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PART II – CONSTRUCTION MATERIALS AND METHODS

SECTION 15.

STREETS

15.1. GENERAL

Curb, gutter, crosspans, sidewalk, ramps, driveway access, street surfacing and/or rejuvenation of asphaltic concrete in public right-of-way under the jurisdiction of the City, shall be installed in accordance with approved engineered plans, these Specifications and the General Conditions of the “Engineering Code of Standards and Specifications for Design and Construction of Public Improvements” of the City of Arvada. These Specifications shall apply to all new construction within the City of Arvada.

Requirements for site preparation, care of topsoil, excavation, embankment and treatment of cut areas are covered in Section 5 and 20 of these Specifications.

The Contractor shall obtain a permit from the Engineering Division and notify the Engineering Division in writing, twenty-four (24) hours before the planned construction is to commence or when work is to be resumed following a delay.

15.2. MATERIALS

Materials that are to be manufactured, processed, furnished and installed in street subgrades and finished surfaces, shall conform to the minimum standards hereinafter referred to.

Specifications for materials as set forth by the American Society for Testing Materials (ASTM), the American Association of State Highway Testing Officials (AASHTO) and the Colorado Department of Transportation (CDOT) are made a part of these Specifications. Referenced standards are considered to be the latest edition and revisions thereof.

15.2.1. Concrete

Class "A" concrete, as set forth in Part II Section 10 of these Specifications, shall be used in the construction of curbs, gutters, sidewalks and cross pans.

15.2.2. Borrow

Loose friable soil reasonably free of refuse, stumps, roots and rocks. The maximum dimension of any rocks placed in fills shall not exceed two-thirds of the depth of lift being placed or six (6) inches, whichever is the lesser.

15.2.3. Aggregates for Subbase and Base Course

Aggregate and soil aggregate meeting the gradation hereinafter specified which have a plastic index not to exceed six (6), when tested in accordance with AASHTO T89 and T90 respectively, shall conform to the quality requirements of AASHTO M-147 and to Section 703.03 of the Colorado Department of Transportation Standard Specifications except as modified below. In addition, the material must have a minimum R-value of 78 or a minimum CBR of 80 and must be moisture stable. Moisture stability is determined by R-value testing which shows a drop of 12 points or less in R-value between exudation pressures of 300 psi and 100 psi.

A. SELECT SUBBASE

| <u>Standard Sieve Designation</u> | <u>% By Weight Passing</u> |
|--|--|
| 2/3 the depth of sub-base course layer | 100% |
| #10 | ≤ 80% |
| #200 | 5 – 15 % |
| Characteristics | L.L. = 30 Maximum L.A Abrasion – 50 Maximum |

B. BASE COURSE

| <u>Sieve Designation</u> | <u>% By Weight Passing</u> | |
|--------------------------|----------------------------|----------------|
| | <u>Class 5</u> | <u>Class 6</u> |
| 2-1/2" | | |
| 2" | | |
| 1-1/2" | 100 | |
| 1" | 95-100 | |
| 3/4" | | 100 |
| #4 | 30-70 | 30-65 |
| #8 | | 25-55 |
| #200 | 3-15 | 3-12 |
| L.A. Abrasion | 50 Max | 50 Max |
| Liquid Limit | 30 Max | 30 Max |
| Plasticity Index | 6 Max | 6 Max |

Recycled concrete meeting the above requirements can be substituted. Class 5 shall be used for subgrade stabilization only.

15.2.4. Hot Mix Asphalt (HMA)

Requirements for hot mix asphalt pavements (HMA) shall be in accordance with Part II Section 11 of these Specifications.

15.2.5. Chemical Soil Sterilization Agents

- A. Non-selective, pre and post emergent, soil toxic herbicide that is soluble in water, non-toxic to humans; when used under conditions designated by the manufacturer it shall remain active for a period of one (1) year after application.
- B. Casaron-D, Trysben-200 and Hyvar-X or Hyvar-XL are considered as meeting this specification.

15.2.6. Geogrid

Geogrid soil stabilizers shall be a high density polyethylene, conforming to the design geometry specified in the special conditions. Tensar high strength polymer geogrids SS-1, SS-2 and SS-3 meet this specification.

15.2.7. Geotextile Fabric

Geotextile fabric to be in accordance with Section 712.08 of the latest revisions to the Colorado Division of Transportation Standard Specifications for Road and Bridge Construction.

15.2.8. Cement Treated Aggregate Base Course

This material shall consist of a mixture of aggregate materials as outlined in Section 304 of the Colorado Department of Transportation Standard Specifications, Portland cement and water. Acceptable aggregates are Colorado Department of Transportation Classes 5 and 6.

The materials to be used in the construction shall be tested and a mix design submitted to the Engineer for approval. The mix design report shall contain a description of material sources, gradations and Atterberg Limits of aggregates, cement type, Proctor compaction curves and unconfined compressive strength results for each mix, strength versus cement content curves, a design mix and special construction procedures recommended. Testing shall be in accordance with applicable AASHTO specifications. Minimum in place thickness of this material shall be twelve (12) inches. This shall be verified by coring samples every 250 feet along the roadway in alternating lanes after subgrade has been established. Coring must be done in the presence of a City Engineering Inspector.

The mix must have a minimum five day compressive strength of 650 psi and a maximum of 1,000 psi. Minimum cement content shall be five percent (5%) by weight.

15.2.9. Lime/Fly Ash Stabilized Subgrade

This material shall consist of a mixture of native or imported soils, hydrated or quick lime, Class "C" Fly-Ash (ASTM C 618) and water, as outlined by ASTM Specification C 977 and CDOT Section 307. Dolomitic quicklime, magnesia quicklime with magnesium oxide contents in excess of 4 percent or carbonated hydrated lime, shall not be used. Fly ash may consist of Class C or Class R. Class F fly ash shall only be allowed in conjunction with lime or other stabilizing agents.

The materials to be used in construction shall be tested and a mix design submitted to the Engineer for approval. The mix design report shall contain a description of material sources, gradation (or -200) and Atterberg limits of native soils, Atterberg limits, pH, and 5-day unconfined compressive test results for each mix, strength versus lime/fly-ash content curves, a design mix and special construction procedures recommended. Testing shall be in accordance with applicable AASHTO methods.

The Plasticity Index of the treated soil shall not exceed 10 per AASHTO T89 and T90. The minimum unconfined compressive strength shall be 160 psi, per ASTM D1633. Sulfate concentrations shall not exceed 0.5%. The minimum pH shall be 12.3 after completion of initial mixing with stabilizing agent and at ambient temperature. Swell potential after treatment shall be less than 1% at 200 psf per ASTM D4546.

Minimum in place thickness of this material shall be twelve (12) inches. This shall be verified by coring samples every 250 feet along the roadway in alternating lanes after subgrade has been established. Coring must be done in the presence of a City Engineering Inspector.

15.2.10. Cement Stabilized Subgrade

This material shall consist of a mixture of native or imported soils, Portland cement and water.

The materials to be used in construction shall be tested and a mix design submitted to the Engineer for approval. The mix design report shall contain a description of material sources, gradation (or -200) and Atterberg limits of native soils, pH, and 5-day unconfined compressive test results for each mix, strength versus cement content curves, a design mix and special construction procedures recommended. Testing shall be in accordance with applicable AASHTO methods.

The minimum Portland cement content shall be 3.0% dry weight per ASTM D3. The minimum unconfined compressive strength shall be 160 psi, per ASTM D1633. Sulfate concentrations shall not exceed 0.5%.

Minimum in place thickness of this material shall be twelve (12) inches. This shall be verified by coring samples every 250 feet along the roadway in alternating lanes after subgrade has been established. Coring must be done in the presence of a City Engineering Inspector.

15.2.11. Lime Treated Subgrade

This material shall consist of a mixture of native or imported soils, hydrated or quick lime and water, as outlined by ASTM Specification C 977 and CDOT Section 307.

The materials to be used in construction shall be tested and a mix design submitted to the Engineer for approval. The mix design report shall contain a description of material sources, gradation (or -200), Atterberg limits and sulfate concentrations of native soils, Atterberg limits and 5-day 100 degree F cure unconfined compressive test results for each mix, strength versus lime content curves, a design mix and special construction procedures recommended. Testing shall be in accordance with appropriate AASHTO methods.

The minimum pH shall be 12.3 after initial mixing with stabilizing agent and at ambient temperature. In addition, the Plasticity Index of the treated soil shall not exceed 10 per AASHTO T89 and T90. The minimum acceptable hydrated lime content shall be 5 percent (5%) dry weight per ASTM D3. The minimum unconfined compressive strength shall be 160 psi, per ASTM D1633. Sulfate concentrations shall not exceed 0.5%.

Only mix designs approved by the Engineer shall be used. Approvals are required prior to construction. Minimum in-place thickness for this material shall be twelve (12) inches.

15.3. CONSTRUCTION PRACTICES

All work in public rights-of-way shall be constructed to the lines and grades called for on City approved plans. Stakes to control the work shall be set in the field by survey parties working under the supervision of a registered land surveyor. City survey crews will establish the control for City projects and controls established by developers are subject to checking by City crews.

Bituminous materials and aggregates conforming to Section 11 of these Specifications, shall be blended to the proportions of the job mix formula, spread, finished and compacted in place, utilizing equipment and procedure methods as set forth in Sections 401.01 through 401.20 of the Colorado Department of Transportation Standard Specifications and these Specifications.

15.3.1. Site Preparation, Excavation, and Embankment

(See Part II, Section 5 of the "Engineering Code of Standards and Specifications for Design & Construction of Public Improvements of the City of Arvada".)

15.3.2. Curb, Gutters, Sidewalks, Handicap Ramps and Crosspans

All curbs, gutters, crosspans, sidewalks, handicap walk ramps and driveways shall be cast in place to conform to the dimensions and contain the reinforcing called for by the City of Arvada Standard Detail Drawings. Preparation of subgrade shall be in accordance with the requirements of Part II Section 5 of these Specifications. Subgrade stabilization and treatment procedures shall be in accordance with this section of the Specifications. Forming, concrete placing, finishing and cutting shall conform with the requirements set forth in Part II Section 10.

Crosspans and curb return wings shall have a concrete thickness of not less than eight (8) inches. Driveways, handicap walk ramps and sidewalks shall have a minimum concrete thickness of six (6) inches. Detached sidewalks shall also have a minimum concrete thickness of six (6) inches. All concrete flatwork including crosspans, curb return wings, driveways, walk ramps, curb and gutter and sidewalks shall be reinforced with 1.5 pounds of fibermesh per cubic yard of concrete.

Where curbs and gutters are adjacent to and constructed in conjunction with sidewalks, the concrete shall be placed simultaneously on a compacted subgrade. Monolithic concrete so placed, as in all slabs on grade, shall be divided into ten (10) foot sections by control joints formed with a jointing tool. Control joints shall extend into the concrete for a depth of not less than one (1) inch and shall be approximately 1/8" in width.

Premolded expansion joint filler 1/4" to 1/2" in thickness that extends for the full depth of the concrete shall be installed between all concrete flatwork and any fixed structures or appurtenances such as manholes, utility poles, etc.

Landscaped or earth areas behind curbs and sidewalks shall be backfilled and shaped to drain after the forms have been removed. Areas between property lines and back of sidewalk or curbs shall be shaped and uniformly graded.

Handicap ramps in accordance with Federal regulations are to be constructed at all radius locations and at other locations as shown on the construction drawings or directed by the Engineer. Ramps are to provide the handicapped direction by use of color and surface texture contrasts. Generally, ramps are to provide elevation change at 1:12 maximum grade in direction parallel with centerline of walk and to provide minimum width of 36-inch with 2% maximum cross slope. Landings are to be 5-foot minimum length in direction parallel to centerline of walk with grade not to exceed 2 percent in any direction where feasible. Ramps are to be constructed so that outer edges of the cross walks are aligned with landings. A curb head is to be provided through ramp bottoms and approach transitions. Color contrast is to be provided by furnishing and placing colored truncated dome product material in landing area. Color to be Davis Tile Red. Ramps are to be constructed in accordance with Standard Drawings SD-7 through SD-16 where feasible and to be constructed at City direction where existing conditions dictate variation from these details.

15.3.3. Soil Sterilization

Bituminous parking lots, bicycle trails and walkway subgrades shall be sterilized to prevent plant growth. All surface vegetation, within the limits of the paving shall be removed within three (3) days prior to treating the soil with a sterilant. Soil sterilants shall be applied in

accordance with all Colorado statutes, ordinances or codes pertaining to the use and application of fungicides, insecticides, herbicides, or other agricultural chemicals and the manufacturer's recommendation. Sterilants shall not be applied when the ambient temperature is below seventy (70) degrees Fahrenheit.

Care shall be exercised to prevent powder, spray or vapor drift which may damage gardens, shrubs or trees in the vicinity of the areas being treated. Soil sterilants shall not be used where they may contaminate water used for irrigation or drinking purposes. The Contractor will be held responsible for any damage to plant growth outside the designated treatment areas where such damage is attributable to carelessness or improper application of the soil sterilant.

15.3.4. Aggregate Base Course

Base course shall be placed and compacted in maximum six (6) inch layers on a prepared subgrade that has been proof-rolled within the past 24 hours and found to be stable and non-yielding. Should weather conditions change, such as freezing, precipitation, etc., aggregate base materials shall not be placed until the subgrade is reapproved. Subgrade surface shall be in conformity with the lines, grades and typical cross sections shown on the plans

Each layer shall be densified to ninety-five (95) percent of the Modified Proctor when tested in accordance with AASHTO T-180 and within +/- 3% of optimum moisture content. Water shall be uniformly applied during compaction so as to achieve proper consolidation. In place density tests shall be taken every 250 LF along the roadway per lift alternating each lane. A moisture density curve in accordance with ASTM 698 must be submitted for each source of material. In addition, a gradation analysis in accordance with ASTM 422 and Atterberg Limits in accordance with ASTM 423 and ASTM 424 shall be submitted per every 1,000 tons or fraction thereof of aggregate base course material placed.

The prepared surface, ready to receive the surface course shall be uniformly graded to design elevation so when tested with a ten (10) foot straight edge the variation above or below the testing edge, between any two (2) contact points with the surface, shall not exceed 1/2" for Class 1 or 1/4" for Class 5 or Class 6 base course. Areas that do not conform with these tolerances shall be reworked.

15.3.5. Cement Treated Aggregate Base Course

Cement treated aggregate base course shall be used only where a mix design has been previously submitted and approved by the Engineer. Cement treated aggregate base shall be prepared per the approved mix design and placed, moisture treated and compacted as outlined in Section 307 of the CDOT Standard Specifications.

At least one set of 4 Proctor mold samples of cement treated aggregate base course for each 1,000 square yards of material placed (minimum one per project) shall be obtained and laboratory cured and tested at 7 and 28 days to determine unconfined compressive strength. Samples shall be molded from treated base course within 1.5 hours of final mixing with the material. Cement content, gradation and Atterberg Limits (Plasticity Index) tests shall also be submitted for every 1,000 square yards of material placed.

During placement and compaction, compaction curves will be required for each material used in accordance with AASHTO T 134. Compaction shall be completed within 90 minutes of the time the cement and water is applied. In-place moisture-density tests shall be taken on each lift of material at intervals of 250 lane feet. The field density of the compacted mixture shall be at least 95 percent of the maximum dry density of laboratory specimens prepared from samples taken from the treated subgrade material immediately prior to compacting. The

specimens shall be compacted and tested in accordance with ASTM D 698 or ASTM D 558 as specified in the design. The in-place field density shall be determined in accordance with ASTM D 1556, ASTM D 2167 or ASTM D 2922. The moisture content of the material shall be between 0 and 3 percent above optimum moisture content determined in accordance with ASTM D 698 or ASTM D 558. Compaction curves for each soil type and field density shall be compared to the appropriate curve for percentage compaction determinations.

Thickness tests shall also be taken at intervals of 500 lane feet (every 250 feet along the roadway alternating lanes). If the average of three thickness measurements in one area is less than twelve inches the entire area within 250 feet shall be reworked to the proper depth. When thickness and/or strength criteria fail to meet design parameters, after all possible attempts have been made to correct the deviations, the roadway design section shall be re-evaluated and the pavement structural section adjusted to compensate for the deficiency in the stabilized subgrade thickness and strength.

15.3.6. Cement Stabilized Subgrade

Cement treated subgrade shall be used only where a mix design has been previously submitted and approved by the Engineer. Cement treated subgrade shall be prepared per the approved mix design and placed, moisture treated and compacted as outlined in Section 307 of the CDOT Standard Specifications.

The surface of the road bed shall be bladed to the established lines, grades, and cross-sections as shown on the approved plans and then scarified or ripped. Deleterious materials shall be removed. The length of the ripper teeth shall be no more than 10% greater than the thickness of lime treatment. Areas that contain wet, unstable or unsuitable materials shall be corrected with base material as directed by the Engineer.

At least one sample set (minimum one set of 4 Proctor molds per project) of cement treated subgrade for each 1,000 square yards of material placed shall be obtained and moisture cured at 100°F for five days to determine compressive strength. Samples shall be molded from stabilized soil within 1.5 hours of final mixing with the material. Cement content, gradation and Atterberg Limits for each soil type shall also be submitted for every 1,000 square yards of material placed.

The minimum Portland cement content shall be 3.0% dry weight per ASTM D3. The minimum unconfined compressive strength shall be 160 psi, per ASTM D1633. Sulfate concentrations shall not exceed 0.5%. The Plasticity Index of the treated soil shall not exceed 10 per AASHTO T89 and T90.

During placement and compaction, compaction curves will be required for each material used in accordance with AASHTO T 134. In-place moisture-density tests shall be taken on each lift of material at intervals of 250 lane feet. Compaction shall be completed within 90 minutes of the time the cement and water is applied. The field density of the compacted mixture shall be at least 95 percent of the maximum dry density of laboratory specimens prepared from samples taken from the treated subgrade material immediately prior to compacting. The specimens shall be compacted and tested in accordance with ASTM D 698 or ASTM D 558 as specified in the design. The in-place field density shall be determined in accordance with ASTM D 1556, ASTM D 2167 or ASTM D 2922. The moisture content of the material shall be between 0 and 3 percent above optimum moisture content determined in accordance with ASTM D 698 or ASTM D 558. Compaction curves for each soil type and field density shall be compared to the appropriate curve for percentage compaction determinations.

Initial compaction shall be by means of a sheep foot or segmented wheel roller. Final compaction shall be by means of a smooth wheel or pneumatic tired roller. Areas inaccessible to a mechanical roller shall be compacted to the required density by other means suitable to the Engineer.

Thickness tests shall also be taken at intervals of 500 lane feet (every 250 feet along the roadway alternating lanes). If the average of three thickness measurements in one area is less than twelve inches the entire area within 125 feet shall be reworked to the proper depth.

When thickness and/or strength criteria fail to meet design parameters, after all possible attempts have been made to correct the deviations, the roadway design section shall be re-evaluated and the pavement structural section adjusted to compensate for the deficiency in the stabilized subgrade thickness and strength.

15.3.7. Lime/Fly Ash Stabilized Subgrade

Lime/Fly Ash stabilized subgrade shall be used only where a mix design has been previously submitted and approved by the Engineer. This material shall be prepared per the approved mix design and placed, moisture treated and compacted as outlined by ASTM Specification C 977 and CDOT Section 307. Lime/fly ash stabilized subgrade shall be used where stabilized subgrade is used for the purpose of swell mitigation.

The surface of the road bed shall be bladed to the established lines, grades, and cross-sections as shown on the approved plans and then scarified or ripped. Deleterious materials shall be removed. The depth of the tiller shall be no more than 10% greater than the thickness of lime treatment. Areas that contain wet, unstable or unsuitable materials shall be corrected with base material as directed by the Engineer.

At least one set of 4 Proctor mold samples of lime/fly ash stabilized subgrade per project shall be obtained and moisture cured for 5 days at 100°F to determine compressive strength. Samples shall be molded from stabilized soil within 1.5 hours of final mixing with the material. Lime/fly ash content, alkalinity (pH), gradation and Atterberg Limits (Plasticity Index) shall be submitted for each soil type treated.

The Plasticity Index of the treated soil shall not exceed 10 per AASHTO T89 and T90. The minimum unconfined compressive strength shall be 160 psi, per ASTM D1633. Sulfate concentrations of the treated soil shall not exceed 0.5%. The pH shall be minimum 12.3 after initial mixing

During placement and compaction, compaction curves will be required for each material used in accordance with AASHTO T 134. In-place moisture-density tests shall be taken on each lift of material at intervals of 250 lane feet. The field density of the compacted mixture shall be at least 95 percent of the maximum dry density of laboratory specimens prepared from samples taken from the treated subgrade material immediately prior to compacting. The specimens shall be compacted and tested in accordance with ASTM D 698 or ASTM D 558 as specified in the design. The in-place field density shall be determined in accordance with ASTM D 1556, ASTM D 2167 or ASTM D 2922. The moisture content of the material shall be between 0 and 3 percent above optimum moisture content determined in accordance with ASTM D 698 or ASTM D 558. Compaction curves for each soil type and field density shall be compared to the appropriate curve for percentage compaction determinations.

Initial compaction shall be by means of a sheep foot or segmented wheel roller. Final compaction shall be by means of a smooth wheel or pneumatic tired roller. Areas inaccessible to a mechanical roller shall be compacted to the required density by other means suitable to the Engineer.

Minimum in place thickness of this material shall be twelve (12) inches. This shall be verified by coring samples every 500 lane feet (every 250 feet along the roadway alternating lanes) after subgrade has been established. Coring must be done in the presence of a City Engineering Inspector. If the average of three thickness measurements in one area is less than twelve inches, the entire area within 125 feet of the cores shall be reworked to the proper depth.

When thickness and/or strength criteria fail to meet design parameters, after all possible attempts have been made to correct the deviations, the roadway design section shall be re-evaluated and the pavement structural section adjusted to compensate for the deficiency in the stabilized subgrade thickness and strength.

15.3.8. Lime Treated Subgrade

Lime treated subgrade shall be used only where a mix design has been previously submitted and approved by the Engineer. Lime treated subgrade shall be used where stabilized subgrade is used for the purpose of swell mitigation.

When recommended by the approved soils report and/or pavement design, the surface of the road bed shall be bladed to the established lines, grades, and cross-sections as shown on the approved plans and then scarified or ripped. Deleterious materials shall be removed. The depth of the tiller shall be no more than 10% greater than the thickness of lime treatment. Areas that contain wet, unstable or unsuitable materials shall be corrected with base material as directed by the Engineer.

Lime shall be applied to the prepared roadbed to the depth and width required for the lime treated subgrade stabilization (minimum of twelve (12) inches depth). Application, mixing, and finishing shall be in accordance with Colorado Department of Transportation Specifications, 1999 Edition, Section 307.04 through 307.07 except that the curing period shall be a minimum of 24 hours. Hydrated lime shall conform to the requirements of ASTM C 107-79, Type N. The treated subgrade shall not be mixed when the ambient air temperature at ground level or subgrade is below 40 degrees F. The treated material must be maintained at a minimum temperature of 40 degrees F until the treated material has been fully compacted. Lime slurry shall not be left exposed to the air for more than four hours without initial mixing.

Lime treated subgrade shall be observed and tested on a full-time basis and shall be paid for by the developer on private projects or paid for as called out on the Bid Schedule on City projects. Field moisture-density tests shall be taken at the rate of one for every 250 lane feet. The field density of the compacted mixture shall be at least 95 percent of the maximum dry density of laboratory specimens prepared from samples taken from the treated subgrade material immediately prior to compacting. The specimens shall be compacted and tested in accordance with ASTM D 698 or ASTM D 558 as specified in the design. The in-place field density shall be determined in accordance with ASTM D 1556, ASTM D 2167 or ASTM D 2922. The moisture content of the material shall be between 0 and 3 percent above optimum moisture content determined in accordance with ASTM D 698 or ASTM D 558. Compaction curves will be required for each soil type and field density shall be compared to the appropriate curve for percentage compaction determinations.

Initial compaction shall be by means of a sheep foot or segmented wheel roller. Final compaction shall be by means of a smooth wheel or pneumatic tired roller. Areas inaccessible to a mechanical roller shall be compacted to the required density by other means suitable to the Engineer.

In place thickness shall be verified by coring samples along the roadway after subgrade has been established. Verification shall include the use of a phenolphthalein indicator solution

that changes color at a pH of 10. Indicator solution shall be applied to the bottom of 12" deep cores of the subgrade taken every 500 lane feet (every 250 feet along the roadway alternating lanes). Cores must be done in the presence of an Engineering Inspector. If the thickness is deficient by more than 1" from plan thickness, two additional cores shall be taken at random in the same area to determine an average thickness. If the average thickness is deficient by greater than 1", the entire area within 125 feet of the deficient cores shall be reprocessed.

Laboratory testing for field compacted 5-day strength (one set of 4 Proctor molds per project) shall be required. Laboratory test for plasticity index, alkalinity (pH) and lime content (AASHTO T 232, if requested) determinations shall be required for each 1,000 square yards of subgrade treated, with a minimum of one per project. Samples shall be molded from stabilized soil within 1.5 hours of final mixing with the material.

The results of field density, alkalinity (pH), thickness, plasticity index and strength tests shall be submitted and reviewed by the Engineer. Provided all tests are acceptable, the subgrade will be approved and the paving course can be placed. Should these tests fail to meet project specifications, the strength reduction will be used to calculate increased pavement layer or overlay thicknesses required for the design section.

15.3.9. Manhole, Water Valve Box and Survey Range Box Adjustments

Manholes, valve boxes and survey range boxes shall be adjusted to within ¼" below finish grade before the final surface course of HBP is placed. The Contractor shall remove all foreign matter found or introduced into them in the performance of this work, and it shall be his responsibility to insure proper compaction around same after they have been adjusted. Manholes, valve boxes and range boxes should be set to final grade just prior to the final lift of asphalt being placed on newly constructed or newly re-constructed streets.

Manholes, valve boxes and range boxes that are not raised prior to placement of the final surface course of HBP (either due to oversight or at Contractor's option) shall be raised and/or adjusted in accordance with the following:

If manholes are not set to grade prior to the final lift of HBP being placed, the Contractor shall vertically and uniformly cut the existing asphalt mat full depth three (3) feet square around the center of the manhole with sides parallel and perpendicular to street centerline. Manholes shall be raised to proper grade using concrete riser rings. If more than 12" of concrete riser rings are required to raise the manhole lid to final grade, then a new manhole barrel section must be installed to allow the lid to be set to grade with less than 12" of concrete riser rings. If range boxes and valve boxes are not set to grade prior to the final lift of asphalt being placed, the asphalt mat shall be core drilled full depth 12" diameter centered on the valve box or range box. Auger drilling shall not be allowed. Range boxes shall then be set on compacted subgrade at the proper elevation to match final grade. Adjustable range boxes shall be screw adjusted to within ¼" below existing grade. Valve boxes shall also be screw adjusted to within ¼" below final grade. Drop in type valve box risers shall not be allowed on newly constructed or newly re-constructed streets. New hot mix asphalt (Grading SX, ½" mix) shall be placed and properly compacted in the excavated area. The entire area in the vicinity of the raised manhole, valve box or range box shall then be infrared repaired to blend the patch with the existing asphalt and to eliminate any vertical joints in the final lift of asphalt.

On streets that are being sealed, the Contractor shall cover the manholes, valve boxes and survey range boxes with a roofing paper or other suitable material prior to sealing. The covering shall be left in place for a minimum of forty-eight (48) hours after which it shall be removed and disposed of. All covers shall be clean when work is complete.

On streets that are being overlaid with asphaltic concrete the Contractor shall adjust the valve and range boxes by screwing the adjustable rings upward to finish grade, prior to final rolling.

In the case of manhole rings, the Contractor shall vertically and uniformly cut the existing asphalt mat eight (8) inches from the ring and remove the mat and base to a depth of six (6) inches below finish grade. Rings shall then be removed and the existing riser rings adjusted and pointed to provide the required subgrade for resetting the set rings, free of pressure points. Once the ring is reset to finish grade the collar (eight (8) inch x six (6) inch void between the mat and the ring) shall be filled with asphaltic concrete and compacted in accordance with these Specifications.

15.3.10. Bituminous Tack Coating

Tack Coating shall be applied in accordance with Section 11 of these Specifications. The emulsified asphalt shall be diluted 1:1 with water and applied at 0.10 +/- 0.01 gallons per square yard of diluted material. All surfaces to receive tack coat shall be dry and cleaned by sweeping or other approved method until all dust, debris and other foreign matter is removed. Care shall be taken that the application of bituminous material at any point, especially at the junction of spreads, is not in excess of the specified amount. Coatings shall not be applied when the surface is wet or when the temperature is below sixty (60) degrees Fahrenheit. Prior to paving, all water must have evaporated from the tack coat. All contaminated areas shall be cleaned and tack coat shall be reapplied.

Coatings shall be applied in such a manner as to offer the least inconvenience to traffic and to permit one-way traffic without pickup or tracking of the bituminous material.

15.3.11. Blotting

If after the application of the prime coat or rejuvenating agent, the bituminous material fails to penetrate or if chip and seal applications bleed, approved blotter material shall be spread in the amounts required to absorb any excess bituminous material.

15.3.12. Hot Mix Asphalt (HMA) Pavement

HMA pavement construction shall be in accordance with Part II Section 11 of these Specifications.

15.3.13. Parking Lots, Trails and Walkways

Subgrades for parking lots, bicycle trails and walkways shall have all vegetation removed, subgrade shaped, compacted and the soils then sterilized prior to installing base course and/or asphaltic concrete to prevent plant growth.

Asphaltic concrete Grading S or SX shall be placed and compacted to a minimum compacted thickness of six (6) inches for bicycle trails and walkways, and a minimum density of ninety-five (95) percent of Marshall density (ASTM D1559) or between (92) percent and (96) percent of maximum theoretical density of a laboratory specimen made in the proportions of the job mix formula determined according to Colorado Procedure #51 has been obtained. Compaction shall be uniform and accomplished by means of City approved power rollers and/or hand tamping. Only in areas inaccessible to rollers will hand tamping be permitted. Asphalt thickness for parking lots shall be as called for in the plans.

15.3.14. Hot Mix Asphalt (HMA) Patching

Areas in streets designated to be patched shall be sawcut to the full depth of the asphalt or

cut by a method, approved by the Engineer, which leaves a neat, straight line and vertical face on the existing pavement and no deformation of the surface at the cut. Vertical faces of the cut shall be coated with tack material prior to patching. Subgrade shall be compacted by a roller, where feasible, prior to patching asphalt. Hot mix asphalt pavement (HMA) shall be placed to a minimum depth of six (6) inches. Asphalt lifts for street patching shall not exceed three (3) inches in depth. Finished surface shall match the line and grade of the existing pavement.

HMA patching material shall be in accordance with the Contract Documents on City projects or as approved by the Engineer.

15.3.15. Geogrid - Subgrade Stabilization

Subgrades to be geogrid stabilized shall be cleared of all vegetation or topsoil and then proof rolled to determine local soft spots, observe deflections, rutting and/or pumping. Areas so identified shall be excavated and the void thus created shall be refilled with approved granular material and again proof rolled and shaped, as directed in the field by the City representative.

Sections of specified geogrid shall then be rolled to cover the subgrade, cut and trimmed to clean manholes and valve boxes by one foot while providing a minimum roll overlap of one and one-half feet along the seams. On areas that cannot be covered and properly overlapped with two rolls of geogrid; installation shall commence along the perimeter edges and proceed towards the center of the area making sure the minimum overlap along seams is obtained. Seams between rolls shall be anchored or tied together with wire, polyethylene braid, or stakes driven through the apertures of overlap, on ten (10) foot centers.

Select granular fill materials shall then be end dumped adjacent to the exposed geogrid and then advanced to cover the geogrid in a minimum five (5) inch lift using a front end loader or dozer (or per manufacturer's recommendations). At no time shall the equipment, advancing the fill cover, be in direct contact with the geogrid.

After the initial granular cover lift is placed, the entire lift shall be proof rolled. Rutted and settlements that develop shall be filled with additional select material. Proof rolling and adding of select materials shall continue until the entire geogrid is in tension, the area being stabilized is to the plan designated elevation of cover material, or as directed by the Engineer.

15.3.16. Geotextile Fabric Pavement Systems

Base course and soil subgrades shall be shaped and compacted to grade in preparation for placement of geotextile fabric. Previously asphalted surfaces shall have all distressed areas patched. Existing cracks narrower than 3/8 inch in width shall be filled with a liquid asphalt cement. Cracks larger than 3/8 inch shall be filled with an approved asphalt filler. After patching and filling the existing asphalt surface shall have all dirt, water and grease removed there from. When required, truing or leveling courses of asphalt shall be in place prior to installation of the fabric.

The approved surface to be overlaid shall then be given a tack coat of AC-10 asphalt cement, applied at the rate of 0.20 to 0.25 gallons per square yard, and immediately covered thereafter with the geotextile fabric.

Laydown of the fabric shall be performed such that there are no wrinkles and the overlap between rolls is between two (2) and six (6) inches. Where wrinkles occur, the fabric shall be cut and laid flat. Corrected wrinkle areas and seams between rolls shall be retacked with asphalt cement to insure fabric saturation.

Fabric shall be installed six (6) inches from gutter lip lines or crosspans. Around manholes, valve boxes, vaults, etc., the fabric shall be neat line trimmed and cut six (6) inches from the structure.

Immediately after the fabric is in place, asphalt overlay paving shall commence. The minimum compacted thickness of asphalt overlay pavement, installed over a geotextile fabric, shall be two (2) inches. Use of fabric at locations where a potential for shoving exists, such as turning lanes and stopping intersections, is not recommended.

15.3.17. Cold Milling, Asphalt Surfaces

Milling shall be removal of asphalt pavement by asphalt planing to a specified depth at the edges of a planer pass.

Edge Milling shall be removal of a tapered section of asphalt pavement that is a specified depth from the lip of the concrete gutter and tapering to the existing asphalt grade at a minimum of 6 feet from the lip line. Existing asphalt pavement that may be above the lip of the gutter will not be considered as additional depth of cut.

Specified Depth Milling shall be removal of asphalt pavement to a specified depth over the entire width of the planer pass. Minimum depth of cut at the lip line shall be 1 inch below the lip and existing asphalt pavement that may be above the lip will not be considered as additional depth of cut.

Planing shall result in a surface acceptable to the Engineer. Acceptability shall be based upon the following criteria:

- A. Free of surface ridges in excess of ¼ inch.
- B. Planed surface parallel to lane lines.
- C. Surface area free of excess surface fines.
- D. All planed surfaces, especially wheel ruts, show scoring by planer teeth.
- E. Specified cut depth attained at edges of roadway appurtenances and curb lips.

Removal of asphalt mat shall be accomplished by the use of an approved planing machine or grinder. Planers for lip milling shall be capable of planing the specified width in one pass.

All removed asphalt pavement shall be loaded directly onto trucks by means of a self loading conveyor which is an integral part of the planer. The planer must be capable of picking up all the removed asphalt mat in a single operation. Windrows will not be allowed. All areas planed must be broomed clean with a pick-up type street sweeper before being opened to traffic. All asphalt millings shall be swept from the gutters, sidewalks, yards, driveways, etc.

A sufficient number of pick-up street sweepers shall be used immediately after planing to remove any planed material remaining on the roadway. Failure to clean the roadway will result in suspension of work. Work will not resume until the Engineer has approved the Contractor's revised written description of the method proposed by the Contractor to comply with the requirements of this specification.

The Contractor shall use caution when planing around manholes, water valve boxes and other roadway appurtenances. Manholes, water valve boxes and other similar structures shall either be adjusted to below the bottom of the cut prior to commencing planing operations or cut around using planing equipment. The maximum deviation between the top of the milled pavement and top of the manhole or water valve box shall be no more than ¾

inch in areas open to traffic. This condition may be achieved by placing a temporary wedge of hot mix asphalt (HMA) around the structure. This temporary taper shall be removed prior to placement of new HMA pavement.

Contractor shall protect existing concrete adjacent to milling areas so not to chip or gouge the existing concrete.

Material recovered during the milling operation shall be disposed of by the Contractor at his expense, unless otherwise directed.

Unless otherwise approved, overlay of a milled street shall be within 15 days after the street is milled.

Repair of valve boxes and/or manholes damaged during all milling operations will be the sole responsibility of the Contractor. Repair to include saw cutting +/- 3'X3'X6", excavating, replacing all damaged parts to final resurfacing grade and repaving.

Mill Patching – This work to consist of milling out rectangular areas in accordance with the Street Patching section.

15.3.18. Hot Mix Asphalt (HMA) Overlay

Overlay work shall consist of placing an overlay of plant mixed hot mix asphalt (HMA) on the existing pavement to a specified compacted thickness. Overlay shall not be higher than 1-inch above gutter lip line. Overlay of a milled street shall be completed within 15 days after the street is milled unless approved otherwise by the Engineer. Asphaltic concrete spilled or ravelled into gutters and on sidewalks during lay down operations shall be swept up and removed immediately following the work.

Soil sterilant shall be applied to vegetated cracks in the street and lip lines. City to be notified 24-hours in advance of soil sterilization for inspection purposes. Colorado Department of Transportation Standard Specifications shall be used as a guide for sterilant materials and method of application. Where necessary, weeds shall be removed by a weed burner or other approved method prior to soil sterilization.

Streets shall be swept by a pick-up type of street sweeper prior to tack coat. Tack coat material consisting of a mixture of grade CSS-1h or SS-1h emulsified asphalt and an equal amount of clean water shall be applied at a rate of 0.10 gallons per square yard and allowed to break prior to overlaying the street.

Contractor to sweep gutters and sidewalk immediately following overlay operations and prior to proceeding on to the next street to be overlaid.

15.3.19. Materials Testing

All materials and operations shall be tested in accordance with these Specifications and as directed by the Engineer. Agencies testing soil and rock shall meet the requirements of ASTM D 3740. Agencies testing asphalt or concrete shall meet the requirements of ASTM D 3666 or D 1077, respectively. All testing agencies shall meet the requirements of ASTM E 329.

A trained and properly qualified representative of the testing agency shall observe, sample and test the materials and work on all projects. If any materials furnished or the work performed by the Contractor fails to meet the Specifications, such deficiencies shall be reported to the Engineering Inspector immediately. Preliminary written field reports and/or test results shall be given to the Engineering Inspector immediately after they are performed.

Final reports shall be forwarded to the Engineering Inspector no later than one week following the testing.

Results of all tests, including failing tests, shall be reported. When the work fails to pass tests or meet Specifications, additional tests shall be taken as directed by the Engineer. All testing and retesting services shall be at the expense of the Contractor or Developer except for City projects where the cost of testing will be covered by the City unless otherwise noted in the Special Conditions for a City project. Testing agency personnel are not authorized to stop work or to alter, relax or release any requirements of these Specifications, or to approve, accept or reject any portion of the work.

Reports shall bear the signature of a Professional Engineer registered in the State of Colorado and competent in the required testing practice. All test reports must show the location of the test and include all information specified in the AASHTO or ASTM test procedure used. All test reports shall be attached to a written declaration letter signed by a Professional Engineer on behalf of the private engineering or geotechnical firm stating that the test results and frequency were in general compliance with the plans and specifications.

The use of a testing agency's services does not relieve the Contractor of the responsibility to furnish the required materials and to perform the required construction in full compliance with the Specifications. Passing test results do not constitute acceptance of the work or materials represented by the test. The Contractor is solely responsible for quality control of the work. A Certificate of Occupancy for any building or structure in the development will not be issued until all the final testing reports indicating compliance with these Specifications are reviewed and placed on file by the City.

15.3.20. Minimum Materials Testing Schedule

Note: Materials testing shall be performed by a qualified geotechnical engineer working under the direction of a Colorado Registered Professional Engineer and shall be paid for by the developer on private projects. Testing will be performed and/or paid for by the City on City projects unless otherwise noted in the Special Conditions for the project.

TABLE 15.1

AGGREGATE BASE COURSE

| Test | AASHTO | ASTM | Minimum test frequency | Engineering Code |
|--|---------------|-------------|--|-------------------------|
| Moisture Density | T180 | D 1557 | One test per source | 15.2.3 |
| Curve (Proctor) | T 99 | D 698 | | 15.3.4 |
| Atterberg Limits | T 89 | D 423 | One test per 1,000 tons or fraction thereof placed | 15.2.3 |
| | T 90 | D 424 | | 15.3.4 |
| Gradation | T 27 | D 422 | One test per 1,000 tons or fraction thereof placed | 15.2.3 |
| | T 11 | | | 15.3.4 |
| In-place density and moisture content | T 238 | D 2922 | One test per 250 lane feet per lift or every 200 cubic yds. | 15.3.4 |
| | T 239 | D 3017 | | |

EMBANKMENT

| Test | AASHTO | ASTM | Minimum test frequency | Engineering Code |
|---------------------------------------|----------------|------------------|---|-------------------------|
| Moisture Density Curve (Proctor) | T 180 T 99 | D 1557 D 698 | One test per soil type | 5.4 |
| Atterberg Limits | T 89 T 90 | D 423 D 424 | One test per soil type | 5.4 |
| Gradation | T 27 T 11 | D 422 | One test per soil type | 5.4 |
| In-place density and moisture content | T 238 T 239 | D 2922 D 3017 | One test per 200 yd ³ or every 250 LF, whichever is less | 5.4 5.4.1 |

PIPE TRENCH BACKFILL

| Test | AASHTO | ASTM | Minimum test frequency | Engineering Code |
|---------------------------------------|----------------|------------------|--|-------------------------|
| Moisture Density Curve (Proctor) | T180 T 99 | D 1557 D 698 | One test per soil type | 20.5.5 |
| Gradation | T 27 T 11 | D 422 | One test per soil type | 20.5.5 |
| In-place density and moisture content | T 238 T 239 | D 2922 D 3017 | One test per 250 feet every 2 feet of depth and additional test half way up and within 1 ft. of all manholes and valve boxes. Also one test per every other service line stub trench | 20.5.5 |

SUBGRADE PREPARATION (RECONDITIONING)

| Test | AASHTO | ASTM | Minimum test frequency | Engineering Code |
|---------------------------------------|----------------|------------------|--|-------------------------|
| Moisture Density Curve (Proctor) | T 180 T 99 | D 1557 D 698 | One test per soil type | 5.5.2 100.6 |
| Atterberg Limits | T 89 T 90 | D 423 D 424 | One test per soil type | 5.5.2 100.6 |
| Gradation | T 27 T 11 | D 422 | One test per soil type | 5.5.2 100.6 |
| In-place density and moisture content | T 238 T 239 | D 2922 D 3017 | One test per 250 lane feet alternating lanes | 5.5.2 |

PORTLAND CEMENT TREATED AND FLY ASH TREATED SUBGRADE

| Test | AASHTO | ASTM | Minimum test frequency | Engineering Code |
|--|---------------|----------------------------|--|-------------------------|
| Moisture Density Curve (Proctor) | | D 558 | One test per soil type | 15.2.9 15.3.7 |
| In-place density | | D 1566 D 2167 D 2922 | One test per 250 lane feet | 15.2.9 15.3.7 |
| In place moisture content | | D 2216 D 3017 | One test per 250 lane feet | 15.2.9 15.3.7 |
| Field compacted 5 day compressive Strength | | 1633-A | Four field prepared Proctor mold samples per project Sealed and moist cured at 100°F for 5 days (min one set per project) | 15.3.6 |
| Thickness | | C 174 | One test per 500 lane feet (min two per project) | 15.3.6 |

LIME TREATED SUBGRADE

| Test | AASHTO | ASTM | Minimum test frequency | Engineering Code |
|---|---------------|----------------------------|--|-------------------------|
| Moisture Density Curve | | D 698 | One test per soil type | 15.3.8 |
| In-place density | | D 1556 D 2167 D 2922 | One test per 250 lane feet | 15.3.8 |
| In Place Moisture Content | | D 2216 D 3017 | One test per 250 lane feet | 15.3.8 |
| Alkalinity (pH) | | C 977 or pH meter | One test per 1,000 square yards of subgrade treated | 15.3.8 |
| Field compacted 5 day unconfined compressive strength | T 220 | D 5102-B | Four field prepared Proctor mold samples per project Sealed and moist cured at 100°F for 5 days (min one set per project) | 15.3.8 |
| Atterberg Limits | T 89 T 90 | D 423 D 424 | One test per 1,000 square yards of subgrade treated (min one per project) | 15.3.8 |
| Thickness | | C 174 | One test per 500 lane feet (min two per project) | 15.3.8 |

PORTLAND CEMENT CONCRETE

| Test | AASHTO | ASTM | Minimum test frequency | Engineering Code |
|---|----------------|----------------|--|-------------------------|
| Slump | T 119 | C 143 | One test per 50 yd ³ or fraction thereof placed One test per 100 yd ³ (Paving) | 10.14.2 |
| Air Content | T 196 T 121 | C 173 C 138 | One test per 50 yd ³ or fraction thereof placed One test per 100 yd ³ (Paving) | 10.14.2 |
| Temperature at placement | | C 1064 | One test per 50 yd ³ or fraction thereof placed One test per 100 yd ³ (Paving) | 10.14.2 |
| Compressive Strength | T 22 | C 39 | One set of cylinders per 50 yd ³ or fraction thereof placed One test per 100 yd ³ (Paving) | 10.14.2 |
| Coring (Thickness) | | C 174 | One core per 500 lane feet (Paving only) | 10.14.2 |
| One set of cylinders shall consist of 5 cylinders (2 @ 7 day break, 2 @ 28 day break, 1 @ 56 day break) | | | | |

BITUMINOUS PAVING MIXTURES

| Test | AASHTO | ASTM | Minimum test frequency | Engineering Code |
|---|-------------------------|---------------------------|--|-------------------------|
| Asphalt content | T 164 T 269 TP 53 | D 2172 D 3202 PS 90 | One test per 1,000 tons or fraction thereof placed (minimum one per day) | 11.15 |
| Gradation | T 27 T 11 | C 136 | One test per 1,000 tons or fraction thereof placed (minimum one per day) | 11.15 |
| Maximum theoretical Specific Gravity (Rice) | T 209 | D 2041 | One test per 1,000 tons or fraction thereof placed (minimum one per day) | 11.15 |
| Marshall/Hveem Properties (only on Marshall mix designs) | T 245 T 247 T 166 | D 1559 D 1561 | One test per mix design | 11.15 |
| Air voids & VMA | T 166 CP-44&48 | D 3203 | One test per mix design | 11.15 |
| Nuclear (In Place) Density * | T 166 T 238 | D 1188 D 2950 | One test per 500 lane feet per lift of in-place HBP alternating lanes | 11.15 |
| Coring (Thickness and Density tests) | T166 | D 3549 | One core per 500 lane feet alternating lanes (minimum four per project) | 11.15 |

* Correlation between core densities and nuclear density required for each mix design used. A minimum of 7 core densities shall be used for correlation with nuclear density.

For streets with less than 3,500 lane feet (or where a particular mix design is not used for 3,500 lane feet) all densities shall be taken from cores. Nuclear densities will not be required in these instances.