

Item No. 521
Composite Elevated Water Utility Storage Tank

Notes to Specifier:

Delete these notes and not used paragraphs.

Where options are given, make appropriate selection and delete the other option, fill in all blanks.

Verify all references to paragraphs within this Section and to any applicable Sections, standards or other specified sources of information.

521.1 Description

- A. The Work performed under this Contract shall include all labor, materials and equipment necessary to design, construct, inspect and test a composite elevated water storage tank and all appurtenances and accessories as shown on the Drawings and specified herein. The design shall be the product of one manufacturer. The composite elevated tank shall consist of a welded steel tank and concrete support structure.
- B. The Work shall also include, but shall not be limited to, all labor, materials and equipment necessary to clean, paint and disinfect the water storage tank.
- C. Electrical power at the Site shall be in accordance with **Section [Insert Specification Number “Summary of Work”]** and as indicated in Division 26. The tank manufacturer will be responsible for coordination and installation of all water, sewer, communications and electrical utilities as required.

Note to Specifier: Coordinate paragraph below if cathodic protection is included in this Project.

- D. A cathodic protection system is included as part of the Project per Item 540 “Cathodic Protection.”
- E. System Description:
 - 1. The composite elevated tank consists of the following: foundation, reinforced concrete support structure, all internal and external piping ending at the flexible coupling located outside the pedestal wall, tank accessories, and a welded steel water tank.
 - 2. The support structure must extend vertically from the foundation as a single circular concrete wall.
 - 3. A concrete slab must be provided as structural support for the steel tank within the perimeter of the wall.
 - 4. A reinforced concrete ring beam must be provided to connect the steel tank, concrete slab and concrete support wall. Dimensions shown may be adjusted to suit tank manufacturer’s standard tank shape up to the minimum dimensions shown on the Drawings and in the Specifications.
 - 5. The tank, appurtenances, and all material exposed on the interior of the tank or in contact with stored potable water shall be resistant to degradation from the use of chlorine and chloramines.

- 6. All materials in contact with potable water shall comply with the requirements of the Safe Drinking Water Act, NSF 61 and other federal, state, local, and provincial requirements.
- 7. Hydraulic Design Criteria:

Note to Specifier: Update each parameter for each project. Consult NBU Engineering for max fill rate and required head range. Contact tank manufacturers for standard pedestal diameters and head ranges.

Design Criteria	Base Bid
Minimum Capacity Within Operating Range	[1,000,000] gallons
Maximum Operating (Head) Range	[35] feet
Elevation	
Overflow/Top Capacity Elevation	[725] feet
Pedestal Floor Elevation	[555.5] feet
Inlet/Outlet Pipe Diameter	[16] inches
Overflow Pipe Diameter, minimum	[16] inches
Maximum Fill Rate	[2700] GPM
Maximum Drain Rate (under normal operating conditions, tank manufacturer shall design based on broken pipe analysis as specified)	[2700] GPM

- 8. General Design:
 - a. Design Loads: The steel tank, concrete support structure and foundation shall be designed to safely withstand loads acting separately or in load combinations as specified by the most current editions of AWWA D107, ACI 371R, and ASCE/SEI 7 for category IV structures.
 - b. Foundation Design:
 - i. The concrete foundations shall be designed by the tank manufacturer and compatible with their proposed tank design. Foundations shall be constructed by the tank manufacturer or a Subcontractor directly supervised by the tank manufacturer in accordance with the drawings supplied. Foundations shall be of adequate size to properly distribute the bearing loads from the tank and to resist uplift due to wind forces.
 - ii. The tank manufacturer shall design the foundations accounting for soils and subsurface conditions. The successful tank manufacturer shall satisfy himself as to the adequacy of the geotechnical report that is included with these Contract Documents, and its recommendations. The successful tank manufacturer shall acquire any additional soils and foundation data necessary for the final design at no additional cost to the Owner.

Note to Specifier: Delete paragraph below if not included in project or modify accordingly.

- 9. Architectural Improvements and Subfloors within the Pedestal: The interior layout of stairways, [elevators], piping, electrical and other appurtenances have been

provided within the drawings. The tank manufacturer is responsible for verifying and making any modifications required to provide a complete project as specified to account for varying pedestal diameters, layout of interior, etc. to facilitate the construction of the tank. Any revisions to the interior layout shall be approved by the Engineer and shall meet all applicable codes at no additional cost to the Owner.

521.2 Quality Assurance

A. Qualifications

1. The Work described in this Section shall be performed by an elevated tank manufacturer that has a minimum of 10 years of experience in composite tank design and construction. The Manufacturer shall have designed, constructed and commissioned a minimum of five composite elevated tanks of equal or greater capacity, all in satisfactory operation for at least 5 years. These tanks shall be of the same design as described above.
2. Acceptable Tank Manufacturers:
 - a. McDermott International, Inc./CB&I Storage Tank Solutions.
 - b. Caldwell Tanks, Inc.
 - c. Landmark Tank Structures, LP.
3. Other manufacturers may submit proposals only if they pre-qualify and show conformance with the specification criteria. Request for qualification with supporting documentation must be received in writing 14 days prior to bid date. Documentation must include an experience list detailing the projects completed directly by the manufacturer that comply with this Section. Information to be submitted must also include details of construction, concrete forming process and equipment including concrete support wall placement height, steel tank erection process, rustication pattern and quality control procedures. The Owner and/or Engineer is the sole judge as to the acceptability of the tank manufacturer based on the submitted documentation.
4. Elevated tank design, concrete support structure construction and steel tank construction must not be subcontracted. These items shall be performed by the tank manufacturer.
5. The tank manufacturer must directly employ a full time Professional Engineer licensed in the state in which the tank is being constructed, with a minimum 5 years cumulative experience in the design and construction of composite elevated tanks as described in this Section. The engineer shall be in responsible engineering charge of the Work.
6. The tank manufacturer must have in its employ for this Project a team consisting of a tank superintendent, project manager and foreman(s) each of whom shall have constructed a minimum of five AWWA D107 tanks having a capacity of **[1.0]** MG or greater and have a minimum of 10 years of experience in the construction of composite elevated tanks.
7. All welders employed on the Project shall be tank manufacturer's employees and AWS D1.1 certified if welding structural steel and AWS D1.6 certified if welding stainless steel or ASME Section IX Certified as required by AWWA D107. Welders that have not had proof of certification submitted in accordance with the

Specifications must not be employed on the Project until such certification is submitted.

B. Regulatory Requirements:

1. The elevated tank shall be designed and constructed in compliance with applicable federal, state and local regulations.
2. Personnel safety equipment shall be provided in accordance with OSHA requirements and manufacturer's documentation.

C. Singular Responsibility: It is acknowledged that the successful design and construction of composite elevated storage tanks requires specialized and proprietary knowledge and skills. It is further recognized that successful performance of the tank requires that the earthwork preparation, foundation for the tank and the tank itself be considered an integrated system. Therefore, it is the express intent of this Section to create a singular responsibility for the design and construction of this integrated system required for composite elevated storage tanks. The design and construction of all aspects, including but not limited to, excavation, tank subgrade, fill placement beneath tank, tank foundation, foundation drainage systems, concrete support structure, inlet and outlet pipes, all piping and equipment inside the tank, interior floors and architectural improvements, welded steel tank, and pedestal and welded steel tank finishes must be performed by the tank manufacturer or its Subcontractor under the direct supervision of the tank manufacturer.

521.3 Submittals

A. The following Shop Drawings are required to be submitted prior to the start of tank construction:

1. Construction Drawings:

- a. Contractor may provide the submittal for the tank's foundation separate from the rest of the construction drawings. All other drawings shall be all inclusive in one submittal. Partial submittals for tank design and components will not be accepted and will be returned without review.
- b. Drawings must show all features of the Work, including the size and position of all structural components, interior layout of all floors, the required strength or grade of all materials, and construction tolerances.
- c. Foundation details must also include excavation and backfill required.
- d. Reinforced concrete details shall include construction joints, openings and inserts. Reinforcement shall be clearly indicated on the structural drawings and identified by mark numbers that are used on the fabrication schedule. Location, spacing and splice dimensions shall be shown. Placement and fabrication details shall conform to ACI 318.
- e. Drawings of steel components shall show all details of welded joints and other connections. Standard weld symbols as listed in AWS A2.4 shall be used, unless joint details are shown.
- f. Provide a table showing capacity of the tank in gallons at all levels in 1-foot increments.
- g. Provide design, detail drawings and procedures for the support structure, forming system. Details shall include location of form and construction joints,

- rustications and ties. Procedures shall include form removal criteria and minimum elapsed time for adjacent concrete placement.
- h. Final construction drawings shall be sealed and signed by a professional engineer licensed in the state the tank is constructed in and submitted as Product Data.
- B. The following Product Data are required to be submitted prior to the start of tank construction:
1. Signed and Sealed construction drawings.
 2. Construction Process:
 - a. Provide shop and field welding procedures for all structural joints on the steel tank.
 - b. Repair procedures that will be followed for correcting various types of surface defects during pedestal wall construction, i.e. discolorations, honey combing, etc., if encountered during construction.
 - c. Hot and cold weather concreting procedures.
 - d. Mass concrete thermal control plan for any concrete placements that will have a minimum dimension greater than 3-feet, or any varying thickness section with an average thickness of more than 3-feet. Temperature limits and thermal control plan shall be in accordance with ACI 301, Mass Concrete section. Plan must be signed and sealed by a Professional Engineer licensed in the state where the project is located.
 3. Tank manufacturer's Quality Control Plan.
 4. Design Data: Provide a summary of the design and design calculations for the foundation, support structure, overflow weir, vent, tank and other components sealed and signed by the tank manufacturer's Engineer. Document the codes and standards, methods of analysis, design coefficients, and resultant gravity, snow, wind, and seismic loads utilized.
 5. Product Data:
 - a. Provide a separate concrete mix design for each specified concrete compressive strength indicated on the tank manufacturer's drawings.
 - b. Provide manufacturer's descriptive information for appurtenant equipment and accessories that are not detailed on the Drawings.
 6. Reports/Certification:
 - a. Provide certification that testing and inspection requirements of this Section have been performed and the results comply with the requirements of the Specifications.
 - b. Documentation must include certification of test results and other information required by ASTM A6 or ASTM A20, as applicable.
 - c. Foundation excavation report as inspected by a representative of the tank manufacturer's geotechnical engineer prior to foundation construction.
 - d. Provide report to document field measurements, and certify compliance or non-compliance with the tolerance requirements in Section 5.4.4.1 of AWWA D107.
 - e. Inspection of concrete reinforcement and embedment.

- f. Report on concrete sampling and testing during the Project.
 - g. Conformance to ASTM standards of concrete testing agency.
 - h. Certification of NDT personnel.
 - i. Certification of AWS Certified Welding Inspector (CWI).
 - j. Welding Report(s):
 - i. Welding procedure specification for all welds on the tank.
 - ii. Provide proof of AWS D1.1, AWS D1.6 and/or ASME Section IX certifications of all welders. Documentation shall include a current color photograph of the welder and welder performance qualifications.
 - iii. Summary of visual and inspection of radiographs and other inspections, including location of tests on developed shell plate diagrams.
 - iv. Identification of defective welds and a statement of action/procedure for repair.
 - v. Record of welders employed at each joint.
 - k. Leak and vacuum testing reports.
 - l. Settlement monitoring report.
- C. Certified Test Reports:
- 1. Certified Test Reports shall be submitted to the Owner within 7 days of the test being performed. Failure to submit test reports may result in non-payment for those pay items.
 - 2. Steel mill test reports.
 - 3. Welding test reports.
 - 4. Subgrade compaction report.
 - 5. Concrete test reports during construction.
 - 6. Daily mass concrete thermal monitoring records.
 - 7. Tests on hardened concrete.
 - 8. Settlement monitoring report.
 - 9. Vacuum box testing report.
- D. Operation and Maintenance Manual: Provide O&M Manual with all operating instructions and maintenance procedures for the composite elevated tank, including but not limited to, complete drawings of the composite elevated tank, manuals and operating instructions for equipment, minimum maintenance and inspection instructions.
- E. Logo and Artwork Mock-Up: Provide Owner with a mock-up of the artwork design for approval prior to commencing paint work. Mock-up must be to scale, color and indicate size of logo and lettering. Paint samples of proposed colors shall also be submitted for Owner approval per Item 531 "Coatings for Water Storage Tanks."

521.4 Standards

The following standards dictate standards used in project:

A. ASTM International (ASTM):

ASTM A123	Zinc Coatings on Iron and Steel Products
ASTM A240	Stainless Steel Plate, Sheet and Strip for Pressure Vessels
ASTM A285	Pressure Vessel Plates, Carbon Steel
ASTM A774	Welded Stainless Steel Fittings
ASTM A778	Welded Stainless Steel Tubular Products
ASTM A780	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

B. American Water Works Association (AWWA):

AWWA C200	Steel Water Pipe 6 In. and Larger
AWWA C206	Field Welding of Steel Water Pipe
AWWA C220	Stainless Steel Pipe 4 In. and Larger
AWWA C652	Disinfection of Water Storage Facilities
AWWA D102	Coating Steel Water Storage Tanks
AWWA D107	Composite Elevated Tanks for Water Storage

C. American Concrete Institute:

ACI 117	Standard Tolerances for Concrete Construction and Materials
ACI 302	Specification for Structural Concrete
ACI 303R	Guide to Cast-in-Place Architectural Concrete Practice
ACI 304	Guide for Measuring, Mixing, Transporting and Placing Concrete
ACI 305.1	Specification for Hot Weather Concreting
ACI 306.1	Specification for Cold Weather Concreting
ACI 318	Building Code Requirements for Structural Concrete
ACI 347	Guide to Formwork for Concrete
ACI 350	Code Requirements for Environmental Engineering Concrete Structures and Commentary
ACI 371R	Guide for the Analysis, Design, and Construction of Concrete Pedestal Water Towers

D. American Institute of Steel Construction (AISC):

AISC S335	Specification for Structural Steel Buildings
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E. American National Standard Institute (ANSI):

ANSI B16.5	Pipe Flanges and Flanged Fittings
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F. American Society of Civil Engineers (ASCE):

ASCE/SEI 7	Minimum Design Loads and Associated Criteria for Buildings and Other Structures
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G. American Welding Society (AWS):

AWS A 2.4	Standard Symbols for Welding, Brazing, and Nondestructive Examination
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AWS D1.1	Structural Welding Code – Steel
AWS D1.6	Structural Welding Code – Stainless Steel

H. Federal Aviation Administration (FAA):

FAA 70/7460-1H	Obstruction Marking and Lighting
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I. Miscellaneous Standards:

ASCE/SEI 7	Minimum Design Loads for Buildings and Other Structures
IBC	International Building Code as Adopted by Owner
NACE RP0178	Standard Recommended Practice: Design, Fabrication, and Surface Finish of Metal Tanks and Vessels to be Lined for Immersion Service
NSF/ANSI Standard 61	Drinking Water System Components – Health Effects
OSHA 29 CFR	Part 1910 Occupational Safety and Health Standards
TAC Title 30, Part 1, Chapter 290, Subchapter D	Rules and Regulations for Public Water Systems
SSPC Technology Guide No. 6	Guide for Containing Surface Preparation Debris Generated During Paint Removal Operations

In the event of a conflict between the published standards, codes, and this Section, the more stringent requirement shall govern.

521.5 Sequencing and Scheduling

- A. Notification: The Contractor shall provide notification of the intent to start Work at least 7 days prior to commencing each major phase of the Work.

521.6 Guarantees

- A. Workmanship and Material Guarantee: The tank manufacturer shall guarantee the tank structure against defects in workmanship and material for a period of 2 years. If, within 2 years from final completion of the Project, workmanship or material is proven defective, the tank manufacturer shall repair such defects at their own expense.
- B. Design Warranty: The tank manufacturer shall warrant its design of the proposed facility to be structurally and functionally applicable to serve the intended use of the projected Work. Such intended use is exemplified by the criteria of design, workmanship, and material expressed by the requirements of the Specifications and Drawings prepared by the Engineer. The Owner’s or Engineer’s review of the tank manufacturer’s design, or the Owner’s acceptance and final payment for the Work shall not relieve the tank manufacturer of design responsibility. The Owner shall be the direct beneficiary of the warranty.

521.7 Job Conditions

A. Permits and Easements:

1. Permits or licenses required for permanent structures, changes in existing facilities or advancement of the construction shall be secured and paid for by the tank manufacturer prior to the start of construction. These include building permits, code inspections, etc.
2. Airspace authority permits and site easements have been secured by the Owner prior to construction. **[Reference Appendix [X] for a copy of the permit.]** Contractor will be required to coordinate and permit any temporary structures or cranes exceeding the permitted height with the FAA.

B. Access: Tank manufacturer shall provide access to the Site as indicated on the Drawings.

C. Working Conditions:

1. Safety and Health: Tank manufacturer shall comply with safe working practices and all health and safety regulations of OSHA, state and local health regulatory agencies and Safety Data Sheets (SDS). Provide protective and lifesaving equipment for persons working at the Site.

D. Field Measurements:

Note to Specifier: Include this section if facility will match existing elevated tanks. Delete if not required.

1. Verify layout information for tank shown on the Drawings in relation to property survey and existing structures. Verify dimensions by field measurements. Prior to start of tank design submit the following elevations as Product Data, survey must be completed by licensed surveyor:
 - a. **[Example: Bottom slab elevation of the existing ground storage tank.]**
 - b. **[Example: Overflow elevation of the existing ground storage tank.]**

521.8 Materials

Reinforced Concrete Materials:

- A. All structural concrete materials, foundations, and reinforcement used in constructing the composite elevated tank must comply with applicable requirements of the referenced standards, except as modified in this Section and are the responsibility of the Contractor.
- B. Driveways, mow strips, sidewalks, flumes, and other miscellaneous concrete items shall be in accordance with TxDOT Standard Specifications.

Steel Tank Materials:

- A. Steel tank components, including steel plates, sheets, structural shapes and filler metals shall be in accordance with the referenced standards.

Concrete Support Structure:

- A. **Support Wall:** Wall thickness shall be a minimum of 8 inches, exclusive of any architectural relief provided such that the average compressive stress due to the weight of the structure and stored water is limited to 25 percent of specified compressive strength, but not greater than 1000 psi. A minimum total wall reinforcement of 0.15 percent vertically and 0.20 percent horizontally shall be distributed approximately equally to each face. A minimum of 1.00 percent vertical reinforcement shall be provided in the top 6 feet of the wall extending into the concrete ring beam.
- B. **Tank Floor:** The average compressive stress due to the weight of the structure and stored water shall not exceed 15 percent of the specified compressive strength, nor greater than 600 psi. Minimum total reinforcement in orthogonal directions shall be 0.40 percent distributed approximately equally to each face. Additional reinforcement shall be provided for stress caused by edge restraint effects.
- C. **Openings:** Openings 8 feet or wider used for vehicle access shall be strengthened against vehicle impact and local buckling by means of an internal buttress located on each side of the opening. The buttress shall consist of a thickened, reinforced concrete wall section that is integrally formed and placed with the support wall. The buttress section shall be not less than 3 feet wide and 6 inches thicker than the nominal wall dimension.

Concrete Support Structure / Steel Tank Interface:

- A. **Interface Region:** The geometry of the interface shall provide for positive drainage and not allow either condensation or precipitation to accumulate at the top of the concrete wall or ring beam.
- B. **Ring Beam:** The ring beam shall be reinforced concrete with a nominal width and height of at least two times the support wall thickness. Minimum radial reinforcement shall be 0.25 percent. Circumferential reinforcement shall be not less than 1.0 percent. For direct tension, reinforcement shall be provided such that the average service load stress in tension reinforcement due to the weight of the structure and stored water does not exceed 12,750 psi.
- C. **Ring beam design** shall consider unbalanced forces from the steel tank cone and concrete slab, load conditions varying with water level, eccentricity of loads resulting from design geometry, and allowance for variations due to construction imperfection and tolerance.

Steel Tank

- A. **General:** The steel tank shall be all welded construction and shall be designed in accordance with applicable sections of AWWA D107. The required capacity and dimensions of the tank are noted on the Drawings and in this Section of the Specifications.
- B. **Roof Support:** All structural members supporting the roof of the steel tank shall be flat bar or sealed square tubular sections. I-beams or other sections with horizontal projections may be used if the nominal depth is 10 inches or greater. Support beams shall be seal welded to the underside of the roof plate along the entire length of the beam.

- C. Cone: For areas of the elevated tank where the water is supported by a steel cone, the tank manufacturer shall submit evidence that the design is based on a finite element shell analysis. The analysis shall include the effects of material and geometric non-linearities and residual stresses. The modeled imperfection shall not be less than as specified in AWWA D107. The cone model should recognize the restraint conditions compatible with the actual response of the concrete support structure. The design shall have a minimum factor of safety of 2.0 against buckling.

Accessories:

A. General:

- 1. Accessories shall comply with the minimum requirements of the Specifications, Codes and Standards listed in this Section, current applicable safety regulations, and the operating requirements of the structure.
- 2. Electrical isolation kits must be used between dissimilar pipe and other metal materials.

B. Name Plate:

- 1. Provide minimum 8-inch by 10-inch laser engraved stainless steel name plate on the exterior of the pedestal next to the man door. Name plate must include the following information:
- 2. Manufacturer.
- 3. Manufacturer’s Job Number.
- 4. Date of Completion.
- 5. Capacity.
- 6. Tank Diameter.
- 7. Head Range.
- 8. Bottom Height AMSL.
- 9. Overflow Height AMSL.

C. Ladders:

- a. Install ladders with appurtenances as indicated:

Location	Material	Ladder Safety System Req.
Interior Tank (Tank Floor to Roof)	316 Stainless Steel	X
Interior Access Tube	Galvanized Steel	X
Ladders within Pedestal	Galvanized Steel	X
Top Platform to Bottom of Tank Manway	Galvanized Steel	X

- b. All ladders must be designed and installed per ANSI A14.3 and OSHA 1910 standards. D-rings and/or lanyard rings and tie-off points must be designed for a minimum tensile load of 5000 lb. Tie-off locations must be provided at all ladder transition points and at hatches, including hatches that do not provide ladder access.

- c. Ladder rails must be punched for the rungs and welded on both sides of the rail.
- d. Ladders that terminate at platforms or landings shall extend a minimum of 48 inches beyond the platform elevations.

Note to Specifier: Complete specification ID and coordinate safety ladder systems with notes within the referenced specification.

- e. Include ladder safety systems on all ladders as specified in **Section [Insert Specification Number] [“Insert Specification Name.”]**
 - f. Tank Interior Ladder - Ladder brackets located on the access tube exterior must be reinforced at the access tube shell so that potential ice damage is confined to the ladder and bracket and not the access tube shell.
- D. Pedestal Intermediate Platforms:
- a. General:
 - a. All components must be galvanized steel.
 - b. Platforms and guard rails are to be in accordance with OSHA 1910 and designed for a minimum live load of 60 psf per the IBC.
 - c. Grating must be used for the walking surface.
 - d. Platforms must be provided with guard rails, mid-rails and toe plates.

Note to Specifier: Complete specification ID and coordinate self-closing gates with notes within the referenced specification.

- e. Openings in platforms must include self-closing safety gates as specified in **Section Insert Specification Number “Insert Specification Name.”** Gate size must be at least 30 inches wide.
 - b. Interior Pedestal Ladder Platforms:
 - a. Provide intermediate offset platforms on the support wall ladder at maximum intervals shown on the Drawings. Platforms must be a minimum 3 feet by 3 feet.
 - b. Platforms must be arranged for straight run ladder and operable without removing fall prevention equipment.
 - c. Pedestal Top Platform:
 - a. A minimum 4-foot wide top platform designed for a minimum live load of 60 psf per the IBC must be located at the top of the support wall to provide access from the support wall ladder to the roof access ladder located on the interior of the access tube. Provide a wider platform as required to provide clearance for tank floor manway ladder.
 - b. At the top platform, provide one manual hoist. Provide permanent sleeves for mounting at top platform and two sleeves welded on top of tank that would allow portable hoist to be used over access tube and tank hatches. Refer to **Section [insert Specification Number] [“Insert Specification Name.”]**
- E. Pedestal Access
- a. Personnel Door:

- a. Door frames shall be 14-gauge with concealed reinforcement at hardware locations. Expansion type anchors for existing openings shall be installed near the top, bottom and intermediate point of each jamb to rigidly secure the frame. Doors shall be 1-3/4-inch thick insulated, reinforced, full, flush type with 16-gauge face sheets and concealed reinforcement at hardware locations. All edges shall be finished flush with watertight seams. Frame shall be galvanized. Shop applied finish for the door shall be baked on rust inhibitive primer. Field finish shall be compatible with the tank exterior and approved by Owner. Standard hardware shall be stainless steel and include three 4-1/2-inch-by-4-1/2-inch hinges, industrial duty closer and lockset keyed to the Owner's requirements.
 - b. Size, quantity and location of personnel door(s) shall be as shown on the Drawings.
 - b. Overhead Vehicle Door:
 - a. Door installation shall be on the interior face of the support wall. The door frame shall be a steel plate fabrication detailed, fastened and reinforced to accept the door. Frame shall be galvanized. Steel brackets shall be installed to the interior face of the wall with expansion anchors, which enclose and support the counterbalance assembly with sealed bearings.
 - b. Operation shall be manual with a chain hoist.
 - c. The curtain shall be formed of 22-gauge steel interlocking slats with end locks and wind locks designed for a wind loading of 20 psf. Torsion springs shall be mounted on a solid torsion rod, which is attached to an exterior mounted spring tension adjustment wheel. A 24-gauge steel hood shall be provided with a weather seal to protect the assembly.
 - d. The curtain, bottom bar, brackets, guides, hood, pipe, chain and appurtenance shall be galvanized. Provide with locking device. Wall penetration at door is to be completely sealed on top and provided with brush or alternate seal between curved pedestal wall and door.
 - e. Size, quantity and location of vehicle door(s) shall be as shown on the Drawings.
- F. Tank Openings:
- a. Floor:
 - a. Provide a 30-inch diameter manhole through the tank floor. The manhole assembly must include a 316 stainless steel handwheel operator and threaded components.
 - b. The manhole must be operable from a ladder located on the upper platform and shall be designed to withstand the pressure of the tank contents without leakage.
 - c. Upper platform must provide for required clearances and landing space for manhole ladder per OSHA. Provide deflector plate at hatch ladder as required by OSHA.

b. Roof Access:

Note to Specifier: Adjust table below as required, if installing active mixing system, verify if additional hatch needs to be added for access.

- a. Hatch dimensions indicate on the Drawings are to be considered internal clear opening length and width. Provide hatches as indicated on the Drawings and as below:

Hatch Location	Qty.	Clear Opening Size
Access Tube Roof Hatch	1	36" x 42"
Tank Interior Roof Hatch	1	36" x 42"
Interior Tank Painter's Rail Access Hatch	1	36" x 36"

b. General:

- i. Hatches must be installed on a minimum 4-inch curb. Hatch lid shall have a minimum 2-inch overhang as required by TCEQ Chapter 290. Provide a neoprene gasket between steel curb and hatch.
- ii. An EPDM rubber gasket shall be used to make a positive seal when the hatch is closed.
- iii. Aluminum shall have a clear anodic finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.
- iv. Installation shall be in accordance with the manufacturer's written instructions.
- v. Hatches must open to a 90-degree angle.

Note to Specifier: Complete specification ID and coordinate confined space entry signage with notes within the referenced specification.

- vi. Refer to **Section [Insert Specification Number] ["Insert Specification Name"]** for confined space entry signage requirements.
- vii. Contractor must indicate the location of hinges, latches, pad lock staple, and lift handle on submittal for verification of orientation with the project plans.
- viii. Manufacturer must provide a lifetime guarantee against defects in materials and workmanship.

c. Access Tube Roof Hatch:

- i. Provide a 6-inch diameter aluminum vent with #16 stainless steel insect screen on the access tube hatch cover.
- ii. Hatch must be single leaf and constructed of aluminum with 316 stainless steel hardware. Hatch must be rated for a minimum live load of 300 psf.
- iii. Hatch must be equipped with fixed exterior and interior opening handles and interior padlock staple. Removable T-handles will not be accepted.

- iv. The hatch must have stainless steel gas shocks or springs to assist in opening the hatch and reducing the force during closing.
- v. A stainless steel or aluminum hold open arm with push/pull handle must automatically keep the cover in its upright, open position.
- vi. Provide field installed stainless steel eyelet on hatch with 1-inch diameter paracord rope with knots at 12-inch spacing to aid in closing the hatch while descending access tube ladder.
- vii. Approved Manufacturers:
 - a) Halliday Products.
 - b) Babcock-Davis.
 - c) Bilco Company.
 - d) Milcor, Inc.
 - e) U.S.F. Fabrication.
 - f) Approved Equal.

d. Tank Interior Roof Hatch:

- i. Hatch must be single leaf and constructed of aluminum with 316 stainless steel hardware. Hatch must be rated for a minimum live load of 300 psf.
- ii. Hatch must be equipped with stainless steel pressure locks/twist latches on the exterior of hatch, 3 each minimum and an exterior padlock staple.
- iii. The hatch must have stainless steel gas shocks or springs to assist in opening the hatch and reducing the force during closing.
- iv. A 316 stainless steel or aluminum hold open arm with push/pull handle must automatically keep the cover in its upright, open position.
- v. Approved Manufacturers:
 - a) Halliday Products – F1R.
 - b) U.S.F. Fabrication, Inc.
 - c) Approved Equal.

- e. Interior Tank Painter's Rail Access Hatch: Provide hatch on the tank roof to access the tank interior rigging rail. Provide a bolted 316 stainless steel or aluminum cover with a 2-inch down turned edge and a gasketed interface. Hardware must be 304 stainless steel.

G. Access Tube:

- a. Provide a minimum 72-inch diameter centrally located access drywell through the steel tank to provide access to the tank roof from the upper walkway platform and to house future telecommunication cabling.
- b. The access tube shall incorporate a 2-inch-by-2-inch channel to collect condensation that may form on the interior surface. A flexible 3/4-inch PVC hose complete with backflow preventer shall drain the channel to the overflow pipe.

- c. Provide painted steel brackets and clamp system at maximum 10-foot vertical intervals for antenna, conduits and cable mounting within access tube. Brackets shall be drilled or fabricated to be compatible with standard conduit clamp systems. Installation and spacing shall be in accordance with OSHA ladder clearance and electrical code requirements. Reinforce access tube as required at the connections to support the weight of proposed and future conduits.

Note to Specifier: Discuss antenna mounting requirements with NBU Engineering. Adjust section accordingly.

H. Roof Railing:

- a. Provide a 42-inch roof guardrail with top rails, mid rails, and toe plates in accordance with OSHA requirements. The circular guardrail must extend at least 3 feet beyond the outside of any roof appurtenances, including cathodic protection hand holes, if included.
- b. Roof railing must be a structurally designed appurtenance for mounting antennas and other loads as specified. Provide design calculations, design assumptions and design for rail with tank Shop Drawings.
- c. Tank manufacturer is to design the guardrail to support the following:
 - a. Tank engineer is to assume **[four]** future antennas to be mounted anywhere on the guardrail, weighing at least 32 pounds with approximate dimensions of 36 inches by 36 inches by 12 inches and mounted just above the handrail height.
 - b. Install painted carbon steel 2-inch angle iron, 18-inches wide at 4-foot maximum spacing from the access tube to the guardrail to mount conduits. Install stainless steel Unistrut with stainless steel hardware to the angle iron. Angle iron is to be seal welded on both sides at the attachment to the roof. Provide conduit supports on the roof at 0-120-240 azimuth locations.

- I. Exterior Pedestal Rigging Access: Provide one 30-inch by 30-inch square hatch near the top of the support wall. Opening must be accessible from a platform and provide access to the exterior-rigging rail located at the tank/support wall intersection. The access openings shall be provided with a hinged aluminum louvered vent with a #16 stainless steel insect screen.

- J. Painter’s Rails: Provide permanently installed rails suitable for rolling trolleys at the following locations:

Location	Material
Tank Interior Painter’s Rail at Tank Shell	Galvanized steel and coated with tank interior coating system for 6” minimum on each side of attachments to roof.
Tank Interior Painter’s Rail at Access Tube	Galvanized steel and coated with tank interior coating system for 6” minimum on each side of attachments to roof.
Pedestal Exterior Painter’s Rail Accessible from Top Platform	Galvanized Steel
Pedestal Interior Painter’s Rail Accessible from Top Platform	Galvanized Steel

K. Piping:

Materials:

- a. Ductile Iron Pipe in accordance with Item 510 "Pipe."
- b. Stainless steel pipe and fittings must be Type 304L/316L stainless steel fabricated from material meeting the requirements of ASTM A240 as indicated. Fabrication, inspection, testing, marking and certification of pipe and fittings shall be in accordance with ASTM A778 and A774 respectively. Backing flanges, retaining rings and related hardware must be 304L/316L stainless steel to match adjacent piping and drilled to ANSI B16.5 Class 150. Pipe, fittings and welds shall be cleaned and passivated.

Inlet/Outlet Pipe:

- a. Provide inlet/outlet pipe that extends from the base of the support structure and connects to the tank as shown on the Drawings.
- b. The bottom capacity level of the tank's operating range must be at or above the elevation of the outlet. Pipe material within the pedestal must be Schedule 10S, Type 304L stainless steel. Pipe material within the tank must be Schedule 10S, Type 316L stainless steel and coated with interior coating system.
- c. The inlet/outlet pipe shall be designed to support all related static and dynamic loads. Type 304L stainless steel steel brackets, guides and hangers shall be provided on the support wall and tank floor at a maximum of 20-foot intervals.
- d. The inlet/outlet pipe shall be designed and constructed to accommodate any differential movement caused by settlement and by thermal expansion and contraction over the range of extreme temperature differences expected for the support wall and pipe. The required flexibility shall be provided by a rubber expansion joint located near grade in the vertical section of pipe. Expansion joint is to be constructed of EPDM rubber and must be ANSI/NSF 61 certified. Backing flanges, retaining rings and related hardware must be 304 stainless steel. Electrical isolation flange kits must be used between dissimilar pipe materials.

Overflow Pipe:

- a. Provide an overflow pipe from the tank's overflow weir to the bottom of the pedestal. The top of the overflow must be located within the tank at the overflow elevation. It must run adjacent to the access tube and extend through the tank floor. The pipe must run vertically supported by the pedestal wall to grade.
- b. A base elbow shall direct the overflows through the support wall, where the pipe shall be terminated with a flap valve. Pipe material within the pedestal must be Schedule 10S, Type 304L stainless steel. Pipe material within the tank must be Schedule 10S, Type 316L stainless steel and coated with interior coating system.
- c. The entrance to the overflow pipe shall incorporate a conical weir or weir box and be designed for the maximum inlet flow rate. The design must be based on the water level cresting a maximum of 6 inches above the overflow elevation. Weir must be constructed of 316 stainless steel and coated with interior coating system.

- d. The overflow shall be designed to support all related static and dynamic loads. Type 304L stainless steel brackets, guides and hangers shall be provided on the support wall and tank floor at intervals not exceeding 20 feet. The overflow, weir section and support brackets and hangers within the tank shall be stainless steel and supported by the access tube.
- e. The overflow pipe shall be designed and constructed to accommodate any differential movement caused by settlement and by thermal expansion and contraction over the range of extreme temperature differences expected for the support wall and pipe. A layout with sufficient upper offset to accommodate differential movement is acceptable. If this method is not applicable, the required flexibility shall be provided by an expansion joint located near grade in the vertical section of pipe. Expansion joint is to be constructed of EPDM rubber and must be ANSI/NSF 61 certified. Backing flanges, retaining rings and related hardware must be 304 stainless steel.

Flap Valve:

- a. Flap valve must consist of a cast iron frame, cover (flap) and adjustable hinge blocks.
- b. Assembly bolts, hinge pins and keepers must be 304 stainless steel.
- c. Hinge bushing must be bronze.
- d. Valve must assure positive closing with less than a 1/16" gap.
- e. Valve frame must be able to connect to a flanged connection. Mating flange and flap valve flange must be 125 lb. standard drilling. The number of bolt holes in the valve flange must match the mating flange and be able to rotate the valve sufficiently to mount it horizontal or vertical to the ground.
- f. If mounted in a horizontal position, provide a counterweight as required to operate the valve and maintain a positive closure while not in use.
- g. Seat faces must have a resilient seat, neoprene rubber or equal.
- h. Valve will be prepared and coated as specified. Shop applied primers must be confirmed by the manufacturer to be compatible with specified coating system.
- i. Approved Manufacturers:
 - i. Waterman Industries – Model F-55
 - ii. Approved Equal"

Note to Specifier: Verify if a separate tank drain is required per the piping layout and manufacturer's tank design.

Tank Drain:

A 6-inch diameter stainless steel drainpipe shall penetrate the tank at the low point of the tank floor and connect to the overflow pipe. The drain inlet shall be fitted with a gate valve with handwheel accessible from the upper platform as shown in the Drawings. The drain pipe shall have a wall thickness equal to or greater than standard weight pipe. Pipe material for the full extent of the drain shall be Schedule 10S, Type 304L stainless steel.

Note to Specifier: Include section below and complete specification ID if an active mixing system is required. Remove this section if mixing system is not required.

Active Water Storage Tank Mixing System:

- a. Install an active mixing system on the interior of the tank as specified in Section [### ## ## **“Active Water Storage Tank Mixing System.”**]
- b. Tank manufacturer is responsible for coordination and compatibility of the design of the mixing system and the construction of the tank.

Tank Ventilation:

- a. Tank Vent shall be as indicated on the Drawings. The tank manufacturer to size roof ventilator to pass air so that the maximum fill/draw rate shall not develop pressure within the tank per the design parameters provided and a broken pipe analysis assuming a broken pipe immediately outside of the tank's foundation. Broken pipe analysis shall be based on largest diameter inlet/outlet pipe with a break 5 feet beyond the pedestal wall.
- b. Approved Manufacturer(s):
 - i. AST Model Vent by Advance Tank and Construction Co.
 - ii. Approved Equal.
- c. Vent shall be constructed of Aluminum with a #16 316 stainless steel insect screen, minimum diameter is 24 inches, meeting current AWWA and TCEQ standards.
- d. Vent shall be securely fastened using 316 stainless steel hardware.
- e. Vent shall be provided with a pressure-vacuum relief mechanism that will operate in the event that the vent fails. The mechanism shall be designed to return automatically to its original position after operation. The pressure/vacuum relief mechanism shall be located on the tank roof above the maximum weir crest elevation, and incorporated in the vent assembly.
- f. Contractor shall include detailed calculations of vent sizing and broken pipe analysis with design calculations and Shop Drawings.

Interior Floors:

Slab on Grade: The tank manufacturer is responsible for the floor slab design at the base of the support structure including all dead and live loads. At a minimum, the slab must be designed for a 10 KIP axle load, 2 each – 10"x20" wheel contact areas at 6' c-c. Provide a 6-inch minimum thickness, 3500-psi concrete floor slab. The minimum reinforcement required is #4 reinforcing steel at 12-inch centers each way. Provide 1/2-inch expansion joint between floor slab and support wall and at pipes and supports that extend through the floor. Place cap strip and sealant over the expansion joint. The slab shall be sloped at 0.5 percent toward the vehicle door for drainage.

Level Monitoring and Sampling:

- a. Provide 3/4-inch stainless steel threaded couplings welded to inlet/outlet pipe(s) a maximum of 5 feet above grade with isolation stainless steel ball valves.
- b. Provide coupling(s) for pressure gauge(s) as shown on the Drawings. Provide pressure gauge(s) as shown on the Drawings. Refer to Item No. 511 Water Valves & Fire Hydrants

- c. Provide two couplings for future use. Plug valve with stainless steel or bronze plug.
- d. Provide one coupling for sampling port with ball valve and ball valve type hose bid. Label sampling port as specified.
- e. Provide additional monitoring and sampling lines within the access tube as indicated on the Drawings.
- f. Pressure Transmitter: Provide 1-inch stainless steel threaded coupling welded to the tank drain pipe as assessable from upper platform with isolation stainless steel ball valve. Provide pressure transducer as shown on the Drawings and as indicated in **[Division 26]**.
- g. Electrode Holders: Provide two 4-inch standard weight steel pipe blind flanged outlets with 125 lb. flange to allow mounting of flanged electrode holders, furnished and welded to the roof.

Note to Specifier: Complete specification ID and coordinate lightning protection with notes within the referenced specification.

Lightning Protection: Provide a lightning protection system for the elevated tank as indicated in **Section [Insert Specification Number] [“Insert Specificaiton Name.”]**

Communications Equipment:

Note to Specifier: Consult with NBU Engineering on location, type, and number of antennas to be provided for current operations and future system expansions.

- a. The Owner’s antenna mounts shall be provided at the top of the tank. Two antenna locations shall be provided. The location of the mount on top of the tank shall be coordinated with the Owner.
- b. Future antenna location openings in the tower pedestal and foundation shall be provided as shown on the Drawings. All openings shall include watertight, removable plugs.
- c. Provide galvanized steel z-bracket conduit hangers at 10-foot intervals adjacent to the pedestal access ladder and above each spare conduit location indicated in the plans within the pedestal. Install conduit hangers around the top of the pedestal at 5-foot intervals to allow for horizontal transition of conduits from vertical supports up the pedestal to the top landing. Length of conduit hangers will be as required to provide adequate spacing between the quantity of conduits required for the Project, 24 inches minimum.
- d. Provide the maximum amount of 2-inch threaded couplings with PVC plugs for penetrations through the roof plate covering the access tube for electrical and future antenna conduits.

Electrical and Lighting:

- a. All Work shall be performed and all materials shall be provided in accordance with National Electric Code and the governing electrical, safety and inspection codes, regulations and ordinances. Refer to Division 26 for additional requirements.

Steel Tank Painting:

- a. Refer to Item 531 “Coatings for Water Storage Tanks.”

Source Quality Control:

- a. Tests: Review mill test certifications of all steel plate, structural components and reinforcement to ensure compliance with specification requirements.
- b. Inspections: Provide inspection of shop fabricated components in accordance with AWWA D107.

521.9 Delivery and Storage

- A. Handling and Shipping: The tank manufacturer shall handle materials and fabricated components in a manner that will protect them from damage. Allow painted materials adequate cure time prior to stacking or shipping.
- B. Storage and Protection: Protect delivered materials and equipment from damage. Store in well-drained areas and provide blocking to minimize contact with the ground.

521.10 Construction Methods

Examination

- A. Foundation Excavation: The foundation bearing surface and excavation shall be inspected by a representative of the geotechnical engineer prior to foundation construction. Verification of the applicable design and construction recommendations is required in a letter signed and sealed by the geotechnical engineer and submitted to the Engineer. The geotechnical engineer must be retained by the tank manufacturer. The tank manufacturer may contract with the same geotechnical engineer that the Engineer used during the design of the Project.
- B. Environmental Conditions: Prior to performing any Work, verify the expected temperature, humidity and weather conditions are within the specified limitations for executing the Work.
- C. Elevated Tank Components: After completion of each major component and prior to proceeding with the next stage of construction, verify that tolerance inspections and material quality control tests conform to the requirements as specified in this Section.

Reinforced Concrete Construction

- A. Reinforcement: Fabrication, placement, development and splicing of reinforcement shall be in accordance with ACI 318, ACI 371R, and ACI 117.
- B. Formwork:
 1. Formwork design, installation and removal shall comply with the minimum requirements of ACI 318, ACI 371R, and ACI 117 and with the applicable recommendations of ACI 347.
 2. Forming systems shall be designed with the provision of ties and bracing such that concrete components conform to the correct dimensions, shape, alignment and elevation without leakage of mortar. Formwork systems shall be designed to safely support all loading conditions. Embedded items shall be properly positioned and

secured. Form surfaces shall be cleaned of foreign materials and coated with a release agent prior to placing reinforcement.

C. Concrete: Concrete proportioning, production, placement, quality control and curing procedures shall comply with ACI 318, ACI 371R and ACI 117. Concrete shall satisfy the specific structural, durability and architectural requirements of the completed components.

1. Proportioning: The proportions of materials for concrete shall be established to provide adequate workability and proper consistency to permit concrete to be worked readily into the forms and around reinforcement without excessive segregation or bleeding. Unless otherwise specified, concrete without high range water reducer shall be proportioned to produce concrete slumps at the point of placement between 2 and 4 inches. If high range water reducer is used, concrete slump prior to addition shall be 3 to 4 inches. The slump, after addition of high range water reducer, shall be a maximum of 8 inches. Air shall be entrained to provide concrete with 3.0 to 6.0 percent air content.

2. Production: Concrete that arrives at the Project with slump below that suitable for placing, may have water added within the limits of the maximum permissible water-cement ratio. Maximum slump shall not be exceeded. The water shall be incorporated by additional mixing equal to at least half of the total mixing time required. For concrete with site-administered high range water reducer, the pre-plasticized minimum slump requirement shall be attained as permissible by addition of water and mixing prior to the addition of the water reducer.

a. Placement: Prior to concrete placement, all snow, ice, water or other foreign material shall be removed from the spaces that the concrete will occupy. Concrete shall be deposited in its final position in accordance with ACI 318 or ACI 350. These shall be moved at short intervals to prevent stacking of concrete.

b. All concrete shall be consolidated by vibration while fresh concrete is still plastic so that the concrete is thoroughly worked into the corners of forms and around the reinforcement and embedded items to eliminate all air or stone pockets which may cause honeycombing, pitting, or planes of weakness. Internal vibrators shall be the largest practical size that can be used in the Work and they shall be operated by competent workmen.

D. Weather:

1. Hot and/or cold weather concreting conditions must be determined, as outlined in ACI 301 and requirements of that Section must govern. Protection must be in accordance with ACI 301. Concrete must not be placed during precipitation.

2. Cold Weather:

a. If air temperature has fallen to or is expected to fall below 40 deg F during the protection period (a minimum of 48 hours but not less than that required by ACI 306.1), then cold weather concreting shall be performed in accordance with ACI 306.1.

- b. In cases where the temperature drops below 40 deg F after the concreting operations have been started, sufficient canvas and framework or other type of housing shall be furnished to enclose and protect the structure, in accordance with the requirements of ACI 306.1. Sufficient heating apparatus to provide heat shall be supplied, and heating source and protection from combustion gas shall be in accordance with ACI 306.1. The concrete shall be protected when placed under all weather conditions. Should concrete placed under such conditions prove unsatisfactory, remove and replace the concrete at no cost to the Owner.
 - c. When the air temperature is above 30 deg F:
 - 1. The minimum concrete temperature at the time of mixing shall be 60 deg f unless other requirements of ACI 306.1 are met, which may allow for a lower mix temperature.
 - 2. The minimum concrete temperature at time of placement and during the protection period shall be 55 deg F unless other requirements of ACI 306.1 are met, which may allow for a lower temperature.
 - d. The means used to heath a concrete mix shall be in accordance with ACI 306.1.
 - e. Salts, chemicals, or other foreign materials shall not be mixed with the concrete to prevent freezing. Calcium chloride is not permitted.
3. Hot Weather:
- a. Hot weather is defined as any combination of high air temperature, low relative humidity, and wind velocity that impairs the quality of the concrete. Hot weather concreting shall be in accordance with ACI 305.1. Concrete shall be placed in the forms without the addition of any more water than that required by the design (slump). No excess water shall be added on the concrete surface for finishing. Control of initial set of the concrete and extending the time for finishing operations may be accomplished with the use of approved water reducing and set retarding admixture, as specified.
 - b. Maximum time intervals between the addition of mixing water and/or cement to the batch, and the placing of concrete in the forms shall not exceed the following (excluding HRWR admixture use):

Concrete Temperature	Maximum Time from Water Batch to Placement
Non-Agitated Concrete	
Up to 80 deg F	30 Minutes
Over 80 deg F	15 Minutes
Agitated Concrete	
Up to 75 deg F	90 Minutes

Concrete Temperature	Maximum Time from Water Batch to Placement
75 to 89 deg F	60 Minutes

1. The use of an approved set-retarding admixture will permit the extension of the above time maximums by 30 minutes, for agitated concrete only.
2. The use of an approved high range water reducing (HRWR) or hydration-controlling admixture will allow placement time extensions as determined by the manufacturer.
- c. The maximum temperature of fresh concrete at time of discharge shall not exceed 95 deg F. The temperature of the mixing water shall be reduced by the use of chilled water or ice.
- d. The maximum temperature of fresh concrete with high range water reducing admixture shall not exceed 100 deg F at time of discharge.
- e. Under extreme heat, wind, or humidity conditions, concreting operations may be suspended if the quality of the concrete being placed is not acceptable.
4. Mass concrete placement shall be in accordance with the thermal control plan for each placement per ACI 301. Failure to consistently control temperature within the predicted limits will be reason for subsequent rejection of the thermal control plan.

Foundation:

- A. Excavation: After verification of the foundation-bearing surface, provide a 2-inch thick concrete working slab within the lower excavation limits. Grade the Site to prevent runoff from entering the excavation.
- B. Concrete Construction:
 1. For shallow foundations, reinforcement placed adjacent to a concrete working slab shall have a 2-inch minimum cover, and reinforcing steel shall be supported by precast concrete block, metal or plastic bar supports.
 2. The sides of foundations shall be formed using any suitable system conforming to ACI 318. Earth cuts shall not be used as forms for vertical surfaces. Forms shall be provided on top sloping surfaces steeper than 2.5 horizontal to 1 vertical. Straight form panels may be used to form circular foundation shapes. The minimum design radius shall be maintained at all sections.
- C. Finish:
 1. Formed surfaces shall have a smooth form finish when exposed and a rough form finish when not exposed.
 2. Unformed surfaces shall have a troweled finish when exposed and floated finish when not exposed.

Concrete Support Structure

A. Architectural Concrete Construction:

1. The exposed exterior surface of the concrete support wall is designated architectural concrete. The concrete and formwork requirements of this Section shall be strictly enforced to ensure concrete of the highest practicable structural and architectural standard. Concrete proportioning, placing, and finishing shall be in accordance with ACI 301, Section 5, except as modified by this Section. Formwork design, installation and removal shall comply with the minimum requirements of ACI 318, and ACI 117, except as modified by this Section.
2. Attention shall be given to ensure the same concrete design mix is used throughout the support wall. The proportion, type and source of cement and aggregates shall not be changed. Uniform moisture content and placing consistency and finished concrete color shall be maintained throughout the entire support structure.
3. Drop chutes shall be used in all wall concreting operations where concrete placement is 5 feet or greater in drop height. Concrete shall be placed directly inside the reinforcement cage. The concrete pour rate and placement procedures shall prevent aggregate segregation and form splatter with the resulting surface finish variations.
4. Support wall reinforcement shall be installed with plastic supports. Maximum spacing of supports for welded wire fabric shall be 5-foot centers, horizontal and vertically.
5. Forming systems shall be designed with the provision of ties and bracing such that concrete components conform to the correct dimensions, shape, alignment and elevation. Embedded items shall be properly positioned and secured. Form surfaces shall be thoroughly cleaned of concrete residue and coated with a release agent prior to placing reinforcement. Do not allow excessive release agent to accumulate on the form. Steel forms shall be coated with a non-staining, rust preventative form oil or otherwise protected. Rust stained steel formwork shall not be used.
6. The forming system for the pedestal wall shall be fully engineered and detailed with procedures to meet the increased demands of architectural concrete. The support wall shall be constructed with a jump form process using form segments prefabricated to match the wall curvature. Concrete pour height shall be a minimum of 4 feet and a maximum of 10 feet. Form panels shall extend the full height of the concrete pour using only vertical panel joints. Form system shall be designed to be secured to the previous wall pour. The space between the form and the previous pour shall be sealed to prevent grout leakage. Wall forms shall incorporate a positive means of adjustment to maintain dimensional tolerances specified. Wall forms shall be adjusted for vertical plumb and circularity and locked into position prior to concrete placement. Panels shall be designed for lateral pressures associated with full height plastic concrete head, and support and bracing shall be provided for construction related impact loads and wind loads. Working platforms that allow safe access for inspection and concrete placement shall be provided. Form surfaces shall be steel, plastic or fiberglass coated material.

7. The form system shall incorporate a uniform pattern of vertical and horizontal rustications to provide architectural relief to the exterior wall surface. Rustication strips shall be sealed to the form face to eliminate the grout leakage that results in broken corners, color variations and rock pockets. Broken edges and chamfers will not be accepted. All construction joints and panel joints shall be located in rustications. Vertical panel joints shall be sealed using closures which combine with the form pattern to eliminate grout leakage and panel joint lines. All joints shall be grout tight. The vertical and horizontal rustications shall be proportioned and combined to impart a symmetrical architectural pattern to the completed structure. Form ties shall be located in a uniform pattern. No architectural form treatment is required on the interior surface.
 8. Support wall concreting shall be per the tank manufacturer's standard procedures submitted to the Engineer.
 9. Wall forms shall not be disturbed or removed until the concrete has attained sufficient strength to prevent forming operations or environmental loads from causing surface damage or excessive stress. Form removal shall be based on early age concrete strength testing. The minimum concrete strength shall be established by the tank manufacturer, based on an analysis of stress at critical stages throughout the forming and concrete operations. Early age concrete testing shall be in accordance with ACI 228.1R-89. Pull Out testing in accordance with ASTM C900-99, Maturity Method testing in accordance with ASTM C1074-93, or field cured cylinders compressive strength tested in accordance with ASTM C172 are the acceptable methods to determine early concrete strength. Contractor shall commit to removing the wall forms based on a standard time period to prevent discoloration or discontinuity of color based on a change in methodology.
 10. The formwork system for the structural floor shall be designed to support all construction loads. Adequate shoring and bracing shall be provided to transfer loads without appreciable movements. Form surfaces shall be steel, plastic or fiberglass coated material. Shoring and forms for the structural slab shall remain in place until the concrete has gained sufficient strength to carry the floor weight without damaging deflections.
 11. Concrete surfaces shall be protected in accordance with the recommendations of ACI 306 until the component attains 35 percent of the specified compressive strength. At this time, protection may be removed subject to the allowable temperature differential. A reasonable temperature differential shall be defined, based on component thickness and restraint conditions.
- B. Finish:
1. Provide a smooth form finish without rub for the interior and exterior support wall. Tie holes shall be plugged using grout on the interior and manufactured plugs on the exterior which match the color of the cured concrete as closely as possible. No tie holes, defect voids larger than 3/8-inch diameter or fins shall be visible on the interior or exterior of the concrete support structure, as viewed from grade.
 2. All concrete surfaces shall be cleaned as required to remove surface contamination. Provide an abrasive sweep blast to the exposed exterior concrete support wall surface. Abrasive blast must be in accordance with TCEQ

requirements (30 TAC Chapter 111) and properly contained per SSPC Technology Guide No. 6, minimum containment Class 2A. Contractor must provide submittal for proposed containment methodology and abrasive to be utilized.

3. Review and determination of acceptance of formed concrete surface will be made by the Owner or Owner’s representative upon form removal. If the concrete is of questionable quality, additional review time may be required to consult with Owner before providing a determination of acceptance.

Note to Specifier: Verify reference for effort and expenses.

4. Succeeding pours shall not be placed until the most recent wall pour has been stripped and the form surface approved. The tank manufacturer shall be responsible to inform the Owner’s representative as to pour and form removal schedule at least 7 days prior to Work and confirm schedule at least 48 hours in advance of Work. Acceptable concrete surfaces should be aesthetically compatible with minimal color and texture variations and minimal surface defects when compared to adjacent panels, and the field mockup panel, when viewed at a distance of approximately 20 feet or as agreed upon by the Engineer and Contractor. Engineering effort required for revisiting and inspecting Work due to Contractor work delays or improper scheduling shall be paid for by the Contractor. Effort and expenses will be billed per the rates established in **[the General Conditions]** and will be deducted from the contract value by Change Order. The Engineer shall not delay the Contractor by lack of attendance to inspect surfaces.
5. Concrete with surface defects exceeding limitations specified herein or not meeting the standard represented by the mock-up panel shall be repaired to meet that standard, or removed at no additional cost to the Owner. Contractor shall submit repair procedures that will be followed for correcting various types of defects, i.e. discolorations, honey combing, etc. to the Engineer prior to the start of pedestal construction.
6. Provide a smooth form finish without rub for the interior slab. The unformed surface shall have a floated finish.

C. Dimensional Tolerances:

1. Support structure concrete construction shall comply with ACI 117 and the following:
 - a. Support Wall Variation:

Thickness	-3% to +5%
Diameter	0.4% ≤ 3 in.
Vertical Alignment:	
In any 10 feet of height	1 in.
In any 50 feet of height	2 in.
Over total height	3 in.

- b. Tank Floor Variation:

Slab floor thickness	-3% to +5%
Dome floor normal radius	-6% to +10%
Finish tolerance measured with a 5 ft. straightedge or radius board	3/4 in.

c. Level Alignment Variation:

From specified elevation	1 in.
From horizontal plane	1/2 in.

d. Offset Between Adjacent Forms:

Exterior exposed surfaces	1/8 in.
Interior exposed surfaces	1/4 in.

D. Mock Up Panel:

1. A mock up panel of the basic concrete support structure shall be constructed using the proposed formwork, concrete, placement, and finishing methods. Minimum size will be 8 feet wide by 8 feet high. This panel shall be agreed upon by the tank manufacturer and Engineer as the reference standard with which to judge surface quality, appearance and uniformity of texture and color. Panel shall be evaluated at a distance of 20 feet from the panel face.
2. If the constructed panel does not meet expectations for color constancy, quantity and extent of bug holes, grout leakage, surface texture, or other defects, the Contractor shall construct additional mock panels until an acceptable quality is agreed upon. Contractor shall pay for all Engineering services and expenses for inspection and administrative effort required to inspect mock panels in excess of two panel reviews. Effort and expenses will be billed per the rates established in the Supplemental Conditions and will be deducted from the contract value by Change Order.
3. This mock panel shall remain immediately adjacent to the tank concrete support structure so it may be compared to the actual support structure construction. The panel shall not be removed from the Site until the Owner has accepted the entire tank.
4. Contractor shall report any proposed changes from procedures and materials used in the original Field Mockup to the Engineer. Engineer may request that a new mockup panel be constructed incorporating the revised procedures and materials at no additional cost to the Owner.
5. Wall construction not meeting expectations, as compared to the mock panel, shall be repaired and/or removed and reconstructed at no additional cost to the Owner.

Steel Tank:

A. Welding:

1. Welding procedures and general welding requirements shall be in accordance with AWWA D107, Section 5.4, "Fabrication and Construction Requirements" and Section A.9.4 through A.9.5.
 2. No structural welding is permitted to any steel embedded in hardened concrete, unless a weld procedure is utilized that will preclude damage to the concrete.
- B. Fabrication: Layout, cutting, forming, edge preparation and workmanship for steel tank components and fabrications shall be in accordance with AWWA D107, Section 5.4, "Fabrication and Construction Requirements".
- C. Tank Erection: Steel tank erection procedures and general requirements shall be in accordance with AWWA D107, Section 5.4, "Fabrication and Construction Requirements".
- D. Structural Slab Lining: Tank floor shall be lined with steel plates that may be shaped to match the shape of the tank floor. Unformed steel liner plates that do not match the shape of the concrete floor may be used provided the liner plate is grouted after welding. The steel liner should be constructed with a 1-inch or larger grout space between the liner plate and the concrete member. Subsequent to testing, the void in the interface between the steel tank floor plate and the supporting structural concrete dome or slab shall be filled with a flowable grout mix using a procedure that removes entrapped air. Provide anchorage in areas where the grout pressure is sufficient to lift the plate.

Tank Painting:

- A. Refer to Item 531 "Coatings for Water Storage Tanks."
- B. Painting of the tank's exterior shell and cone, including logos if included, must be completed on the ground and prior to hoisting.
- C. Galvanized steel must be repaired after welding or if damaged with zinc-based solder in accordance with ASTM A780.

521.11 Field Quality Control

- A. Refer to Item 531 "Coatings for Water Storage Tanks" for coordination of Owner's Representative Field Quality Assurance Coordination during coating operations.
- B. Owner's Representative Field Quality Assurance Coordination for Concrete Placement:
 1. Observations may be conducted by the Owner's representative. Final observations will be performed in the presence of the Owner or their Representative and the Contractor's superintendent. All materials and equipment used in the accomplishment of testing are subject to observation at any time by the Owner's representative. Periodic observation times will be agreed upon by the Owner's representative and Contractor and approved by the Owner.
 2. Contractor must provide a schedule for anticipated:
 - a. Observation of concrete reinforcement before all concrete pours.

- b. Observation of concrete pouring operations.
 - c. Observation and recommendations for acceptance of each lift of the concrete pedestal.
3. Contractor will notify the Owner’s representative at least 7 days prior to any required inspections and confirmed 24 hours prior to inspection. Prior to scheduling an inspection, Contractor is responsible for reviewing work and verifying it is ready for inspection. Once scheduled, if the Owner’s representative finds the Project not ready for inspection any additional trips for re-inspection or inspection for retesting of failed tests shall be borne by the Contractor and deducted from the Contract Value by Change Order. Costs for additional inspection shall be billed at the rates indicated in “Supplemental Conditions.”
- C. Owner’s Representative Field Quality Assurance Coordination for Welding Operations:

- 1. Observations shall be conducted by the Owner’s representative and a third-party inspection company retained by the Engineer. Final observations shall be performed in the presence of the Owner or their Representative and the Contractor’s superintendent. All materials and equipment used in the accomplishment of testing are subject to observation at any time by the Owner’s representative. Periodic observation times will be agreed upon by the Owner’s representative and Contractor and approved by the Owner.
- 2. Contractor shall provide a schedule for anticipated welding operations and shall notify the Owner’s representative at least 7 days prior to any required inspections and confirmed 24 hours prior to inspection. Prior to scheduling an inspection, Contractor is responsible for reviewing work and verifying it is ready for inspection. Once scheduled, if the Owner’s representative finds the Project not ready for inspection any additional trips for re-inspection or inspection for retesting of failed tests shall be borne by the Contractor and deducted from the Contract Value by Change Order.
- 3. Costs for additional inspection shall be billed at the following rates:

Position	Per Day
Welding Inspector	####/hour
Coating Inspector	####/hour
Trip Charge	####/day

- 4. Cost includes all travel expenses.
- 5. Contractor shall not move or remove scaffolding, ladders or other fixtures necessary to provide proper observation until such work has been observed and approved by the Owner’s representative.
- 6. Any work found to be deficient, damaged, or otherwise unacceptable shall be repaired in accordance with these specifications at no additional cost to the Owner.
- 7. Observation and/or acceptance of Contractor’s work by Owner’s representative(s) in no way releases Contractor from any of the terms and conditions of the Contract Agreement.

8. Contractor will provide the inspection and testing of the tank and welds. The number and location of spot radiographs shall be in accordance with AWWA D107 and D107 Appendix A and must include the review of spot radiographs. The Owner's representative may provide additional testing and will review tests provided by the Contractor. All sets of radiographs will be taken at locations selected by the Owner's representative and developed while the Owner's representative is present. All developed film will then be the property of the Owner.
- D. All cost of testing required for the construction of the tank shall be borne by the Contractor. The results of all tests shall be submitted to the Owner within 7 calendar days of the test being completed.
- E. Soil and compaction testing for foundation and backfill will be provided by the Contractor.
- F. Concrete Testing and Inspection:
1. The evaluation and acceptance of concrete shall be in accordance with ACI 301, ACI 318 and ACI 117, except as modified in this Section.
 2. The first sample for concrete that is pumped shall be taken at the point of placement after the concrete has been pumped. After the first sample has been tested and certified to be within the specifications, subsequent samples may be taken from the truck.
 3. Four cylinders shall be made from each sample required. Two cylinders should be tested at 28 days for the strength test. One cylinder should be tested at 7 days to supplement the 28-day tests. The fourth cylinder is a spare to replace or supplement other cylinders.
 4. Slump, air and compressive cylinder testing shall be performed by an independent laboratory. The tank manufacturer shall retain the independent laboratory and provide the Owner with copies of all test results within 7 days of completing the test.
 5. The support wall radius, plumb and thickness shall be verified for each concrete lift at 45-degree intervals. An inspection report certified by the tank manufacturer shall be provided to the Owner at Project completion.
- G. Steel Tank Testing and Inspection:
1. All costs of tests required for the construction of the tank shall be borne by the Contractor. The results of all tests shall be submitted to the Owner within 7 calendar days of the test being completed.
 2. Inspection procedures for the steel tank shall be as required by AWWA D107, Section 9, "Inspection and Testing" and as indicated in D107 Appendix A. Radiographic inspection of full penetration butt-welded joints shall be made by an independent inspection company retained by the tank manufacturer. Contractor shall submit name of company completing the tests.

3. Erection tolerance of the steel cone in the radial direction shall be measured. Provide field measurements at 30-degree intervals.
 4. Weld joints of plate over the structural concrete floor shall be tested for leaks by vacuum box / soap solution testing, or equivalent method prior to grouting.
- H. Provide leak testing per AWWA D107.
- I. Provide settlement testing per AWWA D107, Section 9.7.2. Provide four equally spaced permanent survey points using brass monuments to the support structure. Record elevations and submit survey data prior to filling and upon completion of filling. Settlement must be within the tolerances of Section C.2.2. Larger settlements will not be accepted unless sealed by the tank manufacturer's engineer as being acceptable and as approved by the Owner.
- J. Piping Test Inspection: Refer to Item No. 515 "Pipeline Testing and Acceptance."
- K. Tank Painting Inspection and Testing: Refer to Item No. 531 "Coatings for Water Storage Tanks."

521.12 Clean and Adjust

- A. Site: The Site shall be kept in a clean and safe condition at all times. The tank manufacturer shall remove all construction equipment and debris at Project completion.
- B. Tank Disinfection:
1. Water and sufficient pressure for flushing, cleaning, initial testing and disinfection shall be supplied by the Owner at no cost to the tank manufacturer. Tank manufacturer is responsible for coordination with Owner and all materials required to test and disinfect tank. Tank disinfection shall be in accordance with AWWA C652, Chlorination Method No. 2 or 3.
 2. After disinfection, the tank manufacturer shall arrange for bacteriological testing of water samples from the tank. Failed tests will be supplemented by the tank manufacturer. The tank shall not be placed in service until bacteriological tests pass.
 3. Disinfection of piping shall be performed per Item No. 515 "Pipeline Testing and Acceptance."

521.13 Warranty Inspection

- A. The Owner and Contractor shall observe all surfaces of the reservoir within 11 to 23 months after the reservoir work has been accepted for Substantial Completion and placed in service to establish if remedial work is required. If the water utility is not able to remove the tank from service for the inspection or for any repair work, due to

adverse weather conditions, drought or system limitations, the inspection or repair work may be delayed by the Owner for up to 16 months at no additional cost. All repair work shall be conducted within a schedule approved by the Owner.

- B. The Owner will isolate the reservoir from the distribution system and drain the reservoir. Contractor shall open, clean out, high-pressure water wash and rinse the tank prior to the anniversary observation. After observation of the tank is complete and repair work accepted by Owner, the Contractor shall follow disinfection procedures specified.
- C. Contractor shall provide suitable and adequate equipment including, lighting, ventilation, rigging, cable climbers, mirrors, inspection equipment, and sufficient manpower to clean, disinfect and move equipment and tools around the reservoir, etc., as may be necessary to facilitate complete observation of all interior surfaces. Contractor shall bear all costs of the anniversary observation and shall incorporate such costs into bid.
- D. The Owner will document the inspection in accordance with AWWA D107.
- E. Provide coating inspection per Item 531 "Coatings for Water Storage Tanks."

End of Section