SECTION 33 05 10
UTILITY TRENCH EXCAVATION, EMBEDMENT AND BACKFILL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Excavation, Embedment and Backfill for:
      a. Pressure Applications
         1) Water Distribution or Transmission Main
         2) Wastewater Force Main
         3) Reclaimed Water Main
      b. Gravity Applications
         1) Wastewater Gravity Mains
         2) Storm Sewer Pipe and Culverts
         3) Storm Sewer Precast Box and Culverts
   2. Including:
      a. Excavation of all material encountered, including rock and unsuitable materials
      b. Disposal of excess unsuitable material
      c. Site specific trench safety
      d. Pumping and dewatering
      e. Embedment
      f. Concrete encasement for utility lines
      g. Backfill
      h. Compaction

B. Deviations from this City of Fort Worth Standard Specification
   1. None.

C. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms, and Conditions of the Contract
   2. Division 1 – General Requirements
   3. Section 02 41 13 – Selective Site Demolition
   4. Section 02 41 15 – Paving Removal
   5. Section 02 41 14 – Utility Removal/Abandonment
   6. Section 03 30 00 – Cast-in-place Concrete
   7. Section 03 34 13 – Controlled Low Strength Material (CLSM)
   8. Section 31 10 00 – Site Clearing
   9. Section 31 25 00 – Erosion and Sediment Control
   10. Section 33 05 26 – Utility Markers/Locators
   11. Section 34 71 13 – Traffic Control

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment

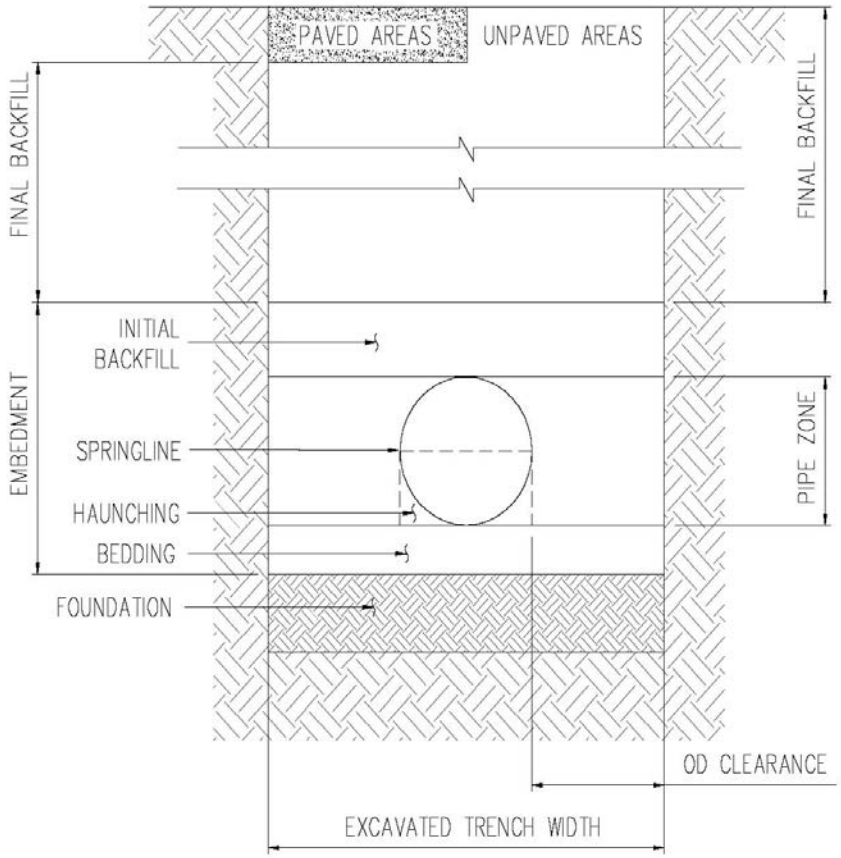
1. Trench Excavation, Embedment and Backfill associated with the installation of an underground utility or excavation
   a. Measurement
      1) This Item is considered subsidiary to the installation of the utility pipe line as designated in the Drawings.
   b. Payment
      1) The work performed and the materials furnished in accordance with this Item are considered subsidiary to the installation of the utility pipe for the type of embedment and backfill as indicated on the plans. No other compensation will be allowed.
2. Imported Embedment or Backfill
   a. Measurement
      1) Measured by the cubic yard as delivered to the site and recorded by truck ticket provided to the City
   b. Payment
      1) Imported fill shall only be paid when using materials for embedment and backfill other than those identified in the Drawings. The work performed and materials furnished in accordance with pre-bid item and measured as provided under "Measurement" will be paid for at the unit price bid per cubic yard of "Imported Embedment/Backfill" delivered to the Site for:
         a) Various embedment/backfill materials
   c. The price bid shall include:
      1) Furnishing backfill or embedment as specified by this Specification
      2) Hauling to the site
      3) Placement and compaction of backfill or embedment
3. Concrete Encasement for Utility Lines
   a. Measurement
      1) Measured by the cubic yard per plan quantity.
   b. Payment
      1) The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid per cubic yard of "Concrete Encasement for Utility Lines" per plan quantity.
   c. The price bid shall include:
      1) Furnishing, hauling, placing and finishing concrete in accordance with Section 03 30 00
      2) Clean-up
4. Ground Water Control
   a. Measurement
      1) Measurement shall be lump sum when a ground water control plan is specifically required by the Contract Documents.
   b. Payment
      1) Payment shall be per the lump sum price bid for "Ground Water Control" including:
         a) Submittals
         b) Additional Testing
         c) Ground water control system installation
         d) Ground water control system operations and maintenance
         e) Disposal of water

f) Removal of ground water control system

5. Trench Safety
   a. Measurement
      1) Measured per linear foot of excavation for all trenches that require trench safety in accordance with OSHA excavation safety standards (29 CFR Part 1926 Subpart P Safety and Health regulations for Construction)
   b. Payment
      1) The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid per linear foot of excavation to comply with OSHA excavation safety standards (29 CFR Part 1926.650 Subpart P), including, but not limited to, all submittals, labor and equipment.

1.3 REFERENCES

A. Definitions
   1. General – Definitions used in this section are in accordance with Terminologies ASTM F412 and ASTM D8 and Terminology ASTM D653, unless otherwise noted.
   2. Definitions for trench width, backfill, embedment, initial backfill, pipe zone, haunching bedding, springline, pipe zone and foundation are defined as shown in the following schematic:



3. Deleterious materials – Harmful materials such as clay lumps, silts and organic material
4. Excavated Trench Depth – Distance from the surface to the bottom of the bedding or the trench foundation
5. Final Backfill Depth
   a. Unpaved Areas – The depth of the final backfill measured from the top of the initial backfill to the surface
   b. Paved Areas – The depth of the final backfill measured from the top of the initial backfill to bottom of permanent or temporary pavement repair

B. Reference Standards

1. Reference standards cited in this Specification refer to the current reference standard published at the time of the latest revision date logged at the end of this Specification, unless a date is specifically cited.
2. ASTM Standards:
   a. ASTM C33-08 Standard Specifications for Concrete Aggregates
   b. ASTM C88-05 Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
   c. ASTM C136-01 Test Method for Sieve Analysis of Fine and Coarse Aggregate
   d. ASTM D448-08 Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
   e. ASTM C535-09 Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
   f. ASTM D588 – Standard Test method for Moisture-Density Relations of Soil-Cement Mixture
   g. ASTM D698-07 Test Method for Laboratory Compaction Characteristics of Soil Using Stand Efforts (12,400 ft-lb/ft3 600 Kn-m/M3)).
   h. ASTM 1556 Standard Test Methods for Density and Unit Weight of Soils in Place by Sand Cone Method.
   i. ASTM 2487 – 10 Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)
   j. ASTM 2321-09 Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
   k. ASTM D2922 – Standard Test Methods for Density of Soils and Soil Aggregate in Place by Nuclear Methods (Shallow Depth)
   l. ASTM 3017 - Standard Test Method for Water Content of Soil and Rock in place by Nuclear Methods (Shallow Depth)
   m. ASTM D4254 - Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculations of Relative Density
3. OSHA
   a. Occupational Safety and Health Administration CFR 29, Part 1926-Safety Regulations for Construction, Subpart P - Excavations

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination

1. Utility Company Notification
   a. Notify area utility companies at least 48 hours in advance, excluding weekends and holidays, before starting excavation.

b. Request the location of buried lines and cables in the vicinity of the proposed work.

B. Sequencing

1. Sequence work for each section of the pipe installed to complete the embedment and backfill placement on the day the pipe foundation is complete.
2. Sequence work such that proctors are complete in accordance with ASTM D698 prior to commencement of construction activities.

1.5 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00.

B. All submittals shall be approved by the City prior to construction.

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Shop Drawings

1. Provide detailed drawings and explanation for ground water and surface water control, if required.
2. Trench Safety Plan in accordance with Occupational Safety and Health Administration CFR 29, Part 1926-Safety Regulations for Construction, Subpart P - Excavations
3. Stockpiled excavation and/or backfill material
   a. Provide a description of the storage of the excavated material only if the Contract Documents do not allow storage of materials in the right-of-way of the easement.

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE, AND HANDLING

A. Storage

1. Within Existing Rights-of-Way (ROW)
   a. Spoil, imported embedment and backfill materials may be stored within existing ROW, easements or temporary construction easements, unless specifically disallowed in the Contract Documents.
   b. Do not block drainage ways, inlets or driveways.
   c. Provide erosion control in accordance with Section 31 25 00.
   d. Store materials only in areas barricaded as provided in the traffic control plans.
   e. In non-paved areas, do not store material on the root zone of any trees or in landscaped areas.
2. Designated Storage Areas
   a. If the Contract Documents do not allow the storage of spoils, embedment or backfill materials within the ROW, easement or temporary construction easement, then secure and maintain an adequate storage location.
   b. Provide an affidavit that rights have been secured to store the materials on private property.
   c. Provide erosion control in accordance with Section 31 25 00.

d. Do not block drainage ways.
e. Only materials used for 1 working day will be allowed to be stored in the work zone.

B. Deliveries and haul-off - Coordinate all deliveries and haul-off.

1.11 FIELD [SITE] CONDITIONS

A. Existing Conditions

1. Any data which has been or may be provided on subsurface conditions is not intended as a representation or warranty of accuracy or continuity between soils. It is expressly understood that neither the City nor the Engineer will be responsible for interpretations or conclusions drawn there from by the Contractor.
2. Data is made available for the convenience of the Contractor.

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED [OR] OWNER-SUPPLIED PRODUCTS

2.2 MATERIALS

A. Materials

1. Utility Sand
   a. Granular and free flowing
   b. Generally meets or exceeds the limits on deleterious substances per Table 1 for fine aggregate according to ASTM C 33
   c. Reasonably free of organic material
   d. Gradation: sand material consisting of durable particles, free of thin or elongated pieces, lumps of clay, loam or vegetable matter and meets the following gradation may be used for utility sand embedment/backfill

Sieve Size	Percent Retained
½"	0
¼"	0-5
#4	0-10
#16	0-20
#50	20-70
#100	60-90
#200	90-100

   e. The City has a pre-approved list of sand sources for utility embedment. The pre-approved list can be found on the City website, Project Resources page. The utility sand sources in the pre-approved list have demonstrated continued quality and uniformity on City of Fort Worth projects. Sand from these sources are pre-approved for use on City projects without project specific testing.
2. Crushed Rock
   a. Durable crushed rock or recycled concrete
   b. Meets the gradation of ASTM D448 size numbers 56, 57 or 67

c. May be unwashed
d. Free from significant silt clay or unsuitable materials
e. Percentage of wear not more than 40 percent per ASTM C131 or C535
f. Not more than a 12 percent maximum loss when subjective to 5 cycles of sodium sulfate soundness per ASTM C88

3. Fine Crushed Rock
   a. Durable crushed rock
   b. Meets the gradation of ASTM D448 size numbers 8 or 89
   c. May be unwashed
   d. Free from significant silt clay or unsuitable materials.
   e. Have a percentage of wear not more than 40 percent per ASTM C131 or C535
   f. Not more than a 12 percent maximum loss when subjective to 5 cycles of sodium sulfate soundness per ASTM C88
4. Ballast Stone
   a. Stone ranging from 3 inches to 6 inches in greatest dimension.
   b. May be unwashed
   c. Free from significant silt clay or unsuitable materials
   d. Percentage of wear not more than 40 percent per ASTM C131 or C535
   e. Not more than a 12 percent maximum loss when subjected to 5 cycles of sodium sulfate soundness per ASTM C88
5. Acceptable Backfill Material
   a. In-situ or imported soils classified as CL, CH, SC or GC in accordance with ASTM D2487
   b. Free from deleterious materials, boulders over 6 inches in size and organics
   c. Can be placed free from voids
   d. Must have 20 percent passing the number 200 sieve
6. Blended Backfill Material
   a. In-situ soils classified as SP, SM, GP or GM in accordance with ASTM D2487
   b. Blended with in-situ or imported acceptable backfill material to meet the requirements of an Acceptable Backfill Material
   c. Free from deleterious materials, boulders over 6 inches in size and organics
   d. Must have 20 percent passing the number 200 sieve
7. Unacceptable Backfill Material
   a. In-situ soils classified as ML, MH, PT, OL or OH in accordance with ASTM D2487
8. Select Fill
   a. Classified as SC or CL in accordance with ASTM D2487
   b. Liquid limit less than 35
   c. Plasticity index between 8 and 20
9. Cement Stabilized Sand (CSS)
   a. Sand
      1) Shall be clean, durable sand meeting grading requirements for fine aggregates of ASTM C33 and the following requirements:
         a) Classified as SW, SP, or SM by the United Soil Classification System of ASTM D2487
         b) Deleterious materials
            (1) Clay lumps, ASTM C142, less than 0.5 percent
            (2) Lightweight pieces, ASTM C123, less than 5.0 percent

(3) Organic impurities, ASTM C40, color no darker than standard color
(4) Plasticity index of 4 or less when tested in accordance with ASTM D4318.

b. Minimum of 4 percent cement content of Type I/II portland cement
c. Water
1) Potable water, free of soils, acids, alkalis, organic matter or other deleterious substances, meeting requirements of ASTM C94
d. Mix in a stationary pug mill, weigh-batch or continuous mixing plant.
e. Strength
1) 50 to 150 psi compressive strength at 2 days in accordance with ASTM D1633, Method A
2) 200 to 250 psi compressive strength at 28 days in accordance with ASTM D1633, Method A
3) The maximum compressive strength in 7 days shall be 400 psi. Backfill that exceeds the maximum compressive strength shall be removed by the Contractor for no additional compensation.
f. Random samples of delivered product will be taken in the field at point of delivery for each day of placement in the work area. Specimens will be prepared in accordance with ASTM D1632.

10. Controlled Low Strength Material (CLSM)
a. Conform to Section 03 34 13
11. Trench Geotextile Fabric
a. Soils other than ML or OH in accordance with ASTM D2487
1) Needle punch, nonwoven geotextile composed of polypropylene fibers
2) Fibers shall retain their relative position
3) Inert to biological degradation
4) Resist naturally occurring chemicals
5) UV Resistant
6) Mirafi 140N by Tencate, or approved equal
b. Soils Classified as ML or OH in accordance with ASTM D2487
1) High-tenacity monofilament polypropylene woven yarn
2) Percent open area of 8 percent to10 percent
3) Fibers shall retain their relative position
4) Inert to biological degradation
5) Resist naturally occurring chemicals
6) UV Resistant
7) Mirafi FW402 by Tencate, or approved equal
12. Concrete Encasement
a. Conform to Section 03 30 00.

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION

A. Verification of Conditions
   1. Review all known, identified or marked utilities, whether public or private, prior to excavation.
   2. Locate and protect all known, identified and marked utilities or underground facilities as excavation progresses.
   3. Notify all utility owners within the project limits 48 hours prior to beginning excavation.
   4. The information and data shown in the Drawings with respect to utilities is approximate and based on record information or on physical appurtenances observed within the project limits.
   5. Coordinate with the Owner(s) of underground facilities.
   6. Immediately notify any utility owner of damages to underground facilities resulting from construction activities.
   7. Repair any damages resulting from the construction activities.

B. Notify the City immediately of any changed condition that impacts excavation and installation of the proposed utility.

3.3 PREPARATION

A. Protection of In-Place Conditions
   1. Pavement
      a. Conduct activities in such a way that does not damage existing pavement that is designated to remain.
         1) Where desired to move equipment not licensed for operation on public roads or across pavement, provide means to protect the pavement from all damage.
      b. Repair or replace any pavement damaged due to the negligence of the contractor outside the limits designated for pavement removal at no additional cost to the City.
   2. Drainage
      a. Maintain positive drainage during construction and re-establish drainage for all swales and culverts affected by construction.
   3. Trees
      a. When operating outside of existing ROW, stake permanent and temporary construction easements.
      b. Restrict all construction activities to the designated easements and ROW.
      c. Flag and protect all trees designated to remain in accordance with Section 31 10 00.

d. Conduct excavation, embedment and backfill in a manner such that there is no damage to the tree canopy.
e. Prune or trim tree limbs as specifically allowed by the Drawings or as specifically allowed by the City.
   1) Pruning or trimming may only be accomplished with equipments specifically designed for tree pruning or trimming.
f. Remove trees specifically designated to be removed in the Drawings in accordance with Section 31 10 00.

4. Above ground Structures
   a. Protect all above ground structures adjacent to the construction.
   b. Remove above ground structures designated for removal in the Drawings in accordance with Section 02 41 13

5. Traffic
   a. Maintain existing traffic, except as modified by the traffic control plan, and in accordance with Section 34 71 13.
   b. Do not block access to driveways or alleys for extended periods of time unless:
      1) Alternative access has been provided
      2) Proper notification has been provided to the property owner or resident
      3) It is specifically allowed in the traffic control plan
   c. Use traffic rated plates to maintain access until access is restored.

6. Traffic Signal – Poles, Mast Arms, Pull boxes, Detector loops
   a. Notify the City's Transportation Management Division a minimum of 48 hours prior to any excavation that could impact the operations of an existing traffic signal.
   b. Protect all traffic signal poles, mast arms, pull boxes, traffic cabinets, conduit and detector loops.
   c. Immediately notify the City's Transportation Management Division if any damage occurs to any component of the traffic signal due to the contractors activities.
   d. Repair any damage to the traffic signal poles, mast arms, pull boxes, traffic cabinets, conduit and detector loops as a result of the construction activities.

7. Fences
   a. Protect all fences designated to remain.
   b. Leave fence in the equal or better condition as prior to construction.

3.4 INSTALLATION

A. Excavation

1. Excavate to a depth indicated on the Drawings.
2. Trench excavations are defined as unclassified. No additional payment shall be granted for rock or other in-situ materials encountered in the trench.
3. Excavate to a width sufficient for laying the pipe in accordance with the Drawings and bracing in accordance with the Excavation Safety Plan.
4. The bottom of the excavation shall be firm and free from standing water.
   a. Notify the City immediately if the water and/or the in-situ soils do not provide for a firm trench bottom.
   b. The City will determine if any changes are required in the pipe foundation or bedding.

5. Unless otherwise permitted by the Drawings or by the City, the limits of the excavation shall not advance beyond the pipe placement so that the trench may be backfilled in the same day.
6. Over Excavation
   a. Fill over excavated areas with the specified bedding material as specified for the specific pipe to be installed.
   b. No additional payment will be made for over excavation or additional bedding material.
7. Unacceptable Backfill Materials
   a. In-situ soils classified as unacceptable backfill material shall be separated from acceptable backfill materials.
   b. If the unacceptable backfill material is to be blended in accordance with this Specification, then store material in a suitable location until the material is blended.
   c. Remove all unacceptable material from the project site that is not intended to be blended or modified.
8. Rock – No additional compensation will be paid for rock excavation or other changed field conditions.

B. Shoring, Sheeting and Bracing
1. Engage a Licensed Professional Engineer in the State of Texas to design a site specific excavation safety system in accordance with Federal and State requirements.
2. Excavation protection systems shall be designed according to the space limitations as indicated in the Drawings.
3. Furnish, put in place and maintain a trench safety system in accordance with the Excavation Safety Plan and required by Federal, State or local safety requirements.
4. If soil or water conditions are encountered that are not addressed by the current Excavation Safety Plan, engage a Licensed Professional Engineer in the State of Texas to modify the Excavation Safety Plan and provide a revised submittal to the City.
5. Do not allow soil, or water containing soil, to migrate through the Excavation Safety System in sufficient quantities to adversely affect the suitability of the Excavation Protection System. Movable bracing, shoring plates or trench boxes used to support the sides of the trench excavation shall not:
   a. Disturb the embedment located in the pipe zone or lower
   b. Alter the pipe's line and grade after the Excavation Protection System is removed
   c. Compromise the compaction of the embedment located below the spring line of the pipe and in the haunching

C. Water Control
1. Surface Water
   a. Furnish all materials and equipment and perform all incidental work required to direct surface water away from the excavation.
2. Ground Water
   a. Furnish all materials and equipment to dewater ground water by a method which preserves the undisturbed state of the subgrade soils.
   b. Do not allow the pipe to be submerged within 24 hours after placement.

c. Do not allow water to flow over concrete until it has sufficiently cured.
d. Engage a Licensed Engineer in the State of Texas to prepare a Ground Water Control Plan if any of the following conditions are encountered:
    1) A Ground Water Control Plan is specifically required by the Contract Documents
    2) If in the sole judgment of the City, ground water is so severe that an Engineered Ground Water Control Plan is required to protect the trench or the installation of the pipe which may include:
        a) Ground water levels in the trench are unable to be maintained below the top of the bedding
        b) A firm trench bottom cannot be maintained due to ground water
        c) Ground water entering the excavation undermines the stability of the excavation.
        d) Ground water entering the excavation is transporting unacceptable quantities of soils through the Excavation Safety System.
e. In the event that there is no bid item for a Ground Water Control and the City requires an Engineered Ground Water Control Plan due to conditions discovered at the site, the contractor will be eligible to submit a change order.
f. Control of ground water shall be considered subsidiary to the excavation when:
    1) No Ground Water Control Plan is specifically identified and required in the Contract Documents
g. Ground Water Control Plan installation, operation and maintenance
    1) Furnish all materials and equipment necessary to implement, operate and maintain the Ground Water Control Plan.
    2) Once the excavation is complete, remove all ground water control equipment not called to be incorporated into the work.
h. Water Disposal
    1) Dispose of ground water in accordance with City policy or Ordinance.
    2) Do not discharge ground water onto or across private property without written permission.
    3) Permission from the City is required prior to disposal into the Sanitary Sewer.
    4) Disposal shall not violate any Federal, State or local regulations.

D. Embedment and Pipe Placement

1. Water Lines less than, or equal to, 12 inches in diameter:
    a. The entire embedment zone shall be of uniform material.
    b. Utility sand shall be generally used for embedment.
    c. If ground water is in sufficient quantity to cause sand to pump, then use crushed rock as embedment.
        1) If crushed rock is not specifically identified in the Contract Documents, then crushed rock shall be paid by the pre-bid unit price.
    d. Place evenly spread bedding material on a firm trench bottom.
    e. Provide firm, uniform bedding.
    f. Place pipe on the bedding in accordance with the alignment of the Drawings.
    g. In no case shall the top of the pipe be less than 42 inches from the surface of the proposed grade, unless specifically called for in the Drawings.
    h. Place embedment, including initial backfill, to a minimum of 6 inches, but not more than 12 inches, above the pipe.

i. Where gate valves are present, the initial backfill shall extend to 6 inches above the elevation of the valve nut.
j. Form all blocking against undisturbed trench wall to the dimensions in the Drawings.
k. Compact embedment and initial backfill.
l. Place marker tape on top of the initial trench backfill in accordance with Section 33 05 26.

2. Water Lines 16-inches through 24-inches in diameter:
   a. The entire embedment zone shall be of uniform material.
   b. Utility sand may be used for embedment when the excavated trench depth is less than 15 feet deep.
   c. Crushed rock or fine crushed rock shall be used for embedment for excavated trench depths 15 feet, or greater.
   d. Crushed rock shall be used for embedment for steel pipe.
   e. Provide trench geotextile fabric at any location where crushed rock or fine crushed rock come into contact with utility sand
   f. Place evenly spread bedding material on a firm trench bottom.
   g. Provide firm, uniform bedding.
      1) Additional bedding may be required if ground water is present in the trench.
      2) If additional crushed rock is required not specifically identified in the Contract Documents, then crushed rock shall be paid by the pre-bid unit price.
   h. Place pipe on the bedding according to the alignment shown on the Drawings.
   i. The pipe line shall be within:
      1) ±3 inches of the elevation on the Drawings for 16-inch and 24-inch water lines
   j. Place and compact embedment material to adequately support haunches in accordance with the pipe manufacturer's recommendations.
   k. Place remaining embedment including initial backfill to a minimum of 6 inches, but not more than 12 inches, above the pipe.
   l. Where gate valves are present, the initial backfill shall extend to up to the valve nut.
   m. Compact the embedment and initial backfill to 95 percent Standard Proctor ASTM D 698.
   n. Density test performed by a commercial testing firm approved by the City to verify that the compaction of embedment meets requirements.
   o. Place trench geotextile fabric on top of the initial backfill.
   p. Place marker tape on top of the trench geotextile fabric in accordance with Section 33 05 26.

3. Water Lines 30-inches and greater in diameter
   a. The entire embedment zone shall be of uniform material.
   b. Crushed rock shall be used for embedment.
   c. Provide trench geotextile fabric at any location where crushed rock or fine crushed rock come into contact with utility sand.
   d. Place evenly spread bedding material on a firm trench bottom.
   e. Provide firm, uniform bedding.
      1) Additional bedding may be required if ground water is present in the trench.

2) If additional crushed rock is required which is not specifically identified in the Contract Documents, then crushed rock shall be paid by the pre-bid unit price.

f. Place pipe on the bedding according to the alignment shown on the Drawings.

g. The pipe line shall be within:

1) ±1 inch of the elevation on the Drawings for 30-inch and larger water lines

h. Place and compact embedment material to adequately support haunches in accordance with the pipe manufacturer's recommendations.

i. For steel pipe greater than 30 inches in diameter, the initial embedment lift shall not exceed the spring line prior to compaction.

j. Place remaining embedment, including initial backfill, to a minimum of 6 inches, but not more than 12 inches, above the pipe.

k. Where gate valves are present, the initial backfill shall extend to up to the valve nut.

l. Compact the embedment and initial backfill to 95 percent Standard Proctor ASTM D 698.

m. Density test may be performed by a commercial testing firm approved by the City to verify that the compaction of embedment meets requirements.

n. Place trench geotextile fabric on top of the initial backfill.

o. Place marker tape on top of the trench geotextile fabric in accordance with Section 33 05 26.

4. Sanitary Sewer Lines and Storm Sewer Lines (HDPE)

a. The entire embedment zone shall be of uniform material.

b. Crushed rock shall be used for embedment.

c. Place evenly spread bedding material on a firm trench bottom.

d. Spread bedding so that lines and grades are maintained and that there are no sags in the sanitary sewer pipe line.

e. Provide firm, uniform bedding.

1) Additional bedding may be required if ground water is present in the trench.

2) If additional crushed rock is required which is not specifically identified in the Contract Documents, then crushed rock shall be paid by the pre-bid unit price.

f. Place pipe on the bedding according to the alignment shown in the Drawings.

g. The pipe line shall be within ±0.1 inches of the elevation, and be consistent with the grade shown on the Drawings.

h. Place and compact embedment material to adequately support haunches in accordance with the pipe manufacturer's recommendations.

i. For sewer lines greater than 30 inches in diameter, the embedment lift shall not exceed the spring line prior to compaction.

j. Place remaining embedment including initial backfill to a minimum of 6 inches, but not more than 12 inches, above the pipe.

k. Compact the embedment and initial backfill to 95 percent Standard Proctor ASTM D 698.

l. Density test may be performed by a commercial testing firm approved by the City to verify that the compaction of embedment meets requirements.

m. Place trench geotextile fabric on top of the initial backfill.

n. Place marker tape on top of the trench geotextile fabric in accordance with Section 33 05 26.

5. Storm Sewer (RCP)
   a. The bedding and the pipe zone up to the spring line shall be of uniform material.
   b. Crushed rock shall be used for embedment up to the spring line.
   c. The specified backfill material may be used above the spring line.
   d. Place evenly spread bedding material on a firm trench bottom.
   e. Spread bedding so that lines and grades are maintained and that there are no sags in the storm sewer pipe line.
   f. Provide firm, uniform bedding.
      1) Additional bedding may be required if ground water is present in the trench.
      2) If additional crushed rock is required which is not specifically identified in the Contract Documents, then crushed rock shall be paid by the pre-bid unit price.
   g. Place pipe on the bedding according to the alignment of the Drawings.
   h. The pipe line shall be within ±0.1 inches of the elevation, and be consistent with the grade, shown on the Drawings.
   i. Place embedment material up to the spring line.
      1) Place embedment to ensure that adequate support is obtained in the haunch.
   j. Compact the embedment and initial backfill to 95 percent Standard Proctor ASTM D 698.
   k. Density test may be performed by a commercial testing firm approved by the City to verify that the compaction of embedment meets requirements.
   l. Place trench geotextile fabric on top of pipe and crushed rock.
6. Storm Sewer (PP - Polypropylene)
   a. The entire embedment zone shall be of uniform material.
   b. Crushed rock shall be used for embedment up to top of pipe.
   c. Place evenly spread bedding material on a firm trench bottom.
   d. Spread bedding so that lines and grades are maintained and that there are no sags in the storm sewer pipe line.
   e. Provide firm, uniform bedding.
      1) Additional bedding may be required if ground water is present in the trench.
      2) If additional crushed rock is required which is not specifically identified in the Contract Documents, then crushed rock shall be paid by the pre-bid unit price.
   f. Place pipe on the bedding according to the alignment shown in the Drawings.
   g. The pipe line shall be within ±0.1 inches of the elevation, and be consistent with the grade shown on the Drawings.
   h. Place and compact embedment material to adequately support haunches in accordance with the pipe manufacturer's recommendations.
   i. Compact the embedment and initial backfill to 95 percent Standard Proctor ASTM D 698.
   j. Density test may be performed by City to verify that the compaction of embedment meets requirements.
   k. Place trench geotextile fabric on top of the initial backfill.
7. Storm Sewer Reinforced Concrete Box
   a. Crushed rock shall be used for bedding.
   b. The pipe zone and the initial backfill shall be:

1) Crushed rock, or
2) Acceptable backfill material compacted to 95 percent Standard Proctor density

c. Place evenly spread compacted bedding material on a firm trench bottom.
d. Spread bedding so that lines and grades are maintained and that there are no sags in the storm sewer pipe line.
e. Provide firm, uniform bedding.
1) Additional bedding may be required if ground water is present in the trench.
2) If additional crushed rock is required which is not specifically identified in the Contract Documents, then crushed rock shall be paid by the pre-bid unit price.
f. Fill the annular space between multiple boxes with crushed rock, CLSM according to 03 34 13.
g. Place pipe on the bedding according to the alignment of the Drawings.
h. The pipe shall be within ±0.1 inches of the elevation, and be consistent with the grade, shown on the Drawings.
i. Compact the embedment initial backfill to 95 percent Standard Proctor ASTM D698.

8. Water Services (Less than 2 Inches in Diameter)
a. The entire embedment zone shall be of uniform material.
b. Utility sand shall be generally used for embedment.
c. Place evenly spread bedding material on a firm trench bottom.
d. Provide firm, uniform bedding.
e. Place pipe on the bedding according to the alignment of the Plans.
f. Compact the initial backfill to 95 percent Standard Proctor ASTM D698.

9. Sanitary Sewer Services
a. The entire embedment zone shall be of uniform material.
b. Crushed rock shall be used for embedment.
c. Place evenly spread bedding material on a firm trench bottom.
d. Spread bedding so that lines and grades are maintained and that there are no sags in the sanitary sewer pipe line.
e. Provide firm, uniform bedding.
1) Additional bedding may be required if ground water is present in the trench.
2) If additional crushed rock is required which is not specifically identified in the Contract Documents, then crushed rock shall be paid by the pre-bid unit price.
f. Place pipe on the bedding according to the alignment of the Drawings.
g. Place remaining embedment, including initial backfill, to a minimum of 6 inches, but not more than 12 inches, above the pipe.
h. Compact the initial backfill to 95 percent Standard Proctor ASTM D698.
i. Density test may be required to verify that the compaction meets the density requirements.

E. Trench Backfill

1. At a minimum, place backfill in such a manner that the required in-place density and moisture content is obtained, and so that there will be no damage to the surface, pavement or structures due to any trench settlement or trench movement.

a. Meeting the requirement herein does not relieve the responsibility to damages associated with the Work.

2. Backfill Material
   a. Final backfill (not under existing pavement or future pavement)
      1) Backfill with:
         a) Acceptable backfill material
         b) Blended backfill material, or
         c) Select backfill material, CSS, or CLSM when specifically required
   b. Final backfill depth 15 feet or greater (under existing or future pavement)
      1) Backfill depth from 0 to15 feet deep
         a) Backfill with:
            (1) Acceptable backfill material
            (2) Blended backfill material, or
            (3) Select backfill material, CSS, or CLSM when specifically required
      2) Backfill depth from 15 feet and greater
         a) Backfill with:
            (1) Select Fill
            (2) CSS, or
            (3) CLSM when specifically required
         b)
   c. Backfill for service lines:
      1) Backfill for water or sewer service lines shall be the same as the requirement of the main that the service is connected to.
3. Required Compaction and Density
   a. Final backfill (depths less than 15 feet/under existing or future pavement)
      1) Compact acceptable backfill material, blended backfill material or select backfill to a minimum of 95 percent Standard Proctor per ASTM D698 at moisture content within -2 to +5 percent of the optimum moisture.
      2) CSS or CLSM requires no compaction.
   b. Final backfill (depths 15 feet and greater/under existing or future pavement)
      1) Compact select backfill to a minimum of 98 percent Standard Proctor per ASTM D 698 at moisture content within -2 to +5 percent of the optimum moisture up to the final grade.
      2) CSS or CLSM requires no compaction.
   c. Final backfill (not under existing or future pavement)
      1) Compact acceptable backfill material blended backfill material, or select backfill to a minimum of 95 percent Standard Proctor per ASTM D 698 at moisture content within -2 to +5 percent of the optimum moisture.
4. Saturated Soils
   a. If in-situ soils consistently demonstrate that they are greater than 5 percent over optimum moisture content, the soils are considered saturated.
   b. Flooding the trench or water jetting is strictly prohibited.
   c. If saturated soils are identified in the Drawings or Geotechnical Report in the Appendix, Contractor shall proceed with Work following all backfill procedures outlined in the Drawings for areas of soil saturation greater than 5 percent.
   d. If saturated soils are encountered during Work but not identified in Drawings or Geotechnical Report in the Appendix:
      1) The Contractor shall:
         a) Immediately notify the City.

b) Submit a Contract Claim for Extra Work associated with direction from City.

2) The City shall:

a) Investigate soils and determine if Work can proceed in the identified location.

b) Direct the Contractor of changed backfill procedures associated with the saturated soils that may include:

(1) Imported backfill

(2) A site specific backfill design

5. Placement of Backfill
   a. Use only compaction equipment specifically designed for compaction of a particular soil type and within the space and depth limitation experienced in the trench.
   b. Flooding the trench or water setting is strictly prohibited.
   c. Place in loose lifts not to exceed 12 inches.
   d. Compact to specified densities.
   e. Compact only on top of initial backfill, undisturbed trench or previously compacted backfill.
   f. Remove any loose materials due to the movement of any trench box or shoring or due to sloughing of the trench wall.
   g. Install appropriate tracking balls for water and sanitary sewer trenches in accordance with Section 33 05 26.
6. Backfill Means and Methods Demonstration
   a. Notify the City in writing with sufficient time for the City to obtain samples and perform standard proctor test in accordance with ASTM D698.
   b. The results of the standard proctor test must be received prior to beginning excavation.
   c. Upon commencing of backfill placement for the project the Contractor shall demonstrate means and methods to obtain the required densities.
   d. Demonstrate Means and Methods for compaction including:
      1) Depth of lifts for backfill which shall not exceed 12 inches
      2) Method of moisture control for excessively dry or wet backfill
      3) Placement and moving trench box, if used
      4) Compaction techniques in an open trench
      5) Compaction techniques around structure
   e. Provide a testing trench box to provide access to the recently backfilled material.
   f. The City will provide a qualified testing lab full time during this period to randomly test density and moisture continent.
      1) The testing lab will provide results as available on the job site.
7. Varying Ground Conditions
   a. Notify the City of varying ground conditions and the need for additional proctors.
   b. Request additional proctors when soil conditions change.
   c. The City may acquire additional proctors at its discretion.
   d. Significant changes in soil conditions will require an additional Means and Methods demonstration.

3.5 REPAIR [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD QUALITY CONTROL

A. Field Tests and Inspections

1. Proctors
   a. The City will perform Proctors in accordance with ASTM D698.
   b. Test results will generally be available to within 4 calendar days and distributed to:
      1) Contractor
      2) City Project Manager
      3) City Inspector
      4) Engineer
   c. Notify the City if the characteristic of the soil changes.
   d. City will perform new proctors for varying soils:
      1) When indicated in the geotechnical investigation in the Appendix
      2) If notified by the Contractor
      3) At the convenience of the City
   e. Trenches where different soil types are present at different depths, the proctors shall be based on the mixture of those soils.
2. Density Testing of Backfill
   a. Density Tests shall be in conformance with ASTM D2922.
   b. Provide a testing trench protection for trench depths in excess of 5 feet.
   c. Place, move and remove testing trench protection as necessary to facilitate all test conducted by the commercial testing firm approved by the City.
   d. The commercial testing lab will perform moisture/density test for every 200-ft or less of trench length, as measured along the length of the pipe. A minimum of one test shall be performed for every 2 vertical feet of compacted backfill material, independent of the contractor's lift thickness for compaction. Test locations shall be staggered within each lift so that successive lifts are not tested in the same location. A random number generator may be used to determine test locations. Moisture/density tests shall be performed at a depth not more than 2 feet above the top of the pipe bedding and in 2-foot increments up to the final grade. The project inspector or project manager may request testing at an increased frequency and/or at specific locations.
   e. The contractor can proceed with subsequent earthwork only after test results for previously completed work comply with requirements. If the required compaction density has not been obtained, the backfill should be scarified and moistened or aerated, or removed to a depth required, and be replaced with approved backfill, and re-compacted to the specified density at the contractor's expense. In no case will excavation, pipe-laying, or other operation be allowed to proceed until the specified compaction is attained.
   f. The testing lab will provide results to Contractor and the City's Inspector upon completion of the testing.
   g. A formal report will be posted to the City's Accela (Developer Projects) and BIM 360 (City Projects) site within 48 hours.
   h. Test reports shall include:
      1) Location of test by station number

2) Time and date of test
3) Depth of testing
4) Field moisture
5) Dry density
6) Proctor identifier
7) Percent Proctor Density

3. Density of Embedment
   a. Storm sewer boxes that are embedded with acceptable backfill material, blended backfill material, cement modified backfill material or select material will follow the same testing procedure as backfill.
   b. The City may test fine crushed rock or crushed rock embedment in accordance with ASTM D2922 or ASTM 1556.

B. Non-Conforming Work

1. All non-conforming work shall be removed and replaced.

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING [NOT USED]

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

END OF SECTION

Revision Log		
DATE	NAME	SUMMARY OF CHANGE
12/20/2012	D. Johnson	1.2 – Added Item for Concrete Encasement for Utility Lines Various Sections – Revised Depths to Include 15' and greater 3.3.A – Additional notes for pavement protection and positive drainage. 3.4.E.2 – Added requirements for backfill of service lines. 3.4.E.5 – Added language prohibiting flooding of trench
6/18/2013	D. Johnson	1.2.A.3 – Clarified measurement and payment for concrete encasement as per plan quantity 2.2.A – Added language for concrete encasement
11/09/16	Z. Arega	2.2.A.1.d Modify gradation for sand material
2/26/2021	Z. Arega	2.2 A. 1. E. - Added reference to pre-approved list of sand sources for embedment; 3.3 A. 6. - Changed reference to Transportation Management Division; 3.4 - Provided clarification re: use of commercial testing firms approved by City and backfill requirements; and 3.7 A. 2. Provided clarification re: backfill testing requirements.

4/2/2021	M Owen	3.4 D. 6. Add requirements Storm Sewer (PP - Polypropylene)

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