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## PART II - CONSTRUCTION MATERIALS AND METHODS

### SECTION 20.

#### EXCAVATION, BEDDING, AND BACKFILL FOR PIPELINES

##### 20.1. GENERAL

Piping for storm drainage, irrigation lines, sanitary sewers, water systems, service lines and laterals, to be installed in easements or public right-of-way, under the jurisdiction of the City, shall be excavated, bedded, backfilled and the trench resurfaced in accordance with approved engineered plans, and the City of Rifle Engineering Code of Standards and Specifications for the Design and Construction of Public Improvements.

The contractor performing the work shall be properly licensed with the City, obtain all permits, and give twenty-four (24) hours written notice to the Public Works Department Engineering Division, setting forth the time construction is to commence or when work is to be resumed following a delay. The contractor shall maintain a complete set of approved drawings and specifications, covering the work being performed, on the project at all times.

##### 20.2. MATERIALS

Materials, other than pipe and fittings, which are to be placed within the trench limits and below finished grade, shall conform to the minimum standards hereinafter referred to.

Specifications and detailed recommendations for acceptable Practices set forth by the American Society for Testing Materials (ASTM), the American Association of State Highway Transportation Officials (AASHTO) and the Colorado Department of Transportation (CDOT) are made a part of these specifications.

20.2.1. Foundation Stabilizer Material - 3/4" to 1 1/2" dense, durable rock with less than fifteen (15) percent passing the #4 sieve.

20.2.2. Bedding - Free draining material meeting the specifications and gradation for the specific application set forth as follows:

**BEDDING MATERIAL**

<b>BEDDING TYPE</b>	<b>SQUEEGEE*</b>	<b>AGGREGATE**</b>	<b>FILLER SAND***</b>
AASHTO Spec.	Local by-product	M-43	M-6
CDOT Spec.	Local by-product	#67	
<b>SIEVE SIZE</b>	<b>% PASSING SQUARE MESH SIEVE</b>		
1 1/2"			
1"		100	
3/4"		90-100	
1/2"			
3/8"	100	20-55	100
#4	40-90	0-10	95-100
#8		0-5	
#16			45-80
#50			10-30
#100			2-10
#200	0-5		
P.I.	0	0	0
L.L.	0	0	0

\*Local Platte River by-product allowed on all sizes and types of conduits

"Pipe Bedding B" is an acceptable alternative to Squeegee

\*\*May be used in lieu of squeegee on 27" and larger conduits only

\*\*\*To be used for sewer main casing pipe filler only

20.2.3. Backfill - Soils and soil aggregate mixtures classified in accordance with AASHTO M-145, Table 2, which also meets the categories hereinafter specified.

**A. SPECIAL BACKFILL MATERIAL**

Gravel, Stone Fragments, Sands and Silty Soils

Group Classification	A-1-a	A-1-b	A-3	A-2-4
Sieve Analysis % Passing				
#10	50 Max.			
#40	30 Max.	50 Max.	51 Min.	
#200	15 Max.	25 Max.	10 Max.	35 Max.
Characteristics of L.L.				40 Max.
Fractions (-#40 Sieve) P.I.	6 Max.	6 Max.	N.P.	10 Max.

The following is also acceptable as a **Special Backfill Material**.

CDOT Class 1 Structure Backfill Material	
Sieve Size	% Passing Square Mesh Sieve
2"	100
#4	30-100
#50	10-60
#200	5-20
P.I.	6 Max
L.L.	35 Max

**B. ACCEPTABLE BACKFILL MATERIAL**

Silty or Light Clayey Gravel and Sandy and Silty Soils

Group Classification	A-2-5	A-4	A-5
Sieve Analysis - % Passing			
#200	35 Max.	36 Min.	36 Min.
Characteristics of L.L.	41 Min.	40 Max.	41 Min.
Fractions (-#40 Sieve) P.I.	10 Max.	10 Max.	10 Max.

**C. GENERALLY UNACCEPTABLE BACKFILL MATERIAL**

Heavy Clayey Gravel and Silty, Clayey Soils

Group Classification	A-2-6	A-2-7	A-6	A-7
Sieve Analysis - % Passing				
#200	35 Max.	35 Max.	36 Min.	36 Min.
Characteristics of L.L.	40 Max.	41 Min.	40 Max.	41 Min.
Fractions (-#40 Sieve) P.I.	11 Min.	11 Min.	11 Min.	11 Min.

Note: Material in Category C above shall be disposed of and replaced with acceptable backfill material, unless specifically approved in writing by the Project Engineer for use as backfill.

20.2.4. Surfacing - See Concrete Part II Section 10 and Streets Section 15 of these Standard Specifications.

**20.3. CONSTRUCTION PRACTICES**

Prior to excavating in hard surfaced areas, the outer limits of the trench shall be string lined and the surfacing cut in a vertical plane by sawing, roller blade or jack hammering. Drop blades are not acceptable. Nominal trench width limits at the surface, which shall be the width used in determining the quantity of resurfacing or patching for payment, shall be three feet plus the outside diameter of the pipe, unless otherwise approved in writing by the City Engineer. During construction, should the vertical asphalt edges ravel, they shall be trued to a vertical plane to a point six (6) inches outside the limits of excavation prior to placing the resurfacing material.

20.3.1. Embankment - Depressed areas shall be raised to the proposed crown elevation of the pipe to be installed, prior to excavating the pipe trench. Preparation and placement of fill in low depressed areas shall be performed as set forth under Embankment in Section 5 of these specifications.

20.3.2. Excavation - The excavation shall be made to lines and grades shown on the plans and as established by the Project Engineer. All excavation shall be classified as "unclassified" or "rock" excavation only. Excavation shall include materials of every description, and of whatever substance encountered, to the depths and of the areas required for the construction work. All excavation not classified as "rock excavation" as defined below shall be "unclassified". "Unclassified" shall mean no classification will be made of the materials excavated neither as to depth, nature, composition, hardness nor degree of water content.

Surfacing materials such as concrete and asphalt shall be removed to neat lines and disposed of independently of the underlying soil; base course and gravel are to be salvaged to stockpile, protected from contamination and reused for special backfill.

Soils removed from the trench which meet the requirements for backfill materials, shall be stockpiled in a manner which will not endanger the performance of the work, obstruct sidewalks or driveways and provide the least possible interference with traffic. Soils encountered which are unacceptable for use as backfill shall be disposed of by the contractor at his expense.

At no time will trench excavation be permitted to advance ahead of the installed pipe in excess of eighty (80) feet at any one time during the performance of the work.

20.3.2a Rock Excavation – Rock excavation shall consist of igneous, metamorphic and sedimentary rock which cannot be excavated without blasting or the use of rippers, and all boulders or other detached stones each having a volume of one (1) cubic yard or more as determined by physical or visual measurement.

20.3.2b Blasting – Excavation by use of blasting shall be allowed for portions of the work which may be expedited by use of such methods. The Project Engineer may limit or prevent the use of blasting whenever, in their opinion, the blasting may harm public safety or public or private property. All blasting shall be conducted in accordance with all applicable laws, ordinances and regulations imposed by federal, state and local authorities . All trench walls shall be shored or braced prior to blasting. The contractor shall be responsible for and take special precautions to prevent damage to all adjacent structures whenever blasting is performed.

20.3.3. Wet Trench - The contractor shall provide and maintain adequate equipment to properly remove and dispose of all surface or ground water entering the trench. The use of any sanitary sewer connected to the City effluent lines to dispose of trench water will not be permitted. The trench shall be dry at all times during pipe installation and so maintained until the jointing operation is complete. It is the responsibility of the contractor to use pipe foundation stabilizer material to assist him in maintaining a dry trench.

20.3.4. Trench Depth - Where soft unstable soils, dense shale, or rock is encountered at the normal trench bottom, the contractor shall undercut and dispose of such materials, to the limits established by the Project Engineer, and backfill the void thus created with pipe foundation stabilizer material.

In dense shale or rock, the undercutting shall be not less than six (6) inches and in unstable soils to not less than twelve (12) inches below the bottom of the pipe bell and the void replaced to within six (6) inches of the pipe with the stabilizer material.

The normal trench depth shall be a minimum of six (6) inches lower than the bottom of the pipe bell, unless an additional bedding thickness is called for on the drawings. Where pipe collars, bells, or flanges protrude in excess of six (6) inches from the pipe barrel, the contractor shall hand excavate in these areas sufficiently to allow the pipe bell to rest uniformly on the bedding material. Pipe being supported by the collars, bells or flanges on natural soils will not be allowed. Unauthorized and excessive trench depths shall be filled to

bedding subgrade with foundation stabilizer material at the contractor's expense. Reuse of trench excavated soils will not be permitted in the trench until the pipe and bedding materials have been properly installed.

- 20.3.5. Trench Width - The allowable trench width, regardless of the type of soil encountered, the depth of excavation or method of bedding densification, shall not exceed the outside diameter of the pipe barrel plus twenty-four (24) inches or be less than the outside diameter of the pipe barrel, plus twelve (12) inches when measured at any point below the top of the pipe bell, flange or collar.

When necessary to minimize sliding or caving of the trench, it will be permissible to slope the banks from the surface to an elevation twelve (12) inches above the top of the bells, flanges or collars. Trench banks below said elevation shall be maintained in a vertical plane as stated herein above, until the pipe has been bedded and backfilled to an elevation of twelve (12) inches above the pipe barrel. Excavated material shall be piled a sufficient distance from the trench banks to avoid sliding or caving of the trench walls.

- 20.3.6. Unauthorized Trench Width - Where the width of the lower portion of the trench exceeds the maximum width herein above stated, the contractor, at his expense, shall furnish and install special pipe embedment or concrete encasement to protect the pipe from the additional loading. The type and quantities of special pipe embedment shall be determined by the Project Engineer, based on a pipe strength equal to the three edge bearing ultimate strength stipulated for a non-reinforced rigid pipe of comparable diameter, saturated backfill weighing 120 pounds per cubic foot and allowance for truck or other live loads where applicable.

- 20.3.7. Trench Supports - Whenever the sides of the trench will not stand vertically and within the limits herein above specified during the pipe installation, the contractor shall install sheeting and shoring to prevent any excessive widening or sloughing. Where excavations are made under severe water conditions, the Project Engineer, at his discretion, may require the contractor to use an approved piling instead of sheeting.

- 20.3.8. Surplus Excavated Material - All waste and surplus excavated materials shall be removed from the project and disposed of by the contractor.

## **20.4. BEDDING**

All pipe, regardless of type or diameter, shall be installed on sufficient bedding material so as to provide a minimum of six (6) inches separation between the subsoil and the pipe barrel, after consolidation. See Bedding Material Paragraph 20.2.2 for types of acceptable bedding material and Standard Drawing SS-1 for pipe bedding and backfill limits.

- 20.4.1. Fully Embedded Pipe - Pipe twenty-four (24) inches and smaller in diameter, regardless of type, and all non-reinforced concrete, clay, asbestos cement, ductile iron, cast iron, CSP, PVC, steel, flexible and profile wall pipes, regardless of diameter, shall be enveloped with consolidated bedding material from six (6) inches below the pipe barrel, between the trench banks and to a cover above the pipe of not less than twelve (12) inches. French or perforated underdrains shall be fully embedded in the pipe foundation stabilizer material to six (6) inches each side of the underdrain pipe.

- 20.4.2. Partially Embedded Pipe - Prestressed concrete cylinder (PCCP) and reinforced concrete (RCP) pipes twenty-seven (27) inch and larger in diameter, need only be granularly embedded between six (6) inches below the pipe barrel to pipe springline and horizontally to adjacent trench walls.

- 20.4.3. Bedding Installation - Pipe bedding material shall be placed in the trench to a loose depth of seven (7) inches and then fine graded along centerline of the pipe barrel to a thickness of six (6) inches. Special precautions shall be taken to remove sufficient bedding material at the point where the pipe bell, collar or flange falls, insuring a uniform bearing of the pipe barrel throughout its length.

After the pipe is properly joined and set to line and grade, a second loose lift of bedding material, not to exceed eight (8) inches, shall be placed along each side of the pipe and then consolidated by tamping or vibration until uniform support under the pipe haunch is obtained. Additional bedding shall be carefully placed to the limits specified and then consolidated by a combination of tamping and vibrating. At all times special precautions shall be taken to prevent displacement of or damage to the pipe.

- 20.4.4. Densification of Bedding - Bedding material shall be compacted to 70% relative density as determined by ASTM D2049.

## 20.5. **BACKFILL**

Backfill of the trench, after the bedding material is in place and consolidated, shall be conducted in a manner to prevent damage to the pipe or its coating. When backfilling over a flexible conduit, compaction must be controlled to the extent that elongation along any axis of the pipe shall not exceed two (2) percent for steel or five (5) percent for plastic conduits.

Backfill shall be uniformly graded and free of all frozen material, clods, rocks, stones, etc. Tractor drawn tamping equipment shall not be used closer than eighteen (18) inches from rigid pipe or thirty-six (36) inches from flexible pipe.

Concrete placed in a trench to cradle or encase the pipe shall be covered with not more than thirty-six (36) inches of loosely placed backfill material and the concrete then allowed to cure for a period of five (5) days before the trench backfill is consolidated by one of the methods hereinafter described.

In areas where the trench has been sheeted, for whatever reasons, extra precautions shall be taken during backfill to solidly fill all cavities behind the sheeting when it is being abandoned in place, or to solidly fill all cavities in or adjoining the trench as the sheeting is being removed.

- 20.5.1. Generally Unacceptable Soils for Backfill - Soils which possess a Plastic index of twenty (20) or greater shall be disposed of and replaced with a material which meets the requirements of an acceptable or special backfill material, as specified in the Materials portion of this section of the specifications, Section 20.2.3.) In general, unacceptable backfill materials may only be used for backfilling pipelines which cross open fields and which will not be subjected to heavy loading for a period of two (2) years.

If approved in writing by the Project Engineer, backfilling with this unacceptable backfill material shall be accomplished by placing the material in loose lifts, not to exceed three (3) feet over the bedded pipe, followed by longitudinal rolling of each lift with a motor patrol, loaded truck or other rubber tired equipment until the full width of the backfill in the trench shall have been consolidated equally. Upon completion of the backfilling and compaction within the trench limits, the top of the trench shall be graded and mounded sufficiently to allow for subsidence to the level of the adjacent ground surface.

Should the total cover over the pipe be less than three (3) feet, longitudinal rolling will not be allowed. However, the trench backfill material shall be puddled with water, allowed to cure and the trench then mounded.

Backfill of this nature shall not be performed in easements across lands not owned by the City unless specific authorization in writing has been obtained from the property owners involved, which allows backfilling in the manner herein above described and which also absolves the City of all responsibility for subsidence.

20.5.2. Trenches in Streets - Soils at optimum moisture content which are placed in the manner hereinafter described and which meet the requirements set forth under the materials portion of this specification, for acceptable or special backfill material, shall be used in filling trenches which are within the limits of public thoroughfares and rights-of-way. Backfill over the consolidated bedding shall be placed in loose twelve (12) inch lifts and each lift thoroughly consolidated by wheel rolling, tamping, vibrating, or by other proposed means of compaction acceptable to the City representative, until the relative compaction, when determined in accordance with AASHTO T-99 or T-180, is equal or greater than the minimum value hereinafter shown for the various classes of soil and type of compaction. Compacted backfill shall be placed to minimum depth of thirty six (36) inches over the top of the pipe before a vibratory roller or hydro hammer can be used over the pipe.

Squeegee bedding shall be consolidated by tamping, vibrating or a combination thereof, to 70% relative density as determined by ASTM D2049.

Soil Classification (AASHTO M-145)	Minimum Relative Compaction (percent)		Moisture % of optimum
	AASHTO T-99	AASHTO T-180	
A-1 through A-5	100	95	-3, +3
A-6 and A-7	95	90	-1, +3

Backfilling and compacting in lifts shall continue until the trench has been filled or the elevation of the subgrade for base course has been reached.

Consolidation shall be obtained by the use of hand tampers having a minimum weight of twenty (20) pounds and a facial area in excess of twenty-four (24) square inches or by other proposed means of compaction acceptable to the City representative. Hydro hammers or vibratory rollers shall not be used prior to placing a three (3) foot loose lift of acceptable backfill material above the twelve (12) inches of prior compacted bedding material. In cases where compacted bedding is required only to pipe springline, backfill material shall be compacted in six (6) inch lifts from springline to a depth of twelve (12) inches over the pipe crown prior to placing a three (3) foot loose lift of backfill, in preparation for vibratory rolling or hydro hammering. Large self powered or tractor drawn compactors shall not be used within thirty six (36) inches of any pipe crown or sidewalls.

20.5.3. Vibrating and Jetting - Consolidation of backfill by vibrating and jetting will only be allowed in open fields and when the backfill material has a plastic index of six (6) or less and when consolidation is obtained in the following manner:

Backfill shall be loosely placed over the consolidated bedding to within six (6) inches of finish grade and allowed to set for a period of five (5) days, providing sufficient time for the concrete encasements and mortars to become hard enough to withstand the backfill consolidation.

The loose backfill shall then be consolidated by water jetting and vibration. Water at a minimum pressure of forty (40) psi shall be injected into the backfill through a rigid pipe nozzle to within one (1) foot of the top of the pipe. If water is not available from a distribution system, the contractor shall equip a supply tank, or other water source, with a suitable pressure pump. Vibrators shall be of the immersion type of adequate power to consolidate the mass and of sufficient length to reach within one (1) foot of the top of the pipe.

Care shall be taken to use only sufficient water at each jetting point to insure permeation of the backfill and proper consolidation and not result in surface saturation. The vibrator shall not be removed from the mass until after the jet is removed. The jetting pipe nozzle and the vibrator shall be inserted in the backfill at sufficiently close intervals along the trench to insure that uniform consolidation will result.

After the jetted and vibrated backfill has settled, and the surface is dry enough to be stable, the balance of the trench shall be filled in eight (8) inch loose lifts, each lift being thoroughly compacted with vibrators and tampers. This part of the backfill shall have the proper moisture content to permit thorough compaction to the relative compaction specified in Section 20.5-2.

- 20.5.4 Compaction Testing – A minimum of one compaction test per every 250 feet of trench or 200 cubic yards of fill material is required. Tests will be performed by the City's soil tester on City projects. On developer projects, compaction test results shall be submitted by the contractor's soil tester. The testing shall be at varying depths and locations. Additional testing may be required around valve boxes, manholes or in questionable areas of backfill where initial tests show the compaction does not meet the compaction standards specified in Section 20.5.2 of this section of the Specifications. Additional testing may also be required if significant moisture or freezing conditions have affected the previously consolidated backfill material before permanent asphalt surfacing has been placed. The successful passing of a compaction test or tests does not constitute acceptance of the work or materials represented by the tests or any portion of the work or materials. The Contractor is solely responsible for quality control of his work. The work will only be accepted by the City upon completion and after expiration of the warranty period required in the Rifle Engineering Code of Standards and Specifications.
- 20.5.5. Utility Service Line Backfill - Water and sewer service stubs being installed in previously surfaced streets shall be bedded with materials as described in Section 20.2.2 and backfilled with CDOT Class 6 Road Base, Flow Fill or Flash Fill only. Road base material is to be installed in the manner described below and shall be consolidated to the relative compaction specified in Section 20.5.2 of this section of the Specifications. Base course shall be installed in consolidated lifts, not to exceed twelve (12) inches and each lift consolidated to the density required before the subsequent lift is placed in the trench. Consolidation shall be performed in the manner described in Section 20.5.2 above.
- 20.5.6. Street Maintenance During Construction - The maximum amount of open trench ahead of the installed pipe shall not exceed one hundred (100) linear feet. At the end of each shift, or shifts shortened for cause, the pipe trench shall be backfilled, compacted, surface graded and the trench filled to within ten (10) lineal feet of the excavated trench face. However, any liability resulting from trenches left open or improperly backfilled and maintained shall be at the contractors expense.

During the progress of the work backfilled trenches shall be maintained free of chuckholes, ruts, loose rocks and dust. Daily the contractor shall level to grade non-paved surfaces and spray thereon dust palatives or water in sufficient quantity to control dust, until such time as the trench is permanently asphalt surfaced.

Every 7-10 calendar days maximum, all unpaved trenches on the project shall be re-excavated to a depth of six (6) inches below finish grade. Asphalt edges along the trench shall be trued to a vertical plane and then asphaltic primed. Subgrade shall be leveled and recompacted. The void thus created shall then be filled with two (2) or three (3) compacted lifts of Colorado Department of Transportation Grading S bituminous asphaltic surfacing material. During winter months the initial two (2) lifts of Grading S shall not exceed a total depth of five (5) inches. The remaining one (1) inch void shall be compacted full, using CDOT Grading SX. Sufficient Grading SX material shall be used to allow feathering the finish trench surface over and onto asphalt that existed prior to construction.

In the event hot mix bituminous material is not available during winter months, the contractor shall install and maintain a temporary two (2) inch layer of cold mix asphalt atop the trench. As

soon as the hot mix plants are again producing Grading S the contractor shall re-excavate the trench and install the six (6) inch of bituminous mix as herein above outlined.

Immediately following installation of the temporary or permanent asphalt surfacing, the entire width of the asphalt surface and concrete gutters, if in place, shall be cleaned of all debris, power broomed and maintained free of rock and debris throughout the construction period.

- 20.5.7. Surface Restoration - Paving, curb, gutters, sidewalk, improved surfaces, or other street improvements removed, damaged or destroyed during construction shall be replaced to the same elevation and alignment, equal to and consistent with the undisturbed portions of the improvements existing prior to trench excavation. Subgrade for all restored surfaces shall be thoroughly compacted by mechanical or hand tampers weighing not less than twenty (20) pounds, by vibratory rollers or by other proposed means of compaction acceptable to the City representative.
- 20.5.8. Maintenance of Backfill and Surface Warranty - Backfill shall be maintained in a satisfactory condition and all areas showing signs of settlement shall be filled and maintained for a period of one (1) year following the date of final acceptance for all work performed, EXCEPT the warranty period for settlement in asphalt surfaced streets shall be for two (2) years. When the developer or contractor is notified by the City that any backfill is hazardous, he shall correct such hazardous condition at once.
- 20.5.9. Housekeeping Restoration and Clean Up - See Section 5 of these Standard Specifications.