ATTACHMENT B: TECHNICAL SPECIFICATIONS

FOR

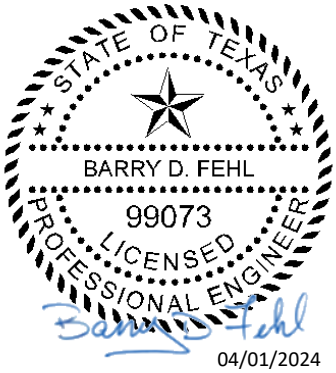
LAST TUBER'S EXIT IMPROVEMENTS – UNDERWATER LANDING

CITY OF NEW BRAUNFELS

APRIL 2024

ISSUED FOR BID

STRUCTURAL/CIVIL
Division: 02, 03, 05, 10, 31, 35



04/01/2024

Freese and Nichols, Inc.
10431 Morado Circle, Suite 300
Austin, Texas 78759
Texas Registered Engineering Firm F-2144

NEB23370

02 41 00 DEMOLITION

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary for every type of required demolition.

B. Furnish equipment of every type required to demolish and transport construction debris away from the Site.

1.02 STANDARDS

A. Work shall be performed in accordance with the codes and ordinances of the agency having authority over the Place of Record.

1.03 DELIVERY AND STORAGE

A. Stockpile construction debris at the Site only as long as necessary to haul to a disposal site. Stack materials neatly and handle in an orderly manner until removed from the Site.

1.04 JOB CONDITIONS

A. Contractor shall visit the Site and determine the extent of demolition required and the Site conditions that might affect its proposal. Include costs of covering all aspects of the demolition as part of the proposal.

B. The Drawings shall be carefully reviewed to determine the extent of necessary demolition and to identify elements of the existing construction which are to remain in place. Report any discrepancies to Owner and Engineer before disturbing existing conditions. Property lines and limits of demolition shall be accurately located prior to beginning site demolition. Start of demolition activities shall represent confirmation by Contractor that existing conditions are as presented in the Contract Documents. Demolition outside the limits indicated on the Drawings, or outside the property lines shall not be performed.

1. For process piping demolition confirm with the Owner that current operations will not be impacted and provide temporary equipment with Owner to keep systems functional during demolition process if required.

C. Material removed during demolition, and any equipment not otherwise designated to remain the property of the Owner, shall become the property of the Contractor, and shall be promptly removed from the Site.

2.00 PRODUCTS

2.01 MATERIALS

A. New materials and equipment for patching and extending work shall meet the requirements of the individual Sections in these Contract Documents. For materials not addressed in these documents, materials used shall meet or exceed the dimensions and quality of the existing work.

3.00 EXECUTION

3.01 SITE CLEARING

A. Perform site clearing to the limits indicated on the Drawings. Scrape the Site, removing brush, trees, weeds and trash. Haul debris away from the Site to an approved site as it accumulates.

B. Grub out tree and brush roots within the limits of the concrete structures. Remove rock out-croppings and boulders from any area within the limits of grading or structures. Remove roots and backfill any excavation resulting from tree removal with suitable soil for final grading plan.

C. Trees not located within the construction limits, or otherwise indicated for removal, shall remain in place. Visit the Site with the Engineer or Owner and identify those trees that are to remain. Mark all other trees with yellow paint to indicate removal. Protect remaining trees during construction. Wrap the tree trunks with 2 x 4 timbers if construction equipment must operate in close proximity to them.

D. Only designated trees shall be removed. In the event that trees other than those designated are erroneously removed or damaged to the point of distress, install replacement trees of equal size and number to compensate for those destroyed, at no additional cost to the Owner.

E. Provide dust control as needed or requested by the Owner.

3.02 REMOVAL OF CONCRETE

A. Remove parts of the existing concrete slab and sack concrete steps as indicated on the Drawings. Saw-cut the existing slab as shown on the Drawings. Cut the reinforcing flush with the face of the saw cut. Perform the remainder of the demolition, removing underground piping, or installing new Work. Provide dust control as needed or as requested by the Owner.

3.03 BACKFILLING

A. Backfill cavities resulting from demolition. Fill cavities occurring within the limits of buildings, structures, or pavements in accordance with the requirements of other Sections of the Specifications. Backfill and compact cavities outside the construction limits to the same density as the surrounding earth. No testing is required for backfill outside the limits of new construction.

3.04 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment which remain or are to be reused.

END OF SECTION

03 11 00 CONCRETE FORMING

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish material and labor to form, tie, brace and support wet concrete, reinforcing steel and embedded items until the concrete has developed sufficient strength to remove forms.

1.02 QUALITY ASSURANCE

A. Design Criteria: Forms shall be designed for the pressure exerted by a liquid weighing 150 pounds per cubic foot. The rate of placing the concrete, the temperature of the concrete, and all other pertinent factors shall be taken into consideration when determining the depth of the equivalent liquid. An additional design live load of 50 pounds per square foot shall be used on horizontal surfaces.

B. Alignment Control:

1. True alignment of walls and other vertical surfaces having straight lines or rectangular shapes shall be controlled and checked by the following procedures:

a. Forming shall be arranged with provisions for adjusting the horizontal alignment of a form, after the form has been filled with concrete to grade, using wedges, turn buckles, or other adjustment methods. Establish a transit line or other reference so that adjustments can be made to an established line while the concrete in the top of the form is still plastic.

b. Adjusting facilities shall be at intervals which permit adjustments to a straight line. Concrete shall not be placed until adequate adjusting facilities are in place.

C. Tolerances: Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

1.03 SUBMITTALS

A. Submittals shall include:

1. Shop Drawings:

a. Manufacturers' literature for "approved equal" products

2. Record Data.

a. Manufacturers' literature for specified products.

1.04 STANDARDS

A. The applicable provisions of the following standards shall apply as if written here in their entirety:

1. American Concrete Institute (ACI) Specifications:

ACI 117	Specifications for Tolerances for Concrete Construction and Materials
ACI 301	Specifications for Structural Concrete

ACI 318	Building Code Requirements for Structural Concrete

2. American Institute of Steel Construction (AISC) Publication:
    a. AISC Manual of Steel Construction.
3. American Iron and Steel Institute (AISI) Publication:
    a. AISI Cold Formed Steel Design Manual.
4. American Plywood Association (APA) Standards:
    a. APA Design/Construction Guide: Concrete Forming.

1.05 DELIVERY AND STORAGE

A. Lumber for forms shall be stacked neatly on platforms raised above ground.

1.06 JOB CONDITIONS

A. The Contractor shall notify the Engineer upon completion of various portions of the work required for placing concrete so that compliance with the plans and specifications may be monitored. The Engineer will authorize the Contractor to proceed with the placement after this has been completed and corrections, if required, have been made.

B. In hot weather, both sides of the face forms may be required to be treated with oil to prevent warping and to secure tight joints.

2.00 PRODUCTS

2.01 MATERIALS

A. Lumber: Properly seasoned and of good quality; free from loose or unsound knots, knot holes, twists, shakes, decay, splits, and other imperfections which would affect its strength or impair the finished surface of the concrete.
    1. Refer to Section 03 30 00 “Cast-In-Place Concrete” for finish requirements.

B. Fiber Board Form Lining: Hardboard finished smooth on one side; minimum thickness of 3/16 inch thoroughly wet with water at least 12 hours before using.

C. Plywood Form Lining: Conforming to APA HDO; exterior exposure waterproof adhesive, 3/8 inch thick.

D. Form Oil: Light, clear oil; shall not discolor or injuriously affect the concrete surface, subsequent coatings, or delay or impair curing operations.

2.02 FABRICATIONS

A. Lumber: Lumber for facing or sheathing shall be surfaced on at least one side and two edges and sized to uniform thickness. Lumber of nominal 1-inch thickness or plywood of 3/4-inch thickness shall be permitted for general use on structures, if backed by a sufficient number of studs and wales.

B. Special Form Lumber:

1. Molding for chamfer strips or other uses shall be made of redwood, cypress, or pine materials of a grade that will not split when nailed, and which can be maintained to a true line without warping. The form shall be mill cut and dressed on all faces. Fillet forms at sharp corners, both inside and outside and at edges, with triangular chamfer strips at all non-contiguous edges exposed to view. Thoroughly oil chamfer strips before installation on forms.

2. All moldings, panel work, and bevel strips shall be straight and true with neatly mitered joints, and designed so that the finished work shall be true, sharp and clean cut.

C. Forms:

1. Forms shall be built mortar tight and of material sufficient in strength to prevent bulging between supports.

2. Reused forms or form lumber shall be maintained clean and in good condition as to accuracy, shape, strength, rigidity, tightness, and smoothness of surface.

3. All forms shall be so constructed as to permit removal without damage to the concrete. Exercise special care in framing forms for copings, offsets, railing and ornamental work, so that there will be no damage to the concrete when the forms are removed.

D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.

E. Metal Forms:

1. The specifications for “Forms” regarding design, mortar tightness, filleted corners, beveled projections, bracing, alignment, removal, re use, oiling, and wetting shall apply equally to metal forms.

2. The metal used for forms shall be of such thickness that the forms will remain true to shape. Bolt and rivet heads on the facing sides shall be countersunk. Clamps, pins, or other connecting devices shall be designed to hold the forms rigidly together and to allow removal without injury to the concrete.

3. Metal forms which do not present a smooth surface or line up properly shall not be used. Exercise special care to keep metal free from rust, grease, or other foreign material that discolors the concrete.

F. Form Linings:

1. Timber forms for exposed concrete surfaces which are to be given a rubbed finish shall be face-lined with an approved type of form lining material.

2. If plywood is used for form lining, it shall be made with waterproof adhesive and have a minimum thickness of 3/4 inch. It shall preferably be oiled at the mill and then re-oiled or lacquered on the job before using.

3. If fiber board is used, apply water to the screen side on the board. Stack the boards screen side to screen side. Use the smooth hard face as the contact surface of the form. Such surfaces may be formed with 3/4-inch thick plywood made with waterproof

adhesive if backed with adequate studs and wales. The greatest strength of the outer plies should be at right angles to the studding. In this case, form lining will not be required.

4. Carefully align edges and faces of adjacent panels and fill the joints between panels with patching plaster or cold-water putty to prevent leakage. Lightly sand with No. 0 sandpaper to make the joints smooth.
5. Forms which are reused shall have all unused form tie holes filled and smoothed as specified above.

G. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

H. Form Ties:

1. Metal form ties shall be used to hold forms in place and to provide easy metal removal. The use of wire for ties shall not be permitted.
2. Leave no metal or other material within 1-1/2 inches of the surface, when removing form tie assemblies which are used inside the forms to hold the forms in correct alignment. The assembly shall provide cone-shaped depressions in the concrete surface at least 1 inch in diameter and 1-1/2 inches deep to allow filling and patching. Such devices, when removed, shall leave a smooth depression in the concrete surface without undue injury to the surface from chipping or spalling.
3. Burning off rods, bolts, or ties shall not be permitted.
4. Metal ties shall be held in place by devices attached to wales. Each device shall be capable of developing the strength of the tie.
5. Metal and wooden spreaders which are separate from the forms shall be wired to top of form and shall be entirely removed as the concrete is placed.

I. Falsework:

1. Falsework shall be designed and constructed so that no excessive settlement or deformation occurs. Falsework shall provide necessary rigidity.
2. Timber used in falsework centering shall be sound, in good condition and free from defects which impair its strength.
3. Steel members shall be of adequate strength and shape for the intended purpose.
4. Timber piling used in falsework may be of any wood species which satisfactorily withstands driving and which adequately supports the superimposed load.

5. When sills or timber grillages are used to support falsework columns, unless founded on solid rock, shale or other hard materials, place them in excavated pits. Backfill to prevent the softening of the supporting material from form drip or from rains that may occur during the construction process. Sills or grillages shall be of ample size to support the superimposed load without settlement.
6. Falsework not founded on a satisfactory spread footing shall be supported on piling, which shall be driven to a bearing capacity to support the superimposed load without settlement.

3.00 EXECUTION

3.01 PREPARATION

A. Before placing concrete, ensure that embedded items are correctly, firmly and securely fastened into place. Embedded items shall be thoroughly clean and free of oil and other foreign material. Anchor items shall be set to the correct location, alignment and elevation by the use of suitable templates.

3.02 INSTALLATION

A. Pre-Placement:

1. During the elapsed time between building the forms and placing the concrete, maintain the forms to eliminate warping and shrinking.
2. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
    a. For concrete surfaces exposed to view: Class A, 1/8 inch.
    b. For concrete surfaces to receive a rubbed finish: Class A, 1/8 inch.
    c. For concrete surfaces not exposed to view: Class D, 1 inch.
3. Construct forms tight enough to prevent loss of concrete mortar.
4. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood inserts for forming keyways, reglets, recesses, and the like, for easy removal.
5. Do not use rust-stained steel form-facing material.
6. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
7. Treat the facing of forms with suitable form oil before concrete is placed. Apply oil before the reinforcement is placed. Wet form surfaces which will come in contact with the concrete immediately before the concrete is placed.
8. At the time of placing concrete, the forms shall be clean and entirely free from all chips, dirt, sawdust, and other extraneous matter at the time. Forms for slab, beam and girder

construction shall not have tie wire cuttings, nails or any other matter which would mar the appearance of the finished construction. Clean forms and keep them free of foreign matter during concrete placement.

B. Placement:

1. Set and maintain forms to the lines designated, until the concrete is sufficiently hardened to permit form removal. If, at any stage of the work, the forms show signs of bulging or sagging, immediately remove that portion of the concrete causing this condition. If necessary, reset the forms and securely brace against further movement.
2. Provide adequate cleanout openings where access to the bottom of the forms is not otherwise readily attainable.
3. Chamfer exterior corners and edges of permanently exposed concrete.
4. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
5. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement. Carefully and accurately place and support reinforcement in concrete structures.

C. Removal: Remove forms so that the underlying concrete surface is not marred or damaged in any way. Forms shall not be removed until the concrete has attained sufficient strength to safely carry the dead load, but in no case less than the number of curing days set forth in the following table:

Forms	Curing Days
Forms for concrete of minor structural load carrying importance	1 day
Forms for walls, massive structural components and other members not resisting a bending moment during curing	1 day
Forms and falsework under slabs, beams and girders where deflections due to dead load moment may exist (for spans < or = 10 feet)	7 days
Forms and falsework under slabs, beams and girders where deflections due to dead load moment may exist (for spans > 10 feet and < or = 20 feet)	14 days
Forms and falsework under slabs, beams and girders where deflections due to dead load moment may exist (for spans > 20 feet)	21 days

D. Reuse:

1. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
2. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Owner's Representative.

END OF SECTION

03 21 00 REINFORCING STEEL

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor and reinforcing materials required to cut, bend, tie, splice, place and support the reinforcement in the material grades, sizes, quantities and locations specified.

1.02 QUALITY ASSURANCE

A. Tolerances:

1. Reinforcing shall be placed where specified, with the following maximum tolerances, plus or minus:

a. Concrete Cover: 1/4 inch.

b. Reinforcing Bar Spacing: 1/4 inch in 12 inches.

1.03 SUBMITTALS

A. Submittals shall include:

1. Shop Drawings:

a. Reinforcing bar layout drawing with bar lists clearly marked and referenced to the Drawings. Include:

1). Material, grade, bar schedules, stirrup spacing, bent bar diagrams, arrangement, and supports of concrete reinforcing. Do not scale dimensions from structural drawings to determine lengths of reinforcing bars. Reproductions of contract drawings are unacceptable.

2). Additional reinforcing required for openings through concrete structures.

2. Record Data: Manufacturers' literature for specified products.

3. Certified Test Reports:

a. Certification of steel quality, size, grade and manufacturer's origin.

1.04 STANDARDS

A. The applicable provisions of the following standards shall apply as if written here in their entirety:

1. ASTM International (ASTM) Standards:

ASTM A1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

2. American Concrete Institute (ACI) Publications:

ACI 301	Specification for Structural Concrete

ACI SP-66	ACI Detailing Manual
ACI 318	Building Code Requirements for Structural Concrete

3. Concrete Reinforcing Steel Institute (CRSI) Publications:

CRSI	Manual of Standard Practice

1.05 DELIVERY AND STORAGE

A. Store reinforcement above the surface of the ground upon platform skids or other supports. Protect from mechanical and chemical injury and surface deterioration caused by exposure to conditions producing rust. When placed in the Work, reinforcement shall be free from dirt, scale, dust, paint, oil and other foreign material. Tag and store reinforcement for ease of correlation with Shop Drawings.

1.06 JOB CONDITIONS

A. Proposed deviations from reinforcing indicated on the Drawings or Specifications shall be approved in writing by the Engineer prior to fabrication.

B. Lap lengths shall be of the length shown on the Drawings or noted in lap and embedment table, and shall be in compliance with ACI 318.

C. Specified cover for reinforcing shall be maintained throughout construction. Bars shall be cut to lengths necessary to allow for proper clearances. Cover of concrete shall be measured from face of forms to outside face of reinforcement.

D. Stirrups shall be hooked.

2.00 PRODUCTS

2.01 MATERIALS

A. Steel Reinforcing Bars: Billet-Steel bars for concrete reinforcement conforming to ASTM A615; Grade 60, deformed, with minimum yield strength of 60,000 psi.

B. Welded Wire Reinforcement: Cold-drawn steel wire conforming to ASTM A1064; flat sheets fabricated in accordance with ASTM A1064.

C. Supports (Chairs): Bar supports shall be of the proper type for the intended use.

1. Exposed Surface: CRSI Class 2 – Moderate Protection.

2. Unexposed Surface: CRSI Class 3 – No Protection.

D. Spacers: Precast mortar blocks with a 28-day compressive strength that is greater than the specified concrete strength in which the blocks are being placed. Additionally:

1. Cure a minimum of 4 days.

2. Blocks shall be in the form of a frustum positioned such that its size increases away from the formed surface. The surface placed adjacent to the forms shall not exceed 2-1/2 x 2-1/2 inches or 3 inches in diameter.

3. Blocks shall be accurately cast to the thickness required and the surface to be placed adjacent to the forms shall be a true plane free of surface imperfections.

4. Wires ties for securing reinforcement shall be embedded in the block.

E. Mechanical Splices:

1. Mechanical splices shall develop at least 125 percent of the reinforcement yield strength.

2. Cadweld splices as manufactured by Erico Products, Inc.

F. Zinc Repair Material: ASTM A780, zinc-based solder, paint containing zinc dust, or sprayed zinc.

3.00 EXECUTION

3.01 FABRICATION

A. Reinforcing bars shall be bent cold by machine to shapes indicated on the Drawings; true to shapes indicated; irregularities in bending shall be cause for rejection. Unless otherwise noted, all hook and bend details and tolerances shall conform to the requirements of ACI SP-66 and ACI 318.

1. Fabricate reinforcement to provide lapped connections, bends and transitions in reinforcement as required for continuity of the typical reinforcement specified on the Drawings.

2. Unless otherwise detailed, intersecting wall and/or beam reinforcement shall extend to the far face and terminate in a standard hook. Reinforcement at the outside face of corners shall be continuous or provide lap splices at each side of the corner.

3.02 PREPARATION

A. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials.

B. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcement.

3.03 INSTALLATION

A. General: Place the reinforcement carefully and accurately in the concrete structures. Rigidly tie and support the reinforcement. Welding of any type of reinforcement shall not be permitted.

B. Splices:

1. Splice reinforcement only as indicated on the Drawings or as approved by the Engineer prior to fabrication. Splices shall preferably occur at points of minimum stress.

2. Lap Splice: Lengths shall be as indicated on the Drawings. Rigidly wire the bars at all splices. Overlap sheets of wire fabric sufficiently to maintain a uniform strength and securely fasten.

3. Mechanical Splice: Cadweld splices or approved equal, installed in accordance with the manufacturer's instructions and recommendations. The splice device shall develop at least 125 percent of the specified yield strength of the reinforcement.

4. Welding of reinforcing steel splices shall not be permitted.

C. Placement:

1. Place reinforcement, as indicated on the Drawings with the specified tolerances. Hold securely in place during the placing of the concrete. The minimum clear distance between bars shall be per ACI 318 unless noted otherwise. Always pass vertical stirrups around the main tension members and securely attach thereto. Wire reinforcing together at a sufficient number of intersections to produce a sound, sturdy mat or cage of reinforcement that will maintain the reinforcement in correct positions when the concrete is placed.

2. Hold the reinforcing steel in concrete slabs firmly in place with wire supports or "chairs." Sizing and spacing of the chairs shall be sufficient to properly support the steel, and shall be in accordance with CRSI Publications "Manual of Standard Practice in."

3. Space the reinforcing steel in concrete walls the proper distance from the face of the forms, as indicated on the Drawings:

a. For wall surfaces exposed to view, use chairs.

b. For wall surfaces not exposed to view, use chairs or precast mortar blocks.

4. Where reinforcing conflicts with location of anchor bolts, inserts, etc., submit prompt notifications so that revisions can be made before concrete is placed. No cutting or moving of reinforcing shall be permitted without the prior approval of the Engineer.

5. Welded wire shall be fabricated flat sheets, in longest practical lengths. Lap joints one mesh. Do not locate end laps over beams of continuous structures or midway between supporting beams. Offset end laps of adjacent widths to prevent continuous lap. Fasten ends and sides of welded wire fabric at 48 inches O.C. with tie wire.

6. Reinforcing shall extend through construction joints.

7. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

3.04 FIELD QUALITY CONTROL

A. Concrete shall not be placed until the Engineer has observed the final placing of the reinforcing steel and has given permission to place concrete.

END OF SECTION

03 30 00 CAST-IN-PLACE CONCRETE

1.00 GENERAL

1.01 SUMMARY

A. Furnish labor, materials, mixing and transporting equipment and incidentals necessary to proportion, mix, transport, place, consolidate, finish, and cure conventional concrete in the structure and permeable/pervious concrete on the existing staircase and integrated ramp.

1.02 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and silica fume; subject to compliance with requirements.

1.03 SUBMITTALS

A. Submittals shall include:

1. Shop Drawings:

a. Conventional Concrete:

1). Mix Design: For each mix design, provide documentation using field test data or trial mixture data in accordance with ACI 301, which includes average strength documentation using either field strength test data or trial mixtures.

2). Submit a schedule to the Owner's representative which shows the sequence of concrete placements.

3). Procedures for placement through water if required.

4). If joints are not detailed on the Drawings, construction joint details and locations shall be submitted to the Engineer for approval.

b. Permeable Concrete:

1). Mix Design: For each mix design, provide documentation using field test data or trial mixture data which includes density of the permeable concrete relative to the void content.

2. Certified Test Reports:

a. Materials used in the mix design and which will be used during production of concrete for the Project.

b. Water: Verification that all potable mix water and curing water sources do not exceed the non-potable water limits listed in ASTM C1602 Table 2.

1). Test mix water chloride content as indicated in ASTM C1602 Table 2.

c. Aggregate, conforming to ASTM C33, including the test reports for soundness and abrasion resistance.

d. Aggregate:

1). Verification that aggregate is not “potentially reactive” per ASTM C1260.

2). Or a cement chemical analysis indicating that the total alkali content is acceptable per Paragraph 2.02.A.

e. 7-day and 28-day compressive strength tests results.

f. If the sum total of chlorides in mix water and aggregates exceeds 80 percent of the specified limit for hardened concrete, then prior to use of concrete, test mix design to verify acceptable chloride ion concentrations in accordance with ASTM C1218.

3. Record Data:

a. Manufacturer’s literature on specified materials.

b. Documentation indicating conformance with ASTM C94 requirements.

1). Concrete delivery tickets in accordance ASTM C94.

c. Documentation of supplier's National Ready Mixed Concrete Association certification.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed concrete work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Manufacturer Qualifications:

1. A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C94 requirements for production facilities and equipment.

2. Manufacturer must be certified according to the National Ready Mixed Concrete Association’s Certification of Ready Mixed Concrete Production Facilities.

C. Testing Agency Qualifications:

1. An independent testing agency, acceptable to authorities having jurisdiction and the Engineer, qualified according to ASTM C1077 and ASTM E329 to conduct the testing indicated.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer’s plant, each aggregate from one source, and each admixture from the same manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver cement in bulk or bags which are plainly marked with the brand and manufacturer’s name. Immediately upon receipt, store cement in a dry, weather-tight, and properly ventilated structure which excludes moisture. Storage facilities shall permit easy access for inspection and identification. Cement not stored in accordance with the requirements shall not be used.

B. Sufficient cement shall be in storage to complete placement of concrete started. In order that cement may not become unduly aged after delivery, maintain records of delivery dates.

Use cement which has been stored at the Site for 60 days or more before using cement of lesser age. No cement shall be used which is lumped, caked, stored more than 90 days, or whose temperature exceeds 170 F.

1.06 STANDARDS

A. Mixing, sampling, placing, curing and testing of concrete, and the materials used shall be in compliance with the latest revisions of the following standards, unless otherwise noted in the Contract Documents. The Contractor shall maintain one copy of each of the applicable standards at the construction field office.

1. ASTM International (ASTM) Standards:

ASTM Standards	
ASTM C31	Standard Practice for of Making and Curing Concrete Test Specimens in the Field
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C42	Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C94	Standard Specification of Ready Mixed Concrete
ASTM C109	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars
ASTM C125	Standard Terminology Relating to Concrete and Concrete Aggregates
ASTM C138	Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C143	Standard Test Method for Slump of Hydraulic Cement Concrete
ASTM C150	Standard Specification for Portland Cement
ASTM C171	Standard Specification for Sheet Materials for Curing Concrete
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173	Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C191	Standard Test Method for Time of Setting of Hydraulic Cement by Vicat Needle
ASTM C192	Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C290	Standard Specification for Elastomeric Joint Sealants
ASTM C309	Standard Specification for Liquid Membrane Forming Compounds for Curing Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete

ASTM Standards	
ASTM C579	Standard Test Methods for Compressive Strength of Chemical Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C827	Standard Test Method for Change in Height at Early Stages of Cylindrical Specimens of Cementitious Mixtures
ASTM C845	Standard Specification for Expansive Hydraulic Cement
ASTM C881	Standard Specification for Epoxy Resin Base Bonding Systems for Concrete
ASTM C1157	Standard Performance Specification for Hydraulic Cement
ASTM C1218	Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
ASTM C1240	Standard Specification for Silica Fume used in Cementitious Mixtures
ASTM C1260	Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM C1688	Standard Test Method for Density and Void Content of Freshly Mixed Pervious Concrete
ASTM C1754	Density and Void Content of Hardened Pervious Concrete
ASTM D1751	Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM E96	Standard Test Methods for Water Vapor Transmission of Materials

2. American Concrete Institute (ACI) Standards:

ACI Standards	
ACI 211.1	Standard Practice for Selecting Proportions for Normal, Heavy-weight, and Mass Concrete
ACI 301	Specification for Structural Concrete
ACI 305.1	Specification for Hot Weather Concreting
ACI 306.1	Standard Specification for Cold Weather Concreting
ACI 308.1	Specification for Curing Concrete
ACI 318	Building Code Requirements for Structural Concrete

ACI Standards	
ACI 522.1-20	Specification for Construction of Pervious Concrete Pavement

3. Concrete Plant Manufacturers Bureau (CPMB) Standards:
    a. Concrete Plant Standards.

2.00 PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
    1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
    2. Products: Subject to compliance with requirements, provide one of the products specified.
    3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
    4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 CONCRETE MATERIALS

A. Cementitious Material; General: If the fine and/or coarse aggregates test "Potentially Reactive", in accordance with ASTM C1260, then a low alkali cementitious material shall be used. A low alkali cementitious material shall be such that, the Sodium Oxide Equivalent ($N_{a2}O_{eq}$) shall not exceed 0.6 percent of the total cementitious material content.

B. Cement; Provide one of the following:
    1. Type I or I/II Portland cement, conforming to ASTM C150.
    2. Type IL blended hydraulic cement, conforming to ASTM C595 (conventional concrete only).
    3. Type GU hydraulic cement, conforming to ASTM C1157 (conventional concrete only).
    4. Type IP or IS blended hydraulic cement, conforming to ASTM C595 (permeable concrete only).

C. Supplementary Cementitious Materials (SCM):
    1. Fly Ash/Pozzolans: Conforming to ASTM C618, Class F fly ash; used in all classes of concrete. If fly ash is not available then provide a straight cement mix.

D. Coarse Aggregate:
    1. Crushed stone or gravel conforming to ASTM C33, in the gradation size specified.
        a. Class: Negligible weathering region, but not less than 1N.

2. For gradation size number 57, the maximum aggregate size of 1 inch is:

Sieve Size	Percent Retained	Percent Passing
1-1/2”	0	100
1”	0-5	95-100
1/2”	40-75	25-60
No. 4	90-100	0-10
No. 8	95-100	0-5

E. Fine Aggregate:

1. Washed and screened natural sands or sands manufactured by crushing stones; conforming to ASTM C33. The gradation in ASTM C33 for air entrained concrete is:

Sieve Size	Percent Retained	Percent Passing
3/8”	0	100
#4	0-5	95-100
#8	0-20	80-100
#16	15-50	50-85
#30	40-75	25-60
#50	70-90	10-30

2. Fine aggregate shall have not more than 45 percent retained between any two consecutive sieves. Its fineness modulus, as defined in ASTM C125, shall be not less than 2.3 nor more than 3.1.

F. Normal-Weight Aggregate for Slab-on-Grade: ASTM C33, combined gradations as follows:

Sieve Size	Percent Retained	Percent Passing
1 ½”	8-18	100
¾”	8-22	95-100
#30 and #50	8-15	80-100
Top sieve	0-4	50-85
#100	1.5-5	25-60

G. Water: Potable and complying with ASTM C1602.

2.03 CONCRETE ADMIXTURES

A. Measure and dose admixtures in accordance with manufacturer’s recommendations.

B. Air Entraining Admixture: Conforming to ASTM C260.

C. Set Retarding Admixtures: Conforming to ASTM C494; Types B and D.

D. Water Reducing Admixtures, High Range (HRWR): High Range Water Reducer shall comply with ASTM C494, Type F or G. HRWR shall be added to the concrete mix at the concrete batch plant. HRWR may not be added at placement site except to redose a batch and only after approval of the HRWR manufacturer. The high range water reducing admixture shall be able to maintain the plasticity range without significant loss of slump or rise in concrete temperature for 2 hours. Other admixtures may only be used with the HRWR if approved by the HRWR manufacturer. A representative of the HRWR manufacturer shall be present during any large placement, placement of slabs, or during times of unusual circumstance which may require changes to the product formulation.

1. Manufacturers:

a. GCP Applied Technologies.

b. Master Builders Solutions US LLC.

c. Sika Corporation.

2.04 VAPOR RETARDERS

A. Plastic Vapor Retarder: ASTM E1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape for sealing lap joints, penetrations, and as required for securing terminations.

1. Available Products:

a. Fortifiber Corporation; Moistop Ultra A.

b. Raven Industries Inc.; Vapor Block 15.

c. Reef Industries, Inc.; Griffolyn Type-105.

d. Stego Wrap (15-mil) Vapor Barrier; STEGO INDUSTRIES LLC.

e. Huskey Yellow Guard, 15-mil Vapor Barrier; Poly-America, L.P.

2.05 CURING MATERIALS

A. Water: Potable and complying with ASTM C1602 **.**

B. Absorbent Material: AASHTO M182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd. dry.

C. Sheet Curing Material: Conforming to ASTM C171.

1. Waterproof paper.

2. Polyethylene film.

3. White burlap - polyethylene film.

D. Membrane Curing Compounds: Membrane curing compound conforming to ASTM C309; applied according to the manufacturer's recommendations. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, 18 to 22 percent solids.

1. Products:

a. Diamond Clear VOX; Euclid Chemical Co.

b. Lambco Glazecote 30; Lambert Corporation.

c. Dress & Seal; Laticrete International, Inc.

d. Vocomp-20; W.R. Meadows, Inc.

e. Cure & Seal 250E; Nox-Crete Products Group, Kinsman Corporation.

f. Starseal 0800; Vexcon Chemicals, Inc.

g. Approved equal.

E. Finishing Aid: Spraying material designed to form a monomolecular film on fresh concrete that reduces the rate of evaporation of surface moisture prior to finishing. This material is not a curing compound. Concrete must be cured as specified.

1. MasterKure ER 50; Master Builders Solutions US LLC.

2. Approved equal.

2.06 RELATED MATERIALS

A. Expansion and Isolation Joint Filler:

1. Water retaining structures: ASTM D1752, Type I or II.

B. Expansion Joint Sealant:

1. Non-water retaining structures: ASTM C920, Type S or M, Grade P or NS as applicable, Class 35, Use T, UV resistance.

2. Backing material for sealant shall be a rod of diameter and composition recommended by the sealant manufacturer.

C. Bonding Agent: Water-based epoxy modified, with integral corrosion inhibitor. Install according to the manufacturer's recommendations.

1. Sika Armatec 110 EpoCem; Sika Corporation.

2. MasterEmaco P 124; Master Builders Solutions US LLC.

3. Approved equal.

D. Bonding Agent: Epoxy bonding system shall conform to ASTM C881. Install according to the manufacturer's recommendations.

1. Sikadur 32, Hi-Mod LPL; Sika Corporation.

2. Master Emaco ADH 326; Master Builders Solutions US LLC.

3. Approved equal.

E. Non-Shrink Grout:

1. Non-Shrink Epoxy Structural Grouts: Furnished in two components from the factory and mixed on the Site; conforming to ASTM C579, ASTM C580, and ASTM C827; chemical resistant, water resistant and a minimum 7-day compressive strength of 12,000 psi.

a. Use for vibrating equipment.

b. Products:

1). Sikadur 42, Grout-Pak; Sika Corporation.

2). Five Star HP Epoxy Grout; Five Star Products, Inc.

3). MasterFlow 648; Master Builders Solutions US LLC.

F. Zinc Rich Primer: Aluminum surfaces which contact or are embedded in concrete shall be coated with zinc rich primer. Primer shall be:

1. Tneme-Zinc; Tnemec Company, Inc.
2. MasterProtect P 8100AP; Master Builders Solutions US LLC.
3. Approved equal.

2.07 REPAIR MATERIALS

A. Structural Concrete Repair Material: Low-shrink, non-slump, non-metallic, quick setting patching mortar; as approved by the manufacturer for each application and applied accordance with the manufacturer's recommendations.

1. Products:
   a. Five Star Structural Concrete; Five Star Products, Inc.
   b. SikaTop 123; Sika Corporation.
   c. SikaTop 122; Sika Corporation.
   d. MasterEmaco N 425; Master Builders Solutions US LLC.
   e. Approved equal.

2.08 CONVENTIONAL CONCRETE MIXTURES

A. Design Criteria:

1. Provide a mix design for each concrete application indicated.
2. All Conventional Concrete shall be normal weight concrete composed of cement, fine aggregate, coarse aggregate, admixtures, and water, as specified. Any concrete being placed underwater shall include anti-washout addition Master Builders UW-450, no substitutions.
3. ACI 211.1 shall be the basis for selecting the proportions for concrete made with aggregates of normal and high density and of workability suitable for usual cast in place structures.
4. The workability of any mix shall be as required for the specific placing conditions and the method of placement. The concrete shall have the ability to be worked readily into corners and around reinforcing steel without the segregation of materials or the collection of free water on the surface. Compliance with specified slump limitations shall not necessarily designate a satisfactory mix.
5. In no case shall the amount of coarse material produce harshness in placing or honeycombing in the structure when forms are removed. The maximum amount of

coarse aggregate (dry loose volume) per cubic foot of finished concrete shall not exceed 0.82 cubic feet.

6. In calculating water-cement ratio: The water content shall include the amount of water batched or to be added later, plus the free water in the aggregate, and minus the water content at SSD conditions.
7. No allowance shall be made for the evaporation of water after batching. If additional water is required to obtain the desired slump, a compensating amount of cement shall also be added. In no case shall the maximum water cement ratio exceed the specified maximum or that of the approved mix design.
8. Air Entrainment: Provide the percent air entrainment in each concrete mix design as recommended by ACI 318:
    a. Exposure Class: F1, unless otherwise specified/restricted:
9. Maximum water-soluble chloride ion content in concrete, by percent weight of concrete, shall not exceed ACI 318 Exposure Class C1.
10. When job conditions dictate, water-reducing and set-controlling admixtures may be used. Only specified admixtures shall be used. Admixtures shall be batched at the batch plant.
11. High Range Water Reducer (HRWR): HRWR may be permitted to be used in mix designs if approved by the Engineer.
12. If fly ash is to be used in place of cement, no more than 25 percent of the cement may be replaced.
    a. Concrete shall be capable of developing two-thirds of the required 28-day compressive strength in 7 days.

B. Concrete Classifications:

Class	Min. 28-Day Compressive Strength (psi)	Max. Size Aggregate (inches)	Max. Water: Cementitious Materials Ratio	Slump +/-1 (inches)
C	4000	1.0, Size No. 57	0.45	4 (8*)
* Slump shown is with HRWR.				

C. Concrete Usage:

Class	Usage
Class C Use	Footings and slabs, and other items unless noted otherwise

D. Required Average Compressive Strength:

1. All concrete is required to have an average compressive strength greater than the specified strength. The required average compressive strength shall be established according to the requirements of ACI 301.

2. Standard Deviation: Calculate a standard deviation and establish the required average compressive strength (fcr') in accordance with ACI 301. If field test records are not available, select the required average strength from ACI 301.

E. Documentation of Required Average Compressive Strength:

1. Documentation indicating the proposed concrete proportions will produce an average compressive strength equal to or greater than fcr'. Documentation shall consist of field strength records or trial mixture.

2. Field Strength Test Records: Document field strength test records according to ACI 301, which is partially restated here:

   a. If field test data are available and represent a single group of at least 10 consecutive strength tests for one mixture, using the same materials, under the same conditions, and encompassing a period of not less than 45 days, verify that the average of the field test results equals or exceeds fcr'.

   b. If the field test data represent two groups of strength tests for two mixtures, plot the average strength of each group versus the water-cementitious materials ratio of the corresponding mixture proportions and interpolate between them to establish the required mixture proportions for fcr'.

3. Trial Mixtures:

   a. Establish trial mixture proportions according to ACI 301, which is partially restated here:

      1). Make at least three trial mixtures complying with performance and design requirements. Each trial mixture shall have a different cementitious material content. Select water-cementitious materials ratios that will produce a range of compressive strengths encompassing fcr'.

      2). Submit a plot of a curve showing the relationship between water-cementitious materials ratio and compressive strength.

      3). Establish mixture proportions so that the maximum water-cementitious materials ratio is not exceeded when the slump is at the maximum specified.

   b. Trial mixtures shall be designed, sampled, and tested by an independent testing laboratory, retained and paid by the Contractor and approved by the Owner.

   c. Provide 7-day and 28-day strengths test results.

4. Revisions to concrete mixtures:

   a. When less than 15 compressive strength tests results for a given class of concrete are available from the current Project:

      1). If any of the following criteria are met, take immediate steps to increase average compressive strength of the concrete.

         a). A 7-day compressive strength test result multiplied by 1.5 falls below the required 28-day compressive strength.

         b). A 28-day compressive strength test result is deemed not satisfactory.

b. When at least 15 compressive strength test results for a given class of concrete become available from the current Project:

1). Calculate the actual average compressive strength, standard deviation and required average compressive strength using the previous 15 consecutive strength tests. Submit results in graphical form with each 28-day test result for that class of concrete.

2). If any of the following criteria are met, take immediate steps to increase average compressive strength of the concrete.

a). A 28-day compressive strength test result is deemed not satisfactory.

b). The average compressive strength falls below the required average compressive strength.

c. When revisions to the mix design are required, notify the Engineer in writing of the corrective actions taken.

2.09 PERMEABLE CONCRETE MIXTURES

A. Design Criteria:

1. Provide a mix design for each concrete application indicated.
2. All permeable concrete shall be composed of cement, aggregate, admixtures, and water, as specified.
3. ACI 522.1-20 shall be the basis for selecting the proportions for permeable concrete pavement.
4. The void concrete of the mixture shall be determined by ASTM C1688.
5. When job conditions dictate, water-reducing and set-controlling admixtures may be used. Only specified admixtures shall be used. Admixtures shall be batched at the batch plant.
6. If fly ash is to be used in place of cement, no more than 50 percent of the cement may be replaced.

B. Concrete Classifications:

Class	Void Content (%)	Max. Size Aggregate (inches)
A	20-25	1.0, Size No. 57

C. Concrete Usage:

Class	Usage
Class A Use	Pavement on existing staircase and integrated ramp

D. Trial Mixtures:

1. Establish trial mixture proportions according to ACI 301, which is partially restated here:

a. Make at least three trial mixtures complying with performance and design requirements. Each trial mixture shall have a different cementitious material content.

b. Submit a plot of a curve showing the relationship between water-cementitious materials ratio and the density and void content of the mixes.

2. Trial mixtures shall be designed, sampled, and tested by an independent testing laboratory, retained and paid by the Contractor and approved by the Owner.

3. Provide void content and density test results in accordance with ASTM C1754 Density and Void Content of Hardened Pervious Concrete.

E. Revisions to concrete mixtures:

1. When revisions to the mix design are required, notify the Engineer in writing of the corrective actions taken.

2.10 OFF-SITE BATCH PLANT

A. Batch plants shall be an established concrete batching facility meeting the requirements of the Concrete Plant Standards of the Concrete Plant Manufacturers Bureau.

2.11 CONCRETE MIXING

A. Mixers may be stationary, truck, or paving mixers of approved design. They shall be capable of combining the materials into a uniform mixture and of discharging without mixture segregation. Stationary mixers shall be provided with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed. The mixers or mixing plant shall include a device for automatically counting the total number of batches of concrete mixed. The mixers shall be operated at the drum or mixing blade speed designated by the manufacturer on the name plate.

B. The mixing time for stationary mixers shall be based upon the mixer's ability to produce uniform concrete throughout the batch and from batch to batch. For guidance purposes, the manufacturer's recommendations, or 1 minute for 1 cubic yard plus 1/4 minute for each additional cubic yard may be used. Final mixing time shall be based on mixer performance. Mixers shall not be charged in excess of the capacity specified by the manufacturer.

C. When a stationary mixer is used for partial mixing of the concrete (shrink mixed), the stationary mixing time may be reduced to the minimum necessary to intermingle the ingredients (about 30 seconds).

D. When a truck mixer is used, either for complete mixing (transit-mixed) or to finish the partial mixing in a stationary mixer and in the absence of uniformity test data, each batch of concrete shall be mixed not less than 70 nor more than 100 revolutions of the drum, at the rate of rotation designated by the manufacturer of the equipment as mixing speed. If the batch is at least 1/2 cubic yard less than the rated capacity, in the absence of uniformity test data, the number of revolutions at mixing speed may be reduced to no less than 50. Additional mixing shall be performed at the speed designated by the manufacturer of the

equipment as agitating speed. When necessary for proper control of the concrete, mixing of transit-mixed concrete shall not be permitted until the truck mixer is at the Site of the concrete placement. Truck mixers shall be equipped with accurate revolution counters.

3.00 EXECUTION

3.01 PREPARATION

A. Notify the Owner's representative upon completion of various portions of the work required for placing concrete, so that inspection may be made as early as possible. Keep the Owner's representative informed of the anticipated concrete placing schedules.

B. All items, including lines and grades, forms, waterstops, reinforcing, inserts, and the Contractor's concreting materials and equipment shall be in compliance with the Contract Documents before proceeding.

C. Do not place any concrete until formwork and the placing reinforcement in that unit is complete. Place no concrete before the completion of all adjacent operations which might prove detrimental to the concrete.

D. Brilliantly light the Site so that all operations are plainly visible when concrete mixing, placing, and finishing, continues after daylight. Whenever possible, concrete finishing shall be completed in daylight hours.

E. When placing concrete, the forms shall be clean and entirely free from all chips, dirt, sawdust and other extraneous matter. Forms for slab, beam and girder construction shall not have tie wire cuttings, nails, or any other matter which would mar the appearance of the finished construction. Clean forms and keep them free of any foreign matter during concrete placing.

F. The concrete shall be mixed in quantities required for immediate use. Any concrete which is not in place within the time limits specified shall not be used. Concrete shall not be re-tempered.

G. Concrete shall not be placed if impending weather conditions would impair the quality of the finished Work.

H. Unless otherwise provided, the following requirements shall govern the time sequence on which construction operations shall be carried.

1. Forms for walls or columns shall not be erected on concrete footings until the concrete in the footing has cured for at least 2 curing days. Concrete may be placed in a wall or column as soon as the forms and reinforcing steel placements are approved.

2. Steel beams or forms and falsework for superstructures shall not be erected on ground-supported concrete substructures until the substructure concrete has cured for at least 4 curing days.

3.02 EMBEDDED ITEMS

A. Where post-installed anchors are not specified on the drawings, place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

1. Install anchor bolts, accurately located, to elevations required.

3.03 JOINTS

A. Expansion Joints and Devices:

1. Workmanship: Exercise careful workmanship in joint construction to separate the concrete sections by an open joint or by the joint materials and make the joints true to the outline indicated.

2. Expansion Joints: Construct expansion joints and devices to provide expansion and contraction. Construct joints which are to be left open or filled with poured joint material with forms which are adaptable for loosening or early removal. In order to avoid jamming by the expansion action of the concrete and the consequent likelihood of injuring adjacent concrete, remove or loosen these forms as soon as possible after the concrete has initially set. Make provisions for loosening the forms to permit free concrete expansion without requiring full removal.

B. Construction Joints:

1. Construction joints are formed by placing plastic concrete in direct contact with concrete which has attained its initial set. When concrete is specified as monolithic, the term shall be interpreted as the manner and sequence of concrete placement so that construction joints do not occur.

2. Additional horizontal and vertical construction joints, when submitted and approved by the Engineer, may have an impact on reinforcing details. Revise reinforcing details to reflect additional joints.

3. Unless otherwise provided, construction joints shall be square and normal to the forms. Provide bulkheads in the forms for all joints except horizontal joints.

4. Clean horizontal construction joints for receiving the succeeding lift using air water cutting. The surface shall be exposed sound, clean aggregate with a 1/4 inch amplitude. After cutting, wash the surface until there is no trace of cloudiness in the wash water.

5. In areas where air water cutting cannot be satisfactorily accomplished, or in areas where it is undesirable to disturb the surface of the concrete before it has hardened, prepare the surface for receiving the next lift by wet sand blasting to immediately remove all laitance and unsound concrete prior to placing of the next lift. Thoroughly wash the surface of the concrete after sand blasting to remove all loose material.

C. Dowel Joints: Install dowel sleeves and dowels or dowel bar and support assemblies at joints where indicated.

1. Use dowel sleeves or lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

D. Hardened Concrete: Where new concrete or grout is to be placed in contact with existing or recently hardened concrete, texture the existing or recently hardened surface by chipping or other means so that an irregular surface having a height variance of not less than 1/4 inch is created. The existing or recently hardened concrete shall then be coated with a bonding agent and new concrete or grout placed.

3.04 CONCRETE PLACEMENT

A. Cold Weather:

1. If air temperature has fallen to or is expected to fall below 40 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.

2. In cases where the temperature drops below 40 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.

3. When the air temperature is above 30 F:

   a. The minimum concrete temperature at the time of mixing shall be 60 F unless other requirements of ACI 306.1 are met, which may allow for a lower mix temperature.

   b. The minimum concrete temperature at the time of placement and during the protection period shall be 55 F unless other requirements of ACI 306.1 are met, which may allow for a lower temperature.

4. The means used to heat a concrete mix shall be in accordance with ACI 306.1.

5. Salts, chemicals, or other foreign materials shall not be mixed with the concrete to preventing freezing. Calcium chloride is not permitted.

B. Hot Weather:

1. 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.

2. 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 F	30 Minutes
Over 80 F	15 Minutes
Agitated Concrete	
Up to 75 F	90 Minutes

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

a. The use of an approved set-retarding admixture will permit the extension of the above time maximums by 30 minutes, for agitated concrete only.

b. The use of an approved high range water reducing (HRWR) or hydration-controlling admixture will allow placement time extensions as determined by the manufacturer.

3. The maximum temperature of fresh concrete at time of discharge shall not exceed 95 F. The temperatures of the mixing water shall be reduced by the use of chilled water or ice.

4. The maximum temperature of fresh concrete with high range water reducing admixture shall not exceed 100 F at time of discharge.

5. On days when the predicted high temperature is 90 F or higher, the initial curing of test specimens shall be according to ASTM C31 except that the means of maintaining moisture and temperature shall be limited to the following options:

   a. Immersion of molded specimens with plastic lids in water saturated with calcium hydroxide.

   b. Suitable moisture loss control combined with a temperature-controlled environment.

   c. Other methods as approved by the Engineer.

6. Under extreme heat, wind, or humidity conditions, concreting operations may be suspended if the quality of the concrete being placed is not acceptable.

C. Handling and Transporting:

1. Delivery tickets shall be required for each batch and shall be in accordance with ASTM C94. Each delivery ticket must show plainly the amount of water, in gallons that can be added to the mixer truck at the Site without exceeding the maximum water cement ratio approved for that mix design. Amount of water added must be in proportion to contents of truck.

2. Arrange and use chutes, troughs, or pipes as aids in placing concrete so that the ingredients of the concrete are not segregated. They shall be steel or steel lined. When steep slopes are necessary, equip the chutes with baffles or make in short lengths that reverse the direction of movement. Extend open troughs and chutes, if necessary, inside the forms or through holes left in the forms. Terminate the ends of these chutes in vertical downspouts.

3. Keep chutes, troughs, and pipes clean and free from coatings of hardened concrete by thoroughly flushing with water before and after placement. Discharge water used for flushing away from the concrete in place.

4. Use pumping equipment that has sufficient capacity so that:

   a. Discharge of pump concrete does not result in segregation.

b. Modification of accepted concrete mixture is not required.

5. Carting or wheeling concrete batches on completed concrete floor slab shall not be permitted until the slab has aged at least 4 curing days. Unless pneumatic tired carts are used, wheel the carts on timber planking so that the loads and impact are distributed over the slab. Curing operations shall not be interrupted for the purpose of wheeling concrete over finished slabs.

D. Depositing:

1. The method and manner of placing shall prevent segregation or separation of the aggregate or the displacement of the reinforcement. Use drop chutes or tremies as necessary.

2. Free Fall: Concrete shall not be allowed to free fall more than 10 feet when HRWR admixture is used or 5 feet without the use of HRWR. Free falling concrete shall avoid striking reinforcing during placement. Placement of concrete for heights exceeding the free fall limit shall be placed using a tremie.

   a. Concrete shall not be allowed to free fall through water. Place as indicated below.

3. Prevent the splattering of forms and reinforcing bars if the splattered concrete will dry or harden before incorporation into the mass.

4. Fill each part of the forms by directly depositing concrete as near its final position as possible. Work the concrete under and around the reinforcement bars. Depositing large quantities at one point in the forms, then running or working it along the forms shall not be permitted.

   a. Place required sections in one continuous operation to avoid additional cold joints. Each layer shall be fluid and concrete shall not have taken initial set when a new layer is placed upon it. Not more than 1 hour shall elapse between the placing of successive concrete layers in any portion of the structures included in continuous placement.

5. Place in continuous horizontal layers with a depth of from 1 to 3 feet. If excessive bleeding causes water to form on the surface of the concrete in tall forms, revise mix design to reduce the bleeding.

6.

7. For slopes greater than 2 percent, start concrete placement at low end and proceed upslope.

8. After the concrete has taken initial set, the forms shall not be jarred. No force or load shall be placed upon projecting reinforcement.

E. Consolidating:

1. Compact each layer of concrete and flush the mortar to the surface of the forms by continuous-working mechanical vibrators. Apply the vibrator to the concrete immediately after deposit. Move vibrator throughout the layer of the newly placed concrete, several inches into the plastic layer below. Thoroughly work the concrete around the reinforcement, embedded fixtures and into the corners and angles of the forms until it is well-compacted.

2. Mechanical vibrators shall not be operated so that they penetrate or disturb previously placed layers which are partially set or hardened. They shall not be used to aid the flow of concrete laterally. The vibration shall be of sufficient duration to completely compact and embed reinforcement and fixtures, but not to an extent causing segregation.

3. Keep vibrators constantly moving in the concrete and apply vertically at points uniformly spaced, not farther apart than the radius over which the vibrator is visibly effective. The vibrator shall not be held in one location longer than required to produce a liquified appearance on the surface.

4. When submerged in concrete, internal vibrators shall maintain a frequency of not less than 6000 impulses per minute for heads with diameters greater than 5 inches and 10,000 impulses for smaller vibrator heads. The vibration intensity (amplitude) shall be sufficient to produce satisfactory consolidation.

    a. Vibrator head shall be sufficiently small to allow placement between reinforcing steel.

    b. Provide at least one standby vibrator.

    c. Check vibrators intended for regular service or standby service prior to concreting operations.

F. Placement in Water:

1. Deposit concrete in water only when dry conditions cannot be obtained. The forms, cofferdams, or caissons shall be sufficiently tight to prevent any water flowing through the space where concrete is to be deposited. Pumping of water shall not be permitted while the concrete is being placed, nor until it has set for at least 36 hours.

2. Carefully place the concrete using a tremie, closed bottom dumping bucket, or another approved method which does not permit the concrete to fall through the water without protection. The concrete shall not be disturbed after being deposited. Regulate depositing to maintain horizontal surfaces.

3. When a tremie is used, it shall consist of a tube constructed in sections having water-tight connections. The means of supporting the tremie shall permit the movement of the discharge end over the entire top surface of the work and shall allow the tremie to be rapidly lowered to retard the flow. The number of times it is necessary to shift the location of the tremie shall be held to a minimum for any continuous placement of concrete. During the placing of concrete, keep the tremie tube full to the bottom of the hopper. When a batch is dumped into the hopper, slightly raise the tremie, but not out of the concrete at the bottom, until the batch discharges to the level of the bottom of the hopper. Stop the flow by lowering the tremie. Continue placing operations until the work is completed.

4. When concrete is placed by means of the bottom dump bucket, the bucket shall have a capacity of not less than 1/2 cubic yard. Lower the bucket gradually and carefully until it rests upon the concrete already placed. Raise it very slowly during the discharge travel to maintain still water at the point of discharge and to avoid agitating the mixture.

5. Use a sump or other approved method to channel displaced fluid and concrete away from the shaft excavation. Recover slurry and dispose of it as approved. Do not discharge displaced fluids into or in close proximity to streams or other bodies of water.

G. Placement in Slabs:

1. When monolithic slabs are placed in strips, the widths of the strips, unless otherwise specified or indicated, shall insure that concrete in any one strip is not allowed to lie in place for more than 1 hour before the adjacent strips are placed.

2. Immediately before placing concrete, thoroughly dampen the subgrade to receive concrete to prevent moisture absorption from the concrete.

3. As soon as concrete placing is complete for a slab section of sufficient width to permit finishing operations, level the concrete, strike off, tamp and screed. The screed shall be of a design adaptable to the use intended, shall have provision for vertical adjustment and shall be sufficiently rigid to hold true to shape during use.

4. The initial strike off shall leave the concrete surface at an elevation slightly above grade so that, when consolidation and finishing operations are completed, the surface of the slab is at grade elevation.

5. Continue tamping and screeding operations until the concrete is properly consolidated and free of surface voids. Bring the surface to a smooth, true alignment using longitudinal screeding, floating, belting, and/or other methods.

6. When used, templates shall be of a design which permits early removal so satisfactory finishing at and adjacent to the template is achieved.

7. While the concrete is still plastic, straighten the surface as required to achieve specified flatness requirements. Remove high spots and fill depressions with fresh concrete and re-float. Continue to check during the final finishing operation, until the surface is true to grade and free of depressions, high spots, voids, or rough spots.

H. Placement in Foundations: Place concrete in deep foundations so that segregation of the aggregates or displacement of the reinforcement is avoided. Provide suitable chutes or vertical pipes. The placing of concrete bases above mud slab is permitted after the forms are free from water and the seal course cleaned. Execute necessary pumping or bailing during concreting from a suitable sump located outside the forms.

3.05 FINISHING FORMED SURFACES

A. Forms for walls shall be removed as specified in Section 03 11 00 “Concrete Forming.” Patch, repair, finish, and clean concrete after form removal. Finish concrete not more than 7 days after form removal. Cure concrete as finishing progresses.

B. Air voids, for all types of finishes, are defects and shall be removed by rubbing or patching.

C. No Finish: Patch tie holes. Repair defects larger than 1-1/2 inches in diameter or 1/2 inch deep. Remove projections larger than 1 inch.

D. Rough Finish: Patch tie holes. Repair defects larger than 3/4 inches wide or 1/4 inch in depth. Remove projections larger than 1/4 inch.

E. Smooth Finish: The form facing material shall produce a smooth, uniform texture on the concrete. Patch tie holes. Repair defects larger than 3/4 inch wide or 1/2 inch deep. Remove projections flush with the adjacent surface.

3.06 FINISHING FLOORS AND SLABS

A. General: Screed, restraighten, and finish concrete surfaces. Do not wet concrete surfaces.

B. Finish slabs and steps monolithically and apply the following finish:

1. Stamp Finish: Apply SikaStamp Pattern Heavy Stone Texture per manufacturer's instructions.

2. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes.

3.07 MISCELLANEOUS CONCRETE ITEMS

A. Normal Shrinkage Grouting:

1. Prior to grout application, thoroughly clean the surface of all foreign matter. Roughen concrete surface to CSP 4 and wet as required for a saturate surface dry condition (SSD). Set forms in place; tight and securely anchored to prevent the loss of grout.

2. The necessary materials and tools shall be on hand before starting grouting operations.

3. After preparing surface and immediately prior to grouting, provide scrub coat of grout material. Do not allow scrub coat to dry prior to placing grout.

4. After mixing, quickly and continuously place the grout to avoid overworking, segregation and breaking down of the initial set. Mix and place the grout where indicated on the Drawings. Cure grout using wet curing method for concrete. Grout shall receive a trowel finish, unless otherwise noted.

B. Non-Shrink Grout:

1. Obtain field technical assistance from the grout manufacturer, as required, to ensure that grout mixing and installation comply with the manufacturer's recommendations and procedures.

2. Roughen concrete surface as required by the manufacturer, but not less than CSP 4. Saturate the surface to achieve an SSD condition. Baseplates shall be free of oil, grease, laitance and other foreign substances.

a. Epoxy Grout: Surface shall be dry as recommended by the manufacturer.

3. Place grout according to the manufacturer's directions so that spaces and cavities below the bottom of the baseplates are completely filled. Provide forms where structural components of the baseplates do not confine the grout. Trowel finish the non-shrink grout where the edge of the grout is exposed to view and after the grout has reached its

initial set. Cut off the exposed edges of the grout at a 45-degree angle to the baseplate, bedplate, member, or piece of equipment.

4. Wet cure a minimum of 3 days, but not less than that recommended by the manufacturer.
    a. Epoxy Grout: Dry curing is acceptable if recommended by the manufacturer.
5. Use epoxy non-shrink grout under all machinery, pumps, equipment, and where chemicals are present that would abate cementitious non-shrink grouts.

3.08 CONCRETE CURING AND PROTECTION

A. General: Begin curing of concrete immediately after completion of finishing activities for unformed concrete and immediately after removal of forms from formed concrete. Apply curing method without staining, marring, or damaging concrete surfaces. Where pedestrian traffic is unavoidable, provide suitable walkways to protect the curing material and the concrete surface from damage. Unless a particular curing method is specified, select the appropriate curing method from the curing options indicated.

B. Length of Curing Period:
    1. Curing Day: A day on which the ambient temperature is above 50 deg. F for at least 18 hours.
    2. Curing Period: 7 consecutive curing days.
    3. Extended Curing Period: When curing day requirements are not met, then extend the curing period by one day for each day not in compliance. Extend curing up a maximum total of 14 consecutive days.

C. Wet Curing with Absorbent Material:
    1. Cover concrete surfaces with absorbent material and hold it in contact with concrete surface. Provide a minimum 8-inch lap of adjacent material section edges.
    2. Apply water to absorbent material and saturate. Maintain saturated condition for curing period – do not allow absorbent material to dry.
    3. Do not use wet curing if curing water will be subject to freezing during the curing period.

D. Sheet Curing: Cover concrete surfaces with sheets and hold in contact with concrete surface. Apply in accordance with manufacturer recommendations, which includes placement, patching holes, and tape joints per manufacturer recommendations.

E. Membrane Curing:
    1. Cover the surface of the concrete with a continuous, uniform film. Application shall be in accordance with manufacturer recommendations. Prevent overspray as necessary to meet project requirements.
    2. Do not allow foot traffic on surface in accordance with manufacturer recommendations.
    3. Repair film if damaged within the curing period.
    4. Unless preapproved, do not use membrane curing on surfaces that:
        a. Receive concrete topping, terrazzo, paint, floor hardener, or other finish.

b. Are specified to have a rubbed finish.

F. Protection: During and after curing period, protect concrete surfaces from damage, marring, or staining by construction activities.

3.09 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.

B. After the tie rods are broken back or removed, thoroughly clean the holes to remove grease and loose particles. Patch holes with structural concrete repair material or non-shrink grout. After the holes are completely filled, strike off flush excess mortar and finish the surface to render the filled hole inconspicuous.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. If the surface of the concrete is bulged, uneven, or shows honeycombing or form marks, which in the Engineer's opinion cannot be repaired satisfactorily, remove and replace the entire section.

2. Patch honeycomb and minor defects in all concrete surfaces with structural concrete repair material. Cut back each defective area with a pneumatic chipping tool as deep as the defect extends, but in no case less than 1/2 inch. Prepare the existing concrete and apply repair material according to the manufacturer's recommendations. Finish the surface of the patches to match finish on surrounding concrete.

3. Immediately after form removal, cut out honeycombs, rock pockets, and voids to expose solid concrete but not less than 1-inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with repair material before bonding agent has dried.

4. Repair defects on surfaces exposed to view by blending white cement and standard cement so that, when dry, patching mortar will match surrounding color. Patch a test area at an inconspicuous location to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, pop outs, honeycombs, rock pockets, crazing and cracks in excess of 0.01-inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.

2. After concrete has cured at least 14 days, correct high areas by grinding.

3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.

4. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mix as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

5. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Engineer's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Engineer's approval.

3.10 FIELD QUALITY CONTROL

A. Testing:

1. General:

a. Tests shall be required throughout the Work to monitor the quality of concrete. Samples shall be taken in accordance with ASTM C172.

b. Engineer may waive these requirements on concrete placements of 10 cubic yards or less. However, evidence shall be furnished showing a design mix which meets the Specifications.

c. Unless noted otherwise, testing of the materials, ready mix, transit mix, or central plant concrete will be by an independent testing agency. The independent testing agency will be approved by the Owner and paid by the Contractor. A summary of all tests performed will be available. No concrete shall be placed without a representative present at either the plant or at the Site.

d. Unless the Owner's laboratory is on the Site, provide housing for the curing and storage of test specimens and equipment.

2. Slump Test: Slump tests, in accordance with ASTM C143, shall be used to indicate the workability and consistency of the concrete mix from batch to batch. Generally, a slump test shall be made at the start of operations each day, at regular intervals throughout a working day, and at any time when the appearance of the concrete suggests a change in uniformity.

3. Air Content Test: Tests for the concrete's air content shall be made in accordance with ASTM C231 or ASTM C173, at the point of delivery of concrete, prior to placing in forms. The test shall be made frequently to monitor a proper air content uniform from batch to batch.

4. Temperature Test: Test for the concrete's temperature in accordance with ASTM C1064 and as follows: the temperature of the concrete to be placed shall be taken with a thermometer immediately before placement, with the point of measurement being in the chute or bucket. Temperature test shall be performed for each truck. Record temperatures on batch ticket.

5. Density: Determine the concrete density for concrete in accordance with ASTM C138. Density shall be measured at the same frequency as measuring air content.

6. Compression Test:

    a. Compression test specimens shall be 6-by-12-inch concrete cylinders made and cured in accordance with ASTM C31. If the maximum aggregate size is no larger than 1 inch, 4-by-8-inch concrete cylinders are acceptable. No fewer than two 6-by-12-inch or three 4-by-8-inch specimens shall be made for each test Sample. Samples shall be taken at a minimum of every 50 cubic yards of concrete for each class placed. At least one set of test specimens per day shall be made for each class of concrete used that day. Initial cure of specimens shall be in a temperature and moisture-controlled environment as specified in ASTM C31. Initial cure shall be in an enclosure such that the temperature is uniform and can be monitored. The temperature range of initial curing shall be recorded using a maximum-minimum thermometer. See "Hot Weather" section of this specification for additional requirements. Final cure of specimens shall be under laboratory conditions specified in ASTM C31. Additional concrete cylinders may be required for curing on the job under actual job curing conditions. These Samples could be required when:

        1). There is a possibility of the air temperature surrounding the concrete falling below 40 F, or rising above 90 F.

        2). The curing procedure may need to be improved and/or lengthened.

        3). It is necessary to determine when the structure may be put into service.

    b. Compression strength tests shall be made on the laboratory-cured and job-cured concrete cylinders at 7 and 28 days, in accordance with ASTM C39. The value of each test result shall be the average compressive strength of all of the cylinders in the test Sample. All cylinders within a test Sample shall be taken at the same time from the same batch of concrete. For the 28-day cylinders, the strength level shall be satisfactory if the averages of all sets of three consecutive strength test results exceed the required design compressive strength, and no individual strength test result falls below the required compressive strength by more than 500 psi. The method of initial curing and maximum and minimum initial curing temperatures shall be included on concrete compression test reports.

7. High Early Strength Concrete Test: When Type "III" High Early Strength Portland cement is used instead of Type "I" Portland cement, the minimum allowable 28-day strength for Type "I" Portland cement concrete shall be at 7 days. The ages at time of test for Type "III" shall be 3 days and 7 days, instead of 7 days and 28 days, respectively, for Type "I."

8. Failure to Meet Requirements:

    a. Should the 28-day strengths shown by the test specimens fall below the required values, additional curing shall be performed on those portions of the structures

represented by the test specimens at the Contractor's expense. Test cores shall be obtained and tested in accordance with ASTM C42. If additional curing does not give the strength required, the Owner reserves the right to require strengthening, replacement of those substandard portions of the structure, or additional testing, at the Contractor's expense.

b. Upon receipt of the Contractor's written request, substandard concrete work may be reexamined in place by nondestructive testing methods or core Samples, in accordance with ACI 301. The services of an independent testing laboratory shall be retained, and all expenses paid without compensation from the Owner. Laboratory results shall be evaluated by the Engineer, who shall make the final decision on acceptability of the concrete in question. Core Sample holes shall be repaired.

B. The Owner may withhold payment for any section of concrete which does not meet the requirements of the Specifications. Withheld payment shall be based upon the unit prices established for concrete and reinforcing steel. Payment shall be withheld until the unacceptable concrete has been refinished, removed and replaced or otherwise brought into conformance with the Specifications.

END OF SECTION

Concrete Mix Design

Project Name: _____

FNI Project Number: _____

Project Location: _____

Owner: _____

General Contractor: _____

Mix Number / Class: _____

A. Mix Design:

Cement	=	_____	lb/yd³
Fly Ash	=	_____	lb/yd³
Other Cementitious Material: _____	=	_____	lb/yd³
Fine Aggregate	=	_____	lb/yd³
Coarse Aggregate	=	_____	lb/yd³
Water	=	_____	lb/yd³
Water Reducing Admixture	=	_____	oz/yd³
High Range Water Reducer	=	_____	oz/yd³
Air Entraining Admixture	=	_____	oz/yd³
Other Admixture: _____	=	_____	oz/yd³
Slump	=	_____	inches
Gross Weight	=	_____	lb/yd³
Air Content	=	_____	percent
Water/Cement Ratio	=	_____	

B. Materials:

	Source	ASTM	Type	Remarks
Cement				
Fly Ash				
Other Cementitious Material: _____				
Fine Aggregate				
Coarse Aggregate				
Water				
Water Reducer				
High Range Water Reducer				
Air Entraining				

	Source	ASTM	Type	Remarks
Other Admixture: _____				

C. Determination of Average Strength Required (fcr'):

1. Test Records Available:

A. Summary of Test Records (Provide Supporting Documentation):

Test Group No.	No. of Consecutive Tests	Specified Strength (psi)	Standard Deviation (psi)
Average Standard Deviation:			

B. Standard Deviation Modification Factor (ACI 301, Table 4.2.3.3.(a)2): ____.

C. Standard Deviation Used: ____.

D. Average Compressive Strength Required: ____.

2. Test Records Not Available:

A. Average Compressive Strength Required (ACI 301, Table 4.2.3.1, if required): ____.

D. Documentation of Required Average Compressive Strength (Check One):

1. Field Strength:

a. Field Strength Test Records (ACI 301, Table 4.2.3.3.a): ____. *Complete Attachment A.

2. Trial Mixtures:

a. Trial Mixtures (ACI 301, Table 4.2.3.1, if required): ____. *Complete Attachment B.

I, _____ certify that the above information is correct and all gradations, cement certifications, and test results are located at our place of business for review by the Engineer.

Name: _____ Date: _____

Title: _____

Company: _____

Address: _____

_____

_____

Attachment A

Documentation of Required Average Strength – Field Strength Records

(ACI 301, 4.2.3.4.a or 4.2.3.4.b)

A. Summary of Test Records (Provide Supporting Documentation):

Test Record No.	No. of Tests in Record	Duration of Record (days)	Water-Cementitious Materials Ratio	Average Strength (psi)

B. Interpolation used? _____.

1. Provide an interpolation calculation or plot of strength versus proportions.

C. Submit the following data for each mix:

1. Brand, type, and amount of cement.
2. Brand, type, and amount of each admixture.
3. Source of each material used.
4. Amount of water.
5. Proportions of each aggregate material per cubic yard.
6. Gross weight per cubic yard.
7. Measured slump.
8. Measured air content.
9. Results of consecutive strength tests.

END OF ATTACHEMENT A

Attachment B

Documentation of Required Average Strength – Trial Mixtures

(ACI 301, 4.2.3.4.c)

A. Summary of Test Record(s):

Trial Mix No.	7-Day Tests		28-Day Tests		Water-Cementitious Materials Ratio	Slump (in)	Air Content (percent)	Temperature (F)
	No. of Test Cylinders	Strength (psi)	No. of Test Cylinders	Strength (psi)				

B. Maximum water-cementitious materials ratio _____.

1. Provide an interpolation calculation or plot of strength versus water-cementitious materials ratio.

C. Submit the following data for each mix:

1. Brand, type, and amount of cement.
2. Brand, type, and amount of each admixture.
3. Amount of water used in trial mixes.
4. Proportions of each aggregate material per cubic yard.
5. Gross weight per cubic yard.
6. Measured slump.
7. Measured air content.
8. Compressive strength developed at 7 days and 28 days, from not less than three test cylinders cast for each 7-day and 28-day test.

END OF ATTACHMENT B

05 52 13 PIPE AND TUBE RAILINGS

1.00 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Steel pipe and tube railings.
2. Steel ADA grab bars.

1.03 COORDINATION

A. Coordinate installation of anchorages that are not specified as post-installed anchors. For anchors installed prior to concrete placement, furnish setting drawings, templates, and directions for installing anchorages, including sleeves, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project Site in time for installation.

1.04 ACTION SUBMITTALS

A. Product Data: For the following:

1. Manufacturer's product lines of mechanically connected railings.
2. Grout and anchoring cement.
3. For each type of paint product. Include preparation requirements and application instructions.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each type of exposed finish required.

1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
2. Fittings.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Welding certificates.

C. Product Test Reports: For pipe and tube railings, for tests performed by a qualified testing agency, according to ASTM E894 and ASTM E935.

1.06 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra paint materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.07 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, “Structural Welding Code – Steel.”

1.08 DELIVERY, STORAGE, AND HANDLING

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

1.09 FIELD CONDITIONS

A. Field Measurements: Verify measurements before fabrication

2.00 PRODUCTS

2.01 MANUFACTURERS

A. Steel Pipe and Tube Railings:

1. VIVA Railing, LLC
2. Wagner, R & B, Inc.

B. Source Limitations: Obtain each type of railing from a single source from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer to design railings, including attachment to building construction.

B. Structural Performance: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:
    a. Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.
    b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
    c. Uniform and concentrated loads need not be assumed to act concurrently.
2. ADA Grab Bars:
    a. Concentrated load of 250 lbf (0.89 kN) applied in any direction.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

2.03 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

2.04 STEEL AND IRON

A. Pipe: ASTM A53/A53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.

1. Provide galvanized finish for all handrails and appurtenant items.

B. Plates, Shapes, and Bars: ASTM A36/A36M.

C. ADA Grab Bar: ASTM A53/A53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.

1. Provide galvanized finish for grab bars and appurtenant items.

2.05 FASTENERS

A. General: Provide the following:

1. Hot-Dip Galvanized Railings: Hot-dip zinc-coated steel fasteners complying with ASTM A153/A153M or ASTM F2329 for zinc coating.

2. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.

1. Provide tamper-resistant flat-head machine screws for exposed fasteners unless otherwise indicated.

C. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to 4 times the load imposed when installed in concrete, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.

2.06 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Etching Cleaner for Galvanized Metal: Complying with MPI#25.

C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

D. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

2.07 PAINTING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Behr Process Corporation.
2. Benjamin Moore & Co.
3. Coronado Paint; Benjamin Moore Company.
4. Dulux (formerly ICI Paints); a brand of AkzoNobel.
5. Glidden Professional.
6. Kelly-Moore Paint Company Inc.
7. PPG Architectural Finishes, Inc.
8. Pratt & Lambert.
9. Sherwin-Williams Company (The).

B. Paint:

1. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."
2. Material Compatibility:
   a. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
   b. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
3. Color: Paint color shall be color code PMS 293C, or approved equal.

2.08 FABRICATION

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Fabricate connections in a manner that excludes water. Provide weep holes where water may accumulate.

F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

G. Connections: Fabricate railings with welded connections unless otherwise indicated.

H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove flux immediately.

4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

5. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.

I. Form Changes in Direction as Follows:

1. As detailed.

2. By radius bends of radius indicated or by inserting prefabricated elbow fittings of radius indicated.

J. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

K. Close exposed ends of railing members with prefabricated end fittings.

L. Flanges, Fittings, and Anchors: Provide flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.

M. Provide inserts and other anchorage devices for connecting railings to concrete. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

2.09 STEEL AND IRON FINISHES

A. Galvanized Railings and Grab Bars:

1. Hot-dip galvanize exterior steel railings and grab bars, including hardware, after fabrication.

2. Comply with ASTM A123/A123M for hot-dip galvanized railings and grab bars.

3. Comply with ASTM A153/A153M for hot-dip galvanized hardware.

4. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

B. For galvanized railings and grab bars, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.

C. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.

3.00 EXECUTION

3.01 INSTALLATION, GENERAL

A. Fit exposed connections together to form tight, hairline joints.

B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

1. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.

2. Set posts plumb within a tolerance of 1/16 inch in 3 feet (2 mm in 1 m).

3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet (6 mm in 3.5 m).

C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

D. Adjust railings before anchoring to ensure matching alignment at abutting joints.

E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.02 RAILING CONNECTIONS

A. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in “Fabrication” Article whether welding is performed in the shop or in the field.

3.03 ANCHORING POSTS

A. Cover anchorage joint with flange of same metal as post, welded to post after placing anchoring material.

B. Leave anchorage joint exposed with 1/8-inch (3-mm) buildup, sloped away from post.

C. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:

1. For steel pipe railings, weld flanges to post and bolt to metal supporting surfaces.

3.04 ATTACHING RAILINGS

A. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A780/A780M.

3.05 PAINTING

A. Section includes surface preparation and the application of paint systems on the handrails surrounding the ADA transfer system as noted on the drawings.

B. Field Conditions:

1. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

2. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

3. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

C. Preparation: Remove grease and oil residue from galvanized metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

D. Application: Apply paints according to manufacturer's written instructions

E. Paint Schedule:

1. Latex System MPI EXT 5.3H:

a. Prime Coat: Primer, galvanized, water based, MPI #134.

b. Intermediate Coat: Latex, exterior, matching topcoat.

c. Topcoat: Latex, exterior, low sheen (MPI Gloss Level 3-4), MPI #15.

d. Topcoat: Latex, exterior, semi-gloss (MPI Gloss Level 5), MPI #11.

e. Topcoat: Latex, exterior, gloss (MPI Gloss Level 6), MPI #119.

F. Cleaning and Protection:

1. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

2. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

3. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

4. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

G. Field Quality Control:

1. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
    a. Contractor shall touch up and restore painted surfaces damaged by testing.
    b. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.06 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

END OF SECTION

10 14 26 PANEL SIGNAGE

1.00 GENERAL

1.01 WORK INCLUDED

A. This Section of the specification describes the requirements for the sign that is to be mounted on the concrete sack wall at the location of the ADA transfer system as shown on the drawings.

1.02 SUBMITTALS

A. Submit under provisions of Section 15 of the City of New Braunfels Project Manual.

B. The following to be submitted for approval by the Engineer:

1. Product Data: Manufacturer's data sheets on the sign to be installed.

2. Shop Drawings: Shop drawings with letter style, dimensions, materials, finishes and general layout for the sign, with sizes, edge and corner treatment, and mounting methods shown.

3. Selection Samples: For each finish specified, two complete sets of color chips representing manufacturer's full range of available colors, patterns and finishes

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer shall have five years' experience manufacturing and fabricating products of similar type and scope as those specified in this section.

B. Regulatory Requirements: Comply with applicable provisions in ADA-ABA Accessibility Guidelines, ICC/ANSI A117.1 and Unified Federal Accessibility Standards (UFAS)

1.04 REFERENCES

A. Americans with Disabilities Act (ADA).
B. American National Standards Institute (ANSI):

1. ANSI A117.1 - Accessible and Usable Buildings and Facilities Standards.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's recommendations for delivery, storage and handling.

B. Materials shall be delivered to the location in unopened, labeled factory containers. Upon delivery, materials shall be inspected for damage. Deficient materials shall not be used.

1.06 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside the manufacturer's absolute limits.

2.00 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturer: Corpus Christi Stamp Works Inc. DBA/ National Signage Affiliates, which is located at: P. O. Box 2189 502 S. Staples (78401) ; Corpus Christi, TX 78403; Toll Free Tel: 800-322-4515; Email: (sales@ccswsignsystems.com); Web: www.nationalsignageaffiliates.com

B. Requests for substitutions will be considered in accordance with the provisions of Section 26 of the City of New Braunfels' Project Manual.

2.02 PANEL SIGNAGE

A. Description: Non-illuminated panel signage with a 1/8-inch thick aluminum panel.

B. Size: 36-inches high by 60-inches wide.

C. Graphic Process: Frisket painting method.

D. Mounting: Mounted on wall using stainless steel concrete anchors. One anchor to be placed in each corner of the sign. A stainless steel washer must be placed on each side of the sign when installing. Sign to mounted such that the bottom of the sign is six feet above the concrete landing adjacent to the wall where the sign is being mounted.

E. Text: All capital letters with the following text:

1. Line 1 of sign: ADA EXIT

2. Line 2 of sign: SUBMERGED GRAB BARS

F. Font Style: Arial

G. Font Size: 8 inches

H. Text Spacing: Normal

I. Text Placement: Text must be centered both horizontally and vertically.

J. Color: Sign to be white with black letters.

3.00 EXECUTION

3.01 EXAMINATION

A. Installer shall examine signs for defects, damage, and compliance with specifications. Installation shall not proceed until satisfactory conditions are achieved.

B. Inspect conditions of substrate and other conditions which may affect installation of signage.

C. Do not begin installation until substrates are within manufacturer's specified tolerances and have been prepared in accordance with manufacturer's instructions.

D. If substrate preparation is the responsibility of another installer, do not proceed with installation. Notify the Engineer of any unsatisfactory conditions immediately.

E. Commencement of work is deemed as acceptance of installation conditions.

3.02 PREPARATION

A. Verify mounting heights and locations for signage will comply with specified requirements, including accessibility requirements.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions. Clean mounting locations of dirt, dust, grease or similar conditions that would prevent proper installation.

3.03 INSTALLATION

A. Install in accordance with manufacturer's printed installation instructions, and in proper relationship with adjacent work.

B. Set level, plumb, rigid and at heights indicated with surfaces free from defects.

3.04 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

31 05 16 AGGREGATES FOR EARTHWORK

1.00 GENERAL

1.01 WORK INCLUDED

A. This Section of the specifications describes the various classes of Aggregate Fill. All of the classes of Aggregate Fill contained in this specification may not be used on this project. The classes of Aggregate Fill used on this project are shown on the drawings or specified in other sections of the specifications. This Section does not include installation. Installation of Aggregate Fill is included in other sections of the specifications and/or on the drawings.

1.02 QUALITY ASSURANCE

A. Classification Testing:

1. Contractor Testing:

a. Arrange and pay for the services of an independent testing laboratory to sample and test proposed Aggregate Fill materials.

b. Submit the test results to the Engineer, and obtain approval prior to providing Aggregate Fill.

2. Owner Testing: The Owner shall arrange and pay for additional testing on the Aggregate Fill after delivery to the project site as determined necessary by the Engineer.

B. Contamination Certification:

1. Obtain a written, notarized certification from the Supplier of each proposed Aggregate Fill source stating that to the best of the Supplier's knowledge and belief there has never been contamination of the source with hazardous or toxic materials.

2. Submit these certifications to the Engineer prior to proceeding to furnish Aggregate Fill to the site. The lack of such certification on a potential Aggregate Fill source shall be cause for rejection of that source.

1.03 STANDARDS

A. Aggregate Fill shall be classified into the appropriate class listed below according to ASTM testing procedures as specified for the various classes.

1. American Society for Testing and Materials (ASTM) Standards:

ASTM C33	Specification for Concrete Aggregates
ASTM C88	Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium sulfate
ASTM C125	Terminology Relating to Concrete and Concrete Aggregates
ASTM C131	Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C535	Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM D448	Classification for Sizes of Aggregate for Road and Bridge Construction

2.00 PRODUCTS

2.01 MATERIALS; CLASSIFICATIONS

A. Class 1 Aggregate Fill: Consist of durable particles of crushed stone free of silt, clay, or other unsuitable materials and have a percentage of wear of not more than 40 percent when tested in accordance with ASTM C131 or C535. When material is subjected to five cycles of the sodium sulfate soundness test in accordance with ASTM C88, Sodium Sulfate Solution, the weighted percentage of loss shall not exceed 12 percent. The source of the material shall be approved by the Engineer and meet the following gradation in accordance with ASTM D448, size number 57:

Sieve Size Square Opening	Percent Passing
1-1/2”	100
1”	95-100
1/2”	25-60
No. 4	0-10
No. 8	0-5

B. Class 10 Aggregate Fill:

1. Consist of washed and screened natural sands or sands manufactured by crushing stones complying with the requirements and tests of ASTM C33. The gradation as included in ASTM C33 is as follows:

Sieve Size Square Opening	Percent Passing
3/8”	100
No. 4	95-100
No. 8	80-100
No. 16	50-85
No. 30	25-60
No. 50	10-30
No. 100	0-10

2. Class 10 Aggregate Fill shall have not more than 45 percent passing any sieve and retained on the next consecutive sieve of those shown above, and its fineness modulus, as defined in ASTM C125, shall be not less than 2.3 nor more than 3.1.

3.00 EXECUTION (NOT APPLICABLE)

END OF SECTION

31 23 10 STRUCTURAL EXCAVATION AND BACKFILL

1.00 GENERAL

1.01 SUMMARY

A. This Section specifies excavation, backfill materials, backfill placement and compaction procedures, and other construction activities incidental to project structures.

1.02 DEFINITIONS

A. Cofferdams: Any temporary or removable structure constructed to hold the surrounding earth and/or water out of the excavation, whether the structure is formed of soil, timber, steel, concrete, or a combination thereof, including the use of pumping wells or well points as required by design.

1.03 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design of cofferdams, including comprehensive engineering analysis by a qualified professional engineer for project specific site conditions. Design shall comply with AASHTO LRFD Bridge Design Specifications, latest addition.

1.04 QUALIFICATION ASSURANCE

A. Cofferdam Designer: A professional engineer licensed in the State of Texas.

B. Testing Agency: An independent testing agency that is AASHTO accredited.

1.05 SUBMITTALS

A. Submittals shall include:

1. Qualification Data: For professional engineer responsible for cofferdam design and testing agency.
2. Shop Drawings: Cofferdam placement and details for record purposes. These shop drawings shall bear the stamp and signature of the Registered Professional Engineer licensed in the State of Texas taking ownership of the drawings.
3. Calculations: For cofferdam indicated to comply with project specific site conditions, include geotechnical and structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Submittal shall be for record purposes.
4. Material grade, weight, length, and designation of steel sheet pile section(s) used.
5. Bracing details.
6. Excavation sequence and procedure.
7. Provisions made for dewatering, indicating stage of excavation vs. necessary drawdown, water loading conditions, soil loads and equipment loads.
8. Any other items incidental or significant to this work.

9. Equipment Description. Complete hammer, extractors, and other installation appurtenances.
10. Provide list of compaction equipment to be used.
11. Backfill material classifications: For each soil or aggregate backfill material provide a certification by the testing agency.
12. Compaction Test Results: Submit test results within 24 hours of successful testing.

1.06 STANDARDS

A. Material classification, placing, and testing shall be in compliance with the latest revisions of the following standards, unless otherwise noted in the Contract Documents.

1. ASTM International (ASTM) Standards:

ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D2487	Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D4253	Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D6938	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

B. Any other testing required by these specifications and not specifically referenced to a standard shall be performed under ASTM or other appropriate standards as designated by the Engineer.

1.07 DELIVERY AND STORAGE

A. Deposit material to be used for backfill in storage piles at points convenient for handling of the material during the backfilling operations and as required to prevent contamination with other materials.

1.08 JOB CONDITIONS

A. Review subsurface investigations. A limited subsurface investigation has been performed by Beyond Engineering and an interpretation memorandum from that investigation is a part of the Construction Documents for information purposes only. The precise profile of soil and rock strata beneath this Site is not known.

B. Review the Site and determine the conditions which may affect the structural excavation, prior to the commencement of the excavation.

2.00 PRODUCTS

2.01 BACKFILL MATERIALS

A. Compacted Coarse Aggregate: Compacted coarse aggregate shall be Class 1 Aggregate Fill as specified in Section 31 05 16 “Aggregates for Earthwork.”

B. Fine-Graded Granular Material: Fine-graded granular material shall be Class 10 Aggregate Fill as specified in Section 31 05 16 “Aggregates for Earthwork.”

C. Levelling Course For Slab-On-Grade:

1. Provide a 3-inch layer of compacted Class 10 Aggregate Fill between the Class 1 Aggregate Fill and native soils.

2.02 COMPACTION EQUIPMENT

A. Compaction equipment shall conform to the following requirements.

1. Hand-Directed Compaction Equipment: Use of power tampers and vibratory plate compactors will be required due to the limited space within the cofferdam.

2.03 COFFERDAMS

A. Interior Dimensions: Of sufficient size to allow for all construction and inspection activities but shall be constructed within the limits shown on the Drawings. If the Contractor determines that the size of the cofferdam must extend beyond the limits shown on the Drawings to complete the work, he must receive approval of the Engineer prior to any construction of the cofferdam.

B. Walls: Watertight. Extend below proposed subgrade as required to prevent water infiltration through subgrade. Contractor shall provide a plan for providing a seal at the interface of the cofferdam and the concrete sack wall and/or bank of the river. Wall height shall be as required in Section 31 23 19.01 “Care of Water During Construction”.

C. Provide pumping or bailing system as required by cofferdam design and/or Construction Document requirements.

D. Provide mud slab as required by cofferdam design. Mud slab shall be installed as indicated below.

3.00 EXECUTION

3.01 PREPARATION

A. Clear and grub the area to be excavated prior to the start of excavation. Remove the surficial vegetation, waste and soils to a minimum depth of 12 inches. Depth of removal shall not be less than that required to remove trees, shrubs, stumps, roots, and other organic material above and below ground from within the area to be excavated. Ensure below grade organic material is removed to a minimum depth of 18 inches below bottom of footing/structure.

3.02 EXCAVATION FOR FOUNDATIONS

A. General: Excavate subgrade to the depth indicated on Drawings, +/- 0.1 feet tolerance. Extend limits of the excavation beyond the perimeter of the foundations.

1. Exposed subgrade surfaces shall be level and of sound, stable material; free of mud, frost, snow, or ice. Testing agency or Owner's representative shall confirm exposed subgrade is a suitable bearing material based on the Construction Documents.

2. Proof roll the exposed subgrade in accordance with TxDOT Item 216. Do not proof roll wet or saturated subgrades.

3. Where unsound or unstable material is uncovered, notify Owner's representative.

4. Remove objectionable material and replace after approval is received from Owner's representative. Replacement material shall be as indicated here unless otherwise indicated on Drawings:

a. Soil subgrade replacement material: Class 1 Aggregate Fill**.**

B. Mud Slab: Where/if required per Contractor's cofferdam design, install mud slab on exposed foundation subgrade surface within 8 hours of subgrade exposure. Confirm subgrade is free of loose, unsound, and/or deleterious material before placement of mud slab.

C. When the material encountered at footing bearing elevation is found to be partially rock or incompressible material, but otherwise satisfactory for the foundation, remove the incompressible material to a depth of 6 inches below the footing grade and 12 inches on each side and backfill with Class 1 Aggregate Fill underlain with Class 10 Aggregate Fill.

D. Excavation Safety: All excavations shall be in accordance with OSHA requirements.

3.03 COFFERDAMS

A. Install and remove cofferdams without disturbing the subgrade or marring the structure.

B. Pump or bail water as required for construction and inspection work, and to prevent hydrostatic uplift pressures when not accounted for in the cofferdam design.

C. The removal of the temporary cofferdams shall be accomplished in a manner not injurious to the properties adjacent to and in the proximity of the project excavations.

3.04 WATER IN FOUNDATION EXCAVATIONS

A. General:

1. Prevent water infiltration into foundation excavations. Remove standing water from excavation prior to placing concrete.

2. Do not dewater a foundation excavation while placing concrete or for a period of at least 24 hours after concrete placement.

B. Rock Foundation Subgrade: If rock material becomes weathered due to water infiltration, then remove weathered material and provide rock replacement material to restore foundation subgrade elevation.

C. Soil Foundation Subgrade: If foundation subgrade becomes saturated do not disturb the subgrade. Wait for water to evacuate the subgrade and subgrade surface to adequately stiffen prior to placing concrete. If subgrade is disturbed, then wait until subgrade has dried out, excavate disturbed subgrade and provide replacement material as indicated above.

3.05 COMPACTED BACKFILL

A. General: Backfill excavated spaces and areas not occupied by the permanent structure.

1. Backfill behind any concrete vertical face shall not be placed until the concrete has reached its 28-day compressive strength or 7 days, whichever is longer.

2. Structures with soil on opposing (opposite) sides shall be backfilled to prevent uneven loading of the structure – evenly raise backfill on opposing sides of the structure. The maximum differential backfill height between opposing sides is 1 foot.

3. Maximum Loose Lift Height:

a. Hand-Directed Compaction Equipment: 4 inches.

4. Previous Compacted Layer: If backfill placement occurs over a period of time greater than 24 hours, then scarify and recompact the previous day's final compacted layer.

a. Scarify and Recompact: 6-inch depth; adjust the moisture content; recompact.

b. Saturated subgrades shall not be worked on until sufficiently dry and hardened. Scarify and recompact layers damaged by weather or construction equipment.

B. Moisture: Prior to compacting backfill, mix and aerate or water the loose lift backfill material as necessary to adjust the moisture content and evenly distribute throughout. The material shall contain moisture within the limits specified below.

1. In accordance with ASTM D6938, determine the optimum moisture content for the maximum dry density.

2. Backfill moisture content shall be as indicated in Table 1, "Compacted Fill."

3. Aggregate fill: Completely cohesionless materials, shall be at a moisture content which will allow use of the specified compaction equipment and consistent achievement of the specified density.

C. Compaction: As required to achieve the specified density, increase the number of passes above the minimum specified and/or modify the weight of the equipment.

1. Determine the maximum dry density in accordance with ASTM D698 for cohesive soils and ASTM D4253 for cohesionless soils.

2. Minimum number of passes for all compacted fill types: 8.

3. Cohesive Soils: A tamping compactor shall be used.

4. Cohesionless or low cohesive soils: A vibratory roller or vibratory plate compactors shall be required if the material is cohesionless or with less than 15 percent passing the No. 200 sieve. Confirm applicability of vibratory compaction equipment in the field.

5. Overlap passes a minimum of 50 percent of the baseplate width for hand-directed equipment.

6. Backfill density shall be as indicated in Table 1, "Compacted Fill."

Table 1: Compacted Fill			
Backfill Type	**Density[1,2]**	**Moisture Content[2, 3, 4]**	**Comments**
Class 1 Aggregate Fill	95%	0% to +5%	N/A
Class 10 Aggregate Fill	98%	See Note 4	N/A

[1] The percentage indicated is the minimum required percentage of the maximum dry density as determined by the applicable ASTM standard.
[2] Below Vehicular Pavement: Scarify to a depth of 8, moisture condition, and recompact to not less than 100 percent of the maximum dry density.
[3] Range indicated is the acceptable tolerance with respect to the optimum moisture content.
[4] Completely cohesionless materials, shall be at a moisture content which will allow use of the specified compaction equipment and result in consistent achievement of the specified density.

3.06 FIELD QUALITY CONTROL

A. Contractor is responsible for the costs involved in providing an approved testing agency to perform quality control testing of backfill operations and verification of subgrade bearing material. The testing laboratory shall make tests of in-place density and moisture in accordance with ASTM Standards previously mentioned in this Section. The testing agency shall monitor backfill operations continuously or at intervals acceptable to the Owner's representative. It shall be the responsibility of the Contractor to notify the testing agency a minimum of 2 business days before backfill operations begin.

1. Unless noted otherwise, in-place density tests shall be conducted at a rate of one test for every lift.

2. In-place density tests shall be conducted at a rate acceptable to the Owner's representative.

END OF SECTION

31 23 19.01 CARE OF WATER DURING CONSTRUCTION

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to operate pumps, piping and other facilities to assist in the removal of surface water, stormwater runoff, and ground water, and provide protection of the work site from water of any source. Build and maintain the necessary temporary cofferdams, berms, diversions, impounding works, channels and ditches to protect the work site from streamflow and stormwater runoff. The Contractor shall be solely responsible for the design, layout, construction, maintenance and subsequent removal and disposal of all elements of the temporary cofferdam. Remove the temporary works, equipment, and materials after completion in accordance with this Section and the applicable Drawings.

1.02 SUBMITTALS

A. Submittals shall be in accordance with City of New Braunfels specifications and shall include:

1. Plans and procedures for handling flood flows, stormwater runoff, and dewatering excavations for approval by the Engineer. Modifications to these plans shall also be submitted for approval by the Engineer.

2. Plans shall include a demonstration that any cofferdams or diversions provide at least 10-year flood protection for protected structures under construction.

3. Submit a closure plan at least 30 days prior to beginning closure. This plan shall outline the Contractor's proposed work schedules, including shift schedules, beginning and ending dates, and equipment.

B. Approval of submittals does not relieve the Contractor of full responsibility and liability for care of water during construction.

2.00 PRODUCTS (NOT APPLICABLE)

3.00 EXECUTION

3.01 FLOOD FLOWS AND OTHER SURFACE WATER

A. The Contractor is responsible for handling and diverting any flood flows, stormwater runoff, stream flows, or any other water, including groundwater encountered during the progress of the work. Build, maintain, and operate cofferdams, channels, flumes, sumps, berms, ditches, and other temporary works as needed to divert stream flow or stormwater runoff water through or around the construction site and away from construction work while it is in progress. The handling of stormwater runoff should be coordinated with the erosion control plan. Unless otherwise approved by the Owner, a diversion must discharge into the same natural watercourse in which its headworks are located. Construct permanent Work in areas free from water. Full responsibility for the successful dewatering of the work areas rests with the Contractor. Remove protective works, after they have served their purpose, in a manner satisfactory to the Owner or its representative.

3.02 DEWATERING EXCAVATED AND OTHER FOUNDATION AREAS

A. Contractor is responsible for dewatering foundations for all areas during construction of the Project, including areas of required backfills. Lower the water table as needed to keep work areas free of standing water or excessively muddy conditions as needed for proper performance of the construction work. Furnish, prepare, and maintain drains, sumps, casings, well points, and other equipment needed to dewater areas for required construction work. Any dewatering method that causes a loss of fines from foundation areas shall not be permitted. Keep available standby equipment to ensure the proper and continuous operation of the dewatering system. Provide continuous monitoring (24 hours per day) of the dewatering system to ensure continuous operation.

B. Construction modifications in the dewatering system may be required by the Engineer to provide adequate performance. In the event of failure of the system, flooding of the excavation may be ordered by the Engineer until the system is operative.

3.03 COFFERDAM INSTALLATION

A. Upon beginning the cofferdam construction, the work shall be continuously prosecuted to completion in a diligent and expeditious manner. The selection, excavation, and processing of closure materials shall meet the applicable specifications. The stockpiling of materials may be necessary for completion of the cofferdam.

B. The Contractor must construct the cofferdam within the limits shown on the Drawings. If the Contractor determines that the limits of the cofferdam must be extended beyond the limits shown on the Drawings to complete the work, he must receive approval of the Engineer prior to any construction of the cofferdam.

C. Contractor is responsible for the design of the cofferdam. Height of the cofferdam must be at an adequate elevation to divert flood flows. Additionally, the top elevation of the cofferdam shall be at a minimum El. 588.0, which is two feet higher than the opposite bank ground elevation.

3.04 HISTORICAL INFORMATION

A. For the available data, The estimated flow, water surface elevation, and velocity of channel at the site, are as follows:

Profile	Q Total (cfs)	Water Surface Elevation (ft)	Velocity of Channel (ft/s)
2-yr	7,647	586.20	11.66
5-yr	15,956	592.15	11.29
10-yr	22,319	594.94	12.08
25-yr	30,828	598.39	12.53
50-yr	37,863	601.18	12.62
100-yr	45,853	604.13	12.76
500-yr	77,270	613.13	13.79

END OF SECTION

31 63 33 MICROPILES

1.00 GENERAL

1.01 WORK INCLUDED

A. This work shall consist of designing micropiles, furnishing all labor and materials, and performing all operations necessary to install micropiles at the locations and to the required capacities indicated in the contract documents.

1.02 SUBMITTALS

A. Submit the design and method-of-installation information outlined below as a shop drawing. The Engineer will require 15 work days to review the submittal. Do not begin work prior to receiving approval by the Engineer. Approval of the installation method by the Engineer does not constitute a guarantee of acceptable pile installations. Acceptable installations are the responsibility of the Contractor.

B. Include in the submittal:

1. Pile computations and design details for each design capacity including, but not limited to, nominal diameter, length, reinforcement, pile connections, grout materials, post grout tube and grouting pressures.

2. Details of equipment for pile installation.

3. Details of procedures for pile installation including, but not limited to, installation sequence and the approximate time required for each sequence step.

4. Procedures for advancing through boulders and other obstructions.

5. Procedures for containment of drilling fluid and spoil, and disposal of spoil.

C. Where applicable, drawings that show the specific work can be performed under limited headroom conditions and as close to obstructions, as site conditions warrant, to install the piles at the locations indicated in the contract documents. Provide information on the length of the casing sections to be used, as dictated by the length of the drill mast and by the available overhead clearance, and the resulting location of joints.

D. When steel drill casing/pipe is used as reinforcement, account for the reduced area of the threaded joint in the structural design of the pile, particularly for the capacity in tension and bending. Identify any joint location restrictions that must be followed in construction.

E. Procedures and equipment for placing grout.

1. Prepare the mix design for the grout and obtain documentation from an independent laboratory showing the following:

a. The mix design conforms to the submitted mix and meets the strength requirements set by the Contractor.

b. The compressive strength of the mix, tested at 3, 7, 14, and 28 days.

c. The specific gravity of the grout mix.

2. Identify a method for monitoring quality control of the mix. Minimum requirements are:

a. Contractor shall use a Baroid Mud Balance per American Petroleum Institute (API) Recommended Practice (RP) 13B-1: Standard Procedure for Testing Water- Based Drilling Fluids, to check the specific gravity of the mixed grout prior to placement of the grout into each micropile.

b. The grout should be tested by the Contractor for compressive strength at 3, 7, and 28 days in accordance with AASHTO T106/ASTM C109. The testing should consist of no less than one set of three 2-inch grout cubes for each 3-, 7-, 14, and 28-day tests. The testing is to be performed by an independent laboratory and the frequency of testing should be each day of construction or every 10 micropiles, whichever occurs more frequently. The compressive strength shall be the average of the 3 cubes tested.

3. Provide pressure gages capable of measuring the actual grout pressures used and such that actual pressure readings are within the middle third of the gage.

F. If proposed, details of post-grouting equipment and procedures, including the method, sequence of operations and equipment required.

G. Layout drawings showing the proposed sequence of pile installation. Coordinate this sequence with the proposed phasing and scheduling.

1.03 QUALITY ASSURANCE; DEFINITIONS

A. Bond Breaker: A device or special treatment incorporated into a length of a micropile that will allow no load to be transferred to the soil over that length. A bond breaker also provides full lateral support of the pile over the length of the bond breaker.

Grout placed in contact with the soil using gravity pressure only will not be considered to constitute a bond breaker.

B. Bond Zone: The gravity grouted, pressure grouted, and/or post grouted length of a micropile that provides the pile's capacity.

C. Design Loads: The load permitted on a pile. The design loads are indicated in the contract documents.

D. Drill Casing: Steel pipe of flush joint type used in the drilling process to stabilize the drill hole.

E. Duplex drilling: A method of progressing and cleaning out a hole for installing a micropile in which the outer drill casing is progressed simultaneously with an inner drill rod string. The drill casing is cleaned using reverse circulation. Intimate contact between the soil and an outer drill casing is maintained during drilling.

F. Micropile: A small-diameter (typically less than 12 inches), friction pile formed by removing material using non-vibratory and non-displacement methods to create a cased open, cylindrical hole in the ground, which is subsequently filled with grout and steel reinforcement.

G. Mill Secondary: Mill rejected American Petroleum Institute (API) casing, a.k.a. “Mill Rejects,” “Structural Grade,” “Limited Service,” or “Minimum Test Pipe.”

H. Non-production pile: Non-production piles are piles that are not incorporated into the substructure. For example, test piles which are abandoned after testing has been completed.

I. Permanent Casing: A steel casing installed in the upper portion of a micropile to increase the pile's moment capacity and lateral capacity against horizontal loads.

J. Positive circulation or flush: A method of progressing and cleaning out a hole for a micropile wherein drilling fluid is injected into the hole and returns upward along the outside of the drill casing.

K. Post grouting: A method used to increase pile capacity after the grout column has reached initial set by pumping grout at very high pressure (up to 7000 kPa) through a sleeved port pipe (post grout tube).

L. Pressure grouting: A method used to develop pile capacity wherein pressure is applied continuously to the top of the fluid grout column through the drill head as the casing is removed from the bond zone.

M. Production pile: A pile which will be incorporated into the structure's foundation.

N. Recirculation: A method of handling drilling fluid where the fluid coming back out of the hole is captured in a pan and reused.

O. Reverse circulation: A method of cleaning the inside of the drill casing. Drilling fluid is circulated down through the drill rods and returns upwards through the inside of the drill casing to flush the drill casing clean.

P. Static Pile Load Test: A test to verify design assumptions and the adequacy of the contractor’s installation methods.

Q. Telltale: A simple mechanical device, a.k.a. “strain rod,” that is used to measure deflection in concrete or steel. The device consists of a small-diameter steel rod that is fixed at a selected point along or within the pile. This rod is encased, and free to move, in a slightly larger pipe or tube which extends up to the pile top. Dial gages are used to measure the deflections at the top of the rod.

R. Tremie grouting: A method used to place grout in a wet hole. A grout tube is placed to the bottom of the drill hole. While keeping the tube opening submerged in the grout, grout is pumped into the hole, causing the drilling fluid to be displaced.

2.00 PRODUCTS

2.01 MATERIALS

A. Drill Casing. Provide drill casing consisting of flush joint type steel pipe of appropriate thickness to withstand the stresses associated with advancing it into the ground, in addition to the stresses due to hydrostatic and earth pressures.

B. Drill Casing/Pipe Used as Reinforcement. Provide steel drill casing/pipe used as reinforcement conforming to ASTM A252, with the exception that spiral welded pipe shall not be allowed.

Approval of the steel drill casing/pipe used as reinforcement shall be done in accordance with the following procedure:

1. Requirements for Micropile Structural Casing. Structural casing that is installed in coupled (spliced) sections shall meet the following requirements:

    a. The casing shall be flush joint and the pipe joint shall be completely shouldered and with no stripped threads.

    b. All welded connections, if neeed, shall be performed by experienced welders. Welds shall be full penetration welds for full structural load capacity. Welds shall be Ultrasonic (UT) or Radiograph Tested (RT). These requirements do not apply to minor welding that does not carry structural load, such as cutting teeth and tacking on bearing plates.

    If significant tension loads are being considered, the Engineer will require the Contractor to provide data demonstrating the adequacy of the proposed detail.

    The design shall limit the maximum yield stress of steel (Fy) to 80 ksi.

C. Bar Reinforcement. Provide Bar reinforcement meeting the requirements of “Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement” - ASTM A615, Grade 80, or continuously threaded "Uncoated High-Strength Steel Bars for Prestressing Concrete" - ASTM A722.

D. Grout. Provide a pumpable grout consisting of, as a minimum, Portland Cement - Type 2 and Water. The use of Grout Sand and Fly Ash in the mix is optional.

E. Centralizers and Spacers. Provide centralizers and spacers fabricated from schedule 40 PVC pipe, tube, steel, or material non-detrimental to the reinforcing steel. Wood shall not be used.

3.00 EXECUTION

3.01 PREPARATION

A. Engage a professional engineer, licensed and registered to practice in Texas, to design the piles in accordance with FHWA’s “Micropile Design and Construction, Reference Manual,” Publication No. FHWA-NHI-05-039. The Contractor's Engineer shall design the piles to perform satisfactorily for both structural and geotechnical requirements. The Contractor's Engineer shall design the diameter, length, reinforcement, pile connections, grout strengths, and grouting pressures, and select the equipment, procedures and methods so that each pile meets the pile acceptance criteria, can support the ultimate tension and compression loads, and meet other requirements, indicated in the contract documents.

Progress all micropiles using steel drill casing.

The Contractor performing the work described in this specification shall submit proof of the following:

1. Two projects in the past two years on which the Contractor has successfully installed micropiles or soil tiebacks using non-displacement methods, under similar site conditions to those indicated in the contract documents.

2. The proposed On-Site Supervisor for this work must have supervised the successful installation of micropiles or soil tiebacks on at least two projects in the past two years.

B. DRILLING AND EXCAVATION

1. Advance the hole using a duplex drilling method. Do not drill or flush ahead of the drill casing by more than one foot. Perform drilling and excavation in such a manner as to prevent the collapse of the hole. Use of bentonite slurry is not permitted. Use of polymer slurry to remove cuttings from the cased hole must be approved by the Engineer.
2. If obstructions are encountered during excavation for a pile, progress through them by means of coring or a tricone roller bit. Use of drop type impact hammers and blasting are not permitted. Use of a down-the-hole hammer requires approval by the Engineer.
3. Control the procedures and operations so as to prevent mining, damage or settlement to adjacent structures, tunnels, utilities or adjacent ground. If any mining, damage or settlement occurs, halt operations. Provide a written plan to the Engineer for review with procedures to avoid reoccurrence. Resume work only after the Engineer has approved the plan in writing. Repair all damage and settlement at no additional cost to the Owner.
4. Control the procedures and operations so as to prevent the soil at the bottom of the hole from flowing into the hole at all times during installation and cleaning out. Monitor the rate of fluid flow used to progress the holes.
5. Control drilling fluid and dispose of spoil in accordance with the approved procedure.
6. Do not progress a hole, pressure grout, or post-grout, within a radius of 5 pile diameters or 5 ft, whichever is greater, of a micropile until the grout for that micropile has set for 24 hours or 48 hours if a retarder is used.

C. REINFORCEMENT AND POST GROUT TUBE PLACEMENT

1. Provide centralizers sized to position the reinforcement within 1/2 inch of plan location from the center of the pile; sized to allow grout tremie pipe insertion to the bottom of the drillhole; and sized to allow grout to freely flow up the drill hole and casing and between adjacent reinforcing bars. Centralizers, spaced not to exceed 10 ft, must be used to center the reinforcement for its entire length. Securely attach the centralizers to withstand installation stresses. Do not drop, but lower the steel reinforcement to its specified location in the hole. If a post grout tube is used, attach it to the steel reinforcement prior to lowering it.

D. GROUT PLACEMENT AND CASING REMOVAL

1. Provide quality control of the mix by monitoring grout quality. Measure grout consistency by determining grout density per API Recommended Practice (RP) 13B-1 by the Baroid Mud Balance Test at a frequency, of at least one test per micropile, and provide the information to the inspector.
2. The Engineer will perform quality assurance of the mix by reviewing test results from the compressive tests to be performed as described in paragraph 1.02.E.2.b above.
3. Place grout by means of a tremie pipe from the bottom of the pile upward. Record the initial volume of grout required to fill the hole. Record grouting pressure and volume of grout being pumped into the pile during pressure grouting. Upon completion, maintain the grout level at or above the pile cut off elevation until the grout has set.

4. Locate the grout pressure and volume measuring gages at the pile installation site so that they are accessible and legible to the inspector.

5. After grouting, the micropile shall not be loaded for a minimum of three days.

E. Post Grouting

1. Provide the equipment and materials to perform post grouting. Perform post grouting after the grout has reached initial set. Record the pressure at which the grout was pumped, the total volume pumped, and the volume pumped through each port (if applicable).

F. Construction Tolerances

1. Install the piles so that the center of each micropile does not vary from the plan location by more than 3 inches. Do not allow the micropile to vary from the vertical by more than 1/4 inch per foot, as measured above ground.

2. Cut off the top of the pile at the elevation indicated in the contract documents.

3. If the soil at the pile tip is post grouted, monitor the elevation of the pile top during post grouting.

G. Non-Production Micropile Testing

1. One non-production micropile shall be installed within the cofferdam but should be located at least five feet from the location of any production pile. The Contractor shall submit the proposed location of the non-production micropile to the Engineer for approval.

2. The non-production micropile shall be loaded to 200 percent of the design load. The non-production micropile shall be tested in compression and tension. The load test shall be evaluated by the Contractor and Engineer to assume compliance with job performance requirements.

3. The load shall be applied with a calibrated hydraulic jack. A leveling plate shall be attached to the surface of the test pile and the jack shall be set in position with the load centered on the pile.

4. The tests shall be performed in accordance with ASTM D 1143-81, Testing of Piles under Axial Compressive Load and ASTM D 3689 Standard Test Methods for Deep Foundations Under Static Axial Tensile Load.

5. Perform the tension tests prior to the compression test.

6. The tension test load shall be applied in compliance with ASTM D 3689, Paragraph 8.1.2 Quick Test. Keep the load constant for 5 minutes for each interval. The maximum load shall be maintained for 1 hour or until the movement is less than or equal to 0.001 foot per hour. Remove the load in 5 equal decrements, keeping the load constant for 5 minutes for each interval.

7. The compression test load shall be applied in compliance with ASTM D 1143-81, Paragraph 5.6 Quick Pile Test. In essence the load shall be applied in intervals in increments of 20 percent of the anticipated working load to maximum of a least 200 percent of the working load. The maximum load shall be maintained for 1 hour. Load increments shall be maintained as applied as described in ASTM D 1143.81, Paragraph

5.4. Readings of settlements and rebounds shall be referred to a constant elevation benchmark and shall be recorded to 1/1000 of a foot for each increment or decrement of load.

8. Following the 1-hour hold on the maximum load, the test piles shall rebound as described in ASTM D 1143.81, Paragraph 6.2. Six settlement and rebounded readings shall be made in addition to the initial and final readings (total of 8) during each load or rebound cycle.
9. The rebound curve shall be established by unloading in decrements of 75, 50, 25 and 10 percent of the total applied load.
10. Contractor guarantees that should the test pile fail to give acceptable results, he will modify his design and install and test another pile at his expense. He also guarantees that he will repair or replace at his own expenses all structural damage caused by inability of his piles to support the working loads satisfactorily for a period of two years.
11. Test Acceptance Criteria
    a. The pile shall support the specified test load without failure. Pile failure is defined as continued pile top displacement without supporting an increase in applied load.
    b. The pile shall support the specified maximum test load with a total pile top displacement of not greater than 3/8 inch at the maximum load tested.
    c. While holding the maximum test load, increase in the pile top displacement (creep) measured between 1 minute and 10 minutes shall not exceed 1/16 inch. The creep rate between 6 and 60 minutes shall not exceed 1/8 inch per log cycle of time in minutes.

H. Pile Acceptance Criteria
1. Pile meets Construction Tolerance criteria.
2. Pile was installed in accordance with the approved submittal.
3. Pile is not damaged.
4. Pile was installed using the same method, materials, grout volumes, and pressures as the accepted test pile.

I. Unacceptable Piles.
1. Unacceptable piles are piles which do not meet the acceptance criteria identified in Paragraph H above.
2. Submit to the Engineer for approval a written plan of remedial action showing how to correct the problem and prevent its recurrence. Repair, augment, or replace the unacceptable pile in accordance with the approved remedial plan at no additional cost to the Owner.

END OF SECTION

35 13 13.01 BUOY WARNING SYSTEM

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to install a buoy warning system in accordance with this specification and the applicable drawings. The warning system shall consist of an anchored buoy at the upstream end of the landing and an anchored buoy at the downstream end of the landing as shown on the drawings. Each buoy unit shall include the shackle, chain, swivel, and regulatory buoy.

1.02 SUBMITTALS

A. Contractor shall provide the following submittals prior to the performance of any work. Submittals shall include the following record data:

1. Manufacturer's Data Sheets for Buoys, Anchors, Cable, and Fittings

2.00 PRODUCTS

2.01 MANUFACTURED PRODUCTS

A. Anchor:
Each buoy shall be anchored to the landing with a ½" hot dipped galvanized ASTM grade 36 standard threaded U-Bolt with a center-to-center spacing of 4 inches and a minimum embedment depth of 3 inches

B. Chain and Fittings:
The buoy chain shall be $^{3}/_{16}$" hot dipped galvanized chain with an 800-lb working load limit, or approved equal. Hardware to attach the chain, buoys and anchor shall consist of $^{3}/_{16}$" ASTM grade 36 shackles on either end of the chain, or approved equal, as shown on the drawings. Furnish chain, shackles, swivels, and other required hardware of compatible size as specified and shown on the drawings. All hardware shall be hot-dipped galvanized.

C. Can Warning Buoys:
Can warning buoys shall be TUFFBUOY regulatory buoys (white) No. W961R manufactured by Worthington Products, Inc., Canton, Ohio, or approved equal. Marker buoys shall be marked as specified and shown on drawings.

3.00 EXECUTION

3.01 INSTALLATION

A. Install the buoy warning system in accordance with this specification, the appropriate drawings, notes thereon, and manufacturer's recommendations.

END OF SECTION