. There is at least a 9½' area between the perimeter fence and the subject tank, and a much larger staging area between the two tanks. These areas provide sufficient room for both containment equipment and moderate to large blasting and painting equipment. There is cellular utility equipment and other small utility boxes present on site, including some positioned immediately adjacent to the tank foundations. There is an additional large staging area outside the perimeter security fence, which will provide ample room for large equipment and vehicles. A double-wide access gate provides sufficient entry into the secured site, which is relatively level and covered with a uniform layer of gravel. Access to the tank is gained from Mary Dunn Rd via a long dirt road, which is in generally good condition however the position of the access road limits entrance of larger vehicles and equipment from one direction only. In addition adjacent tree cover may cause minor obstruction to large vehicles. There is both electric and water available on site.

INSPECTION DATA - EXTERIOR

EXTERIOR ROOF

Roof plates:

General condition: The roof is comprised of ten rows of rolled roofing material as indicated in photograph #1, which remains intact but heavily weathered. The junctions of the asphalt roofing material are sealed with a mastic sealant, which also seals the nails anchoring the asphalt material to the wood roof. In some areas, the sealer is cracked and split at the lap points. This deterioration, as well as scattered tearing at the nails is allowing portions of the roofing material to lift as shown in the enclosed video clip. Separation at these laps appears to have allowed at least some water to penetrate the lapped joints and the nailed areas. There are wet spots at the head of each nail, and the nails themselves are rusting to a medium to heavy grade.

Photograph #1

Overall, the roof surfaces appear to be well protected, but evidence of deterioration suggests repairs to the asphalt roofing material and mastic sealer should be performed before infiltration of rain water or deterioration of the underlying wood takes place.

The center roof at the junction with the center post is also sealed with the black mastic material, which has begun to shrink and crack as illustrated in photograph #3. Large cracks are now evident that may allow penetration of water to the underlying wood surfaces and possibly the inner water chamber.

Photograph #2

The outer edge of the roof and the vertical overhead are in the same general condition as the remainder of the roof, with widespread nail heads showing through the roofing material in these areas. There has also been some wear and damage along the outer roof perimeter most likely resulting from rigging lines and other securing lines.

Photograph #3

Degree of deterioration: The extent of significant deterioration to date is minimal. The roofing material is still in fair to good condition however the separation at

various seams and nailing points does make it susceptible to wind damage.

Roof vent(s):

Type: One 12"Ø goose-neck design PVC venting pipe, which is fixed to a wooden venting hatch assembly. The pipe opening is covered with a stainless fine mesh screen secured in place with a stainless banding clamp. The end of the goose-neck assembly is supported from the roof surface with a metal bracket assembly as shown in photograph #4.

Photograph #4

General condition: All PVC venting pipe sections appear to be in excellent condition, with no significant deterioration noted. The metal framework supporting the end of the vent pipe also appears to be in very good condition, with only minor discoloring, but no significant rust formation.

The bolts that secure the base of the PVC venting pipe to the vent hatch cover are exhibiting a heavy degree of rusting, with no appreciable metal loss. The venting hatch is also in very good condition, although widespread light to medium corrosion is evident along all nails heads of the cover and raised neck as shown in photograph #5.

Photograph #5

Degree of rusting: Medium to heavy rusting present along all of the retention bolts and exposed nail heads.

Condition of metal: Good, with no measurable metal loss currently taking place.

Condition of screen: The mesh screen and securing band are of stainless steel material, and appear to be in excellent condition.

Photograph #6

Are any repairs required? No repairs are required at this time except for possible cleaning and painting of the retention bolts as well as the nail heads in order to help prevent metal loss from occurring.

Roof ladder and/or handrail: The roof is not equipped with an access ladder or handrail system. There are handrail extensions from the access ladder however these items are addressed in the ladder section of this report.

Roof access manhole(s):

Type: One 21"×21" square wooden roof hatch with a 5" raised wood neck and boxed wood cover coated in asphalt shingling and sheet metal.

Photograph #7

General condition: The roof hatch appears to be in very good condition, with no significant deterioration of the raised neck or the fitted cover. There are minor tears and one small missing section of the top layer of shingles as shown in photograph #7. The exposed underlying layer of tar paper does not appear to have been compromised.

The majority of all securing nails on the exterior of the hatch cover are now exhibiting light to medium corrosion. The interior of the wood cover and raised neck are in very good condition, with no significant dry rot or splitting of the wood noted. It was also noted that the interior surfaces have been coated with a white paint that appears to be in sound condition as indicated in photograph #8.

Photograph #8

Degree of rusting: Medium to heavy rusting was observed along the majority of the nail heads

Condition of metal: No measurable metal loss of the nail heads was observed.

Are manholes equipped with hasps and padlocks? The roof hatch is not secured with a lock or bolts, but does fit very tightly over the hatch opening.

Coaxial cables/Cellular antenna array(s): The tank is not equipped with any antennas or cellular arrays at this time.

Rigging attachments:

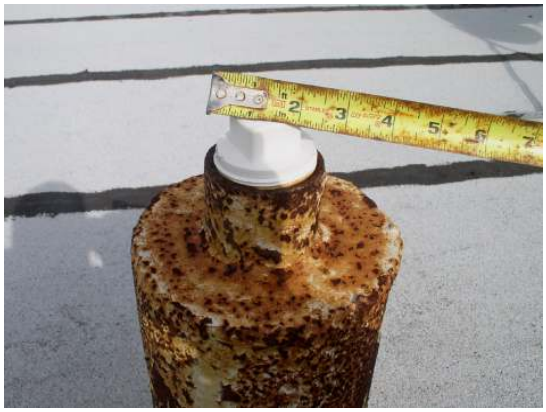
Type: The roof is equipped with a steel center post and underlying framework, with a single rigging coupling and plug on the top face.

Photograph #9

General condition of coating: The coatings on the steel center post appear to be in poor condition, with extensive coating failure and medium to heavy corrosive activity along 75-85% of the visible surfaces as shown in photograph #9.

The remaining coatings were also in poor condition, with cracking present throughout.

There is a 2”Ø rigging coupling at the top of the center post, with a white plastic cap present as shown in photograph #10. This coupling is used for the purpose of rigging the interior surfaces of the subject tank typically with a “Merry-go-round” assembly similar to the rigging used for the inspection of the interior tank surfaces.



Photograph #10

The threads on the cap were damaged, so upon completion of the interior inspection the coupling was sealed with a new steel threaded plug.

Degree of rusting: Medium to heavy rusting was observed along 75-85% of the exterior surfaces as previously referenced. Heavy rusting was observed along 100% of the visible interior surfaces of the center post as shown in photograph #11.

Photograph #11

Condition of metal: The center post still appears to be structurally capable of supporting at least light loads however evidence of metal loss along the interior surfaces would suggest the structural integrity has been compromised.

Furthermore the center post is secured in place by additional structural members attached to the bar joists which support the roof. This structure is exhibiting substantial corrosive activity and metal loss as further detailed in the “Interior Roof” section of this report.

EXTERIOR SHELL

Shell plates:

General condition of coating: The protective coatings along the exterior surfaces of the shell were noted to be in very good to excellent condition with at least 95% of the coatings still intact and providing sound protection to the underlying steel surfaces as indicated in photograph #12. There was however, evidence of excessive weathering along the red paneled sections of the checkerboard design. This weathering has resulted in thinning of the finish coat of paint and the exposure of the intermediate coat which was noted to be intact with no further degradation evident at this time as shown in photograph #13 as well as the enclosed video.

Photograph #12

Upon close examination of several of the red panel sections it was also noted that some of this thinning was also the result of thin coating application as there were areas of minor holidays present in the red paint.

Isolated areas of topcoat delamination were also observed along the checkerboard area which has resulting in the exposure of a grey coat of paint. This condition is very minor and appears to be affecting less than 0.5% of the checkerboard surfaces.

Photograph #13

The remaining surfaces were exhibiting scattered areas of blistered coating which in some areas has fractured resulting in the exposure of the steel substrate. This deterioration appears to be localized to rivet heads and lap seams as well as surfaces immediately adjacent to these areas as indicated in photograph #14. This deterioration appears to be the result of seepage emanating from the interior of the tank when filled which is not uncommon for riveted structures. At this time the tank was empty therefore no active seepage was present.

In addition, there are also localized areas of crazed cracked coating primarily along rivet heads as shown in the enclosed video.

Photograph #14

Degree of rusting: Medium to heavy rusting along isolated areas of stratified rust formations was observed along approximately 5% of the rivet heads and lap seams.

However, the presence of rust staining along these areas does give the impression that there is a greater percentage of rusting taking place. Additional light to medium rusting was also observed along areas of crazed cracked coatings.

Photograph #15

Condition of metal: Good, with only isolated areas of slight metal loss taking place from current corrosive activity as shown in photograph #15. There is however, evidence of slight to moderate metal loss from past corrosion along both the shell plates and rivet heads.

Adhesion of coatings: The adhesion of the existing coating was noted to be generally very good (3A+) at least along areas tested. There was however isolated areas in which the coating has been compromised as evidenced by blistering along the seams and isolated areas of topcoat delamination along the checkerboard surfaces as previously referenced.

DFT of coatings: 5.5 to 18.1 mils, with an average of 9.91 mils for the readings taken along the exterior shell. Refer to the attached printout for individual readings.

Photograph #16

Condition of laps and rivets: The rivets and lap seams were in generally good to very good condition. At least 90% of all visible rivets were exhibiting 98% or greater head dimension with the remaining rivets exhibiting up to a 35% reduction in head size. The majority of the seams appear to be tight however some of the coating deterioration observed during this inspection appears to be the result of past water seepage.

Roof to shell junction:

Photograph #17

General condition of coating: The top of the shell is equipped with an L-angle with the horizontal leg extending outwards as shown in photograph #17. The coating along the visible surfaces of the rim angle is in generally good condition with the exception of the leading edge of the horizontal leg as well as scattered areas along bolted connections, rivets and splice connections. There is also evidence of coating failure and rust formation along the bottom leading edge of the vertical leg of the angle.

Degree of rusting: There is evidence of medium to heavy rust as well as isolated areas of stratified rust formation along the leading edge of the horizontal leg and along

scattered bolted connections. Furthermore, there is evidence of light to medium rusting along the junction of the vertical leg of the angle to the shell.

Photograph #18

Condition of metal: There was no evidence of any appreciable metal loss taking place from active corrosive activity. There is however, evidence of slight to moderate metal loss from past corrosion, primarily along the leading edge of the horizontal leg of the angle as well as the bottom edge of the vertical leg and isolated areas along the splice joints as indicated in photograph #18.

It was also noted that the outer edge of the wood roof structure extends up 6.25" to 6.5" above the rim angle and is overlapped with the asphalt roofing material from the roof as shown in photograph #19. The wood structure does not lie evenly along the top of the rim angle therefore leaving various sized gaps between the wood and rim angle which appear to span a large percentage of the roof perimeter. Attempts to seal these gaps have been made using what appears to be an elastomeric sealer. It was noted however, that there are voids in the application of the sealer and it appears that the sealer has pulled away from the rim angle along additional areas. This has resulted in small gaps between the wood and rim angle which appear to range from less than a 0.250" to as much as 0.700" as measured along accessible areas. These areas appear to be the primary points of entry for various insects which were reported to have been found when the tank was cleaned out. There was larger spacing between the lower edge of the roofing material and wood framework measuring as much as 1.0 to 1.5".

Photograph #19

Overflow system:

Type: The overflow system is comprised of a 6"Ø steel pipe that exits through an elbow from the top shell ring as shown in photograph #20, and then extends vertically down the shell to the third shell ring. The steel pipe is then coupled through a flange assembly to a PVC pipe that terminates in a 45º elbow approximately 20" above grade. The base of the pipe is supported by a U-bolt and pipe support bracket from ground level, and the elbow opening is covered with a stainless wire mesh screen.

Photograph #20

General condition of coating: The coatings along the overflow pipe are in fair to good condition with the

exception of scattered crazed cracking and coating delamination taking place along approximately 15% of the referenced surfaces. The majority of this deterioration is along the backside of the pipe and has resulted in the exposure of the steel substrate and subsequent medium to heavy rusting as indicated in photograph #21.

Photograph #21

Degree of rusting: Rusting is primarily of a medium to heavy grade and is affecting 15% of the referenced surfaces.

Condition of metal: There was no evidence of any significant metal loss taking place along the exterior surfaces of the overflow pipe. Ultra-sonic thickness testing of the pipe wall, once corrected for paint thickness, indicated that the steel was 0.250" in thickness with no evidence of any significant metal loss taking place along the interior surfaces at least along areas tested. Refer to the attached diagram for individual readings.

There was however evidence of both past and current metal loss along the top 4" x 8" x ¼" overflow support bracket as shown in photograph #22. The leading edge of the bracket is exhibiting areas of excessive thinning as well as complete penetrations due to both past and current metal loss. This metal loss is localized primarily to one side of the bracket and the bracket is currently structurally sound and a viable point of attachment to the overflow. The remaining (7) support brackets were also exhibiting small, localized areas of metal loss however to a much lesser degree.

Photograph #22

Condition of screen/flapper: The opening of the overflow pipe is covered with a large mesh galvanized screening which is clamped in place around the outside of the pipe as shown in photograph #23. The screening is in good condition and adequately secured in place at this time.

Photograph #23

Is there a weir box? There is no external weir box present

DFT of coatings: 6.9 to 25.5 mils, with an average of 12.73 mils for the readings taken along the exterior pipe surfaces. Refer to the attached printout for individual readings.

Shell manhole(s):

Type: The shell is equipped with the original 20”×18” oval manhole secured with a single center retention bolt and clamp assembly as well as a newer 23” inside diameter round shell manhole with flanged neck and hinged cover secured by (20) perimeter retention bolts.

Photograph #24

General condition of coating: The coatings along the oval manhole are exhibiting extensive cracking and delamination primarily along the cover as shown in photograph #24. The delamination has resulted in the exposure of a previously applied coating system consisting of an aluminum coat of paint as well as an orange colored primer suggesting that at least the primer may be lead bearing. The coatings along the round manhole and reinforcement pad are in generally very good condition with at least 95% of the coatings still intact and providing adequate protection. The remaining surfaces are exhibiting scattered areas of coating failure and subsequent rust formation along the hinge assembly, the outer edges of the cover and flange assembly as well as the exposed bolt holes and underside of the neck to reinforcement pad connection.

Degree of rusting: Medium to heavy rust and stratified rust formations are affecting 10% of the oval manhole surfaces with the majority of this rusting along the manhole cover handles. Light to medium rusting along with a few scattered areas of heavy rusting were observed along no more than 5% of the referenced surfaces.

Photograph #25

Condition of metal: Both manholes are in generally very good condition with no significant metal loss taking place except for the handle assemblies along the original manhole cover. One handle is exhibiting moderate to severe metal loss with as much as a 30% reduction in size noted while the other handle is exhibiting as much as a 10% reduction in size.

Are manholes leaking? There was no evidence that either of the shell manholes were leaking.

Shell ladder(s):

Is ladder equipped with a cage? Yes.
Is there a ladder gate? Yes.
Are there rest stop platforms? None.
How far from ground level? 20'±.
Safety climb device: Yes. **Type:** Flexible cable.
Condition: The fall prevention device is intact and functional.


Photograph #26

General condition of coating: The coatings along the access ladder assembly are in generally fair to good condition with at least 70% of the referenced coatings still intact and providing adequate protection.

The remaining surfaces are exhibiting areas of failure primarily in the form of extensive crazed cracked and delaminated coatings which is prevalent along the ladder rungs as well as the vertical slats of the ladder cage as shown in photographs #27 and #28.


Photograph #27

There is also significant coating failure and subsequent rust formation along the majority of the support brackets where they connect to the ladder side rails. During previous maintenance these ladder supports were modified and welded to the ladder side rails as further detailed in the enclosed video.

Degree of rusting: Medium to heavy rusting was observed along as much as 30% of the ladder rungs, ladder cage, handrail extensions and ladder supports.

Condition of metal: The ladder is in sound structural condition with no significant metal loss observed.

Rigging attachments: The exterior shell is not equipped with any rigging attachments other than the center post in the roof previously referenced in this report.


Photograph #28

EXTERIOR FOUNDATION & ATTACHMENTS

Floor plate extension:

General condition of coating: The base of the shell is encased within concrete as should in photograph #29. The exterior of the bottom transition angle was not visible for inspection. The bottom set of rivets located just above the concrete were found to be in very good condition with the exception of scattered areas of complete failure resulting in the exposure of the steel substrate surfaces and subsequent rust formation.

Photograph #29

Degree of rusting: Medium to heavy rust as well as scattered areas of stratified rust formations were observed along as much as 20% of the referenced rivets.

Condition of metal: The rivets appear to be in generally very good to excellent condition with only a few isolated rivets currently exhibiting slight metal loss not exceeding 5% of the affected rivet heads.

Anchor bolts:

General condition of coating: The base of the tank shell is equipped with (10) 1¼"Ø × 20" tall anchor bolts secured to very narrow chair assemblies measuring 2¼" between the side plates. The coatings along the outboard surfaces of the anchor bolt assemblies are in generally very good condition with less than 10% of the surfaces exhibiting failure to the substrate and subsequent rust formation. The majority of this rusting is along the underside of the top plates of the chairs, edges of securing rivets as well as several of the retention nuts as shown in photograph #30.

Photograph #30

The inboard surfaces of the anchor bolts and chair assemblies however, are exhibiting a much greater degree of deterioration with complete failure to the steel substrate noted along at least 50-60% of the referenced surfaces as indicated in photograph #31.

Photograph #31

Degree of rusting: Rusting is primarily of a medium to heavy grade with scattered areas of stratified rust formations.

Condition of metal: All of the anchor bolts are exhibiting varying degrees of metal loss from both past and current corrosion ranging from a 5% to as much as a 70% reduction in thickness of the anchor bolt as shown in photographs #32 and #33.

Photograph #32

Photograph #33

At this time at least (3) of the anchor bolts are exhibiting 50% or greater metal loss and should be replaced as soon as possible. However due to the presence of metal loss along all of the bolts and the extreme difficulty in properly maintaining these bolts due to the very tight confines of the anchor bolt chairs consideration should be given to replacing all of the anchor bolts by either cutting down the bolts to an area representing full dimensional thickness then welding new bolts in place, or drilling the foundation and installing completely new anchor bolt and chair assemblies between the existing anchor assemblies.

Foundation:

Concrete chipped or cracked: There is evidence of degradation in the form of cracked and spalling concrete along the vertical face of the foundation; however this condition does not appear to have significantly progressed since our last inspection performed in 1997. It appears that the majority of the degradation currently taking place is of the cover coat of concrete which was applied during the last rehabilitation of the tank. This cover coat of concrete was applied along the outer cambered edge of the foundation and slopes up to the shell of the tank as shown in photograph #34.

Photograph #34

Grout chipped or cracked: The cover coat of concrete along the top of the foundation also serves as the grout between the shell and foundation. This concrete is exhibiting some cracking and general degradation however the juncture between the concrete and shell is additionally sealed by what appears to be an elastomeric sealer which is in good condition.

Indication of settlement: There are no indications of settlement.

Undermining of foundation: There was no evidence to suggest that the foundation is being undermined.

Indication of leakage: There were no indications that the tank has been leaking.

Condition of valve vault: N/A

Site drainage conditions: Drainage appeared to be adequate.

Additional foundation attachments:

Type: None

INSPECTION DATA - INTERIOR

INTERIOR ROOF

Was tank empty? Yes.

Underside of roof plates:

General condition: The wood planks that comprise the roof structure were found to be in generally very good to excellent condition. There does not appear to be any significant damage or rot evident at this time. The coating on the underside of the roof planks also appears to be in good condition, with no significant failure noted as indicated in photograph #35.

Photograph #35

The junctions with the roof and venting hatches also appear to be in very good condition, with no significant deterioration noted. The securing bolts along the base of the venting pipe are exhibiting extensive medium to heavy corrosion similar to that observed along the exterior surfaces.

Photograph #36

Degree of deterioration: There was no appreciable deterioration evident along the underside of the roof at this time.

Roof to shell connection:

General condition of coating: The roof to shell angle was found to be in fair condition, with the exception of heavy cracking and delamination along the top horizontal face of the angle as shown in photograph #37. This failure has resulted in light to medium rust and localized areas of heavy corrosion along at least 30% of the visible surfaces.

There are also a number of gaps present between the top face of the rim angle and the outer perimeter of the wood roof support. These gaps may be the result of failure in the mastic sealer at the junction of the top rim angle and the outer roof and most likely the source of the reported insect infiltration.

Photograph #37

Degree of rusting: Rusting is affecting as much as 30% of the referenced surfaces and is primarily of a light to medium grade with localized areas of heavy rusting.

Condition of metal: Minor past metal loss was noted along the visible portions of the rim angle, which appeared to be adequately sealed by the existing paint system along the majority of surfaces as shown in photograph #38. There are areas of heavy corrosive activity which appears to be exhibiting minor new metal loss at this time.

Photograph #38

Roof framing:

Type: The interior roof support is comprised of a series of (4) bar joist assemblies supported atop the roof to shell angle and set of center beams anchored to the joists which reinforce the center roof rigging post. There is also additional lateral bracing present. This bracing appears to secure the bar joist assemblies in place at least when initially installed.

Photograph #39

General condition of coating: The coatings along the bar joist assemblies are in generally good condition, with at least 80% of the surfaces still being afforded reasonable protection as shown in photograph #39. The remaining surfaces are exhibiting complete failure resulting in exposure of the underlying substrate, which is now exhibiting heavy rust and stratified rust formation. The greatest degree of corrosive activity is occurring along the center truss area, which is additionally supported by four channel beams supporting the center rigging post as shown in photograph #40. This corrosive activity has resulted in heavy rust and stratified rust formations along both the top and bottom flanges of the channel beams, scattered areas of the web sections, the center post surfaces as well as the points of connections to the bar joists.

Photograph #40

There is also evidence of stratified rust and metal loss along the ends of the bar joists where they rest atop the shell rim angle. Stratified rust is heavy in some areas, suggesting that at least moderate, if not severe, metal loss may be taking place. These areas will have to be closely assessed and descaled to determine the exact extent of metal loss, but it appears to be at least a 20% reduction in plate thickness along the associated surfaces has already resulted.

The lateral bracing between the bar joists is in very poor condition, with damage, severe metal loss and fractures of the braces themselves. Their current condition suggests the bracing no longer provides any significant structural benefit to the roof support structure.

Photograph #41

Degree of rusting: At this time, the stratified rust formation appears to be very heavy in areas of the channel beams and center post assembly as illustrated in photograph #41 and is affecting at least 55% of the referenced surfaces. This condition also extends onto the adjacent bar joist surfaces as well as the ends of the joists near the shell perimeter. Overall, as much as 20% of the roof framework is affected with some degree of corrosive activity.

Condition of metal: There is as much as a 30-40% reduction in dimensional size of various components of the center post, channel beams and adjacent joist surfaces. Slight to moderate metal loss, representing 10-20% reduction in dimensional size of the associated surfaces was noted along the outer joist surfaces. However, these surfaces will have to be cleaned of all corrosion products before and accurate assessment of metal loss could be made.

Photograph #42

Rigging attachments:

Type: The roof is equipped with a steel center post and underlying framework, with a single rigging coupling and plug on the top face as previously referenced. This is the rigging assembly for both the exterior and interior surfaces of the tank and therefore a very important component of the tank structure.

Photograph #43

General condition of coating: The coatings along the surfaces of the entire assembly are in very poor condition with extensive coating failure and corrosive activity currently taking place as previously referenced. Even the interior portion of the center rigging post is in poor condition, with widespread cracking and delamination of the coatings and medium to heavy corrosion noted.

Degree of rusting: Widespread medium to heavy rust and stratified rust formations were observed along the majority of all surfaces.

Condition of metal: The rigging post was utilized for rigging both the exterior and interior surfaces of the tank during this inspection as indicated in photograph #43. Though adequate for this purpose, the current extent of deterioration would suggest the structural integrity of the rigging assembly may be compromised and unsafe for the purpose of rigging larger staging. Furthermore, continued corrosive activity will completely compromise the structural integrity of this item making it completely unsafe for any purpose.

Cathodic protection: The tank is not equipped with a cathodic protection system.

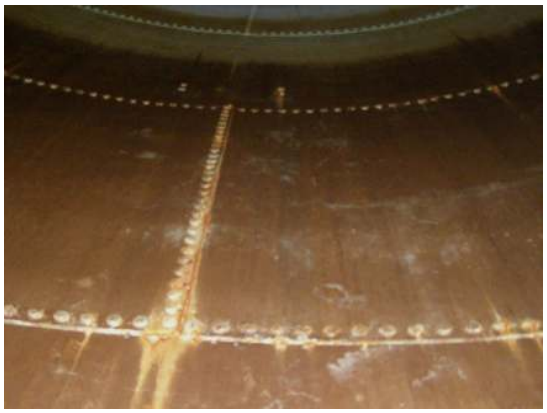
INTERIOR SHELL

Shell plates:

General condition of coating: The top two rings of the interior shell were found to be in excellent condition, with less than 0.1% of the surfaces exhibiting visible corrosive activity. This rusting was primarily located along lap seams, which were not seal coated during the last scheduled maintenance, as were the lower (15) shell rings. At this time, there is no evidence of any active metal loss taking place, nor evidence of any significant past metal loss. Rivet heads in this area were in very good to excellent condition, with 98% of the rivets retaining 95% or greater head dimension. Only isolated rivet heads appear to be exhibiting any metal loss, with less than a 5% reduction in head dimension.

Photograph #44

Shell rings 16-18 were also found to be in generally very good to excellent condition, although a slight increase in overall deterioration was taking place. Approximately 1-2% of the rivets and lap seams along this area, which appears to be the fluctuation zone of the tank, are exhibiting medium to heavy rust formation, primarily along lap seams and previously pitted surfaces as shown in photograph #45. This rusting is primarily of a surface grade, with no appreciable metal loss taking place.



Photograph #45

Several areas were descaled of their corrosion product, with no appreciable metal loss observed. The shell surfaces were found to be heavily stained from the mid-point of the #19 ring to the tank floor.

The lap seams and rivets of rings 16-18 were not sealed with the elastomeric sealant that was applied to the lower fifteen rings, however they are still in very good to excellent condition, and with at least 90% of the rivet heads retaining at least 90% or greater head dimension as shown in photograph #46. Only scattered rivets were exhibiting metal loss with less than 10% reduction in head dimension, primarily due to past metal loss. There is no significant metal loss taking place from active corrosion.

Photograph #46

The elastomeric urethane applied to the lap seams and rivet heads along the shell from the floor to the #15 shell ring appears to be in very good condition. Localized areas have

cracked and peeled resulting in moisture entrapment along the underlying surfaces. The sealant has also adequately sealed the majority of the past metal loss along the seams, with only minor areas of new corrosion resulting in any furtherance of metal loss as indicated in photograph #47. This new deterioration is barely measurable, with less than 1/32" deterioration noted in areas measured.

Photograph #47

The extent of corrosive activity decreases along the #10 through #14 shell rings, with less than 1% of the surfaces showing any evidence of failure to the substrate and subsequent rusting. Past pitting has resulted in approximately 40-50 shallow pits per shell ring, with the majority remaining sealed by the existing coating system as indicated in photograph #48. 95% of all rivet heads on rings #10 through #14 have retained at least 95% or more of head fullness. Only localized areas appear to be showing no more than a 5-10% reduction in size, but is somewhat masked by the elastomeric sealer present.

Photograph #48

The coatings along the #1 through #9 shell rings are also in generally very good to excellent condition with at least 99.5% of the coatings still intact and providing sound protection to the underlying steel surfaces. The remaining surfaces were exhibiting scattered areas of failure to the substrate and subsequent rust formation primarily along rivet heads however isolated areas were also observed along the shell plate's surfaces as well.

Degree of rusting: Rusting ranges primarily between a medium to heavy grade however it is quite infrequent with less than 1% of the entire shell surfaces affected.

Condition of metal: Significant past metal loss was noted, with the majority of new corrosion resulting along the edges of this past deterioration. This pitting ranges from 0.100"-0.200" in depth, as recorded. The majority of the past pitting was adequately sealed by the existing paint system. Along lower shell surfaces, the majority of past pitting was shallow at 0.050"-0.075" however scattered deep pitting measuring 0.5"-1" in diameter and 0.150"-0.210" in depth was observed. These deep pits are present at a frequency of less than 20-25 per shell ring. Refer to the summary sheet for detailed information regarding both active and past metal loss along the shell surfaces.

Photograph #49

Adhesion of coatings: Overall adhesion of the existing coatings, including the elastomeric sealer along the rivets and lap seams is very good to excellent. X-cut adhesion testing indicated at least a (4+) reading along all areas tested. There was however a very few isolated areas of peeling top coat and delaminated sealer noted as detailed within the enclosed video.

Photograph #50

DFT of coatings: Epoxy coating: 4.7 to 31.1 mils, with an average of 12.57 mils for the readings taken along the interior shell. Elastomeric sealer: 17.2 to 72.7 mils, with an average of 34.2 mils for the readings taken along the interior shell. Refer to the attached printouts for individual readings.

Condition of laps and rivets: Overall condition of both lap seams and rivets heads was very good as previously stated.

Support columns: The water chamber is not equipped with any roof support columns.

Photograph #51

Interior weir box:

General condition of coating: The coating along the interior section of overflow which extends into the tank as shown in photograph #51 is in poor condition along the exterior surfaces, with significant rusting taking place along at least 70% of visible surfaces. The coating along the inboard surfaces is significantly better with only localized rusting evident. There is only minor corrosion and rust staining emanating from the unsealed junction of the overflow pipe and the shell wall.

Degree of rusting: Rusting is of a light to medium grade and is affecting at least 70% of the exterior surfaces and 5% of the visible interior surfaces.

Condition of metal: There was no evidence of any appreciable metal loss taking place.

Photograph #52

Shell manhole(s) (interior face):

General condition of coating: The coating along the interior surfaces of the original shell manhole is in excellent condition with no deterioration present.

Degree of rusting: There is currently no rusting taking place.

Condition of metal: There is no active metal loss present. There is however evidence of past metal loss in the form of pitting however this metal loss is generally very shallow.

Tank ladder: The interior water chamber is not equipped with an access ladder.

Rigging attachments:

Type: The top shell ring is equipped with a painter's rigging rail approximately 2' below the roof to shell junction.

Photograph #53

General condition of coating: The majority of the visible coatings along the painter's rail were found to be in good condition, with only localized areas of failure resulting in light to medium corrosion along the rail standoffs and the interior face of the rail vertical plate.

Degree of rusting: Light to medium rusting was observed along as much as 10% of the visible surfaces.

Condition of metal: The referenced item appears to be intact with no significant metal loss observed. Nevertheless this rail should be thoroughly inspected and tested prior to utilizing the rail for rigging purposes.

INTERIOR FLOOR

Floor plates:

General condition of coating: The coating along the floor surfaces is in very good to excellent condition with at least 98% of the coating intact and providing sound protection to the steel substrate. The remaining surfaces are exhibiting localized areas of minor blistering as well as minor rust formation resulting from the fracturing of some of the referenced blisters as shown in photograph #55. In addition, there are also a few areas of coating failure which have resulted in a more aggressive degree of corrosion as well as metal loss in the form of pitting.

Photograph #54

There also a few isolated areas of top coat delamination resulting in the exposure of the base coat of primer which still appears to be intact and providing adequate protection to the steel substrate.

Degree of rusting: Rusting is primarily of a light to medium grade affecting less than 1% of the floor surfaces. There area however a few isolated areas of heavy rusting which has resulted in pitting of the floor surfaces.

Photograph #55

Condition of metal: The floor surfaces are in generally very good condition with the exception of (4) active pits. This pitting measures approximately 0.250 to 0.50" in diameter and 0.050 to 0.080" in depth.

Adhesion of coatings: The adhesion of the existing coating appears to be good except for isolated areas of top coat delamination and areas of blistering.

DFT of coatings: Epoxy coating: 8.5 to 29.3 mils, with an average of 18.19 mils for the readings taken along the interior floor. Elastomeric sealer: 42.9 to 59.5 mils, with an average of 51.91 mils for the readings taken along the interior floor. Refer to the attached printouts for individual readings.

Photograph #56

Condition of laps and rivets: Lap seams and rivets appeared to be in very good condition however the Elasto-Shield sealer does impede through assessment.

Was bottom of tank cleaned out? All floor surfaces were cleaned by water department personnel prior to the inspection.

Photograph #57

Silt stop:

Height of silt stop:

General condition of coating: The coating along the exterior surfaces is in generally good condition with only scattered areas of medium to heavy rusting observed along less than 2% of the referenced surfaces. Heavy tuberculation was observed along the majority of all interior surfaces of the fill line.

Degree of rusting: Medium to heavy along less than 2% of exterior surfaces and at least 80% of visible interior surfaces.

Condition of metal: There was no measurable metal loss along the exterior surfaces of the fill line assembly however there appears to be at least slight to moderate metal loss along the interior surfaces of the pipe as shown in photograph #58.

Photograph #58

Rigging attachments:

Type: There are two rigging lugs welded to the center floor area as shown in photograph #59.

General condition of coating: The coatings along these two items are in poor condition with extensive failure and subsequent rusting taking place along the majority of all surfaces.

Degree of rusting: Rusting is of a medium to heavy grade affecting at least 90% of the referenced surfaces.

Condition of metal: The rounded rigging lug appears to be in sound structural condition with no measurable metal loss evident. In fact this lug was the one utilized for rigging the interior surfaces. The rectangular lug appears to be older and exhibiting evidence of past metal loss as well as questionable attachment to the floor surfaces. In fact, someone has already marked this lug as being no good.

Photograph #59

ULTRASONIC AND PIT DEPTH MEASUREMENTS:

Shell Ring #1

- Ultrasonic thickness readings: .591, .604, .607, .605, .599, .608, .613, .611, 610, .598, .604, .607

- Pit measurements: Only a few isolated areas of active pitting measuring no more than 0.35" are present. Past pitting is a generalized condition scattered throughout the ring with the majority measuring less than 0.050"to 0.065" in depth. Only isolated areas measuring 0.100" to 0.150"were observed.

Shell Ring #2

- Ultrasonic thickness readings: .580, .588, .590, .583, .578, .585, .587, .597, .584, .582, .589, .587

- Pit measurements: No active pitting was observed. Past pitting is a generalized condition scattered throughout the ring with the majority measuring less than 0.050" to 0.065" in depth. Only isolated areas measuring 0.100" to 0.150" were observed.

Shell Ring #3

- Ultrasonic thickness readings: .478, .478, .476, .457, .519, .520, .437, .437, .529, .539, .426, .425

- Pit measurements: No active pitting was observed. Past pitting is a generalized condition scattered throughout the ring with the majority measuring less than 0.050" to 0.065" in depth. Only isolated areas measuring in slight excess of 0.100" were observed and appear to number no more than 10 pits per ring.

Shell Ring #4

- Ultrasonic thickness readings: .458, .442, .449, .448, .453, .451, .453, 449, .446, .450, .452, .448"

- Pit measurements: No active pitting was observed. Past pitting is a generalized condition scattered throughout the ring with the majority measuring less than 0.050" to 0.065" in depth. Only isolated areas measuring in slight excess of 0.100" were observed and appear to number no more than 10 pits per ring.

Shell Ring #5

- Ultrasonic thickness readings: .416, .416, .438, .425, .425, .418, .433, .436, .433, .426, .421, .419

- Pit measurements: No active pitting was observed. Past pitting is a generalized condition scattered throughout the ring with the majority measuring less than 0.050" to 0.065" in depth. Only isolated areas measuring in slight excess of 0.100" were observed and appear to number no more than 10 pits per ring.

Shell Ring #6

- Ultrasonic thickness readings: .399, .400, .427, .358, .390, .425, .436, .382, .379, .390, .411, .432

- Pit measurements: No active pitting was observed. Past pitting is a generalized condition scattered throughout the ring with the majority measuring less than 0.050" to 0.065" in depth. Only isolated areas measuring in slight excess of 0.100" were observed and appear to number no more than 10 pits per ring.

Shell Ring #7

- Ultrasonic thickness readings: .350, .379, .375, .375, .362, .381, .383, .383, .352, .361, .361, .381

- Pit measurements: Only a few isolated areas of active pitting measuring no more than 0.35" are present. Past pitting is a generalized condition scattered throughout the ring with the majority measuring less than 0.050" to 0.075" in depth. Isolated pits measuring 0.110" to 0.150" were also observed. Deep pitting averaged 10 to 15 pits per ring.

Shell Ring #8

- Ultrasonic thickness readings: .389, .379, .381, .372, .377, .383, .390, .383, 380, .369, .371, .384

- Pit measurements: Two active areas of pitting along the upper girth seam rivet heads resulting in exposure of the rivet hole and shank area. Past pitting is a generalized condition scattered throughout the ring with the majority measuring less than 0.050" to 0.075" in depth. Isolated pits were also measuring 0.110" to 0.150". Deep pitting averaged 10 to 15 pits per ring.

Shell Ring #9

- Ultrasonic thickness readings: .350, .378, .385, .385, .392, .385, .386, .351, .349, .377, .382, .382

- Pit measurements: No active pitting was observed. Past pitting is a generalized condition scattered throughout the ring with the majority measuring less than 0.050" to 0.075", with scattered heavy pitting measuring to be 0.110" to 0.150" in depth. Deep pitting averaged 10 to 15 pits per ring.

Shell Ring #10

- Ultrasonic thickness readings: .385, .379, .380, .386, .382, .390, .391, .389, .370, .369, .389, .360

- Pit measurements: No active pitting. Past pitting is generalized throughout the shell ring surfaces with the vast majority measuring less than 0.050" to 0.075"in depth. Isolated pits were also measured to be .125", .150", .165", .210", .125", .115", .130", .120", .125" in depth. Deep pitting is estimated to be at 20-25 pits.

Shell Ring #11

- Ultrasonic thickness readings: .377, .378, .384, .383, .390, .387, .381, .375, .370, .387, .387, .390

- Pit measurements: No active pitting. Past pitting is generalized throughout the shell ring surfaces with the vast majority measuring less than 0.050" to 0.075"in depth. Isolated pits were also measured to be: .170", .170", .125", .125", .125", .130", .125", .110", .110" in depth. Deep pitting is estimated to be at 20-25 pits.

Shell Ring #12

- Ultrasonic thickness readings: .375, .376, .380, .385, .382, .379, .382, .383, .384, .379, .379, .381

- Pit measurements: Only a few isolated areas of active pitting measuring no more than 0.35" are present. Past pitting is generalized throughout the shell ring surfaces with the vast majority measuring less than 0.050" to 0.075"in depth. Isolated pits were also measured to be.150", .155", .187", .187", .160", .150", .150", .140", .125" in depth. Deep pitting is estimated to be at 20-25 pits.

Shell Ring #13

- Ultrasonic thickness readings: Past thickness measured and determined to be 0.3125”

- Pit measurements: Only a few isolated areas of active pitting measuring no more than 0.35” are present. Past pitting was affecting as much as 15% of ring surfaces with the vast majority measuring less than 0.070” in depth. Isolated pits were also measured to be .185”, .185”, .165”, .170”, .160”, .175”, .160”, .187”, .170” in depth. Deep pitting is estimated to number less than 40 pits.

Shell Ring #14

- Ultrasonic thickness readings: Past thickness measured and determined to be 0.3125”

- Pit measurements: Only a few isolated areas of active pitting measuring no more than 0.35” are present. Past pitting was affecting as much as 15% of ring surfaces with the vast majority measuring less than 0.070” in depth. Isolated pits were also measured to be .200”, .150”, .150”, .120”, .160”, .150”, .175”, .164”, .160” in depth. Deep pitting appears to number 40-50 pits.

Shell Ring #15

- Ultrasonic thickness readings: Past thickness measured and determined to be 0.3125”

- Pit measurements: No active pitting. Past pitting was affecting as much as 25% of ring surfaces with the vast majority measuring less than 0.075” in depth. Isolated pits were also measured to be .100”, .100”, .110”, .100”, .220”, .195”, .120”, .140” in depth and on average 0.275” to 0.400” in diameter. Deep pitting appears to number 40-50 pits.

Shell Ring #16

- Ultrasonic thickness readings: Past thickness measured and determined to be 0.275”

- Pit measurements: No active pitting. Past pitting was affecting as much as 20% of ring surfaces with the vast majority measuring less than 0.060” in depth. Isolated pits were also measured to be .140”, .120”, .151”, .095”, .090”, .100”, .120”, .140”, .150” in depth and on average 0.375 to 0.50” in diameter. Deep pitting appears to number 40-50 pits.

Shell Ring #17

- U.T. readings: .262", .267", .281", .290", .277", .274", .281", .273", .288", .289", .273", .276"

- Pit measurements: No active pitting. Past pitting was affecting as much as 20% of ring surfaces with the vast majority measuring less than 0.060" in depth. Isolated pits were also measured to be .113", .148", .160", .151", .125", .125", .100", .100", .145" in depth and on average 0.375 to 0.50" in diameter. Deep pitting appears to number 40-50 pits.

Shell Ring #18

- Ultrasonic thickness readings: Plate thickness measured and determined to be 0.250"

- Pit measurements: No active pitting. Past pitting was affecting as much as 20% of ring surfaces with the vast majority measuring less than 0.050" in depth. Isolated pits were also measured to be .100", .120", .105", .125", .150", .150", 110", .160", .110" in depth and on average 0.375" to 0.50" in diameter. Deep pitting appears to number 40-50 pits.

Shell Ring #19

- Ultrasonic thickness readings: Plate thickness measured and determined to be 0.250"

- Pit measurements: No active pitting taking place nor any significant past metal loss

Shell Ring #20

- Ultrasonic thickness readings: Plate thickness measured and determined to be 0.250"

- Pit measurements: No active pitting taking place

Overflow pipe

- Ultrasonic thickness readings: .299, .293, .297, .303, .311, .309, .312, .294, .293, .298

- Pit measurements: No significant pitting taking place along exterior surfaces of pipe.

Variances in Ultrasonic thickness measurements are attributable to actual plate thickness as well as the exterior paint thickness from which the Ultrasonic thickness reading were procured from. The paint thickness outlined in the attached DFT report should be subtracted from the U.T. readings recorded above in order to establish a more exact value.

Ultrasonic thickness testing could not be performed along bar joists due to limited access. However bar joists appeared to be comprised of ¾" bar and 1.5" x 1.5" x ¼" L-angle.

APPENDICES

APPENDICES FOR THIS REPORT INCLUDE:

Individual DFT Measurements for:

Exterior Shell Surfaces
Exterior Overflow Pipe
Interior Shell Surfaces
Interior Floor Surfaces

Metals Test Results for:

Exterior Coating System
Interior Coating System

Additional Materials that Accompany this Report:

Exterior Inspection Video with narration
Interior Inspection Video with narration
Additional Digital Photographs in a pdf gallery

Readings - Exterior Shell Ring 1

Reading	Coat 1 (mil)
1	8.0
2	7.5
3	7.7
4	9.8
5	15.0
6	16.5
7	7.3
8	9.1
9	10.0
10	9.5

Summary - Exterior Shell Ring 1

	Coat 1 (mil)
Max	16.50
Min	7.30
Mean	10.04
StdDev.	3.18

Annotations - Exterior Shell Ring 1

Gage Model: 6000
Gage S/N: 12345
Probe Model: FN
Probe S/N: 12345
User:
Part:
Substrate:

Readings - Exterior Shell Ring 2

Reading	Coat 1 (mil)
1	8.4
2	9.2
3	10.7
4	9.2
5	13.1
6	9.6
7	10.7
8	10.2
9	12.6
10	8.1

Summary - Exterior Shell Ring 2

Reading	Coat 1 (mil)
Max	13.10
Min	8.10
Mean	10.18
StdDev.	1.66

Annotations - Exterior Shell Ring 2

Gage Model: 6000
Gage S/N: 12345
Probe Model: FN
Probe S/N: 12345
User:
Part:
Substrate:

Readings - Exterior Shell Ring 3

Reading	Coat 1 (mil)
1	11.1
2	8.9
3	6.3
4	7.4
5	7.9
6	7.0
7	6.7
8	7.4
9	10.9
10	9.9

Summary - Exterior Shell Ring 3

	Coat 1 (mil)
Max	11.10
Min	6.30
Mean	8.35
StdDev.	1.75

Annotations - Exterior Shell Ring 3

Gage Model: 6000
Gage S/N: 12345
Probe Model: FN
Probe S/N: 12345
User:
Part:
Substrate:

Readings - Exterior Shell Ring 4

Reading	Coat 1 (mil)
1	9.8
2	8.6
3	12.1
4	11.2
5	7.7
6	9.7
7	11.6
8	10.9
9	6.9
10	7.8

Summary - Exterior Shell Ring 4

Reading	Coat 1 (mil)
Max	12.10
Min	6.90
Mean	9.63
StdDev.	1.82

Annotations - Exterior Shell Ring 4

Gage Model: 6000
Gage S/N: 12345
Probe Model: FN
Probe S/N: 12345
User:
Part:
Substrate:

Readings - Exterior Shell Ring 5

Reading	Coat 1 (mil)
1	15.8
2	12.2
3	8.9
4	8.1
5	11.8
6	9.3
7	9.6
8	11.5
9	11.4
10	7.1

Summary - Exterior Shell Ring 5

	Coat 1 (mil)
Max	15.80
Min	7.10
Mean	10.57
StdDev.	2.51

Annotations - Exterior Shell Ring 5

Gage Model: 6000
Gage S/N: 12345
Probe Model: FN
Probe S/N: 12345
User:
Part:
Substrate:

Readings - Exterior Shell Ring 6

Reading	Coat 1 (mil)
1	10.5
2	7.7
3	10.6
4	8.6
5	8.8
6	14.1
7	9.5
8	9.1
9	7.4
10	8.0

Summary - Exterior Shell Ring 6

	Coat 1 (mil)
Max	14.10
Min	7.40
Mean	9.43
StdDev.	1.96

Annotations - Exterior Shell Ring 6

Gage Model: 6000
Gage S/N: 12345
Probe Model: FN
Probe S/N: 12345
User:
Part:
Substrate:

Readings - Exterior Shell Ring 7

Reading	Coat 1 (mil)
1	11.9
2	8.9
3	8.3
4	6.2
5	8.3
6	10.3
7	7.2
8	10.2
9	8.5
10	9.0

Summary - Exterior Shell Ring 7

Reading	Coat 1 (mil)
Max	11.90
Min	6.20
Mean	8.88
StdDev.	1.62

Annotations - Exterior Shell Ring 7

Gage Model: 6000
Gage S/N: 12345
Probe Model: FN
Probe S/N: 12345
User:
Part:
Substrate:

Readings - Exterior Shell Ring 8

Reading	Coat 1 (mil)
1	7.4
2	6.9
3	8.1
4	9.3
5	7.7
6	7.8
7	7.8
8	8.5
9	10.5
10	6.5

Summary - Exterior Shell Ring 8

Reading	Coat 1 (mil)
Max	10.50
Min	6.50
Mean	8.05
StdDev.	1.16

Annotations - Exterior Shell Ring 8

Gage Model: 6000
Gage S/N: 12345
Probe Model: FN
Probe S/N: 12345
User:
Part:
Substrate:

Readings - Exterior Shell Ring 9

Reading	Coat 1 (mil)
1	8.5
2	6.3
3	9.0
4	8.5
5	8.0
6	7.5
7	8.0
8	9.4
9	12.8
10	9.6

Summary - Exterior Shell Ring 9

Reading	Coat 1 (mil)
Max	12.80
Min	6.30
Mean	8.76
StdDev.	1.71

Annotations - Exterior Shell Ring 9

Gage Model: 6000
Gage S/N: 12345
Probe Model: FN
Probe S/N: 12345
User:
Part:
Substrate:

Readings - Exterior Shell Ring 10

Reading	Coat 1 (mil)
1	7.6
2	5.5
3	8.0
4	9.1
5	6.8
6	6.7
7	7.9
8	8.1
9	11.2
10	9.2

Summary - Exterior Shell Ring 10

Reading	Coat 1 (mil)
Max	11.20
Min	5.50
Mean	8.01
StdDev.	1.58

Annotations - Exterior Shell Ring 10

Gage Model: 6000
Gage S/N: 12345
Probe Model: FN
Probe S/N: 12345
User:
Part:
Substrate:

Readings - Exterior Shell Ring 11

Reading	Coat 1 (mil)
1	10.3
2	9.0
3	8.2
4	9.0
5	9.2
6	8.2
7	10.3
8	10.2
9	9.5
10	9.7

Summary - Exterior Shell Ring 11

	Coat 1 (mil)
Max	10.30
Min	8.20
Mean	9.36
StdDev.	0.79

Annotations - Exterior Shell Ring 11

Gage Model: 6000
Gage S/N: 12345
Probe Model: FN
Probe S/N: 12345
User:
Part:
Substrate:

Readings - Exterior Shell Ring 12

Reading	Coat 1 (mil)
1	9.6
2	9.0
3	8.8
4	6.2
5	7.4
6	7.4
7	8.0
8	9.8
9	8.5
10	9.0

Summary - Exterior Shell Ring 12

Reading	Coat 1 (mil)
Max	9.80
Min	6.20
Mean	8.37
StdDev.	1.12

Annotations - Exterior Shell Ring 12

Gage Model: 6000
Gage S/N: 12345
Probe Model: FN
Probe S/N: 12345
User:
Part:
Substrate:

Readings - Exterior Shell Ring 13

Reading	Coat 1 (mil)
1	12.3
2	12.1
3	8.9
4	10.8
5	8.9
6	8.6
7	10.3
8	9.2
9	10.2
10	8.5

Summary - Exterior Shell Ring 13

Reading	Coat 1 (mil)
Max	12.30
Min	8.50
Mean	9.98
StdDev.	1.40

Annotations - Exterior Shell Ring 13

Gage Model: 6000
Gage S/N: 12345
Probe Model: FN
Probe S/N: 12345
User:
Part:
Substrate:

Readings - Exterior Shell Ring 14

Reading	Coat 1 (mil)
1	10.3
2	8.9
3	9.2
4	9.6
5	12.4
6	10.7
7	9.8
8	8.2
9	12.7
10	9.9

Summary - Exterior Shell Ring 14

Reading	Coat 1 (mil)
Max	12.70
Min	8.20
Mean	10.17
StdDev.	1.44

Annotations - Exterior Shell Ring 14

Gage Model: 6000
Gage S/N: 12345
Probe Model: FN
Probe S/N: 12345
User:
Part:
Substrate:

Readings - Exterior Shell Ring 15

Reading	Coat 1 (mil)
1	12.8
2	7.2
3	11.1
4	9.5
5	14.2
6	11.3
7	10.5
8	9.0
9	10.4
10	10.9

Summary - Exterior Shell Ring 15

	Coat 1 (mil)
Max	14.20
Min	7.20
Mean	10.69
StdDev.	1.94

Annotations - Exterior Shell Ring 15

Gage Model: 6000
Gage S/N: 12345
Probe Model: FN
Probe S/N: 12345
User:
Part:
Substrate:

Readings - Exterior Shell Ring 16

Reading	Coat 1 (mil)
1	10.4
2	9.5
3	8.9
4	8.0
5	8.4
6	11.7
7	10.9
8	14.1
9	14.8
10	12.4

Summary - Exterior Shell Ring 16

	Coat 1 (mil)
Max	14.80
Min	8.00
Mean	10.91
StdDev.	2.34

Annotations - Exterior Shell Ring 16

Gage Model: 6000
Gage S/N: 12345
Probe Model: FN
Probe S/N: 12345
User:
Part:
Substrate:

Readings - Exterior Shell Ring 17

Reading	Coat 1 (mil)
1	12.3
2	11.6
3	9.4
4	11.1
5	12.0
6	15.3
7	18.1
8	14.6
9	13.7
10	13.6

Summary - Exterior Shell Ring 17

Reading	Coat 1 (mil)
Max	18.10
Min	9.40
Mean	13.17
StdDev.	2.46

Annotations - Exterior Shell Ring 17

Gage Model: 6000
Gage S/N: 12345
Probe Model: FN
Probe S/N: 12345
User:
Part:
Substrate:

Readings - Exterior Shell Ring 18

Reading	Coat 1 (mil)
1	11.0
2	10.9
3	13.7
4	12.1
5	12.6
6	9.8
7	10.5
8	13.8
9	12.2
10	15.3

Summary - Exterior Shell Ring 18

Reading	Coat 1 (mil)
Max	15.30
Min	9.80
Mean	12.19
StdDev.	1.71

Annotations - Exterior Shell Ring 18

Gage Model: 6000
Gage S/N: 12345
Probe Model: FN
Probe S/N: 12345
User:
Part:
Substrate:

Readings - Exterior Shell Ring 19

Reading	Coat 1 (mil)
1	12.7
2	10.9
3	11.8
4	11.7
5	12.1
6	7.2
7	9.5
8	10.7
9	15.7
10	12.0

Summary - Exterior Shell Ring 19

Reading	Coat 1 (mil)
Max	15.70
Min	7.20
Mean	11.43
StdDev.	2.19

Annotations - Exterior Shell Ring 19

Gage Model: 6000
Gage S/N: 12345
Probe Model: FN
Probe S/N: 12345
User:
Part:
Substrate:

Readings - Exterior Shell Ring 20

Reading	Coat 1 (mil)
1	10.7
2	7.7
3	7.8
4	12.4
5	8.5
6	9.0
7	10.8
8	10.1
9	11.8
10	10.3

Summary - Exterior Shell Ring 20

	Coat 1 (mil)
Max	12.40
Min	7.70
Mean	9.91
StdDev.	1.62

Annotations - Exterior Shell Ring 20

Gage Model: 6000
Gage S/N: 12345
Probe Model: FN
Probe S/N: 12345
User:
Part:
Substrate:

Readings - Exterior Overfow Pipe

	Reading	Coat 1 (mil)
	1	14.7
	2	8.6
	3	10.4
	4	10.4
	5	8.5
	6	9.6
	7	12.8
	8	11.2
	9	15.9
	10	10.8
	11	6.9
	12	11.8
	13	10.3
	14	10.7
	15	11.7
	16	19.1
	17	25.5
	18	16.2
	19	18.0
	20	11.5

Summary - Exterior Overfow Pipe

	Reading	Coat 1 (mil)
	Max	25.50
	Min	6.90
	Mean	12.73
	StdDev.	4.39

Annotations - Exterior Overfow Pipe

Gage Model: 6000
Gage S/N: 12345
Probe Model: FN
Probe S/N: 12345
User:
Part:
Substrate:

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Readings - Interior Shell Ring 1

Reading	Time & Date	Coat 1 (mil)
1	11:33:46 AM 3/11/2008	10.3
2	11:33:56 AM 3/11/2008	12.2
3	11:34:00 AM 3/11/2008	12.7
4	11:34:03 AM 3/11/2008	6.6
5	11:34:06 AM 3/11/2008	21.8
6	11:34:08 AM 3/11/2008	10.0
7	11:34:26 AM 3/11/2008	18.4
8	11:34:29 AM 3/11/2008	11.9
9	11:34:32 AM 3/11/2008	9.7
10	11:34:34 AM 3/11/2008	8.9
11	11:34:38 AM 3/11/2008	13.9
12	11:34:41 AM 3/11/2008	11.4
13	11:34:43 AM 3/11/2008	23.8
14	11:34:52 AM 3/11/2008	11.5
15	11:34:55 AM 3/11/2008	13.0
16	11:35:12 AM 3/11/2008	12.4
17	11:35:22 AM 3/11/2008	15.8
18	11:35:26 AM 3/11/2008	13.4
19	11:35:30 AM 3/11/2008	11.1
20	11:35:33 AM 3/11/2008	11.1

Summary - Interior Shell Ring 1

Reading	Time & Date	Coat 1 (mil)
Max		23.80
Min		6.60
Mean		12.99
StdDev.		4.18

Annotations - Interior Shell Ring 1

Gage Model: 6000F3
Gage S/N: 66013
Probe Model: F
Probe S/N: 43253
User:
Part:
Substrate:

Readings - Interior Shell Ring 2

Reading	Time & Date	Coat 1 (mil)
1	11:36:05 AM 3/11/2008	9.2
2	11:36:08 AM 3/11/2008	5.6
3	11:36:11 AM 3/11/2008	12.7
4	11:36:15 AM 3/11/2008	16.5
5	11:36:18 AM 3/11/2008	10.7
6	11:36:27 AM 3/11/2008	10.7
7	11:36:29 AM 3/11/2008	14.3
8	11:36:31 AM 3/11/2008	9.6
9	11:36:37 AM 3/11/2008	12.5
10	11:36:39 AM 3/11/2008	11.8
11	11:36:41 AM 3/11/2008	11.9
12	11:36:54 AM 3/11/2008	13.9
13	11:36:56 AM 3/11/2008	10.5
14	11:36:58 AM 3/11/2008	12.9
15	11:37:01 AM 3/11/2008	13.6
16	11:37:03 AM 3/11/2008	13.6
17	11:37:09 AM 3/11/2008	11.6
18	11:37:11 AM 3/11/2008	10.5
19	11:37:14 AM 3/11/2008	11.2
20	11:37:16 AM 3/11/2008	5.9

Summary - Interior Shell Ring 2

Reading	Time & Date	Coat 1 (mil)
Max		16.50
Min		5.60
Mean		11.46
StdDev.		2.62

Annotations - Interior Shell Ring 2

Gage Model: 6000F3
Gage S/N: 66013
Probe Model: F
Probe S/N: 43253
User:
Part:
Substrate:

Readings - Interior Shell Ring 3

Reading	Time & Date	Coat 1 (mil)
1	12:08:56 PM 3/11/2008	10.3
2	12:09:03 PM 3/11/2008	8.4
3	12:09:06 PM 3/11/2008	9.3
4	12:09:16 PM 3/11/2008	15.2
5	12:09:32 PM 3/11/2008	10.8
6	12:09:36 PM 3/11/2008	9.4
7	12:09:40 PM 3/11/2008	15.7
8	12:09:44 PM 3/11/2008	31.1
9	12:09:54 PM 3/11/2008	19.8
10	12:09:58 PM 3/11/2008	10.0
11	12:10:02 PM 3/11/2008	11.1
12	12:10:09 PM 3/11/2008	11.1
13	12:10:14 PM 3/11/2008	6.9
14	12:10:18 PM 3/11/2008	4.7
15	12:10:20 PM 3/11/2008	14.7
16	12:10:23 PM 3/11/2008	16.9
17	12:10:35 PM 3/11/2008	6.6
18	12:10:39 PM 3/11/2008	11.0
19	12:10:43 PM 3/11/2008	9.8
20	12:10:46 PM 3/11/2008	7.2

Summary - Interior Shell Ring 3

Reading	Time & Date	Coat 1 (mil)
Max		31.10
Min		4.70
Mean		12.00
StdDev.		5.87

Annotations - Interior Shell Ring 3

Gage Model: 6000F3
Gage S/N: 66013
Probe Model: F
Probe S/N: 43253
User:
Part:
Substrate:

Readings - Interior Shell Ring 4

Reading	Time & Date	Coat 1 (mil)
1	12:16:57 PM 3/11/2008	13.2
2	12:17:00 PM 3/11/2008	8.6
3	12:17:02 PM 3/11/2008	12.3
4	12:17:04 PM 3/11/2008	7.6
5	12:17:08 PM 3/11/2008	7.1
6	12:17:11 PM 3/11/2008	9.6
7	12:17:14 PM 3/11/2008	10.1
8	12:17:16 PM 3/11/2008	9.2
9	12:17:18 PM 3/11/2008	12.8
10	12:17:20 PM 3/11/2008	12.0
11	12:17:22 PM 3/11/2008	17.4
12	12:17:25 PM 3/11/2008	8.9
13	12:17:27 PM 3/11/2008	12.8
14	12:17:29 PM 3/11/2008	11.9
15	12:17:32 PM 3/11/2008	10.0
16	12:17:34 PM 3/11/2008	11.5
17	12:17:37 PM 3/11/2008	10.4
18	12:17:39 PM 3/11/2008	16.1
19	12:17:41 PM 3/11/2008	11.4
20	12:17:55 PM 3/11/2008	13.3

Summary - Interior Shell Ring 4

Reading	Time & Date	Coat 1 (mil)
Max		17.40
Min		7.10
Mean		11.31
StdDev.		2.61

Annotations - Interior Shell Ring 4

Gage Model: 6000F3
Gage S/N: 66013
Probe Model: F
Probe S/N: 43253
User:
Part:
Substrate:

Readings - Interior Shell Ring 5

Reading	Time & Date	Coat 1 (mil)
1	12:18:12 PM 3/11/2008	12.8
2	12:18:15 PM 3/11/2008	13.7
3	12:18:17 PM 3/11/2008	14.1
4	12:18:19 PM 3/11/2008	12.1
5	12:18:21 PM 3/11/2008	11.9
6	12:18:24 PM 3/11/2008	14.7
7	12:18:26 PM 3/11/2008	13.1
8	12:18:28 PM 3/11/2008	15.3
9	12:18:30 PM 3/11/2008	13.1
10	12:18:32 PM 3/11/2008	14.6
11	12:18:35 PM 3/11/2008	11.2
12	12:18:37 PM 3/11/2008	13.0
13	12:18:39 PM 3/11/2008	14.6
14	12:18:41 PM 3/11/2008	13.4
15	12:18:43 PM 3/11/2008	16.9
16	12:18:51 PM 3/11/2008	15.1
17	12:18:53 PM 3/11/2008	18.0
18	12:19:05 PM 3/11/2008	13.7
19	12:19:08 PM 3/11/2008	13.2
20	12:19:12 PM 3/11/2008	13.5

Summary - Interior Shell Ring 5

Reading	Time & Date	Coat 1 (mil)
Max		18.00
Min		11.20
Mean		13.90
StdDev.		1.62

Annotations - Interior Shell Ring 5

Gage Model: 6000F3
Gage S/N: 66013
Probe Model: F
Probe S/N: 43253
User:
Part:
Substrate:

Readings - Interior Shell Ring 6

Reading	Time & Date	Coat 1 (mil)
1	12:23:58 PM 3/11/2008	12.4
2	12:24:11 PM 3/11/2008	17.7
3	12:24:13 PM 3/11/2008	11.6
4	12:24:15 PM 3/11/2008	9.9
5	12:24:17 PM 3/11/2008	10.7
6	12:24:19 PM 3/11/2008	20.6
7	12:24:22 PM 3/11/2008	14.7
8	12:24:24 PM 3/11/2008	18.6
9	12:24:26 PM 3/11/2008	13.7
10	12:24:29 PM 3/11/2008	15.6
11	12:24:31 PM 3/11/2008	13.5
12	12:24:33 PM 3/11/2008	12.0
13	12:24:36 PM 3/11/2008	29.9
14	12:24:38 PM 3/11/2008	12.6
15	12:24:40 PM 3/11/2008	12.5
16	12:24:49 PM 3/11/2008	16.9
17	12:24:51 PM 3/11/2008	9.3
18	12:24:54 PM 3/11/2008	9.0
19	12:24:59 PM 3/11/2008	17.5
20	12:25:01 PM 3/11/2008	15.3

Summary - Interior Shell Ring 6

Reading	Time & Date	Coat 1 (mil)
Max		29.90
Min		9.00
Mean		14.70
StdDev.		4.80

Annotations - Interior Shell Ring 6

Gage Model: 6000F3
Gage S/N: 66013
Probe Model: F
Probe S/N: 43253
User:
Part:
Substrate:

Readings - Interior Shell Ring 7

Reading	Time & Date	Coat 1 (mil)
1	12:25:11 PM 3/11/2008	10.1
2	12:25:13 PM 3/11/2008	14.2
3	12:25:17 PM 3/11/2008	13.0
4	12:25:19 PM 3/11/2008	13.3
5	12:25:21 PM 3/11/2008	12.1
6	12:25:23 PM 3/11/2008	13.5
7	12:25:24 PM 3/11/2008	23.4
8	12:25:27 PM 3/11/2008	11.2
9	12:25:29 PM 3/11/2008	12.2
10	12:25:31 PM 3/11/2008	12.4
11	12:25:33 PM 3/11/2008	13.6
12	12:25:35 PM 3/11/2008	13.4
13	12:25:37 PM 3/11/2008	13.6
14	12:25:39 PM 3/11/2008	15.6
15	12:25:42 PM 3/11/2008	12.1
16	12:25:45 PM 3/11/2008	11.4
17	12:25:47 PM 3/11/2008	9.8
18	12:25:49 PM 3/11/2008	8.8
19	12:25:51 PM 3/11/2008	11.1
20	12:25:53 PM 3/11/2008	10.3

Summary - Interior Shell Ring 7

Reading	Time & Date	Coat 1 (mil)
Max		23.40
Min		8.80
Mean		12.76
StdDev.		3.01

Annotations - Interior Shell Ring 7

Gage Model: 6000F3
Gage S/N: 66013
Probe Model: F
Probe S/N: 43253
User:
Part:
Substrate:

Readings - Interior Shell Ring 8

Reading	Time & Date	Coat 1 (mil)
1	12:29:56 PM 3/11/2008	14.7
2	12:29:58 PM 3/11/2008	18.8
3	12:30:02 PM 3/11/2008	14.8
4	12:30:04 PM 3/11/2008	18.2
5	12:30:06 PM 3/11/2008	15.1
6	12:30:08 PM 3/11/2008	16.8
7	12:30:10 PM 3/11/2008	14.6
8	12:30:12 PM 3/11/2008	14.8
9	12:30:14 PM 3/11/2008	18.9
10	12:30:16 PM 3/11/2008	12.5
11	12:30:18 PM 3/11/2008	12.6
12	12:30:21 PM 3/11/2008	28.5
13	12:30:23 PM 3/11/2008	18.0
14	12:30:33 PM 3/11/2008	14.6
15	12:30:35 PM 3/11/2008	13.4
16	12:30:37 PM 3/11/2008	14.3
17	12:30:39 PM 3/11/2008	9.5
18	12:30:41 PM 3/11/2008	13.5
19	12:30:43 PM 3/11/2008	14.6
20	12:30:47 PM 3/11/2008	11.4

Summary - Interior Shell Ring 8

Reading	Time & Date	Coat 1 (mil)
Max		28.50
Min		9.50
Mean		15.48
StdDev.		3.91

Annotations - Interior Shell Ring 8

Gage Model: 6000F3
Gage S/N: 66013
Probe Model: F
Probe S/N: 43253
User:
Part:
Substrate:

Readings - Interior Shell Ring 9

Reading	Time & Date	Coat 1 (mil)
1	12:31:00 PM 3/11/2008	10.1
2	12:31:02 PM 3/11/2008	28.6
3	12:31:04 PM 3/11/2008	12.1
4	12:31:06 PM 3/11/2008	11.2
5	12:31:08 PM 3/11/2008	9.7
6	12:31:11 PM 3/11/2008	19.3
7	12:31:13 PM 3/11/2008	29.9
8	12:31:15 PM 3/11/2008	13.2
9	12:31:18 PM 3/11/2008	15.4
10	12:31:20 PM 3/11/2008	13.2
11	12:31:22 PM 3/11/2008	12.9
12	12:31:35 PM 3/11/2008	11.6
13	12:31:37 PM 3/11/2008	24.5
14	12:31:39 PM 3/11/2008	14.8
15	12:31:41 PM 3/11/2008	13.5
16	12:31:43 PM 3/11/2008	11.9
17	12:31:45 PM 3/11/2008	21.0
18	12:31:47 PM 3/11/2008	10.6
19	12:31:50 PM 3/11/2008	11.1
20	12:31:52 PM 3/11/2008	15.3

Summary - Interior Shell Ring 9

Reading	Time & Date	Coat 1 (mil)
Max		29.90
Min		9.70
Mean		15.49
StdDev.		6.03

Annotations - Interior Shell Ring 9

Gage Model: 6000F3
Gage S/N: 66013
Probe Model: F
Probe S/N: 43253
User:
Part:
Substrate:

Readings - Interior Shell Ring 10

Reading	Time & Date	Coat 1 (mil)
1	12:37:32 PM 3/11/2008	20.8
2	12:37:37 PM 3/11/2008	20.8
3	12:37:39 PM 3/11/2008	22.3
4	12:37:41 PM 3/11/2008	16.5
5	12:37:44 PM 3/11/2008	12.5
6	12:37:46 PM 3/11/2008	10.7
7	12:37:48 PM 3/11/2008	22.5
8	12:37:56 PM 3/11/2008	7.3
9	12:37:58 PM 3/11/2008	6.9
10	12:38:00 PM 3/11/2008	9.8
11	12:38:02 PM 3/11/2008	10.5
12	12:38:04 PM 3/11/2008	7.2
13	12:38:07 PM 3/11/2008	7.7
14	12:38:09 PM 3/11/2008	9.3
15	12:38:11 PM 3/11/2008	13.0
16	12:38:14 PM 3/11/2008	29.5
17	12:38:18 PM 3/11/2008	22.8
18	12:38:20 PM 3/11/2008	10.3
19	12:38:22 PM 3/11/2008	11.1
20	12:38:26 PM 3/11/2008	13.5

Summary - Interior Shell Ring 10

Reading	Time & Date	Coat 1 (mil)
Max		29.50
Min		6.90
Mean		14.25
StdDev.		6.59

Annotations - Interior Shell Ring 10

Gage Model: 6000F3
Gage S/N: 66013
Probe Model: F
Probe S/N: 43253
User:
Part:
Substrate:

Readings - Interior Shell Ring 11

Reading	Time & Date	Coat 1 (mil)
1	12:38:41 PM 3/11/2008	33.0
2	12:38:45 PM 3/11/2008	8.4
3	12:38:47 PM 3/11/2008	9.3
4	12:38:49 PM 3/11/2008	8.3
5	12:38:56 PM 3/11/2008	17.8
6	12:38:58 PM 3/11/2008	10.2
7	12:39:01 PM 3/11/2008	11.4
8	12:39:03 PM 3/11/2008	8.9
9	12:39:13 PM 3/11/2008	15.7
10	12:39:16 PM 3/11/2008	9.2
11	12:39:19 PM 3/11/2008	10.6
12	12:39:21 PM 3/11/2008	7.9
13	12:39:26 PM 3/11/2008	14.2
14	12:39:28 PM 3/11/2008	12.0
15	12:39:30 PM 3/11/2008	8.8
16	12:39:44 PM 3/11/2008	18.4
17	12:39:46 PM 3/11/2008	12.6
18	12:39:48 PM 3/11/2008	16.3
19	12:39:50 PM 3/11/2008	15.0
20	12:39:53 PM 3/11/2008	15.2

Summary - Interior Shell Ring 11

Reading	Time & Date	Coat 1 (mil)
Max		33.00
Min		7.90
Mean		13.16
StdDev.		5.76

Annotations - Interior Shell Ring 11

Gage Model: 6000F3
Gage S/N: 66013
Probe Model: F
Probe S/N: 43253
User:
Part:
Substrate:

Readings - Interior Shell Ring 12

Reading	Time & Date	Coat 1 (mil)
1	12:46:45 PM 3/11/2008	14.6
2	12:46:51 PM 3/11/2008	29.7
3	12:46:53 PM 3/11/2008	22.5
4	12:46:55 PM 3/11/2008	27.8
5	12:46:57 PM 3/11/2008	12.7
6	12:46:59 PM 3/11/2008	13.9
7	12:47:01 PM 3/11/2008	9.2
8	12:47:07 PM 3/11/2008	13.3
9	12:47:09 PM 3/11/2008	14.4
10	12:47:11 PM 3/11/2008	13.7
11	12:47:14 PM 3/11/2008	13.4
12	12:47:16 PM 3/11/2008	10.5
13	12:47:18 PM 3/11/2008	22.2
14	12:47:20 PM 3/11/2008	12.3
15	12:47:22 PM 3/11/2008	13.4
16	12:47:24 PM 3/11/2008	11.0
17	12:47:27 PM 3/11/2008	11.5
18	12:47:29 PM 3/11/2008	10.0
19	12:47:31 PM 3/11/2008	8.9
20	12:47:33 PM 3/11/2008	11.0

Summary - Interior Shell Ring 12

Reading	Time & Date	Coat 1 (mil)
Max		29.70
Min		8.90
Mean		14.80
StdDev.		5.95

Annotations - Interior Shell Ring 12

Gage Model: 6000F3
Gage S/N: 66013
Probe Model: F
Probe S/N: 43253
User:
Part:
Substrate:

Readings - Interior Shell Ring 13

Reading	Time & Date	Coat 1 (mil)
1	12:47:43 PM 3/11/2008	11.2
2	12:47:45 PM 3/11/2008	14.6
3	12:47:47 PM 3/11/2008	21.9
4	12:47:53 PM 3/11/2008	21.4
5	12:47:55 PM 3/11/2008	19.1
6	12:47:56 PM 3/11/2008	9.0
7	12:47:59 PM 3/11/2008	7.8
8	12:48:01 PM 3/11/2008	11.4
9	12:48:03 PM 3/11/2008	10.1
10	12:48:05 PM 3/11/2008	9.2
11	12:48:07 PM 3/11/2008	10.0
12	12:48:33 PM 3/11/2008	11.6
13	12:48:35 PM 3/11/2008	18.7
14	12:48:38 PM 3/11/2008	17.4
15	12:48:41 PM 3/11/2008	10.0
16	12:48:43 PM 3/11/2008	9.0
17	12:48:45 PM 3/11/2008	7.2
18	12:48:48 PM 3/11/2008	8.7
19	12:48:50 PM 3/11/2008	11.7
20	12:48:52 PM 3/11/2008	28.8

Summary - Interior Shell Ring 13

Reading	Time & Date	Coat 1 (mil)
Max		28.80
Min		7.20
Mean		13.44
StdDev.		5.84

Annotations - Interior Shell Ring 13

Gage Model: 6000F3
Gage S/N: 66013
Probe Model: F
Probe S/N: 43253
User:
Part:
Substrate:

Readings - Interior Shell Ring 14

Reading	Time & Date	Coat 1 (mil)
1	12:54:07 PM 3/11/2008	7.6
2	12:54:14 PM 3/11/2008	14.7
3	12:54:20 PM 3/11/2008	8.6
4	12:54:25 PM 3/11/2008	10.0
5	12:54:27 PM 3/11/2008	9.9
6	12:54:30 PM 3/11/2008	18.5
7	12:54:33 PM 3/11/2008	7.5
8	12:54:39 PM 3/11/2008	15.2
9	12:54:41 PM 3/11/2008	19.6
10	12:54:43 PM 3/11/2008	8.2
11	12:54:46 PM 3/11/2008	10.9
12	12:54:54 PM 3/11/2008	9.2
13	12:54:57 PM 3/11/2008	11.9
14	12:54:59 PM 3/11/2008	21.8
15	12:55:02 PM 3/11/2008	9.5
16	12:55:04 PM 3/11/2008	19.2
17	12:55:07 PM 3/11/2008	11.2
18	12:55:09 PM 3/11/2008	11.6
19	12:55:11 PM 3/11/2008	11.8
20	12:55:13 PM 3/11/2008	11.3

Summary - Interior Shell Ring 14

Reading	Time & Date	Coat 1 (mil)
Max		21.80
Min		7.50
Mean		12.41
StdDev.		4.31

Annotations - Interior Shell Ring 14

Gage Model: 6000F3
Gage S/N: 66013
Probe Model: F
Probe S/N: 43253
User:
Part:
Substrate:

Readings - Interior Shell Ring 15

Reading	Time & Date	Coat 1 (mil)
1	12:55:25 PM 3/11/2008	11.4
2	12:55:32 PM 3/11/2008	12.5
3	12:55:34 PM 3/11/2008	9.6
4	12:55:36 PM 3/11/2008	8.7
5	12:55:39 PM 3/11/2008	10.4
6	12:55:41 PM 3/11/2008	9.4
7	12:55:43 PM 3/11/2008	11.4
8	12:55:45 PM 3/11/2008	7.4
9	12:55:51 PM 3/11/2008	10.1
10	12:55:53 PM 3/11/2008	12.1
11	12:55:55 PM 3/11/2008	12.0
12	12:55:57 PM 3/11/2008	7.9
13	12:55:59 PM 3/11/2008	8.6
14	12:56:01 PM 3/11/2008	10.3
15	12:56:03 PM 3/11/2008	11.4
16	12:56:15 PM 3/11/2008	16.6
17	12:56:17 PM 3/11/2008	10.0
18	12:56:19 PM 3/11/2008	11.9
19	12:56:21 PM 3/11/2008	14.8
20	12:56:24 PM 3/11/2008	15.0

Summary - Interior Shell Ring 15

Reading	Time & Date	Coat 1 (mil)
Max		16.60
Min		7.40
Mean		11.07
StdDev.		2.39

Annotations - Interior Shell Ring 15

Gage Model: 6000F3
Gage S/N: 66013
Probe Model: F
Probe S/N: 43253
User:
Part:
Substrate:

Readings - Interior Shell Ring 16

Reading	Time & Date	Coat 1 (mil)
1	1:03:07 PM 3/11/2008	10.0
2	1:03:09 PM 3/11/2008	10.4
3	1:03:11 PM 3/11/2008	10.4
4	1:03:16 PM 3/11/2008	10.9
5	1:03:18 PM 3/11/2008	13.8
6	1:03:20 PM 3/11/2008	9.6
7	1:03:22 PM 3/11/2008	10.7
8	1:03:24 PM 3/11/2008	9.1
9	1:03:27 PM 3/11/2008	11.7
10	1:03:29 PM 3/11/2008	10.6
11	1:03:31 PM 3/11/2008	8.9
12	1:03:33 PM 3/11/2008	7.8
13	1:03:35 PM 3/11/2008	11.7
14	1:03:37 PM 3/11/2008	10.9
15	1:03:39 PM 3/11/2008	9.0
16	1:03:42 PM 3/11/2008	9.1
17	1:03:46 PM 3/11/2008	17.3
18	1:03:48 PM 3/11/2008	12.9
19	1:03:50 PM 3/11/2008	13.6
20	1:03:52 PM 3/11/2008	13.0

Summary - Interior Shell Ring 16

Reading	Time & Date	Coat 1 (mil)
Max		17.30
Min		7.80
Mean		11.07
StdDev.		2.21

Annotations - Interior Shell Ring 16

Gage Model: 6000F3
Gage S/N: 66013
Probe Model: F
Probe S/N: 43253
User:
Part:
Substrate:

Readings - Interior Shell Ring 17

Reading	Time & Date	Coat 1 (mil)
1	1:04:03 PM 3/11/2008	8.1
2	1:04:05 PM 3/11/2008	8.8
3	1:04:07 PM 3/11/2008	7.4
4	1:04:09 PM 3/11/2008	12.1
5	1:04:11 PM 3/11/2008	10.4
6	1:04:13 PM 3/11/2008	8.9
7	1:04:15 PM 3/11/2008	16.5
8	1:04:17 PM 3/11/2008	9.2
9	1:04:19 PM 3/11/2008	9.5
10	1:04:22 PM 3/11/2008	28.9
11	1:04:24 PM 3/11/2008	7.6
12	1:04:26 PM 3/11/2008	8.6
13	1:04:28 PM 3/11/2008	9.9
14	1:04:43 PM 3/11/2008	10.6
15	1:04:45 PM 3/11/2008	8.9
16	1:04:47 PM 3/11/2008	10.1
17	1:04:49 PM 3/11/2008	9.4
18	1:04:52 PM 3/11/2008	10.5
19	1:04:54 PM 3/11/2008	9.7
20	1:04:56 PM 3/11/2008	14.5

Summary - Interior Shell Ring 17

Reading	Time & Date	Coat 1 (mil)
Max		28.90
Min		7.40
Mean		10.98
StdDev.		4.75

Annotations - Interior Shell Ring 17

Gage Model: 6000F3
Gage S/N: 66013
Probe Model: F
Probe S/N: 43253
User:
Part:
Substrate:

Readings - Interior Shell Ring 18

Reading	Time & Date	Coat 1 (mil)
1	1:05:14 PM 3/11/2008	10.7
2	1:05:16 PM 3/11/2008	10.9
3	1:05:18 PM 3/11/2008	11.9
4	1:05:20 PM 3/11/2008	9.8
5	1:05:22 PM 3/11/2008	7.3
6	1:05:24 PM 3/11/2008	9.8
7	1:05:26 PM 3/11/2008	7.3
8	1:05:28 PM 3/11/2008	7.8
9	1:05:30 PM 3/11/2008	9.2
10	1:05:32 PM 3/11/2008	7.2
11	1:05:34 PM 3/11/2008	7.3
12	1:05:36 PM 3/11/2008	7.4
13	1:05:39 PM 3/11/2008	9.8
14	1:05:41 PM 3/11/2008	7.6
15	1:05:43 PM 3/11/2008	11.5
16	1:05:45 PM 3/11/2008	10.6
17	1:05:47 PM 3/11/2008	13.0
18	1:05:49 PM 3/11/2008	9.4
19	1:05:51 PM 3/11/2008	10.3
20	1:05:53 PM 3/11/2008	11.6

Summary - Interior Shell Ring 18

Reading	Time & Date	Coat 1 (mil)
Max		13.00
Min		7.20
Mean		9.52
StdDev.		1.82

Annotations - Interior Shell Ring 18

Gage Model: 6000F3
Gage S/N: 66013
Probe Model: F
Probe S/N: 43253
User:
Part:
Substrate:

Readings - Interior Shell Ring 19

Reading	Time & Date	Coat 1 (mil)
1	1:06:12 PM 3/11/2008	11.4
2	1:06:14 PM 3/11/2008	11.4
3	1:06:16 PM 3/11/2008	15.9
4	1:06:18 PM 3/11/2008	15.9
5	1:06:21 PM 3/11/2008	11.3
6	1:06:22 PM 3/11/2008	14.2
7	1:06:25 PM 3/11/2008	11.4
8	1:06:27 PM 3/11/2008	16.3
9	1:06:29 PM 3/11/2008	13.5
10	1:06:32 PM 3/11/2008	10.3
11	1:06:34 PM 3/11/2008	9.7
12	1:06:36 PM 3/11/2008	16.9
13	1:06:38 PM 3/11/2008	14.0
14	1:06:40 PM 3/11/2008	8.1
15	1:06:42 PM 3/11/2008	9.1
16	1:06:45 PM 3/11/2008	10.9
17	1:06:47 PM 3/11/2008	9.7
18	1:06:49 PM 3/11/2008	12.5
19	1:06:51 PM 3/11/2008	11.9
20	1:06:57 PM 3/11/2008	9.3

Summary - Interior Shell Ring 19

Reading	Time & Date	Coat 1 (mil)
Max		16.90
Min		8.10
Mean		12.18
StdDev.		2.62

Annotations - Interior Shell Ring 19

Gage Model: 6000F3
Gage S/N: 66013
Probe Model: F
Probe S/N: 43253
User:
Part:
Substrate:

Readings - Interior Shell Ring 20

Reading	Time & Date	Coat 1 (mil)
1	1:07:10 PM 3/11/2008	6.3
2	1:07:12 PM 3/11/2008	6.3
3	1:07:19 PM 3/11/2008	10.9
4	1:07:22 PM 3/11/2008	7.6
5	1:07:24 PM 3/11/2008	6.3
6	1:07:33 PM 3/11/2008	7.7
7	1:07:35 PM 3/11/2008	6.8
8	1:07:38 PM 3/11/2008	8.2
9	1:07:40 PM 3/11/2008	8.4
10	1:07:43 PM 3/11/2008	8.6
11	1:07:45 PM 3/11/2008	10.5
12	1:07:48 PM 3/11/2008	6.7
13	1:07:50 PM 3/11/2008	7.1
14	1:07:53 PM 3/11/2008	9.3
15	1:07:55 PM 3/11/2008	9.1
16	1:08:01 PM 3/11/2008	10.2
17	1:08:03 PM 3/11/2008	11.0
18	1:08:06 PM 3/11/2008	7.7
19	1:08:14 PM 3/11/2008	9.7
20	1:08:17 PM 3/11/2008	9.5

Summary - Interior Shell Ring 20

Reading	Time & Date	Coat 1 (mil)
Max		11.00
Min		6.30
Mean		8.39
StdDev.		1.57

Annotations - Interior Shell Ring 20

Gage Model: 6000F3
Gage S/N: 66013
Probe Model: F
Probe S/N: 43253
User:
Part:
Substrate:

Readings - Interior Shell Elasto-shield

Reading	Time & Date	Coat 1 (mil)
1	2:31:17 PM 3/11/2008	60.8
2	2:31:19 PM 3/11/2008	33.9
3	2:31:21 PM 3/11/2008	38.4
4	2:31:26 PM 3/11/2008	25.8
5	2:31:30 PM 3/11/2008	23.0
6	2:31:32 PM 3/11/2008	24.5
7	2:31:36 PM 3/11/2008	17.2
8	2:31:38 PM 3/11/2008	20.5
9	2:31:41 PM 3/11/2008	27.5
10	2:31:45 PM 3/11/2008	21.0
11	2:31:47 PM 3/11/2008	43.6
12	2:32:06 PM 3/11/2008	38.6
13	2:32:08 PM 3/11/2008	41.1
14	2:32:28 PM 3/11/2008	29.2
15	2:32:32 PM 3/11/2008	72.7
16	2:32:34 PM 3/11/2008	25.3
17	2:32:37 PM 3/11/2008	69.0
18	2:32:42 PM 3/11/2008	32.3
19	2:32:44 PM 3/11/2008	32.8
20	2:32:46 PM 3/11/2008	27.4
21	2:32:48 PM 3/11/2008	27.9
22	2:32:50 PM 3/11/2008	31.8
23	2:32:54 PM 3/11/2008	27.4
24	2:32:58 PM 3/11/2008	39.5
25	2:33:00 PM 3/11/2008	34.4
26	2:33:02 PM 3/11/2008	30.2
27	2:33:04 PM 3/11/2008	26.4
28	2:33:06 PM 3/11/2008	47.9
29	2:33:08 PM 3/11/2008	32.4
30	2:33:10 PM 3/11/2008	32.8
31	2:33:12 PM 3/11/2008	30.9
32	2:33:15 PM 3/11/2008	23.8
33	2:33:17 PM 3/11/2008	27.2
34	2:33:23 PM 3/11/2008	31.6
35	2:33:25 PM 3/11/2008	46.8
36	2:33:27 PM 3/11/2008	22.5
37	2:33:29 PM 3/11/2008	51.6
38	2:33:33 PM 3/11/2008	34.9
39	2:33:35 PM 3/11/2008	46.2
40	2:33:38 PM 3/11/2008	31.3
41	2:33:40 PM 3/11/2008	20.0

Summary - Interior Shell Elasto-shield

Reading	Time & Date	Coat 1 (mil)
Max		72.70
Min		17.20
Mean		34.20
StdDev.		12.48

Annotations - Interior Shell Elasto-shield

Gage Model: 6000F3
Gage S/N: 66013
Probe Model: F
Probe S/N: 43253
User:
Part:
Substrate:

Readings - Interior Floor Plates

Reading	Time & Date	Coat 1 (mil)
1	3:12:26 PM 3/11/2008	9.5
2	3:12:28 PM 3/11/2008	8.5
3	3:12:33 PM 3/11/2008	10.6
4	3:12:36 PM 3/11/2008	10.5
5	3:12:38 PM 3/11/2008	13.3
6	3:12:40 PM 3/11/2008	11.8
7	3:12:47 PM 3/11/2008	14.4
8	3:12:49 PM 3/11/2008	13.1
9	3:12:51 PM 3/11/2008	13.7
10	3:12:53 PM 3/11/2008	20.0
11	3:12:56 PM 3/11/2008	26.6
12	3:12:58 PM 3/11/2008	22.7
13	3:13:00 PM 3/11/2008	27.8
14	3:13:02 PM 3/11/2008	26.0
15	3:13:08 PM 3/11/2008	26.0
16	3:13:10 PM 3/11/2008	26.9
17	3:13:12 PM 3/11/2008	24.7
18	3:13:15 PM 3/11/2008	29.3
19	3:13:17 PM 3/11/2008	14.2
20	3:13:21 PM 3/11/2008	14.3

Summary - Interior Floor Plates

Reading	Time & Date	Coat 1 (mil)
Max		29.30
Min		8.50
Mean		18.19
StdDev.		7.23

Annotations - Interior Floor Plates

Gage Model: 6000F3
Gage S/N: 66013
Probe Model: F
Probe S/N: 43253
User:
Part:
Substrate:

Readings - Interior Floor Elasto-shield

Reading	Time & Date	Coat 1 (mil)
1	3:13:44 PM 3/11/2008	59.5
2	3:13:47 PM 3/11/2008	51.8
3	3:13:49 PM 3/11/2008	46.1
4	3:13:51 PM 3/11/2008	54.7
5	3:13:53 PM 3/11/2008	55.1
6	3:13:55 PM 3/11/2008	58.4
7	3:14:00 PM 3/11/2008	49.6
8	3:14:02 PM 3/11/2008	48.6
9	3:14:04 PM 3/11/2008	42.9
10	3:14:07 PM 3/11/2008	52.4

Summary - Interior Floor Elasto-shield

Reading	Time & Date	Coat 1 (mil)
Max		59.50
Min		42.90
Mean		51.91
StdDev.		5.26

Annotations - Interior Floor Elasto-shield

Gage Model: 6000F3
Gage S/N: 66013
Probe Model: F
Probe S/N: 43253
User:
Part:
Substrate:

GROUNDWATER ANALYTICAL

Groundwater Analytical, Inc.
P.O. Box 1200
228 Main Street
Buzzards Bay, MA 02532

Telephone (508) 759-4441
FAX (508) 759-4475
www.groundwateranalytical.com

April 2, 2008

Mr. David Merithew
R.L. Merithew Inc.
110 Elm St, #10
Bridgewater, MA 02324

LABORATORY REPORT

Project: **MA-Barnstable Mary Dunn #1**
Lab ID: **115781**
Received: **03-20-08**

Dear David:

Enclosed are the analytical results for the above referenced project. The project was processed for Standard turnaround.

This letter authorizes the release of the analytical results, and should be considered a part of this report. This report contains a sample receipt report detailing the samples received, a project narrative indicating project changes and non-conformances, a quality control report, and a statement of our state certifications.

The analytical results contained in this report meet all applicable NELAC or NVLAP standards, except as may be specifically noted, or described in the project narrative. The analytical results relate only to the samples received. This report may only be used or reproduced in its entirety.

I attest under the pains and penalties of perjury that, based upon my inquiry of those individuals immediately responsible for obtaining the information, the material contained in this report is, to the best of my knowledge and belief, accurate and complete.

Should you have any questions concerning this report, please do not hesitate to contact me.

Sincerely,

Eric H. Jensen
Operations Manager

EHJ/elm
Enclosures

GROUNDWATER ANALYTICAL

Sample Receipt Report

Project: **MA-Barnstable Mary Dunn #1**
Client: **R.L. Merithew Inc.**
Lab ID: **115781**

Delivery: **GWA Courier**
Airbill: **n/a**
Lab Receipt: **03-20-08**

Temperature: **n/a**
Chain of Custody: **Present**
Custody Seal(s): **n/a**

Lab ID	Field ID		Matrix	Sampled	Method				Notes
115781-1	Interior Floor		Solid	3/11/08 0:00	EPA 6010B/7471A 5 RCRA Metals				
Con ID	**Container**	**Vendor**	**QC Lot**	**Preserv**	**QC Lot**	**Prep**	**Ship**		
C1088390	Plastic Bag	n/a	n/a	None	n/a	n/a	n/a		

Lab ID	Field ID		Matrix	Sampled	Method				Notes
115781-2	Interior Shell Ring #3		Solid	3/11/08 0:00	EPA 6010B/7471A 5 RCRA Metals				
Con ID	**Container**	**Vendor**	**QC Lot**	**Preserv**	**QC Lot**	**Prep**	**Ship**		
C1088391	Plastic Bag	n/a	n/a	None	n/a	n/a	n/a		

Lab ID	Field ID		Matrix	Sampled	Method				Notes
115781-3	Interior Shell Ring #16		Solid	3/11/08 0:00	EPA 6010B/7471A 5 RCRA Metals				
Con ID	**Container**	**Vendor**	**QC Lot**	**Preserv**	**QC Lot**	**Prep**	**Ship**		
C1088392	Plastic Bag	n/a	n/a	None	n/a	n/a	n/a		

Lab ID	Field ID		Matrix	Sampled	Method				Notes
115781-4	Interior Sealer		Solid	3/11/08 0:00	EPA 6010B/7471A 5 RCRA Metals				
Con ID	**Container**	**Vendor**	**QC Lot**	**Preserv**	**QC Lot**	**Prep**	**Ship**		
C1088393	Plastic Bag	n/a	n/a	None	n/a	n/a	n/a		

Lab ID	Field ID		Matrix	Sampled	Method				Notes
115781-5	Exterior Bottom Ring		Solid	3/13/08 0:00	EPA 6010B/7471A 5 RCRA Metals				
Con ID	**Container**	**Vendor**	**QC Lot**	**Preserv**	**QC Lot**	**Prep**	**Ship**		
C1088394	Plastic Bag	n/a	n/a	None	n/a	n/a	n/a		

Lab ID	Field ID		Matrix	Sampled	Method				Notes
115781-6	Exterior Shell Ring #14		Solid	3/13/08 0:00	EPA 6010B/7471A 5 RCRA Metals				
Con ID	**Container**	**Vendor**	**QC Lot**	**Preserv**	**QC Lot**	**Prep**	**Ship**		
C1088395	Plastic Bag	n/a	n/a	None	n/a	n/a	n/a		

Lab ID	Field ID		Matrix	Sampled	Method				Notes
115781-7	Exterior Shell Ring #20		Solid	3/13/08 0:00	EPA 6010B/7471A 5 RCRA Metals				
Con ID	**Container**	**Vendor**	**QC Lot**	**Preserv**	**QC Lot**	**Prep**	**Ship**		
C1088396	Plastic Bag	n/a	n/a	None	n/a	n/a	n/a		

GROUNDWATER ANALYTICAL

Trace Metals

Field ID:	**Interior Floor**	Matrix:	**Solid**
Project:	**MA-Barnstable Mary Dunn #1**	Container:	**Plastic Bag**
Client:	**R.L. Merithew Inc.**	Preservation:	**Cool**
Laboratory ID:	**115781-1**	Percent Solids:	**n/a**
Sampled:	**03-11-08 00:00**		
Received:	**03-20-08 15:37**		

Analysis Method	QC Batch ID	Prep Method	Prepared	Sample Weight	Instrument ID	Analyst
EPA 6010B[1]	MB-01404-S	EPA 3050B	03-21-08 08:08	0.221 g	ICP-1 PE 3000	MWR
EPA 7471A[2]	MP-2272-S	EPA 7471A	03-21-08 10:35	0.6 g	CVAA-1 PE FIMS	MFP

CAS Number	Analyte	Concentration	Notes	Units	Reporting Limit	DF	Analyzed	Method
7440-38-2	Arsenic, Total	BRL		mg/Kg	6.8	1	03-24-08 12:06	EPA 6010B[1]
7440-43-9	Cadmium, Total	BRL		mg/Kg	1.1	1	03-24-08 12:06	EPA 6010B[1]
7440-47-3	Chromium, Total	BRL		mg/Kg	23	1	03-24-08 12:06	EPA 6010B[1]
7439-92-1	Lead, Total	**150**		mg/Kg	23	1	03-24-08 12:06	EPA 6010B[1]
7439-97-6	Mercury, Total	BRL		mg/Kg	0.028	1	03-21-08 20:45	EPA 7471A[2]

Method Reference: Test Methods for Evaluating Solid Waste, US EPA, SW-846, Third Edition, Update III (1996).

Report Notations: BRL Indicates concentration, if any, is below reporting limit for analyte. Reporting limit is the lowest concentration that can be reliably quantified under routine laboratory operating conditions. Reporting limits are adjusted for sample size and dilution.

DF Dilution Factor.

GROUNDWATER ANALYTICAL

Trace Metals

Field ID:	**Interior Shell Ring #3**	Matrix:	**Solid**
Project:	**MA-Barnstable Mary Dunn #1**	Container:	**Plastic Bag**
Client:	**R.L. Merithew Inc.**	Preservation:	**Cool**
Laboratory ID:	**115781-2**	Percent Solids:	**n/a**
Sampled:	**03-11-08 00:00**		
Received:	**03-20-08 15:37**		

Analysis Method	QC Batch ID	Prep Method	Prepared	Sample Weight	Instrument ID	Analyst
EPA 6010B[1]	MB-01404-S	EPA 3050B	03-21-08 08:08	0.214 g	ICP-1 PE 3000	MWR
EPA 7471A[2]	MP-2272-S	EPA 7471A	03-21-08 10:35	0.6 g	CVAA-1 PE FIMS	MFP

CAS Number	Analyte	Concentration	Notes	Units	Reporting Limit	DF	Analyzed	Method
7440-38-2	Arsenic, Total	BRL		mg/Kg	7.0	1	03-24-08 12:09	EPA 6010B[1]
7440-43-9	Cadmium, Total	BRL		mg/Kg	1.2	1	03-24-08 12:09	EPA 6010B[1]
7440-47-3	Chromium, Total	BRL		mg/Kg	23	1	03-24-08 12:09	EPA 6010B[1]
7439-92-1	Lead, Total	BRL		mg/Kg	23	1	03-24-08 12:09	EPA 6010B[1]
7439-97-6	Mercury, Total	BRL		mg/Kg	0.027	1	03-21-08 20:49	EPA 7471A[2]

Method Reference: Test Methods for Evaluating Solid Waste, US EPA, SW-846, Third Edition, Update III (1996).

Report Notations: BRL Indicates concentration, if any, is below reporting limit for analyte. Reporting limit is the lowest concentration that can be reliably quantified under routine laboratory operating conditions. Reporting limits are adjusted for sample size and dilution.

DF Dilution Factor.

GROUNDWATER ANALYTICAL

Trace Metals

Field ID:	**Interior Shell Ring #16**	Matrix:	**Solid**
Project:	**MA-Barnstable Mary Dunn #1**	Container:	**Plastic Bag**
Client:	**R.L. Merithew Inc.**	Preservation:	**Cool**
Laboratory ID:	**115781-3**	Percent Solids:	**n/a**
Sampled:	**03-11-08 00:00**		
Received:	**03-20-08 15:37**		

Analysis Method	QC Batch ID	Prep Method	Prepared	Sample Weight	Instrument ID	Analyst
EPA 6010B[1]	MB-01404-S	EPA 3050B	03-21-08 08:08	0.201 g	ICP-1 PE 3000	MWR
EPA 7471A[2]	MP-2272-S	EPA 7471A	03-21-08 10:35	0.6 g	CVAA-1 PE FIMS	MFP

CAS Number	Analyte	Concentration	Notes	Units	Reporting Limit	DF	Analyzed	Method
7440-38-2	Arsenic, Total	BRL		mg/Kg	7.5	1	03-24-08 12:13	EPA 6010B[1]
7440-43-9	Cadmium, Total	BRL		mg/Kg	1.2	1	03-24-08 12:13	EPA 6010B[1]
7440-47-3	Chromium, Total	BRL		mg/Kg	25	1	03-24-08 12:13	EPA 6010B[1]
7439-92-1	Lead, Total	**28**		mg/Kg	25	1	03-24-08 12:13	EPA 6010B[1]
7439-97-6	Mercury, Total	BRL		mg/Kg	0.036	1	03-21-08 20:52	EPA 7471A[2]

Method Reference: Test Methods for Evaluating Solid Waste, US EPA, SW-846, Third Edition, Update III (1996).

Report Notations: BRL Indicates concentration, if any, is below reporting limit for analyte. Reporting limit is the lowest concentration that can be reliably quantified under routine laboratory operating conditions. Reporting limits are adjusted for sample size and dilution.

DF Dilution Factor.

GROUNDWATER ANALYTICAL

Trace Metals

Field ID:	**Interior Sealer**	Matrix:	**Solid**
Project:	**MA-Barnstable Mary Dunn #1**	Container:	**Plastic Bag**
Client:	**R.L. Merithew Inc.**	Preservation:	**Cool**
Laboratory ID:	**115781-4**	Percent Solids:	**n/a**
Sampled:	**03-11-08 00:00**		
Received:	**03-20-08 15:37**		

Analysis Method	QC Batch ID	Prep Method	Prepared	Sample Weight	Instrument ID	Analyst
EPA 6010B[1]	MB-01404-S	EPA 3050B	03-21-08 08:08	0.256 g	ICP-1 PE 3000	MWR
EPA 7471A[2]	MP-2272-S	EPA 7471A	03-21-08 10:35	0.6 g	CVAA-1 PE FIMS	MFP

CAS Number	Analyte	Concentration	Notes	Units	Reporting Limit	DF	Analyzed	Method
7440-38-2	Arsenic, Total	BRL		mg/Kg	5.9	1	03-24-08 12:16	EPA 6010B[1]
7440-43-9	Cadmium, Total	BRL		mg/Kg	0.98	1	03-24-08 12:16	EPA 6010B[1]
7440-47-3	Chromium, Total	BRL		mg/Kg	20	1	03-24-08 12:15	EPA 6010B[1]
7439-92-1	Lead, Total	BRL		mg/Kg	20	1	03-24-08 12:16	EPA 6010B[1]
7439-97-6	Mercury, Total	BRL		mg/Kg	0.018	1	03-21-08 21:02	EPA 7471A[2]

Method Reference: Test Methods for Evaluating Solid Waste, US EPA, SW-846, Third Edition, Update III (1996).

Report Notations: BRL Indicates concentration, if any, is below reporting limit for analyte. Reporting limit is the lowest concentration that can be reliably quantified under routine laboratory operating conditions. Reporting limits are adjusted for sample size and dilution.

DF Dilution Factor.

GROUNDWATER ANALYTICAL

Trace Metals

Field ID:	**Exterior Bottom Ring**	Matrix:	**Solid**
Project:	**MA-Barnstable Mary Dunn #1**	Container:	**Plastic Bag**
Client:	**R.L. Merithew Inc.**	Preservation:	**Cool**
Laboratory ID:	**115781-5**	Percent Solids:	**n/a**
Sampled:	**03-13-08 00:00**		
Received:	**03-20-08 15:37**		

Analysis Method	QC Batch ID	Prep Method	Prepared	Sample Weight	Instrument ID	Analyst
EPA 6010B[1]	MB-01404-S	EPA 3050B	03-21-08 08:08	0.286 g	ICP-1 PE 3000	MWR
EPA 7471A[2]	MP-2272-S	EPA 7471A	03-21-08 10:35	0.6 g	CVAA-1 PE FIMS	MFP

CAS Number	Analyte	Concentration	Notes	Units	Reporting Limit	DF	Analyzed	Method
7440-38-2	Arsenic, Total	**7.2**		mg/Kg	5.2	1	03-24-08 12:19	EPA 6010B[1]
7440-43-9	Cadmium, Total	**1.7**		mg/Kg	0.87	1	03-24-08 12:19	EPA 6010B[1]
7440-47-3	Chromium, Total	**310**		mg/Kg	17	1	03-24-08 12:19	EPA 6010B[1]
7439-92-1	Lead, Total	**24,000**		mg/Kg	87	5	03-25-08 11:58	EPA 6010B[1]
7439-97-6	Mercury, Total	BRL		mg/Kg	0.016	1	03-21-08 21:05	EPA 7471A[2]

Method Reference: Test Methods for Evaluating Solid Waste, US EPA, SW-846, Third Edition, Update III (1996).

Report Notations: BRL Indicates concentration, if any, is below reporting limit for analyte. Reporting limit is the lowest concentration that can be reliably quantified under routine laboratory operating conditions. Reporting limits are adjusted for sample size and dilution.

DF Dilution Factor.

GROUNDWATER ANALYTICAL

Trace Metals

Field ID:	**Exterior Shell Ring #14**	Matrix:	**Solid**
Project:	**MA-Barnstable Mary Dunn #1**	Container:	**Plastic Bag**
Client:	**R.L. Merithew Inc.**	Preservation:	**Cool**
Laboratory ID:	**115781-6**	Percent Solids:	**n/a**
Sampled:	**03-13-08 00:00**		
Received:	**03-20-08 15:37**		

Analysis Method	QC Batch ID	Prep Method	Prepared	Sample Weight	Instrument ID	Analyst
EPA 6010B[1]	MB-01404-S	EPA 3050B	03-21-08 08:08	0.148 g	ICP-1 PE 3000	MWR
EPA 7471A[2]	MP-2272-S	EPA 7471A	03-21-08 10:35	0.6 g	CVAA-1 PE FIMS	MFP

CAS Number	Analyte	Concentration	Notes	Units	Reporting Limit	DF	Analyzed	Method
7440-38-2	Arsenic, Total	BRL		mg/Kg	10	1	03-24-08 12:22	EPA 6010B[1]
7440-43-9	Cadmium, Total	BRL		mg/Kg	1.7	1	03-24-08 12:22	EPA 6010B[1]
7440-47-3	Chromium, Total	**54**		mg/Kg	34	1	03-24-08 12:22	EPA 6010B[1]
7439-92-1	Lead, Total	**880**		mg/Kg	34	1	03-24-08 12:22	EPA 6010B[1]
7439-97-6	Mercury, Total	BRL		mg/Kg	0.11	1	03-21-08 21:08	EPA 7471A[2]

Method Reference: Test Methods for Evaluating Solid Waste, US EPA, SW-846, Third Edition, Update III (1996).

Report Notations: BRL Indicates concentration, if any, is below reporting limit for analyte. Reporting limit is the lowest concentration that can be reliably quantified under routine laboratory operating conditions. Reporting limits are adjusted for sample size and dilution.

DF Dilution Factor.

GROUNDWATER ANALYTICAL

Trace Metals

Field ID:	**Exterior Shell Ring #20**	Matrix:	**Solid**
Project:	**MA-Barnstable Mary Dunn #1**	Container:	**Plastic Bag**
Client:	**R.L. Merithew Inc.**	Preservation:	**Cool**
Laboratory ID:	**115781-7**	Percent Solids:	**n/a**
Sampled:	**03-13-08 00:00**		
Received:	**03-20-08 15:37**		

Analysis Method	QC Batch ID	Prep Method	Prepared	Sample Weight	Instrument ID	Analyst
EPA 6010B[1]	MB-01404-S	EPA 3050B	03-21-08 08:08	0.05 g	ICP-1 PE 3000	MWR
EPA 7471A[2]	MP-2272-S	EPA 7471A	03-21-08 10:35	0.6 g	CVAA-1 PE FIMS	MFP

CAS Number	Analyte	Concentration	Notes	Units	Reporting Limit	DF	Analyzed	Method
7440-38-2	Arsenic, Total	BRL		mg/Kg	30	1	03-24-08 12:25	EPA 6010B[1]
7440-43-9	Cadmium, Total	BRL		mg/Kg	5	1	03-24-08 12:25	EPA 6010B[1]
7440-47-3	Chromium, Total	BRL		mg/Kg	100	1	03-24-08 12:25	EPA 6010B[1]
7439-92-1	Lead, Total	BRL		mg/Kg	100	1	03-24-08 12:25	EPA 6010B[1]
7439-97-6	Mercury, Total	BRL		mg/Kg	0.15	1	03-21-08 21:12	EPA 7471A[2]

Method Reference: Test Methods for Evaluating Solid Waste, US EPA, SW-846, Third Edition, Update III (1996).

Report Notations: BRL Indicates concentration, if any, is below reporting limit for analyte. Reporting limit is the lowest concentration that can be reliably quantified under routine laboratory operating conditions. Reporting limits are adjusted for sample size and dilution.

DF Dilution Factor.

GROUNDWATER ANALYTICAL

Project Narrative

Project:	**MA-Barnstable Mary Dunn #1**	Lab ID:	**115781**
Client:	**R.L. Merithew Inc.**	Received:	**03-20-08 15:37**

A. Documentation and Client Communication

The following documentation discrepancies, and client changes or amendments were noted for this project:

1 . No documentation discrepancies, changes, or amendments were noted.

B. Method Modifications, Non-Conformances and Observations

The sample(s) in this project were analyzed by the references analytical method(s), and no method modifications, non-conformances or analytical issues were noted, except as indicated below:

1 . Samples 115781-1 through -7 were not received with sample collection times listed on the Chain of Custody. Samples were reported with a sampling collection time of 00:00 by the laboratory.

GROUNDWATER ANALYTICAL

228 Main Street, P.O. Box 1200
Buzzards Bay, MA 02532
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www.groundwateranalytical.com

CHAIN-OF-CUSTODY RECORD AND WORK ORDER

№ 109139

Project Name: MA-BARNSTABLE MARY DUNN #1	Firm: MERITHEW, INC.
Project Number:	Address: 110 ELM ST UNIT#10
Sampler Name: DAVID MERITHEW	City / State / Zip: BRIDGEWATER, MA 02324
Project Manager: DAVID MERITHEW	Telephone: 508-279-9965

INSTRUCTIONS: Use separate line for each container (except replicates).

TURNAROUND

- ☑ STANDARD (10 Business Days)
- ☐ PRIORITY (5 Business Days)
- ☐ RUSH (RAN-_____)
  (Rush requires Rush Authorization Number)
- ☐ Please Email to:_____
- ☐ Please FAX to:_____

BILLING

- ☐ Purchase Order No.:_____
- ☐ Third Party Billing:_____
- ☐ GWA Quote:_____

ANALYSIS REQUEST

OPTIONS: Volatiles: ☐ TIC Search | Semivolatiles: ☐ Acid Only ☐ B/N Only ☐ TIC Search | Pest/Herb/PCBs: Extractable, Vol. | Metals: ☐ Specify For Water Samples ☐ Total ☐ Dissolved

SDWA: ☐ 524.2/MTBE | ☐ 525.2 | ☐ 505 ☐ 508 | ☐ 531.1 | ☐ 515.1 | ☐ 504.1 EDB/DBCP | ☐ Lead and Copper

NPDES: ☐ 624 | ☐ 602/MTBE | ☐ 601 | ☐ 601/602/MTBE | ☐ 625 | ☐ 625 PAHs only | ☐ 608 Pesticides | ☐ 608 PCBs | ☐ 615 | ☐ 13 Priority Pollutant

RCRA/21E: ☐ 8260B TCL+MTBE ☐ 8260B NH PETROLEUM ☐ 8260B | ☐ 8270C | ☐ 8270C PAHs only | ☐ 8081A Pesticides | ☐ 8082 PCBs | ☐ 8151A Herbicides | ☐ 8011 EDB/DBCP | ☐ 8 RCRA ☐ 8 RCRA ☐ MA List Metals ☐ 23 TAL | ☐ Specify:

Petroleum Hydrocarbon — Ext. TPH: ☐ TPH-IR ☐ Diesel Range Organics (DRO) ☐ ME DRO ☐ CT ETPH ☐ MA DEP EPH w/all targets ☐ EPH Carbon Ranges only ☐ EPH w/4 PAHs ☐ Hydrocarbon Fingerprint (GC/FID by ASTM D3328-00-Mod.) ☐ TPH by GC/FID (8015B Mod) Quantitative Only ☐ Gasoline Range Organics (GRO) ☐ ME GRO ☐ MA DEP VPH w/all targets ☐ VPH Carbon ranges only — Vol. TPH

Haz. Waste: ☐ TCLP ☐ SPLP ☐ 8 Metals ☐ Pb only ☐ VOA ☐ Semi VOA ☐ Pesticides ☐ Herbicides ☐ Corrosivity (as pH) ☐ Reactivity ☐ Ignitability (as Flashpoint) ☐ Paint Filter ☐ MA Basic Disposal Criteria: 9060B, TPH by GC, PCBs, 5 Metals, Corrosivity, Ignitability, Reactivity

General Chemistry: ☐ Nitrate ☐ Nitrite ☐ Chloride ☐ Fluoride ☐ Sulfate ☐ Dissolved Phosphorus ☐ Ammonia ☐ TKN ☐ Total Phosphorus ☐ Total N (as N02/N03/TKN) ☐ Oil & Grease ☐ COD ☐ TOC ☐ BOD ☐ TDS ☐ TSS ☐ TS ☐ Alkalinity ☐ Cyanide, Total ☐ Cyanide, Physiologically Available ☐ pH ☐ Dissolved Oxygen ☐ Turbidity ☐ Total Coliform ☐ Fecal Coliform ☐ HPC

Other

Sampling DATE	Sampling TIME	SAMPLE IDENTIFICATION	Matrix	Type	Container(s)	Preservation	Filtered	LABORATORY NUMBER (Lab Use Only)
3/11/08		INTERIOR FLOOR	PAINT	COMPOSITE / GRAB	1 PLASTIC 5345		YES / NO	
3/11/08		INTERIOR SHELL RING #3	PAINT	COMPOSITE / GRAB	1 PLASTIC 5345		YES / NO	
3/11/08		INTERIOR SHELL RING #16	PAINT	COMPOSITE / GRAB	1 PLASTIC 5345		YES / NO	
3/11/08		INTERIOR SEALER	PAINT	COMPOSITE / GRAB	1 PLASTIC 5345		YES / NO	
3/13/08		EXTERIOR BOTTOM RING	PAINT	COMPOSITE / GRAB	1 PLASTIC 5345		YES / NO	
3/13/08		EXTERIOR SHELL RING #14	PAINT	COMPOSITE / GRAB	1 PLASTIC 5345		YES / NO	
3/13/08		EXTERIOR SHELL RING #20	PAINT	COMPOSITE / GRAB	1 PLASTIC 5345		YES / NO	

REMARKS / SPECIAL INSTRUCTIONS

MA DEP MCP Data Enhancement Affirmation
☐YES ☐NO MCP Data Certification is required.
☐YES ☐NO MCP Drinking Water Sample Required.
(Require collection of contingent duplicate sample. Trip blanks are also required. If VOA sample collected)
Signature:_____

DATA QUALITY OBJECTIVES

Regulatory Program

State	Standard	Deliverables
☐ CT	☐ MCP GW-1/S-1	☐ PWS Form
☑ ME	☐ MCP GW-2/S-2	☐ MWRA
☐ MA	☐ NY STARS	☐_____
☐ NH	☐ Drinking Water	
☐ NY	☐ Wastewater	
☐ RI	☐ Waste Disposal	
☐ VT	☐ Dredge Material	
☐___	☐_____	

Project Specific QC

Many regulatory programs and EPA methods require project specific QC. Project specific QC includes Sample Duplicates, Matrix Spikes, and/or Matrix Spike Duplicates. Laboratory QC is not project specific unless prearranged. Project specific QC samples are charged on a per sample basis. **Each MS, MSD and Sample Duplicate requires an additional sample aliquot.**

Project Specific QC Required	Selection of QC Sample
☐ Sample Duplicate	☐ Please use sample:
☐ Matrix Spike	
☐ Matrix Spike Duplicate	_____

CHAIN-OF-CUSTODY RECORD

NOTE: All samples submitted subject to Standard Terms and Conditions on reverse hereof.

	Date	Time			
Relinquished by Sampler:			Received by: JE Clesy	3/20/08	1000
Relinquished by: JE Clesy	3/20/08	1537	Received by: Tammy Almeida		
Relinquished by: Beth Merithew	3/20/08	10:00	Received by Laboratory:		

Receipt Temperature: ☐ Ice ☐ Refrigerated 2-6°C Recommended
Container Count: 7
Shipping/Airbill Number:
Custody Seal Number:
Method of Shipment: ☐ GWA Courier ☐ Express Mail ☐ Federal Express ☐ UPS ☐ Hand ☐_____

Quality Assurance/Quality Control

A. Program Overview

Groundwater Analytical conducts an active Quality Assurance program to ensure the production of high quality, valid data. This program closely follows the guidance provided by *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans,* US EPA QAMS-005/80 (1980), and *Test Methods for Evaluating Solid Waste,* US EPA, SW-846, Update III (1996).

Quality Control protocols include written Standard Operating Procedures (SOPs) developed for each analytical method. SOPs are derived from US EPA methodologies and other established references. Standards are prepared from commercially obtained reference materials of certified purity, and documented for traceability.

Quality Assessment protocols for most organic analyses include a minimum of one laboratory control sample, one method blank, one matrix spike sample, and one sample duplicate for each sample preparation batch. All samples, standards, blanks, laboratory control samples, matrix spikes and sample duplicates are spiked with internal standards and surrogate compounds. All instrument sequences begin with an initial calibration verification standard and a blank; and excepting GC/MS sequences, all sequences close with a continuing calibration standard. GC/MS systems are tuned to appropriate ion abundance criteria daily, or for each 12 hour operating period, whichever is more frequent.

Quality Assessment protocols for most inorganic analyses include a minimum of one laboratory control sample, one method blank, one matrix spike sample, and one sample duplicate for each sample preparation batch. Standard curves are derived from one reagent blank and four concentration levels. Curve validity is verified by standard recoveries within plus or minus ten percent of the curve.

B. Definitions

Batches are used as the basic unit for Quality Assessment. A Batch is defined as twenty or fewer samples of the same matrix which are prepared together for the same analysis, using the same lots of reagents and the same techniques or manipulations, all within the same continuum of time, up to but not exceeding 24 hours.

Laboratory Control Samples are used to assess the accuracy of the analytical method. A Laboratory Control Sample consists of reagent water or sodium sulfate spiked with a group of target analytes representative of the method analytes. Accuracy is defined as the degree of agreement of the measured value with the true or expected value. Percent Recoveries for the Laboratory Control Samples are calculated to assess accuracy.

Method Blanks are used to assess the level of contamination present in the analytical system. Method Blanks consist of reagent water or an aliquot of sodium sulfate. Method Blanks are taken through all the appropriate steps of an analytical method. Sample data reported is not corrected for blank contamination.

Surrogate Compounds are used to assess the effectiveness of an analytical method in dealing with each sample matrix. Surrogate Compounds are organic compounds which are similar to the target analytes of interest in chemical behavior, but which are not normally found in environmental samples. Percent Recoveries are calculated for each Surrogate Compound.

GROUNDWATER ANALYTICAL

Quality Control Report
Laboratory Control Samples

Category: **Metals**
Matrix: **Soil**
Units: **mg/Kg**

Sample Type	Method	QC Batch ID	Prep Method	Prepared	Analyzed	Instrument ID	Analyst
LCS	EPA 6010B	MB-1404-SL	EPA 3050B	03-21-08 08:08	03-24-08 11:35	ICP-1 PE 3000	MWR
LCS	EPA 7471A	MP-2272-SL	EPA 7471A	03-21-08 10:35	03-21-08 20:26	CVAA-1 PE FIMS	MFP
LCSD	EPA 6010B	MB-1404-SL	EPA 3050B	03-21-08 08:08	03-24-08 11:56	ICP-1 PE 3000	MWR
LCSD	EPA 7471A	MP-2272-SL	EPA 7471A	03-21-08 10:35	03-21-08 20:29	CVAA-1 PE FIMS	MFP

CAS Number	Analyte	LCS			LCS Duplicate				QC Limits		Method
		Spiked	Measured	Recovery	Spiked	Measured	Recovery	RPD	LCS	RPD	
7440-38-2	Arsenic	89	86	**97%**	89	85	**95%**	**1 %**	81-119 %	30 %	EPA 6010B
7440-43-9	Cadmium	74	61	**82%**	74	60	**81%**	**1 %**	80-120 %	30 %	EPA 6010B
7440-47-3	Chromium	98	98	**100%**	98	94	**96%**	**2 %**	79-121 %	30 %	EPA 6010B
7439-92-1	Lead	89	85	**95%**	89	83	**94%**	**1 %**	82-118 %	30 %	EPA 6010B
7439-97-6	Mercury	4.5	4.5	**101%**	4.5	4.2	**94%**	**4 %**	66-133 %	30 %	EPA 7471A

Method Reference: Test Methods for Evaluating Solid Waste, US EPA, SW-846, Third Edition, Update III (1996).

Report Notations: All calculations performed prior to rounding. Quality Control Limits are defined by the methodology, or alternatively based upon the historical average recovery plus or minus three standard deviation units.

GROUNDWATER ANALYTICAL

Quality Control Report
Method Blank

Category: **Metals**
Matrix: **Soil**

Analysis Method	QC Batch ID	Prep Method	Prepared	Sample Volume	Instrument ID	Analyst
EPA 6010B	MB-1404-SB	EPA 3050B	03-21-08 08:08	0.5 g	ICP-1 PE 3000	MWR
EPA 7471A	MP-2272-SB	EPA 7471A	03-21-08 10:35	0.6 g	CVAA-1 PE FIMS	MFP

CAS Number	Analyte	Concentration	Notes	Units	Reporting Limit	DF	Analyzed	Method
7440-38-2	Arsenic	BRL		mg/Kg	3.0	1	03-24-08 11:31	EPA 6010B
7440-43-9	Cadmium	BRL		mg/Kg	0.5	1	03-24-08 11:31	EPA 6010B
7440-47-3	Chromium	BRL		mg/Kg	10	1	03-24-08 11:31	EPA 6010B
7439-92-1	Lead	BRL		mg/Kg	10	1	03-24-08 11:31	EPA 6010B
7439-97-6	Mercury	BRL		mg/Kg	0.017	1	03-21-08 20:26	EPA 7471A

Method Reference: Test Methods for Evaluating Solid Waste, US EPA, SW-846, Third Edition, Update III (1996).

Report Notations: BRL Indicates concentration, if any, is below reporting limit for analyte. Reporting limit is the lowest concentration that can be reliably quantified under routine laboratory operating conditions. Reporting limits are adjusted for sample size and dilution.

DF Dilution Factor.

GROUNDWATER ANALYTICAL

Certifications and Approvals

Groundwater Analytical maintains environmental laboratory certification in a variety of states.
Copies of our current certificates may be obtained from our website:

http://www.groundwateranalytical.com/qualifications.htm

MAINE

Department of Environmental Protection, LB-0072 — Asbestos Analytical Laboratory (Bulk)

MASSACHUSETTS

Department of Environmental Protection, M-MA-103 — Potable Water and Non-Potable Water
http://public.dep.state.ma.us/labcert/labcert.aspx

Department of Labor,
Division of Occupational Safety, AA000195 — Asbestos Analytical Services, Class A
http://www.mass.gov/dos/forms/la-rpt_list_aa.pdf

NIST NATIONAL VOLUNTARY LABORATORY ACCREDITATION PROGRAM (NVLAP)

NVLAP Lab Code 200751-1 — Bulk Asbestos Fiber Analysis (PLM)
http://ts.nist.gov/Standards/scopes/plmtm.htm

RHODE ISLAND

Department of Health,
Division of Laboratories, LAO00054 — Potable and Non-Potable Water Microbiology, Organic and Inorganic Chemistry
http://www.health.ri.gov/labs/outofstatelabs.pdf

Department of Health,
Office of Occupational and Radiological Health, AAL-110B3 — Asbestos Analytical Service, Polarized Light Microscopy (PLM)
http://www.health.ri.gov/environment/occupational/asbestos/licensees/AsbestosAnalyticalLabs.pdf

U.S. DEPARTMENT OF AGRICULTURE

USDA, Soil Permit, S-53921 — Foreign soil import permit

GROUNDWATER ANALYTICAL

Certifications and Approvals

MASSACHUSETTS **Department of Environmental Protection, M-MA-103**

Groundwater Analytical maintains MassDEP environmental laboratory certification for only the methods and analytes listed below. Analyses for certified analytes are conducted in accordance with MassDEP certification standards, except as may be specifically noted in the project narrative.

Potable Water (Drinking Water)

Analyte	Method
1,2-Dibromo-3-Chloropropane	EPA 504.1
1,2-Dibromoethane	EPA 504.1
Alkalinity, Total	SM 2320-B
Antimony	EPA 200.9
Barium	EPA 200.7
Beryllium	EPA 200.7
Cadmium	EPA 200.7
Calcium	EPA 200.7
Chlorine, Residual Free	SM 4500-CL-G
Chromium	EPA 200.7
Copper	EPA 200.7
Cyanide, Total	Lachat 10-204-00-1-A
E. Coli	EC-MUG SM 9221-F
E. Coli	Enz. Sub. SM 9223
E. Coli	NA-MUG SM 9222-G
Fecal Coliform	MF SM 9222-D
Fluoride	EPA 300.0
Fluoride	SM 4500-F-C
Heterotrophic Plate Count	SM 9215-B
Mercury	EPA 245.1
Nickel	EPA 200.7
Nitrate-N	EPA 300.0
Nitrate-N	Lachat 10-107-04-1-C
Nitrite-N	EPA 300.0
Nitrite-N	Lachat 10-107-04-1-C
Perchlorate	EPA 314.0
pH	SM 4500-H-B
Sodium	EPA 200.7
Sulfate	EPA 300.0
Thallium	EPA 200.9
Total Coliform	Enz. Sub. SM 9223
Total Coliform	MF SM 9222-B
Total Dissolved Solids	SM 2540-C
Turbidity	SM 2130-B
Volatile Organic Compounds	EPA 524.2

Non-Potable Water (Wastewater)

Analyte	Method
Aldrin	EPA 608
Alkalinity, Total	Lachat 10-303-31-1-A
Aluminum	EPA 200.7
Ammonia-N	Lachat 10-107-06-1-B
Antimony	EPA 200.7
Antimony	EPA 200.9
Arsenic	EPA 200.7
Arsenic	EPA 200.9
Beryllium	EPA 200.7
Biochemical Oxygen Demand	SM 5210-B
Cadmium	EPA 200.7
Calcium	EPA 200.7

Non-Potable Water (Wastewater)

Analyte	Method
Chemical Oxygen Demand	SM 5220-D
Chlordane	EPA 608
Chloride	EPA 300.0
Chlorine, Total Residual	SM 4500-CL-G
Chromium	EPA 200.7
Cobalt	EPA 200.7
Copper	EPA 200.7
Copper	EPA 200.9
Cyanide, Total	Lachat 10-204-00-1-A
DDD	EPA 608
DDE	EPA 608
DDT	EPA 608
Dieldrin	EPA 608
Fluoride	EPA 300.0
Hardness (CaCO3), Total	EPA 200.7
Hardness (CaCO3), Total	SM 2340-B
Heptachlor	EPA 608
Heptachlor Epoxide	EPA 608
Iron	EPA 200.7
Kjeldahl-N	Lachat 10-107-06-02-D
Lead	EPA 200.7
Lead	EPA 200.9
Magnesium	EPA 200.7
Manganese	EPA 200.7
Mercury	EPA 245.1
Molybdenum	EPA 200.7
Nickel	EPA 200.7
Nitrate-N	EPA 300.0
Nitrate-N	Lachat 10-107-04-1-C
Non-Filterable Residue	SM 2540-D
Oil and Grease	EPA 1664
Orthophosphate	Lachat 10-115-01-1-A
pH	SM 4500-H-B
Phosphorus, Total	Lachat 10-115-01-1-C
Phosphorus, Total	SM 4500-P-B,E
Polychlorinated Biphenyls (Oil)	EPA 600/4-81-045
Polychlorinated Biphenyls (Water)	EPA 608
Potassium	EPA 200.7
Selenium	EPA 200.7
Selenium	EPA 200.9
Sodium	EPA 200.7
Strontium	EPA 200.7
Sulfate	EPA 300.0
Thallium	EPA 200.7
Thallium	EPA 200.9
Titanium	EPA 200.7
Total Dissolved Solids	SM 2540-C
Total Organic Carbon	SM 5310-B
Vanadium	EPA 200.7
Volatile Aromatics	EPA 602
Volatile Aromatics	EPA 624
Volatile Halocarbons	EPA 624
Zinc	EPA 200.7

Mary Dunn #1 Riveted Stdp Barnstable, MA
Inspected by Merithew, Inc. March 11, 2008


Exterior tank 1


Exterior anchor bolt 1


Exterior anchor bolt 2


Exterior anchor bolt 3


Exterior anchor bolt 4


Exterior anchor bolt 5

Mary Dunn #1 Riveted Stdp Barnstable, MA
Inspected by Merithew, Inc. March 11, 2008


Exterior anchor bolt 6


Exterior anchor bolt 7


Exterior anchor bolt 8


Exterior anchor bolt 9


Exterior anchor bolt 10


Exterior anchor bolt 11

Mary Dunn #1 Riveted Stdp Barnstable, MA
Inspected by Merithew, Inc. March 11, 2008


Exterior anchor bolt 12


Exterior anchor bolt 13


Exterior anchor bolt 14


Exterior anchor bolt 15


Exterior anchor bolt 16


Exterior anchor bolt 17

Mary Dunn #1 Riveted Stdp Barnstable, MA
Inspected by Merithew, Inc. March 11, 2008


Exterior anchor bolt 18


Exterior foundation 1

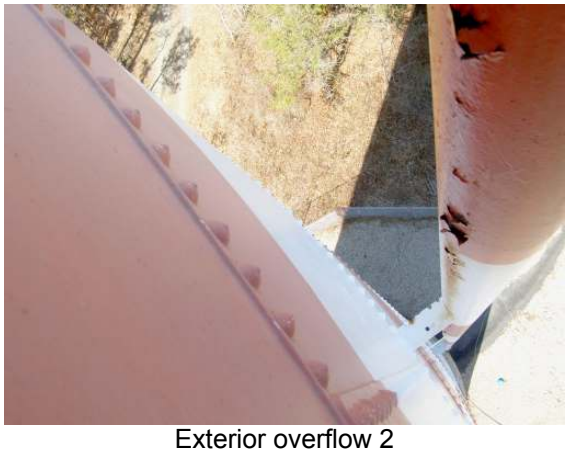

Exterior foundation 2


Exterior foundation 3


Exterior foundation 4


Exterior overflow 1

Mary Dunn #1 Riveted Stdp Barnstable, MA
Inspected by Merithew, Inc. March 11, 2008


Exterior overflow 2


Exterior overflow 3

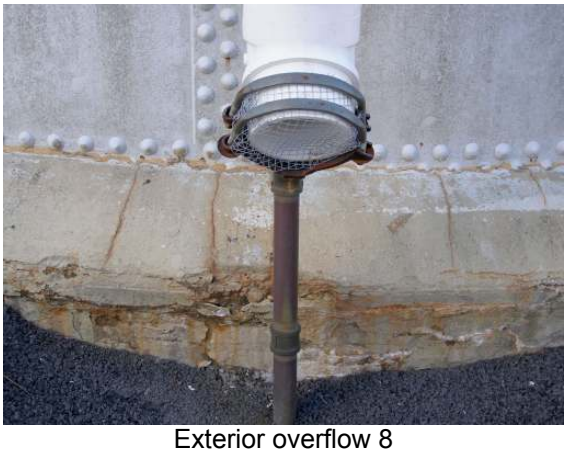

Exterior overflow 4


Exterior overflow 5


Exterior overflow 6


Exterior overflow 7

Mary Dunn #1 Riveted Stdp Barnstable, MA
Inspected by Merithew, Inc. March 11, 2008


Exterior overflow 8


Exterior overflow 9


Exterior roof 1


Exterior roof 2


Exterior roof 3


Exterior roof 4

Mary Dunn #1 Riveted Stdp Barnstable, MA
Inspected by Merithew, Inc. March 11, 2008


Exterior roof 5


Exterior roof 6


Exterior roof 7


Exterior roof center post 1


Exterior roof center post 2


Exterior roof center post 3

Mary Dunn #1 Riveted Stdp Barnstable, MA
Inspected by Merithew, Inc. March 11, 2008

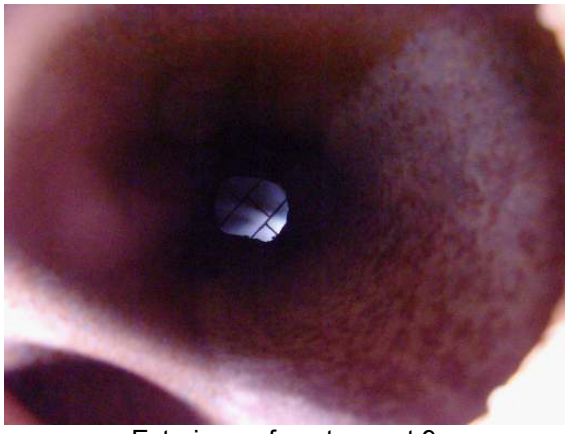

Exterior roof center post 4


Exterior roof center post 5


Exterior roof center post 6


Exterior roof center post 7


Exterior roof center post 8


Exterior roof center post 9

Mary Dunn #1 Riveted Stdp Barnstable, MA
Inspected by Merithew, Inc. March 11, 2008


Exterior roof center post 10

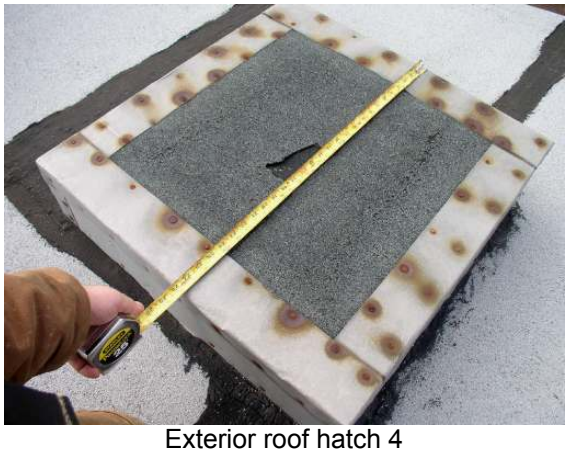

Exterior roof center post 11


Exterior roof center post 12


Exterior roof hatch 1


Exterior roof hatch 2


Exterior roof hatch 3


Exterior roof hatch 4


Exterior roof hatch 5


Exterior roof hatch 6


Exterior roof hatch 7


Exterior roof to shell angle 1


Exterior roof to shell angle 2

Mary Dunn #1 Riveted Stdp Barnstable, MA
Inspected by Merithew, Inc. March 11, 2008

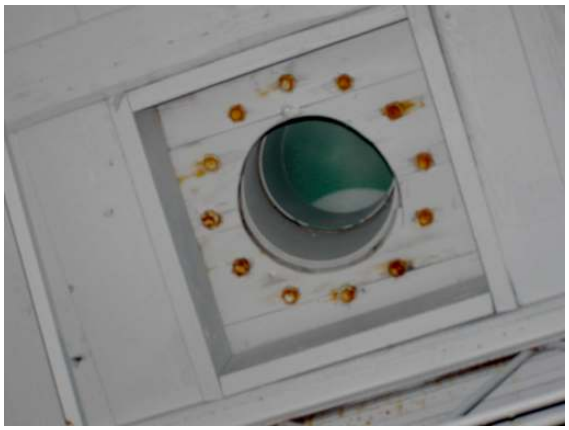

Exterior roof to shell angle 3


Exterior roof to shell angle 4


Exterior roof to shell angle 5


Exterior roof vent 1


Exterior roof vent 2


Exterior roof vent 3

Mary Dunn #1 Riveted Stdp Barnstable, MA
Inspected by Merithew, Inc. March 11, 2008


Exterior roof vent 4


Exterior roof vent 5


Exterior roof vent 6


Exterior shell 1


Exterior shell 2


Exterior shell 3

Mary Dunn #1 Riveted Stdp Barnstable, MA
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Exterior shell 4


Exterior shell 5


Exterior shell 6


Exterior shell 7


Exterior shell 8


Exterior shell 9

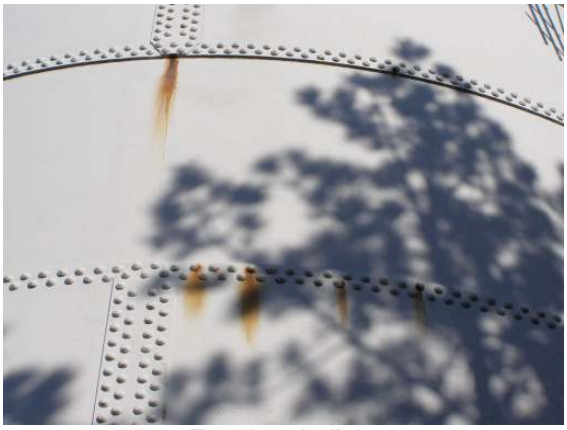
Mary Dunn #1 Riveted Stdp Barnstable, MA
Inspected by Merithew, Inc. March 11, 2008


Exterior shell 10


Exterior shell 11


Exterior shell 12


Exterior shell 13


Exterior shell 14


Exterior shell 15

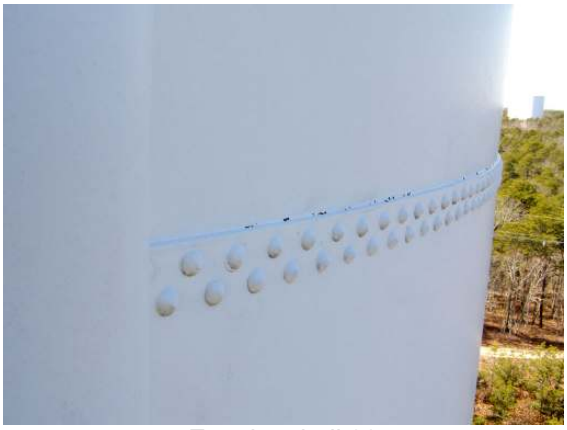
Mary Dunn #1 Riveted Stdp Barnstable, MA
Inspected by Merithew, Inc. March 11, 2008


Exterior shell 16


Exterior shell 17


Exterior shell 18


Exterior shell 19


Exterior shell 20


Exterior shell ladder 1

Mary Dunn #1 Riveted Stdp Barnstable, MA
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Exterior shell ladder 2


Exterior shell ladder 3


Exterior shell ladder 4


Exterior shell ladder 5


Exterior shell ladder 6


Exterior shell ladder 7

Mary Dunn #1 Riveted Stdp Barnstable, MA
Inspected by Merithew, Inc. March 11, 2008


Exterior shell ladder 8


Exterior shell ladder 9


Exterior shell ladder 10


Exterior shell ladder 11


Exterior shell ladder 12


Exterior shell ladder 13


Exterior shell ladder 14


Exterior shell ladder 15


Exterior shell ladder 16

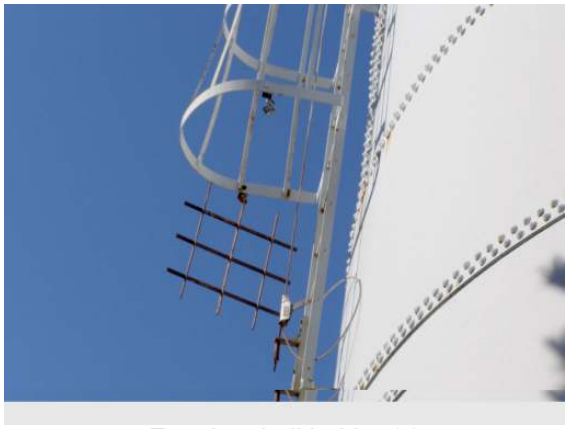

Exterior shell ladder 17


Exterior shell ladder 18


Exterior shell ladder 19

Mary Dunn #1 Riveted Stdp Barnstable, MA
Inspected by Merithew, Inc. March 11, 2008


Exterior shell ladder 20


Exterior shell ladder 21


Exterior shell ladder 22


Exterior shell manhole 1


Exterior shell manhole 2


Exterior shell manhole 3

Mary Dunn #1 Riveted Stdp Barnstable, MA
Inspected by Merithew, Inc. March 11, 2008


Exterior shell manhole 4


Exterior shell seams 1


Exterior shell seams 2


Exterior shell seams 3


Exterior shell seams 4


Exterior shell seams 5

Mary Dunn #1 Riveted Stdp Barnstable, MA
Inspected by Merithew, Inc. March 11, 2008


Exterior shell seams 6


Exterior shell seams 7

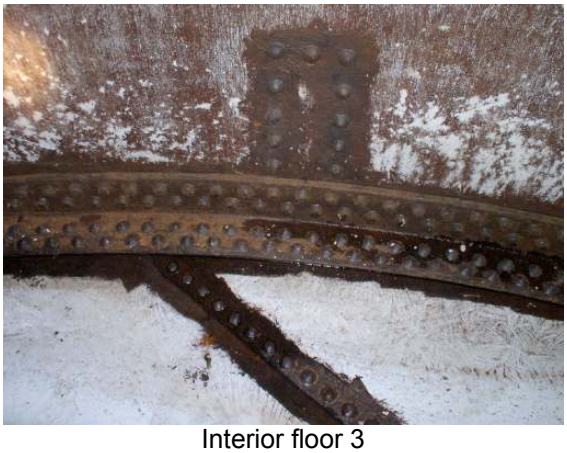

Exterior site 1


Exterior site 2


Interior floor 1


Interior floor 2

Mary Dunn #1 Riveted Stdp Barnstable, MA
Inspected by Merithew, Inc. March 11, 2008


Interior floor 3


Interior floor 4


Interior floor 5

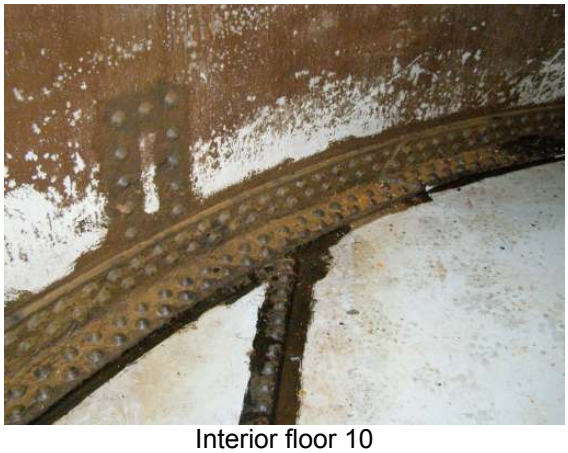

Interior floor 6


Interior floor 7


Interior floor 8

Mary Dunn #1 Riveted Stdp Barnstable, MA
Inspected by Merithew, Inc. March 11, 2008


Interior floor 9


Interior floor 10


Interior floor 11


Interior floor 12


Interior floor 13


Interior floor rigging lug 1

Mary Dunn #1 Riveted Stdp Barnstable, MA
Inspected by Merithew, Inc. March 11, 2008


Interior floor rigging lug 2


Interior floor rigging lug 3


Interior overflow 1


Interior roof 1


Interior roof 2


Interior roof 3

Mary Dunn #1 Riveted Stdp Barnstable, MA
Inspected by Merithew, Inc. March 11, 2008


Interior roof framing 1


Interior roof framing 2


Interior roof framing 3


Interior roof framing 4


Interior roof framing 5


Interior roof framing 6


Interior roof framing 7


Interior roof framing 8


Interior roof framing 9


Interior roof framing 10


Interior roof framing 11


Interior roof framing 12

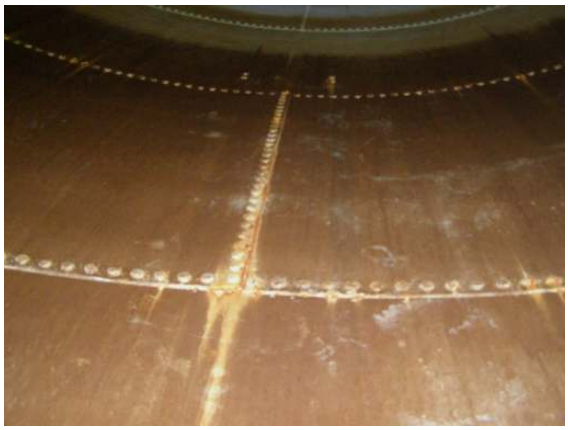
Mary Dunn #1 Riveted Stdp Barnstable, MA
Inspected by Merithew, Inc. March 11, 2008


Interior roof to shell junction 1


Interior shell 1


Interior shell 2


Interior shell 3


Interior shell 4


Interior shell 5

Mary Dunn #1 Riveted Stdp Barnstable, MA
Inspected by Merithew, Inc. March 11, 2008

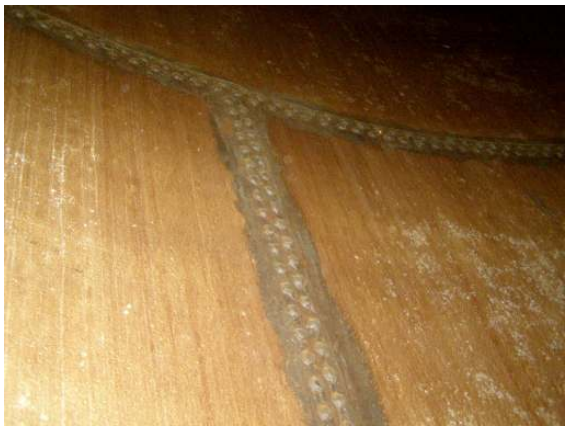

Interior shell 6


Interior shell 7


Interior shell 8


Interior shell 9


Interior shell 10


Interior shell 11

Mary Dunn #1 Riveted Stdp Barnstable, MA
Inspected by Merithew, Inc. March 11, 2008


Interior shell 12


Interior shell 13


Interior shell 14


Interior shell 15


Interior shell 16


Interior shell 17

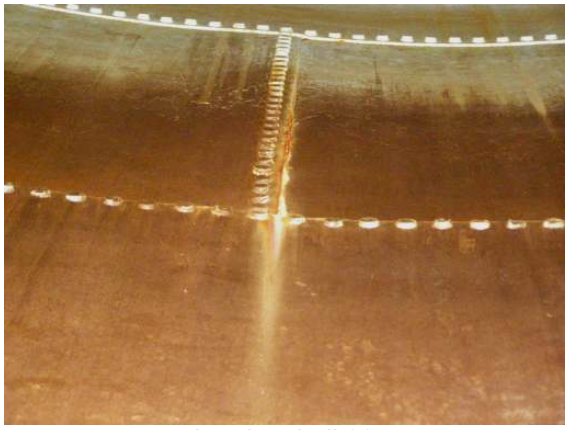
Mary Dunn #1 Riveted Stdp Barnstable, MA
Inspected by Merithew, Inc. March 11, 2008

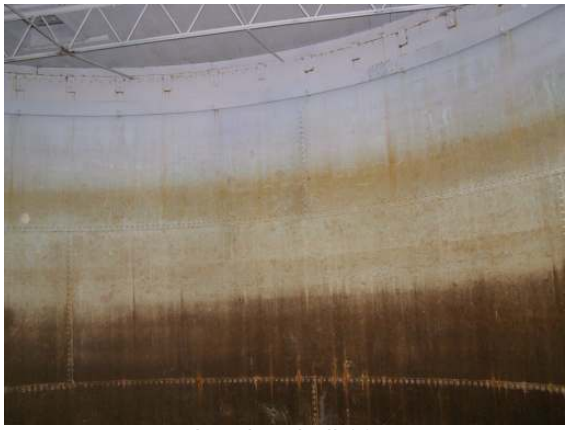

Interior shell 18


Interior shell 19


Interior shell 20


Interior shell 21

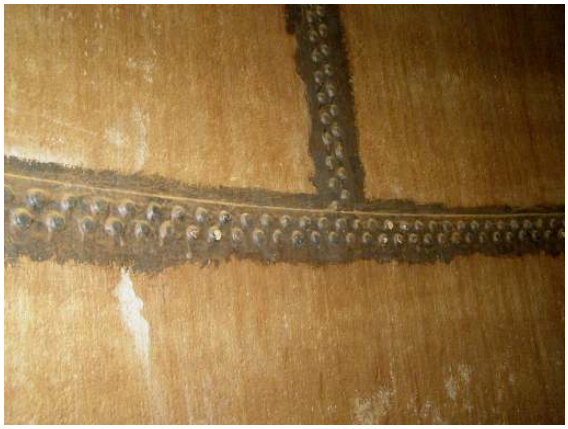

Interior shell 22


Interior shell 23

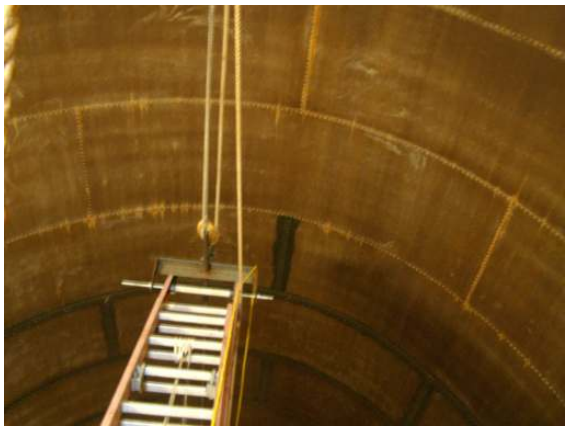
Mary Dunn #1 Riveted Stdp Barnstable, MA
Inspected by Merithew, Inc. March 11, 2008


Interior shell 24


Interior shell 25


Interior shell 26


Interior shell 27


Interior shell 28


Interior shell 29

Mary Dunn #1 Riveted Stdp Barnstable, MA
Inspected by Merithew, Inc. March 11, 2008


Interior shell 30


Interior shell 31


Interior shell 32


Interior shell manhole 1


Interior shell manhole 2


Interior shell manhole 3

Mary Dunn #1 Riveted Stdp Barnstable, MA
Inspected by Merithew, Inc. March 11, 2008


Interior shell pitting 1


Interior shell pitting 2


Interior shell pitting 3


Interior shell pitting 4


Interior shell pitting 5


Interior silt stop 1

Mary Dunn #1 Riveted Stdp Barnstable, MA
Inspected by Merithew, Inc. March 11, 2008

Interior silt stop 2

Water Storage Tank
Daily Inspection Log

Tank Location: _____

Description: _____

Date: _____

Water System Employee: _____

	OK	Problem	Description
Tank Site			
Perimeter Fence			
Locks			
Unauthorized Entry			
Lights			
Exterior of Tank			
Leakage Evident			
Overflow Evident			
Vandalism/Graffiti			
Debris Onsite			

Additional Notes:

Water Storage Tank
Monthly Inspection Log

Tank Location: _____

Description: _____

Date: _____

Water System Employee: _____

	OK	Problem	Description
Tank Site			
Locks			
Perimeter Fence			
Lights			
Insect Problem			
Exterior of Tank			
Foundation			
Leakage or Overflow Evident			
Corrosion Evident			
Vandalism/Graffiti			
Ladders			
Overflow			
Manholes			
Vents			

Additional Notes:

RESERVOIR MIXING ANALYSIS (TMS)

12-May-2008

RESERVOIR / TANK NAME: **MARY DUNN NO. 1**

CONSULTANT: Weston & Sampson Engineers, Inc.
Contact: Johanna Nagle
Address:
phone
fax
email

UTILITY / OWNER: Town of Barnstable, MA
Contact:
Address:
phone
fax
email

RED VALVE REP.: NE3
Contact: Bob Mack

ANALYSIS BY: Michael Duer

** If "Effective" Tank Diameter is shown, the tank diameter is calculated to make the volume compute correctly. Mixing times are based on volume.

RESERVOIR / TANK DATA

Tank Diameter	25	ft
Tank Width		ft
Tank Length		ft
Tank Depth (SWD)	98	ft
Tank Volume	359,855	Gallons
Tank Volume	48,106	ft^3
Gallons Per Foot =	3,672	

INLET / OUTLET PIPES

Outlet Dia. = 6 in

* Effective Diameter of TMS (See Note 1)

Effec. Dia (in) = AT
Effec. Dia (in) = AT
Effec. Dia (in) = AT
Effec. Dia (in) = AT

FILL / DRAW RATES

	Fill Rates (gpm) min, ave, peak, future	Draw Rates (gpm) min, ave, peak, future
	20	20
	35	35
	50	50
	65	65

PROPRIETARY NOTICE

FILL

INLET FLOW RATES (gpm)		Time to Fill Tank from Empty to H.W.L (Hours)	(Days)	Time to Fill to 1' Depth (Minutes)	(Hours)	Input Fill Time (Hours)	Resulting Increase In Water level (ft)	Volume Change (gallons)
min	20	299.88	12.49	183.60	3.06	4	1.3	4,800.00
ave	35	171.36	7.14	104.91	1.75	3	1.7	6,300.00
peak	50	119.95	5.00	73.44	1.22	2	1.6	6,000.00
future	65	92.27	3.84	56.49	0.94	1	1.1	3,900.00

GUIDE TO TANK FLUCTUATION AND TURNOVER

FILL

INLET FLOW RATES (gpm)		Jet Velocity (fps)	JV^2 / 2g (feet)	Reynold's Number	Inlet Momentum (ft^4 / min^2)	Velocity Gradient, G (1/sec)	Theoretical Mixing Time (Fill Time Req'd for Complete Mixing) MT = K * V^(2/3) / M^(1/2) (Minutes)	(Hours)	Req'd Drawdown on Previous Draw to Mix on Next Fill (feet)	% Turnover Required (%)	Volume Exchange Required (gallons)
									(SEE NOTE 2)	(SEE NOTE 2)	(SEE NOTE 2)
min	20	**5.10**	**0.40**	66,578	818	1.00	**471.3**	**7.9**	**2.6**	**2.6**	**9,356**
ave	35	**6.70**	**0.70**	100,948	1,881	1.73	**310.9**	**5.2**	**3.0**	**3.0**	**10,796**
peak	50	**8.10**	**1.02**	132,665	3,248	2.50	**236.5**	**3.9**	**3.2**	**3.3**	**11,875**
future	65	**9.20**	**1.32**	161,207	4,797	3.24	**194.7**	**3.2**	**3.4**	**3.5**	**12,595**

SEE NOTE 2

MINIMUM TANK FLUCTUATION TARGET

DRAW

OUTLET FLOW RATES (gpm)		TIME TO DRAW TANK FROM FULL TO EMPTY (Hours)	(Days)	Time to Draw Down 1' Depth (Minutes)	(Hours)	Pipe Velocity (fps)	Volume Exchange Required (gallons)	Draw Time Required (Hours)	
min	20	299.88	12.49	183.60	3.06	0.23	12,595	10.5 @	20 gpm Draw Rate
ave	35	171.36	7.14	104.91	1.75	0.40	12,595	6.0 @	35 gpm Draw Rate
fire	50	119.95	5.00	73.44	1.22	0.57	12,595	4.2 @	50 gpm Draw Rate
future	65	92.27	3.84	56.49	0.94	0.74	12,595	3.2 @	65 gpm Draw Rate

*** NOTE:** 1. TIDEFLEX VALVES ARE INHERENTLY A VARIABLE ORIFICE SO THE TMS EFFECTIVE DIAMETER VARIES WITH FLOW RATE
2. MIXING TIME EQUATIONS DO NOT ACCOUNT FOR DIFFERENCES IN TEMPERATURE BETWEEN INLET WATER AND TANK (BUOYANT JETS) THESE CALCULATIONS MAY UNDERESTIMATE THE FILL TIME REQUIRED FOR MIXING.

TIDEFLEX Mixing System for Reservoirs

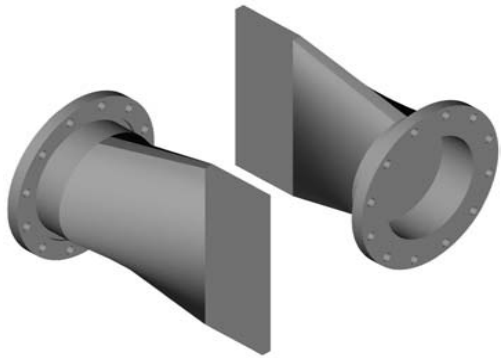
FILL AND DRAW MANIFOLD HYDRAULICS

65 GPM _ FILL
65 GPM _ DRAW

Reservoir Name:	**Mary Dunn No. 1**	Ambient Density =	**62.4**	lbm/ft^3
Reservoir Size:	**25' Dia. X 98' SWD**	Effluent Density =	**62.4**	lbm/ft^3
Reservoir Capacity:	**0.37 MG**	dS/S =	**0**	
End User:	**Town of Barnstable, MA**	C =	**100**	Hazen Williams Roughness Coefficient
Consultant:	**Weston & Sampson**	Cd =	**0.95**	

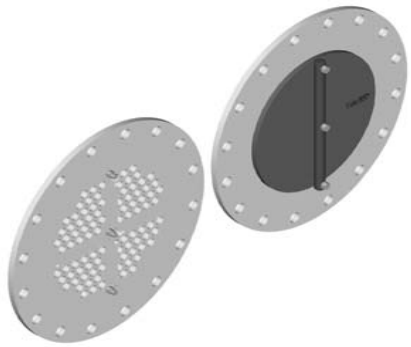
FILL CYCLE MANIFOLD HYDRAULICS

	Cumulative Flow	Jet Velocity	Friction Loss	Total Head
	(gpm)	(fps)	(ft)	(ft)
	22.04	9.19	0.002	1.4
	32.42	9.19	0.000	1.4
	42.80	9.19	0.008	1.4
	65.00	9.22	0.026	1.4
TOTALS	**65.0**	**9.2 (AVE)**	**0.04**	**1.4**



DRAW CYCLE MANIFOLD HYDRAULICS

Disk Material	Membrane Material	Support Rod Material	Fastener Material	Outlets - Fire Flow	Headloss For WF-3
				(gpm)	(ft)
TBD	TBD	TBD	TBD	65	0.05



TIDEFLEX RESERVOIR MIXING ANALYSIS

The Reservoir Mixing Analysis (RMA) is to be supplied to the water utility/owner as it provides guidance on the tank turnover/fluctuation required to ensure complete mixing during the fill cycles. Maintaining water quality in tanks and reservoirs is a combination of achieving complete mixing AND tank turnover to minimize water age. It is critical to achieve complete mixing to prevent a localized increase in water age (and associated water quality problems) due to short-circuiting and dead zones.

The RMA calculates the dependent variables and uses the mixing time formula to calculate the "Theoretical Mixing Time" (MT) at various filling flow rates. The MT is the fill time required to achieve complete mixing. The required drawdown (in feet), % turnover, and the required volume exchange (in gallons) are calculated based on these mixing times. These values are shown in the "Guide to Tank Fluctuation and Turnover" section of the RMA. A slightly greater drawdown/turnover is typically recommended to be conservative.

Within the "Guide to Tank Fluctuation and Turnover" is a "Minimum Tank Fluctuation Target". This is applicable for tanks that operate in fill-then-draw. This is the minimum amount the tank should be drawn down on the draw cycles to ensure complete mixing on the fill cycles. This data is intended to be used by operators in conjunction with SCADA and strip charts (where applicable) to verify adequate tank turnover and to determine "pump on" and "pump off" set points (where applicable). For tanks that operate in simultaneous fill and draw, the "Theoretical Mixing Time" (fill time required to achieve complete mixing) should be used to ensure the minimum fill time required is achieved.

The RMA also provides data on the time required to draw down the tank, at various draw rates, to the required level as determined by the mixing time calculations.

Note, the data provided on the required drawdown, % turnover and volume exchange are to ensure complete mixing of the tank volume to prevent water quality problems associated with short-circuiting, incomplete mixing, and increased water age. A water age evaluation of the entire distribution system may dictate greater tank turnover than provided with the RMA. As long as the actual tank turnover/fluctuation is equal to or greater than that provided with the RMA, the tank will be completely mixed.

Tideflex® Technologies

RESERVOIR MIXING ANALYSIS (TMS)

09-May-2008

RESERVOIR / TANK NAME: **MARY DUNN NO. 2**

CONSULTANT: Weston & Sampson Engineers, Inc.
Contact: Johanna Nagle
Address:
phone
fax
email

UTILITY / OWNER: Town of Barnstable, MA
Contact:
Address:
phone
fax
email

RED VALVE REP.: NE3
Contact: Bob Mack

ANALYSIS BY: Michael Duer

** If "Effective" Tank Diameter is shown, the tank diameter is calculated to make the volume compute correctly. Mixing times are based on volume.

RESERVOIR / TANK DATA

Tank Diameter	42	ft
Tank Width		ft
Tank Length		ft
Tank Depth (SWD)	98	ft
Tank Volume	1,015,655	Gallons
Tank Volume	135,773	ft^3
Gallons Per Foot =	10,364	

INLET / OUTLET PIPES

Outlet Dia. = 6 in

* Effective Diameter of TMS (See Note 1)

Effec. Dia (in) =	AT	50
Effec. Dia (in) =	AT	80
Effec. Dia (in) =	AT	120
Effec. Dia (in) =	AT	165

FILL / DRAW RATES

Fill Rates (gpm) min, ave, peak, future	Draw Rates (gpm) min, ave, peak, future
50	50
80	80
120	120
165	165

PROPRIETARY NOTICE

FILL

INLET FLOW RATES (gpm)		Time to Fill Tank from Empty to H.W.L (Hours)	Time to Fill Tank from Empty to H.W.L (Days)	Time to Fill to 1' Depth (Minutes)	Time to Fill to 1' Depth (Hours)	Input Fill Time (Hours)	Resulting Increase In Water level (ft)	Volume Change (gallons)
min	50	338.55	14.11	207.28	3.45	4	1.2	12,000.00
ave	80	211.59	8.82	129.55	2.16	3	1.4	14,400.00
peak	120	141.06	5.88	86.37	1.44	2	1.4	14,400.00
future	165	102.59	4.27	62.81	1.05	1	1.0	9,900.00

GUIDE TO TANK FLUCTUATION AND TURNOVER

FILL

INLET FLOW RATES (gpm)		Jet Velocity (fps)	JV^2 / 2g (feet)	Reynold's Number	Inlet Momentum (ft^4 / min^2)	Velocity Gradient, G (1/sec)	Theoretical Mixing Time (Fill Time Req'd for Complete Mixing) MT = K * V^(2/3) / M^(1/2) (Minutes)	(Hours)	Req'd Drawdown on Previous Draw to Mix on Next Fill (feet)	% Turnover Required (%)	Volume Exchange Required (gallons)
									(SEE NOTE 2)	(SEE NOTE 2)	(SEE NOTE 2)
min	50	**5.10**	**0.40**	105,269	2,045	0.94	**595.3**	**9.9**	**2.9**	**2.9**	**29,454**
ave	80	**6.40**	**0.64**	149,167	4,107	1.49	**420.1**	**7.0**	**3.2**	**3.3**	**33,517**
peak	120	**7.90**	**0.97**	202,975	7,604	2.25	**308.8**	**5.1**	**3.6**	**3.6**	**36,564**
future	165	**9.30**	**1.34**	258,238	12,309	3.10	**242.7**	**4.0**	**3.9**	**3.9**	**39,611**

SEE NOTE 2

MINIMUM TANK FLUCTUATION TARGET

DRAW

OUTLET FLOW RATES (gpm)		TIME TO DRAW TANK FROM FULL TO EMPTY (Hours)	(Days)	Time to Draw Down 1' Depth (Minutes)	(Hours)	Pipe Velocity (fps)	Volume Exchange Required (gallons)	Draw Time Required (Hours)	
min	50	338.55	14.11	207.28	3.45	0.57	39,611	13.2	@ 50 gpm Draw Rate
ave	80	211.59	8.82	129.55	2.16	0.91	39,611	8.3	@ 80 gpm Draw Rate
fire	120	141.06	5.88	86.37	1.44	1.36	39,611	5.5	@ 120 gpm Draw Rate
future	165	102.59	4.27	62.81	1.05	1.87	39,611	4.0	@ 165 gpm Draw Rate

*** NOTE:** 1. TIDEFLEX VALVES ARE INHERENTLY A VARIABLE ORIFICE SO THE TMS EFFECTIVE DIAMETER VARIES WITH FLOW RATE
2. MIXING TIME EQUATIONS DO NOT ACCOUNT FOR DIFFERENCES IN TEMPERATURE BETWEEN INLET WATER AND TANK (BUOYANT JETS) THESE CALCULATIONS MAY UNDERESTIMATE THE FILL TIME REQUIRED FOR MIXING.

TIDEFLEX Mixing System for Reservoirs

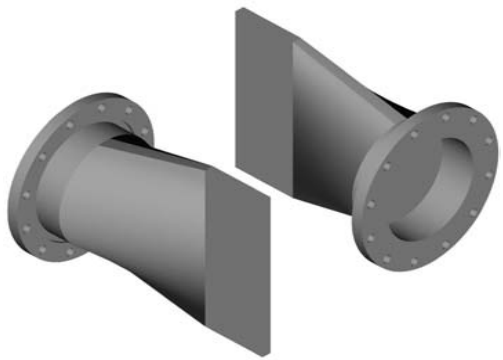
FILL AND DRAW MANIFOLD HYDRAULICS

165 GPM _ FILL
165 GPM _ DRAW

Reservoir Name:	**Mary Dunn No. 2**	Ambient Density =	**62.4**	lbm/ft^3
Reservoir Size:	**42' Dia. X 98' SWD**	Effluent Density =	**62.4**	lbm/ft^3
Reservoir Capacity:	**1 MG**	dS/S =	**0**	
End User:	**Town of Barnstable, MA**	C =	**100**	Hazen Williams Roughness Coefficient
Consultant:	**Weston & Sampson**	Cd =	**0.95**	

FILL CYCLE MANIFOLD HYDRAULICS

	Cumulative Flow	Jet Velocity	Friction Loss	Total Head
	(gpm)	(fps)	(ft)	(ft)
	54.05	9.20	0.012	1.4
	81.43	9.24	0.000	1.4
	108.82	9.24	0.044	1.4
	165.00	9.39	0.148	1.6
TOTALS	**165.0**	**9.3 (AVE)**	**0.20**	**1.6**



DRAW CYCLE MANIFOLD HYDRAULICS

Disk Material	Membrane Material	Support Rod Material	Fastener Material	Outlets - Fire Flow	Headloss For WF-3
				(gpm)	(ft)
TBD	TBD	TBD	TBD	165	0.2