

SECTION 02221

TRENCHING, BACKFILLING AND COMPACTION

PART 1 GENERAL

1.01 SUMMARY

- A. Work to be performed under this section shall include all labor, equipment, materials and miscellaneous items necessary to perform all excavation, backfilling and compaction of underground pipelines, conduits, cables and appurtenances shown on the Drawings and specified herein.
- B. All work within the rights-of-way of the Federal Government of the Colorado Division of Highways, County Governments or Municipal Governments shall be done in compliance with requirements issued by those agencies. All such requirements shall take precedence over these Specifications. It shall be the Contractor's responsibility to secure all required excavation permits and pay all costs thereof. Contractor will be required to obtain necessary road cut permits.

1.02 SUBMITTALS

- A. Bedding Material
 - 1. Submit sieve analysis
- B. Select Fill
 - 1. Submit sieve analysis

1.03 FIELD CONDITIONS

- A. Existing Utilities. Underground utilities, except service lines, known to the Engineer have been shown on the Drawings. Locations are approximate only and may prove to be inaccurate. The Contractor is responsible for verification of the existence, location and protection of all utilities within the construction area.
 - 1. Before commencing with work, the Contractor shall notify all public and private companies who may have utilities within the project limits. The Contractor shall coordinate with these entities all excavation performed. The Contractor shall obtain all permits required by utility owners.
 - 2. In the event of damage to any existing utility, the Contractor shall be solely responsible for the repair and payment for repair of all such damage.
 - 3. The Contractor shall make arrangements for and pay all costs for relocation of utilities requiring relocation as indicated on the Drawings. Should utility obstructions, not shown on the Drawings, be encountered and require relocation, the Contractor shall notify the Owner and the

Engineer and shall make arrangements necessary for such relocation.
The Owner shall pay the costs for such relocation.

- B. Existing Improvements. The Contractor shall restore or protect from damage all existing improvements encountered in performance of the work. Improvements damaged, as a result of this work shall be restored to original condition or better, as determined by the Engineer.
 - 1. Adjacent property shall be protected by the Contractor from any damage. The Contractor shall be held solely liable for any damage to adjacent property and shall be responsible for all costs resulting from repair of such damage.
- C. Soil Conditions. It shall be the responsibility of the Contractor to examine soil conditions and characteristics, including the presence of groundwater that will be encountered within the limits of construction.

1.04 PROTECTION OF WORK

- A. Safety. All excavation shall be protected by barricades, lights, signs, etc., as required by governing federal, state and local safety codes and regulations.
- B. Sheet piling, Shoring and Bracing. Where trench walls are not excavated at a stable slope, the Contractor shall provide and maintain support sufficient to prevent caving, sliding or failure and property or bodily damage. Any damage due to inadequate support shall be repaired at the sole expense of the Contractor.
 - 1. Under normal construction conditions, support shall be removed as work progresses. Support shall remain installed if directed by the Engineer or if pipe does not have sufficient strength to support backfill based on trench width as defined by the sheet piling. Sheet piling shall not be removed after the start of backfilling.
 - 2. Use of a movable trench shield or coffin box will not be allowed where pipe strength is insufficient to support backfill as defined by the trench width after the trench shield is removed.
 - 3. The Contractor shall be held solely responsible for any violation of applicable safety standards. Particular attention is called to minimum requirements of OSHA and COSH (Colorado Occupational Safety and Health).
- C. Site Drainage. Excavation to be protected from surface water at all times. At no time shall excavated area be allowed to fill with storm water runoff. Contractor shall provide proper, temporary drainage structures at their cost to detour runoff from excavated areas.

1.05 BLASTING

- A. No blasting shall be permitted without written consent of the Engineer. Blasting

shall be done only after Engineer receives permission from the appropriate governmental authority(ies). Blasting shall be performed only by properly licensed, experienced individuals and in a manner such that no damage to any property or persons will occur due to either the blast or debris. Contractor shall provide proof of insurance as required by these Specifications, the governing authority or as required by Engineer prior to any blasting. All damage as the result of blasting shall be repaired, at the Contractor's expense, to the satisfaction of the Engineer. All earth or rock loosened by blasting shall be removed from excavations prior to proposed construction.

1.06 CONSTRUCTION IN STREETS

- A. When construction operations are located within streets make provisions at cross streets and walks for free passage of vehicles and pedestrians. Do not block streets or walks without prior approval.

PART 2 PRODUCTS

2.01 EMBEDMENT MATERIAL

- A. Pipeline embedment material shall comply with the appropriate classes as listed below and as illustrated in the Construction Drawings:
 - 1. Class A - Use where improper trenching or unexpected trench conditions require its use as determined by the Engineer.
 - a. Characteristics - Concrete cradle foundation with densely compacted Class 6 aggregate base backfill to 12" above top of pipe, or densely compacted Class 6 aggregate granular foundation with concrete arch cover to 6" above top of pipe.
 - 2. Class B - Use for all PVC, DIP, CMP and concrete pipe under normal construction conditions.
 - a. Characteristics - Densely compacted Class 6 aggregate granular foundation of depth shown on Typical Details with densely compacted Class 6 aggregate 12" above top of pipe.

2.02 SELECT MATERIAL

- A. Subject to approval by the Engineer, select material shall be allowed in place of the aggregate backfill for Class B when excavation and soil conditions allow, but only if approved by Engineer. Contractors shall bid project based upon Class B. If Class A or select material is used, price adjustments shall be made.
 - 1. Characteristics - Soil materials free from rocks, clods, and organic material.

2.03 CONCRETE FOR EMBEDMENT

- A. Shall be 2000 psi concrete (28-day compressive strength). Reinforcement shall conform to ASTM A615, Grade 40.

2.04 BACKFILL MATERIAL

- A. Characteristics - Native materials free from debris, organic matter and frozen material. Uniformly graded sufficient to allow proper compaction.
- B. Gradation - No boulders greater than 6-inch diameter in top 12 inches of backfill.
 - 1. Generally no boulders greater than 12-inch diameter in remainder of trench. Limited number of boulders not exceeding 24-inch diameter to be allowed at discretion of Engineer provided boulders can be uniformly dispersed and will not interfere in compactive effort.

PART 3 EXECUTION

3.01 SITE PREPARATION

- A. Clearing. Remove all vegetation, stumps, roots, organic matter, debris and other miscellaneous structures and materials from project site. Dispose of off site.
- B. Topsoil Removal. Strip existing topsoil from all areas to be disturbed by construction. Topsoil to be stockpiled separately from excavated materials.
- C. Pavement Removal. See Section 02101 - Removal of Structures and Obstructions.

3.02 TRENCH EXCAVATION

- A. Limits of Excavation. Trenches to be excavated along lines and grades shown on the Drawings, or as modified in the field by the Engineer. Trench widths for pipe loading to be measured 12 inches above top of pipe.
 - 1. Minimum trench width to be the outside diameter of the pipe or conduit plus 18 inches.
 - 2. Maximum trench width to be the outside diameter of the pipe or conduit plus 24 inches for all pipes or conduits with outside diameter of 24 inches or less, and plus 30 inches for all pipes or conduits with outside diameters greater than 24 inches.
 - 3. If maximum trench width is exceeded, Contractor will provide at his expense, higher strength pipe or special bedding including concrete at the direction of the Engineer.
 - 4. Trench excavation not to be completed more than 100 feet in advance of pipe installation. Backfill to be completed within 100 feet of pipe installation.
- B. Groundwater Control. Contractor to maintain facilities on-site to remove all groundwater from trench and keep water at least 12 inches below the trench bottom to a point such that a firm base for pipe or conduit installation exists.

Facilities shall be maintained until all concrete is cured and backfilling is in place at least 24 inches above anticipated water levels before water removal is discontinued; all water removal shall be subject to approval by the Engineer.

- C. Stockpile Excavated Material. Excavated material to be stockpiled so as not to endanger the work or public safety. Maintain existing vehicular and pedestrian traffic with minimum disruption. Maintain emergency access and access to existing fire hydrants and water valves. Maintain natural drainage courses and street gutters.
 - 1. Backfill material to be segregated from stockpiled topsoil and unusable backfill materials.
- D. Excavation for Appurtenances. Excavation to be done in accordance with these Specifications and as shown on the Drawings. Adequate working clearances to be maintained around appurtenances. Provisions for base and bottom preparations shall apply to all appurtenances. Precautions to be taken to maintain trench widths in the vicinity of adjacent pipelines and conduits.

3.03 BOTTOM PREPARATION

- A. Undisturbed Foundation. Where soils are suitable and have adequate strength, bottom to be graded and hand-shaped such that pipe barrel rests uniformly on undisturbed soil. All rocks or stones, which may result in a point bearing on the pipe, shall be removed.
 - 1. Undisturbed grades shall be within 0.1 feet \pm tolerance. Soils for final pipe grade placed within these limits shall be fine granular (100% passing No. 4 sieve) or may be native materials, hand compacted to 95% maximum density.
- B. Bell Holes. Material to be removed to allow installation of all fitting and joint projections without affecting placement of pipe.
- C. Over-excavation. Whenever trench is over-excavated to eliminate point bearing by rocks or stones or when undisturbed grade tolerances of 0.1' are exceeded, the Contractor is to re-establish grade using Class 6 aggregate bedding material. Compaction shall be 95% maximum density. All work to re-establish grade shall be at the Contractor's expense.
- D. Unstable Materials. Materials incapable of supporting superimposed loadings are defined as unstable materials. Should unstable materials be encountered during excavation, immediately notify Engineer. If, in the opinion of the Engineer, unstable soil excavation is required and the Contractor could not have reasonably been expected to discover the existence of such materials during his site investigation, then a contract price for Unstable Soil Excavation shall be negotiated between Owner and Contractor. No payment shall be made for materials excavated prior to notification of the Engineer and negotiation of payment for extra work.
- E. Inclusion of a bid item for Unstable Soil Excavation indicates such excavation is

anticipated. The Contractor is to notify the Engineer prior to any unstable soil excavation; no payment shall be made for excavation prior to authorization of Engineer.

- F. **Rock Excavation.** Rock excavation shall be defined as removal of boulders in excess of three (3) cubic yards of solid or fractured rock, which makes hand shaping of the bottom impossible and which requires techniques, such as blasting or jacking for removal, other than those which are being employed by the Contractor or are normally used in trench excavation, such as use of backhoes, trenchers, draglines, etc. Should unanticipated rock conditions be encountered, immediately notify the Engineer. If in the opinion of the Engineer, rock excavation is required and the Contractor has in fact made a diligent and determined effort to remove the material using normal excavation procedures as stated above, and the Contractor could not have reasonably been expected to determine the existence of such material during his site investigation, then a contract price for rock excavation shall be negotiated between the Contractor and the Owner. No payment shall be made for excavation performed prior to determination of a negotiated price.
1. Rock shall be removed to a 4" depth below grade. Additionally, all rock loosened during jacking, blasting, etc., shall be removed from the trench. For payment purposes, maximum trench width to be paid for shall be as defined in Subsection 3.02, A. Maximum depth to be paid for shall be 12" below required grade. All over-excavation shall be replaced as specified in Subsection 3.03, C.
 2. Inclusion of a bid item for rock excavation indicates such excavation is anticipated. Contractor to notify Engineer prior to any rock excavating; no payment shall be made for excavation prior to notification.

3.04 BACKFILLING

- A. **Tamping Equipment.** Except immediately next to the pipe, mechanical or air operated tamping equipment to be used. Hand equipment, such as T-bar, to be used to pipe if necessary. Care to be taken when compacting under, along side and immediately above pipe to prevent crushing, fracturing or shifting of the pipe. The Contractor is to note densities required for materials being backfilled and shall use appropriate approved equipment to obtain those densities.
1. Wheel rolling is not considered to be an adequate compaction technique to meet these Specifications and will not be allowed. Where 85% compaction is required, wheel rolling may be considered. Before acceptance, the Contractor shall backfill a portion of the trench and pay for density testing to verify adequacy of the proposed backfill techniques.
 2. A hydro hammer may be allowed to obtain the specified density up to 4' in depth. The Contractor will be required to re-excavate those areas that have been tamped so that density tests can be taken to insure that the specified intensity is being obtained full depth.
- B. **Moisture Control.** Generally maintain moisture of backfill material with $\pm 2\%$ of

optimum moisture content as determined by ASTM D698. Maintain closer tolerances as needed to obtain densities required.

- C. Compaction. Maximum density (100%) based on ASTM D698 or AASHTO T99.
 - 1. Bedding Material, including material used for over-excavation of any kind: 95%.
 - 2. Select Material: 95%.
 - 3. Backfill beneath existing or proposed pavement, roadways, sidewalks, curbs, utility lines and other improvements or within 5' horizontally of such improvements: 95%.
 - 4. Backfill within public or designated right-of-way: 95% or as shown on the Drawings.
 - 5. Backfill within undeveloped, green or undesignated area: 90%.
 - 6. Backfill for any fill over over-cut grading in areas of lot/home construction: 95%.

- D. Placing Backfill. The maximum loose lifts of backfill material to be placed in the reverse order as removed and as follows: use smaller lifts where necessary to obtain required densities:
 - 1. Bedding and select material: 6" (or see Section 3.03A).
 - 2. Backfill Material: 12" where 95% compaction required; 24" where less than 95% compaction required.

- E. Backfilling Appurtenances. Backfilling to be done generally at the same time as adjacent pipelines. Backfilling procedure to conform to this section. Use special techniques or materials as shown on drawings.

- F. Disposal of Excess Excavation. Contractor to dispose of excess excavation off site. Disposal in any case shall be the sole responsibility of the Contractor.

- G. Jetting. Jetting and water inundation are generally not permitted methods of compaction. The Engineer may allow jetting under certain field conditions. If jetting is allowed; techniques including depth of lifts, amount of water to be used, penetration of hose jet, etc., shall be submitted to the Engineer for approval. The contractor remains solely responsible for the results gained when using this method. Any areas of compaction that do not meet the requirements of the Contract will be removed and recompacted at the Contractor's expense. No jetting will be allowed on materials with a 200-minus gradation of greater than 15%. Contractor shall pay cost of all water used, soil classification testing and compaction testing and any retesting or recompaction required. No jetting shall be done prior to written approval and direction of the Engineer.

- H. Maintenance of Backfill. Contractor shall maintain all backfill in a satisfactory

condition during the extent of the contract and warranty period. All surface deterioration determined to be the responsibility of the Contractor and all settlement shall be repaired at once by the Contractor upon notice by the Owner. All costs for repair and all liability as a result of surface deterioration or settlement shall be the responsibility of the Contractor.

- I. Clay Barrier Water Stops. Because of the presence of ground water, a clay barrier may be required to be installed full depth in trench in place of all bedding material and backfill. This barrier shall be full depth and two feet thick and installed every 500 lineal feet of trench. Clay barrier installation shall be considered incidental to the pipe installation and not paid for separately.

3.05 SURFACE RESTORATION

- A. All existing surface improvements and site conditions disturbed or damaged during construction to be restored to a condition equal to pre-construction condition. All restoration costs are considered incidental to excavation and backfill.
 1. Improvements. Replace, repair or reconstruct all improvements as required. Work will not be accepted until Engineer and all affected property owners accepts restoration. Improvements include, by example, other utilities, culverts, structures, curb and gutter, mailboxes, signs, sprinkler systems, etc.
 2. Final Grading. The Contractor is to re-establish existing final grade or finish final grades as modified and shown on the Drawings. The Contractor is to backfill to proper subgrade elevation with backfill material to allow placement of surface improvements or materials.
 3. Roadways. All roadways to be restored to original condition with material types removed. Materials and methods to conform to Section 02222 - Embedment and Base Course Aggregate; and Section 02612 - Hot Bituminous Pavement. Additional requirements are:
 - a. Minimum base course material on gravel roadways or minimum depth gravel on hard surface roadways to be 8", unless shown otherwise on Drawings.
 - b. Minimum bituminous surfacing to be 3" unless shown otherwise on Drawings.
 - c. Minimum concrete pavement surfacing to be 6", unless shown otherwise on Drawings.

3.06 COMPACTION

- A. It should be fully understood that it will be the sole responsibility of the Contractor to achieve the specified densities for all embedment and backfill material placed. Contractor will be responsible for ensuring that correct methods are being used for the placement and compaction of said materials. Correct backfill methods include, but are not limited to:
 1. Use of proper equipment for existing soil condition encountered.

2. Moisture content of existing soils; determination if water should be added or if soil should be air dried to reduce moisture content.
 3. Thickness of backfill lift.
- B. Contractor may, at his own expense, have an approved geotechnical engineer monitor the methods of backfill and compaction used to ensure that the desired densities are being obtained.
 - C. Inspection and testing will be performed as directed by the Engineer. Testing will be conducted as a quality control check to verify the Contractor's compliance with the standards indicated in the Specifications.

3.07 INSPECTION AND TESTING

- A. Inspection and testing to be performed shall be at the direction of the Engineer. All retesting and retesting shall be paid for by Contractor and to be performed by a soils testing firm approved by the Engineer. Contractor shall excavate as required to allow testing. Contractor shall backfill all test excavations in accordance with these Specifications. Any areas that require a specified density, including fill, backfill, trenches, embankments, road base, hot bituminous pavement, backfill for structures, shall be tested. All test results shall be submitted to the Engineer by the geotechnical engineer.

3.08 DENSITY TESTING AND CONTROL

- A. Reference Standards. Density/moisture relationships to be developed for all soil types encountered according to ASTM D698 or AASHTO T99.
- B. Field Testing. Testing for density during compaction operations to be done in accordance with ASTM D2922 using nuclear density methods.
- C. Frequency of Testing. Minimum of one (1) test every 150' trench per lift or as directed by Engineer. Contractor to excavate to depths required by Engineer for testing and backfill test holes to density specified.
- D. Retesting. In the event of failure to meet compaction criteria, Contractor shall re-excavate and re-backfill at direction of Engineer.

3.09 PAYMENT FOR TESTING

- A. Contractor is responsible for all costs of testing of backfill.

PART 4 MEASUREMENT AND BASIS OF PAYMENT

Where items are specifically included on the bid schedule, they will be paid for by the unit given. All other items in this section that are essential to the project but for which there are no specific pay items, will not be measured and paid for separately but shall be included in the project.

END OF SECTION