

**DIVISION 2 – SITE WORK****SECTION 02200 – EXCAVATION, BACKFILL, AND COMPACTION****1. GENERAL**

These specifications are general in nature and are designed to cover excavation and backfill for embankments, roadways, pipe lines and their appurtenances, and structures. In cases where a provision is applicable to a particular type of construction or use, it is covered in the specification for the specific application e.g. Standard Specifications for Sewer System. Where there is a more stringent requirement in such a specification, compliance shall be with the specific specification which is directly applicable to the situation.

A Contractor shall comply with all applicable laws and regulations including "Rules and Regulations Governing Excavation Work" of the State of Colorado and receive an Encroachment and Excavation permit from the Town when working on Town right of way.

**1.01. Description**

Work under this section includes clearing and grubbing, excavation, controlling surface flow, seep, and groundwater, dewatering and stabilization, bedding and backfilling, with moisture control, and grading, and compaction to specified density and elevations needed for construction as well as complete site restoration. Also included are stockpiling excavated material to be used as fill and removal of unsuitable and excess soils from site and furnishing and installing flowable fill.

**1.02. Related Work Specified Elsewhere**

Section 02508 - Asphalt Paving and Patching  
Section 02712 - Water System - Minimum Design Standards  
Section 02713 – Water System Construction  
Section 02722 - Sewer System - Minimum Design Standards  
Section 02723 – Sewer System Construction  
Section 03000 - Concrete

**1.03. Measurements and Levels**

Contractor shall verify all drawing measurements and levels in relation to existing elevations, grades, and adjacent structures, and determine conditions and requirements for excavations, fill, backfill, and all sheeting, shoring, bracing, and protection of the premises and buildings. Contractor shall carefully and accurately lay out all lines and levels of the new construction before proceeding with any Work.

**1.04. Conformance Testing**

All testing shall be performed and arranged and paid for by the Contractor. OR will determine location and frequency of such tests to ensure that minimum requirements specified below are met at all locations. At Owner's discretion, Owner may arrange for or perform additional such tests. Each lift shall be tested for compaction and moisture content at two OR designated locations per 150 lf of trench and 2 tests per 600 sf of surface area and results shall be approved by the OR. If tests fail to meet the specified density or moisture content, or to pass proof rolling tests, additional tests will be required in the vicinity of the failed test to determine the extent of the inadequate compaction, then corrective actions shall be taken by the Contractor. After the deficiencies have been corrected, additional tests will be taken in approximately the

same location and number as was used to determine the extent of the failed area to demonstrate conformance with the specifications. The cost of all testing required due to failed tests and as needed to determine adequacy of compaction methods shall also be paid by the Contractor. In addition, Town reserves the right to contract directly for testing. The Contractor will be responsible to reimburse the Town for any Town contracted tests that fail to meet the contract requirements.

Contractor shall arrange and pay for tests for determination of maximum density and optimum moisture in accordance with the requirements of ASTM 698 - Moisture density relations of soils using a 5.5 lb. hammer and 12-inch drop for native materials and ASTM 1557 Modified Proctor for structural and road base materials. With ASTM 698 use method A, B, C, or D as appropriate, based on soil condition and judgment of the qualified party conducting tests. When appropriate, determine the correct rock correction. Samples tested shall be representative of materials to be placed.

Contractor shall arrange and pay for tests to determine optimum moisture density curve and Atterburg limits for each type of material or combination of materials encountered or utilized.

Tests for density control to verify the compaction of the materials in any area of backfill will be in accordance with the requirements of ASTM D 2922 - Density of Soil and Soil Aggregate In-Place by Nuclear Methods, or ASTM D 1556 - Density of Soil In-Place by the Sand-Cone Method. Use test results as basis for density control of compaction operations. The Town will also use visual observations of deflection (proof-rolling) to determine the adequacy of moisture control and compaction.

Organic content test results shall represent organics by percent of volume and by weight.

#### **1.05. Existing Conditions**

Protect from damage or restore to original condition all surface and sub-surface improvements existing prior to commencement of construction.

Prior to commencing construction, the Contractor shall be responsible for documenting the existing condition of the construction site and surrounding areas. Photographs and written descriptions of all substandard pre-existing conditions are recommended. Width of gravel and/or pavement, depth of such, and existence of drainage should be noted for roadways, as should broken fences and other landscape and structures which are in need of repair. Unless sub-standard conditions are adequately documented prior to commencing construction, the Contractor will be held responsible for restoring the site to conditions which the Town consider to be those which are standard and/or were pre-existing. Since construction equipment tends to be destructive of gravel and asphalt roads, particular attention should also be paid to recording conditions of roads which will be traversed by construction equipment even if there will not be any construction along the specific roadway.

#### **1.06. Protection of Existing Utilities**

The Town will assist the Contractor in locating existing utilities of which it has knowledge. Contractor shall be responsible for scheduling with the Town sufficiently in advance for the Town to have someone available to provide such assistance. It will be the Contractor's responsibility to contact all other utilities to get assistance in locating their lines and buried structures. The Contractor will be responsible for verifying the locations of all utilities and for repairing any damage caused by his Work. The Contractor must file notice of intent to excavate with each of these entities at least 48 hours prior to commencing work. All utility lines, including cables and pipelines, in the vicinity of the work shall be exposed by the Contractor

before work is started. If, after exposure, a conflict is discovered, Contractor shall propose a remedy which shall be subject to approval of the Town and all other effected parties.

## **2. PRODUCTS**

### **2.01. Submittals**

Contractor shall furnish preliminary representative test samples of native and base materials to an approved independent testing laboratory and shall pay for testing to determine that the materials conform with the Contract Documents and to determine proctor and optimum moisture values for each earthen and base material proposed for use on the project. Appropriately labeled samples of each material tested shall be kept on site in a one gallon zip lock bag for comparison with materials being placed. All fill and backfill material must be tested and proctor curves, and other required lab test results shall be available on site and approved by the Engineer before fill and backfill is started.

Submittal information for materials specified by CDOT tables or maximum gradation requirements will require sieve analysis and other test results to demonstrate conformance with CDOT table data and notes. Submittal shall include optimum moisture density curve for each type of material or combination of materials encountered or utilized and Atterberg limits for each clayey material.

Materials for foundation(s) shall meet the requirements in the approved foundation submittal.

### **2.02. General Use Materials**

General use materials are intended to be used in trenches above the pipe zone, and for embankment fill to sub-grade elevations.

On-site materials obtained from excavation, free of any unsuitable materials (see below), shall be deemed acceptable for general use. On-site materials encountered during excavations which are appropriate for specific uses shall be separated and stockpiled for their later intended use (i.e. topsoil, fine bedding, etc.).

Imported and on-site material for general use shall be non-expansive soil, pit run, or bank run sands and gravels with 4" maximum rock size, adequate binders, capable of being compacted and tested as specified herein unless other material is specified for the particular structure or work.

Imported materials for general use shall be taken from borrow areas acceptable to the Engineer. All borrow materials shall meet the same quality criteria as is required herein for on site materials to be used as fill.

Town Engineer reserves right to reject any material he/she finds to be unacceptable.

### **2.03. Bedding and Pipe Zone Materials Classification**

Pipe zone area is defined as the backfill placed within twelve (12) inches of the pipes fittings and appurtenances. All pipe zone materials must be free of sharp edges and other matter which could damage the pipe.

Class A	Flowable fill shall have one half sack of cement per cubic yard of concrete. Aggregates and sands for flowable fill shall meet the requirements for concrete in CDOT Section 703.
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Class B	Well graded crushed stone or crushed gravel meeting the requirements of Class 6 specified below for "Road Construction Materials."
Class C	Selected soil of low permeability free from clods and stones greater than 3/4 inch in maximum dimension and free of all unsuitable materials as defined below.
Class D	Screened or Washed Rock, of single grade 1-1/2" or less, free of clay and fine particles (for gravity sewer lines use only).
Class E	Bedding sand passing #4 screen or less (for pressurized water lines only).

**2.04. Road Construction Materials**

Road construction materials are those used for road sub-base, base and finished road surfaces. CDOT Class 2 materials shall be well graded natural or crushed aggregate with sufficient filler or binding materials which when placed and compacted result in a firm, dense, unyielding foundation. CDOT Class 6 materials shall consist of crushed gravel or crushed stone base course material of hard, durable particles or fragments of stone or gravel crushed to required size and a filler of sand or other finely divided mineral matter. Not less than 60% by weight of the aggregate particles shall be particles having at least one fractured face. The composite base course material shall be free from vegetable matter, expansive materials, and lumps or balls of clay. The class 2 and 6 materials shall meet the following requirements:

<u>Gradation (% Passing)</u>	<u>Class 2</u>	<u>Class 6</u>
4"	100%	-----
3"	95-100%	-----
2"	-----	-----
1"	-----	-----
3/4"	-----	100%
No. 4	-----	30-65%
No. 8	-----	25-55%
No. 200	3-15%	3-12%
Liquid Limit	35 Max.	30 Max. (nonplastic)
Plasticity Index	6 Max.	6 Max.
Resistance Value	75 Min.	78 Min.

Inclusion of fractured concrete and/or recycled asphalt pavement is prohibited.

Structural subgrade and backfill materials are defined as those materials used to prepare for structural construction.

Class 6	Meeting the requirements of Class 6 specified above for "Road Construction Materials."
Class D	Washed Rock, of single grade 1-1/2" or less, free of clay and fine particles. (not for use around pressured pipe lines)

On site and borrow area sand and gravels if available may be used for structural backfill material except where special foundation material is otherwise specified.

**2.05. Unsuitable Materials**

Expansive materials and material that contain debris, roots, organics, or frozen materials, stone or concrete having a maximum dimension larger than 4 inches or materials that are unsuitable for providing

stable slopes, fill, backfill, foundation or subgrade material for structures or surfaces shall be classified as unsuitable. Otherwise suitable material which is unsuitable due to excess moisture content will not be classified as unsuitable unless it cannot be dried by manipulation, aeration, or blending with other materials satisfactorily to meet moisture limits for proper compaction.

**2.06. Topsoil**

Topsoil shall consist of loose friable loam with minimum 15% organic matter, reasonably free of admixtures of subsoil, refuse, stumps, roots, rocks, brush, weeds and weed seed, heavy clay, hard clods, toxic substances or other material which would be detrimental to the proper development of vegetative growth, including construction debris.

**2.07. Riprap**

Material for riprap shall come from rock stockpiled while excavating or imported. Material used for riprap shall be dense, sound rock fragments which are resistant to abrasion and shall be free from cracks, seams, and other defects that would decrease its durability and to resist destruction by water and/or frost action. Unless otherwise called for on the plans riprap shall have a D-50 of 12”.

**2.08. Spot Subgrade Reinforcement and Sub-Grade Stabilization**

Material includes sound, tough, durable crushed stone, or gravel, consisting of angular pieces varying from 1 inch to 4 inches in maximum diameter or other Engineer approved material, with necessary filler in dry conditions, and when a geotextile is used. In wet conditions, and without geotextile, rock shall be without fines. When a smaller material is necessary for filler, screened gravel, or sand may be used to completely fill all voids.

**2.09. Geotextiles**

Geotextiles and geogrids used for stabilization shall be designed specifically for stabilization and/or soil reinforcement and of a type recommended by the manufacturer for the application. Geotextiles for stabilization shall be a woven material Mirafi RS380i, or approved equal. Geogrids shall be at least equal to Miragrid or Tensar SS with a tensile strength of 200 x 134 psi. The grid shall have sufficiently large openings which are capable of interlocking with the on-site soils. Geotextile used to separate rock and gravel from native materials and for drains shall be non-woven 12 oz/sy filter fabric, Mirafi 1120N or approved equal.

**2.10. Capillary Water Barrier Material (CWB)**

Clean, crushed stone, crushed or uncrushed gravel composed of hard, durable particles, uniformly graded with 1-1/2 inch maximum particle size and not more than three percent (3%) of minimum particle size passing a No. 4 sieve.

**2.11. Seed, Mulch, and Tackifier**

All seed shall be furnished in sealed bags or containers showing the name and address of the supplier, the seed name or mix, the lot number, net weight, % of weed seed content, and the guaranteed percentage of purity and germination. All seed furnished must be certified as free from noxious weeds as defined by local, state, BLM and USFS. Seed shall be harvested from a location of not more than 200 mile radius of the site. Seed which has become wet, moldy, old, or otherwise damaged or not labeled will be rejected. The Contractor shall furnish a signed statement certifying that the seed furnished is from a lot that has

been tested by a recognized laboratory for seed testing within six months prior to the date of delivery and shall be certified weed free. Seed mix shall be a mix approved by BLM or CSU for the micro-climate where the seed is being placed. Grass areas on private property have are disturbed shall be replaced with sod of a mix similar to the surrounding area to the satisfaction of the owner.

Materials for straw mulching shall consist of straw from native grasses and shall be certified weed free in accordance with State and Federal requirements for weed free straw. Straw in such an advanced stage of decomposition as to smother or retard the normal growth of grass will not be accepted. Old, dry straw, which breaks instead of bending will not be accepted. Mulch tackifier shall be consistent with CDOT section 213.

### **3. EXECUTION**

#### **3.01. Clearing and Grubbing**

The area to be occupied by permanent construction shall be cleared and grubbed of trees, stumps, roots, brush, rubbish, and other objectionable matter to the extent necessary for orderly performance of the work and to a depth sufficient to remove organics and other materials unsuitable for the intended purpose. Unstable saturated materials shall be removed or stabilized. All clearing limits shall be staked by the Contractor and approved by the Town prior to any construction. The Contractor is responsible for and shall exercise care in his work area. If there is disturbance to improvements or vegetation outside the clearing limits, the Contractor shall take remedial action at his own expense. No trees shall be removed or injured outside the area to be occupied by the work without the prior approval of the property owner and/or the Town. The Town will mark trees within the clearing limits to be removed.

Where applicable, strip existing topsoil prior to trenching operations. Depth of stripping shall be determined in the field by the Town based on depth of the topsoil and roots. Stockpile topsoil material for replacement after all backfilling and compacting operations are completed.

The Contractor shall be responsible for the protection of all surface improvements, structures, buried utilities, and plantings that have not been designated for removal or modification as part of this project. The Contractor shall exercise care in his work to ensure that no damage will occur to lawns, shrubs, hedges, trees, and other plantings adjacent to the right of way or in areas of access to the work. If there is disturbance to structures or plantings, the Contractor shall take remedial action at his own expense. No act, representation, or instruction of the Town shall in any way relieve the Contractor from liability for damages or costs that result from activities of the Contractor. The Contractor may with permission of the property owner, remove fences and other property to expedite trenching operations. These shall be repaired to the satisfaction of the property owner as soon as backfilling operations are completed.

#### **3.02. Removal of Cleared and Unsuitable Materials**

Materials from the clearing operations shall be the responsibility of the Contractor and shall be removed from the site of the work and disposed of in a manner satisfactory to the Owner and Town, and in accordance with state and local regulations at the expense of the Contractor. The Contractor shall make an effort to channel materials of value from the clearing and grubbing to beneficial use.

During the process of clearing or excavation, saturated soils, soils such as peat, soft clay, quicksand, cobble, large rock or other materials which are unsuitable for bedding may be encountered. Unless there is a use for these materials elsewhere on the project, these materials shall be removed from the site and disposed of by the Contractor. If removal of unsuitable materials results in excavation below the grade required for

bedding, the area shall be backfilled to grade with suitable bedding materials complying with the provisions of applicable specifications for the work being constructed.

### **3.03. Access Roads and Bypasses**

The Contractor shall be responsible for providing all access roads required to get materials and equipment to the work areas. When required, the Contractor shall construct and maintain detours or bypasses around portions of the work that conflict with traffic. All barricades and safety devices required to protect persons from injury and to avoid property damage shall be determined and furnished by the Contractor. When necessary, the Contractor shall provide suitable bridges at crossings where traffic must cross open trenches. Construction of access ways on private or government property must have written approval of the property owner prior to commencing construction.

No road will be completely closed unless expressly approved by the Town in writing where there is minimal traffic impact. If a detour around the construction is not feasible, then the installation across the road will be made one-half at a time to allow through traffic around the construction. Adequate traffic control and signage must be provided by the Contractor and is subject to approval of the Town Marshall.

### **3.04. Pavement Cutting**

Where trench excavation requires the removal of asphaltic and/or concrete pavement, the pavement shall be cut in a straight line parallel or perpendicular to the direction of trench excavation as applicable. The cut shall be made with a spadebit air hammer, by sawing, or with similar approved equipment to obtain a straight, square, and clean break. Ripping the asphalt/concrete will not be allowed. The pavement cuts shall be at least one foot wider in each direction than the anticipated limits of the open trench. No excavation in paved areas will be started until after the pavement has been cut. The paving material obtained from excavations in paved areas shall be disposed of by the Contractor. All areas where pavement is removed shall be restored as specified herein and shown on the typical drawings. Temporary surfaces shall be placed until the permanent repair can be made.

All surface improvements consisting of, but not limited to, pavements, gutters, driveways, curbs, and sidewalks damaged by the Contractor during the progress of work shall be replaced at Contractor expense. The construction of the repairs shall result in work equal to or better than that which existed before the damage was done.

### **3.05. Dust Control**

The Contractor will be required to furnish and apply an environmentally acceptable dust palliative to control dust on the project site and along haul routes. Dust control may consist of water or other substances found not to be detrimental to the Work or the surroundings as approved in writing by the Town. Spreading of water or water mixture shall be done with acceptable sprinkling equipment. Such equipment shall be a type which ensures uniform and controlled distribution of the palliative without ponding, washing, or adverse impacts to the public, private property, or the environment.

### **3.06. Drainage**

The Contractor shall maintain the excavations, borrow areas, and site free from water throughout the work and shall shape excavations and surrounding areas to minimize the entrance of water. Drain surface water or seepage by gravity or temporary pumps or other approved means. Discharge such waters in a manner which conforms with all federal, state, and local requirements. Use drainage methods which will prevent softening or undercutting of foundation bottoms or trenches or other conditions detrimental to

proper construction procedures. Accomplish the foregoing by the use of sumps and gravel blankets, well points, drain lines, or other means approved by the Town. Remove any water encountered to the extent necessary to provide firm subgrade. If the trench or foundation bottom or other excavation becomes unstable due to the entrance of water into the open excavation, the saturated soil shall be removed and suitable backfill placed and compacted to grade at Contractor's expense. Handling of drainage, live flow, seepage, groundwater, runoff, discharges, and other water shall be included in the scope of Contractor's unit costs for the work to which it is associated.

### 3.07. Excavation

Excavation for pipe shall be by open trenches unless otherwise specified or shown on the approved plans. The trench shall be excavated using conventional methods. Any method which is not in accordance with normally accepted practice must receive prior approval of the Town. Excavation shall be made to line and grade shown on the approved plans. The banks of the trench shall be kept as nearly vertical as soil conditions will permit, but shall not exceed the angle of repose of the soil. Vertical trench walls shall be used in the pipe zone wherever possible.

#### A. Grade Stakes

The Developer's engineer shall provide grade stakes for all pipeline excavation. These stakes shall locate the pipelines both horizontally and vertically for sewer and at least horizontally for water. Where finished grade of the ground will differ significantly from existing grade, vertical control shall be provided for water and other utilities. Maximum distance between grade stakes shall be 50 feet unless otherwise approved by the Town. All appurtenances and structures shall be staked for location and elevation. Grade stakes shall also be provided for structures and fill.

#### B. Tolerances

Complete excavations and fills with suitable equipment to line and grades as shown on the plans within a horizontal tolerance of  $\pm 0.20$  ft and a vertical tolerance of  $\pm 0.1$  ft unless otherwise noted on the plans or specified for a specific location or application.

Subgrade excavations for structures shall be within a horizontal tolerance of  $\pm 0.10$  ft and a vertical tolerance of  $\pm 0.05$  ft unless otherwise noted on the plans or in an approved submittal.

Pipelines shall be installed to within a horizontal tolerance of  $\pm 0.20$  ft and a vertical tolerance of  $\pm 0.01$  ft and for gravity utility lines, structures and fills shall be installed to within a horizontal tolerance of  $\pm 0.10$  ft and a vertical tolerance of  $\pm 0.01$  ft unless otherwise noted on the plans or required by an approved foundation and/or structures submittal.

#### C. Stockpiling Material

Where material is excavated from the trenches and piled adjacent thereto, it shall be piled sufficiently away from the edge of the trench to prevent caving of the trench wall and to permit safe access along the trench. In unsupported trenches the minimum distance from the edge of the trench to the toe of the spoil bank should not be less than one half the total depth of the excavation, nor less than three feet or farther as soil conditions dictate. With sheeted trenches, the toe of the spoil bank should be at least three feet from the edge of the trench.

D. Sheeting Bracing and Shoring

Where necessary or called for on the excavation stabilization plan, or needed to control the width of the excavation, excavation shall be braced and sheeted to provide complete safety to persons working in or around the trenches and minimize the width of the trenches and shall comply with applicable federal (OSHA), state, and local laws, regulations, and ordinances. The Contractor shall be fully responsible for sufficiency and adequacy of bracing excavations with respect to work under construction and to adjacent utility lines and public and private property. Remove sheeting and shoring as excavations are backfilled in a manner to protect the material, construction, and compaction and/or other structures, utilities or property. No such sheeting will be permitted to remain in the trench or excavation except when, in the opinion of the Contractor, field conditions or the type of sheeting or methods of construction used by the Contractor are such as to make the removal of sheeting unsafe. In such cases, with Town approval, portions of the sheeting to be cut off to such depth as he/she may approve and permit lower portions thereof to remain in the trench.

E. Drainage and Groundwater Control

Maintain the excavations and site free from water throughout the work. Remove any water encountered in the trench to the extent necessary to provide firm subgrade, to keep water level below final pipe grade and to prevent entrance of water into the pipeline. Contractor shall furnish and operate adequate pumping equipment to keep the water level below the grade of construction. Water shall not be permitted to run through lengths of pipe already laid without written approval of the Town. Ends of all pipes shall be capped or plugged to ensure that water, dirt, etc., does not enter the pipe. Should any dirt, mud, etc., enter the pipe during installation, the Contractor shall flush the pipe thoroughly in the presence of the Town's representative to ensure complete removal of all foreign objects prior to connection to the existing system.

Use drainage methods which will prevent softening of foundation bottoms, undercutting of footings, or other conditions detrimental to proper construction procedures. Accomplish the foregoing by the use of sumps and gravel blankets, well points, drain lines, or other means approved by the Town. Grade as necessary to prevent surface water from flowing into trenches or other excavations. Remove any surface or ground water accumulated in the excavation by the use of well points, pumps or other approved methods. If the trench bottom becomes unstable due to the entrance of surface water into the open excavation, the saturated soil shall be removed and suitable backfill placed and compacted to pipe grade.

F. Use of Explosives

No blasting will be permitted without written consent of the Town. Should the use of explosives be required, and their use approved by the Town, exercise all possible precautions in the use, storage, or transport of same. Employ only competent, experienced personnel. Comply with all local and state requirements. Contractor assumes full responsibility and liability for all damage which may be caused by his use of explosives.

G. Sequencing

The Contractor shall excavate in advance of pipe laying only a sufficient length to assure steady progress in the installation of pipe. The length of open trench shall be limited where necessary to accommodate traffic, public safety, or as required by the Town and/or other entities with authority, in vicinity of the work being performed.

Pipeline installation shall follow trench excavation within 100 lineal feet. Trench backfill shall follow pipe installation within 50 lineal feet. Approved cleanup shall follow trench excavation within 300 lineal feet. Open trench length shall be kept to a minimum and not exceed the length that can be installed and backfilled in a work day. Particular care shall be taken to provide minimum interference with mail delivery and school bus operation. If the work will require a road to be closed, the Contractor shall notify the proper agencies, in writing with a copy of the notice to the Town. In State and County road rights of way, the amount of open trench permitted shall be in accordance with the requirements of the respective agencies.

H. Excavation to Grade

All installation of utilities and structures shall be to the grade designated on the approved plans and in conformance with Town specifications and standards. Excavation for water lines shall be to a depth sufficient to provide a minimum cover below finished grade of the depth listed in the Water Specification or shown on the approved Drawings. Specific authorization may be given by the Town to reduce the minimum cover by up to 6" along short sections to eliminate or minimize conflict with other utilities or to facilitate connections if O & M problems are not likely to result from such a change. Additional trench depth shall be provided where street and roadway grades will probably be lowered under future construction and where necessary to provide clearance between ditches, culverts, and other structures. The Town shall determine in the field the additional trench depth required in locations where possible future lowering of street grades or other future construction makes greater depth desirable.

Sewer line excavation shall be to the depth necessary to provide the grade and bury depth shown on the approved plans. When tying into an existing line, the Contractor shall excavate at the manhole or approved tie in and shall begin laying pipe from the existing facility unless otherwise authorized by the Town. More detailed specifications are discussed in other sections of this standards.

Where utilities are to be installed in fill, construct fill a minimum of 2' above top of pipe prior to excavation for utility installation.

I. Trench Width

Alignment of trenches shall be carefully controlled so that uniform distances are maintained from property lines and so that the pipe will be laid with adequate space for compaction of backfill between the pipe and trench walls. All excavation shall be of sufficient width to provide ample room for proper joining of pipe and fittings. Minimum trench width shall be twelve (12) inches plus pipe OD. Maximum trench width will be restricted to pipe diameter plus two feet unless otherwise approved by the Town. If the maximum trench width is exceeded, provide special bedding, encasement, or higher strength pipe as approved by the Town.

**3.08. Bedding, Backfill, and Compaction of Embankment, Pipe Lines, and Structures****A. Pipe Bedding****i. Bedding Preparation**

The bottom of the trenches shall be accurately graded to provide uniform bearing and support throughout the pipe length. Excess loading of the bell will not be permitted under any circumstances. Dig bell holes and depressions for joints after trench bottom has been graded. Bell holes and depressions shall be only of such length, depth, and width as required for properly making the particular type of joint. The use of earth mounds for bedding the pipe will not be permitted.

All sharp stones, trash, and other materials which may damage the pipe or interfere with the proper bedding of the pipe and the placement and compaction of the backfill shall be removed from the trench. The soil in the bottom of the trench shall be loose, and at the optimum moisture, so that uniform bedding and compaction around the pipe is easily obtainable. Should any material be encountered which would prevent the obtaining of suitable bedding, e.g. wet, unstable, etc., the trench shall be over-excavated to a depth of 6 inches minimum below the outside bottom of the conduit, except at points of rock and earth transitions, at which point the rock shall be excavated to a minimum of 12 inches below the outside bottom of the flexible conduit as shown on the typical drawing for pipe bedding. Backfill any over-excavation, required or inadvertent, with materials equivalent to, and compacted as specified for haunching materials according to these specifications.

If the trench bottom becomes unstable due to the entrance of water into the excavation, the saturated soil shall be removed and suitable bedding placed and compacted to pipe grade.

**ii. Placing Bedding Material**

The bottom of the trench must be dry or well-drained before bedding and backfilling is started. Place material below and around the pipe by hand to prevent damage or displacement of the pipe. Place in lifts not to exceed 3" in compacted thickness in the pipe zone.

Whenever flexible pipe is used, special care shall be employed in the pipe bedding. Flexible pipes include PVC sewer and water pipe, fiberglass pipe, lightweight steel pipe, polyethylene pipe, and other similar pipes. Conform to recommendations of (1) AWWA C 900 Appendix A Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4 inch Through 12 inch for Water, (2) Uni-Bell PVC Handbook and relevant Unibell recommended practice manuals, and (3) ASTM Designation D 2321 Standard Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe.

**B. Backfill and Compaction**

The Contractor shall proceed with backfilling as soon as practicable, but not until Work is inspected by Town and Engineer and all tests satisfactorily completed. Compaction or consolidation shall follow as soon after the placing as is practical.

Backfill material shall consist of material which after placement and compaction will result in a stabilized soil condition capable of supporting the normal traffic and use loads that may be encountered. Normally the backfill material above the pipe zone will be obtained from the soil banks accumulated from the trench excavation. The backfill materials shall be free of vegetation,

lumps, trash, lumber, and other unsuitable or objectionable materials. The backfill placed within twelve (12) inches of the pipe (the pipe zone), shall be a Class B, C, or D material, depending on the application and site conditions, and shall not contain any sharp rocks, stones larger than 3/4" in diameter or other objects that might damage the pipe. Outside the pipe zone, backfill shall not contain rocks or other objects whose largest dimension exceeds four (4) inches. All such material shall be removed from the work area and disposed of in a manner acceptable to the Town. Moisture control of fill will be required to facilitate achieving acceptable soil densities. Unless otherwise specified for a specific application, moisture content shall be +/- 2% of optimum.

Construct fills and embankments to the lines and grades indicated on the drawings. Immediately prior to placing fill or base material, scarify the entire area upon which fill is to be placed to a depth of 12 inches. The foundation for earthen fill shall also be prepared by disking or scarifying parallel to the axis of the fill, and compacted such that the surface materials of the foundation will bond well with the first layer of fill as is specified for the subsequent layers of earthen materials.

Compact existing subgrade surfaces if densities are not equal to that required for backfill materials. Plow, step, or bench sloped surfaces steeper than 4 to 1 on which backfill is to be placed in such a manner that fill material will adequately bond with existing surfaces. Scarify where necessary to ensure uniform compaction and good bonding between lifts.

Backfill areas to grades, contours, levels, and elevations required. Place approved excavated or imported material in successive horizontal layers of 8 inches or less loose depth for full width of cross section, bring to optimum moisture content for compaction, and compact each layer to the required density with equipment designed for compaction purposes for the type of material. Backfill systematically in continuous level layers for the full width of the cross section. Uniformly place each layer to the specified maximum lift (or less) and thoroughly blade mix or otherwise blend during the spreading to ensure uniformity of material in each layer. The distribution and gradation of the materials throughout the earthen fill shall be such that the fills will be free from lenses, pockets, streaks, or layers of material differing substantially in texture, gradation, or moisture from the surrounding materials. The materials, when compacted in the earthen fill, shall be blended sufficiently to secure the best practicable degree of compaction and stability. If there is a varying degree of permeability in material for embankments, the most impervious materials shall be placed in the central portion of the earthen fill and the more pervious materials shall be placed so that the permeability of the fill will be gradually increased toward the upstream and downstream slopes of the earthen fill. Testing of each lift shall be performed prior to placing the next lift in accordance with the specified testing requirements.

i. Structure and Appurtenance Backfill and Compaction

Backfill around structures and appurtenances such as vaults, manholes, foundations, buildings, valves, valve boxes, cleanouts, miscellaneous structures with care to prevent damage to the work. Materials shall be compacted to 95% standard proctor for native materials and 95% modified proctor for processed materials both at +/-2% optimum, unless otherwise noted on the plans for a particular use, using equipment which will not damage the structures, appurtenances or surrounding construction.

Compact each layer continuously over its entire area and make sufficient trips with the compaction equipment to ensure that the required density has been obtained uniformly. Backfill simultaneously on each side of foundation walls and other structures to equalize soil pressures. Do not backfill against or operate heavy equipment adjacent to walls until all structural elements

are constructed, cured, properly braced, and approved by the Engineer. Do not operate heavy equipment closer to foundations than a horizontal distance equal to height of backfill above bottom of foundation. Compact remaining area with hand tampers suitable for material being compacted. Where needed, the hand work (e.g. compaction with a whacker) for a lift should be done in advance of and blended into the work of the larger equipment.

Perform all compaction with approved equipment well suited to location, structure, and materials being compacted. Do not begin compaction until structures are properly secured and have adequate strength. Perform compaction while the material is at the specified moisture content. Maintain optimum moisture content during final rolling and until compacted material is covered by subsequent construction. Remove loose material and protect material until covered.

ii. Pipe Zone Compaction

After the pipeline has been installed, suitable backfill material shall be hand placed in up to 3" lifts to the pipe centerline (springline) and hand tamped with appropriate tamping equipment and compacted to provide firm uniform support for the pipe. Take care to ensure that sufficient material has been worked under the haunch of the pipe to provide adequate side support. With rigid pipe, if care has been taken to shape the bedding material to the curvature of the pipe, only one stage of placement will be required to bring the haunching material to the spring line. Compact haunching material to a minimum of 95% Standard Proctor Density. Additional backfill shall then be hand placed and hand compacted in 3" lifts to provide at least six inches of suitable cover over the top of the pipe before any material is placed with machinery. Take care to avoid contact between the pipe and compaction equipment to avoid damage or displacement. Where specified or called for on the plans, pipe zone shall be backfilled with flowable fill.

Compaction of backfill materials shall be done in such a way the sufficient backfill has been placed to ensure that such compaction equipment will not have a damaging effect on the pipe or its installation yet ensure proper compaction through the depth of the trench and around the pipe. Any damage resulting from the backfilling or compaction of the backfill shall be repaired by the Contractor in a timely manner. At all times precautions should be taken to prevent flotation of the pipeline due to entry of water into the trench and ensure proper compaction through the depth of the trench and around the pipe.

iii. Upper Trench Compaction

Within the public right of way and in Town easements, minimum compaction through the entire depth shall be 95% of maximum dry density as measured by Standard Proctor tests for native materials. Structural materials such as road base shall be compacted to 95% of maximum dry modified Proctor. Moisture control at +/- 2% of optimum of all fill will be required to facilitate achieving acceptable densities. On private property, density shall be at least 90% or original soil density whichever is greater. Top soil need not be compacted.

In general, backfill shall be mechanically compacted by means of tamping rollers, sheep foot rollers, pneumatic tire rollers, vibrating roller or other mechanical tampers which are appropriate for the material being compacted. Compaction by jetting or flooding shall not be permitted. The trench shall be filled to provide a minimum of 3 feet of cover over the pipe before rolling equipment is used and 50 inches before utilizing a hydrohammer during compaction.

C. Surface Restoration

On completion of backfill operations and other work, the entire site shall be cleared of all debris, and ground surfaces shall be finished to smooth, uniform slopes and shall present a neat and workman-like appearance. The final grade in unpaved streets and other areas will be graded to match existing grades without producing drainage problems. Areas which are to receive pavements, surfacing, topsoil, or landscaping shall be graded as required to allow installation of the specific surface treatment. Depths of road base shall be per typical trench detail drawing. Restoration of grass, shrubs, and other plants shall be done to the extent required to restore the damaged areas to a condition as close as practical to that which existed prior to construction. Replace topsoil without compacting, to depth which was stripped in landscaped areas. Tree damage shall be repaired in accordance with good horticultural practice.

No permanent pavement shall be restored until the backfill is determined to be adequate and able to properly support the pavement. All paved areas shall be replaced with suitable pavement.

The finished surface of roads impacted directly or indirectly by the project will be restored to their original or better condition as determined by the owner(s) involved. Asphalt damage shall be repaired with hot mix asphalt (4" minimum depth, and not less than the thickness of asphalt removed), and damaged concrete, repaired with concrete by cutting and replacing to the closest control joints. The Town, County, or State Road Department as applicable, shall be notified two working days prior to repair so that inspection can be provided.

The respective property owner shall be the final judge of the acceptance of restoration work. In cases where sub-standard conditions existed prior to beginning construction, it shall be the Contractor's responsibility to have documented such conditions or to restore the site to standard conditions acceptable to the Engineer, respective property owner and Town. Pavement repair shall be guaranteed for a period of one year.

The Town shall be the final judge of the acceptance of restoration work. The Contractor shall be responsible for returning all roadways traversed with his equipment to conditions at least as good as existed prior to commencing construction. Again, in cases where sub-standard conditions existed prior to beginning construction, it shall be the Contractor's responsibility to have documented such conditions or to restore the site to standard conditions acceptable to the Town.

D. Patching

Prior to replacing asphalt on properly compacted backfill, square up any ragged edges of adjoining pavement. Such cutting shall be done in accordance with "Pavement Cutting" paragraph above. Apply approved prime coat to Class 6 roadbase and tack coat against sides where pavement is to be placed, in accordance with manufacturer's recommendations. Lay two 2" mats of hot bituminous asphalt to area and compact to 92-96% of Rice Density. Place patching material around the edges and work inward. Unless otherwise specified herein, materials and construction methods shall comply with the Colorado Departments of Transportation (CDOT) Specifications, Section 401 - Hot Mix Pavements.

Concrete work shall be removed and replaced to the nearest joint on each side of the trench. (See Town standard drawing for concrete replacement.) Replace at least 6" past the trench width in

each direction. Concrete shall be a 3/4" CDOT Class B meeting the requirements of Section 601 with no more than 20% flyash. Thickness of the concrete mat shall equal the thickness of the surrounding concrete but not less than 4" thick. Immediately prior to placing concrete, foundation shall be thoroughly moistened. After placing, the surface shall be shaped to match surrounding surface, floated with a wooden or magnesium float, and given a broom finish. All outside edges of slab and all joints shall be edged with a 1/4" radius edging tool. Expansion joints shall be placed to match surrounding concrete. Use tool joints, saw cut or zip strips as needed to match existing concrete. Joints shall be ¼ depth of the concrete. Place construction joints around all appurtenances. Premolded expansion joint filler or thicker shall be installed in the joints for the full depth. Use of the water to finish concrete is prohibited. Concrete shall be protected from freezing for a minimum of 3 days. The concrete shall be kept continuous moisture for a minimum of 7 days by the use of a Town approved membrane applied in accordance with manufacturer's recommendation or other Town approved technique. . During curing all traffic both pedestrian and traffic shall be excluded.

E. Topsoiling

i. Conservation

When excavating, stockpile on site topsoil for future placement. Topsoil material is subject to approval. Conserve, or import if necessary, sufficient topsoil to cover a depth of 6" all disturbed areas which are not covered by riprap, road base, hard surface, or a structure.

ii. Clearing

Prior to placing topsoil remove vegetation and clear ground surface of all other materials that would hinder proper grading, tillage or subsequent maintenance operations.

iii. Placing Topsoil

Place topsoil on all disturbed areas which are not access or road ways, or designated to be covered by other materials. Prior to placing topsoil, prepare previously constructed grades as required such that when topsoiling is completed the proper grade will be achieved. After grading, scarify areas to be topsoiled to a depth of at least six inches. Perform work only during periods when beneficial results are likely to be obtained.

Perform spreading so that planting can proceed with little additional soil preparation or tillage.

Do not place topsoil when subgrade is frozen, excessively wet, extremely dry, or in a condition otherwise detrimental to proper grading or proposed planting.

F. Revegetation

Prior to commencing construction, it will be necessary to determine the amount and type of vegetation which naturally occurred on the areas to be disturbed. This will be done by counting the quantity of each type of vegetation in randomly selected representative quadrants of the site to be disturbed. Quadrants shall be either a square foot or a square yard depending on the density of the vegetation. Assessment shall be completed in accordance with the Contractor's Storm Water Management Plan.

Disturbed areas that are to be revegetated shall be left in a roughened condition. Roughen vertical depth shall be approximately 3". Roughening shall be completed with undulations running

parallel to contouring. Use erosion control logs, silt berms, silt fence, or other suitable means to limit erosion prior to revegetation.

Preparatory to seeding, the top 4" of the topsoil shall be tilled into an even and loose seed bed 4" deep, free of clods, in excess of 2" diameter and brought to desired line and grade. Reseeding shall be done in accordance with specifications, requirements of the landowner, the recommendations from CSU Extension, BLM, and good horticultural practice for the areas being revegetated. Seed mix on private property shall be selected by the land owner. Where lawn and in other grassy areas are disturbed, sod shall be provided for restoration. Furnish and install sod in accordance with CDOT standard 212.05. Contractor shall make arrangements to keep it moist until it is established.

Seed shall not be placed in windy weather or when the ground is frozen or likely to freeze in the next 48 hours. Seeding shall only take place in the fall or early spring. Hand broadcasting of seed will only be permitted for small areas which not accessible to machine methods. In places where the seed is not drilled, the application rate of the seed shall be doubled.

In all areas where the slope is 3:1 or flatter, seeding will be accomplished in general conformance with CDOT Section 213. In larger areas, use an approved mechanical power drawn drill followed by packer wheels or drag chains. The drill shall be operated in a direction generally perpendicular to the direction of the slope. Drill seed 1/2" deep with rows spaced no more than 4" apart. Seed that is extremely small shall be sowed from a separate hopper adjusted to the proper rate of application. Hydromulching will be allowed only if adequate water will be applied to the seed to keep the mulch continuously moist until the seedlings are established.

On all slopes steeper than 3:1, and smaller areas seed shall be applied by means of a mechanical broadcaster at double the rate required for drill seeding. The surface shall be cat tracked up and down the side slope prior to, or just after, seeding to create depressions to help hold seed and moisture. All seed sown by mechanical broadcasters shall be raked into the soil to a depth of 1/2" prior to cat tracking.

Unless more stringent requirements are specified in the storm water management plan, weed free native grass straw shall be applied at the rate of two tons per acre in areas that have native vegetation. It shall be uniformly crimped in with a crimper or other approved method to a minimum depth of 3". The seeded areas shall be mulched and crimped within 24 hours after seeding. Alternately a mulch with tackifier (200#/Ac) may be used. Jute, soils blanket, or other suitable covering shall be secured to all slopes steeper than 3:1 as soon after mulching as practical. The material shall be applied smoothly but loosely on the soil surface without stretching. Workers shall minimize the amount of walking of the seedbed even after the jute is applied. The upslope end of each piece of jute mesh shall be buried in a narrow trench about 6" deep. The jute shall be secured in the trench with compacted dirt fill. Where one roll of jute ends and a second begins, the upslope piece should be brought over the buried end of the second roll with a 12" overlap to form a junction slot. Where two or more widths are side by side the overlap shall be at least 6".

Seeded areas that have been disturbed prior to or during mulching operations shall be reseeded. Areas not properly mulched or that are damaged shall be repaired or remulched as needed to meet the standards specified herein. Mulching activities shall not occur during windy weather.

Where shrubs or trees were present prior to the disturbance, it is recommended that the same type shrubs and trees be re-planted at approximately the same density as originally present,

unless the slope prohibits such plantings. Where trees in excess of 3" caliber are damaged or removed during project, replace trees with trees of similar species at twice the density. Protect such plantings from wildlife damage.