

Technical Specifications

Town of Richland Haldane Center Athletic Support Facility

Town of Richland, NY



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CAST-IN-PLACE CONCRETE

Part 1 - General

1.1 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required and install cast-in-place concrete complete as shown on the Drawings and as specified herein.
- B. Furnish, as required to establish concrete mixes, all sampling and laboratory testing of products and materials performed by an independent testing laboratory engaged by and at the expense of the Contractor. Field sampling, testing, inspection and related laboratory tests will be provided by the General Contractor.

1.2 RELATED WORK

- A. Concrete formwork per ACI.
- B. Concrete reinforcement per ACI.
- C. Concrete joints and joint accessories per ACI.
- D. Concrete finishes are included per ACI.
- E. Miscellaneous metals are per ACI.

1.3 SUBMITTALS

- A. Submit product data for:
 - 1. Sources of cement, fly ash, aggregates, and batched concrete. Indicate name and address of mill or quarry.
 - 2. Air-entraining admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations and conformity to ASTM standards.
 - 3. Water reducing admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations and conformity to ASTM standards.
 - 4. Sheet curing material. Product data including catalogue cut, technical data and conformity to ASTM standard.
 - 5. Material Safety Data Sheets (MSDS) for all concrete components and admixtures.
 - 6. Crystalline waterproofing admixture. Product data including manufacturer, product names, and dosage ranges.
- B. Test Reports
 - 1. Aggregates: Conformance to ASTM standards, including sieve analysis, mechanical properties, deleterious substance content, and mortar bar expansion test results.
 - 2. Cement and fly ash: Conformance to ASTM standards, including chemical analysis and physical tests.
 - 3. Concrete mixes: For each formulation of concrete proposed for use, submit constituent quantities per cubic yard, water cementitious ratio, air content, concrete slump, type and manufacturer of cement and type and manufacturer of fly ash. Provide either Paragraph a. or b., below, for each mix proposed.

- a. Standard deviation data for each proposed concrete mix based on statistical records. Provide the following for each strength data point used in the calculation of the standard deviation for determination of the minimum required average strength:
 - i. Date of sampling and name of testing laboratory.
 - ii. Name of concrete batch plant.
 - iii. Water cementitious ratio.
 - iv. Slump of batch.
 - v. Air content of batch.
 - vi. Compressive strengths of all cylinders tested at that age in that batch.
 - vii. Temperature and unit weight of batch.
 - b. Water cementitious ratio curve for concrete mixes based on laboratory tests. Provide average cylinder strength test results at 7, 14 and 28 days for laboratory concrete mix designs. Provide results of 14 day tests if available.
4. Concrete shrinkage test results: submit concrete shrinkage results for concrete to be used in liquid containing structures at 28 days for use in accordance with the procedure in ACI 209 based on predicting ultimate concrete shrinkage. Test according to ASTM C157.
- C. Certifications
1. Submit certification of ready mix concrete plant by NRMCA or RIDOT.
 2. Certify that admixtures used in the same concrete mix are compatible with each other and the aggregates.
 3. Certify that the Contractor is not associated with the independent testing laboratory proposed for use by the Contractor nor does the Contractor or officers of the Contractor's organization have a beneficial interest in the laboratory.
- D. Qualifications
1. Independent Testing Laboratory
 - a. Name and address
 - b. Listing of technical services to be provided. Indicate external technical services to be provided by other organizations.
- E. Other
1. Cold and Hot Weather Concreting Plans

1.4 REFERENCES STANDARDS

- A. American Society for Testing and Materials (ASTM)
1. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 2. ASTM C33 - Standard Specification for Concrete Aggregates.
 3. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 4. ASTM C42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
 5. ASTM C94 - Standard Specification for Ready-Mixed Concrete.

6. ASTM C138 - Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
 7. ASTM C 143 - Standard Test Method for Slump of Hydraulic-Cement Concrete
 8. ASTM C150 - Standard Specification for Portland Cement
 9. ASTM C157 – Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
 10. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete
 11. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
 12. ASTM C192 - Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
 13. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
 14. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
 15. ASTM C311 - Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for use in Portland Cement Concrete.
 16. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.
 17. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
 18. ASTM C1077 -Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.
 19. ASTM C1260 - Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
 20. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection and/or Testing.
- B. American Concrete Institute (ACI).
1. ACI 209R – Prediction of Creep, Shrinkage, and Temperature Effects in Concrete Structures.
 2. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.
 3. ACI 232.2R - Use of Fly Ash in Concrete.
 4. ACI 304R - Guide for Measuring, Mixing, Transporting and Placing Concrete.
 5. ACI 304.2R - Placing Concrete by Pumping Methods.
 6. ACI 305R - Hot Weather Concreting.
 7. ACI 306R - Cold Weather Concreting.
 8. ACI 318 - Building Code Requirements for Structural Concrete and Commentary.
 9. ACI 350 - Code Requirements for Environmental Engineering Concrete Structures and Commentary.
- C. National Ready Mixed Concrete Association (NRMCA)
1. Quality Control Manual, Section 3 – Certification of Ready Mixed Concrete Production Facilities.

- D. Rhode Island Department of Transportation (RIDOT)
 - 1. Certification of Ready mixed Concrete meeting RIDOT standards.
- E. Truck Mixer Manufacturers Bureau (TMMB)
 - 1. TMMB 100 - Truck Mixer, Agitator and Front Discharge Concrete Carrier Standards.
- F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.5 QUALITY ASSURANCE

- A. Comply with ACI 318, ACI 350 and other stated specifications, codes and standards. Apply the most stringent requirements of other stated specifications, codes, standards, and this Section when conflicts exist.
- B. Independent testing laboratory shall meet the requirements of ASTM E329 and ASTM CI077 and be acceptable to the Engineer. Laboratories affiliated with the Contractor or in which the Contractor or officers of the Contractor's organization have a beneficial interest are not acceptable.
- C. Use only one source of cement and aggregates for the project. Provide concrete uniform in color and appearance.
- D. At least ten working days before the first concrete placement attend a preconstruction meeting to review the requirements for concrete placement, waterstop placement, jointing, concrete curing, hot weather concreting, cold weather concreting and finishing.
- E. If, during the progress of the work, it is impossible to secure concrete of the specified workability and strength with the materials being furnished, the Engineer may order such changes in proportions or materials, or both, as may be necessary to secure the specified properties. Make all changes so ordered at no additional cost to the Owner.
- F. If, during the progress of the work, the materials from the sources originally accepted change in characteristics, make, at no additional cost to the Owner, new acceptance tests of materials and establish new concrete mixes with the assistance of an independent testing laboratory.
- G. All field testing and inspection services and related laboratory tests required will be provided by the General Contractor. The cost of such work will be paid for by the General Contractor. Methods of testing will comply with the latest applicable ASTM methods. The following items will be tested by the Owner to verify conformity with this Section.
 - 1. Concrete placements - compressive strength (cylinders), slump, and air content.
 - 2. Other materials that may require field testing.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Cement: Store in weathertight buildings, bins or silos to provide protection from dampness and contamination and to prevent warehouse set.
- B. Aggregate: Arrange and use stockpiles to prevent segregation or contamination with other materials or with other sizes of like aggregates. Build stockpiles in successive horizontal layers not exceeding three feet in thickness. Complete each layer before the next is started. Do not use frozen or partially frozen aggregate.
- C. Sand: Arrange and use stockpiles to prevent contamination. Allow sand to drain to a uniform moisture content before using. Do not use frozen or partially frozen sand.
- D. Admixtures: Store in closed containers to prevent contamination, evaporation or damage.

- Provide agitating equipment to uniformly disperse ingredients in admixture solutions which tend to separate. Protect liquid admixtures from freezing and other temperature changes which could adversely affect their characteristics.
- E. Fly Ash: Store in weathertight buildings, bins or silos to provide protection from dampness and contamination.
 - F. Sheet Curing Materials: Store in weathertight buildings or off the ground and under cover.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. Like items of materials shall be the end products of one manufacturer in order to provide standardization for appearance, maintenance and manufacturer's service.

2.2 MATERIALS

- A. Materials shall comply with this Section and any applicable State or local requirements.
- B. Cement: Domestic Portland cement conforming to ASTM CI50, Type I/II or II. Do not use air entraining cements. Cement brand must be approved by the Engineer and one brand shall be used throughout the work unless otherwise authorized.
- C. Aggregates:
 - 1. Fine Aggregate: Washed inert natural sand conforming to ASTM C33.
 - 2. Coarse Aggregate: Well-graded crushed stone or washed gravel conforming to ASTM C33. Grading requirements as listed in ASTM C33, Table 2 for the specified coarse aggregate size number listed in Table 1 herein. Limits of deleterious substances and physical property requirements as listed in ASTM C33, Table 3 for severe weathering regions. Do not use coarse aggregates known to be deleteriously reactive with alkalis in cement.
 - 3. The fine and coarse aggregates used shall not cause expansion of mortar bars greater than 0.1 percent in 16 days when tested in accordance with ASTM CI260 and using the cement proposed for the project. If aggregates proposed for use do not meet this requirement, then satisfy either a. or b. below.
 - a. Total equivalent alkali content of the cement used shall not exceed 0.60 percent as provided in the Optional Chemical Requirements of ASTM C 150.
 - b. The fine and coarse aggregates used shall not cause expansion of mortar bars greater than 0.1 percent in 16 days when tested in accordance with ASTM CI260 and using the cement and fly ash proposed for the project. The proportions of the cement-fly ash mix shall be the same as those proposed for the project.
- D. Water: Potable water free of oil, acid, alkali, salts, chlorides (except those attributable to drinking water), organic matter, or other deleterious substances.
- E. Admixtures: Use admixtures free of chlorides and alkalis (except for those attributable to drinking water). The admixtures shall be from the same manufacturer when it is required to use more than one admixture in the same concrete mix. Use admixtures compatible with the

concrete mix including other admixtures.

1. Air Entraining Admixture: Conforming to ASTM C260. Proportion and mix in accordance with manufacturer's recommendations.
 2. Water Reducing Admixture: Conforming to ASTM C494, Type A. Proportion and mix in accordance with manufacturer's recommendations.
 3. Do not use admixtures causing retarded or accelerated setting of concrete without written approval from the Engineer. Use retarding or accelerating water reducing admixtures when so approved.
 4. Crystalline Waterproofing Admixture: Provide crystalline waterproofing admixture for the cast-in-place concrete walls of the SBR, WAS, and Effluent Storage Tanks that are common with occupied spaces. Follow the manufacturer's written directions for proper dosage and application method.
- F. Fly Ash: Class F fly ash complying with ASTM C618, including the requirements of Table I but with the Loss of Ignition (LOI) limited to 3 percent maximum and the optional physical requirements of Table 3. Test in compliance with ASTM C311 with a minimum of one sample weighing four pounds taken from each 200 tons of fly ash supplied for the project.
- G. Sheet Curing Materials: Waterproof paper, polyethylene film or white burlap-polyethylene sheeting, all conforming to ASTM C 171.

2.3 MIXES

- A. An independent testing laboratory engaged by and at the expense of the Contractor shall establish concrete mixes and perform all sampling and laboratory testing of products and materials.
- B. Select proportions of ingredients to meet the design strength and materials limits specified in Table I and to produce placeable, durable concrete conforming to these specifications. Proportion ingredients to produce a homogenous mixture which will readily work into corners and angles of forms and around reinforcement without permitting materials to segregate or allowing free water to collect on the surface.
- C. Base concrete mixes on standard deviation data of prior mixes with essentially the same proportions of the same constituents or, if not available, develop concrete mixes by laboratory tests using the materials proposed for the work. Follow the direction provided by ACI 301 for concrete mix design selecting either the Trial Batch or Field Test Data methods.
- D. Test the fly ash and concrete mixture to provide test data confirming that the fly ash in combination with the cement to be used meets all strength requirements and is compatible with the other concrete additives.
- E. Test aggregates for potential alkali reactivity in accordance with ASTM C1260. If initial testing indicates aggregates are not potentially reactive repeat test at 3 month intervals.
- F. Compression Tests: Provide testing of the proposed concrete mixes to demonstrate compliance with the compression strength requirements in conformity with the provisions of ACI 318.
- G. . Entrained air, as measured by ASTM C231, shall be as shown in Table 1.
 1. If the air entraining agent proposed for use in the mix requires testing methods other than ASTM C231 to accurately determine air content, make special note of this requirement in the admixture submittal specified under Paragraph 1.03.
- H. Slump of the concrete as measured by ASTM C143, shall be as shown in Table 1.

- I. Proportion admixtures according to the manufacturer's recommendations. Two or more admixtures specified may be used in the same mix provided that the admixtures in combination retain full efficiency and have no deleterious effect on the concrete or on the properties of the other admixture(s).

Class	Design Strength	Fine Aggregate	Coarse Aggregate	W/C Ratio	Slump Range (In.)	Cementitious Content (%)	Air Entrainment (%)
A	4000	Sand	57(9)	0.45	2-4	20	4-7
B	4500	Sand	57	0.42	3-5	20	4-7

Notes:

1. Minimum compressive strength in psi at 28 days
2. Size Number in ASTM C33
3. W/C is Maximum Water Cementitious ratio by weight
4. Cementitious Content shall contain no more than 25% of fly ash (ACI 318 table 4.2.3)

PART 3 - EXECUTION

3.1 MEASURING MATERIALS

- A. Provide concrete composed of Portland cement, fly ash, fine aggregate, coarse aggregate, water and admixtures as specified and produced by a plant complying with ACI 318 and ASTM C94. Batch all constituents, including admixtures, at the plant.
- B. Measure materials for batching concrete by weighing in conformity with and within the tolerances given in ASTM C94 except as otherwise specified. Use scales last certified by the local Sealer of Weights and Measures within one year of use.
- C. Weigh cement and fly ash in individual weigh batchers that are separate and distinct from the weigh batchers used for other materials. When cement and fly ash are weighed in a cumulative weigh batcher, the cement shall be weighed first.
- D. Measure the amount of free water in fine aggregates within 0.5 percent with a moisture meter. Compensate for varying moisture contents of fine aggregates. Record the number of gallons of water as-batched on printed batch tickets.
- E. Dispense admixtures either manually using calibrated containers or measuring tanks, or by means of an automatic dispenser approved by the manufacturer of the specific admixture.
 1. Charge air-entraining and chemical admixtures into the mixer as a solution using an automatic dispenser or similar metering device.
 2. Inject multiple admixtures separately during the batching sequence.

3.2 MIXING AND TRANSPORTING

- A. Provide ready-mixed concrete produced by equipment complying with ACI 318 and ASTM C94 and produced by a plant certified by the NRMCA. Do not hand-mix. All truck mixers shall carry a rating plate conforming to TMMB 100. Clean each transit mix truck drum and reverse drum rotation before the truck proceeds under the batching plant. Equip each transit-mix truck with a continuous, nonreversible, revolution counter showing the number of revolutions at mixing speeds.
- B. Transport ready-mix concrete to the site in watertight agitator or mixer trucks loaded not in excess of their rated capacities as stated on the name plate.
- C. Keep the water tank valve on each transit truck locked at all times. Any addition of water must be directed by the Special Inspector and approved by the Engineer, and accounted for by being held back during the batching operation. Incorporate water directed to be added by additional mixing of at least 50 revolutions at mixing speed after the addition of all water. Meter all added water and show the amount of water added' on each delivery ticket.
- D. Comply with ACI 318 and ASTM C94 for all central plant and rolling stock equipment and methods.
- E. Select equipment of size and design to provide continuous flow of concrete at the delivery end. Use metal or metal-lined non-aluminum discharge chutes with stapes not exceeding one vertical to two horizontal and not less than one vertical to three horizontal. Chutes more than 20-ft long and chutes not meeting slope requirements may be used if concrete is discharged into a hopper before distribution.
- F. Do not retemper (mix with or without additional cement, aggregate, or water) concrete or mortar which has partially hardened.
- G. Handle concrete from mixer to placement providing concrete of specified quality in the placement area and not exceeding the maximum time interval specified in Paragraph 3.02 104. Dispatch trucks from the batching plant so they arrive at the work site just before the concrete is required to avoid excessive mixing of concrete while waiting or delays in placing successive layers of concrete in the forms. Remix for a minimum of 5 minutes prior to discharge or testing.
- H. Furnish a delivery ticket for ready mixed concrete to the Special Inspector as each truck arrives. Provide a printed record of the weight of cement and each aggregate as batched individually on each ticket. Use the type of indicator that returns for zero punch or returns to zero after a batch is discharged. Indicate for each batch the weight of fine and coarse aggregate, cement, fly ash, and water, moisture content of fine and coarse aggregate at time of batching, and types, brand and quantity of each admixture, the quantity of concrete delivered, the time any water is added and the amount, and the numerical sequence of the delivery. Show the time of day batched and time of discharge from the truck. Indicate the number of revolutions of transit mix truck.
- I. Temperature and Mixing Time Control
 - 1. In cold weather (see Paragraph 3.07D) maintain the as-mixed temperature of the concrete and concrete temperatures at the time of placement in the forms as indicated in Table 3.
 - 2. If water or aggregate has been heated, combine water with aggregate in the mixer before cement is added. Do not add cement to mixtures of water and aggregate when the temperature of the mixture is greater than 90 degrees F.
 - 3. In hot weather (see Paragraph 3.07E), cool ingredients before mixing to maintain temperature of the concrete below the maximum placing temperature of 90 degrees F. Well crushed ice may be substituted for all or part of the mixing water.

4. The maximum time interval between the addition of mixing water and/or cement to the batch and the final placing of concrete in the forms shall not exceed the following 90 minutes. In hot weather conditions, the maximum time interval as stated above shall not exceed 60 minutes without special provisions made to slow the rate of hydration of the cement.

3.3 INSPECTION AND COORDINATION

- A. Batching, mixing, transporting, placing and curing of concrete shall be subject to the inspection of the Special Inspector at all times. Advise the Special Inspector of readiness to proceed at least six working hours prior to each concrete placement. The Special Inspector will inspect the preparations for concreting including the preparation of previously placed concrete, the reinforcing and the alignment, cleanliness and tightness of formwork. Do not place concrete without the inspection and acceptance of the Special Inspector.

3.4 EMBEDDED ITEMS

- A. Secure to forms as required or set for embedment as required, all miscellaneous metal items, sleeves, reglets, anchor bolts, anchors, inserts and other items furnished under other Sections and required to be embedded into concrete. Set and secure such items in the locations and alignments needed so they are not displaced by concrete placement.
- B. Clean embedded items free of rust, mud, dirt, grease, oil, ice, or other injurious contaminants which would reduce or prevent bonding with concrete.
- C. Coat or isolate all aluminum embedments to prevent aluminum-concrete reaction or electrolytic action between aluminum and steel.
- D. Do not embed piping in concrete unless shown on the Drawings.
- E. Do not embed electrical conduits in concrete unless shown on the Drawings.
- F. Pipes and conduits embedded within a slab or wall (other than those merely passing through) shall satisfy the following, unless otherwise shown on the Drawings or approved:
 - a. Maximum outside dimension of pipe or conduit shall not be greater than one third the overall thickness of the slab or wall.
 - b. Spacing of pipes or conduits shall be greater than or equal to three diameters or widths on center.

Fabricate piping and conduit such that the cutting, bending, or relocation of reinforcing steel is not required.

- G. Close open ends of piping, conduits, and sleeves embedded in concrete with caps or plugs prior to placing concrete.
- H. Ensure all specified tests and inspections on embedded piping are completed and satisfactory before starting concrete placement. Ensure all mechanical or electrical tests and inspections are completed and satisfactory prior to starting concrete placement. Do not place concrete until unsatisfactory items and conditions have been corrected.
- I. Position embedded anchor bolts using templates.
- J. Check location, alignment, and support of anchor bolts, piping, electrical conduits, and other items which will be fully or partially embedded in concrete before depositing concrete. Correct mislocated and misaligned items and secure items which have become loose before depositing concrete.

- K. Correct all embedded items not installed in the location or alignment needed or displaced by concrete placement at no additional cost to the Owner.

3.5 CONCRETE APPEARANCE

- A. Remix concrete showing either poor cohesion or poor coating of the coarse aggregate with paste. Reject remixed concrete showing either poor cohesion or poor coating of the coarse aggregate with paste. Make, at no additional cost to the Owner, changes in the concrete mix design for future deliveries only by adjusting one or more of the following if the slump is within the allowable limit, but excessive bleeding, poor workability, or poor finishability are observed:
 - 1. The gradation of aggregate.
 - 2. The proportion of fine and coarse aggregate.
 - 3. The percentage of entrained air, within the allowable limits.
- B. Provide concrete having a homogeneous structure which, when hardened, will have the specified strength, durability and appearance. Provide mixtures and workmanship such that concrete surfaces, when exposed, will require no finishing except as specified in Section 03350.

3.6 PLACING AND COMPACTING

A. Placing

- 1. Verify that all formwork completely encloses concrete to be placed and is securely braced prior to concrete placement. Remove ice, standing water, dirt, debris, and other foreign materials from forms and exposed joint surfaces. Confirm that reinforcement and other embedded items are securely in place. Have a worker at the location of the placement who can check that reinforcement and embedded items remain in designated locations and alignments while concrete is being placed. Sprinkle semi-porous subgrades or forms to eliminate suction of water from the mix. Do not place concrete on frozen subgrade, snow, or ice.
- 2. Deposit concrete as near its final position as possible to prevent segregation due to rehandling or flowing. Place concrete continuously at a rate that allows the concrete previously placed to be integrated with fresh plastic concrete. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials or on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the section. If the section cannot be placed continuously, place construction joints as specified or as approved.
- 3. Pumping of concrete will be permitted. Use a mix design and aggregate sizes chosen for pumping and submit for approval. Do not use pipelines made of aluminum or aluminum alloy. When concrete is pumped, slump will be determined at point of truck discharge and air content will be determined at point of placement.
- 4. Remove temporary spreaders from forms when the spreader is no longer needed. Temporary spreaders may remain embedded in concrete only when made of galvanized steel or concrete and if prior approval has been obtained.
- 5. Do not place concrete for supported elements until concrete previously placed in the supporting element has attained design strength.
- 6. Where surface mortar is to form the base of a finish, especially surfaces designated to be painted, work coarse aggregate back from forms to bring the full surface of the mortar

against the form. Prevent the formation of surface voids.

7. Slabs

- a. After bulkheads, screeds and jointing materials have been positioned, place concrete continuously between joints beginning at a bulkhead, edgeform, or corner. Place each batch into the edge of the previously placed concrete to avoid stone pockets and segregation.
- b. Avoid delays in placement. If there is a delay in placement, spade and consolidate the concrete placed after the delay at the edge of the previously placed concrete to avoid cold joints. Bring concrete to correct level and strike off with a straightedge. Use bullfloats or darbies to smooth the surface, leaving it free of humps or hollows.
- c. Where slabs are to be placed integrally with the walls below them, place the walls and compact as specified. Allow one hour to pass between placement of the wall and the overlying slab to permit consolidation of the wall concrete. Keep the top surface of the wall moist to prevent cold joints.

8. Formed Concrete

- a. Place concrete in forms using tremie tubes taking care to prevent segregation. Maintain bottom of tremie tubes in contact with the concrete already placed. Do not permit concrete to drop freely more than 4-ft. Place concrete for walls in 12-in to 24-in lifts, keeping the surface horizontal.

B. B. Compacting

1. Consolidate concrete by vibration and puddling, spading, rodding or forking so that concrete is completely worked around reinforcement, embedded items and openings and into corners of forms. Continuously perform puddling, spading, rodding and forking along with vibration of the placement to eliminate air or stone pockets which may cause honeycombing, pitting or planes of weakness.
2. Compact all concrete with mechanical vibrators. Do not order concrete until vibrators (including standby units in working order) are on the job.
3. Use mechanical vibrators having a minimum frequency of 8000 vibrations per minute. Insert vibrators and withdraw at points from 18-in to 30-in apart. Vibrate sufficiently at each insertion to consolidate concrete, generally from 5 to 15 seconds. Do not over vibrate so as to segregate. Keep standby vibrators on the site during concrete placing operations.
4. Concrete Slabs: Vibration for concrete slabs less than 8-in thick shall be by vibrating screeds. Vibration for concrete slabs 8-in and thicker shall be by internal vibrators and (optionally) with vibrating screeds. Place vibrators into concrete vertically. Do not lay vibrators horizontally or lay over.
5. Walls and Columns: Use internal vibrators (rather than form vibrators) unless otherwise approved by the Engineer. In general, for each vibrator needed to melt down (level) the batch at the point of discharge, one or more additional vibrators must be used to densify, homogenize and perfect the surface. Insert vibrators vertically at regular intervals, through the fresh concrete and slightly into the previous lift, if any.
6. Amount of Vibration: Use vibrators to consolidate properly placed concrete. Do not use vibrators to move or transport concrete in the forms. Continue vibration until:
 - a. Frequency of vibrator returns to normal.
 - b. Surface appears liquefied, flattened and glistening.

- c. Trapped air ceases to rise.
- d. Coarse aggregate has blended into surface, but has not disappeared.

3.7 CURING AND PROTECTION

A. Protect all concrete work against injury from the elements and defacements of any nature during construction operations.

B. Curing Methods

1. Curing Methods for Concrete Surfaces: Cure concrete to retain moisture and maintain a temperature of at least 50 Degrees F at the concrete surface for a minimum of seven days after placement. Use the following curing methods as specified:

- a. Water Curing: Keep entire concrete surface wet by ponding, continuous sprinkling or covered with saturated burlap. Begin water curing as soon as concrete attains an initial set and maintain water curing 24 hours a day. Do not permit the surface of the concrete to dry out at any time during the curing period. Temperature of curing water shall be within 20 Degrees F of the concrete temperature.
- b. Sheet Material Curing: Cover entire surface with sheet material. Anchor sheeting to prevent wind and air from lifting the sheeting or entrapping air under the sheet. Place and secure sheet as soon as initial concrete set occurs.
- c. Liquid membrane curing compounds following the manufacturer's written instructions.

2. Specified applications of curing methods:

- a. Slabs for Liquid Retaining Structures: Water curing only.
- b. Slabs on Grade and Footings (not used to retain liquids): Water curing or sheet material curing.
- c. Structural Slabs (other than Liquid Retaining Structures): Water curing.
- d. Horizontal Surfaces which will Receive Additional Concrete, Coatings, Grout or Other Material that Requires Bond to the substrate: Water curing.
- e. Formed Surfaces: None if nonabsorbent forms are left in place seven days. Water curing if absorbent forms are used. Water curing if forms are removed prior to seven days. Exposed horizontal surfaces of formed walls or columns shall be water cured for seven days or until next placement of concrete is made.
- f. Surfaces of Concrete Joints: Water curing or sheet material curing.

C. Protect finished surfaces and slabs from the direct rays of the sun to prevent checking and crazing.

D. Cold Weather Concreting

- 1. For this Specification, "cold weather" is defined as a period when for more than three successive days, the average daily outdoor temperature drops below 40 degrees F. Calculate average daily temperature as the average of the highest and the lowest temperature during the period from midnight to midnight.
- 2. Batch, deliver, place, cure and protect concrete during cold weather in compliance with the recommendations of ACI 306R and the additional requirements of this Section.
- 3. Review the cold weather concreting plan at the preconstruction meeting. Include the methods and procedures for use during cold weather including the production,

transportation, placement, protection, curing and temperature monitoring of the concrete and the procedures to be implemented upon abrupt changes in weather conditions or equipment failures.

4. The minimum temperature of concrete immediately after placement and during the protection period shall be as indicated in Table 3. The temperature of the concrete in place and during the protection period shall not exceed these values by more than 20 degrees F. Prevent overheating and non-uniform heating of the concrete.

Table 3		
Concrete Temperatures Minimum Dimension of Section		
Min. conc. Temp:	<u><12-in</u> 55 Degree F	<u>12 to 36-in</u> 50 Degree F

5. Protect concrete during periods of cold weather to provide continuous warm, moist curing.
 - a. To calculate the weighted average daily air temperature, sum hourly measurements of the air temperature in the shade at the surface of the concrete taking any measurement less than 50 degrees F as 0 degrees F. Divide the sum thus calculated by 24 to obtain the weighted average temperature for that day.
 6. Do not use salt, manure or other chemicals for protection.
 7. During periods not defined as cold weather, but when freezing temperatures are expected or occur, protect concrete surfaces from freezing for the first 24 hours after placing.
- E. Hot Weather Concreting
1. For this Specification, "hot weather" is defined as any combination of high air temperatures, low relative humidity and wind velocity which produces a rate of evaporation as estimated in ACI 305R, approaching or exceeding 0.2 pounds per square foot per hour (lb/sq ft/hr).
 2. Batch, deliver, place, cure and protect concrete during hot weather in compliance with the recommendations of ACI 305R and the additional requirements of this Section.
 - a. Temperature of concrete being placed shall not exceed 90 degrees F. Maintain a uniform concrete mix temperature below this level. The temperature of the concrete shall not cause loss of slump, flash set or cold joints.
 - b. Promptly deliver concrete to the site and promptly place the concrete upon its arrival at the site, not exceeding the maximum time interval specified in Paragraph 3.021.4. Provide vibration immediately after placement.
 - c. The Engineer may direct the Contractor to immediately cover concrete with sheet curing material.
 3. Review the hot weather concreting plan at the preconstruction meeting. Include the methods and procedures for use during hot weather including production, placement, and curing.

3.8 REMOVAL OF FORMS

- A. Do not remove forms before the concrete has attained a strength of at least 70 percent of its specified design strength for beams and slabs and at least 30 percent of its specified design strength for walls and vertical surfaces.
- B. Do not remove shores until the concrete has attained at least 70 percent of its specified design strength and also sufficient strength to support safely its own weight and the construction live loads upon it.
- C. In cold weather, when temperature of concrete exceeds ambient air temperature by 20 Degrees F at the end of the protection period, loosen forms and leave in place for at least 24 hours to allow concrete to cool gradually to ambient air temperature.

3.9 FIELD AND LABORATORY TESTS

- A. Concrete temperature at time of placement will be taken by the Special Inspector (or Owner's testing laboratory inspector).
- B. Sets of field control cylinder specimens will be taken by the Special Inspector (or Owner's testing laboratory inspector) during the progress of the work, in compliance with ASTM C31. The number of sets of concrete test cylinders taken of each class of concrete placed shall not be less than one set for each 100 c.y. of concrete nor less than one set for each 5,000 sq ft of surface area for slabs or walls. Specimens shall be formed in 6-in diameter by 12-in long non-absorbent cylindrical molds.
 - 1. A "set" of test cylinders shall consist of four cylinders: one to be tested at seven days, and two to be tested and their strengths averaged at 28 days. The fourth may be used for a special test at 3 days or to verify strength at 56-days for concrete containing slag or fly ash as cementitious materials.
 - 2. When the average 28 day compressive strength of the cylinders in any set falls below the required compressive strength or below proportional minimum seven-day strengths (where proper relation between 7 and 28 day strengths have been established by tests), change proportions, cementitious content, or temperature conditions to achieve the required strengths at no additional cost to the Owner.
- C. Cooperate in the making of tests by allowing free access to the work for the selection of samples. Provide four firmly braced, insulated, heated, closed wooden curing boxes, each sized to hold ten specimens, complete with cold weather temperature and hot weather temperature control thermostat for initial curing and storage from time of fabrication until shipment to Owner's testing lab. Protect the specimens against injury or loss through construction operations. Furnish material and labor required for the purpose of taking concrete cylinder samples. All shipping of specimens will be paid for by the Owner.
- D. Slump tests will be made in the field by the Special Inspector (or Owner's testing laboratory inspector) immediately prior to placing the concrete. Such tests will be made in accordance with ASTM C143. When concrete is pumped, slump will be determined at point of truck discharge. If the slump is outside the specified range, the concrete will be rejected.
- E. Test for air content will be made by the Special Inspector (or Owner's testing laboratory inspector) on a fresh concrete sample. Air content for concrete made of ordinary aggregates having low absorption shall be made in compliance with either the pressure method complying with ASTM C231 or by the volumetric method complying with ASTM C 173. If aggregates with high absorptions are used, the latter test method shall be used. When concrete is pumped, air content will be determined at point of placement.

3.10 FIELD CONTROL

- A. The Engineer may have cores taken from any questionable area in the concrete work such as construction joints and other locations as required for determination of concrete quality. The results of tests on such cores shall be the basis for acceptance, rejection or determining the continuation of concrete work. The right of the Engineer to take such cores shall not be construed as creating any obligation to take such cores, and not exercising this right to do so shall not relieve the Contractor from meeting the requirements of these Specifications.
- B. Cooperate in obtaining cores by allowing free access to the work and permitting the use of ladders, scaffolding and such incidental equipment as may be required. Repair all core holes with non-shrink grout as specified in Section 03600. The work of cutting, testing and repairing the cores will be at the expense of the Contractor if defective work is uncovered. If no defective work is found, such cost will be at the expense of the Owner.

3.11 FAILURE TO MEET REQUIREMENTS

- A. Should the strengths shown by the test specimens made and tested in compliance with the previous provisions fall below the values given in Table 1, the Engineer may require changes in proportions or materials, or both, to apply to the remainder of the work in accordance with Paragraph 1. 5.E. Furthermore, the Engineer may require additional curing on those portions of the structure represented by the test specimens which fall below the values given in Table I. The cost of such additional curing shall be at no additional cost to the Owner. In the event that such additional curing does not give the strength required, as evidenced by core and/or load tests, the Engineer may require strengthening or replacement of those portions of the structure which fail to develop the required strength. Coring and testing and/or load tests and any strengthening or concrete replacement required because strengths of test specimens are below that specified, shall be at no additional cost to the Owner. In such cases of failure to meet strength requirements the Contractor and Owner shall confer to determine what adjustment, if any, can be made in compliance with Sections titled "Strength" and "Failure to Meet Strength Requirements" of ASTM C94. The "purchaser" referred to in C94 is the Contractor.
- B. When the tests on control specimens of concrete fall below the required strength, the Engineer will permit check tests for strengths to be made by means of typical cores drilled from the structure in compliance with ASTM C42 and C39. In cases where tests of cores fall below the values given in Table I, the Engineer, in addition to other recourses, may require load tests on anyone of the slabs, walls, beams, and columns in which such concrete was used. Test need not be made until concrete has aged 60 days. The Engineer may require strengthening or replacement of those portions of the structure which fail to develop the required strength. All coring and testing and/or load tests and any strengthening or concrete replacement required because strengths of test specimens are below that specified, shall be at no additional cost to the Owner.
- C. Should the strength of test cylinders fall below 60 percent of the required minimum 28 day strength, the concrete shall be rejected and shall be removed and replaced at no additional cost to the Owner.

3.12 PATCHING AND REPAIRS

- A. It is the intent of these Specifications to require quality work including forming, mixture and placement of concrete and curing so completed concrete surfaces will require no patching or repairs.
- B. As soon as the forms have been stripped and the concrete surfaces exposed: remove fins and other projections; fill recesses left by the removal of form ties; and repair surface defects

which do not impair structural strength. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete.

- C. Immediately after removal of forms remove tie cones and metal portions of ties as specified in Section 03100. Fill holes promptly upon stripping as follows: Moisten the hole with water, followed by a 1/16-in brush coat of neat cement slurry mixed to the consistency of a heavy paste. Immediately plug the hole with a 1 to 1.5 mixture of cement and concrete sand mixed slightly damp to the touch (just short of "balling"). Hammer the grout into the hole until dense, and an excess of paste appears on the surface in the form of a spider web. Trowel smooth with heavy pressure. Avoid burnishing.
- D. When filling tie cone holes and patching or repairing exposed surfaces use the same source of cement and sand as used in the parent concrete. Adjust color to match by addition of white cement. Rub lightly with a fine carborundum stone at an age of one to five days if necessary to bring the surface down with the parent concrete. Do not damage or stain the virgin skin of the surrounding parent concrete. Wash thoroughly to remove all rubbed matter.
- E. Defective concrete and honeycombed areas: Chip down square and at least 1-in deep to sound concrete with hand chisels or pneumatic chipping hammers. Irregular voids or surface stones need not be removed if they are sound, free of laitance, and firmly embedded in the parent concrete. If honeycomb exists around reinforcement, chip to provide a clear space at least wide all around the steel. For areas less than 1-II2-in deep, the patch may be made in the same manner as described above for filling form tie holes, care being exercised to use adequately dry (non-trowelable) mixtures and to avoid sagging. Thicker repairs will require build-up in successive 1-II2-in layers on successive days, each layer being applied (with slurry, etc.) as described above.
- F. For very heavy (generally formed) patches, the Engineer may order the addition of pea gravel to the mixture and the proportions modified as follows:

<u>Material</u>	<u>Volumes</u>	<u>Weights</u>
Cement	1.0	1.0
Sand	1.0	1.0
Pea Gravel	1.5	1.5

- G. The Contractor may use a pre-packaged patching compound, such as: Poly-Patch by Euclid Chemical Company; Emaco R31 0 by BASF Chemical Company; Sikatop J 22 Plus by Sika Chemical Corporation or equal only if approved by the Engineer for use and for color match.

3.13 SCHEDULE

- A. The following (Table 5) are the general applications for the various concrete classes and design strengths:

Class	Design Strength (psi)	Description
A	4,000	General concrete, building foundations, foundation walls, retaining walls, building walls and pilasters, lightweight concrete, ductbanks, and sidewalks/accessibility ramps. Not applicable to liquid-retaining structures.

Table -5

B	4,500	Liquid-retaining structure concrete
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END OF SECTION

EARTHWORK

Part 1 - General

1.1 SUMMARY

- A. This Section includes excavation and backfilling including the loosening, removing, refilling, transporting, storage and disposal of all materials classified as "earth" necessary to be removed for the construction and completion of all work under the Contract, and as shown on the Contract Drawings, specified or directed.
- B. Where certain features related to Earthwork are shown on the Contract Drawings, the Contractor shall be entirely responsible for final sequencing, scheduling, coordinating and planning the actual areas and their implementation in accordance with all laws and property ownership. These may include storage and staging areas, temporary stock pile areas, vehicle parking areas, temporary haul roads for construction ingress and egress, and other similar zones and land uses.

1.2 REFERENCES

- A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American Society for Testing and Materials (ASTM)
 - a. A328 – Specification for Steel Sheet Piling
 - b. D698 – Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³) (600 kN-m/m³)
 - c. D1556 –Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
 - d. D1557 –Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³) (2,700 kN-m/m³)
 - d. D1760 – Specification for Pressure Treatment of Timber Products
 - e. D2922 –Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

1.3 DEFINITIONS

- A. Excavation (including Trenching)
 - 1. Grubbing, stripping, removing, storing and re-handling of all materials of every name and nature necessary to be removed for all purposes incidental to the construction and completion of all the work under construction.
 - 2. All sheeting, sheet piling, bracing and shoring, and the placing, driving, cutting off and removing of the same.
 - 3. All diking, ditching, fluming, coffer-damming, pumping, bailing, draining, well pointing, or otherwise disposing of water.
 - 4. The removing and disposing of all surplus materials from the excavations in the manner specified.
 - 5. The maintenance, accommodation and protection of traffic and pedestrian travel and the temporary paving of highways, roads and driveways.
 - 6. The supporting and protecting of all tracks, rails, buildings, curbs, sidewalks, pavements, overhead wires, poles, trees, vines, shrubbery, pipes, sewers, conduits

or other structures or property in the vicinity of the work, whether over or underground or which appear within or adjacent to the excavations, and the restoration of the same in case of settlement or other injury.

7. All temporary bridging and fencing and the removing of same.

B. Earth

1. All materials such as sand, gravel, clay, loam, ashes, cinders, pavements, muck, roots or pieces of timber, soft or disintegrated rock, not requiring blasting, barring, or wedging from their original beds, and specifically excluding all ledge or bedrock and individual boulders or masonry larger than one-half cubic yard in volume.

C. Backfill

1. The refilling of excavation and trenches to the line of filling indicated on the Contract Drawings or as directed using materials suitable for refilling of excavations and trenches; and the compacting of all materials used in filling or refilling by rolling, ramming, watering, puddling, etc., as may be required.

D. Spoil

1. Surplus excavated materials not required or not suitable for backfills or embankments.

E. Embankments

1. Fills constructed above the original surface of the ground or such other elevation as specified or directed.

F. Limiting Subgrade

1. The underside of the pipe barrel for pipelines
2. The underside of footing lines for structures

G. Excavation Below Subgrade

1. Excavation below the limiting subgrades of structures or pipelines.
2. Where materials encountered at the limiting subgrades are not suitable for proper support of structures or pipelines, the Contractor shall excavate to such new lines and grades as required.

1.4 COORDINATION REQUIREMENTS

A. Coordinate layout and installation of all Contract work with earthwork activities and space requirements.

B. Submit specially prepared Coordination Drawings for this Project as required to provide for all required coordination, drawn to scale.

1.5 QUALITY ASSURANCE

A. Testing Services:

1. General: Testing of materials, testing for moisture content and compaction during placement and compaction of fill materials, and of compaction requirements for compliance with technical requirements of these Specifications shall be performed by a testing laboratory as specified in Section entitled "Special Provisions", Testing Laboratory Services Furnished by Contractor.
2. Contractor's Testing Agency Scope:
 - a. Test Contractor's proposed materials in the laboratory and field for compliance with these Specifications.
 - b. Perform field moisture content and density tests to verify that the specified compaction of backfill materials has been obtained.
3. Technicians representing the testing laboratory shall inspect the materials in the field and perform tests and shall report their findings to the Engineer and Contractor. When the materials furnished or the Work performed fails to fulfill Specification requirements, the technician will direct the attention of the Engineer and Contractor to such failure.
 - a. The technician shall not act as foreman or perform other duties for Contractor. Work will be checked as it progresses, but failure to detect any defective Work or materials shall not in any way prevent later rejection when such defect is discovered, nor shall it obligate the ENGINEER for final acceptance. Technicians are not authorized to revoke, alter, relax, enlarge, or release any requirements of the Contract Documents, nor to approve or accept any portion of the Work.
4. It shall be the responsibility of Contractor to accomplish the specified compaction for backfill, fill, and other earthwork. It shall be the responsibility of Contractor to control his operations by confirmation tests to verify and confirm that Contractor has complied, and is complying at all times, with the requirements of these Specifications concerning compaction, control, and testing.
5. The frequency of Contractor's confirmation tests shall be not less than as follows; each test location for trenches shall include tests for each layer, type, or class of backfill from bedding to finish grade:
 - a. Trenches for utilities and piping - One location every 250 linear feet
 - b. For Structural Backfill: On a 50-foot grid under the precast concrete storage tank and extending past the foundation a minimum of one interval on all sides every compacted lift, but no less than one per lift on each side of the structure for structures less than 60 feet long on a side.
 - c. In General Fill: One per 1,000 square feet on every compacted lift
6. If compaction fails to conform to the specified requirements, Contractor shall remove and replace the backfill at proper density or shall bring the density up to specified level by other means acceptable to the Engineer. Frequency of confirmation tests for remedial Work shall be double that amount specified for initial confirmation tests.

1.6 SUBMITTALS

- A. Excavation Plan: Prior to start of excavation operations, submit written plan to demonstrate compliance with OSHA Standard 29 CFR Part 1926.650. As a minimum, excavation plan shall include:
 1. Name of competent person, responsibly in charge.
 2. Excavation method(s) or protective system(s) to be used
 3. Copies of "manufacturer's data" or other tabulated data if protective system(s) are designed on the basis of such data.

- B. Contractor shall prepare shop drawings for the following items, as required:
1. Sheeting and bracing, or other protective system(s).
 2. Dewatering system, including Control of Water Management Plan
 3. Drawings shall be prepared by a Registered Professional Engineer recognized as expert in the specialty involved. Contractor shall be solely responsible for designing, installing, operating and maintaining whatever system is necessary to satisfactorily accomplish all necessary sheeting, bracing, protection, underpinning and dewatering.

1.7 JOB CONDITIONS

- A. Existing Reservoir: During the construction of the tanks inlet and outlet piping work located within the existing West bowl/basin *of the reservoir, the existing East bowl/basin, as indicated on the Drawings, shall remain in service. The water level will fluctuate based on the Owner's normal operation, and will be lowered to a maximum elevation of approximately 429.50'. Contractor's Excavation Support and Dewatering Systems shall accommodate the Owner's uninterrupted use of the East bowl/basin of the reservoir during construction.
- B. Subsurface Information: Refer to Special Conditions for available Data on subsurface conditions. Data is not intended as a representation or warranty of continuity of conditions between soil borings nor of groundwater levels at dates and times other than date and time when measured. Owner will not be responsible for interpretations or conclusions drawn there from by Contractor. Data is solely made available for the convenience of Contractor.
- C. Existing Structures: The Drawings show certain surface and underground structures adjacent to the Work. This information has been obtained from existing records. It is not guaranteed to be correct or complete and is shown for the convenience of Contractor. Contractor shall explore ahead of the required excavation to determine the exact location of all structures. They shall be supported and protected from damage by Contractor. If they are broken or damaged, they shall be restored immediately by Contractor at his expense.
- D. Existing Utilities: Locate existing underground utilities in the areas of the Work. If utilities are to remain in place, provide adequate means of protection during all operations.
1. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, consult piping or utility owner and Engineer immediately for directions as to procedure. Cooperate with Owner and utility owner in keeping services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
 2. Do not interrupt existing utilities serving facilities occupied and used by Owner or others, except when permitted in writing by Engineer and then only after acceptable temporary utility services have been provided.
- E. Protection of Persons and Property: Barricade open excavations occurring as part of the Work and post with warning lights. Operate warning lights during hours from dusk to dawn each day and as otherwise required. See Section entitled "Special Provisions", for additional requirements for Protection of Work and Property.

1. Protect structures, utilities, pavements, embankments, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations
 2. Protect all bench marks, monuments, and reference points. If the bench marks, monuments, or reference points are disturbed or destroyed, they shall be replaced to the satisfaction of the Engineer, at the Contractor's expense.
 3. Protect and barricade, where necessary, existing trees, shrubs, drainage swales, pavement, and other features outside the work limits from damage due to this construction
 4. Protect existing trees and other vegetation indicated to remain in place against unnecessary cutting, breaking, or skinning of roots, skinning and bruising of bark, smothering of trees by stockpiling of materials within drip line.
- F. Dust Control: Conduct all operations and maintain areas of activity, including watering of operations, sweeping and sprinkling of roadways, to minimize creation and dispersion of dust, as specified in the Section entitled "Special Provisions".

PART 2 - PRODUCTS

2.1 WOOD SHEETING AND BRACING

- A. Wood sheeting and bracing shall be sound and straight; free from cracks, shakes and large or loose knots; and shall have dressed edges where directed.
- B. It shall conform to National Design Specifications for Stress Grade Lumber having a minimum fiber stress of 1200 pounds per square inch.
- C. Sheeting and bracing to be left in place shall be pressure treated in accordance with ASTM D1760 for the type of lumber used and with a preservative approved by the Engineer.

2.2 STEEL SHEETING AND BRACING

- A. Steel sheeting and bracing shall be sound.
- B. It shall conform to ASTM A328 with a minimum thickness of 3/8 inch

2.3 GEOTEXTILE MATERIALS

- A. Geotextile for Silt Fence: Woven geotextile fabric, manufactured for silt fence complying with the following measurements per test methods referenced:
 1. Grab Tensile Strength: 247 lbf; ASTM D4632.
 2. Sewn Seam Strength: 222 lbf; ASTM D4632.
 3. Tear Strength: 90 lbf; ASTM D4533.
 4. Puncture Strength: 90 lbf; ASTM 4833.
 5. Apparent Opening Size: No. 60 sieve, maximum; ASTM 4751.
 6. Permittivity: 0.02 per second, minimum; ASTM D4491.
 7. UV Stability: 50 percent after 500 hours' exposure; ASTM D4355.

Product shall be Mirafi 100X, Mirafi Envirofence, or approved equal.

- B. Geotextile for Structural Subgrade Reinforcement: Shall be an integrally formed, biaxial geogrid manufactured from polypropylene, complying with the following measurements per test methods referenced:

1. Tensile Strength @ 2% Strain: 410 lb/ft (MD Value); ASTM D6637.
2. Tensile Strength @ 5% Strain: 810 lb/ft (MD Value); ASTM D6637.
3. Ultimate Tensile Strength: 1310 lb/ft (MD Value); ASTM D6637.
4. Aperture Dimensions: 1x1.3 in. (Nom).
5. Minimum Rib Thickness: 0.05 in. (Nom.)

Product shall be Tensar Earth Technologies, Inc., Biaxial Geogrid BX1200 or approved equal.

- C. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measure per test methods referenced:

1. Grab Tensile Strength: 157 lbf; ASTM D 4632.
2. Sewn Seam Strength: 142 lbf; ASTM D 4632.
3. Tear Strength: 56 lbf; ASTM D 4533.
4. Puncture Strength: 56 lbf; ASTM D 4833.
5. Apparent Opening Size: No. 70 sieve, maximum; ASTM D 4751.
6. Permittivity: 0.1 per second, minimum; ASTM D 4491.

Product shall be Mirafi 140N or approved equal.

- D. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following measured per test methods referenced:

1. Grab Tensile Strength; 247 lbf; ASTM D 4632.
2. Sewn Seam Strength; 222 lbf; ASTM D 4632.
3. Tear Strength: 90 lbf; ASTM D 4533.
4. Puncture Strength: 90 lbf; ASTM D 4833.
5. Apparent Opening Size: No.60 sieve, maximum; ASTM D 4751.
6. Permittivity: 0.02 per second, minimum; ASTM D 4491.
7. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

Product shall be Mirafi 500X or approved equal.

2.4 COMPACTION EQUIPMENT

- A. Vibratory Rollers: Vibratory rollers for compacting granular materials shall be equipped with a smooth steel compaction drum. Rollers shall impart a minimum compactive energy of 30 tons. Maximum loose lift thickness for vibratory compaction shall be limited to 12 inches.

- B. **Hand Operated Equipment:** Hand operated equipment shall be used for compacting material over pipes and against walls, in corners, and in trenches. Maximum loose lift thickness for hand operated compaction equipment shall be limited to 6 inches. Compaction within 5 ft of tank walls shall be completed using hand operated equipment.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Provide Engineer with sufficient notice and with means to examine the areas and conditions under which excavating, filling, and grading are to be performed. Engineer will notify Contractor, in writing, if conditions are found that may be detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3.2 SITE PREPARATION

- A. Clear all areas to be occupied by permanent construction or embankments of all trees, brush, roots, stumps, logs, wood, asphalt (to the extents indicated on the Drawings), and other materials and debris. Clean and strip subgrades for fills and embankments of vegetation, sod, topsoil and organic matter. All waste materials shall be removed from the Site and properly disposed of by Contractor. Burning will not be permitted
- B. The limits of clearing shall be as indicated on the Contract Drawings. The Contractor shall verify these limits with the Engineer in the field prior to the start of work.
- C. Trees and other miscellaneous features damaged or removed during the performance of the Work that are not designated for removal shall be replaced by the Contractor to the satisfaction of the Engineer at no cost to the Owner.

3.3 UNAUTHORIZED EXCAVATION

- A. Whenever excavations are carried beyond or below the lines and grades shown on the Contract Drawings, or as given or directed by the Engineer, all such excavated space shall be refilled with select fill, controlled low strength material, concrete or other materials as the Engineer may direct. All backfilling and compacting of unauthorized excavations shall be at the Contractor's expense.
- B. All material which slides, falls or caves into the established limits of excavations due to any cause whatsoever, shall be removed and disposed of at the Contractor's expense and no extra compensation will be paid to the Contractor for refilling of the void areas left by the slide, fall or cave-in, including any materials or select fill required.

3.4 CONTROL OF WATER

- A. **General**
 - 1. The Contractor shall at all times provide and maintain proper and satisfactory means and devices for the control and removal of all water (i.e. surface and ground) entering the excavations, or other parts of the Work and shall remove all

- such water as fast as it may collect, in such manner as shall not interfere with the prosecution of the work or the proper placing of pipes, structures, or other work.
2. Unless otherwise specified, all excavations which extend down to or below the static groundwater elevations shall be de-watered by lowering and maintaining the groundwater beneath such excavations at all times when work thereon is in progress, during subgrade preparation and the placing of the structure or pipe thereon.
 3. Water shall not be allowed to rise over or come in contact with any masonry, concrete or mortar, until at least 24 hours after placement, and no stream of water shall be allowed to flow over such work until such time as the Engineer may permit.
 4. Where the presence of fine grained subsurface materials and a high groundwater table may cause the upward flow of water into the excavation with a resulting quick or unstable condition, the Contractor shall install and operate a well point system to prevent the upward flow of water during construction.
 5. Water pumped or drained from excavations, or any sewers, drains or water courses encountered in the work, shall be disposed of in a suitable manner without injury to adjacent property, the work under construction, or to pavements, roads, drives, and water courses. No water shall be discharged to sanitary sewers. Sanitary sewage shall be pumped to sanitary sewers or shall be disposed of by an approved method.
 6. All dewatering activities shall be conducted in accordance with laws and permits. All such discharges shall be controlled and pre-treated as necessary.
 7. Any damage caused by or resulting from dewatering operations shall be the sole responsibility of the Contractor.

B. Work Included:

1. Preparation and submittal of a written "Control of Water Management Plan" to manage and control dewatering activities.
2. The construction and removal of cofferdams, sheeting and bracing, and the furnishing of materials and labor necessary thereof.
3. The excavation and maintenance of ditches and sluiceways.
4. The furnishing and operation of pumps, well points, and appliances needed to maintain control of water related to the work in a satisfactory manner.
5. The installation and removal of temporary sediment and discharge control devices.

C. Well Point Dewatering Systems

1. Installation
 - a. The well point system shall be designed and installed by or under the supervision of an organization whose principal business is well pointing and which has at least five consecutive years of similar experience and can furnish a representative list of satisfactory similar operations, including contact names and telephone numbers.
 - b. Well point headers, points and other pertinent equipment shall not be placed within the limits of the excavation in such a manner or location as to interfere with the laying of pipe or trenching operations or with the excavation and construction of other structures.
 - c. Detached observation wells of similar construction to the well points shall be installed at intervals of not less than 50 feet along the opposite side of the

excavation from the header pipe and line of well points, to a depth of at least 5 feet below the proposed excavation. In addition, one well point in every 50 feet shall be fitted with a tee, plug and valve so that the well point can be converted for use as an observation well. Observation wells shall be not less than 1 inches in diameter.

- d. Standby gasoline or diesel powered equipment shall be provided so that in the event of failure of the operating equipment, the standby equipment can be readily connected to the system. The standby equipment shall be maintained in good order and actuated regularly not less than twice a week.
2. Operation
 - a. Where well points are used, the groundwater shall be lowered and maintained continuously (day and night) at a level not less than 2 feet below the bottom of the excavation. Excavation will not be permitted at a level lower than 2 feet above the water level as indicated by the observation wells.
 - b. The effluent pumped from the well points shall be examined periodically by qualified personnel to determine if the system is operating satisfactorily without the removal of fines.
 - c. The water level shall not be permitted to rise until construction in the immediate area is completed and the excavation backfilled.

3.5 STORAGE OF MATERIALS

A. Sod

1. Any sod cut during excavation shall be removed and stored during construction so as to preserve the grass growth. Sod damaged while in storage shall be replaced in like kind at the sole expense of the Contractor.

B. Topsoil

1. Topsoil suitable for final grading shall be removed and stored separately from other excavated material.
2. Control erosion run-off from stockpiles by installing silt fencing. Maintain silt fence during construction and remove upon completion of work.

C. Excavated Materials

1. All excavated materials shall be stored in locations so as not to endanger the work, and so that easy access may be had at all times to all parts of the excavation. Stored materials shall be kept neatly piled and trimmed, so as to mitigate impact to public travel and to adjoining property owners.
2. Special precautions shall be taken to permit access at all times to fire hydrants, fire alarm boxes, police and fire department driveways, and other points where access may involve the safety and welfare of the general public.

3.6 DISPOSAL OF MATERIALS

A. Spoil Material

1. All spoil materials shall be disposed of as required by the local, state or federal regulations and as described in the Special Provisions and on the Contract Drawings.

2. The surface of all spoil areas shall be graded and dressed and no unsightly mounds or heaps shall be left on completion of the work. On site disposal areas, if permitted, shall be permanently restored with turf establishment or as otherwise specified.

3.7 SHEETING AND BRACING

A. Installation

1. The Contractor shall furnish, place and maintain such sheeting, bracing and shoring as may be required to support the sides and ends of excavations in such manner as to prevent any movement which could, in any way, injure the pipe, structures, or other work; diminish the width necessary for construction; otherwise damage or delay the Work; endanger existing structures, pipes or pavements; or cause the excavation limits to exceed the right-of-way limits.
2. Used material shall be in good condition, not damaged or excessively pitted. All steel or wood sheeting designated to remain in place shall be new. New or used sheeting may be used for temporary work.
3. In no case will bracing be permitted against pipes or structures in trenches or other excavations.
4. Sheeting shall be driven as the excavation progresses, and in such manner as to maintain pressure against the original ground at all times. The sheeting shall be driven vertically with the edges tight together, and all bracing shall be of such design and strength as to maintain the sheeting in its proper position. Seepage that carries fines through the sheeting shall be plugged to retain the fines.
5. Where breast boards are used between soldier pile, the boards shall be back packed with soil to maintain support. All timber used for breast boards (lagging) shall be new or used, meeting the requirements for Douglas Fir Dense Construction grade with a bending strength not less than 1500 psi or Southern Pine No. 2 Dense.
6. Safe and satisfactory sheeting, shoring and bracing shall be the entire responsibility of Contractor.
7. All municipal, County, State and Federal ordinances, codes, regulations and laws shall be observed.

B. Removal

1. In general, all sheeting and bracing, whether of steel, wood or other material, used to support the sides of trenches or other open excavations, shall be withdrawn as the trenches or other open excavations are being refilled. That portion of the sheeting extending below the top of a pipe or structural foundation shall not be withdrawn, unless otherwise directed, before more than 6 inches of earth is placed above the top of the pipe or structural foundation and before any bracing is removed. The voids left by the sheeting shall be carefully refilled with selected material and rammed tight with tools especially adapted for the purpose or otherwise as may be approved.
2. The Contractor shall not remove sheeting and bracing until the work has attained the necessary strength to permit placing of backfill.

C. Left in Place

1. If, to serve any purpose of his own, the Contractor files a written request for permission to leave sheeting or bracing in the trench or excavation, the Engineer

- may grant such permission, in writing, on condition that the cost of such sheeting and bracing be assumed and paid by the Contractor.
2. The Contractor shall leave in place all sheeting, shoring and bracing which are shown on the Contract Drawings or specified to be left in place or which the Engineer may order, in writing, to be left in place. All shoring, sheeting and bracing shown or ordered to be left in place will be paid for under the appropriate item of the Contract. No payment allowance will be made for wasted ends or for portions above the proposed cutoff level, which are driven down instead of cut-off.
 3. In case sheeting is left in place, it shall be cut off or driven down as directed so that no portion of the same shall remain within 12 inches of the street subgrade or finished ground surface.

3.8 TRENCH SHIELDS

- A. Excavation of earth material below the bottom of a shield shall not exceed the limits established by ordinances, codes, laws and regulations.
- B. When using a shield for pipe installation:
 1. Any portion of the shield that extends below the mid-diameter of an installed rigid pipe (e.g., PCCP) shall be raised above this point prior to moving the shield ahead for the installation of the next length of pipe.
 2. The bottom of the shield shall not extend below the mid-diameter of installed flexible pipe (e.g., Steel, DI, PVC, etc.) at any time.
- C. When using a shield for the installation of structures, the bottom of the shield shall not extend below the top of the bedding for the structures.
- D. When a shield is removed or moved ahead, extreme care shall be taken to prevent the movement of pipe or structures or the disturbance of the bedding for pipe or structures. Pipe or structures that are disturbed shall be removed and reinstalled as specified.

3.9 BACKFILLING

- A. General
 1. Contractor shall furnish, place and compact general fill, imported structural fill, crushed stone, leveling course, road subbase and other materials required for structures, embankments, pipelines, utilities and other items to be installed to provide the finished grades as shown and as described herein
 2. All excavations shall be backfilled to the original surface of the ground or to such other grades as may be shown, specified or directed.
 3. Backfill excavations as promptly as Work permits, but not until completion of the following
 - a. Inspection, testing, approval, and recording of locations of underground ductbanks and utilities
 - b. Removal of concrete formwork
 - c. Removal of shoring and bracing, and backfilling of voids with satisfactory materials
 - d. Removal of trash and debris
 - e. Permanent or temporary horizontal bracing is in place on horizontally supported walls.

4. Backfilling shall be done with suitable excavated materials that can be satisfactorily compacted during refilling of the excavation. In the event the excavated materials are not suitable, Select Fill materials as specified or ordered by the Engineer shall be used for backfilling.
5. Backfill and fill adjacent to structures and over imported structural fill shall be deposited in layers not to exceed 6-inches in un-compacted thickness and mechanically compacted with large vibratory plate compactors. Compaction of structures backfilled by rolling will be permitted provided the desired compaction is obtained and damage to the structure is prevented. Compaction of structural backfill and/or general backfill by inundation with water will not be permitted.
6. The material shall be placed at a moisture content and density as specified in the compaction density requirements, as specified in Sections entitled "Excavation and Fill" and "Structural Excavation and Fill". Contractor shall provide equipment capable of adding measured amounts of water to the backfill and/or select backfill material to bring it to a condition within the range of the required moisture content. CONTRACTOR shall provide equipment capable of discing, aerating, and mixing the soil to provide reasonable uniformity of moisture content throughout the fill material and to reduce the moisture content of the borrow material by air drying, if necessary. If the subgrade or lift of earth material must be moisture conditioned before compaction, the fill material shall be sufficiently mixed or worked on the subgrade to provide a uniform moisture content throughout the lift of material to be compacted. Materials at moisture content in excess of the specified limit shall be dried by aeration or stockpiled for drying.
7. Keep excavations dry during backfilling operations. No backfill or fill material shall be placed when free water is standing on the surface of the area where the fill is to be placed. No compaction of fill will be permitted with free water on any portion of the fill to be compacted. No fill shall be placed or compacted in a frozen condition or on top of frozen material. Any fill containing organic materials or other unacceptable material previously described shall be removed and replaced with approved fill material prior to compaction.
8. Any settlement occurring in the backfilled excavations shall be refilled and compacted.

B. Unsuitable Materials

1. Stones and pieces of rock greater than six inches in any single dimension shall not be used in any portion of the backfill.
2. All stones and pieces of rock shall be distributed through the backfill and alternated with earth backfill in such a manner that all interstices between them shall be filled with earth.
3. Stone and pieces of rock greater than 1.5-inches in any single dimension shall not be used in the initial backfill (centerline of pipe to 12-inches above the top of pipe).
4. Fill containing organic materials, ice, frost, or other unacceptable material/debris shall be removed and replaced with approved fill material as specified.

C. Compaction and Density Control

1. Compaction shall be performed with equipment suitable for the type of fill material being placed. The vibratory roller shall impart a minimum compactive force of 30 tons. A minimum of four complete systematic passes shall be made

- to compact each lift. Hand operated compacting equipment shall be used within a distance of ten feet from the wall of any completed below grade structure or as directed by Engineer. Equipment shall be provided that is capable of compacting in restricted areas next to structures and around piping.
2. Particular care shall be taken to compact structural fill, which will be beneath pipes, roads, or other surface construction or structures. In addition, wherever a trench passes through structure backfill, the structure backfill shall be placed and compacted to a minimum depth of 12-inches above the top of the pipe before the trench is excavated. Compacted areas, in each case, shall be adequate to support the item to be constructed or placed thereon.
 3. The compaction shall be as specified for the type of earthwork, i.e., structural, trenching.
 - a. The compaction specified shall be the percent of maximum dry density.
 - b. The compaction equipment shall be suitable for the material encountered.
 4. Where required, to assure adequate compaction, in-place density test shall at the expense of the Contractor be made by an approved testing laboratory.
 - a. The moisture-density relationship of the backfill material shall be determined by ASTM D698, Method D.
 - 1) Compaction curves for the full range of materials used shall be developed.
 - b. In-place density shall be determined by the methods of ASTM D1556 or ASTM D2922 and shall be expressed as a percentage of maximum dry density.
 5. Where required, to obtain the optimum moisture content, the Contractor shall add, at its expense, sufficient water during compaction to assure the specified maximum density of the backfill. If, due to rain or other causes, the material exceeds the optimum moisture content, it shall be allowed to dry, assisted if necessary, before resuming compaction or filling efforts.
 6. If the specified densities are not obtained because of improper control of placement or compaction procedures, or because of inadequate or improperly functioning compaction equipment, Contractor shall perform whatever Work is required to provide the required densities. This Work shall include complete removal of unacceptable fill areas, and replacement and re-compaction until acceptable fill is provided, at no additional cost to the Owner.
 7. The Contractor shall be responsible for all damage or injury done to pipes, structures, property or persons due to improper placing or compacting of backfill.

3.10 OTHER REQUIREMENTS

A. Drainage

1. All material deposited in roadway ditches or other water courses shall be removed immediately after backfilling is completed and the section, grades and contours of such ditches or water courses restored to their original condition, in order that surface drainage will be obstructed no longer than necessary.

B. Unfinished Work

1. When, for any reason, the work is to be left unfinished, all trenches and excavations shall be filled and all roadways, sidewalks and watercourses left unobstructed with their surfaces in a safe and satisfactory condition. The surface of all roadways and sidewalks shall have a temporary pavement.

- C. Hauling Material over Public Roads and Streets
 - 1. When it is necessary to haul material over public streets or pavements, the Contractor shall provide suitable, tight vehicles so as to prevent deposits on the streets or pavements. In all cases where any materials are dropped from the vehicles, the Contractor shall clean up the same as often as required to keep the crosswalks, streets and pavements clean and free from dirt, mud, stone and other hauled material.

- D. Dust Control
 - 1. It shall be the sole responsibility of the Contractor to control the dust created by any and all of his operations to such a degree that it will not endanger the safety and welfare of the general public, as specified in Section entitled "Special Provisions".
 - 2. Calcium chloride and petroleum products shall not be used for dust control.

- E. Test Pits
 - 1. For the purpose of obtaining detail locations of under-ground obstructions, the Contractor shall make excavations in advance of the work. Payment for the excavations ordered by the Engineer will be made under an appropriate item of the Contract and shall include sheeting, bracing, pumping, excavation and backfilling.

END OF SECTION

STRUCTURAL EXCAVATION & FILL

Part 1 - General

1.1 SUMMARY

- A. This Section includes excavation, backfill and compaction as required for the construction of structures in accordance with the applicable provisions of the Section entitled "Earthwork" unless modified herein, or as shown on the Contract Drawings.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 LIMITS OF EXCAVATION

- A. Excavations shall be made to the elevations or subgrades specified and shall be only of sufficient size to allow suitable room for the proper construction of structures and appurtenances, including allowances for sheeting, de-watering, and other similar work necessary for completion of the Contract.
- B. The elevation of the bottom of footings shown shall be considered as approximate only and Engineer may direct such changes in dimensions and elevations as may be required to secure a satisfactory footing. All structure excavations shall be hand-trimmed to permit the placing of full widths, and lengths of footings on horizontal beds. Rounded and undercut edges will not be permitted
- C. Subgrade materials are moisture and disturbance sensitive and every effort should be made to minimize the disturbance of the subgrades during excavations
- D. In no case will undercutting excavation faces be permitted
- E. Notify the Engineer when excavations have reached the required elevations. The Engineer will observe the excavations and bearing conditions. After review by the Engineer, the excavations may be required to proceed deeper or additional measures taken, due to disturbance of the subgrade, variation in subsurface conditions, or the presence of unsuitable soils at the design subgrade level. Replace the excavated material with compacted select fill materials, crushed stone, geotextile inclusions, lean concrete or other suitable material as directed by the Engineer. Excavation and replacement of materials, as described above, due to disturbance of the subgrade by Contractor activities shall be remediated by the Contractor at no additional cost to the Owner.

3.2 SUBSURFACE REINFORCEMENT

- A. Where an unstable subgrade is encountered and subject to the approval of the Engineer, select fill materials may be used for subgrade reinforcement if satisfactory results can be obtained thereby. Such material shall be as specified by Engineer and applied in thin layers, each layer being entirely embedded in the subsoil by thorough tamping.
- B. All excess material shall be removed to compensate for the displacement by the select fill material and the finished elevation shall not be above the specified subgrade.
- C. Where subgrade reinforcement is unsatisfactory, a concrete mud mat of sufficient thickness to withstand subsequent construction operations shall be installed below the specified elevation and the structural concrete deposited thereon.

3.3 REMOVAL OF WATER

- A. The Contractor shall at all times provide and maintain proper and satisfactory means and devices for the removal of all water entering the excavations, and shall remove all such water as fast as it may collect, in such manner as shall not interfere with the prosecution of the work or the proper placing of pipes, structures, or other work.
- B. Where the structure or pipeline is to be placed below the ground water table, well points, sumps/pumps, trench drains, or other acceptable methods shall be used to permit construction of said structure or pipeline under dry conditions. Dry conditions shall prevail until concrete has reached sufficient strength to withstand earth and hydrostatic loads and until the pipelines are properly jointed, tested and backfilled. In addition, protect excavation from flooding. Water level shall be maintained below top of backfill at all times
- C. Dewatering shall not be permitted within the zone of influence (ZOI) of structures.
- D. The removal of water shall be in accordance with the Section entitled "Earthwork".

3.4 BACKFILLING

- A. All structural backfill shall be placed in horizontal loose lifts, not exceeding 12-inches in thickness, and shall be mixed and spread in a manner to provide uniform lift thickness and to obtain the specified densities after placing. Each lift shall be compacted by not less than four complete passes/coverages of the specified compactor. Structural backfill shall be placed to the underside of all concrete slabs.
- B. Backfilling shall be with suitable excavated materials which can be compacted as specified. In the event the excavated materials are not suitable, special backfill as specified or ordered by the Engineer shall be used for backfilling.
- C. Backfilling around structures shall not be commenced before the structure has developed sufficient strength to withstand the loads applied. No backfill material shall be allowed to fall directly on a structure, until at least 12 inches of material has been hand-placed and compacted nor shall any material be pushed directly against a structure in backfilling.

3.5 COMPACTION

- A. Compaction shall be performed with equipment suitable for the type of fill material being placed. The vibratory roller shall impart a minimum compactive force of 30 tons. A minimum of four complete systematic passes shall be made to compact each lift. Hand operated compacting equipment shall be used within a distance of ten feet from the wall of any completed below grade structure or as directed by Engineer. Equipment shall be provided that is capable of compacting in restricted areas next to structures and around piping.
- B. Particular care shall be taken to compact structural fill, which will be beneath pipes, roads, or other surface construction or structures. In addition, wherever a trench passes through structure backfill, the structure backfill shall be placed and compacted to a minimum depth of 12-inches above the top of the pipe before the trench is excavated. Compacted areas, in each case, shall be adequate to support the item to be constructed or placed thereon
- C. Perform backfill around structures using the specified procedures, except that within ten feet of foundations and underground structures, light compaction equipment shall be used, with the gross weight of the equipment not exceeding 7,000 pounds. Provide equipment that is capable of the required compaction within restricted areas next to structures and around piping.
- D. The degree of compaction required for select fill materials shall be as listed below. Material shall be moistened or aerated as necessary to provide the moisture content that will facilitate obtaining the specified compaction
 - 1. Within zone of influence (ZOI) of perimeter footings and tank slabs minimum compaction required shall be 95% maximum density.
 - 2. Non-Load bearing areas adjacent to the tanks minimum compaction required shall be 92% maximum density.
 - 3. Paved areas minimum compaction required shall be 92% maximum density up to 3 feet below finished grade and 95% maximum density in the upper 3 feet.
 - 4. Landscaped areas minimum compaction required shall be 90% maximum density.
- E. The density shall be determined as set forth in the Section entitled "Earthwork".

END OF SECTION

Trenching and backfilling

Part 1 - General

1.1 SUMMARY

- A. This Section includes excavation and backfill as required for pipe installation or other construction in the excavation or trench, and removal and disposal of water, in accordance with the applicable provisions of the Section entitled "Earth Moving" unless modified herein, or as shown on the Contract Drawings.

1.2 SUBMITTALS

- 1. Not Used

PART 2 - PRODUCTS

- A. Not used

PART 3 - EXECUTION

3.1 EXCAVATION

- A. The trench excavation shall be located as shown on the Contract Drawings or as specified. Under ordinary conditions, excavation shall be by open cut from the ground surface. Where the depth of trench and soil conditions permit, tunneling may be required beneath cross walks, curbs, gutters, pavements, trees, driveways, railroad tracks and other surface structures. No additional compensation will be allowed for such tunneling over the price bid for open cut excavation of equivalent depths below the ground surface unless such tunnel excavation is specifically provided for in the Contract Documents.
- B. Trenches shall be excavated to maintain the depths as shown on the Contract Drawings or as specified for the type of pipe to be installed.
- C. The alignment and depth shall be determined and maintained by the use of a string line installed on batter boards above the trench, a double string line installed along side of the trench or a laser beam system.
- D. The minimum width of trench excavation shall be 6 inches on each side of the pipe hub for 21-inch diameter pipe and smaller and 12 inches on each side of the pipe hub for 24-inch diameter pipe and larger.
- E. Trenches shall not be opened for more than 300 feet in advance of pipe installation nor left unfilled for more than 100 feet in the rear of the installed pipe when work is in progress without the consent of the Owner's Designated Representative. Open trenches shall be protected and barricaded as required.
- F. Bridging across open trenches shall be constructed and maintained where required.

3.2 SUBGRADE PREPARATION FOR PIPE

- A. Where pipe is to be laid on undisturbed bottom of excavated trench, mechanical excavation shall not extend lower than the finished subgrade elevation at any point.

- B. Where pipe is to be laid on special granular material the excavation below subgrade shall be to the depth specified or directed. The excavation below subgrade shall be refilled with special granular material as specified or directed, shall be deposited in layers not to exceed 6 inches and shall be thoroughly compacted prior to the preparation of pipe subgrade.
- C. The subgrade shall be prepared by shaping with hand tools to the contour of the pipe barrel to allow for uniform and continuous bearing and support on solid undisturbed ground or embedment for the entire length of the pipe.
- D. Pipe subgrade preparation shall be performed immediately prior to installing the pipe in the trench. Where bell holes are required they shall be made after the subgrade preparation is complete and shall be only of sufficient length to prevent any part of the bell from becoming in contact with the trench bottom and allowing space for joint assembly.

3.3 STORAGE OF MATERIALS

- A. Traffic shall be maintained at all times in accordance with the applicable Highway Permits. Where no Highway Permit is required at least one-half of the street must be kept open for traffic.
- B. Where conditions do not permit storage of materials adjacent to the trench, the material excavated from a length as may be required, shall be removed by the Contractor, at his cost and expense, as soon as excavated. The material subsequently excavated shall be used to refill the trench where the pipe had been built, provided it be of suitable character. The excess material shall be removed to locations selected and obtained by the Contractor.
 - 1. The Contractor shall, at his cost and expense, bring back adequate amounts of satisfactory excavated materials as may be required to properly refill the trenches.
- C. If directed by the Owner's Designated Representative, the Contractor shall refill trenches with select fill or other suitable materials and excess excavated materials shall be disposed of as spoil.

3.4 REMOVAL OF WATER AND DRAINAGE

- A. The Contractor shall at all times provide and maintain proper and satisfactory means and devices for the removal of all water entering the trench, and shall remove all such water as fast as it may collect, in such manner as shall not interfere with the prosecution of the work.
- B. The removal of water shall be in accordance with the Section entitled "Earth Moving".

3.5 PIPE EMBEDMENT

- A. All pipes shall be protected from lateral displacement and possible damage resulting from superimposed backfill loads, impact or unbalanced loading during backfilling operations by being adequately embedded in suitable pipe embedment material. To ensure adequate lateral and vertical stability of the installed pipe during pipe jointing and embedment operations, a sufficient amount of the pipe embedment material to hold the pipe in rigid alignment shall be uniformly deposited and thoroughly compacted on each side, and back of the bell, of each pipe as laid.
- B. Concrete cradle and encasement of the class specified shall be installed where and as shown on the Contract Drawings or ordered by the Owner's Designated Representative. Before any concrete is placed, the pipe shall be securely blocked and braced to prevent movement or flotation. The concrete cradle or encasement shall extend the full width of the trench as excavated unless otherwise authorized by the Owner's Designated Representative. Where

concrete is to be placed in a sheeted trench it shall be poured directly against sheeting to be left in place or against a bond-breaker if the sheeting is to be removed.

- C. Embedment materials placed above the centerline of the pipe or above the concrete cradle to a depth of 12 inches above the top of the pipe barrel shall be deposited in such manner as to not damage the pipe. Compaction shall be as required for the type of embedment being installed.

3.6 BACKFILL ABOVE EMBEDMENT

- A. The remaining portion of the pipe trench above the embedment shall be refilled with suitable materials compacted as specified.
 - 1. Where trenches are within the ditch-to-ditch limits of any street or road or within a driveway or sidewalk, or shall be under a structure, the trench shall be refilled in horizontal layers not more than 8 inches in thickness, and compacted to obtain 95% maximum density, and determined as set forth in the Section entitled "Earth Moving".
 - 2. Where trenches are in open fields or unimproved areas outside of the ditch limits of roads, the trench shall be refilled in horizontal layers not more than 8 inches in thickness, and compacted to obtain 90% maximum density, and determined as set forth in the Section entitled "Earthwork".
 - 3. Hand tamping shall be required around buried utility lines or other subsurface features that could be damaged by mechanical compaction equipment.
 - 4. In place density compaction testing as set forth in the Section entitled "Earthwork" shall be completed as directed by the Owner's Designated Representative.
- B. Backfilling of trenches beneath, across or adjacent to drainage ditches and water courses shall be done in such a manner that water will not accumulate in unfilled or partially filled trenches and the backfill shall be protected from surface erosion by adequate means.
 - 1. Where trenches cross waterways, the backfill surface exposed on the bottom and slopes thereof shall be protected by means of stone or concrete rip-rap or pavement.
- C. All settlement of the backfill shall be refilled and compacted as it occurs.
- D. Surfaces shall be restored as specified in the Section entitled "Restoration of Surfaces".

END OF SECTION

EMBANKMENT

Part 1 - General

1.1 SUMMARY

- A. This Section includes construction of earth embankments constructed to established lines and grades at the locations as shown on the Contract Drawings and as directed by the Engineer.

1.2 REFERENCES

- A. Materials and installation shall comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American Society for Testing and Materials (ASTM)
 - a. D698 Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³) (600 kN-m/m³)
 - b. D1556 Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
 - c. D2922 Test Methods for Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth)

1.3 SUBMITTALS

- A. Submit the following in accordance with the General Conditions/General Requirements.
 - 1. Proposed testing laboratory
 - 2. Source of off-site materials
 - 3. Compaction curves for all materials to be used

1.4 TESTING

- A. All testing, including field and laboratory services, shall be at the Contractor's expense without additional compensation, except where separate payment is specified.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Embankment material shall be free from frost, stumps, trees, roots, sods, muck, marl, vegetable matter or other unsuitable material and shall be suitable for compaction as described in the following provisions. Where embankments are to be placed underwater only acceptable granular materials shall be used.
- B. Embankment materials shall be obtained from acceptable soils on the site, or approved off-site sources.

PART 3 - EXECUTION

3.1 PREPARATION OF SUBGRADE

- A. The entire surface to be covered with embankment shall be grubbed and stripped of all grass, vegetation, topsoil, rubbish, or other unsuitable materials before any embankment material is placed.
 - 1. Topsoil shall be stockpiled or placed as designated.
 - 2. Other grubbed and stripped materials shall be removed as spoil.
- B. Stripped or excavated surfaces on which embankments are to be placed shall be compacted to the required density of the embankment prior to any fill being placed.

3.2 PLACEMENT AND COMPACTION

- A. Materials shall be placed in lifts not greater than 8 inches of thickness unless a greater thickness is allowed by the Engineer upon demonstration by the Contractor that the materials and compaction efforts are adequate to obtain the required density.
- B. Material shall be placed in a uniform lift and thoroughly compacted by compaction equipment suitable for the material encountered to obtain the required density prior to the placement of succeeding lift.
 - 1. Each lift shall be tested for proper compaction before successive lifts are applied.
- C. Stones shall not exceed 6 inches in greatest dimension and shall be well distributed throughout the soil mass. Stone shall be defined as rock material either in its natural or broken state.
- D. Stones not well mixed with soil material shall not be used in earth embankments unless the stone material is sufficiently deteriorated or friable so as to be compactable to achieve minimum voids and required density.
- E. If the required density is not obtained, compaction of the embankment shall continue until specified densities are obtained, before any additional embankment is placed. Improperly compacted embankment shall be removed.
- F. Where required, the Contractor shall, at his expense, add sufficient water during the compaction effort to assure proper density. If, due to rain or other causes, the material exceeds the optimum moisture content for satisfactory compaction, it shall be allowed to dry, assisted by dicing or harrowing, if necessary, before compaction or filling effort is resumed.
- G. The Contractor shall be required to seal the working surface at the close of each day's operation and when practical prior to rainfall. Sealing shall be accomplished by rolling the surface with a smooth wheel steel roller.
- H. Compaction or consolidation achieved by traveling trucks, machines and other equipment will not be accepted unless such procedures are approved by the Engineer and proper compaction density is achieved.

- I. Hand tamping shall be required around buried utility lines or other subsurface features that could be damaged by mechanical compaction equipment.
- J. Embankments shall be constructed to such elevations as to make allowance for any settlement that may occur. Prior to the construction of any structure, roadway or other ground feature and before final acceptance of the contract, the Contractor shall regrade the embankments to conform to the established lines and grades.

3.3 DENSITY CONTROL

- A. Embankments shall be compacted to 90% of maximum dry density as determined by the density tests designated in ASTM D 698, Method D.
 - 1. Compaction curves for the full range of soil materials to be used in the embankment shall be developed by an approved independent testing laboratory.
- B. Field control samples shall be taken and tested by the testing laboratory as required to assure that adequate compaction of the embankment material is being achieved.
- C. A minimum of one (1) in-place density test shall be made for every (10,000) square feet of compacted area per lift.
 - 1. In-place density of soils shall be determined by the methods described in ASTM D1556 or ASTM D2922 and expressed as a percentage of the maximum dry density.

END OF SECTION

Restoration of surfaces

Part 1 - General

1.1 SUMMARY

- A. This Section includes restoration and maintenance of all types of surfaces, sidewalks, curbs, gutters, culverts and other features disturbed, damaged or destroyed during the performance of the work under or as a result of the operations of the Contract.
- B. The quality of materials and the performance of work used in the restoration shall produce a surface or feature equal to the condition of each before the work began.

1.2 REFERENCES

- A. Materials and installation shall comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American Society for Testing and Materials (ASTM)
 - a. D1557- Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³) (2,700 kN-m/m³)

1.3 SUBMITTALS

- A. Submit the following in with the General Provisions.
 - 1. A schedule of restoration operations. After an accepted schedule has been agreed upon it shall be adhered to unless otherwise revised with the approval of the Engineer.
 - 2. A Deviation Schedule if there is a proposed change from the original schedule.

PART 2 - PRODUCTS

- A. Not used

PART 3 - EXECUTION

3.1 GENERAL

- A. In general, permanent restoration of paved surfaces will not be permitted until one month has elapsed after excavations have been completely backfilled as specified. A greater length of time may be granted before permanent restoration of surfaces is undertaken if additional time is required for shrinkage and settlement of the backfill.
- B. The replacement of surfaces at any time, as scheduled or as directed, shall not relieve the Contractor of responsibility to repair damages by settlement or other failures.

3.2 TEMPORARY PAVEMENT

- A. Immediately upon completion of refilling of the trench or excavation, the Contractor shall place a temporary pavement over all disturbed areas of streets, driveways, sidewalks, and other traveled places where the original surface has been disturbed as a result of

construction operations.

- B. Unless otherwise specified or directed the temporary pavement shall consist of compacted run-of-crusher limestone to such a depth as required to withstand the traffic to which it will be subjected.
- C. Where concrete pavements are removed, the temporary pavement shall be surfaced with asphalt "cold patch". The surface of the temporary pavement shall conform to the slope and grade of the area being restored.
- D. Control of dust shall be the Contractor's responsibility. All surfaces shall be treated as frequently as may be required in the opinion of the Owner's Representative.
- E. Temporary pavement shall be maintained by the Contractor in a safe and satisfactory condition until such time as the permanent pavement is completed. The Contractor shall immediately remove and restore all pavement that is deemed unsatisfactory to the Owner's Representative.

3.3 PERMANENT PAVEMENT REPLACEMENT

- A. The permanent and final repaving of all streets, driveways and surfaces where pavement has been removed, disturbed, settled or damaged by or as a result of performance of the Contract shall be repaired and replaced by the Contractor, with a new and similar pavement.
 - 1. The top surface shall conform with the grade of existing adjacent pavement and the entire replacement shall meet the current specifications of the local government for each type of pavement.
 - 2. Where the local government has no specification for the type of pavement, the work shall be done in conformity with the State Department of Transportation.
 - 3. Transportation Standard which conforms to the closest type of surface requiring replacement, as determined by the Owner's Representative.

3.4 PREPARATION FOR PERMANENT PAVEMENT

- A. When scheduled and within the time specified, the temporary pavement shall be removed and a base prepared, at the depth required by the local government or Highway Permit, to receive the permanent pavement.
 - 1. The base shall be brought to the required grade and cross-section and thoroughly compacted before placing the permanent pavement.
 - 2. Any base material that has become unstable for any reason shall be removed and replaced with compacted base materials.
- B. Prior to placing the permanent pavement, all service boxes, manhole frames, manhole covers, and similar structures within the area shall be adjusted to the established grade and cross-section.
- C. The edges of existing asphalt pavement shall be sawcut to a minimum of 1 foot beyond the excavation or disturbed base, whichever is greater.
 - 1. All cuts shall be parallel or perpendicular to the centerline of the street, unless otherwise shown or directed.

3.5 ASPHALT PAVEMENT

- A. The permanent asphalt pavement replacement shall be replaced with bituminous materials of the same depth and kind as the existing materials unless otherwise specified.
- B. Prior to placing of any bituminous pavement a tack coat sealer shall be applied to the edges of the existing pavement and other features.
- C. The furnishing, handling, and compaction of all bituminous materials shall be in accordance with the State Department of Transportation Standards.

3.6 CONCRETE PAVEMENT AND PAVEMENT BASE

- A. Concrete pavements and concrete bases for asphalt, brick or other pavement surfaces shall be replaced with 4,000 psi concrete, air-entrained.
- B. Paving slabs or concrete bases shall be constructed to extend 1 foot beyond each side of the trench and be supported on undisturbed soil. Where such extension of the pavement will leave less than 2 feet of original pavement slab or base, the repair of the pavement slab or base shall be extended to replace the slab to the original edge of the pavement or base unless otherwise indicated on the Contract Drawings.
- C. Where the edge of the pavement slab or concrete base slab falls within the excavation, the excavation shall be backfilled with Special Backfill compacted to 95% maximum dry density as determined by ASTM D 698 up to the base of the concrete.
- D. The new concrete shall be of the same thickness as the slab being replaced and shall contain reinforcement equal to the old pavement.
 - 1. New concrete shall be placed and cured in accordance with the applicable provisions of the State Department of Transportation Standards.

3.7 STONE OR GRAVEL PAVEMENT

- A. All pavement and other areas surfaced with stone or gravel shall be replaced with material to match the existing surface unless otherwise specified.
 - 1. The depth of the stone or gravel shall be at least equal to the existing.
 - 2. After compaction the surface shall conform to the slope and grade of the area being replaced.

3.8 CONCRETE WALKS, CURBS AND GUTTER REPLACEMENT

- A. Concrete walks, curbs, and gutters removed or damaged in connection with or as a result of the construction operations shall be replaced with new construction.
 - 1. The minimum replacement will be a flag or block of sidewalk.
- B. Walks shall be constructed of 4,000 psi concrete, air-entrained with NYSDOT #1 stone aggregate on a 4-inch base of compacted gravel or stone.
 - 1. The walk shall be no less than 4 inches in thickness. Otherwise, the thickness of the replaced walk where greater than 4 inches shall have construction joints spaced no more than 25 feet apart, shall have expansion joints spaced no more than 50 feet apart, and shall be sloped at right angles to the longitudinal centerline at approximately an inch per foot of width.
- C. One-half (1/2) inch expansion joint material shall be placed around all objects within the sidewalk area as well as objects to which the new concrete will abut, such as valve boxes,

manhole frames, curbs, buildings and others.

- D. Walks shall be hand-floated and broom-finished, edged and grooved at construction joints and at intermediate intervals matching those intervals of the walk being replaced.
 - 1. The intermediate grooves shall be scored a minimum of 1/4 of the depth of the walk.
 - 2. The lengths of blocks formed by the grooving tool, and distances between construction and expansion joints shall be uniform throughout the length of the walk in any one location.
- E. The minimum length of curb or gutter to be left in place or replaced shall be 5 feet. Where a full section is not being replaced, the existing curb or gutter shall be sawcut to provide a true edge.
 - 1. The restored curb or gutter shall be the same shape, thickness and finish as being replaced and shall be built of the same concrete and have construction and expansion joints as stated above for sidewalks.

3.9 LAWNS AND IMPROVED AREAS

- A. The area to receive topsoil shall be graded to a depth of not less than 4 inches or as specified below the proposed finished surface.
 - 1. If the depth of existing topsoil prior to construction was greater than 4 inches, topsoil shall be replaced to that depth.
- B. The furnishing and placing of topsoil, seed and mulch shall be in accordance with the Technical Specification 32 93 13 entitled "Topsoil and Seeding".
- C. When required to obtain germination, the seeded areas shall be watered in such a manner as to prevent washing out of the seed.
- D. Any washout or damage that occurs shall be regraded and reseeded until a good sod is established.
- E. The Contractor shall maintain the newly seeded areas, including regrading, reseeding, watering, and mowing in accordance with Technical Specification 32 93 13 entitled "Topsoil and Seeding".

3.10 CULTIVATED AREA REPLACEMENT

- A. Areas of cultivated lands shall be graded to a depth to receive topsoil of not less than the depth of the topsoil before being disturbed. All debris and inorganic material shall be removed prior to the placing of the topsoil.
- B. The furnishing and placing of topsoil shall be in accordance with Technical Specification 32 93 13 entitled "Topsoil and Seeding".
- C. After the topsoil has been placed and graded, the entire area disturbed during construction shall be cultivated to a minimum depth of 12 inches with typical farm equipment.
 - 1. Any debris or inorganic materials appearing shall be removed.
 - 2. The removal of stones shall be governed by the adjacent undisturbed cultivated area.
- D. Grass areas shall be re-seeded using a mixture equal to that of the area before being disturbed, unless otherwise specified.

3.11 OTHER TYPES OF RESTORATION

- A. Trees, shrubs and landscape items damaged or destroyed as a result of the construction operations shall be replaced in like species and size.
 - 1. All planting and care thereof shall meet the standards of the American Nursery and Landscaper Association.
- B. Swales and other water courses shall be reshaped to the original grade and cross-section and all debris removed. Where required to prevent erosion, the bottom and sides of the water course shall be protected.
- C. Storm sewers and culverts damaged or removed as a result of the construction operations shall be replaced with like size and material and shall be replaced at the original location and grade. When there is minor damage to a pipe, and with the consent of the Owner's Representative, a repair may be undertaken if satisfactory results can be obtained.
- D. Should brick pavements be encountered in the work, the restoration shall be as set forth in the Special Provisions, or as directed.

END OF SECTION

Topsoil and seeding

Part 1 - General

1.1 SUMMARY

- A. This Section includes topsoil, fertilizer, seed, mulch anchorage, and associated work.
- B. Seeding shall be as scheduled below.

1.2 REFERENCES

- A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. “Standard Specifications, Construction and Materials, New York Department of Transportation, Office of Engineering” (NYS DOT Specification).

1.3 SUBMITTALS

- A. Submit the following in accordance with the General Provisions.
 - 1. The location of source and data for off-site topsoil.
 - 2. Analysis of the seed.
 - 3. Certification that each container complies with the provisions of New York State Agriculture and Markets’ Law.
 - 4. Hydroseeder data including material and application rates, if applicable.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Topsoil

- 1. Topsoil shall be unfrozen, friable clayey loam free from clay lumps, stones, roots, sticks, stumps, brush or foreign objects.
- 2. All topsoil incorporated into the completed contract, whether originating on-site or off-site, shall be screened.
- 3. All stones and rocks larger than 1/4-inch diameter shall be removed from topsoil prior to placement.

B. Fertilizer

- 1. Fertilizer shall be a standard quality commercial carrier of available plant food elements. A complete prepared and packaged material containing a minimum of 10 percent nitrogen, 10 percent phosphoric acid and 10 percent potash.
- 2. Each bag of fertilizer shall bear the manufacturer's guaranteed statement of analysis.

C. Seed Mixtures

- 1. Seed mixtures shall be of commercial stock of the current season's crop and shall be delivered in unopened containers bearing the guaranteed analysis of the mix.
- 2. All seed shall meet the State standards of germination and purity.

Table 1-1 Seed Mixtures		
Specie	Lawn Area	Un-manitained* Areas
Kentucky Bluegrass	50	20
Creeping Red Fescue	30	20
Manhattan Pennfine Ryegrass	20	60
*% by weight		

D. Mulch shall be stalks of oats, wheat, rye or other approved crops which are free from noxious weeds.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The area to receive topsoil shall be graded to a depth of not less than 4 inches or as specified, below the proposed finished surface. If the depth of topsoil existing prior to construction was greater than 4 inches, the topsoil shall be replaced not less than the greater depth.
 - 1. All debris and inorganic material shall be removed and the surface loosened for a depth of 2 inches prior to the placing of the topsoil.
 - 2. The topsoil shall not be placed until the subgrade is in suitable condition and shall be free of excessive moisture and frost.
- B. Satisfactory topsoil removed from the excavations shall be placed on the prepared subgrade to the depth required.
 - 1. In the event the topsoil removed during excavation is unsatisfactory or inadequate to obtain the required finish grades, the Contractor shall furnish the required quantity of satisfactory topsoil from approved sources off site.
 - 2. All topsoil shall be screened and be free from stones, roots, sticks and other foreign substances and shall not be placed in a frozen or muddy condition.
 - 3. The finished surface shall conform to the lines and grades of the area before disturbed or as shown on the Contract Drawings. Any irregularities shall be corrected before the placement of fertilizer and seed.
- C. The fertilizer shall be applied uniformly at the rate of 20 pounds per 1000 square feet.
 - 1. Following the application of the fertilizer and prior to application of the seed, the topsoil shall be scarified to a depth of at least 2 inches with a disc or other suitable method traveling across the slope if possible.
- D. When the topsoil surface has been fine graded, the seed mixture shall be uniformly applied

upon the prepared surface with a mechanical spreader at a rate of not less than 10 pounds per 1000 square feet.

1. The seed shall be raked lightly into the surface and rolled with a light hand lawn roller.
 2. Seeding and mulching shall not be done during windy weather.
- E. The mulch shall be hand or machine spread to form a continuous blanket over the seed bed, approximately 2 inches uniform thickness at loose measurement. Excessive amounts or bunching of mulch will not be permitted.
1. Mulch shall be anchored by an acceptable method.
 2. Unless otherwise specified, mulch shall be left in place and allowed to decay.
 3. Any anchorage or mulch that has not decayed at time of first mowing, shall be removed. Anchors may be removed or driven flush with ground surface.
- F. Seeded areas shall be watered as often as required to obtain germination and to obtain and maintain a satisfactory sod growth. Watering shall be in such a manner as to prevent washing out of seed.
- G. Hydroseeding may be accepted as an alternative method of applying fertilizer, seed and mulch. The Contractor shall submit all data regarding materials and application rates to the Engineer for review.

3.2 MAINTENANCE

- A. All lawn areas shall be mowed by the Contractor before the new grass reaches a height of 4 inches.
1. Infrastructure (Sewer and Water Line) Projects
 2. Following the establishment of a good stand of grass and the first mowing, the Contractor's obligation shall end except for the repair of settlement or damage.
 3. Site Development, Plants and Similar Projects
 4. The Contractor shall maintain the newly seeded areas in good condition until acceptance, including regular mowing to a height of 2 inches.

END OF SECTION

LEAKAGE TESTS

Part 1 - General

1.1 SUMMARY

- A. This Section includes leakage tests of all hydraulic structures, pressure and non-pressure piping for leakage as shown on the Contract Drawings.
- B. The Contractor shall provide all labor, material, tools, equipment, and incidentals as shown, specified, and required to clean, flush, disinfect, and test piping as required.
- C. The Work also includes all labor and materials required to prepare structure and piping for testing and disinfecting, conveying water to testing location, performing testing, and all labor and materials required to drain and dispose of water used for testing and disinfecting.
- D. All testing shall be witnessed by the Engineer.

1.2 REFERENCES

- A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American Society for Testing and Materials (ASTM)

1.3 SUBMITTALS

- A. Testing shall not commence without acceptance of procedure by Engineer.
- B. Test and Evaluation Reports: Reports of test results.

Part 2 - products

1.4 WATER FOR TESTING

- A. Permission shall be obtained from the owner of the water system before the use of water from any existing system. The Contractor shall:
 - 1. Conform to the requirements of the Village.
 - 2. Give notice at least 24 hours before the use of water for any reason.

Part 3 - execution

1.5 LEAKAGE TESTS FOR HYDRAULIC STRUCTURES

- A. Tanks, vaults, wells and other fluid containing structures, (excluding manholes and unless otherwise noted, structures used in storm sewer systems) shall be tested before backfilling by filling the structure with water to overflowing, or other level as may be directed by the Engineer, and observing the water surface level twenty-four hours thereafter.

1. When testing absorbent materials such as concrete, the structure shall be filled with water at least 24 hours before the test is started.
- B. The exterior surface, especially at the construction joint, will be inspected for leakage during and upon completion of the 24-hour test.
 1. Leakage will be considered to be within the allowable limits when there is no visible sign of leakage on the exterior surface and where the water surface does not drop except as associated with evaporation.
 2. A slight dampness on the exterior wall surface during the test period will not be considered as leakage, except in the case of prestressed concrete structures.

1.6 TESTS ON PRESSURE PIPING FOR TRANSPORT OF WATER OR SEWAGE

A. General

1. Pipelines designed to transport water or sewage under pressure shall be tested hydrostatically and for leakage prior to being placed in service.
2. The length of piping and sections included in the tests shall meet the approval of the Engineer.
3. Equipment in or attached to the pipes being tested shall be protected. Any damage to such equipment during the test shall be repaired by the Contractor at his expense.
4. When piping is to be insulated or concealed in a structure, tests shall be made before the pipe is covered.
5. All fittings, hydrants and appurtenances must be properly braced and harnessed before the pressure is applied. Thrust restraining devices which will become a part of the system must also be tested at the test pressure.
6. When testing absorbent pipe materials such as concrete, the pipeline shall be filled with water at least 24 hours before the test is made.
7. If the line fails the test, the Contractor shall explore for the cause of the excessive leakage and after repairs have been made the line shall be retested. This procedure shall be repeated until the pipe complies.

B. Pressure Test

1. Test pressure shall be as scheduled or, where no pressure is scheduled, shall be 150 psi.
2. Test pressure shall be held on the piping for a period of at least 2 hours, unless a longer period is requested by the Engineer.

C. Leakage Test

1. The leakage test shall be conducted concurrently with the pressure test.
2. The rate of leakage shall be determined at 15-minute intervals by means of volumetric measurement of the makeup water added to maintain the test pressure. The test shall proceed until the rate of leakage has stabilized or is decreasing below an allowable value, for three consecutive 15-minute intervals. After this, the test pressure shall be maintained for at least another 15 minutes.
 - a. At the completion of the test the pressure shall be released at the furthest point from the point of application.
3. All exposed piping shall be examined during the test and all leaks, defective material or joints shall be repaired or replaced before repeating the tests.

4. The allowable leakage for pressure pipelines shall not exceed the following in gallons per 24 hours per inch of diameter per mile of pipe:

Type of Pipe	Leakage
Ductile iron	10
Polyvinyl chloride, thermal plastic or fiberglass with rubber joints	10
Polyvinyl chloride, thermal plastic or fiberglass with solvent-cemented joints	0
High Density Polyethylene, with butt fused joints	0
Prestressed Concrete with steel and rubber joints	10
Steel with welded joints	0
Steel with harnessed or push-on joints	10
Wrought Steel	0
Copper	0

All piping inside structures	0
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5. Regardless of the above allowable leakage, any visible leaks shall be permanently corrected by the Contractor.

1.7 TEST FOR NON-PRESSURE PIPELINES FOR TRANSPORT OF WATER OR SEWAGE

A. General

1. Pipelines designed to carry water or sewage in open channel flow or at minimal pressures shall be tested for leakage prior to being placed in service.
2. The leakage shall be determined by exfiltration, infiltration or low pressure air.
 - a. The testing method directed by the Engineer shall take into consideration the groundwater elevation of the section of pipe being tested.
 - b. The maximum non-pressure pipeline to be tested for leakage shall be the section between manholes or 600 feet as directed by the Engineer.
3. Intermediate leakage tests during construction shall be made at the Contractor's discretion. Upon completion of any pipeline, the entire system including manholes shall be tested for compliance to allowable leakage.
4. When testing absorbent pipe materials such as concrete, the pipeline shall be filled with water at least 24 hours before the test is made.
5. Groundwater level shall be determined by the Contractor prior to any testing by reading the water level at the observation pipe in the manholes.
6. If the line fails the test, the Contractor shall explore for the cause of the excessive leakage and after repairs have been made the line shall be retested. This procedure shall be repeated until the pipe complies.

B. Exfiltration Testing

1. Exfiltration tests shall be made by filling a section of pipeline with water and measuring the quantity of leakage.
2. The head of water at the beginning of the test shall be at least 2 feet above the highest pipe within the section being tested.
 - a. Should groundwater be present within the section being tested, the head of water for the test shall be 2 feet above the hydraulic gradient of the groundwater.
 - b. Should the requirement of 2 feet of water above the highest pipe subject any joint at the lower end of the test section to a differential head of greater than 11.5 feet another method of testing shall be employed.

C. Infiltration Testing

1. Infiltration tests will be allowed only when the water table gauges determine the groundwater level to be 2 feet or more above the highest pipe of the section being tested.
2. Infiltration test shall be made by measuring the quantity of water leaking into a section of pipeline.
3. Measurement of the infiltration shall be by means of a calibrated weir constructed at the outlet of the section being tested.

D. Allowable Leakage for Non-Pressure Pipelines

- The allowable leakage (exfiltration or infiltration) for non- pressure pipelines shall not exceed the following in gallons per 24 hours per inch of diameter per 1000 feet of pipe:

Type of Pipe	Leakage
Ductile iron - mechanical or push-on joints	10
Polyvinyl chloride, thermal plastic or fiberglass with rubber joints	10
Polyvinyl chloride, thermal plastic or fiberglass with solvent-cemented joints	0
Concrete with rubber joints	10
Concrete with steel and rubber joints	10
Corrugated Steel	95
Cast iron soil pipe	
1. drains and vents	0

2. sewer laterals	
All piping inside structures	0

2. Regardless of the above allowable leakage any spurting leaks detected shall be permanently stopped.

END OF SECTION

PIPELINE INSTALLATION

Part 1 - General

1.1 SUMMARY

- A. This Section includes all metallic and non-metallic pipelines as shown on the Contract Drawings, complete with fittings and specials.
- B. Certain features of pipes shall be as scheduled.

1.2 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards, and specifications, except where more stringent requirements have been specified herein:
 - 1. American Society of Testing and Materials (ASTM)
 - 2. American Water Works Association (AWWA)

1.3 SUBMITTALS

- A. In addition to those submittals identified in the General Provisions, the following items shall be submitted:
 - 1. Manufacturer's certification that all materials furnished is in compliance with the applicable requirements of the referenced standards and this specification.
 - 2. Layout drawings are required for pipelines to be installed within structures, showing the location including the support system, sleeves and appurtenances.

PART 2 PRODUCTS

2.1 MATERIALS AND CONSTRUCTION

- A. Pipe
 - 1. Materials for the piping, joints and fittings shall be as specified in the Section for the type of pipe to be installed, shown in the pipe schedule or on the Contract Drawings.
 - a. Pipe and appurtenances shall comply with the applicable standards for its type of material.

B. Joints

1. Type of joints shall be as scheduled in the pipe schedule or as shown or noted on the Contract Drawings.

C. Inspection

1. Pipe and appurtenances shall be inspected by the Contractor in the presence of the Engineer on delivery and prior to installation for conformance with the standards and specifications.
 - a. Materials not conforming to the standards and specifications shall not be stored on site but removed at once and replaced with material conforming to the specifications.

PART 3 EXECUTION

3.1 INSTALLATION - UNDERGROUND

A. General

1. Install pipelines, fittings, specials, and accessories in accordance with the configuration shown on the Contract Drawings.
2. Excavation and backfilling shall be in accordance with the applicable provisions of the Section entitled "Excavation and Fill".
3. Blocking will not be permitted under pipe, except where the pipe is to be laid with concrete cradle or encasement.
4. No pipe shall be laid upon a foundation in which frost exists; nor at any time when there is danger of the formation of ice or the penetration of frost at the bottom of the excavation.
5. Temporary bulkheads shall be placed in all open ends of pipe whenever pipe laying is not actively in process. The bulkheads shall be designed to prevent the entrance of dirt, debris or water.
6. Precautions shall be taken to prevent the flotation of the pipe in the event of water entering the trench.

B. Location and Grade

1. Pipelines and appurtenances shall be located as shown on the Contract Drawings or as directed and as established from the control survey in accordance with the Special Provisions.

2. The alignment and grades shall be determined and maintained by a method acceptable to the Engineer.

C. Subgrade

1. The subgrade for pipelines shall be earth or special embedment as specified or directed and shall be prepared in accordance with the Section entitled "Excavation and Fill".

D. Joints

1. Joints shall be assembled using gaskets, lubricants and solvents as furnished by the pipe manufacturer and in accordance with the manufacturer's recommendations.

E. Embedment

1. Embedment shall be deposited and compacted in accordance with the Section entitled "Excavation and Fill", and the Section for the type of pipe being installed and shall be one of the embedments shown below unless otherwise specified or directed.

2. Type "A" Embedment

Pipe of: Cast Iron Soil
 Copper
 Corrugated Steel
 Ductile Iron
 Reinforced Concrete
 Prestressed Concrete
 Vitrified Clay
 Wrought Steel

- a. The embedment shall be native material excavated from the trench, which is acceptable to the Engineer, containing no stones larger than 1-1/2 inches in size or debris.
- b. Embedment material shall be deposited and tamped in 6-inch layers to the centerline of the pipe.

- c. Native material placed above the centerline of the pipe to a depth of 12 inches above the pipe shall be deposited in such manner as to not damage the pipe.
- d. When specified or directed, Select Fill material shall be used in lieu of the native material for a or c above.

3. Type "B" Embedment

Pressure pipe of: Fiberglass

 Polyvinyl Chloride

 Steel

 Thermal Plastic, including high density polyethylene

- a. The embedment shall consist of compacted Type F granular material placed from a depth of 4 inches below the pipe to the centerline of the pipe.
 - 1) Embedment material shall be deposited and hand-compacted in 6-inch maximum layers.
- b. From the centerline to the top of the pipe the embedment shall be native material excavated from the trench, which is acceptable to the Engineer, containing no stones larger than 1-1/2 inches in size and shall be lightly compacted.
- c. From the top of the pipe to one foot above the pipe, acceptable native material shall be deposited in such manner as to not damage the pipe.
- d. When the native material under b or c above is not acceptable, to the Engineer, Select Fill materials shall be used.

4. Type "C" Embedment

Non-pressure pipe of: Fiberglass

 Polyvinyl chloride

 Thermal plastic, including smooth interior corrugated polyethylene

- a. The embedment shall consist of compacted Type F granular materials placed from a depth of 4 inches below the pipe to a depth of 12 inches over the pipe.
 - 1) Embedment material shall be deposited and hand-compacted in 6-inch maximum layers.

F. Thrust Restraints

1. Pressure pipelines shall have thrust restraints in the form of thrust blocks, tie rods, or anchors of the size and type specified or as required by the pressure and stability of the supporting surface.
 - a. Thrust restraints shall be installed at all changes in direction, changes in size, dead ends or other locations where shown.
 - b. Thrust restraints shall be in place, and when of concrete (Class C) shall have developed the required strength, prior to testing of the pipeline.
 - c. Tie rods and nuts for thrust restraints shall be of high tensile steel and shall have minimum yield strength of 70,000 psi.
 - 1) Tie rods and nuts installed underground shall be coated with two coats of coal tar pitch preservative coating after installation.

G. Service Connections

1. Connections to in-service pressure pipelines shall be in accordance with the applicable provisions of the Section entitled "Water Service Connections".
2. Connections to sewers shall be saddle, wye or tee branches as specified.
 - a. Saddle and wye branches shall be installed, in general, so that the top of the branch is at the top of the pipe.
 - b. Each saddle, wye and tee branch shall have a concrete cradle as shown on the Contract Drawings.
3. Laterals of the kind and size of pipe as specified shall be installed as shown, specified or directed.
 - a. Bends, as required, shall be used between the connection and the lateral, to obtain the correct slope and to allow the horizontal angle of the lateral to be at 90 degrees to the main line or other angle as specified or directed.

- b. Minimum slope for a lateral shall be 1/4 inch per foot.
 - c. Maximum slope for a lateral shall be 2 feet per foot unless otherwise specified.
 - d. Each lateral having a slope of 1 foot per foot or greater shall have a concrete cradle as shown on the Contract Drawings or as a minimum Class C concrete shall be placed 6" each side of and from a depth of 3 inches below to the centerline of the lateral pipe.
 - e. Laterals specified to exceed the maximum slope shall be supported to prevent excessive load being applied to the main line pipe and shall be encased in a minimum of 6 inches of Class C concrete.
 - f. The end of each connection or lateral shall be sealed by means of a removable watertight plug as shown on the Contract Drawings.
 - g. The end of each connection or lateral shall have a 2-inch by 4-inch marker extending vertically from the stopper to 3 feet above the ground surface. The portion of the 2-inch by 4-inch marker extending above the ground shall be painted green.
4. Connections and ends of laterals shall not be backfilled until a record has been made of the "as-built" location of each.

H. Connection to Existing Structures or Manholes

- 1. Where a stub has been provided the connection shall be made to the existing pipe.
- 2. Where no stub has been provided, the Contractor shall make an opening for inserting the connecting pipe.
 - a. When specified, a sleeve shall be installed and a watertight joint formed.
 - 1) The carrier pipe shall be installed in the sleeve and the joint made watertight.
 - b. Where no sleeve is specified, the space between the pipe and the wall of the structure or manhole shall be made watertight.
 - c. A joint shall be in the pipe at or within 5 feet of a structure or manhole.
 - d. A channel shall be built or the existing channel revised, to direct the flow from or into the new pipe.

- e. Care shall be taken to avoid damage to the existing structure or manhole and to prevent debris from entering any existing channel. Any damage shall be repaired and debris removed.

3.2 INSTALLATION - EXPOSED

- A. Exposed pipelines shall be carefully erected and neatly arranged.
 - 1. Pipelines shall run parallel to the nearest wall of structures.
- B. Supports and anchors shall be adequate to support the pipe filled with water with a minimum safety factor of 5 and for the test pressure specified.
- C. Special supports shall be as specified in the Section for the type of pipe being installed.

3.3 FIELD TESTING AND CHLORINATION

- A. Perform leakage tests in accordance with the applicable provisions of the Section entitled "Leakage Tests", at the test pressure specified or scheduled.
- B. Disinfect pipelines and appurtenances designed to convey potable water in accordance with the Section entitled "Disinfecting of Water Utility Distribution".

3.4 CUTTING AND SPECIAL HANDLING

- A. Field cuts of pipes shall be in accordance with the manufacturer's instructions.
- B. Where a pipe requires special handling or installation it shall be in accordance with the Section for that type of pipe.

3.5 FINAL INSPECTION OF SEWERS

- A. Each section of pipe between manholes shall be inspected prior to final acceptance.
 - 1. In larger pipelines the inspection shall be by traversing the inside of the pipe.
 - 2. In smaller pipelines the inspection shall be by observation with illumination.
 - 3. Where specified, the inspection shall be by closed circuit television.
 - a. Shall be monitored by both the Engineer and the Contractor.
- B. The inspection shall determine the pipeline to be true to line and grade, to show no leaks, to have no obstruction to flow, to have no projections or protruding of connecting pipes or joint materials, shall be free from cracks and shall contain no deposits of sand, dirt or other materials.

- C. All deficiencies located during the inspection shall be corrected.

END OF SECTION

Water service connections

Part 1 - General

1.1 SUMMARY

- A. This Section includes tapping and installing of corporation stops and valves on existing or newly installed pipes without interruption of service complete with connections and accessories, as shown on the Contract Drawings.
- B. Installing of curb stops and boxes where specified or directed.
- C. Certain features of Water Service Connections shall be as scheduled on the Contract Drawings.

1.2 REFERENCES

- A. Materials and installation shall comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American Water Works Association (AWWA)

1.3 SUBMITTALS

- A. Submit the following in accordance with the General Conditions/General Requirements.
- B. Product Data: "Catalog cuts" and specification sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.
- C. Shop Drawings: Detail drawings for each size corporation stop, curb stop, tapping sleeve and valve, and service box

PART 2 - PRODUCTS

2.1 CORPORATION STOPS

- A. Corporation stops shall be threaded to conform to AWWA C800 with standard corporation stop thread at the inlet. The outlet shall be fitted with coupling nut for flared tube service unless otherwise specified.
 - 1. Corporation stops shall be manufactured by:
 - a. Ford
 - b. Hays
 - c. Mueller
 - d. Or equal

2.2 CURB STOPS

- A. Curb stops shall be threaded to conform to AWWA C 800 with coupling nuts for flared tube service.
 - 1. ¾-inch shall be of the inverted new type.
 - 2. 1 inch to 2 inch shall be of the plug-type with "O" ring seals to withstand a minimum

working pressure of 175 psi.

3. Curb stops shall be manufactured by:
 - a. Mueller
 - b. Hays
 - c. Ford
 - d. Or equal

2.3 SERVICE CLAMPS

- A. Service clamps shall be designed for use on the type of pipe to which the connection is being made.
 1. Ductile iron and asbestos-cement service clamps shall be the double strap type with neoprene gaskets.
 2. Polyvinyl chloride pipe service clamps shall be of a full circle design with a minimum width of 2 inches.
 3. Service clamps shall be manufactured by:
 - a. Dresser
 - b. Mueller
 - c. Clow
 - d. Or equal

2.4 SERVICE BOXES

- A. Service boxes shall be constructed of cast iron and sized for the curb stop upon which it is being installed.
 1. Stationary shut-off rod shall be provided unless otherwise specified.
 2. Boxes shall be telescopic with a minimum of 1-foot adjustment.
 3. Service boxes shall be manufactured by:
 - a. Hays
 - b. Mueller
 - c. Clow
 - d. Or equal

2.5 TAPPING SLEEVES AND VALVES

- A. Tapping sleeves and valves shall be used for connections larger than 2 inches.
 1. Tapping sleeves shall be designed and sized in accordance with the recommendations of the manufacturer.
 2. Working pressure shall be 150 psi unless higher pressures are scheduled.
 3. The seal of the tapping sleeve shall be mechanical joint or low lead 2.5% or less. Low lead as conforming to current regulations.
 4. Valves for tapping sleeves shall be designed for the in-tended service and shall conform to the requirements of the Section entitled "Gate Valves Three Inches and Larger".

5. Tapping sleeves and valves shall be manufactured by:
 - a. Clow
 - b. Kennedy
 - c. U.S. Pipe
 - d. Or equal

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with manufacturer’s installation recommendations and requirements.

3.2 INSTALLATION

- A. Install connections and accessories under the direction of personnel who have performed at least ten similar connections as shown on the Contract Drawings, in accordance with the manufacturer’s installation instructions and the applicable provisions of the referenced Standards.
- B. Threaded taps shall be made using a machine designed for cutting, threading and inserting the corporation without interruption of service.
- C. Teflon tape may be used on corporation threads.
- D. Tapping sleeve connections shall be made using a machine to cut and remove the segment through the valve without interruption of service.
- E. Service boxes shall be set plumb and shall be independently supported on two bricks so no weight will be transmitted to the curb stop or carrier pipe.
- F. Maximum Size for Taps

Pipe Material	Pipe Size (inches)				
	4	6	8	12	16 & Larger
Ductile Iron					
w/ Service Clamp	2	2	2	2	2
w/o Service Clamp	-	3/4	1	1-1/2	2
Asbestos-Cement Polyvinyl Chloride					
w/ Service Clamp or pre-threaded collar	3/4	1-1/2	2	2	2
w/o Service Clamp	-	3/4	3/4	3/4	3/4
Steel	Pipe wall thickness governs size of tap using appropriate threadolet or reinforcing.				

3.3 FIELD QUALITY CONTROL

- A. Perform tests in accordance with the following standards:
 1. Perform hydrostatic and leakage tests in accordance with the applicable provisions of the Section entitled “Leakage Tests”, at the test pressure specified or scheduled.

END OF SECTION

DISINFECTING OF WATER UTILITY DISTRIBUTION

Part 1 - General

1.1 SUMMARY

- A. This Section includes cleaning, chlorinating and flushing of all pipelines or structures which shall carry or hold potable water, as shown on the Contract Drawings, including all chemicals required.
- B. All disinfection of piping and structures shall be coordinated and conducted in conjunction with the required hydrostatic testing, as specified in Section entitled "Leakage Tests". Chlorination shall be scheduled such that sampling and flushing will be performed during normal daylight working hours.
- C. All work under this section shall be performed in the presence of the Engineer and a representative of the public health authority having jurisdiction, as required.

1.2 REFERENCES

- A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American Water Works Association (AWWA)

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Backflow preventers shall be tested by certified backflow prevention technician and certified by the authority having jurisdiction within one year or less of date of backflow preventer's use on the Project
 - 2. Comply with requirements and recommendations of authorities having jurisdiction over the Work, including:
 - 3. Oswego County Department of Health
 - 4. Village of Pulaski

1.4 SUBMITTALS

- A. Action Submittals: Provide the following:
 - 1. Product Data:
 - a. Data sheets on chemicals used for disinfection and dechlorination.
 - b. Proof of NSF/ANSI 60 compliance for chemicals used in disinfection and dechlorination
 - c. Results of bacteriological tests.
 - 2. Procedure Submittals (including proposed plans for water conveyance, control, and disposal):
 - a. Cleaning procedures.
 - b. Hydrostatic testing procedures and equipment required, by structure to be tested.

- c. Disinfection procedures and equipment required, by structure to be tested.
- d. Contractor shall obtain water testing meeting Oswego County DOH requirements for submission to the Oswego office.

1.5 WATER FOR TESTING

- A. Permission shall be obtained from the owner of the water system before the use of water from any existing system. The Contractor shall:
 - 1. Conform to the requirements of the Owner.
 - 2. Cost for use shall be as specified in the Section entitled "Special Provisions.
 - 3. Give notice at least 24 hours before the use of water for any reason.

PART 2 - PRODUCTS

2.1 MATERIALS AND CONSTRUCTION

- A. Chlorination shall be by the use of a solution of water and liquid chlorine, sodium hypochlorite and the solution shall be contained in the pipe or structure as specified
- B. Chemicals used for disinfection and dechlorination shall conform to NSF/ANSI 60.

PART 3 - EXECUTION

3.1 CLEANING

- A. Piping:
 - 1. Thoroughly clean all piping, including flushing with water, dry air, or inert gas as required, in manner approved by Engineer, prior to placing in service. Flush chlorine solution and sodium hypochlorite piping with water
 - 2. Piping 24-inch diameter and larger shall be inspected from inside and debris, dirt and foreign matter removed
 - 3. For piping that requires disinfection and has not been kept clean during storage or installation, swab each section individually before installation with five percent sodium hypochlorite solution.
- B. Structures:
 - 1. Prior to testing, remove all scaffolding, planks, tools, rags, dirt, debris, and material not part of the structure
 - 2. Thoroughly clean walls, floors, and operating equipment by sweeping, high-pressure wash, scrubbing, or other methods that will not injure the Work and existing facilities.
 - 3. Remove from the hydraulic structure all water, dirt, and foreign material accumulated during cleaning. Provide temporary pumps, piping, and facilities as required to discharge water from the cleaning operation in manner acceptable to Engineer and in conformance with Laws and Regulations

4. Do not proceed with disinfection or testing until Engineer has accepted in the field results of cleaning

3.2 DISINFECTION / CHLORINATION

A. Piping:

1. Suggested procedure for accomplishing complete and satisfactory disinfection is specified below. Other procedures may be considered for acceptance by Engineer.
 - a. Prior to disinfection, clean piping as specified and flush thoroughly.
 - b. Conform to procedures described in ANSI/AWWA C651, Section 4.7. Use continuous feed and slug method of disinfecting, unless alternative method is approved by Engineer.
2. The chlorine solution shall be admitted to pipelines through corporation stops placed in the horizontal axis of the pipe, to structures by means of tubing extending directly into the structure or other approved methods.
3. Chlorine concentration in water entering the piping shall be between 50 and 100 mg/L, such that minimum residual concentration of 25 mg/L remains after 24-hour retention period. Disinfect piping and all related components. Repeat as necessary to provide complete disinfection.
4. The chlorine treated water shall be retained in the pipe or structure at least 24 hours, unless otherwise directed. During the retention period all valves and hydrants within the treated sections shall be operated.

B. Structures:

1. Hydraulic structures to be disinfected shall be chlorinated by Contractor in accordance with Method 2 in AWWA C652, unless otherwise specified herein.
2. Provide temporary taps, plugs, valves, drains, pumps, tanks, piping, facilities, and connections required to disinfect, dechlorinate, and remove chlorinated water as required.
3. Disinfect hydraulic structures immediately before and in coordination with each structure hydrostatic test, as specified in Section entitled "Leakage Tests".
4. Use solution of water and liquid chlorine, calcium hypochlorite, or sodium hypochlorite. Placement of chlorine powder or tablets inside hydraulic structure as means of disinfection is not allowed.
5. Introduce chlorine solution into hydraulic structure in manner such that the full tank's chlorine residual does not exceed 0.5 mg/L.
6. Upon completion of disinfection of each hydraulic structure, if necessary, shall be dechlorinated until the chlorine residual equals the residual in local potable water system. If residual of local potable water system is not available, dechlorinate to maximum chlorine residual of 0.5 mg/L. Dechlorination shall be in accordance with AWWA C653.

- C. When making repairs to or when specified, structures and portions of pipelines shall be chlorinated by a concentrated chlorine solution containing not less than 200 mg/L) of free chlorine. The solution shall be applied with a brush or sprayed on the entire inner surface of the empty pipes or structures. The surfaces disinfected shall remain in contact with the strong chlorine solution for at least 30 minutes.

3.3 FLUSHING

A. Piping:

1. After the required retention of chlorinated water in the pipe shall be thoroughly flushed until the replacement water shall, upon test, both chemically and bacteriologically, be proven equal to the water quality served to the public from the existing water supply system
2. After final flushing and before the new main is connected to the distribution system, two consecutive sets of acceptable samples, taken at least 24 hours apart, shall be collected from the new main. At least one set of samples shall be collected from every 1,200 ft (366 m) of the new water main, plus one set from the end of the line and at least one set from each branch. Certification forms must include the bacteriological results, the dates of sampling, and detailed information on sampling location.
3. The disposal of chlorinated water from any pipe or structure shall be such it will not cause damage to any vegetation, fish, or animal life. Dilution, dechlorination and/or holding tanks shall be provided by the Contractor to accomplish disposal of chlorinated water.

B. Structures:

1. After the required retention of chlorinated water in the structure, if greater than pipe shall be thoroughly flushed until the replacement water shall, upon test, both chemically and bacteriologically, be proven equal to the water quality served to the public from the existing water supply system
2. After final flushing, if required, and before the new structure is connected to the distribution system, samples for bacteriological testing shall be obtained from each disinfected water structure, as follows:
 - a. Immediately After Completion of Disinfection: Minimum of two samples.
 - b. Twenty-four Hours after Obtaining First Set of Samples: Minimum of two samples.
3. The disposal of chlorinated water from any pipe or structure shall contain no more than 0.5 mg/L residual chlorine (unless a lower limit is shown, specified, or required). This residual chlorine limit is established to prevent damage to vegetation, fish, or animal life.

3.4 FIELD QUALITY CONTROL

- A. The Contractor shall make all arrangements for the testing of the water quality. In areas where the testing of water quality is not performed by the public health authority, the Contractor shall have the required test made by an approved independent laboratory. The results of all tests shall be forwarded to the Engineer and the public health authority having jurisdiction.
- B. The Contractor shall provide the labor and tools as may be required by the Engineer or the public health authority in the sampling for testing of water quality.

- C. All water quality requirements shall be fulfilled prior to the passage of any water through the new system to a public supply or the use of the new system.

END OF SECTION

SANITARY UTILITY SEWERAGE MANHOLES, FRAMES & COVERS

Part 1 - General

1.1 SUMMARY

- A. This Section includes precast manholes of the type scheduled with construction as shown on the Standard Details for Manholes. All manholes shall consist of the combination of base and barrel sections resulting in the fewest number of joints.

1.2 REFERENCES

1. American Society for Testing and Materials (ASTM International)
2. American Association of State Highway Transportation Officials (AASHTO)
3. Occupational Safety and Health Administration (OSHA)
4. State of NY Department of Transportation

1.3 SUBMITTALS

- A. Submit the following in accordance with the General Conditions/General Requirements.
 1. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.
 2. Shop Drawings including dimensional criteria of each structure.

1.4 QUALITY ASSURANCE

- A. Qualifications
 1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Coordinate delivery of all material to allow movement into designated space.
- B. Handle all material components according to manufacturers written instructions. Use factory-installed lifting provisions.

1.6 WARRANTY

- A. Provide parts and labor warranty in accordance with the General Conditions.

1.7 MANUFACTURERS

- A. The following manufacturers are named to establish a standard of quality necessary for the Project:
 1. Neenah Foundry
 2. EJ Castings

3. Or equal

1.8 GENERAL

- A. All manholes, frames and covers shall be supplied as a complete package from the manufacturer, who shall be responsible for proper operation of the coordinated system.
- B. All components of like size and type shall be the product of the same manufacturer for purposes of parts interchangeability.

1.9 MATERIALS AND CONSTRUCTION

A. Manhole Sections

- 1. Precast concrete sections and slabs shall be constructed and reinforced in accordance with ASTM C478, with a minimum wall thickness of 5 inches and with joints having an "O" ring or square Buna N section ring seal.
 - a. Manhole sections shall be waterproofed with bituminous material on the exterior.
- 2. Base sections shall have reinforced flat bottoms protruding 6 inches beyond the outside face of the riser section. The flat bottoms shall be:
 - a. Minimum of 6-inch thickness for risers up to and including 48-inch diameter
 - b. Minimum of 8-inch thickness for risers of larger diameter
- 3. Each opening in the base section for sewers up to and including 20-inch diameter shall contain a flexible rubber connection installed by the manufacturer of the base section.
 - a. Flexible rubber connectors shall be:
 - 1) KOR-N-SEAL
 - 2) Lock Joint Flexible Manhole Sleeve
 - 3) Or equal
- 4. Top sections, tapered or flat, shall be adequate to withstand H-25 wheel loads. All top sections shall have con-centric or eccentric opening as specified or shown for the type of manhole. The edge of eccentric openings for flat top sections shall be a maximum of 2 inches from the inside wall of the barrel section.

B. Manhole Steps

- 1. Steps for manholes shall be manufactured of cast iron in accordance with ASTM A48, Class 30 or others acceptable to the Engineer.
- 2. Steps shall be installed in each manhole in vertical alignment spaced 12 inches on center and shall be placed over the largest benchwall of the manhole.
- 3. Steps shall have a minimum tread width of 14 inches and shall be cast into the manhole sections or other methods of installation with prior acceptance of the Engineer.

C. Frames and Covers

- 1. Manhole frames and covers shall be in accordance with ASTM A48, Class 30, and as listed by the the local Municipality and RIRRC :
- 2. Covers shall be provided with a minimum of two watertight pick holes and shall be solid unless otherwise noted. Frames and covers shall be adequate to bear H-25 wheel loads and shall be provided with machined bearing surfaces. Lettering shall be either "Sanitary Sewer" or "Storm Sewer", depending on the use, or other appropriate designation cast

as directed.

3. When required for bolting the frame to the manhole, holes shall be provided in the frames. Contractor shall submit to Engineer a cover and frame that meets this requirement.

D. Mortar and Bricks

1. Masonry cement for mortar shall meet the requirements of ASTM C91, Type II and shall be mixed with a graded quality sand conforming to ASTM C144. Mix shall be one part masonry cement to three parts sand using the minimum amount of clean water required for workability.
2. Brick shall meet the requirements of ASTM C62, Grade SW, and shall be of a hard-burned manufacture.

1.10 DROP MANHOLES - SPECIAL CONSTRUCTION

A. Type D or H manholes shall be constructed in accordance with the Standard Detail as follows:

1. The polyvinyl chloride (PVC) pipe and fittings shall meet the requirements of ASTM D3034. Joints shall be solvent welded except for those installed vertically. The drop section, tee and nipple shall be of the same diameter as the influent sewer up to the maximum of 12 inches in diameter. For influent sewers over 12 inches in diameter, a 12-inch branch tee, nipple and drop section shall be used.
2. The PVC nipple and the influent sewer shall be joined with a flexible coupling which shall be Band Seal Rubber Adapter, or equal. Tee shall be fitted with a removable plug consisting of two conical aluminum discs, a rubber compression gasket and a permanently extended operating handle. The plug shall provide a watertight seal as the gasket is forced against the pipe wall by drawing the aluminum discs together with the operating handle. The operating handle shall be coated to protect against corrosion.
3. The opening in the manhole barrel for the drop inlet does not require a flexible pipe connector. A watertight seal shall be made between the manhole wall and PVC inlet pipe using a universal compression type annular space sealer constructed of hard rubber links, joined together by bolts of corrosion resistant plated carbon steel or other type seal acceptable to the Engineer. The rubber link material shall remain flexible and be resistant to water and chemical action.

1.11 ACCESSORIES

1.12 SOURCE QUALITY CONTROL

A. Factory Quality Certification

1. Submit copy of factory quality assurance certificate.

PART 2 - EXECUTION

2.1 INSTALLATION

- A. Install structures as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.
- B. Precast manhole bases shall be installed level on a flat stable subgrade. Where an unstable

condition exists, the Contractor shall excavate the unstable material and replace with compacted granular material.

- C. All joints of the manhole shall be filled inside and out with mortar to provide a smooth and continuous surface.
- D. Manhole inverts shall be lined with a half section of pipe of the same type and size as the pipe used for the sewer or shall be constructed of Class C concrete, shaped and troweled to produce a smooth circular cross-section. Manholes having sewer intersections of less than 90 degrees shall have the alignment of a Type "A" benchwall as shown on Standard Detail SD-10. Benchwalls shall have a slope of ½" on 12 inch and the mortar surface shall be given a broom finish.
- E. Mortar beds for brick or manhole frames shall be a maximum thickness of 1- inch.
- F. Manhole frames for Type E and I manholes shall set on a bed of mortar and be bolted to the flat slab top with 4-inch bolts evenly spaced around the frame using concrete expansion anchors. For other types of manholes, the Contractor shall furnish and install up to a maximum of four brick courses as required to adjust the frames to grade. The brick courses shall be plastered with 1/2-inch minimum of cement mortar inside and out.
- G. In drop manholes Type D or H, the space sealer between the manhole wall and PVC inlet pipe shall be assembled with the heads of the bolts on the inside of the manhole.
- H. Markers
 - 1. Unless otherwise specified, two 2 inch by 4-inch markers shall be placed adjacent to each completed manhole except those installed in roadways. The markers shall be buried in the ground a minimum of 6 feet and shall extend above the top of the manhole a minimum of 2 feet.
 - 2. The portion of the marker extending above the ground shall be painted green.

2.2 FIELD QUALITY CONTROL

- A. Perform tests in accordance with the following standards:
 - 1. Perform leakage tests in accordance with the applicable provisions of the Section entitled "Leakage Tests".

END OF SECTION