

DIVISION 31

EARTHWORK

SECTION 31-2316

EXCAVATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Excavating for building volume below grade, footings, slabs on grade and site structures.
- B. Excavating for paving and future paving areas.
- C. Trenching for utilities outside the building as shown.

1.02 RELATED SECTIONS

- A. Section 31-2319 - Control of Water.
- B. Section 31-2200 - Grading.
- C. Section 31-2323 - Fill and Backfill.
- D. Section 31-4100 - Shoring and Bracing.

1.03 PROJECT CONDITIONS

- A. Verify that survey bench mark and intended elevations for the Work are as indicated.

PART 2 – PRODUCTS - NOT USED

PART 3 - EXECUTION

3.01 PREPARATION

- A. Identify required lines, levels, contours, and datum locations.
- B. See Section 312200 for additional requirements.

3.02 EXCAVATING

- A. Excavate to accommodate new structures and construction operations.
- B. Notify Architect of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
- C. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.
- D. Do not interfere with 45 degree bearing splay of foundations.
- E. Cut utility trenches wide enough to allow inspection of installed utilities.
- F. Hand trim excavations. Remove loose matter.

- G. Correct areas that are over-excavated and load-bearing surfaces that are disturbed; see Section 31-2323.
- H. Grade top perimeter of excavation to prevent surface water from draining into excavation.
- I. Remove excavated material that is unsuitable for re-use from site.
- J. Stockpile excavated material to be re-used in area designated on site in accordance with Section 31-2200.

3.03 FIELD QUALITY CONTROL

- A. See Section 01-4000 - Quality Requirements, for general requirements for field inspection and testing.
- B. Provide for visual inspection of load-bearing excavated surfaces before placement of foundations.

3.04 PROTECTION

- A. Prevent displacement of banks and keep loose soil from falling into excavation; maintain soil stability.
- B. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.

END OF SECTION

SECTION 31-2319
CONTROL OF WATER

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Controlling surface water runoff, dewatering pipeline trenches and structural excavations and other elements required for control of water if work conditions should dictate the need.

1.02 RELATED SECTIONS

- A. Section 31-4100 - Shoring and Bracing.
- B. Section 31-2323 - Fill and Backfill.

1.03 SUBMITTAL

- A. Prior to commencing any excavation, the Contractor shall submit a statement of the method, installation and details of proposed dewatering system to Architect. The statement shall also include disposal.

PART 2 - PRODUCTS

- 2.01 Materials and equipment required for control of water shall be furnished and maintained as required to perform the construction.

PART 3 - EXECUTION

3.01 GENERAL

- A. The necessary machinery, appliances and equipment shall be provided and operated to keep excavations free from water during construction, and to dispose of the water so as not to cause injury to public or private property or to cause a nuisance or a menace to the public. Sufficient pumping equipment and machinery in good working condition shall be provided for all emergencies including power outage, and sufficient workmen shall be available at all times for the operation of the pumping equipment.
- B. The dewatering system shall not be shut down between shifts, on holidays or weekends or during work stoppages without written permission from the Engineer.

3.02 CONTROL OF WATER

- A. Control of groundwater such that softening of the bottom of excavations, or formation of "quick" conditions or "boils" during excavation, shall be prevented. Dewatering systems shall be designed and operated so as to prevent removal of the natural soils. Natural or compacted soils softened by saturation with groundwater or standing surface water shall be removed and replaced as instructed by the Architect at no additional expense to the Owner.

- B. During construction of structures, installation of pipelines, placing of structure and trench backfill and the placing and setting of concrete, excavations shall be kept free of water. Surface runoff shall be controlled so as to prevent entry or collection of water in excavations. The static water level shall be drawn a minimum of one (1) foot below the bottom of the excavation, except two (2) feet below the bottom of excavations for structures, so as to maintain the undisturbed state of the foundation soils and allow the placement of fill or backfill to the required density. The dewatering system shall be installed and operated so that the groundwater level outside the excavation is not reduced to the extent that would damage or endanger adjacent structures or property.
- C. The release of groundwater to its static level shall be performed in such a manner as to maintain the undisturbed state of the natural foundation soils, prevent disturbance of compacted backfill and prevent flotation or movement of structures and pipelines. Underdrain systems and hydrostatic relief valves shall be operational prior to release of groundwater.
- D. The Contractor shall not obstruct any component of the existing storm drain system but shall use proper measures to provide for the free passage of surface water.
- E. Provisions shall be made to take care of surplus water, mud, silt, or other runoff pumped from excavations and trenches or resulting from sluicing or other operations. Siltation of completed or partially completed structures and pipelines by surface water or by disposal of water from dewatering operations shall be cleaned up at the Contractor's expense.
- F. Discharge of ground and surface runoff water shall be to the existing drainage ways and storm systems. Contractor shall comply with all applicable federal, state and local laws and regulations pertaining to erosion control and discharge of water off-site.
- G. The Contractor shall be responsible for any damages to existing on- and off-site facilities and work in-place resulting from mechanical or electrical failure of the dewatering system.
- H. Pumping of native silts and sands shall be avoided.

END OF SECTION

SECTION 31-2323
FILL AND BACKFILL

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Filling, backfilling, and compacting for paving and future paving areas and other areas as shown in drawings.
- B. Backfilling and compacting for utilities outside the building and paving areas as shown in drawings.

1.02 RELATED REQUIREMENTS

- A. Section 31-2316 - Excavation.
- B. Section 31-2200 - Grading.
- C. Section 31-2319 - Control of Water.
- D. Section 32-1123 - Aggregate Base Course.
- E. Section 32-1216 - Bituminous Concrete Paving.
- F. Section 33-0000 - Site Utilities.

1.03 DEFINITIONS

- A. Finish Grade Elevations: Indicated on drawings.

1.04 REFERENCE STANDARDS

- A. AASHTO T 180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18 in.) Drop; American Association of State Highway and Transportation Officials; 2001 (2004).
- B. ASTM D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2007.
- C. ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method; 2007.
- D. ASTM D 1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN m/m³)); 2007.

PART 2 – PRODUCTS

2.01 FILL MATERIALS

- A. General Granular Fill - Fill Type A: Conforming to ODOT/APWA SS 02630.10 of ODOT standard - dense-graded aggregate 1 inch – 0 inch, with less than 5 percent passing the

- U.S. Standard No. 200 Sieve. Compact to at least 95 percent of the maximum dry density, as determined by ASTM D 1557.
- B. Granular Permeable Fill - Fill Type B: Coarse aggregate, conforming to ODOT/APWA SS 00430.11 - Granular Drain Backfill Material of ODOT standard. Free draining, 1 inch crushed rock, clean, no fines. Or round 1-1/2 inch rock.
- C. Sand Fill - Fill Type C: Natural River or Bank Sand; Free of silt, clay, loam, friable or soluble materials and organic matter.
- D. Trench Backfill, Type D.
1. Foundation Stabilization: Stabilization material shall be 2 inch minus imported crushed rock of approved clean well graded granular material free from organic matter. Gradation shall conform to ODOT/APWA 2008 Oregon Standard Specifications for Construction.
 2. Pipe Bedding: Bedding material shall be 3/4 inch minus imported crushed rock of approved clean well graded granular material free from organic matter. Gradation shall conform to ODOT/APWA 2008 Standard Specifications for Construction.
 3. Class III: Use imported 3/4 inch minus crushed rock, conforming to the requirements for base aggregates as specified in Section 02630 of the ODOT/APWA 2008 Standard Specifications for Construction.
 4. Pipe Zone Material: In the pipe zone use imported material conforming to pipe bedding material or selected trench side material which is friable and free of vegetation containing no frozen ground, rock, clay masses, clods or other pieces of material larger than 1 inch.
- E. Topsoil - Fill Type E. Topsoil excavated on- site.
- F. Growing Medium Topsoil for Swales (taken from the City of Portland Standard Construction Specifications).
1. General Composition: The medium shall be any blend of loamy soil, sand, and compost that is 30-40 percent compost (by volume) and meets the following criteria.
 2. Particle Gradation: The gradation of the blend shall meet the following gradation criteria:

Sieve Size	Percent Passing
1 inch	75-100
#4	75-100
#10	40-100
#40	15-50
#100	5-25
#200	5-25
 3. Organic Matter Content: Minimum 10 percent.
 4. Power of Hydrogen (pH): The pH of the blended materials shall have a pH of 5 to 8, tested.
 5. General Requirements for Blended Material:
 - a. The materials shall be loose and friable.
 - b. Well mixed and homogenous.
 - c. Free of wood pieces, plastic and other foreign matter.
 - d. No visible free water.
 6. Compost: Shall be the result of biological degradation and transformation of

plant-derived materials under conditions designed to promote aerobic decomposition. The material shall be well composted, free of viable weed seeds, and stable with regard to oxygen consumption and carbon dioxide generation. The compost shall have no visible free water and produce no dust when handled.

It shall meet the following criteria:

- a. 100 percent passing through 1/2 inch screen.
- b. pH shall be between 6 and 8.
- c. Manufactured inert material (plastic, concrete, ceramics, metal, etc.) shall be less than 1.0 percent by weight.
- d. Organic matter content shall be between 35 and 65 percent.
- e. Soluble salt content shall be less than 6.0 mmhos/cm.
- f. Germination (an indicator of maturity) shall be greater than 80%.
- g. Submittal Requirements: Two 5 gallon buckets of the blended material for approval prior to installation.

2.02 ACCESSORIES

- A. Geotextile Fabric: Non-biodegradable, non-woven, permeable stabilization fabric, 5 oz/yd weigh minimum.
 1. Flow Rate: 145 gal/min/sf.
 2. Apparent Opening Size (AOS): 70 US Sieve.
 3. Grab Strength (ASTM D 4632): 100 lbs.
 4. Grab Elongation (ASTM D 4632): 50%
 5. Amoco Style 4546 or equal.
- B. Geotextile Filter Fabric: Same as above.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Identify required lines, levels, contours, and datum locations.
- B. See Section 31-2200 for additional requirements.

3.02 PREPARATION

- A. Scarify and proof roll subgrade surface to a depth of 6 inches to identify soft spots.
- B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with Fill Type A.
- C. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
- D. Until ready to fill, maintain excavations and prevent loose soil from falling into excavation.

3.03 FILLING

- A. Fill to contours and elevations indicated using unfrozen materials.
- B. Employ a placement method that does not disturb or damage other work.

- C. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.
- D. Maintain optimum moisture content of fill materials to attain required compaction density.
- E. Granular Fill: Place and compact materials in equal continuous layers not exceeding 8 inches compacted depth.
- F. Soil Fill: Place and compact material in equal continuous layers not exceeding 8 inches in compacted depth.
- G. Slope grade away from building minimum 2 inches to 10 ft, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.
- H. Correct areas that are over-excavated.
 - 1. Load-bearing foundation surfaces: Use structural fill, flush to required elevation, compacted to 95 percent of maximum dry density.
 - 2. Other areas: Use Fill Type A, flush to required elevation, compacted to minimum 95 percent of maximum dry density.
- I. Compaction Density Unless Otherwise Specified or Indicated:
 - 1. Under paving and similar construction: 95 percent of maximum dry density.
- J. Reshape and re-compact fills subjected to vehicular traffic.

3.04 FILL AT SPECIFIC LOCATIONS

- A. Use general granular fill (Type A) unless otherwise specified or indicated.
- B. Structural Fill:
 - 1. Use Fill Type A.
 - 2. Maximum depth per lift: 8 inches, compacted.
 - 3. Compact to minimum 95 percent of maximum dry density.
- C. Under Interior Slabs-On-Grade:
 - 1. Use Fill Type A or C.
 - 2. Compact to 95 percent of maximum dry density.
- D. Over Subdrainage Piping at drainage areas as shown in drawings:
 - 1. Drainage fill, Fill Type B and geotextile fabric: Section 33-0000.
 - 2. Cover drainage fill with Fill Type A or C.
 - 3. Compact to 95 percent of maximum dry density.
- E. Trench Backfill:
 - 1. Use Fill Type D.
 - 2. Maximum depth per lift: 8 inches, compacted.
 - 3. Compact to 95 percent of maximum dry density.
- F. At Planting Areas:
 - 1. Use Fill Type E.
 - 2. Fill up to finish grade elevations.

3. Compact to 90 percent of maximum dry density.
4. See Section 31-2200 for topsoil placement.

3.05 TOLERANCES

- A. Top Surface of General Filling: Plus or minus 1/2 inch from required elevations.
- B. Top Surface of Filling Under Paved Areas: Plus or minus 1/4 inch from required elevations.

3.06 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirement, for general requirements for field inspection and testing.
- B. Perform compaction density testing on compacted fill in accordance with ASTM D 1556.
- C. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D 698 ("standard Proctor"), ASTM D 1557 ("modified Proctor"), or AASHTO T 180.
- D. If tests indicate work does not meet specified requirements, remove work, replace and retest.

3.07 CLEANING

- A. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

END OF SECTION

SECTION 31-4100

SHORING AND BRACING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Shoring and bracing of trenches and other excavation as required to furnish safe and acceptable working conditions, protect existing and new structures, utilities, vegetation and maintaining existing slopes, fills and open excavations.
- B. The Contractor shall have sole responsibility to determine the construction means and methods required to satisfy the requirements of this section. The method of shoring and bracing may include the use, or the combination of sheeting, shoring, bracing, sloping, sliding trench shield or other methods to accomplish the work.
- C. Shoring and bracing shall also include other means and procedures such as draining and recharging groundwater and routing and disposing of surface runoff, required to maintain the stability of soils.

1.02 RELATED SECTIONS

- A. Section 31-2319 - Control of Water.
- B. Section 31-2323 - Fill and Backfill.

1.03 QUALITY ASSURANCE

- A. The method of protection shall be according to the Contractor's design.
- B. The Contractor shall design sheeting, shoring, bracing, etc. in accordance with Oregon Occupational Safety and Health Act (OSHA).
- C. The Contractor's design shall furnish a safe place of work pursuant to OSHA provisions of 1970 and the subsequent amendments and regulations and provide for protection of the work, structures and other improvements.

1.04 SHORING AND BRACING SAFETY PLAN

- A. For trenches and excavations 5 feet or more in depth, the Contractor shall have a detail plan design of sheeting, shoring, bracing, sloping, etc., available at the work site for review by the Engineer and OSHA representative, to be made for worker protection from hazards of caving ground.

1.05 CONTRACTOR'S SUPERVISOR

- A. The Contractor shall appoint a qualified supervisor, who shall be responsible for determining the shoring system that shall be used, depending on local soil type, water table, and so on.
- B. This supervisor shall have experience in the direction of such excavation and shoring work.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.01 GENERAL

- A. Shoring and bracing shall be installed and maintained continuously and not be limited to normal working hours.
- B. The construction of sheeting, shoring and bracing shall not disturb the state of soil adjacent to the trench of excavation or below the excavation bottom. Sheeting, shoring and bracing shall be removed after placement and compaction of initial backfill except otherwise specified.

3.02 STRUCTURE AND EXISTING PIPING

- A. The Contractor shall provide support of existing and new structures where necessary. Existing piping shall be protected with shoring and bracing where excavation could expose the pipe and/or cause damage to the pipe.

3.03 DAMAGES

- A. Any damages to new or existing structures occurring through settlements, water or earth pressures, or other causes due to failure or lack of sheeting, shoring or bracing, or through negligence or fault of the Contractor shall be repaired by the Contractor at his own expense.

END OF SECTION

DIVISION 32

EXTERIOR IMPROVEMENTS

SECTION 32-1123

AGGREGATE BASE COURSES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Aggregate base course.

1.02 RELATED REQUIREMENTS

- A. Section 31-2200 - Grading: Preparation of site for base course.
- B. Section 31-2323 - Fill: Compacted fill under base course.
- C. Section 32-1216 - Asphalt Paving: Binder and finish asphalt courses.
- D. Section 32-1313 - Concrete Paving: Finish concrete surface course.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Coarse Aggregate Type A: Angular crushed washed stone; free of shale, clay, friable material and debris.
 - 1. Aggregate base shall be uniformly graded from coarse to fine and shall conform to the grading requirements set forth below. Graded in accordance with ASTM C 136, within the following limits (percent passing by weight):
 - a. 4 inch sieve: 100 percent passing. Refer to schedule for location - Subbase Rock.
 - b. 1 inch sieve: 90 to 100 percent passing.
 - c. 1/2 inch sieve: 55 to 75 percent passing
 - d. 1/4 inch sieve: 40 to 55 percent passing
 - e. Of the fraction passing the 1/4 inch sieve 40 to 60 percent shall pass the No. 10 sieve.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that survey bench marks and intended elevations for the work are as indicated.
- B. Verify substrate has been inspected, gradients and elevations are correct, and is dry.

3.02 PREPARATION

- A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.
- B. Do not place aggregate on soft, muddy, or frozen surfaces.

3.03 INSTALLATION

- A. Under Bituminous Concrete Paving:
 - 1. Place Aggregate Type A, Sub-base Rock, 1 inch minus, to a total compacted thickness of 8 inches.
- B. Under Portland Cement Concrete Paving:
 - 1. Place Aggregate Type A to a total compacted thickness of 8 inches.
 - 2. Compact to 95 percent of maximum dry density.
- C. Level and contour surfaces to elevations and gradients indicated.
- D. Add small quantities of fine aggregate to coarse aggregate as appropriate to assist compaction.

- E. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.
- F. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.04 TOLERANCES

- A. Flatness: Maximum variation of 1/4 inch measured with 10 foot straight edge.

3.05 FIELD QUALITY CONTROL

- A. See Section 01-4000 - Quality Requirements, for general requirements for field inspection and testing.
- B. Perform compaction density testing on compacted aggregate base course in accordance with ASTM D1556.
- C. Results will be evaluated in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D698 ("standard Proctor").
- D. If tests indicate work does not meet specified requirements, remove work, replace and retest.

END OF SECTION

SECTION 32-1216

ASPHALT PAVING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Single course bituminous concrete paving.
- B. Double course bituminous concrete paving.
- C. Surface sealer.

1.02 RELATED REQUIREMENTS

- A. Section 31-2200 - Grading: Preparation of site for paving and base.
- B. Section 31-2323 - Fill: Compacted subgrade for paving.

1.03 REFERENCE STANDARDS

- A. AI MS-2 - Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types; The Asphalt Institute; 1994.
- B. ASTM D946 - Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction; 2009a.

1.04 QUALITY ASSURANCE

- A. Perform Work in accordance with State of Oregon Highways standard.
- B. Mixing Plant: Conform to State of Oregon Highways standard.
- C. Obtain materials from same source throughout.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Asphalt Cement: ASTM D946.
- B. Aggregate for Wearing Course: In accordance with State of Oregon Highways standards. 1/2 inch maximum size.
- C. Primer: In accordance with State of Oregon Highways standards.
- D. Tack Coat: Homogeneous, medium curing, liquid asphalt.

2.02 ASPHALT PAVING MIXES AND MIX DESIGN

- A. Wearing Course: 5 to 7 percent of asphalt cement by weight in mixture in accordance with AI MS-2.
- B. Level 2 HMAC Standard Duty.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that compacted subgrade is dry and ready to support paving and imposed loads.
- B. Verify gradients and elevations of base are correct.

3.02 PREPARATION - PRIMER

- A. Apply primer in accordance with manufacturer's instructions.
- B. Apply primer on aggregate base or subbase at uniform rate of 1/3 gal/sq yd.
- C. Use clean sand to blot excess primer.

3.03 PREPARATION - TACK COAT

- A. Apply tack coat in accordance with manufacturer's instructions.
- B. Apply tack coat on asphalt or concrete surfaces over subgrade surface at uniform rate of 1/3 gal/sq yd.

3.04 PLACING ASPHALT PAVEMENT - DOUBLE COURSE

- A. Place asphalt binder course within 24 hours of applying primer or tack coat.
- B. Place wearing course within two hours of placing and compacting binder course.
- C. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.
- D. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.

3.05 CURBS

- A. Install extruded asphalt curbs of straight profile as indicated.

3.06 FIELD QUALITY CONTROL

- A. See Section 01-4000 - Quality Requirements, for general requirements for quality control.

3.07 SCHEDULE

- A. Pavement at Parking Areas: One course; 2 inch compacted thickness.
- B. Pavement at Access Drive: Two courses; 3 inch compacted thickness.

END OF SECTION

SECTION 32-1313

CONCRETE PAVING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Concrete sidewalks, stair steps, integral curbs, parking areas, and extruded curbs and concrete ramps.

1.02 RELATED REQUIREMENTS

- A. Section 31-2200 - Grading: Preparation of site for paving and base and preparation of subsoil at pavement perimeter for planting.
- B. Section 03-3000 - Cast-in-Place Concrete.

1.03 REFERENCE STANDARDS

- A. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; American Concrete Institute International; 1991 (Reapproved 2002).
- B. ACI 301 - Specifications for Structural Concrete for Buildings; American Concrete Institute International; 2010.
- C. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete; American Concrete Institute International; 2000.
- D. ASTM A615/A615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement; 2009b.
- E. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2010.
- F. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2011.
- G. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method; 2010b.
- H. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (nonextruding and Resilient Bituminous Types); 2004 (Reapproved 2008).
- I. ASTM D1752 - Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction; 2004a (Reapproved 2008).

PART 2 PRODUCTS

2.01 PAVING ASSEMBLIES

- A. Comply with applicable requirements of ACI 301.
- B. Concrete Sidewalks and Median Barrier: 3,000 psi 28 day concrete, 4 inches thick, Portland cement, exposed aggregate finish.

2.02 FORM MATERIALS

- A. Form Materials: Conform to ACI 301.
- B. Joint Filler: Preformed; non-extruding bituminous type (ASTM D1751) or sponge rubber or cork (ASTM D1752).
 - 1. Thickness: 1/2 inch.

2.03 REINFORCEMENT

- A. Reinforcing Steel: ASTM A615/A615M Grade 60 (420); deformed billet steel bars; unfinished finish.

2.04 CONCRETE MATERIALS

- A. Obtain cementitious materials from same source throughout.
- B. Concrete Materials: As specified in Section 03-3000.

2.05 CONCRETE MIX DESIGN

- A. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.
- B. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI 301.
 - 1. For trial mixtures method, employ independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.
- C. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended by manufacturer.
- D. Concrete Properties:
 - 1. Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days: 3000 psi.
 - 2. Fly Ash Content: Maximum 15 percent of cementitious materials by weight.
 - 3. Calcined Pozzolan Content: Maximum 10 percent of cementitious materials by weight.
 - 4. Silica Fume Content: Maximum 5 percent of cementitious materials by weight.
 - 5. Water-Cement Ratio: Maximum 40 percent by weight.
 - 6. Total Air Content: 4 percent, determined in accordance with ASTM C173/C173M.
 - 7. Maximum Slump: 4 inches.
 - 8. Maximum Aggregate Size: 1-1/2 inch.

2.06 MIXING

- A. Transit Mixers: Comply with ASTM C94/C94M.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify compacted subgrade is acceptable and ready to support paving and imposed loads.
- B. Verify gradients and elevations of base are correct.

3.02 SUBBASE

- A. See Section 32-1123 for construction of base course for work of this Section.

3.03 PREPARATION

- A. Moisten base to minimize absorption of water from fresh concrete.
- B. Coat surfaces of manhole frames with oil to prevent bond with concrete pavement.
- C. Notify Architect minimum 24 hours prior to commencement of concreting operations.

3.04 FORMING

- A. Place and secure forms to correct location, dimension, profile, and gradient.
- B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.

- C. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.

3.05 REINFORCEMENT

- A. Place reinforcement at midheight of slabs-on-grade.

3.06 PLACING CONCRETE

- A. Place concrete in accordance with ACI 304R.
- B. Ensure reinforcement, inserts, embedded parts, formed joints are not disturbed during concrete placement.

3.07 EXTRUDED CURBS

- A. The pavement shall be dry and cleansed of loose or deleterious Materials prior to curb placement.
- B. Extruded cement concrete curb shall be placed, shaped and compacted true to line and grade with an approved extrusion machine. The extrusion machine shall be capable of shaping and thoroughly compacting the concrete to the required cross section.
- C. The cement concrete mixture shall be homogeneously mixed to conform with above when delivered to the hopper of the curb machine. Each hopper load of cement concrete shall be run through the curb laying machine, adjusted properly to form and compact the cement mix for the concrete curb.
- D. Joints in the extruded cement concrete curb shall be spaced at 15-foot intervals or shall match existing transverse joints or cracks in existing pavement. Joints shall be cut vertically.

3.08 JOINTS

- A. Place 1/2 inch wide expansion joints at 30 foot intervals and to separate paving from vertical surfaces and other components and in pattern indicated.
- B. Provide scored joints:
 - 1. At 3 feet intervals, unless shown otherwise.
 - 2. Between sidewalks and curbs.

3.09 FINISHING

- A. Sidewalk Paving: Light broom, texture perpendicular to direction of travel with troweled and radiused edge 1/4 inch radius.
- B. Median Barrier: Light broom, texture perpendicular to direction of travel with troweled and radiused edge 1/4 inch radius.
- C. Curbs and Gutters: Light broom, texture parallel to pavement direction.

3.10 TOLERANCES

- A. Maximum Variation of Surface Flatness: 1/4 inch in 10 ft.
- B. Maximum Variation From True Position: 1/4 inch.

3.11 PROTECTION

- A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury.

END OF SECTION

SECTION 32-1723.13

PAVEMENT MARKINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Parking lot markings, including parking bays, crosswalks, arrows, handicapped symbols, and curb markings.
- B. Accessibility Signage.

1.02 RELATED REQUIREMENTS

- A. Section 32-1216 - Asphalt Paving.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.04 FIELD CONDITIONS

- A. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Line and Zone Marking Paint: MPI No. 97 Latex Traffic Marking Paint; color(s) as indicated.
 - 1. Parking Lots: White.
 - 2. Handicapped Symbols: Blue.
- B. Signage: See Drawings.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.

3.02 PREPARATION

- A. Allow new pavement surfaces to cure for a period of not less than 14 days before application of marking materials.
- B. Clean surfaces thoroughly prior to installation.
 - 1. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods.
- C. Where oil or grease are present, scrub affected areas with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application; after cleaning, seal oil-soaked areas with cut shellac to prevent bleeding through the new paint.

3.03 INSTALLATION

- A. Begin pavement marking as soon as practicable after surface has been cleaned and dried.
- B. Do not apply paint if temperature of surface to be painted or the atmosphere is less than 50 degrees F or more than 95 degrees F.

- C. Apply in accordance with manufacturer's instructions using an experienced technician that is thoroughly familiar with equipment, materials, and marking layouts.
- D. Apply uniformly painted markings of color(s), lengths, and widths as indicated on the drawings true, sharp edges and ends.
 - 1. Apply paint in one coat only.
 - 2. Wet Film Thickness: 0.015 inch, minimum.
 - 3. Width Tolerance: Plus or minus 1/8 inch.
- E. Parking Lots: Apply parking space lines, entrance and exit arrows, painted curbs, and other markings indicated on drawings.
 - 1. Mark the International Handicapped Symbol at indicated parking spaces.
 - 2. Hand application by pneumatic spray is acceptable.
- F. Symbols: Use a suitable template that will provide a pavement marking with true, sharp edges and ends, of the design and size indicated.

3.04 DRYING, PROTECTION, AND REPLACEMENT

- A. Protect newly painted markings so that paint is not picked up by tires, smeared, or tracked.
- B. Provide barricades, warning signs, and flags as necessary to prevent traffic crossing newly painted markings.
- C. Remove and replace markings that are applied at less than minimum material rates; deviate from true alignment; exceed length and width tolerances; or show light spots, smears, or other deficiencies or irregularities.

END OF SECTION

DIVISION 33

UTILITIES

SECTION 330000

SITE UTILITIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Sanitary Sewer Pipe.
- B. Storm Drain Pipe.
- C. Manholes and Cleanouts.
- D. Inlets-Catch Basins.
- E. Rain Drains.
- F. Precast Trench Drains
- G. Toning Wire and Warning Tape.

1.02 RELATED SECTION

- A. Alternates: Section 01-2100.
- B. Excavation: Section 31-2316.
- C. Grading: Section 31-2200.
- D. Fill and Backfill: Section 31-2323.
- E. Divisions 15 & 16.

1.03 SUBMITTALS

- A. Product Data: Pipe, pipe accessories/appurtenances, and other equipment.

PART 2 - PRODUCTS

2.01 SANITARY SEWER PIPE AND FITTINGS

- A. General. All pipe and fittings shall be American (domestic) made.
- B. Polyvinyl Chloride (PVC) Pipe.
 - 1. Nominal pipe sizes 4 inch through 15 inch.
 - a. PVC pipe shall meet the requirements of ASTM D 3034, SDR 35, PSM Poly (Vinyl Chloride) Sewer Pipe and Fittings.
 - 2. Nominal pipe sizes 18 inch through 27 inch.
 - a. PVC pipe shall meet the requirements of ASTM F 679, T-1 wall thickness of Poly (Vinyl Chloride) large diameter plastic gravity sewer pipe and fittings.

3. PVC pipe shall be furnished with an integral bell gasketed joint. Joint shall conform to ASTM D 3212 with an elastomeric ring type gasket conforming to ASTM F 477.
4. Furnish in standard lengths.
5. PVC pipe shall be manufactured by J-M Manufacturing Company, Pacific Western Extruded Plastics Company or equal.

C. Fittings.

1. General. All fittings shall be of sufficient strength to withstand all handling and load stresses. All fittings shall be of the same materials as the pipe unless otherwise specified. Material joining the fittings to the pipe shall be free from cracks and shall adhere tightly to each joining surface. Use the same type of joints on all fittings that are used on the sanitary sewer gravity main pipe.
2. PVC Fittings.
 - a. Tee-Wyes.
 - 1) Provide tee-wye in the sanitary sewer gravity main for service lateral connections. Tee-wye shall not be closer than 12 inches to any joint or bell of main line sewer main which is 12 inches or less in diameter.
 - 2) Push-on tee-wye fittings shall be as manufactured by GPK Industries, or equal.
 - b. Wyes and Elbows.
 - 1) Provide wyes and elbows for cleanouts and in service laterals as directed by the Engineer.
 - 2) Push-on wyes and elbow fittings shall be as manufactured by GPK Industries, or equal.
 - c. End Plugs.
 - 1) Provide end plugs for service laterals, sanitary sewer main stubs from manholes and wye fittings of cleanouts.
 - 2) Push-on end plug fittings shall be as manufactured by GPK Industries, or equal.

2.02 STORM DRAIN PIPE AND FITTINGS

- A. General. All pipe and fittings shall be American (domestic) made.
- B. Polyvinyl Chloride (PVC) Pipe and Fittings. See Section 330000, Paragraph 2.01.

2.03 MANHOLES AND CLEANOUTS

- A. All materials and products shall be American (domestic) made.
- B. Cast-in-Place Manholes will not be allowed.
 1. Precast concrete manhole sections shall be as shown on the Drawings and Standard Detail Drawings and shall meet the requirements of ASTM C 478. Minimum wall thickness shall be 5 inches. Manhole steps shall not be provided as noted in these specifications.
 2. Manhole cones shall be eccentric unless otherwise noted on the Drawings and have same wall thickness and reinforcement as manholes. Manholes with a

- depth less than 6 feet shall be a flat slab top and furnished with an eccentric access opening.
3. Precast concrete manhole sections shall be a minimum of 48 inches in diameter for manholes with 6 to 18 inch nominal inside diameter pipes and 72 inches in diameter for manholes with 24 to 42 inch nominal inside diameter pipes.
 4. Precast concrete manhole sections shall be the keylock type suitable for placement of joint compound. Sections utilizing a confined "O" ring joint are an approved alternate.
 5. Flexible Pipe to Manhole Connectors.
 - a. Precast concrete manholes base section shall be furnished with flexible pipe to manhole connectors. Flexible connectors shall be rubber conforming to ASTM C 9123 with Type 304 stainless steel band land tightener.
 - b. Flexible connector shall be Korn-N-Seal as manufactured by NPC, Inc., or equal.
- C. Joint Compound.
1. Compound for use in precast manhole section joints shall be a putty-like preformed homogenous blend of hydro-carbon resins and rubber or plasticizing materials with not more than 50 percent by weight of inert mineral filler. The compound shall be specifically manufactured for the intended use and shall be pliable at temperatures between 32 degrees and 135 degrees Fahrenheit. It shall adhere firmly and cohesively to the precast manhole sections when the compound sealed joint is flexed to its maximum intent. The compound shall be accompanied by and used with such primer solution as the manufacturer of the compound may recommend. Compound conforming to Federal Specification SS-S-00210 shall be used.
 2. Joint sealing compound components shall be Ram-Nek Primer and Ram-Nek Joint Sealing Compound as manufactured by K.T. Snyder Company or equal.
- D. Manhole Extension Rings.
1. Concrete grade rings for extensions shall be a maximum of 4 inches high.
 2. In general, manhole extensions will be used on all manholes in roads or streets or in other locations where a subsequent change in existing grade may be likely. Extensions will be limited to a maximum height of 12 inches unless noted otherwise on the Drawings. Finish grade for manhole covers shall conform to finished ground or street surface, and joints shall be mortared unless otherwise directed.
- E. Mortar.
1. Mortar shall conform to requirements of ASTM C 387, or be proportioned one part Type II Portland Cement to two parts clean, well graded Mason's sand which will pass a 1/8 inch screen. Consistency of mortar shall be such that it will readily adhere to precast concrete.
- F. Non-Shrink Grout.
1. Non-shrink grout shall conform to requirements of ASTM C 1107.
 2. Non-shrink grout shall be Master Builders Masterflow 713 Plus, Sonneborn SonogROUT or equal.
- G. Concrete.
1. Cement shall be Type II Portland Cement conforming to ASTM C 150.
 2. Cast-in-place concrete shall conform to ASTM C 94. Compressive strength shall not be less than 3,000 psi at 28 days.

- 3. Maximum aggregate size shall be 1-1/2 inches. Slump shall be between 2 and 4 inches.

H. Frames and Lids.

1. General.

- a. The bearing seat shall not rock when checked with a testing jig. The castings shall not be made by the open mold method and shall be free of porosity; shrink cavities, cold shuts, or cracks or any defects which would impair serviceability. Repair of defects will not be permitted. All castings shall be shot or sandblasted, and the application of paint or other coating will not be permitted. Each casting shall have distinctly cast upon it the initials of the manufacturer and the year of the cast.

- b. Materials shall conform to ASTM A 48, Class 30B with the following revisions.

Tensile Strength		30,000 psi
Traverse Strength (1.2" dia. bar = 18" centers)		
Load	- Pounds	2,600 - 3,000
Deflection	- Inches	0.22 - 0.34
Brinell Hardness	(as cast)	173 - 200

2. Manholes.

a. Frame and Solid Covers.

- 1) Frames and covers shall be Inland Foundry Co. Inc., Pattern Number 802, two hole style, Olympic Foundry, Inc., Part Number MH 26 with MH26S Lid or approved equal.
- 2) Covers shall be marked "STORM" or "SD".
- 3) Paving risers shall be Inland Foundry Co. Inc., Pattern Number 845, Olympic Foundry, Inc., Part Number MH26R, or approved equal.

b. Frame and Slotted Covers.

- 1) Frames and covers shall be Inland Foundry Co., Inc., Pattern Number 802-G slotted cover, Olympic Foundry, Inc., Part Number MH26G Lid or approved equal.
- 2) Paving risers shall be Inland Foundry Co., Inc., Pattern Number 845, Olympic Foundry Inc., Part Number MH26R, or approved equal.

3. Cleanouts.

- a. Frame and cover shall be Inland Foundry Co., Inc., Pattern Number 220 or approved equal.
- b. Cover shall be marked "STORM" or "SD", for storm drains and "SEWER" or "S" for sanitary sewer.

I. Pipe and Fittings.

- 1. Pipe and fittings shown on the Drawings or Standard Detail Drawings shall be in accordance with Section 33-0000.

2.04 INLETS (CATCH BASINS)

- A. All materials and products shall be American (domestic) made.
- B. Cast-in-place catch basins will not be allowed.
- C. Precast Concrete Inlets (Catch Basins)

1. Precast concrete inlet sections shall be Type G-2 catch basin as shown on the Drawings and ODOT/APWA Standard Drawing RD 364.
- D. Concrete.
1. Portland Cement concrete shall conform to requirements of ASTM C 94, Type II. Compressive field strength for manhole bases, inlets and other like structures shall be not less than 3,000 psi at 28 days. Maximum aggregate size shall be 1-1/2 inch. Slump shall be between 2 and 4 inches.
- E. Mortar.
1. Mortar shall conform to requirements of ASTM C 387, or be proportioned one part Portland Cement to two parts clean, well-graded Mason's sand which will pass a 1/8 inch screen. Consistency of mortar shall be such that it will readily adhere to precast concrete.
- F. Frames and Grates
1. Catch basin frames and grates for catch basins shall be Type 2 as shown on ODOT/APWA Standard Drawing RD 364.
 2. Frames and grates shall be tested one within the other and these shall be no more than 1/16 inch rock. When checked by a test jig, the bearing seat of either component shall have no more than 1/16 inch rock. Test jig, shall be furnished by the manufacturer.

2.05 RAIN DRAINS

- A. All pipe and fittings shall be American (domestic) made.
- B. Sealed rain drain pipe.
1. Use solid PVC pipe conforming to ASTM D 3034, SDR 35.
 2. Pipe shall be furnished with a bell end.
 3. Pipe shall be as manufactured by J-M Manufacturing Company, Pacific Western Extruded Plastic Company or equal.
- C. Fittings.
1. General. All fittings shall be of sufficient strength to withstand all handling and load stresses encountered. All fittings shall be of the same materials as the pipe unless otherwise specified. Material joining the fittings to the pipe shall be free from cracks and shall adhere tightly to each joining surface. Use the same type of joints on all fittings that are used on the pipe. Sand collars shall be used at all manhole and catch basin connections.
 2. PVC Pipe. Use push-on type fittings for joints conforming to same standards as the pipe.

2.06 PRECAST TRENCH DRAINS

- A. Manufacturer: ACO Polymer Products, Inc., or approved www.acousa.com. (520) 421-9988.
- B. Type: Heavy duty "Power Drain" Model S100K.
- C. Load Class: F, concrete finish.
- D. Description:
1. Material: Polymer concrete.

2. Channels: 4" internal width.
3. Slope: 0.6% slope.
4. Grate: Slotted ductile iron Class F, "Powerlok" Locking System.
5. Outlets: As required, see Drawings: Site Plan and Plumbing Plan.
6. Accessories:
 - a. All necessary components as required for complete functional Class F rated trench drain system.
 - b. 4" shovel (Model #01315).

2.07 TONING WIRE AND WARNING TAPE

- A. Waterlines
 1. Toning Wire shall be No. 12 AWG, solid copper with blue colored insulation.
 2. Underground Warning Tape shall be 6" wide, APWA Standard Blue color, reading "CAUTION - WATERLINE BURIED BELOW".
- B. Sanitary Sewer and Storm Drains
 1. Toning Wire shall be No. 12 AWG, solid copper with green colored insulation.
 2. Underground Warning Tape shall be 6" wide, APWA Standard green color, reading "CAUTION - SEWER BURIED BELOW".

PART 3 - EXECUTION

3.01 GENERAL

- A. Install products in accordance with manufacturer's recommendations.
- B. Install piping plumb and parallel true to building structural system.
- C. Where possible, use full 20 ft. lengths.
- D. Install branch piping to allow for expansion with offsets and swing joints as necessary to prevent undue strain.
- E. Do not use bushings and close nipples.
- F. Do not penetrate structural members.
- G. Screwed joints shall have less than two percent of threads showing.
- H. Ream pipes to full inside diameter prior to making up joints.
- I. Comply with applicable IAPMO Installation Standard for each particular piping material.
- J. Make branches and elbows with fittings are not acceptable.
- K. Testing of Piping Systems:
 1. Advise Architect or authorized representative when testing will be performed.
 2. Test before concealing pipe joints and welds.
 3. Before testing, isolate all equipment or components which are not rated for test pressures.
 4. Record temperature at start and finish of test. Pressure readings at finish of test shall be adjusted to account for temperature change of medium during the test.
 5. Test pressure shall be as specified herein for each type of piping system.

6. Comply with testing requirements of authorities having jurisdiction, in addition to requirements specified herein.
7. Piping system shall hold test pressure for a minimum of one hour with no leakage.

3.02 SANITARY SEWER AND STORM DRAIN PIPE

- A. Line and Grade for Sanitary Sewer Gravity Mains. Do not deviate from line or grade, as established by Engineer, more than 1/2 inch for line and 1/8 inch for grade, providing that such variation does not result in a level or reverse sloping invert. Measure for grade at the pipe invert, not at the top of the pipe, because of permissible variation in pipe wall thickness. Establish line and grade for pipe by the use of approved lasers or by transferring the cut from the offset stakes to batterboards at maximum intervals of 25 feet. If batterboards prove impractical because of trench conditions, submit other methods of grade and alignment control for approval.
- B. Line and Grade for Service Laterals. Lay the pipe on a straight line and at a uniform grade between the tee-wye and the reconnection point. Where minimum slopes are used, lay pipe by means of a builder's level of good quality and not less than 24 inches in length. Minimum slope shall be 1/4 inch per foot unless otherwise permitted by the Engineer, but in no case less than 1/8 inch per foot.
- C. Pipe Distribution and Handling.
 1. Distribute material on the job no faster than it can be used to good advantage. Unload pipe only by approved means. Do not unload pipe of any size by dropping to the ground. Do not distribute more than one week's supply of material in advance of laying, unless approved.
 2. Inspect all pipe and fittings prior to lowering into trench to ensure no cracked, broken or otherwise defective materials are used. Clean ends of pipe thoroughly. Remove foreign matter and dirt from inside of pipe and keep clean during and after laying.
 3. Use approved implements, tools and facilities for the safe and proper protection of the work. Lower pipe into the trench in such a manner as to avoid any physical damage to the pipe. Remove all damaged or rejected pipe from the job site. Do not drop or dump pipe into trenches.
- D. Pipe Laying and Jointing of Pipe.
 1. Proceed with pipe laying upgrade with spigot or tongue ends pointing in direction of flow. Place pipe in such a manner as to ensure solid bearing between pipe and the full cross sectional in accordance with the recommendations of the manufacturer. Take care to properly align the pipe before joints are forced entirely home. Upon completion of pipe laying, all pipe joints shall be in the "home position", which is defined as the position where the least gap (if any) exists, when pipe components that comprise the joint are fitted together as tightly as the joint design will permit. Gaps at pipe joints shall not exceed that allowed by the manufacturer's recommendations. After installation, prevent movement from any cause including uplift or floating.
 2. Take special care to prevent movement of the pipe after installation when laid within a movable trench shield.
 3. When laying operations are not in progress, protect the open end of pipe from entry of foreign material and block the pipe to prevent movement or creep of gasketed joints.
 4. Plug off pipes which are stubbed out for manhole and wetwell construction or for connection by others.

5. Provide all sewer pipes, 36 inches and smaller in diameter, entering or leaving manholes or other structures, with flexible joints within 18 inches of the exterior wall. Pipes larger than 36 inches in diameter shall have this flexible joint within a distance from the exterior wall equal to one-half the inside pipe diameter.
 6. When cutting and/or machining the pipe is necessary, use only tools and methods recommended by pipe manufacturer.
 7. Place perforated footing drain pipe with perforations down unless otherwise directed.
- E. Installation of Service Laterals and Tee-Wyes.
1. Install tee-wye fittings and service laterals as shown on the plans or as directed by Engineer.
 2. Maximum deflection permissible with any one fitting shall not exceed 45 degrees.
 3. Connect no service laterals to manholes. Make the connection so that the standard pipe joint is located not more than 18 inches from the structure.
 4. Provide ends of all service laterals or fittings with approved watertight end plugs, suitably braced to prevent blowoff during internal air testing. Such plugs shall be removed and their removal shall provide a socket suitable for making a flexible joint lateral connection or extension.
- F. Testing of Sanitary Sewer Gravity Main Pipe.
1. General. All gravity sanitary sewers including service laterals shall successfully pass a low pressure air test prior to acceptance and shall be free of leakage. Test first section of pipe laid, as hereinafter specified, to establish that the pipe material is capable of preventing infiltration and that the sanitary sewer mains are being installed to insure that infiltration of ground water will not exceed the amount set forth herein. Section of pipe tested shall be at least 300 feet in length. If test indicates infiltration exceeding amount hereinafter set forth, defective material or workmanship shall be corrected and test rerun until leakage is within the amount specified.
 2. Water and Test Equipment. Make all arrangements for furnishing water from the nearest hydrant or other approved source for cleaning. Perform the tests and provide personnel, hoses, tank trucks, plugs and other necessary equipment to complete the tests at no cost to the Owner.
 3. Cleaning Prior to Testing and Acceptance. Prior to final testing, acceptance and manhole to manhole inspection of the sewer system by the Engineer, flush and clean all parts of the system. Remove all accumulated construction debris, rocks, gravel, sand, silt and other foreign material from the sewer system at or near the closest downstream manhole. If necessary, use mechanical rodding or bucketing equipment.

Upon Engineer's manhole to manhole inspection of the sewer system, if any foreign matter is still present in the system, reflush and clean the sections and portions of the mains as required.
 4. Test Procedure. Perform tests in a manner satisfactory to and under observation of the Engineer. Any arrangement of testing equipment which will provide observable and accurate measurements of air under the specified conditions will be permitted. Calibrate gauges for air testing with a standard test gauge at the start of each testing day. The calibration shall be witnessed by Engineer; notify him prior to each test.
 5. Time of Test. Make tests of sections of constructed sanitary sewer for acceptance only after all service laterals, manholes, clean-outs, backfilling and compaction are completed between the stations to be tested. Contractor may desire to make air test prior to backfilling for his own purposes. Unless otherwise

approved, do not allow testing of completed sections of sewer between manholes to lag more than one completed section behind the work in progress. Owner may require testing of manhole to manhole sections as they are completed in order to expedite the acceptance of sections of sewer and allow connections prior to the whole system being completed.

6. Repairs. Repair or replace, in a manner approved by the Engineer, any section of pipe not meeting the air test requirements, or which has leakage. Infiltration of ground water in an amount greater than herein specified, following a successful air test as specified, shall be considered as evidence that the original test was in error or that subsequent failure of the pipeline has occurred. Correct such failures occurring within the warranty period in a manner approved by the Engineer at no expense to the Owner. The Contractor, in contracting to do the work, agrees that the leakage allowances as indicated herein are fair and practical.
7. Low Pressure Air Testing.
- a. General. The Engineer may, at any time, require a calibration check of the instrumentation used. Use a pressure gauge having minimum divisions of 0.20 psi and an accuracy of 0.0625 psi. (One ounce per square inch.) All air used shall pass through a single control panel.

All plugs used to close the sewer for the air test must be capable of resisting the internal pressures and must be securely braced. Place all air testing equipment above ground and allow no one to enter a manhole or trench where a plugged sewer is under pressure. Release all pressure before the plugs are removed. Testing equipment used must include a pressure relief valve designed to relieve pressure in the sewer under test at 10 psi or less and must allow continuous monitoring of test pressures in order to avoid excessive pressure. Use care to avoid the flooding of the air inlet by infiltrated ground water. (Inject the air at the upper plug if possible.) Use only qualified personnel to conduct the test.

- b. Ground Water. The presence of ground water will effect the results of the test. Determine the average height of ground water over the sewer immediately before starting the test; the method of checking the ground water height shall be as approved.
- c. Method. Use the time-pressure drop method for all testing. Test procedures are described as follows:
- 1) Clean the sewer to be tested and remove all debris.
 - 2) Plug all sewer outlets with suitable test plugs. Brace each plug securely.
 - 3) Check the average height of ground water over the sewer. The test pressures required below shall be increased 0.433 psi for each foot of average water depth over the sewer.
 - 4) Add air slowly to the section of sewer being tested until the internal air pressure is raised to 4.0 psig greater than the average back pressure of any ground water that may submerge the pipe.
 - 5) After the internal test pressure is reached, allow at least 2 minutes for the air temperature to stabilize, adding only the amount of air required to maintain pressure.
 - 6) After the temperature stabilization period, disconnect the air supply.
 - 7) Determine and record time in minutes and seconds that is required for the internal air pressure to drop from 4.0 psig to 3.5

- psig greater than the average back pressure of any ground water that may submerge the pipe.
- 8) Compare the time recorded in Step 7 with the time required as determined hereinafter.
- d. Acceptance. The sewer shall be considered acceptable if the time measured by the preceding described method is not less than the time as computed according to the following table entitled "Duration for Air Test Pressure Drop", but not less than the minimum time listed in the Table.

DURATION FOR AIR TEST PRESSURE DROP

Pipe Diameter (in.)	Minimum Time (Min:Sec)	Length for Minimum Time (Ft.)	Time for Longer Length (Sec.)
4	2:00	597	0.190 L
6	3:00	398	0.427 L
8	4:00	298	0.760 L
10	5:00	239	1.187 L
12	6:00	199	1.709 L
15	7:00	159	2.671 L
18	8:30	133	3.846 L
21	10:00	114	5.235 L
24	11:30	99	6.837 L
27	13:00	88	8.653 L
30	14:30	80	10.683 L

Where "L" equals length

8. Deflection Test for PVC Pipe. In addition to air testing, do a deflection test to all sanitary sewers constructed of PVC pipe after the trench backfill and compaction has been completed. The test shall be conducted by pulling an approved solid pointed mandrel of a variable deflection measuring gauge through the complete pipeline. The diameter of the mandrel shall be 95 percent of the pipe diameter unless otherwise specified by the Engineer. Conduct testing on a manhole to manhole basis and only after the line has been completely flushed out with water. Locate and repair any sections failing to pass the test and to retest the section, at no expense to Owner.

3.03 MANHOLES AND CLEANOUTS

- A. Construct manholes at locations shown on the Drawings.
- B. Precast concrete base section shall be properly located and set plumb.
- C. Clean ends of precast sections of foreign material and apply primer solution to lower and upper jointing surfaces. Place joint compound in groove of lower section in accordance with manufacturer's recommendation. Set next section in place. Manhole sections with chips or cracks in jointing surfaces shall not be used.
- D. Completed manholes shall be rigid and watertight.

- E. Precast base sections shall be hand troweled with grout to provide flow channels with a smooth surface.
 - 1. Shape flow channels to conform to pipe radius.
 - 2. Remove all rough sections or sharp edges to ensure an unobstructed flow through manhole.
- F. Where a full section of pipe is laid through a manhole, break out the top section to the full width of pipe and diameter of manhole. Cover exposed edges of pipe completely with mortar. Trowel all mortar surfaces smooth.
- G. Mortar and trowel interior and exterior surfaces smooth.
- H. Eccentric cones shall be placed with the slope face on the downstream side of the manhole.
- I. Drop manhole assemblies shall be installed per the Standard Detail Drawing.
- J. Install stubouts from manholes per the Drawings.
- K. Manhole grade rings.
 - 1. Install grade rings to the height directed. Lay grade rings in mortar with sides plumb and tops level. Extensions shall be watertight.
 - 2. Manhole grade rings will be used on all manholes in streets or roads or in other locations where subsequent change in existing grade may be likely. Extensions will be limited to a maximum height of 12 inches. Finish grade for manhole covers shall conform to finished ground or street surface unless otherwise directed.
- L. Frames and Covers.
 - 1. Set frames in a bed of mortar with the mortar carried over the flange of frame.
 - 2. Set frames so tops of cover are flush with surrounding pavement or ground surface, unless otherwise shown or directed.

3.04 INLETS - CATCH BASINS

- A. Conform to details shown on the Standard Detail Drawings and applicable provisions herein.
- B. Remove and keep all water clear from the excavation.
- C. Construct inlets at locations shown on the Drawings.
- D. Mortar and trowel interior and exterior surfaces smooth.
- E. Set frames and grates at elevations shown or as directed. Bearing surfaces shall be clean and provide uniform contact.
- F. Upon completion, clean each structure of all silts, debris and foreign matter, marks or irregularities.

3.05 TRENCH DRAIN

- A. Follow in strict accordance with manufacturer's requirements. Contractor to obtain complete Site Installation Manual.

- B. Position channel accurately straight and true using lazer and stringline. Position using concrete “patties” or using stiff “dry” concrete of same strength of final concrete. Hanging method also approved.
- C. Pour concrete evenly on both sides of channel to avoid dislodging channels.
- D. Finish: Trench concrete flat and taper down to channel edge. Top edge of concrete to be 1/8” above grate.
- E. Install grates per “Powerlok.”
- F. 3,000 psi concrete required. Allow concrete to cure 28 days prior to driving over.

3.06 EXCAVATION AND BACKFILL

- A. General:
 - 1. Determine location of existing underground utilities and services, uncover by hand digging.
 - 2. Completely de-water trenches and excavations before pipe is laid or concrete is placed.
 - 3. When necessary to prevent caving, excavation in sand, gravel or other unstable materials provide shoeing and bracing. Shoring shall remain in place until testing, inspection and backfill for 12 inches above pipe are complete.
 - 4. Remove from site excavation materials not suitable for backfill.
 - 5. Delay backfill trenches until all tests are performed and until after inspection and approval by governing authority.
 - 6. Record Drawings: During progress of underground work, maintain an accurate record of all installation depths and changes in direction for future accurate location. Record daily work progress prior to any backfill.
 - 7. Repair any damage to existing streets, sidewalks, concrete, piping, etc., at Contractor’s expense.
- B. Excavation:
 - 1. Unless otherwise shown, piping shall have the following minimal cover:
 - a. Gas - 18 inches.
 - b. Waste, Storm Drain - 24 inches.
 - c. Waterline - 36 inches.
 - 2. Width: To provide working space, but in no case less than 18 inches plus the inside diameter of the pipe to be places therein.
 - 3. Grade Bottom of Trenches: Carried to lines and grades as shown or as required and established with instruments with proper allowances for pipe thickness and gravel bedding. Any amount of trench excavated below grade shall be corrected with approved materials thoroughly compacted.
- C. Bedding:
 - 1. Buried pipes shall be laid on minimum 4 inches of compacted crushed rock bedding.
 - 2. Bedding shall extend from bottom of pipe to undisturbed earth, be evenly graded to support pipe at proper slope, and compacted to 95% density of AASHTO T-180/ASTM D1557-00.

- D. Backfilling:
1. Under concrete slabs (inside or outside building), paved areas, streets, or sidewalks, backfill shall be pea gravel or crushed rock. Fill material shall extend from bedding material to the bottom of surfacing material, filling voids around pipe. Fill in maximum 8 inch lifts and compact to 95% density of AASHTO T-180/ASTM D1557-00.
 2. For areas outside building, except as specified above, pipe shall be covered with minimum 12 inches of pea gravel or crushed rock and remainder of trench filled with thoroughly compacted native material.
 3. Should any backfilled ditch show settlement at any time through one year warranty period, Contractor shall bring ditch back to grade with compacted fill and repair any damage to concrete or paved areas caused by settlement.

3.07 TONING WIRE AND WARNING TAPE

- A. Wire and tape shall be buried the entire length of trench and placed above pipe per standard trench detail drawing.
- B. Wire shall be brought to the surface and connected at each valve box or manhole. Distance between tracer lead access locations shall not be more than 1,000 feet. Joints or splices in wire shall be waterproof. Toning wire shall be laid on top of the waterline and attached with duct tape at approximately 8' intervals.
- C. Tape shall be placed over the pipe zone material, approximately 6 inches above top of installed pipe. Lay flat and untwisted.

END OF SECTION

