Roadway Design and Construction Specifications
Summary of 2010 Revisions and Updates

SECTION 1.00 INTRODUCTION
♦ Revised the definition of Public Improvements

SECTION 2.00 SUBMITTAL REQUIREMENTS AND PROCEDURES
♦ Clarified plan review schedule.
♦ Clarified plan update process.
♦ Revised the title used by the Parks & Open Space to Parks, Recreation & Open Space to reflect the City’s reorganization.
♦ Minor modifications to the general notes.
♦ Added requirements for street plan and profiles regarding traffic control facilities, irrigation sleeving, phasing of public improvements, and criteria for showing water and sanitary sewer on street plans.
♦ Clarified all retaining walls require a retaining wall permit.
♦ Clarified the requirements for Elevation Certificates for residential and non-residential developments.
♦ Referenced the new “Rules and Regulations Regarding Stormwater (Quality) Discharge for Construction Activities” for the preparation of the Erosion Control Plan.
♦ Included requirements for Urban Centers and TODs for signing and striping plans.
♦ Included requirements for Urban Centers and TODs for street lighting plans.

SECTION 3.00 PLAN AND DRAFTING STANDARDS
♦ Added mylar acceptability authority and further clarified mylar acceptability standards.
♦ Clarified mylar revision process.

SECTION 4.00 ROADWAY DESIGN AND TECHNICAL CRITERIA
♦ Added Urban Center and TODs criteria and standards.
♦ Added criteria regarding sidewalks and driveways.
♦ Changed references from Section 45 to the Aurora Water Department’s new erosion control manual, “Rules and Regulations Regarding Stormwater (Quality) Discharge for Construction Activities”.
♦ Modified the offsite street design criteria to reflect current AASHTO guidelines.
♦ Modified the “Statement of Construction Observation and Materials Testing of Project Improvements” statement to be consistent with the model certification letter handed out by the Public Improvements Inspections.
♦ Added criteria for solar powered street lights alternative.

SECTION 5.00 PAVEMENT DESIGN
♦ Added Urban Center and TODs criteria for pavement design.
SECTION 20.00 EARTHWORK

- Updated tracking mud on City streets to reflect the Aurora Water Department’s new erosion control manual.
- Added section on measurement and payment.

SECTION 22.00 STABILIZED SUBGRADE (formerly LIME STABILIZED SUBGRADE)

- Modified the soluble sulfate content from less than 0.5 percent to less than 0.2 percent.
- Temperature requirements have been added for finishing and curing.
- Mechanically stabilized subgrade subsection has been added.

SECTION 23.00 STREET CONSTRUCTION AGGREGATES

- Added Measurement and Payment section.

SECTION 24.00 HOT MIX ASPHALT PAVEMENT

- Surface tolerances were changed to be in conformance with the Colorado Department of Transportation Standard Specifications for Road and Bridge Construction, Section 1.07 Conformity to Roadway Smoothness Criteria.
- Added Measurement and Payment section.
- Added Stone Mastic Asphalt Pavement section.

SECTION 25.00 ASPHALT PLANING

- Added Measurement and Payment section.

SECTION 27.00 SURFACE TREATMENTS

- This section is a total rewrite.

SECTION 30.00 CONCRETE WORK

- Added Measurement and Payment section.

SECTION 31.00 CONCRETE PAVEMENT

- Clarified the use of screeds.

SECTION 35.00 RIPRAP AND FILTER BLANKET

- Updated the riprap tables to be in conformance with the current Urban Drainage and Flood Control District’s drainage manuals.
- Added Measurement and Payment section.
SECTION 36.00 ROAD CUTS

♦ Clarified who needed to obtain a permit when working in the City’s right-of-way.
♦ Modified the requirements for trench patching, roto-milling and overlay within the City’s public streets.
♦ Added criteria for private landscaping and irrigation within public right-of-way.

SECTION 40.00 SEEDING

♦ Added Measurement and Payment section.

SECTION 41.00 SODDING

♦ Added Measurement and Payment section.

SECTION 42.00 MEDIAN COVER MATERIAL

♦ Added Measurement and Payment section.

SECTION 43.00 CHAIN LINK FENCE

♦ Added Measurement and Payment section.

SECTION 45.00 EROSION AND SEDIMENT CONTROL ASSOCIATED WITH CONSTRUCTION ACTIVITIES

♦ This section has been deleted in its entirety and has been replaced by Aurora Water Department’s “Rules and Regulations Regarding Stormwater (Discharge) for Construction Activities”.

SECTION 50.00 TRAFFIC CONTROL

♦ Updated telephone numbers.

TABLE OF CONTENTS, LIST OF TABLES, LIST OF FIGURES, LIST OF NOMOGRAPHS, AND INDEX

♦ Updated all of the data contained in the above references.
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<td>N5.2</td>
<td>DESIGN CHART, FLEXIBLE PAVEMENTS, LOCAL AND</td>
<td>5</td>
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<td></td>
<td>COLLECTOR EXCEPT COMMERCIAL AND INDUSTRIAL</td>
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<tr>
<td>FIG 3.6</td>
<td>CORRECTION OF MODULUS OF SUBGRADE REACTION FOR</td>
<td>5</td>
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<td></td>
<td>POTENTIAL LOSS OF SUBGRADE SUPPORT (6)</td>
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<tr>
<td>N5.3</td>
<td>DESIGN CHART, RIGID PAVEMENTS, ARTERIALS, ALL</td>
<td>5</td>
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<tr>
<td></td>
<td>COMMERCIAL AND INDUSTRIAN</td>
<td></td>
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<tr>
<td>N5.4</td>
<td>DESIGN CHART, RIGID PAVEMENTS, LOCAL AND COLLECTOR</td>
<td>5</td>
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<tr>
<td></td>
<td>EXCEPT COMMERCIAL AND INDUSTRIAN</td>
<td></td>
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</tbody>
</table>
1.00 INTRODUCTION
1.01 SCOPE
1.02 AUTHORITY
1.03 REVISIONS
1.04 REVIEW AND APPROVAL
1.05 INTERPRETATION
1.06 DEFINITIONS AND TERMS
SECTION 1.00 INTRODUCTION

1.01 Scope
This volume, entitled Roadway Design and Construction Specifications (Specifications) sets forth the minimum acceptable criteria for public and private roadway facilities and parking lots within the City of Aurora. Deviations or variances from these standards, may be considered; however, it shall be the responsibility of the applicant to demonstrate to the satisfaction of the City Engineer the proposed variance meets or exceeds the minimum acceptable criteria. Any proposed waiver of a City Code provision may only be made according to the procedures set forth in the City Code. Policies and technical criteria not specifically addressed in this document shall follow the provisions of the latest editions, or as noted in the Specifications, of the American Association of State Highway and Transportation Officials' "A Policy on Geometric Design of Highways and Streets", and the "Standard Specifications for Road and Bridge Construction" of the Colorado Department of Transportation.

1.02 Authority
Portions of the Aurora City Code most often consulted in this volume include; Streets, Sidewalks, and other Public Places, Chapter 126; Traffic and Vehicles, Chapter 134; Utilities, Chapter 138 including Storm Drainage, Article VII; and Zoning, Chapter 146.

1.03 Revisions
Revisions to these Specifications may be adopted annually and as often as needed. It is the responsibility of the Consultant/Contractor/Developer to obtain the latest revisions from the City.

1.04 Review and Approval
City staff will review all submittals for general compliance with these Specifications. However, approval by the City does not relieve the owner, engineer, or designer from the responsibility of insuring that their calculations, plans, specifications, construction and as-built drawings are correct and in compliance with these Design and Construction Specifications.

1.05 Interpretation
In the interpretation and application of the provisions of the Design and Construction Specifications, the following shall govern:

These Specifications shall be regarded as the minimum requirements needed for the protection of the health, safety, and welfare of the people of Aurora, and shall be liberally construed to further such purposes.
Whenever these Specifications and any other law, ordinance, resolution, rule, or regulation of any kind contain any restrictions covering any of the same subject matter, whichever standards produce higher quality shall govern.

These Specifications shall not abrogate or annul any permits issued before their effective date; any construction plans approved before their effective date; or any final plat documents that have been recommended for approval by the Planning Commission prior to the effective date of these standards.

1.06 Definitions and Terms

Wherever in these Specifications or on the submitted drawings the following terms, acronyms, or pronouns in place of them are used, the intent and meaning shall be interpreted as follows:

1.06.1 Associations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>AASHTO</td>
<td>American Association of State Highway and Transportation Officials</td>
</tr>
<tr>
<td>ACI</td>
<td>American Concrete Institute</td>
</tr>
<tr>
<td>AI</td>
<td>Asphalt Institute</td>
</tr>
<tr>
<td>ASCE</td>
<td>American Society of Civil Engineers</td>
</tr>
<tr>
<td>ASTM</td>
<td>American Society for Testing and Materials</td>
</tr>
<tr>
<td>AWS</td>
<td>American Welding Society</td>
</tr>
<tr>
<td>AWWA</td>
<td>American Water Works Association</td>
</tr>
<tr>
<td>CDOT</td>
<td>Colorado Department of Transportation</td>
</tr>
<tr>
<td>COA</td>
<td>City of Aurora</td>
</tr>
<tr>
<td>CRSI</td>
<td>Concrete Reinforcing Steel Institute</td>
</tr>
<tr>
<td>FHWA</td>
<td>Federal Highway Administration, Department of Transportation</td>
</tr>
<tr>
<td>MUTCD</td>
<td>Manual on Uniform Traffic Control Devices</td>
</tr>
<tr>
<td>PCA</td>
<td>Portland Cement Association</td>
</tr>
<tr>
<td>U. B. C.</td>
<td>Uniform Building Code</td>
</tr>
<tr>
<td>UDFCD</td>
<td>Urban Drainage and Flood Control District</td>
</tr>
</tbody>
</table>

1.06.2 Other Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>A.C.</td>
<td>Asphaltic Concrete</td>
</tr>
<tr>
<td>B.F.E.</td>
<td>Base Flood Elevation</td>
</tr>
</tbody>
</table>
1.06.3 Definitions

**CITY** shall mean the City of Aurora, Colorado, a home rule municipal corporation of the Counties of Adams, Arapahoe, and Douglas.

**CITY CODE** shall mean the duly adopted City Code of the City of Aurora, Colorado, as amended.

**CONTRACTOR** shall mean a person, company, corporation or entity licensed and bonded as a contractor in the City in accordance with the City Code.

**ENGINEER** shall mean the City Engineer, the Director of Aurora Water, the Director of Public Works, or other authorized representative acting on behalf of the City.
EXPRESSIONS Wherever the words, "as directed", "as required", "as permitted", or words of like meaning are used, it shall be understood that the direction, requirements, or permission of the City's Project Manager is intended. Similarly, the words "approved", "acceptable", "satisfactory" shall refer to approval by the City's Project Manager.

Whenever the words "these Specifications" are used it shall be understood that reference is made to the City of Aurora's "Roadway Design and Construction Specifications" and "Public Utility Improvements Rules and Regulations Regarding Standards and Specifications" including all parts, supplements, and revisions pertaining thereto.

OBSERVER shall mean the authorized representative of the Project Manager assigned to observe the work.

PUBLIC IMPROVEMENTS shall mean any improvement the City is authorized to provide under its charter or ordinance passed pursuant to such charter or under the constitution and laws of this state, including, but not limited to physical facilities, whether publicly owned and maintained or not, that are required for the benefit, welfare, or service of more than a single property and include, but not be limited to, the construction, reconstruction, and improvement of the following: streets and avenues, major and minor arterials, collector streets and avenues, service and frontage roads, fire lanes, bike paths, parkways, alleys, passenger facilities, monuments and range boxes, sanitary sewer mains, including laterals to more than a single building service, storm sewers, inlets, concrete drain pans, underdrains, retention and detention facilities, including necessary structures, channel facilities; street lighting, traffic signals, medians, facilities for storm water quality Best Management Practices, water mains, hydrants and valves, meters, tree plantings and landscaping, irrigation facilities, and repairs and replacements thereof necessitated pursuant to the issuance of a City of Aurora building permit or other authorization for use of the land.

DESIGNATED PRIVATE CONSTRUCTION WORK includes: private sewer systems, water and sewer service lines to buildings, grading, drainage structures, retaining walls, parking lots, private streets and walks, fire lanes, driveways, and associated construction.

PROJECT MANAGER The authorized representative of the City who provides overall technical coordination and monitoring of work.

SUBCONTRACTOR Any person, company, corporation or entity licensed and bonded as a contractor in the City in accordance with the City Code which has a direct or indirect contract with the Contractor or other Subcontractor and furnishes and/or performs on-site labor and/or furnishes materials used in connection with the performance of the work.
SURETY shall mean the entity which bonds and guarantees the Contractor's satisfactory performance of the work as described in these specifications. (Bonded)

TESTING AGENCY Any individual or other person or entity which is qualified and licensed to perform the required sampling, analysis, testing, and professional recommendation service.

TRAFFIC ENGINEER shall mean the Traffic Engineer of the City.
2.00 SUBMITTAL REQUIREMENTS AND PROCEDURES
2.01 GENERAL
2.02 DRAWING SUBMITTAL PROCEDURES
2.03 CIVIL CONSTRUCTION PLAN REQUIREMENTS
2.04 STORM DRAINAGE PLANS AND REPORTS
2.05 ROADWAY PLANS
2.06 WATER DISTRIBUTION, SANITARY SEWER, AND STORM SEWER PLANS
2.07 GRADING PLANS
2.08 COMBINING PLANS
2.09 SIGNING AND STRIPING PLANS
2.10 SURVEY CONTROL DRAWING
2.11 STREET LIGHTING PLAN
SECTION 2.00 SUBMITTAL REQUIREMENTS AND PROCEDURES

2.01 General
The procedures outlined herein apply to consulting engineers and developers seeking approval of civil construction plans and reports. Observing these guidelines will assist in timely review. Building permits will not be issued until all related civil construction plans are approved. Before the civil construction plans will be accepted for review the consulting engineer must call 303-739-7300 to schedule a pre-submittal meeting with the Engineering Control staff. A review fee must be paid prior to the Civil Plans being accepted. Prior to the pre-submittal meeting the consultant may obtain a copy of the pre-submittal checklist from the Engineering Control staff to make sure their submittal is complete.

2.02 Drawing Submittal Procedures
2.02.1 Minimum Requirements for Approval In addition to the subdivision plat and/or site plan, adequate detail drawings of all necessary public improvements and of any private construction work not already covered by City specifications shall be submitted for review and approval. For City projects where the City specifications do not cover the work, specifications shall be submitted for review and approval. Approvals will be required for the entire water distribution system (including fire protection facilities), sanitary sewer, storm drainage system (including drainage reports, erosion control plans and reports, storm water quality plans), pavement design reports, grading plans, and roadway design, before issuance of a permit for any phase of development will be approved by the Public Works Department and the Water Department. The only exception is when the Erosion and Sediment Control Plans and Report are approved; a Stormwater Quality Permit may be obtained to begin grading operations prior to the remaining civil plans being approved. However, should the approval of the final grading and/or drainage plan necessitate changes to the Erosion and Sediment and Control Plan, the developer is responsible for those changes to the plans and the necessary changes in the field.

2.02.2 Submittals Submit one legible print (either blueline or blackline) of each sheet for the first submittal, unless otherwise requested, and one for each subsequent submittal and one copy of each report to the Engineering Services Division, City of Aurora Public Works Department, Room 3218, for review. See Section 5.00 PAVEMENT DESIGN for pavement design submittal requirements and for limits of concrete paving required for arterial roadways. For concrete paving on City streets a jointing plan must be submitted. See “Rules and Regulations Regarding
Stormwater (Quality) Discharge for Construction Activities” for erosion and sediment control plans and reports and storm water quality plans submittal requirements.

Developers are cautioned that information submitted to the Building Division or other departments is not automatically forwarded to the Engineering Services Division. Separate submittals are required for civil construction plans and building plans.

2.02.3 Review Priority

The civil construction drawing submittals shall be reviewed in accordance with a schedule established when the plans are submitted. This schedule is based on the number of plans in the submittal package. Each project will receive no more than three reviews. The first review is being the longest, the second not as long and the third review the shortest. The third review is the review for approval. The City is committed to meeting the review schedule established for a project, thereby, a development project is relatively assured of a known time frame for plan approval. Please note the schedule assumes a time frame for the consultant to respond to comments. It is the responsibility of the developer to confirm with their consultant for their time required to respond to the City’s comments.

As each civil plan set is submitted it is placed into the City’s queue of civil plans to be reviewed. In a sense it is a “first come, first served” process with the time of review schedule added to the process. Package submittals include plans as defined in Section 2.02.1 MINIMUM REQUIREMENTS FOR APPROVAL. Piecemeal submittals are those which are missing one or more of the items listed in Section 2.02.1 MINIMUM REQUIREMENTS FOR APPROVAL. Additional engineering information beyond those items described herein may be required as needed.

2.02.4 Review Time

The time required for the review process will be based on the number of sheets submitted. A letter will be mailed detailing the anticipated review time for all projects that will receive Certificate of Occupancies. See the “Development Handbook” distributed by the Office of Development Assistance for the model review schedule.

2.02.5 Returned Plans and Reports

The check prints/report along with the City routing slip/checklist will be returned to the Consultant or his local representative with any comments and necessary revisions noted on the plans and/or the reports. The Consultant or his local representative will be notified when the submittal is
It is strongly recommended Consultants use the routing slip/checklist as an aid for compliance to these specifications.

2.02.6 Resubmittals

2.02.6.01 After making all the revisions requested on the original plans/report the Consultant may resubmit according to the instructions checked at the bottom of the City routing slip. Plans with unaddressed comments may be subject to additional review fees if the plans cannot be approved with the third submittal.

2.02.6.02 All previous check prints/reports and the City routing slip/checklist must accompany each resubmittal for further review and/or approval.

2.02.6.03 When indicated on the City routing slip, the Consultant shall submit mylar originals of the original plans and a revised copy of the drainage report for approval. (See Section 3.0 for mylar requirements.) Once the plans and reports are approved, they will become the property of the City and remain on file in the office of the City Engineer. These approved plans cannot be modified without written permission of the Engineer of Record. One complete set of prints of the approved construction plans will be returned to the Consulting Engineer, who will be notified when they are ready to be picked up.

2.02.6.04 Approvals The length of time for approvals typically ranges from five to ten working days depending on the number of sheets in the plan set. Extremely large plan sets are likely to take longer than ten working days. Right-of-ways and easement dedications by separate document and license agreements must be executed prior to the Civil Plan approval.

2.02.6.05 Time Between Submittals The City’s overall schedule for plan approval is set up for the consultant to turn the plans around in one business week. However, if the consultant decides to take more time to pick up the review comments, that is their prerogative. The consultant and the developer need to be aware this will affect the time to approve the civil plans. A word of caution: should the time between submittals exceed a year this will be cause for stopping the review process and requiring the review process to start over, including new review fees.

2.02.7 Review Status The current status of plans and reports in the review process can be obtained by calling the Engineering Services routing desk, 303-739-
7312. Please limit calls to those absolutely necessary, however, as excessive phone calls only serve to lengthen the time required to review plans.

### 2.02.8 Updating Expired, Approved Civil Plans

Once a set of civil plans are approved they are valid for one year from the date they are approved. If no permits or main extension agreements are executed within that one year, the civil plans approval will expire. It is possible to extend the approval of a set of civil plans for one more year on a case by case basis. To do this, the engineer of record must write a letter to the Associate City Engineer requesting the plans be updated. The letter must include the six-digit plan approval number. Once this letter is received the plans will be reviewed against the current set of criteria to see if the plans need to be brought up to date to those criteria. If not, then, the plans may be approved for one more year. This may be done only once.

### 2.03 Civil Construction Plan Requirements

#### 2.03.1 General

All civil construction plans and drainage reports shall be prepared by, or under the direct supervision of, a Professional Engineer, licensed in the State of Colorado, and shall be reviewed for the minimum requirements set forth herein and in the City Code. The submitter should be aware that whenever unusual or serious problems are anticipated in conjunction with a proposed development, additional information and analysis beyond the minimum requirements of these specifications will be required.

The City is not responsible for the accuracy or adequacy of the design, dimensions and elevations on the plans (which shall be confirmed and correlated at the job site). The City, through the approval of the development plan or drainage report, assumes no responsibility for the completeness and/or accuracy of the development plan or drainage report.

#### 2.03.2 Vicinity Map

Minimum scale is 1" = 2000' showing the location and name of all arterial roadways within one mile of the proposed development and all other roadways in the vicinity of the proposed development. The project area shall be indicated by shading. This map is required on the cover sheet or first sheet of all submittals. The map is also required in all drainage reports.

#### 2.03.3 Key Map

Minimum scale is 1" = 500' showing the location and name of all roadways within and adjacent to the proposed development, all non-existing future roadways and the City plat page(s) on which the development can be found. The plat page information may be obtained from Engineering Services, Room 3218, at
the Aurora Municipal Center. This map should be oriented with the north arrow pointing to the top of the drawing.

This map shall appear in the upper right-hand corner on every sheet showing proposed roadway, water distribution, sanitary sewer, storm drainage, or grading improvements, with the roadway or area to which the design pertains shaded as shown on the following example. If the proposed improvements are shown on a single plan sheet, no key map is required.

Figure 2.1

\[ Image of a map showing key map location. \]

2.03.4 Civil Construction Plans and Detail Sheets All civil construction plans and detail sheets shall conform to the following criteria and show the following information. Additional specific requirements are discussed later in these specifications.

2.03.4.01 Title Block A title block is required on every report, plan sheet and cover sheet submitted. The subdivision name and filing number; site plan name and its City file number (if applicable); the type of improvement; name of Developer/Owner, name of contact, address (including zip code), telephone
number of the Development/Owner contact, the name of the Consultant; name of contact, address (including zip code) and telephone number of contact; and sheet number (consecutive, beginning with the cover sheet) shall be included in the title block. If the plans or reports do not relate to a specific subdivision, the name of the street or channel, as well as the limits of the project, shall be clearly indicated. The title block shall be located in the extreme lower right-hand corner of each sheet. See Section 5.01 for title information needed on Pavement Design Reports.

2.03.4.02 Approval Block  A signature block is required on every sheet and cover sheet of the development plans, the first page of every drainage report, and the first page of every pavement design report submitted for review and approval.

Water distribution plans require the signatures of the City Engineer, Water Department, and Fire Department. Sanitary sewer, storm drainage plans, drainage reports, and erosion and sediment control plans and reports require the signatures of the City Engineer and the Water Department. Overlot or area grading plans require the City Engineer's signature, and if access is proposed onto the public right of way without an approved site plan, the Traffic Engineer's signature also is required. The City Engineer's signature is required on all Roadway Plans and on all pavement design reports. Traffic construction control plans, signing and striping plans, and street light plans, require the City Engineer's signature. Traffic Signal Plans require the Traffic Engineer’s signature. The height of the approval block should be adjusted according to the number of signatures required. The addition of an "Approved for Curb and Gutter Only" and "Approved for Street Permits" block is required on public Roadway Plans only. The addition of an "Approved for Paving Parking Lot" block is required on any plans showing parking lot or private roadway construction.
<table>
<thead>
<tr>
<th>TYPE PLAN</th>
<th>SIGNATURES REQUIRED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water distribution and water system report</td>
<td>City Engineer</td>
</tr>
<tr>
<td></td>
<td>Water Department</td>
</tr>
<tr>
<td></td>
<td>Fire Department</td>
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<tr>
<td>Sanitary sewer system and</td>
<td>City Engineer</td>
</tr>
<tr>
<td>Sanitary sewer report</td>
<td>Water Department</td>
</tr>
<tr>
<td>Storm drainage system and</td>
<td>City Engineer</td>
</tr>
<tr>
<td>drainage report</td>
<td>Water Department</td>
</tr>
<tr>
<td>Roadway and grading</td>
<td>City Engineer</td>
</tr>
<tr>
<td>Roadway modifying existing or new raised median construction within the</td>
<td>City Engineer</td>
</tr>
<tr>
<td>public R.O.W.</td>
<td></td>
</tr>
<tr>
<td>Access proposed onto the public R.O.W. without an approved site plan</td>
<td>City Engineer</td>
</tr>
<tr>
<td></td>
<td>Traffic Engineer</td>
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<tr>
<td>Erosion and sediment control plan and report</td>
<td>City Engineer</td>
</tr>
<tr>
<td></td>
<td>Water Department</td>
</tr>
<tr>
<td>Traffic construction control</td>
<td>City Engineer</td>
</tr>
<tr>
<td>Signing and striping plan</td>
<td>City Engineer</td>
</tr>
<tr>
<td>Pavement design report</td>
<td>City Engineer</td>
</tr>
<tr>
<td>All plans on a case-by-case basis</td>
<td>Parks, Recreation and Open Space</td>
</tr>
<tr>
<td>Traffic Signal Plans</td>
<td>Traffic Engineer</td>
</tr>
<tr>
<td>Street Light Plan</td>
<td>Traffic Engineer</td>
</tr>
</tbody>
</table>
The approval block shall be located in the lower right-hand corner of the sheet just above the title block only. **THE APPROVAL BLOCK SHALL INCLUDE ONLY**
THOSE SIGNATURES NEEDED ON EACH SHEET. An example approval block is provided above.

2.03.4.03 Scale The minimum scales are listed below. Larger scales may be required where necessary to clearly show details. Use a standard engineering scale. All plan drawings shall have the proper bar scale legibly shown on the plan sheet.

- All plan and profile plans
  Horizontal \( 1" = 50' \)
  Vertical \( 1" = 5' \)

- Master drainage plans may use scales as large as \( 1" = 200' \), \( 1" = 100' \) or less is preferred.

- Preliminary, and final drainage plans; overall utility plans (single family detached \( 1" = 50' \); multifamily and commercial \( 1" = 30' \) min.).

- Master and preliminary drainage plans may use scales as large as \( 1" = 500' \) for off-site drainage basins.

- If multiple sheets are used for the drainage study then one large-scale drawing must be a part of the plans to show the whole project. This allows relating the individual sheets to the entire project.

2.03.4.04 North Arrow North shall point towards either the top or the right-hand margin of the sheet only.

2.03.4.05 Date of Plan The original date of the plan and any subsequent revision.

2.03.4.06 Seal and Signature The seal and signature of the Professional Engineer, licensed in the state of Colorado, under whose supervision the plans were prepared is required. Locate and date the seal and signature next to the City of Aurora Approval Block. The mylars shall bear the seal and signature, legibly. It is preferred the seal be an electronic seal affixed to the mylar with an original signature. “Wet stamping” mylars usually become smudged or “bleed” so they are illegible. The original signature shall be done with black ink.

2.03.4.07 Benchmark The benchmark number, description and elevation shall be placed on each sheet showing any form of vertical design, including elevations based on City datum. Call Aurora Surveying at 303-326-8015 for city
benchmark information or access the City’s web page at http://www.auroragov.org (go to the Public Works Department link and select the Vertical Control link).

Example: Benchmark No. ___ chiseled square, "□", at back of walk, southeast corner of Montview Blvd. and Galena St. Elevation 5338.19. Looped to C.O.A. Benchmark. #F-11, chiseled square, "□", concrete based of signal light actuator pole, southeast corner of Montview Blvd. and Havana St. City of Aurora Datum = 5334.03.

Projects shall be prepared using the NAVD 1988 vertical datum and the NAD 83 / 92 HARN horizontal control system (see Section 2.10).

**2.03.4.08 Underground Utilities** The type, size, location, and the number of all underground utilities shall be shown. Field verified elevations and locations are required on all development plans for existing underground utilities which will potentially affect the proposed design or construction. It will be the responsibility of the Contractor to verify the existence and location of all existing underground utilities along his route of work prior to commencing any construction.

**2.03.4.09 Private Improvements** Private improvements such as roadways, sidewalks, driveways, utilities, etc., shall be clearly shown and labeled as such on each sheet of the development plans. See required notes in Section 2.03.5.

When a request is made for the City to assume maintenance of any private improvement, it shall be the responsibility of the person(s) making the request to prove the private improvement was in fact constructed in accordance with the applicable Roadway Design and Construction Specifications in effect at the time of original construction of the private improvement. The City will review these requests under normal review procedures. Private improvements built according to City specifications and standards may be accepted at the City's discretion. Private improvements not constructed in accordance with the applicable Design and Construction Standards and Specifications will not be accepted for maintenance by the City.

**2.03.4.10 Copyright Notes** Copyright notes shall **not** be placed on the mylars or any reports submitted for approval. The City must be able to make copies of the
approved plans and reports at any time without written authorization from the plan’s author.

2.03.5 Required Notes

These notes shall appear on the cover sheet. If a cover sheet has not been used, they shall be put on every sheet of the submittal.

2.03.5.01 City of Aurora plan review is only for general conformance with City of Aurora design criteria and the City Code. The City is not responsible for the accuracy and adequacy of the design, dimensions, and elevations which shall be confirmed and correlated at the job site. The City of Aurora, through the approval of this document, assumes no responsibility for the completeness and/or accuracy of this document.

2.03.5.02 All roadway construction shall conform to City of Aurora "Roadway Design and Construction Specifications," latest revision.

2.03.5.03 All water distribution, sanitary sewer, and storm drainage construction shall conform to City of Aurora "Public Utility Improvements Rules and Regulations Regarding Standards and Specifications," latest revision.

2.03.5.04 All materials and workmanship shall be subject to inspection by the City. The City reserves the right to accept or reject any materials and workmanship that does not conform to the City standards and specifications.

2.03.5.05 The Contractor shall notify the City Public Improvement Inspections Division, 303-739-7420, 24 hours prior to the beginning of construction.

2.03.5.06 Location of existing utilities shall be verified by the Contractor prior to actual construction. For information, contact Utility Notification Center of Colorado, 1-800-922-1987 or 811.

2.03.5.07 The Contractor shall have one signed copy of the plans (approved by the City of Aurora), one copy of the appropriate standards and specifications at the job site at all times, and a copy of any permits and extension agreements needed at the job site at all times.

2.03.5.08 It is the Consultant's responsibility to accurately show existing conditions, both on-site, and off-site, on the construction plans. Any modifications needed due to conflicts, omissions, or changed conditions either on-site or off-site, which arise in the field, will be entirely the Developer's responsibility. The cost to
rectify any adverse situation to meet the City standards and specifications and the City Code shall be borne solely by the Developer.

2.03.5.09 The owner/developer must obtain the written permission of the adjacent property owner(s) prior to any off-site grading or construction.

2.03.5.10 Concrete shall not be placed until the forms have been inspected and a pour slip issued. Pour slips will not be issued unless the Contractor has, at the job site, a copy of the approved plans bearing the signature of the City Engineer and with the "Approved for Curb and Gutter Only" block initialed by the City Engineer's representative.

2.03.5.11 Paving shall not start until a soil report and pavement design is approved by the City Engineer and subgrade compaction tests taken by the developer's geotech are approved by Public Improvements Inspections.

2.03.5.12 Standard City of Aurora curb ramps shall be constructed at all curb returns, at all "T" intersections and at all curbside kiosks or clusters, unless otherwise modified by these plans.

2.03.5.13 All stationing is based on centerline of roadways unless otherwise noted.

2.03.5.14 All elevations are ______________________________ (indicate top of curb or flow line) unless otherwise noted.

2.03.5.15 The City of Aurora shall not be liable for the maintenance of ______________________________. (Insert name of specific private improvement.) These facilities may not meet City standards and shall remain in private maintenance in perpetuity.

2.03.5.16 The contractor/developer is responsible for contacting CDOT to ensure that all work on or adjacent to state highways or CDOT R.O.W. meets CDOT requirements.

2.03.5.17 The streetlight installation cost is funded by the developer/owner. Coordinate the streetlight locations and installation with the Public Works Department 303-739-7300.

2.03.5.18 The Owner/Contractor must obtain a C.D.P.H.E. storm water discharge permit from the Colorado Department of Public Health and Environment, if required.
2.03.5.19 The Owner/Contractor is responsible for coordinating with the Army Corp of Engineers for wetland mitigation or work within the Waters of the U.S., if required. It is the responsibility of the Owner/Contractor to inform the City of Aurora of the Army Corp of Engineer’s requirements. City approval of the construction plans is subject to the Owner/Contractor obtaining a 404 permit, if applicable.

2.03.6 Where applicable label adjacent subdivision names and their City of Aurora Civil Plan approval numbers.

2.03.7 Details The plans shall include adequate details of special structures not covered by City of Aurora Standard Details. Do not include City Standard Details in the plans, but reference them by detail number, only.

2.04 Storm Drainage Plans and Reports

In accordance with the requirements set forth in Chapter 2.00, the City of Aurora "Storm Drainage Design and Technical Criteria" manual, and "Public Utility Improvements Rules and Regulations Regarding Standards and Specifications," the following information shall be shown on all storm drainage plans or included in all drainage reports submitted for approval.

2.04.1 Master Drainage Study A Master Drainage Study Plan and Report is required prior to approval of any planned community zoned district or site plan in excess of 80 acres or any phased commercial/industrial development in excess of 10 acres. The study shall be coordinated with all applicable drainage master plans and prepared according to the City of Aurora "Storm Drainage Design and Technical Criteria" manual.

2.04.2 Preliminary Drainage Plan and Report A Preliminary Drainage Plan and Report must be approved prior to approval of any subdivision plat or site plan. The Preliminary Drainage Plan and Report must be approved by the City Engineer and the Water Department prior to Planning Commission action. The Preliminary Drainage Plan and Report shall be prepared according to the City of Aurora "Storm Drainage Design and Technical Criteria" manual.

2.04.3 Final Drainage Plan and Report The Final Drainage Plan and Report shall be a detailed study and analysis of the proposed development. It shall include detailed calculations for all runoff, as well as for all drainage structures, of facilities within the proposed development. The Final Drainage Plan and Report must be approved by the City Engineer and the Water Department prior to the issuance of
any building permits within the proposed development and prior to the subdivision plat approval. The Final Drainage Plan and Report must be submitted for review and approval with the construction plans for the entire development and will be reviewed concurrently with said construction plans. The report shall be typed on 8-1/2" x 11" paper. All reports shall be bound with either three-ring binder or plastic comb binding. Reports bound with stitching, thermal bindings, glued bindings or perfect bindings will not be accepted. Plans and calculations comprising the Final Drainage Plan and Report shall be prepared in accordance with the City of Aurora "Storm Drainage Design and Technical Criteria" manual.

2.04.4 Title of Storm Drainage Plan and Report All drawings and reports shall include in the title the subdivision name, subdivision filing number, and the lot and block number where applicable.

2.04.5 Channel Plans and Profiles Where streams or channels are Urban Drainage and Flood Control District (UDFCD) maintenance eligible the following note shall be added. “The UDFCD shall be contacted for a channel pre-construction meeting and to establish routine inspection for required elements of the channel, i.e., toe protection, grade control structures, etc.

2.05 Roadway Plans

In addition to the requirements set forth in Section 2.03 CIVIL CONSTRUCTION PLAN REQUIREMENTS, the following information shall be shown on all plans submitted for review and approval of roadways, fire lanes, private streets or drives, and parking lots.

For residential developments only, private street designs shall be completed to the same degree of detail as the design of public local streets. A private street is a privately owned street, roadway, or way providing through access to and from the public street system or providing access to an area of parking spaces. The street width, sidewalks, tree lawn, and other features shall be the same for private streets as the requirements for the equivalent public street. Parking lot driveways or internal circulation driveways with perpendicular parking for multifamily, commercial, or industrial sites shall not be required to conform to standards for private streets.

2.05.1 Plan The plan view shall include, but not be limited to, the following.

2.05.1.01 Show property and/or R.O.W. lines, easements and/or tracts. Type and dimension of easement or tract shall be clearly labeled. R.O.W. and street widths shall be dimensioned. Label lot and blocks. Show sidewalks.
2.05.1.02 Survey lines and stations shall be based on centerline stationing only. Use continuous stationing for each street. Stationing shall be equated to and from flow line stationing at bubbles, horizontal radius curves, and other departures from normal roadway cross sections, i.e., the pavement cross slope is not 2%, and at least 200' from all intersections. Stationing shall be equated to flow line stationing at cul-de-sacs. Also, if the roadway is horizontally curved, whenever the grade is less than 1%, separate flow line profiles are required as the basis for design.

2.05.1.03 Show roadways and roadway names. Label the roadway classification.

2.05.1.04 Show existing and proposed utilities and structures, including, but not limited to: water valves, fire hydrants, sanitary sewer manholes, storm drainage facilities (i.e., inlets, manholes, etc.), telephone, gas, electric, ditches or swales, curbs and gutters, pavement limits, bridges or culverts, guardrails, etc.

2.05.1.05 Station and critical elevation (flow line, invert of pipe, etc.) of all utility or drainage appurtenances, existing and proposed
2.05.1.06 Flow direction arrows, particularly at intersections

2.05.1.07 Match lines and associated sheet numbers.

2.05.1.08 Station and elevation of all curb return PCR; horizontal P.C.s P.T.s, P.C.C.s, etc.; high or low point of all vertical curves, existing and proposed

2.05.1.09 Curb returns radii, existing and proposed

2.05.1.10 Mid-block curb ramp locations at "T" intersections including centerline stationing and flow line elevation at the center of the ramp

2.05.1.11 Complete horizontal curve data (R, Δ, L, PC Sta.)

2.05.1.12 Centerline stations of all non-single family residential driveways and all intersecting roadways

2.05.1.13 Survey line ties to section corners or quarter corners, if not already accomplished on the plat.

2.05.1.14 Show typical roadway cross-section for all roadways, existing and/or proposed, within and adjacent to the proposed development. These cross sections shall appear on the cover sheet, or on the first sheet of the submittal showing the roadway design. They shall indicate type of roadway(s); profile grade design point (centerline, flow line, top of curb, lip of gutter, etc.); roadway width, R.O.W.; type of curb, gutter, and walk; pavement cross slope, etc.

2.05.1.15 Basis of plan view and profile elevations shall be the same, i.e., flow line and flow line, top of curb and top of curb, etc.

2.05.1.16 Show all permanent asphalt patching a minimum of 24” wide.

2.05.1.17 Where the widening of an existing street occurs, provide existing spot elevations along the edge of the existing pavement, at the centerline of the existing roadway/crown line and the existing lip of pan or flow line of the existing curb and gutter at a maximum of 50-foot stations. This allows for the checking of proposed pavement cross-slopes.

2.05.1.18 Show range boxes. Locations are determined by the plat.
2.05.1.19 See Section 5.00 for limits of concrete paving required for arterial-arterial intersections. If three “legs” of an intersection are arterials and the fourth “leg” is a collector all four “legs” shall be concrete per Section 5.00. For concrete paving on City Streets a jointing plan must be submitted.

2.05.1.20 Show traffic control boxes and conduit at intersections where future warrants for traffic signals are likely to be met. See the site plan or contextual site plan for locations.

2.05.1.21 Show irrigation control sleeving locations for medians where required.

2.05.1.22 Show any proposed construction phasing. It must be coordinated with any main extension agreements associated with the utilities as well as any planning documents.

2.05.2 Profile The profile shall include, but not be limited to the following.

2.05.2.01 Show original ground (dashed) and each design grade (heavy, solid). Both grades shall be plainly labeled.

2.05.2.02 For 6" vertical curb and gutter, or mountable curb and gutter, all design elevations shall be top of curb, lip of gutter, or flow line (preferred). For combination curb, gutter, and walk, all design elevations shall be back of walk, or lip of gutter, or flow line (preferred). The basis for as-built information shall be the same as the design (both flow line or both top of curb, etc.) when possible.

2.05.2.03 Stationing shall be continuous for the entire portion of the roadway shown in the plan view, with the centerline station of all non-single family residential driveways and all intersecting roadways clearly labeled.

2.05.2.04 Show all existing curbs, gutters, sidewalks, and asphalt grades at center line and edge of asphalt adjacent to the proposed design. Basis for existing grades shall be as-built elevations or survey data at the intervals not to exceed 50' for a minimum of 100'. Previously approved designs are not an acceptable means of establishing existing grades.

2.05.2.05 Existing utilities. See Section 2.03.4.08, UNDERGROUND UTILITIES.
2.05.2.06 Station and elevation of all P.C.R.s, horizontal P.C.s, P.T.s, P.C.C.s, etc., existing and proposed (optional).

2.05.2.07 Station and elevation of all vertical grade breaks, existing (as-built) and proposed. The use of grade breaks with proposed construction is discouraged. Where street widening occurs with curb and gutter, multiple grade breaks to match the existing profile is not acceptable. Utilize asphalt overlays to best fit a curb line profile and to provide a smooth transition back to the existing pavement.

2.05.2.08 Distance and slope (percentage) between grade breaks and VPI's.

2.05.2.09 Show vertical curves, when necessary, with VPI, VPC, and VPT, high or low point (if applicable) stations and elevations. All vertical curves shall be labeled with length of curve in feet (L) and K (= L/A) where A = algebraic difference in grades in percent. See Table 4.1. All vertical curves shall be symmetrical.

2.05.2.10 Curb return profiles may be required at certain curb returns. If curb return profiles are required, the Consultant will be informed at the time of the initial review and instructions furnished.

2.05.2.11 Separate flow line (or top of curb) profiles are required as the basis for design at "bubbles," cul-de-sacs, horizontal curves when the vertical grade is less than 1%, any departure from normal roadway cross sections, i.e., the pavement cross slope is not 2%, and for at least 200' from all intersections.

2.05.2.12 Water or sanitary sewer line profiles shall not be placed on street plan and profile sheets.

2.06 Water Distribution, Sanitary Sewer, and Storm Sewer Plans

In addition to the requirements set forth in Section 2.03, CIVIL CONSTRUCTION PLAN REQUIREMENTS, the following information shall be shown on all Water Distribution, Sanitary Sewer and Storm Sewer plans submitted for review and approval.

2.06.1 Overall Utility Plan An overall utility plan of the proposed development, including all off-site construction areas shall be submitted for review and approval, and shall include, but not be limited to, the following.

2.06.1.01 Show property and/or R.O.W. lines, easements and/or tracts. Type and dimension of easement or tract shall be clearly labeled existing and proposed for
both on-site and off-site. Property lines and R.O.W. lines shall be dimensioned. Label lot, blocks and tracts.

2.06.1.02 Roadways and roadway names

2.06.1.03 Existing water distribution facilities including, but not limited to, size and location, valves, fire hydrants, blow offs, pressure zones, etc.

2.06.1.04 Existing sanitary sewer facilities including, but not limited to, size, slope, location, hydraulic capacity, and all pertinent information regarding which trunk lines will ultimately receive the wastewater collected by the proposed system

2.06.1.05 Existing storm sewer facilities including, but not limited to, size, slope, pipe type, location, and inlet size.

2.06.1.06 Proposed construction including manholes (with a rim elevation), valve boxes, fire hydrants (with a bottom of bottom flange elevation that is 2” – 6” above final finished grade), water meters (with rim elevation on the meter pit), mains, service lines (including line lengths and sizes), inlets and appurtenances shall be shown and clearly labeled.

2.06.1.07 Proposed outfall point(s) for wastewater from the development

2.06.1.08 Fixture unit table and meter sizing table in accordance with the “Public Utility Improvements Rules & Regulations Regarding Standards & Specifications.”

2.06.1.09 For commercial, industrial, or multi-family projects show dimensioned striping for all handicap-parking stalls.

2.06.1.10 Show any proposed phasing of utilities. This phasing of construction must be coordinated with the main extension agreements executed through the Water Department.

2.06.2 Plan and Profile A Plan and Profile is required on water mains larger than 12” in diameter, all public and private storm sewer and sanitary sewer mains, and for laterals when there is interference with other utilities. The Plan view shall include, but not be limited to, the following.

2.06.2.01 Show property and/or R.O.W. lines, easements and/or tracts. Type and dimension of easement or tract shall be clearly labeled. Property lines and R.O.W. lines shall be dimensioned. Label lot, blocks and tracts.
2.06.2.02 Roadways and roadway names

2.06.2.03 Existing utilities and structures including, but not limited to: water valves, fire hydrants, sanitary sewer manholes, storm drainage facilities, telephone, gas, electric, ditches or swales, curbs and gutters, cross pans, pavement limits, bridges or culverts, guardrails, etc.

2.06.2.04 All water mains, storm sewer, sanitary sewer laterals, mains, or trunk lines shall be tied to the centerline of the City R.O.W., to the centerline of a City easement, to government land corners, or to government landlines.

2.06.2.05 Flow direction arrows at sanitary and storm sewer manholes

2.06.2.06 Match lines and sheet numbers

2.06.3 Profile The profile shall include, but not be limited to, the following.

2.06.3.01 Show original ground (dashed) at each design grade (heavy, solid). Both grades shall be plainly labeled, existing and proposed.

2.06.3.02 All design elevations shall be invert of pipe. Top of pipe is acceptable for existing utilities.

2.06.3.03 Stationing shall be continuous for the entire length of the utility. Centerline and offsets of roadway shall be the basis for stationing whenever possible.

2.06.3.04 Existing and proposed utilities, particularly where crossed, with as-built or proposed elevations and stations and clearance between utilities (See Section 2.03.4.08, UNDERGROUND UTILITIES.)

2.06.3.05 Station and elevation of grade breaks, existing (as-built) and proposed.

2.06.3.06 Distance and grade or slope between grade breaks

2.06.3.07 Show size, type, and structural class of pipe, including ASTM or AWWA specifications on all proposed utility construction.

2.06.3.08 Indicate bedding classification to be used.

2.06.3.09 Show storm sewer design flows. For storm sewers designed for 100-year flow, show and label the 100-year HGL. For storm sewers designed for 2-year flow, show and label the 2-year HGL.
2.06.4 Details The plans shall include adequate details of special structures not covered by City Standard Details. Structural calculations shall be provided for the special structures. The structural calculations must be approved prior to the civil plans approval. The structural calculations must be submitted as a part of the civil plans submittal. Do not include in the plans City Standard Details but reference them by detail number.

2.07 Grading Plans
In addition to the requirements set forth in Section 2.03, CIVIL CONSTRUCTION PLAN REQUIREMENTS, the following information shall be shown on all grading plans submitted for review and approval. The grading plan is the key document for construction of surface improvements. The grading plan must be consistent with any approved site plan and landscape plan. Grading plans are required for all types of development.

2.07.1 Final Grading Plan (for Commercial, Industrial, and Multifamily Sites)
The plan shall include, but not be limited to, the following.

2.07.1.01 Show property and/or R.O.W. lines, easements and/or tracts. Type and dimension of easements or tract shall be clearly labeled. Include Lot and Block numbers.

2.07.1.02 Show existing contours (dashed) at a contour interval of two feet or less, proposed contours (solid) at a contour interval of two feet or less. Contour elevations shall be labeled and proposed contours shall be tied into existing contours. Existing grades are normally expected to extend at least 50 feet beyond property line and beyond flow line of any street adjoining the site.

2.07.1.03 Show building footprints and finished floor or top of foundation elevation of all structures. Plans for residential construction shall show finish floor elevations and the basement/walkout/garden level finish floor elevation and type of foundation, i.e., walkout, garden level, crawl space, or full basement.

2.07.1.04 Identify curb and gutter type (spill or catch). On private property, provide a detail of any curb and gutter that is not an Aurora Standard Detail.

2.07.1.05 Indicate spot elevations at all angle points on curb and gutter. Flow direction arrows may be used to prescribe grading details of paved or landscaped surfaces in lieu of additional spot elevations provided the plan clearly communicates the required grading without ambiguity.
2.07.1.06 Minimum 0.50% slope on all concrete surfaces, minimum 1% slope on all asphalt surfaces, minimum 2% slope on all grass-lined swales and landscape areas.

2.07.1.07 Show and label other surface drainage facilities and appurtenances, such as sidewalk chases, overflow weirs, rip rap placement, etc. The grading plan shall show all surface improvements visible at the surface or affecting drainage of the site.

2.07.1.08 Maximum slopes shall be 3:1 unless approved by Public Works and Planning Departments. The maximum landscaped grades within public right-of-ways shall be 4:1 unless otherwise approved by Public Works.

2.07.1.09 Show and label all retaining walls, top of wall and bottom of wall elevations. Where walls exceed 30-inches in height pedestrian hand rails shall be installed within pedestrian areas. See Section 4.02.7 for more information.

2.07.1.10 An Elevation Certificate shall be required for any non-residential parcel hydraulically connected, touching or including a floodplain in the predevelopment or post development condition, where a non-residential building site with a proposed lowest floor elevation (including basement, crawl space or enclosure floor) that is not shown on the plan as being greater than two feet higher than the base flood elevation. The current Elevation Certificate form established by FEMA shall be used. The Elevation Certificate shall be stamped and signed by an Engineer or Surveyor licensed in the State of Colorado. The Elevation Certificate shall be submitted to the Engineering Division for review and concurrence prior to issuance of a Certificate of Occupancy. The Elevation Certificate shall demonstrate the lowest floor elevation is greater than one-foot above the base flood elevation. The Grading Plan shall note by a prominent asterisk (or other appropriate method) each lot or building site for which an Elevation Certificate shall be provided. The following note shall be added to each sheet of the plans that indicate an Elevation Certificate is required:

No Certificate of Occupancy shall be issued until an Elevation Certificate has been submitted to and approved by the Engineering Division. The Developer/Contractor is encouraged to verify the adequacy of lot grades and the elevation of concrete forms prior to pouring a foundation. It is
recommended the Elevation Certificate be submitted at least a week in advance of a request for a Certificate of Occupancy.

2.07.11 Nonresidential construction on fill in or near Special Flood Hazard Areas (SFHAs) shall adhere to the requirements outlined in the Federal Emergency Management Agency National Flood Insurance Program’s Technical Bulletin 10-01, “Ensuring That Structures Built on Fill in or Near Special Flood Hazard Areas are Reasonably Safe From Flooding” (TB 10-01). Basement walls shall be designed for hydrostatic pressures to at least one foot above the BFE elevation, or, if no BFE elevations are available to at least two feet above the adjacent grade.

2.07.11.01 To avoid certification required in the technical bulletin ensure the lowest floor elevation (basement or crawl space) is at least two feet above the BFE.

2.07.11.02 Another approach to avoid the required certification would be to not allow any basement or crawl space. If a crawl space is used, then openings in the foundation walls shall be required to allow for the equalization of hydrostatic pressure on the foundation walls during flood events (see National Flood Insurance Program’s Technical Bulletin 1, “Openings in Foundation Walls”).

2.07.12 When nonresidential construction takes place on fill in or near SFHAs with basements or crawl spaces, then a Colorado licensed professional engineer or architect must certify the structure(s) is(are) reasonably safe from flooding, according to the criteria described in the TB 10-01.

2.07.2 Area Grading In addition to the above requirements, the following information shall be shown on single-family detached area grading plans. An area grading plan is required for any plan proposing construction of one or more residential lots.

2.07.2.01 Spot elevations at all lot corners and flow direction arrows showing side and rear-lot swales and off-site or cross-lot drainage shall be included. At a minimum, spot elevations shall be shown at rear yard high points, ridgelines, and other locations necessary to define the grading and runoff flow path.

2.07.2.02 Existing and proposed spot elevations shall be shown at all lot corners.

2.07.2.03 No more than two lots may drain through any one lot.
2.07.2.04 For single family only, a building footprint envelope consistent with zoning standards may be used where the actual footprint is not known.

2.07.2.05 FHA lot grading designation (Type A, Type B, etc.), walkouts (W.O.), and garden levels (G.L.), shall be shown on each lot.

2.07.2.06 For any residential lot in or adjacent to a regulated flood plain, provide the base flood elevation (B.F.E.) appropriate for any proposed structure, lowest lot elevation shall be one foot above B.F.E., lowest floor including basement or crawl space shall be two feet above B.F.E., or any other grade requirement related to the flood plain regulations.

2.07.2.07 Show finished floor elevation(s) including lowest finished floor for walkouts and garden levels.

2.07.2.08 Show all retaining walls.

2.07.2.09 Show all inlets and fire hydrants on the streets so driveways will not be placed on top of the inlets or fire hydrants.

2.07.2.10 Where developments have relatively steep street grades the area grading plans shall identify those lots with potential side yard retaining walls. The side yard retaining walls shall be a minimum of two-feet from the side lot line to the face of the retaining wall. This will minimize the need to change area grading plans when plot plans are submitted for approval.

2.07.2.11 Where developments have relatively steep backyard slopes the area grading plan shall identify those lots with potential rear yard retaining walls. The retaining walls shall not inhibit drainage runoff from the lot or from offsite lots. Where possible the retaining walls shall not be placed within the rear utility easements. This will minimize the need to change the area grading plans when plot plans are submitted for approval.

2.07.2.12 An Elevation Certificate shall be required for any residential lot or parcel hydraulically connected, touching, or including a floodplain in the predevelopment or post development condition where a residential structure with a proposed lowest floor elevation (including basement, crawl space or enclosure floor) is not shown on the plan as being greater than four-feet higher than the base flood elevation. If the proposed residential structure is placed on an area of fill within the predevelopment condition’s floodplain, an Elevation
Certificate shall be required. The current Elevation Certificate form established by FEMA shall be used. The Elevation Certificate shall be completed by an Engineer or Surveyor licensed in the State of Colorado. The Elevation Certificate shall be submitted to the Engineering Division for review and concurrence prior to issuance of a Certificate of Occupancy. The Elevation Certificate shall demonstrate the lowest point on the lot or parcel is one-foot or higher above the base flood elevation and the lowest floor is two-feet or higher than the base flood elevation. The Area Grading Plan shall note by a prominent asterisk (or other appropriate method) each lot or residential building site for which an Elevation Certificate shall be provided.

The following note shall be added to each sheet of the plans that indicate an Elevation Certificate is required:

No Certificate of Occupancy shall be issued until an Elevation Certificate has been submitted to and approved by the Engineering Division. The Developer/Contractor is encouraged to verify the adequacy of lot grades and the elevation of concrete forms prior to pouring a foundation. It is recommended the Elevation Certificate be submitted at least a week in advance of a request for a Certificate of Occupancy.

2.07.2.13 Residential construction on fill in or near Special Flood Hazard Areas (SFHAs) shall adhere to the requirements outlined in the Federal Emergency Management Agency National Flood Insurance Program’s Technical Bulletin 10-01, “Ensuring That Structures Built on Fill in or Near Special Flood Hazard Areas are Reasonably Safe From Flooding”. Basement walls shall be designed for hydrostatic pressures to at least one foot above the BFE elevation, or, if no BFE elevations are available to at least two feet above the adjacent grade.

2.07.2.13.01 To avoid certification required in the technical bulletin, ensure the lowest floor elevation (basement or crawl space) is at least four feet above the BFE.

2.07.2.13.02 Another approach to avoid the required certification would be to not allow any basement or crawl space. If a crawl space is used, then openings in the foundation walls shall be required to allow for the equalization of hydrostatic pressure on the foundation walls during flood events (see National Flood Insurance Program’s Technical Bulletin 1, “Openings in Foundation Walls”).
2.07.2.14 When residential construction takes place on fill in or near SFHAs with basements or crawl spaces, then a Colorado licensed professional engineer or architect must certify the structure(s) is(are) reasonably safe from flooding, according to the criteria described in the TB 10-01.

2.07.3 **Erosion Control/Overlot Grading** In most cases the erosion control plan will be combined with the overlot grading plan. However, they may be submitted separately. If an erosion control and overlot grading plan is submitted separately from the rest of the civil construction package in order to obtain a storm water quality permit, only the erosion control plan is approved. The final grading plan is approved when the final drainage study is approved. Refer to the "Rules and Regulations Regarding Stormwater (Quality) Discharge for Construction Activities" for storm water quality control plan, and erosion and sediment control plan requirements.

2.08 **Combining Plans**

The plans described above may be combined, at the discretion of the consulting engineer, provided they are clear and adequately communicate the required information. The Public Works Engineering Control Division plans review staff shall make the final determination for approval or disapproval for the clarity and adequacy. Combining water line and/or sanitary sewer line information with other plans will not be allowed.

2.09 **Signing and Striping Plans**

2.09.1 Signing and striping plans (interim and final, if necessary) shall be submitted for all four-lane, six-lane roadways, two-lane collectors and any other streets designed to accommodate striped bike lanes. See the Aurora Bicycle Facility Design Guidelines adopted July 2008. Signing and striping plans shall include, but not be limited to, all appropriate and applicable regulatory, warning, and guide signs and striping materials in accordance with current City standards. Said plans shall also include street name signs to current City standards on ALL public and private streets as appropriate and applicable.

2.09.2 For TOD and Urban Centers signing and striping plans shall be submitted showing the striping for the parking and other striping requirements such as the Fire Department’s truck set-up areas, bike lanes, etc.

2.09.2.01 Bike lanes shall extend through curb extensions at TOD and Urban Centers intersections up to the cross-walks, if provided, in accordance with MUTCD
standards. The bike lane width shall be five-feet, not including the gutter pan width.

2.10 Survey Control Drawing

2.10.1 A survey control drawing shall be included in the civil plan submittal and shall contain the following:

2.10.1.01 Title of the control drawing, location identification, project name and the entity performing the work.

2.10.1.02 North arrow and scale with bar scale.

2.10.1.03 Legend.

2.10.1.04 Use the City of Aurora GIS Horizontal Control System; Colorado State Plane Coordinates, Central Zone, in NAD 83 / 92 HARN.

2.10.1.05 Include a note explaining the transformation from the Grid State Plane Coordinates to the Project (ground) State Plane Coordinates with the Grid Factor, also known as the Combined Factor (sea level factor and the scale factor combined) shown to eight decimal places.

2.10.1.06 The coordinates shall be in US Survey feet to the hundredth of a foot.

2.10.1.07 Any Public Land Survey System corner that was occupied and has been remonumented must be noted and a monument record must be filed with the State.

2.10.1.08 A tabular listing of the Public Land Survey System corners used, showing both the Grid State Plane Coordinates and the modified Project (ground) State Plane Coordinates. The tabular listing shall also show the Project (ground) State Plane Coordinates for the control points and the found property pins, noting the point numbers, northings, eastings, elevations and descriptions.

2.10.1.09 Use the City of Aurora Vertical Control datum based on the NAVD 1988. List the bench marks used, their I.D. (name), complete description and elevation.

2.10.1.10 The right-of-way shall be shown with adjoining subdivision names. The limits of the right-of-way shall be used to establish the street centerline stationing for plan and profiles.
2.10.11 The survey control shall be tied to key points on the construction plan in order to be able to coordinate between the construction plans and the control plan.

2.10.2 A sample of a survey control drawing may be obtained from the Technical Services Section Supervisor, 303-739-7314.

2.10.3 The Survey Control Drawing shall be signed and sealed by the Professional Land Surveyor, licensed in the State of Colorado, under whose supervision the drawing was prepared.

2.11 Street Lighting Plan

In addition to the requirements set forth in Section 2.03, Civil Construction Plan Requirements, a Street Lighting Plan is required and the following information shall be shown on all Street Lighting Plans submitted for review and approval for all public streets.

2.11.1 Final Street Lighting Plan

The plan shall include the following:

2.11.1.01 Show property and/or R.O.W. lines, easements and/or tracts. All streets shall be labeled. Type and dimension of easements or tract shall be clearly labeled. Include Lot and Block numbers and adjoining subdivision names.

2.11.1.02 Show building footprints for all structures, if known. If unknown, show setback lines.

2.11.1.03 Identify curb, gutter and sidewalks, private driveways, fire hydrants, and inlet locations.

2.11.1.04 Show any existing street lights and label as existing.

2.11.1.05 Show any proposed trees or landscaping installations in the R.O.W. that may have future impacts to street light placement.

2.11.1.06 The street light plan may include the minimum amount of information required in 2.11.1.01 through 2.11.1.05 and a scale of 1 inch equals 100 feet is recommended to minimize the number of plan sheets submitted. An overall development site plan that meets the scaling and fits on one plan sheet is acceptable for the Street Lighting Plan submittal.

2.11.1.07 Show all street light luminaire and pole locations on the plan with a symbol using an “• SL-4”. Provide type of luminaire and pole description in legend (e.g. “• SL-4” indicates 250 watt, HPS Archetype style luminaire mounted on a 33’-6” steel pole, mocha brown color).
2.11.2 Street Lighting Design and Placement Requirements

The City of Aurora requires at least one street light at every public street intersection. Major street intersections may need two or four street lights. See Standard Detail TE-18.1 and TE-18.2.

2.11.2.01 Street Intersection Recommendations: The following criteria apply to suburban, urban centers and transit oriented developments. The following configurations are considered arterials or collector streets.

Four street lights are required, one at each corner for the following intersections:

1. 6-Lane at 6-Lane Intersections
2. 6-Lane at 4-Lane Intersections
3. 4-Lane at 4-Lane Intersections

Two street lights are recommended, one at each near right approach on minor street intersections:

1. 6-Lane at 4-Lane (unsignalized)
2. 6-Lane at 4-Lane
3. 6-Lane at 2-Lane
4. Couplet at any other street

One street light is recommended at each intersection:

1. 4-Lane Collector at Collector
2. 4-Lane Collector at Local
3. 2-Lane at 2-Lane

2.11.2.02 Midblock Street Lights or “infill” Recommendations:

1. Recommend at 160 to 180 feet intervals on 6-Lane Arterials, Boulevards, and Multiway Boulevards.
2. Recommend at 180 to 220 feet intervals on 4-Lane Arterials and 4-Lane Main Streets.
3. Recommend at 250 to 300 feet intervals on all Collectors, 2-Lane Main Streets, and Couplets.
4. Recommend at 250 to 350 feet intervals on all Locals, Neighborhood Streets, and Residential Parkways.
5. Pedestrian lighting recommended at 50 to 80 feet intervals
Midblock interval spacing may vary depending on utilities located both below and above ground, driveways locations, landscaping (tree canopy conflicts) and street lengths, widths and alignments. Areas with high levels of nighttime pedestrian activity are also a consideration and may require a modified spacing interval by the Public Works Department (e.g. RTD bus stops, hospitals, major shopping areas, sport complexes, transit oriented developments (TOD) and urban centers, etc.). Pedestrian lighting needs shall be determined by Public Works and Planning departments based on level of nighttime pedestrian activity.

2.11.2.03 Luminaire and Pole Selection

There are many street light luminaires and pole styles that are acceptable for installation. Luminaires are typically equipped with high pressure sodium lamps. Wattages vary from 50, 70, 100, 150 on residential streets, and 100, 150, 200 and 250 watts on collector streets, and 250 or 400 watts on arterial streets. Coordinate selection and application of available luminaires and wattages with the Public Works Department-Traffic Services (303-739-7300), and the Planning Department (303-739-7250). Areas with high levels of nighttime pedestrian activity (e.g. Transit Oriented Development or Urban Centers) are also a consideration and may require an increased lamp wattage or decreased spacing by the Public Works Department. See Standard TE-18.3.

2.11.2.04 Pole or Luminaire Mounting Height

Pole or luminaire mounting heights vary from 10 feet to 24 feet on residential streets; 19 feet to 33 feet on collector streets, couplets, and main streets; and 28 feet to 40 feet on arterials, boulevards and multiway boulevards. Mounting heights for pedestrian lighting shall be 10 feet to 15 feet. Coordinate selection and application of luminaire mounting heights and available pole styles with the Public Works Department (303-739-7333).

2.11.2.05 City Approval of Street Lighting Equipment

Selected street lighting luminaire, type of lamp and wattage, mounting height and pole type, and the selected luminaire and pole color for installation on all public streets or city right-of-ways shall require pre-approval from the City of Aurora Public Works Department. Street and pedestrian lighting equipment (i.e. luminaires, poles, fixtures, color, etc.) shall meet Xcel Energy standards.
Note: The typical City standard is as follows:

<table>
<thead>
<tr>
<th>Street Type</th>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local, Neighborhood, Residential Parkway</td>
<td>SL-1</td>
<td>100 watt, HPS grey post top on 23’ grey fiberglass pole</td>
</tr>
<tr>
<td>Collector, 2-Lane Main Street</td>
<td>SL-2</td>
<td>100 watt, HPS grey post top on 23’ grey fiberglass pole</td>
</tr>
<tr>
<td>Collector (4), 4-Lane Main Street, Couple</td>
<td>SL-3</td>
<td>250 watt, HPS archetype on 33’-6” steel pole (mocha brown) *</td>
</tr>
<tr>
<td>Arterial, Boulevard, Multiway Boulevard</td>
<td>SL-4</td>
<td>250 watt, HPS archetype on 33’-6” steel pole (mocha brown) *</td>
</tr>
</tbody>
</table>

Collector (4) indicates 4-Lane Collector Roadway
3.00 PLAN AND DRAFTING STANDARDS

3.00 ACCEPTANCE OF MYLAR SUBMITTALS
3.01 MEDIA REQUIREMENTS
3.02 DRAFTING STANDARDS
3.03 PLAN SET INDEXING
3.04 REVISIONS
SECTION 3.00 PLAN AND DRAFTING STANDARDS

3.00 Acceptance of Mylar Submittals

The Technical Services Supervisor has the authority to determine the acceptability of all plans submitted for signature. Acceptability will be based on scanability, media, and drafting standards as outlined below.

3.01 Media requirements

Archival quality media is required. All plans submitted for approval shall be submitted on polyester film, mylar, or photo positive film. The image on film or mylar originals submitted for approval shall not streak, smear, rub or chip off under normal use over time. All media shall be from 3.0 to 5.5 mil double matte. The size of the plans shall be either 24” X 36” or 22”X 34”. Each sheet shall have a two-inch margin on the left edge and a one-half-inch (minimum) margin on all other sides.

Care shall be taken to prevent oils and dirt from contaminating the surface of the media prior to printing or plotting. In the event of contamination, the media shall be cleaned as recommended by the manufacturer.

Plans that indicate the ink or toner has or is flaked, or is easily smeared during normal handling will be rejected at submittal. Professional seals applied to the plans shall be legible and the ink shall be dry and non-smearing. Electronic seals are preferred. Signatures on the plans shall be applied with an indelible marker. Mylars whose scanned images have illegible Professional Seals or signatures will be rejected.

3.02 Drafting Standards

The following shall apply to all plans submitted for approval.

3.02.1 Text

- Minimum lettering size shall be 0.08” high (can only be used to annotate existing features on the plans). Otherwise, minimum text height shall be .10”.
- Where text is less than .14” high, text shall be all capitals.
- All text shall be black.
• Recommended fonts are “Arial”, “Romans”, “Simplex”, or “Leroy”.
• Pen weights shall not exceed the pen weights recommended for the text heights in the chart below:

<table>
<thead>
<tr>
<th>Text Height (in.)</th>
<th>Pen Weight (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>.08</td>
<td>.008</td>
</tr>
<tr>
<td>.10</td>
<td>.010</td>
</tr>
<tr>
<td>.12</td>
<td>.010</td>
</tr>
<tr>
<td>.14</td>
<td>.014</td>
</tr>
<tr>
<td>.175</td>
<td>.018</td>
</tr>
<tr>
<td>.20</td>
<td>.024</td>
</tr>
</tbody>
</table>

3.02.2 Line work

• Minimum line thickness shall be .006”.
• All line work shall be black.

3.02.3 Color and Shading

• Color shall not be allowed on plans.
• Solid hatches shall be shaded no more than 30%, nor less than 12%.
• Solid hatches shall not obscure text or line work.

3.02.4 Photography Used In Plans

• Photographic images added to plans require 40% or less, 80-line screen.
• Use of photographic images requires written approval by Technical Services Supervisor prior to submitting Mylars for approval.

3.03 Plan Set Indexing

Engineering’s policy for indexing plans is to index them by subdivision name and filing number. The subdivision name and filing number shall be clearly shown in the Title Block on each page of the plans.

It is the intent of the Engineering Division to provide the same Engineering Drawing number for all civil construction plans associated with a development. Frequently the set of full construction plans is broken into several sets for review and approval. Ultimately, the plans will be approved and filed together for records purposes. Each submittal shall include a cover sheet with a sheet index on it. The full construction plans shall also have a sheet index on a cover sheet that includes all sheets in the set, irregardless of whether or not they were submitted together or in smaller sets.
All sheets in the plan set will be numbered consecutively from the cover sheet (sheet 1) to the last sheet (usually the final drainage and grading plans). If the consultant prefers a sheet designation different than the numerical system the City requires, those numbers may also be shown in a separate column of the index.

3.04 Revisions

There are two methods of revising approved plan sheets.

- Submit a new sheet to replace the first. Such revisions go through the same review and approval process a new submittal would go through, usually including the current review fee per sheet.

- Edit the approved sheet. Before the edits are allowed, a stamped and signed Revision Authorization form and a check print showing the edits must be submitted to the Engineer of the day. The request is usually handled immediately if the original mylars are stored onsite. If the mylars are not stored on site, the consultant will be contacted when they have been retrieved from archive. Changes require neat lettering and line work. Use of an ultra fine line permanent marker is allowed, however, drafting pen and ink is preferred. Hand lettering shall be done using a lettering guide that enables straight uniform lettering between 1/10 and 1/8 inch high. The consultant shall provide any drafting equipment and supplies required to make the revisions.

The City has a policy to record and maintain large format documents as digital images and allows for destruction of original drawings after 5 years, depending on the progress of the development as determined by the certificate of occupancies within the development.

For sheets approved prior to the five year period, the only method for revising them may be to submit new sheets.
4.00 ROADWAY DESIGN AND TECHNICAL CRITERIA
4.01 GENERAL
4.02 SIDEWALKS, CURB AND GUTTER, DRIVEWAYS, RAILINGS, AND RETAINING WALLS
4.03 DRAINAGE
4.04 HORIZONTAL ALIGNMENT
4.05 VERTICAL ALIGNMENT
4.06 STREETSCAPE DESIGN AND SPECIFICATIONS
4.07 SPECIFICATION FOR FIRE LANES, PRIVATE STREETS OR DRIVES, AND PARKING LOTS
4.08 ROADWAY SPECIFICATIONS
4.09 STREET LIGHT POLICY
SECTION 4.00 ROADWAY DESIGN AND TECHNICAL CRITERIA

4.01 General
This section sets forth the minimum design and technical criteria and specifications to be used in the preparation of all roadway plans, including private streets, drives, parking lots, and fire lanes.

4.02 Sidewalks, Curb and Gutter, Driveways, Railings, and Retaining Walls

4.02.1 Typical Roadway Sections Typical roadway sections are specified by the City Code. These are summarized in Section 4.08 and shown in standard details S1.1, et seq. All public roadways shall be constructed according to typical roadway sections S1.1 to S1.18 unless specifically modified by action of the City Engineer.

4.02.2 Curb and Gutter Mountable curb and gutter shall be used on all local Type 1 and 2 streets. All other streets, including those within the Urban Centers and TODs, shall use 6" vertical curb and gutter.

4.02.3 Curb Ramps Americans with Disabilities Act requires curb ramps be installed at all pedestrian crosswalks for all new construction or reconstruction of curb and sidewalk. Curb ramps shall be shown at all curb returns, "T" intersections, at residential mail kiosks or clustered mailboxes, mid-block pedestrian crossing within Urban Centers or TOD’s and any other location of public necessity. Curb ramps must be shown (located) on the drawings. Curb ramp types shall be called out on the drawings by the specific standard detail S9.1, et seq. Mid-block pedestrian crossings within Urban Centers or TOD’s shall not be used on multiple lane roadways.

4.02.4 Curb Cuts for Driveways Flared curb cuts, Standard Detail S7.4, are not permitted for commercial/industrial or residential driveways where traffic movements would be substantial. When the number of parking spaces exceeds 20, curb returns are required. Inlets and cross pans are required as noted in Section 4.03, DRAINAGE. See Section 6.53, Storm Drainage Design & Technical Criteria manual for exceptions when storm sewer is available.

4.02.5 Guardrails The design, location, and necessity of guardrails for bridge and roadway situations, as well as design of the same, shall be in accordance with AASHTO's, "Roadside Design Guide," latest edition.
4.02.6 **Pedestrian/Bicycle Railings**  Railings will be required at and continuous along vertical separations of 30" or greater or on slopes greater than or equal to 3:1. See standard details S18.1 to S18.4.

4.02.7 **Retaining Walls**  The design of retaining walls, wing walls, and miscellaneous structures that are unattached and not considered part of a building shall be submitted with the Civil Construction Plans to the Engineering Services Division. Details are required on all retaining walls at bridges and structures and shall be included on the drainage or grading drawings. Retaining walls and miscellaneous structures wing walls higher than four feet from grade or adjacent to easements, public right-of-way or fire lanes that intrude on a line projected at 3:1 (H: V) slope from the easement line, right-of-way line or edge of fire lane shall be designed, signed, sealed, and dated by an engineer licensed in the State of Colorado before review by the Public Works Engineering Division. The design for walls that are attached to and part of a building or the building is structurally dependent upon shall be submitted to the Building Inspection Division for review. CDOT standard details for wing walls and head walls are acceptable for use without additional structural analysis as long as the site conditions do not exceed CDOT’s design assumptions. Concrete, poured-in-place retaining walls shall be designed and submitted along with the first submittal of the civil construction drawings for the development.

Terraced retaining walls with a total vertical height greater than four feet shall be designed, signed, sealed, and dated by an engineer licensed in the State of Colorado before review by the Public Works Engineering Division. If the horizontal distance between the terraced walls is less than twice the height of the lower wall (even if the individual walls are less than four feet high) then:

- The entire terraced wall height shall be considered to act as one wall and shall be designed as one wall, or
- Each terrace of the wall can be designed individually as long as such design is accompanied by a global stability analysis that is performed on the entire terraced wall height.

Retaining walls used to support a roadway, driveway, or structure shall be designed, and the plans sealed, signed and dated by an engineer licensed in the State of Colorado. Guardrails and/or pedestrian railings shall be included with the design.
Retaining walls along sidewalks or trails, wing walls and head walls exceeding 30-inches in height require railings. Retaining walls along bicycle trails require railings.

A retaining wall permit shall be obtained from the City’s permit center prior to constructing any retaining walls.

When retaining walls are not cast-in-place retaining walls, the walls are greater than four feet in height, and/or there are terraced retaining walls where the horizontal distance between the walls is less than twice the height of the lower wall (even if the individual walls are less than four feet in height), then the contractor must submit structural calculations (and details as needed on 24” x 36” drawings) to the City for review and approval prior to pulling a permit to construct those walls.

4.02.8 Sidewalks  Sidewalks associated with streets shall have a cross-slope of two percent down toward the street. Other walks’ cross-slope shall have a preferred cross-slope of two percent, but, may on a case-by-case basis range between two-percent to five-percent. There shall be a minimum two-foot recovery zone along sidewalks before there is a significant change of slope.

4.02.9 Driveways  Residential driveways abutting paved public rights-of-ways shall be surfaced with concrete, asphalt, or brick or stone pavers.

4.02.9.1 The maximum permissible grade for single family residential driveways is 14 percent. Where grades are in excess of ten percent there shall be an accompanying pedestrian walk from the street sidewalk to the main entry with steps to keep the walk below ten percent. Those portions of driveways supplying required parking shall not exceed eight percent slope per City Code (Section 146-1509(B)3.)

4.02.9.2 The subgrade shall be compacted to the same requirements as the local streets. See Section 5.

4.02.9.3 Brick and/or stone pavers shall be at least four-inches thick. The brick and/or stone pavers shall be laid within a containment system that will not allow movement from the anticipated wheel loads. This may be in the form of concrete border edging, mortared brick and/or stone pavers, etc.

4.02.9.4 See City Code Section 146-1512 regarding other requirements for construction and maintenance.
4.02.9.5 For those areas of the City still with unpaved streets other surfacing material allowed are recycled asphalt roto-millings or granular road base (Type 2A per Section 23 or equivalent).

4.02.9.6 Relative to single family residences the off-street parking spaces, pads and driveways shall be kept a minimum of three feet from any property line, unless otherwise approved in writing by the City of Aurora Public Works Department and Zoning Division. The addition to existing driveways located adjacent to side property lines shall not impede drainage.

4.02.9.7 A driveway permit is required for all single family residential driveways, pads or parking spaces, except for new single family home construction or where the existing driveways, pads or parking spaces are being replaced with the same material and where the material type, location, size and slope does not change.

4.03 Drainage

4.03.1 Design Standards The drainage system for all private site development, as well as all public rights-of-way, shall be designed in accordance with City of Aurora, "Storm Drainage Design and Technical Criteria Manual," latest edition. This publication may be purchased in the Technical Services Section, Room 3218, in the Aurora Municipal Center. A final drainage report shall be submitted with all civil construction plans submitted for review and shall be considered part of the civil construction plans. The major function of a roadway is the safe conveyance of traffic. Drainage is a secondary function of a roadway, and the safe conveyance of traffic shall at all times take precedence over drainage.

4.03.2 Cross Pans Cross pans shall be constructed in accordance with the standard details. Cross pans are not allowed across collector or arterial roadways, nor are they allowed on roadways with storm sewer systems.

The use of cross pans on roadways where the street grade exceeds 4.5% at the cross pan or in new construction of local streets will be considered only after all other alternatives have been exhausted.

4.03.3 Inlets Inlets shall be located to intercept flow at the point curb capacity for a minor storm (major storm in Urban Centers and TOD’s) is exceeded as indicated on an approved drainage plan. Inlets also shall be located due to nuisance drainage,
icing, or other conditions. Refer to Figures 2, 3, 4A, and 4B in the City of Aurora "Storm Drainage Design & Technical Criteria Manual" for inlet and curb capacity, respectively. Inlets shall also be installed to intercept cross-pavement flows at point of transition in superelevation. See 4.04.4.06. Due to the presence of curb ramps, inlets are not allowed in the curb return but will be located at the tangent points of the curb returns (including Urban Centers and TOD’s). Inlets shall also be located within the parallel and diagonal parking areas of Urban Centers and TOD’s. Top, back of curb elevation, station at the centerline of the inlet, and station offset shall be shown on the plans.

At a street intersection where two streets slope down to the intersection an inlet shall be placed on the through street’s uphill point of curb return and on the intersecting street’s uphill point of curb return.

All inlets within the public right-of-way, or to be maintained by the City, shall be the curb opening Type R modified, constructed in accordance with the standard details S12.1 et seq. The following note shall apply to all inlets in a sump condition located within the public right-of-way:

"Contractor shall maintain a minimum of 0.5% grade at flow line into inlet."

This note shall appear on all applicable street construction plans.

4.03.4 Minimum Pipe Diameter The minimum pipe diameter allowed within the public R.O.W. or to be maintained by the City of Aurora is 18".

4.03.5 Temporary Erosion Control In addition to the requirements identified in the City of Aurora "Rules and Regulations Regarding Stormwater (Quality) Discharge for Construction Activities", latest edition, temporary erosion control is required at the ends of all roadways not completed due to the project phasing, subdivision boundaries, etc. Prevention of erosion at the roadway terminus shall be by methods approved by the City Engineer and the Aurora Water Department, and shall be the responsibility of the Developer.

4.03.6 Sidewalk Chases Storm water from concentrated points of discharge from a minor storm event shall not be allowed to flow over sidewalks, but shall drain to the roadway by the use of chase sections. Chase sections shall not be located within a
curb cut, driveway, curb ramp or curb return. Station, width, and invert elevations of sidewalk chases shall be shown on the plans. Sidewalk chase sections shall be constructed in accordance with standard details S3.1 et seq.

4.04 Horizontal Alignment

4.04.1 Design Speed  Design speed shall be as shown in Table 4.1.

4.04.2 Horizontal Curves  The minimum centerline radius for horizontal curves shall be as shown in Table 4.1. Variances from the requirements of Table 4.1 for local streets only will be considered on a case-by-case basis.

Table 4.1  
Alignment Controls

<table>
<thead>
<tr>
<th>Category</th>
<th>Design Speed MPH</th>
<th>Maximum Grade</th>
<th>K Factor</th>
<th>VCL Min Length Crest</th>
<th>VCL Min Length Sag</th>
<th>SSD</th>
<th>Min. Radius</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARTERIALS</td>
<td>50</td>
<td>6%</td>
<td>160</td>
<td>75</td>
<td>120'</td>
<td>80'</td>
<td>450'</td>
</tr>
<tr>
<td>LOW DENSITY RURAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COLLECTOR 4-LANE</td>
<td>45</td>
<td>*6%</td>
<td>120</td>
<td>65</td>
<td>90'</td>
<td>70'</td>
<td>375'</td>
</tr>
<tr>
<td>COLLECTOR 2-LANE</td>
<td></td>
<td>*5%</td>
<td>120</td>
<td>65</td>
<td>90'</td>
<td>70'</td>
<td>375'</td>
</tr>
<tr>
<td>LOCAL TYPE 1</td>
<td>30</td>
<td>*5%</td>
<td>50</td>
<td>50</td>
<td>50'</td>
<td>50'</td>
<td>250'</td>
</tr>
<tr>
<td>LOCAL TYPE 2</td>
<td>25</td>
<td>*5%</td>
<td>20</td>
<td>30</td>
<td>50'</td>
<td>50'</td>
<td>200'</td>
</tr>
<tr>
<td>LOCAL TYPE 3</td>
<td>35</td>
<td>*5%</td>
<td>50</td>
<td>35</td>
<td>50'</td>
<td>50'</td>
<td>250'</td>
</tr>
</tbody>
</table>

* 8% may be allowed by the City Engineer where an alternate access route, at 6% or less, exists. Local Type 2 streets at cul-de-sacs shall use Local Type 2 criteria except minimum radius may be reduced to 100'
### Table 4.2

**Urban Centers and TOD's Alignment Controls**

<table>
<thead>
<tr>
<th></th>
<th>DESIGN SPEED MPH</th>
<th>MAXIMUM GRADE</th>
<th>K FACTOR</th>
<th>VCL MIN LENGTH CREST</th>
<th>VCL MIN LENGTH SAG</th>
<th>SSD</th>
<th>MIN. RADIUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boulevard 4 or 6 Lanes</td>
<td>50</td>
<td>6%</td>
<td>160</td>
<td>75</td>
<td>120'</td>
<td>80'</td>
<td>450'</td>
</tr>
<tr>
<td>Multiway Boulevard - 4 or 6 Through Lanes</td>
<td>50*</td>
<td>5%</td>
<td>160</td>
<td>75</td>
<td>120'</td>
<td>80'</td>
<td>450'</td>
</tr>
<tr>
<td>Main Street 2 Lanes with Median / Center Turn Lane</td>
<td>35</td>
<td>5%</td>
<td>50</td>
<td>50</td>
<td>50'</td>
<td>50'</td>
<td>250'</td>
</tr>
<tr>
<td>Main Street - Median 4 Lanes</td>
<td>40</td>
<td>5%</td>
<td>70</td>
<td>70</td>
<td>70'</td>
<td>70'</td>
<td>325'</td>
</tr>
<tr>
<td>Main Street - 2 Lanes with Parallel Parking</td>
<td>30</td>
<td>5%</td>
<td>30</td>
<td>40</td>
<td>50'</td>
<td>50'</td>
<td>200'</td>
</tr>
<tr>
<td>Main Street – 2 Lanes with Diagonal Parking</td>
<td>30</td>
<td>5%</td>
<td>30</td>
<td>40</td>
<td>50'</td>
<td>50'</td>
<td>200'</td>
</tr>
<tr>
<td>One Way Couplet 2 Lanes</td>
<td>35</td>
<td>5%</td>
<td>50</td>
<td>50</td>
<td>50'</td>
<td>50'</td>
<td>250'</td>
</tr>
<tr>
<td>Local Urban 2 Lanes</td>
<td>30</td>
<td>5%</td>
<td>30</td>
<td>40</td>
<td>50'</td>
<td>50'</td>
<td>200'</td>
</tr>
<tr>
<td>Residential Parkway 2 Lanes</td>
<td>30</td>
<td>5%</td>
<td>30</td>
<td>40</td>
<td>50'</td>
<td>50'</td>
<td>200'</td>
</tr>
<tr>
<td>Neighborhood 2-Lanes</td>
<td>30</td>
<td>5%</td>
<td>30</td>
<td>40</td>
<td>50'</td>
<td>50'</td>
<td>200'</td>
</tr>
</tbody>
</table>

*The posted speed limit for the access road for the Multiway Boulevard will be 25.*

### 4.04.3 Intersections

#### 4.04.3.01 Turning Radius

All roadways shall intersect at right angles. For the minimum allowable intersection turning radius on cross streets intersecting arterial streets, see standard detail S2.4.

#### 4.04.3.02 Curb Return Radius

Minimum curb return radii shall be as shown in Table 4.3.
### Table 4.3
Curb Return Flow line Radius at Intersections

<table>
<thead>
<tr>
<th></th>
<th>Local</th>
<th>Collector</th>
<th>Arterial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driveway 20 or less spaces*</td>
<td>15</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>Driveway 21 or more spaces</td>
<td>15</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>Alleys**</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Local or private street</td>
<td>15</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>Collector</td>
<td>--</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>Low Density Rural</td>
<td>20</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>Arterials</td>
<td>--</td>
<td>--</td>
<td>25</td>
</tr>
</tbody>
</table>

* Curb cuts may be used in lieu of curb returns if the requirements of Section 4.02.4 are satisfied.**
Alleys shall be constructed with curb cuts per Std. Detail S7.4.

#### 4.04.3.03 Pavement Widening for Short Radii
All curves in local and private streets with radii from 55' to 250' shall be designed using Figure 4.1 to increase pavement width. Centerline radii less than 33' shall not be permitted. For radii between 33' and 55' see Figure 4.4. Additional right-of-way may be required for curve widening.
### Notes

1. No pavement widening required for radius greater than 250’.


3. Private street and local intersection 90° ± 5°.

4. Curve widening should occur on the inside of the curve whenever possible.

#### 4.04.3.04 Entry Islands

At private streets and Type I local streets intersecting with arterial streets, there shall be a raised median placed on the roadway or drive as detailed on standard details S14.1 and S14.2.

#### 4.04.4 Superelevation

Superelevation may be required for arterial roadways and selected collector roadways (usually four-lane collector roadways). Horizontal
curve radius and superelevation shall be in accordance with the recommendations of AASHTO, 1990 Edition and Table 4.4.

Superelevation shall not be used on local roadways. The following procedure is an outline for the correct application of superelevation. Runout lengths are not used in the design of superelevations.

**Table 4.4**

**Superelevations for Horizontal Curvature Runoff Length**

| Arterials, Boulevards, Multi-way Boulevards and Selected Collector Streets |
|-----------------------------|-----------|-----------|-----------|-----------|
| | R | e | L | 2-lane | 4-lane | 6-lane |
| D | R | e | L | 2-lane | 4-lane | 6-lane |
| 1°00' | 5730' | NC | 0 | 0 | 0 |
| 1°30' | 3820' | RC | 150 | 225 | 300 |
| 2°00' | 2865' | .023 | 150 | 225 | 300 |
| 2°30 | 2292' | .026 | 150 | 225 | 300 |
| 3°00' | 1910' | .028 | 150 | 225 | 300 |
| 3°30' | 1637' | .030 | 150 | 225 | 300 |
| 4°00' | 1432' | .033 | 150 | 225 | 300 |
| 5°00' | 1146' | .036 | 150 | 225 | 300 |
| 6°00' | 955' | .040 | 150 | 225 | 300 |

**LOW DENSITY RURAL ROADWAYS and 4-LANE COLLECTORS**

| | | 2-lane | 4-lane | 6-lane |
| 1080' | NC | 0 | -- | -- |
| 820' | .02 | 150 | 225 | -- |
| 770' | .03 | 150 | 225 | -- |
| 745' | .04 | 150 | 225 | -- |

D = Degree of Curve  
R = Radius of Curve  
e = Rate of superelevation  
L = Minimum Length of Superelevation Runoff  
NC = Normal Crown Section  
RC = Reverse Crown


4.04.4.01 Establish horizontal centerline radius, degree of curvature and centerline design grade. The method of attaining superelevations shall be rotation about the centerline design profile.

4.04.4.02 See Table 4.3 to determine rate of superelevation and length of superelevation runoff required for the degree of curvature. On arterials and collectors, the 6-lane, 4-lane, and 2-lane column shall be used respectively.
4.04.4.03 Use the information obtained from Table 4.3 to construct a "super diagram." See Figure 4.2. Intervals at which pavement cross slopes are shown shall not exceed 25 feet. The exterior curb elevation and centerline or median curb elevations shall also be shown.

**FIGURE 4.2**

**SUPERELEVATION DIAGRAM EXAMPLE**

![Super Elevation Diagram](image)

**SUPERELEVATION DIAGRAM**

\( e = \text{MAXIMUM RATE OF SUPERELEVATION IN FEET (PER FOOT OF WIDTH) FOR THE GIVEN DEGREE OF CURVE AND DESIGN SPEED.} \)

4.04.4.04 The superelevation runoff shall be about the horizontal P.C. or P.T. of the curve at a two-thirds to one-third \((2/3 - 1/3)\) ratio, with approximately two-thirds \((2/3)\) of the total length required for the superelevated runoff being achieved prior to the P.C. or after the P.T. of the curve.

4.04.4.05 As part of the construction plans, submit 3-line profiles and super diagrams of the centerline and both outside curb profile elevations shall be radial to the
centerline. Scale for a 3-line profile is 1" = 50' or larger horizontally, 1" = 1' vertically.

4.04.4.06 Station, elevation, and rate of superelevation shall be shown on the plan at each transition point. Special consideration shall be given to potential icing problems when superelevation runoff occurs near sump conditions. Storm sewer inlets shall be placed at or near points where the pavement cross-slope is flat to capture nuisance flows before these flows will cross the pavement.

4.04.4.07 Where there are reverse curves requiring superelevation a tangent length between the curves shall be provided. Its length shall accommodate the runoff lengths of both superelevations.

4.04.5 Railroad Crossings All railroad crossings on arterial streets shall be approved “rubberized” crossings for vehicular and pedestrian traffic.

4.04.6 Barricades Whenever roadways terminate due to project phasing, subdivision boundaries, etc., barricades are required. A note shall be placed on the plans directing the Contractor to construct permanent Type III and/or Type IV barricades (as specified in MUTCD) across the roadway terminus.

4.04.7 Median Turn Bay When ½ of an arterial street with a raised median is constructed, the construction shall include required turn bays on the half being constructed. The turn bays’ curb and gutter shall be constructed through the solid concrete nose.

4.04.8 Urban Centers and TOD’s Intersection and Mid-Block Approach Design Matrix Table 4.5 provides information regarding intersection and mid-block design criteria. All markings (pavement striping) and signing relative to cross-walks shall be in conformance with the Manual on Uniform Traffic Control Devices. Also reference Article 126-36.5 of the City Code for additional information.
Table 4.5
Curb Return Flow Line Radius at Intersections

<table>
<thead>
<tr>
<th></th>
<th>Boulevard – Four or Six Lanes</th>
<th>Multi-way Boulevard – Four or Six Through Lanes</th>
<th>Main Street – Four Lanes with Median/Center Turn Lane</th>
<th>Main Street – Two Lanes with Median/Center Turn Lane (Mid-Block)</th>
<th>Main Street – Two Lanes with Parallel Parking</th>
<th>Main Street – Two Lanes with Diagonal Parking (Mid-Block)</th>
<th>Main Street – Two Lanes with Diagonal Parking</th>
<th>One-Way Couplet – Two Lanes</th>
<th>Residential Parkway – Two Lanes</th>
<th>Residential Parkway – Two Lanes (Mid-Block)</th>
<th>Neighborhood/Local Urban – Two Lanes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curb Extensions</td>
<td>No</td>
<td>Yes (Access street only)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Partial</td>
</tr>
<tr>
<td>Corner Radii</td>
<td>25'</td>
<td>20'</td>
<td>20'</td>
<td>20'</td>
<td>20'</td>
<td>20'</td>
<td>20'</td>
<td>20'</td>
<td>20'</td>
<td>20'</td>
<td>20'</td>
</tr>
<tr>
<td>Exclusive Left Turn Lanes Allowed</td>
<td>Yes</td>
<td>Yes (Thru street only)</td>
<td>Yes⁴</td>
<td>Yes⁴</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes⁴</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Exclusive Right Turn Lanes Allowed</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
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<td>No</td>
</tr>
<tr>
<td>Standard Markings²</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>High Visibility Markings³</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
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<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Colored Paving</td>
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<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
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<td>No</td>
<td>No</td>
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<tr>
<td>Pavers</td>
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<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Pedestrian Refuge Islands</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Yes</td>
<td>NA</td>
</tr>
</tbody>
</table>

1 When intersects with boulevards or existing major arterials.
2 This marking shall only be used when non standard pavement or pavement color is used within the cross walk and when traffic signals are present.
3 This marking shall only be used when standard pavement and color are used and when traffic signals are present.
4.05  **Vertical Alignment**

Design controls for vertical alignment are shown in Table 4.1 Section 4.04.

4.05.1  **Permissible Roadway Grades**  Designers are encouraged to avoid grades that are less than 0.8% to minimize maintenance and icing problems. The minimum allowable grade for any roadway or alley is 0.5%. The maximum allowable grade for any roadway is shown in Table 4.1. The maximum grade for an alley is subject to the approval of the City Engineer.

4.05.2  **Permissible Grades Approaching Intersections**  The maximum approach grade at intersections shall be 3% for the distances shown in the table in Figure 4.3. At intersecting arterials, the maximum permissible grade shall be 2% for 200’ either side of the flow line of the intersecting street. Private driveway, parking lot drive, and fire lane grades, other than single family residential, may be 4% maximum when sloping down toward the public street and up to 6% maximum when sloping up toward the public street. The maximum slope for single family driveways is 14%. In all cases where driveways are steeper than 10%, there shall be an accompanying pedestrian walk to the main entry with steps as needed to allow a maximum slope of 10% on the walk.

![Figure 4.3 Permissible Intersection Grade](image)

See the table on the next page for the continuation of this figure.
4.05.3 Changing Grades  Continuous grade changes or "roller-coastering" shall not be permitted. The use of grade breaks, in lieu of vertical curves, is not encouraged. However, if a grade break is necessary and the algebraic differences in grade (A) does not exceed 0.4%; the grade break will be permitted, except at intersections where algebraic differences in grade of 0.8% will be permitted to facilitate the warping of the side street to meet the through street.
4.05.4 Cross Slopes  Except at intersections, or where superelevation is required, new roadways shall be level from top of curb to top of curb with a 2% crown as measured from centerline to lip of curb, or lip of median curb to lip of outside curb on roadways with raised center islands. Parabolic or curve crowns are not allowed. The cross slope of a street intersecting a street of higher classification shall be warped to match the grade on the higher classification street. In no case shall the pavement cross slope at intersections exceed the grade of the through street. Maximum pavement cross slope is 4% at intersections, as measured across the PCR’s of the intersecting street. The rate of change in pavement cross slope to match the through street shall not exceed 1% every 25 feet horizontally on a local roadway, 1% every 37.5 feet horizontally on a collector roadway, or 1% every 56.5 feet horizontally on arterial roadways. Separate flow line profiles shall be shown until a standard cross section is obtained. Do not show a centerline profile within the area that the separate flow line profiles are shown. See Section 4.05.6 for through street grade precedents. Quarter crowning may be accepted on a case-by-case basis with approval from the City Engineer.

4.05.5 Vertical Curves  All vertical curves shall be symmetrical. Vertical curves shall meet the design criteria found in Table 4.1. The minimum grade within a sag (sump) vertical curve is 0.50%. All vertical curves shall be labeled, in the profile, with length of curve (L) and K (=L/A), High/Low Pts., PI, P.V.C. and P.V.T. stations and elevations.

Requirements of the above policy are established by the City Code, the source of the above policy is, "A Policy On Geometric Design Of Highways And Streets," The American Association of State Highway Officials, 1990 edition.

4.05.6 Intersections  In addition to the requirements set forth in Sections 4.04.3 and 4.05.4, the following criteria shall apply at intersections.

4.05.6.01 The grade of the "through" street shall take precedence at intersections. At intersections of roadways with the same classification, the more important roadway, as determined by the Traffic Engineer, shall have this precedence. See Section 4.05.4.

4.05.6.02 Key factors determining the elevation of the curb return on the side street and the amount of warp needed on a side street transitioning to a through street are:
4.05.6.02.1  For permissible approach grade, see Section 4.05.2.

4.05.6.02.2  For pavement cross slope at the P.C.R.'s on the side street and permissible warp in pavement cross slope, see Section 4.05.4.

4.05.6.02.3  Vertical curve criteria, per Section 4.05.5

4.05.6.02.4  Vertical controls, per Section 4.05.7

4.05.6.03  The elevation at the P.C.R. on the through street is set by the grade of the through street in conjunction with pavement cross slope.

In retrofit situations, pavement cross slopes (from the existing crown or edge of existing asphalt to the lip of gutter) between 1% and 4% may be approved. Where existing streets are widened the cross slope requirements of above apply. Cross slope grade breaks must provide a safe driving condition. The plan or profile of the street shall include existing spot elevations located at the existing curb and gutter lip, crown line (centerline) and the existing edge of asphalt at a maximum of 50-foot spacing. This provides data for verification of existing/proposed cross slopes.

4.05.6.04  Carrying the crown of the side street into the through street is not permitted.

4.05.6.05  Tipping an inlet for the benefit of drainage is not permitted.

4.05.6.06  At an arterial-arterial; boulevard-boulevard; multi-way boulevard-multi-way boulevard intersections, a more detailed drawing of the entire intersection's drivability shall be submitted. See Section 4.05.4 for rates of pavement warp allowed.

Pavement cross slopes in the plan view shall be shown until a normal cross section is obtained on each side of the intersection, in addition to standard requirements of a roadway plan. Also show spot elevations in the intersection, on the plan view, on a 15-foot grid. Show this information on separate plan sheets at minimum scales of 1"=20' horizontally.

4.05.7  Curb Returns  Minimum grade around curb returns, when turning water, shall be 1.27%. Label high point elevation and distance from P.C.R. Label station and elevation of upstream flow line intersection when a cross pan is required.
Maximum fall around a curb return generally equals steepest grade (≥ 2%) coming into or out of a return multiplied by the length of the return, plus .2 of a foot.

4.05.8 Connection with Existing Roadways Connections with existing roadways shall be smooth transitions. If the algebraic difference in grade (A) exceeds 0.40% a vertical curve shall be used to transition the grade following the criteria in Section 4.05.5. Show the existing centerline and/or flow line elevations for 200-feet at 50-foot maximum intervals, unless conditions warrant additional information.

The following note shall appear on all street construction plans where the proposed design is matching an existing street along an existing edge of asphalt:

"Cores showing adequacy of pavement in accordance with an approved soils report and pavement design are required prior to issuance of street permits. If the developer cannot prove adequacy he shall be responsible for the removal of existing pavement and replacement with the properly designed pavement. A minimum of 24-feet of pavement or one-half of the street section, whichever is less, is the required replacement. Any construction beyond centerline of the street in order to match existing grades and to make a safe, drivable surface will also be the developer's responsibility."

4.05.9 Offsite Design and Construction The design grade and existing ground of all roadways that dead end due to project phasing, subdivision boundaries, etc., shall be continued in the proposed plan and profile for at least 500 feet or to its intersection with an arterial roadway. This limit shall be extended to 1,000 feet when arterial roadways are being designed. If the roadway adjacent to the proposed development is not fully improved, the developer is responsible for the design and construction of an asphalt transition beyond the project phasing, subdivision boundaries, etc., of City approved thickness and a 4' wide Type 2 (Table 23.1) aggregate base shoulder for the safe conveyance of traffic from the improved section to the existing roadway. The following formula shall be applied to the taper or lane change necessary for this transition:

\[ L = WS \]

Where:

\[ L = \text{length of transition in feet} \]
\[ W = \text{width of offset in feet} \]
S = speed limit or 85th percentile speed (whichever is greater) for speeds greater than 40 mph.

\[ L = \frac{WS^2}{60} \]

Where:
- \( L \) = length of transition in feet
- \( W \) = width of offset in feet
- \( S \) = speed limit or 85th percentile speed (whichever is greater) for speeds less than or equal to 40 mph.

For temporary transitions, 15:1 may be used as approved by the City Engineer.

The Traffic Engineer should be consulted for any unusual transition conditions. Grade breaks within the transition greater than 1% are not allowed when matching existing dirt or gravel streets.

The cost of pavement transitions shall be borne by the Developer.

4.06 Streetscape Design and Specifications

Contact Planning, Design, and Construction Division of the Parks, Recreation and Open Space Department, 303-739-7160.

4.07 Specification for Fire Lanes, Private Streets or Drives, and Parking Lots

4.07.1 General This section provides design and construction requirements, in addition to those listed elsewhere in this document, and specifically address private streets, driveways, parking lots, and fire lanes.

4.07.2 Pavement Design Soils and pavement design reports are required for fire lanes, private streets or drives, and parking lots per Section 5.00 PAVEMENT DESIGN. All reports must be approved by the City Engineer before a paving permit will be issued.

4.07.3 Drainage Report Preliminary and final drainage reports are required. See Section 2.04, STORM DRAINAGE PLANS AND REPORTS.

4.07.4 Pavement Cross Slopes All asphalt surfaces shall have a minimum grade of 1.00%. If grades are less than 1.00%, the pavement shall be concrete. Inverted crowns used for driveways, fire lanes, or parking lots shall have a swale “V” design
with 1.00% minimum positive slope along the flow line. Drainage pans shall continue to an inlet or other acceptable outfall and will not drain to an asphalt surface. If the pan slope is between 0.5% and 1.0%, a concrete drainage pan shall be installed. The pan shall have a minimum width of 4 feet, and shall be a minimum 6" thick in parking lot areas, a minimum of 10" thick in fire lanes, and driveways. The center depression of the pan shall be 1/4" per foot of pan width (total) minimum. Where bituminous paving adjoins the pan, paving must be 1/8" to 3/8" higher than the elevation of the lip of pan. Reinforcing shall be that as required by standard detail S4.1. If drainage is appropriately provided and the perpendicular parking spaces and adjoining private street form a continuous crowned section, the pans may be omitted. Handicap parking spaces and access aisles shall be level with surface slopes not exceeding 1:50 (2%) in all directions.

4.07.5 Transitions Transitions in street width shall be smooth and shall not pose a hazard to traffic (refer to Section 4.05.9, OFFSITE DESIGN AND CONSTRUCTION). Transitions shall not encroach on the limits of the existing street width. Horizontal alignment and pavement widening in curves shall conform to Section 4.04, HORIZONTAL ALIGNMENT.

4.07.6 Curbs Vertical or mountable curb and gutter shall border all private streets. Refer to City approved site plan.

4.07.7 Parking Area and Parking Lots Island noses for landscaping, utility access, or pedestrian access may be located within areas of perpendicular parking stalls but no island may project within 18 feet of centerline of street. Curb radii shall be a minimum 18" except locations allowing drive-through access.

4.07.7.01 Handicap Parking Handicap parking shall be provided within TODs and Urban Centers streets with diagonal parking. There shall be two universal spaces per each side of the street, per block, where there is diagonal parking. One of the universal spaces shall be van accessible.

4.07.7.02 The resultant grade in any direction within handicap parking shall not exceed two percent.

4.07.8 ADA Ramps Wheelchair access shall be provided along designated pedestrian paths from each area of parking to adjacent buildings and connecting sidewalks. Ramps shall have a minimum width of 48", a maximum slope of 1 vertical on 12
horizontal, approach areas, and turning areas as provided for in the Uniform Federal Accessibility Standards.

**4.07.9 Permissible Grades** The maximum permissible longitudinal grade for fire lanes is 10%. The maximum transverse grade for a fire lane is four percent with a resultant maximum slope of ten percent.

**4.07.10 Construction Observation/Materials Testing of Projects** To assure the quality of construction, a Licensed Professional Engineer (Consultant) shall provide construction observation and materials testing services for all projects falling under the category of private streets, driveways, fire lanes, parking lots, utilities, and other civil works. This Consultant shall be knowledgeable in civil works construction, street and roadway construction, paving techniques, material sampling and testing, and shall be familiar with the City standards and specifications and the design of the project. Construction observers and materials testing technicians shall be under the direct supervision of the Consultant. Periodic construction observation and materials testing services shall be performed daily when significant work is in progress. These services shall be sufficient in scope to determine the quality and adequacy of the construction. The Consultant shall insure compliance with City standards and specifications.

Before a certificate of occupancy can be issued the consultant shall prepare a written statement and shall submit it to the Public Improvement Inspections Division in the following format.

**STATEMENT OF CONSTRUCTION OBSERVATION AND MATERIALS TESTING OF PROJECT IMPROVEMENTS**

(Name of Project)

Our firm was retained to provide construction observation and materials testing services for the above named project. Services were performed daily during the construction of (list type of construction: asphalt parking lot; concrete parking lot; curb and gutter; walks; private streets; drives; fire lanes; etc.). Testing was performed for (list type of testing: concrete and/or asphalt paving subgrade; soils subgrade moisture/density control; base course gradation, moisture/density; asphalt thickness, compaction and laboratory analysis (extraction, gradation, and Marshall value unit weight); concrete slump, air and strength; etc.) Copies of observation logs and materials testing reports are available upon request. It is our professional opinion that the level of testing services and construction observation performed and testing results were adequate to show construction was in substantial compliance with the City of Aurora standards and specifications.

Company Name

Address

(Printed Name) P.E.

(Seal Over Name and date)
4.07.11  Pavement Widening at Curves on Private and Public Local Streets  At an intersection of two private or public local streets with a centerline radius from 33' to 55' Figure 4.4 shall be used. The width of pavement around horizontal curves shall be widened in accordance with Section 4.04.3.03 PAVEMENT WIDENING FOR SHORT RADI. Pavement widening transitions should generally occur over a roadway length of between 100 feet and 200 feet before the points of curvature and tangency. The adequacy of the geometric design will be based on the ability of the designed section to envelope a template based on the coincident passage of a fire truck and standard passenger car at a speed of 10 mph in accordance with AASHTO procedures. The geometric design may be based on a variety of methods including, but not limited to, (1) three point curves, (2) spiral curves, or (3) straight-line transitions.
Figure 4.4

WIDENING DETAIL FOR PRIVATE AND LOCAL STREET INTERSECTIONS

NOTE: RADII LESS THAN 33 FEET NOT ALLOWED.
FOR RADII GREATER THAN 55 FEET, SEE FIGURE 4.1.
4.08 Roadway Specifications

Following is a summary of the minimum roadway construction requirements contained in Article 126-36 of the Aurora City Code (see standard detail S1.1 et seq.).

<table>
<thead>
<tr>
<th>Roadway Type</th>
<th>Minimum Dedicated Right-of-Way Width</th>
<th>Minimum Roadway Width Flow line to Flow line</th>
<th>Landscaping Strip/Tree Lawn</th>
<th>Type of Sidewalk, Curb, and Gutter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Type I</td>
<td>64'</td>
<td>34'</td>
<td>8'</td>
<td>Mountable curb, gutter, and 5' detached walk</td>
</tr>
<tr>
<td>Local Type II</td>
<td>60'</td>
<td>30'</td>
<td>8'</td>
<td>Mountable curb, gutter, and 5' detached walk</td>
</tr>
<tr>
<td>Local Type II Alternate</td>
<td>44'</td>
<td>30'</td>
<td>None</td>
<td>Mountable curb, gutter, and 5' attached walk</td>
</tr>
<tr>
<td>Local Type III</td>
<td>68'</td>
<td>40'</td>
<td>8</td>
<td>6&quot; vertical curb and gutter, and 5' detached walk</td>
</tr>
<tr>
<td>Four Lane Collector</td>
<td>84'</td>
<td>56'</td>
<td>8</td>
<td>6&quot; vertical curb and gutter, and 5' detached walk</td>
</tr>
<tr>
<td>Two Lane Collector</td>
<td>74'</td>
<td>46'</td>
<td>8</td>
<td>6&quot; vertical curb and gutter, and 5' detached walk</td>
</tr>
<tr>
<td>Two Lane Collector Alternate</td>
<td>62'</td>
<td>34'</td>
<td>8</td>
<td>6&quot; vertical curb and gutter, and 5' detached walk</td>
</tr>
<tr>
<td>Low Density Rural</td>
<td>60'</td>
<td>24'</td>
<td>None</td>
<td>4' gravel shoulder each side</td>
</tr>
<tr>
<td>Six Lane Arterial</td>
<td>144'</td>
<td>102'(2-38' roadways; 26' min. raised median)</td>
<td>10' off street</td>
<td>6&quot; vertical curb and gutter and 10' detached walk</td>
</tr>
<tr>
<td>Four Lane Arterial Raised Median</td>
<td>114'</td>
<td>76' (2-31' roadways; 14' min. raised median)</td>
<td>10'</td>
<td>6&quot; vertical curb and gutter, and 8' detached walk</td>
</tr>
<tr>
<td>Four Lane Arterial Painted Median</td>
<td>114'</td>
<td>76' (2-31' roadways; 14' min. raised median)</td>
<td>10'</td>
<td>6&quot; vertical curb and gutter, and 8' detached walk</td>
</tr>
<tr>
<td>Residential Alley</td>
<td>16'</td>
<td>16'</td>
<td>N/A</td>
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</tr>
<tr>
<td>Local Commercial and Industrial Alleys</td>
<td>20'</td>
<td>20'</td>
<td>N/A</td>
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<td>Fire Lanes Commercial</td>
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<td>N/A</td>
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<td>Fire Lanes Residential</td>
<td>N/A</td>
<td>23'</td>
<td>N/A</td>
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</table>

Private streets or drives see Section 2.05 Roadway Plans
### Table 4.7
Urban Centers and TOD’s Roadway Specifications

<table>
<thead>
<tr>
<th>Roadway Type</th>
<th>Minimum Dedicated Right-of-Way Width</th>
<th>Minimum Roadway Width Flow line to Flow line</th>
<th>Landscaping Strip/Tree Lawn</th>
<th>Type of Sidewalk, Curb, and Gutter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boulevard</td>
<td>146’</td>
<td>106’ (2-39’ roadways; 28’ min. raised median)</td>
<td>9.5’</td>
<td>6” vertical curb and gutter and 10’ detached walk</td>
</tr>
<tr>
<td>Multi-way Boulevard w/ parallel parking</td>
<td>166’</td>
<td>132’ (2-7’ parking lanes; 2-16’ local lanes; 2-26’ thru lanes; 2-9’ min. &amp; 1-16’ min. raised median)</td>
<td>NA</td>
<td>6” vertical curb and gutter and 16’ attached walk (hardscape)</td>
</tr>
<tr>
<td>Multi-way Boulevard w/ diagonal parking</td>
<td>182’</td>
<td>148’ (2-16’ parking lanes; 2-16’ local lanes; 2-26’ thru lanes; 2-9’ min. &amp; 1-16’ min. raised median)</td>
<td>NA</td>
<td>6” vertical curb and gutter and 16’ attached walk (hardscape)</td>
</tr>
<tr>
<td>Main Street – 4 Lanes w/ Median / Center Turn Lane</td>
<td>118’</td>
<td>84’ (2-35’ roadways; 16’ min. raised median)</td>
<td>NA</td>
<td>6” vertical curb and gutter and 16’ attached walk (hardscape)</td>
</tr>
<tr>
<td>Main Street – 2 Lanes w/ Median / Center Turn Lane</td>
<td>96’</td>
<td>62’ (2-24’ roadways; 16’ min. raised median)</td>
<td>NA</td>
<td>6” vertical curb and gutter and 16’ attached walk (hardscape)</td>
</tr>
<tr>
<td>Main Street – 2 Lanes w/ Parallel Parking</td>
<td>78’</td>
<td>46’</td>
<td>NA</td>
<td>6” vertical curb and gutter and 16’ attached walk (hardscape)</td>
</tr>
<tr>
<td>Main Street – 2 Lanes w/ Diagonal Parking</td>
<td>90’</td>
<td>58’</td>
<td>NA</td>
<td>6” vertical curb and gutter and 16’ attached walk (hardscape)</td>
</tr>
<tr>
<td>One Way Couplet</td>
<td>73’</td>
<td>41’</td>
<td>NA</td>
<td>6” vertical curb and gutter and 16’ attached walk (hardscape)</td>
</tr>
<tr>
<td>Local Urban – 2 Lanes</td>
<td>66’</td>
<td>34’</td>
<td>NA</td>
<td>6” vertical curb and gutter and 16’ attached walk (hardscape)</td>
</tr>
<tr>
<td>Residential Parkway – 2 Lanes</td>
<td>104’</td>
<td>76’ (2-24’ roadways; 28’ min. raised median)</td>
<td>7.5’</td>
<td>6” vertical curb and gutter, and 6’ detached walk</td>
</tr>
<tr>
<td>Neighborhood – 2 Lanes</td>
<td>62’</td>
<td>34’</td>
<td>7.5’</td>
<td>6” vertical curb and gutter, and 6’ detached walk</td>
</tr>
<tr>
<td>Alleys</td>
<td>20’</td>
<td>20’</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Fire Lanes</td>
<td>NA</td>
<td>23’</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>
4.09 Street light Policy

4.09.1 General Street lighting shall be installed with underground electric service on all "newly developed" dedicated public streets in the City. All property owners abutting these streets shall, at their sole expense, pay the cost of these installations. The installation of street lighting facilities, or the deposit of sufficient funds to insure the installation, will be required as a prerequisite to the issuance of certificates of occupancy for any structure constructed along said streets.

4.09.2 Property Owner's Responsibility The property owner or land developer shall contact the Public Works Department, Engineering Services Division (303-739-7300) to initiate the street light design for any new development during the plan review process. The property owner or developer shall provide a copy of the proposed site plan and/or civil plan which will be used for the proposed street light design. The plan will be returned to the developer for inclusion of any required street lights.

4.09.3 City of Aurora Responsibility The City will provide Xcel Energy with a design plan for the required number, style, and placement of the street lights. Xcel Energy will provide a cost estimate to the City for installing the street lights. The City will initiate the process to install the street lights after payment is received from the property owner. Approximately 120 days are required by Xcel Energy to provide the City with a distribution design and cost estimate for installing the required street lights. The City will provide a quote letter to the property owner or land developer stating his street light cost requirements and payment due date.

4.09.4 Street light Installation Procedure Xcel Energy may schedule the street light installations when the new underground electrical distribution for the new development is being installed. This scheduling will be coordinated by the Xcel Energy representative and the property owner or developer. The property owner or developer is cautioned that any damage occurring to the street lights or the street light underground distribution due to his construction operations will be billed to him.

4.09.5 Solar Powered Street Lights The property owner or land developer may propose the installation of solar powered street lights. The property owner or land developer should contact Public Works Department, Engineering Services Division
at the start of the land development process to discuss the availability and use of solar powered street lights.
5.00 PAVEMENT DESIGN
5.01 REPORT SUBMITTAL AND REVIEW
5.02 REPORT FORMAT
5.03 GEOTECHNICAL INVESTIGATION
5.04 PAVEMENT DESIGN PORTION OF THE REPORT
5.05 SUBGRADE CHARACTERISTICS
5.06 TRAFFIC EQUIVALENT SINGLE AXLE LOADS (ESAL)
5.07 MINIMUM PAVEMENT SECTIONS AND DEFAULT SECTIONS
5.08 PAVEMENT MATERIALS
5.09 PAVEMENT DESIGN PROCEDURE
5.10 MISCELLANEOUS
5.11 FORMS, NOMOGRAPHS, SAMPLE
SECTION 5.00 pavement design

5.00 Pavement Design

5.00.1 General The "AASHTO Guide for Design of Pavement Structures," 1993 (AASHTO Guide) and "Development of Pavement Design Concepts" for Metropolitan Government Pavement Engineers Council are the basis for this design specification.

5.00.2 Scope Work within public right-of-way as well as all sites subject to traffic and/or parking, not excepted below, require a geotechnical investigation and pavement design report (hereafter called “geotechnical and pavement design report” or “report”).

The geotechnical and pavement design report for parking areas of 3,500 square feet or less may be waived for the following types of businesses:

- Day care centers
- Low volume commercial, non-industrial businesses (doctor, dentist, beauty parlor, etc.)
- Areas where truck traffic will be prohibited

If the geotechnical and pavement design report is waived, the pavement section for these parking areas shall be 5" hot bituminous pavement, unless a greater thickness is required by the City Engineer.

5.00.3 The provisions of Section 5.00.2 do not apply to high-volume parking lots such as convenience stores, fast food restaurants, drive-in banks, and similar establishments.

5.00.4 Residential or commercial sites less than or equal to 2.5 acres, or parking areas less than or equal to 2.0 acres, may be eligible for the default pavement section in Table 5.2b in lieu of an approved Geotechnical and Pavement Design Report, if the property owner wishes. This waiver does not apply to industrial lots or public roadways. To obtain approval of a default section, the property owner must complete and sign a default letter form indicating his selection of default paving sections listed in the table attached to the form. An approved site plan must be available for staff to verify site eligibility. If it is verified that the site meets the requirements of the
default section, the approved pavement section shall be as listed in Table 5.2b, or equivalent.

5.00.5 Transit oriented developments (TOD’s) and urban centers have different pavement requirements. These types of developments are defined in Article 126-36.5 of the City Code. TOD’s and urban centers are set up to contain three context zones: Edge, Transition and Core.

Edge Zones may use flexible pavement utilizing the modified ESAL values shown in Table 5.1a located in Section 5.06.1. Concrete pavements may also be used in this zone. See Section 5.08.3 for required uses of concrete pavements.

Core and Transition Zones are required to use concrete pavement utilizing the modified ESAL values shown in Table 5.1a located in Section 5.06.1.

Additive overlays will not be allowed. Rotomilling will be required to the depth of overlay proposed.

5.00.6 Definitions

\( W_{18} \) - 18 Kip Equivalent Single Axle Loads for the design period (20 years) in the design lane. (ESAL)

\( M_R \) - Effective Roadbed Soil Resilient Modulus as correlated from Hveem Stabilometer (R-Value) AASHTO Test Method T 190 for soil groups classified as A-1, A-2-5, A-2-7, A-3, A-4, and A-5, or Unconfined Compressive Strength Test (remold), UCC, AASHTO Test Method T 208 for soil groups classified as A-6, A-7, A-2-4, and A-2-6. In the event that Unconfined Compressive Strength tests results for A-2-4 and A-2-6 soils are not reproducible, R-value testing shall be performed.

\( K \) - Effective Modulus of Subgrade Reaction. \( M_R \) is input and adjustments made for the effects of subbase, rigid foundation near the surface, and potential loss of support due to erosion, as applicable.

5.01 Report Submittal and Review

5.01.1 Initially at least two copies of the Geotechnical and Pavement Design Report (three reports if the submitter wants one copy returned) must be submitted to Engineering Services. Each copy of the report shall have the original stamp and signature of, and be dated by a Colorado registered Professional Engineer competent in the field of
Geotechnical Engineering (herein called “Geotech”). See the general checklist at the end of the section for assistance in preparing a report.

5.01.2 A Geotechnical and Pavement Design Report go through a review and approval process. The report must be submitted in person to the Engineering Services counter personnel in Room 3218 of the City of Aurora Municipal Center, 15151 E. Alameda Parkway, Aurora, CO 80012, phone (303) 739-7312. The report shall not be mailed to Engineering Services' personnel, Public Works' personnel, the Director of Public Works, the City Engineer, or to the City of Aurora Materials Lab.

5.01.3 Satisfactory reports will be approved and signed by the City Engineer. Approval is for one year only. Approved pavement design sections from the approved report will be transferred onto the previously approved civil plans by the City Reviewing Engineer. This must be done before a paving permit can be obtained. A paving permit is required before paving construction is allowed. If a paving permit is needed after the one-year approval period, the Geotech must submit a letter referencing the original report, containing the City of Aurora approved drawing number from the original report, and stating that the recommendations in the original report remain valid and continue to comply with the current City of Aurora criteria at that time.

5.01.4 Contingent upon previously approved civil plans, the review will be generally completed within two weeks for the first review, and within five (5) working days for any subsequent review. The submitter will be notified by phone if the submittal is not approved. Unsatisfactory reports, with appropriate comments, will be made available for pick up. Also, the submitter will be notified by phone if the submittal is approved and if there is a report to pick up (if three reports were submitted, one approved report will be available for pick up).

5.02 Report Format

5.02.1 General The report shall be typed on 8 ½” x 11” paper and properly bound with durable covers. DO NOT HARD BIND: all pages should be easily taken apart and reassembled for copying and scanning purposes.

As a minimum, the report shall contain the following information and in the order enumerated: a title page with the City approval block; a vicinity map; the geotechnical investigation portion of the report (see 5.03); the pavement design
portion of the report (see 5.04); an original stamp and signature of the Geotech responsible for the report.

5.02.2 Title Page with City Approval Block The title page can be on the front cover or must be the very first page of the report. A sample of the title page is included in Section 5.11. The following information shall be shown on the title page:

- Title of the report: Geotechnical and Pavement Design Report
- Subdivision Name and Filing Number. Also, include the Lot and Block numbers if the report does not apply to the entire filing. If the report does not relate to a specific subdivision, the name of the proposed development shall be listed.
- City of Aurora Engineering Drawing Number of approved civil plans.
- Name of Consultant, full address (including zip code), telephone number, and fax number of the Consultant; name of contact person.
- Name of the owner, full address (including zip code), telephone number, fax number; name of contact person.
- A 2" to 2 ½" blank space for the City reviewing engineer’s comments.
- A City approval block, in the dimensions shown on the Sample Title Page.

5.02.3 Vicinity Map The vicinity map shall follow the title page. Minimum scale is 1" = 2000′ showing the location and name of all arterial roadways within one mile of the proposed development and all other roadways in the vicinity of the proposed development. The project area shall be indicated by shading. The appropriate portion of the city map, published by the City, is preferred for this vicinity map. These city maps are available in Room 3218 at the City of Aurora Municipal Center. The map can also be printed from the City website (auroragov.org – eServices – GIS Mapping).

5.02.4 Seal and Signature The geotechnical and pavement design report shall be stamped, signed, and dated by a Geotech licensed as a Professional Engineer in the State of Colorado. The original stamp and signature of the Geotech must be on each copy submitted; photocopies are not acceptable.
The original seal, signature and date shall be affixed on the title or signature page of the report.

5.03 Geotechnical Investigation

The geotechnical investigation portion of the report shall contain the following minimum information:

- If the streets have not been cut to rough construction grade at the time of the borings, a map with location and depth of test holes located to within 5' horizontally and 1' vertically, as located by a Professional Land Surveyor registered in the State of Colorado is required. If the streets are at rough construction grade at the time of the borings, a scaled drawing with the boring locations, within 5' horizontally, is required.
- Ground water elevations, if encountered
- Drill logs with subgrade elevations
- Grading analysis curves, AASHTO T 27 (each sample of A-1 to A-4 soils)
- Atterberg limits, AASHTO T 89 and T 90 (each soil type in each boring)
- Soil classification, AASHTO M 145 and ASTM D 2487
- Moisture-density curves
- Natural Moisture/Density, AASHTO T 265 and T 204 (each drive sample)
- Percent passing No. 200, AASHTO T 11 (each soil type in each boring)
- Sulfate Tests, AASHTO T 290 (1 test per 1,000' of A-6 and A-7 soils)
- Swell Tests, ASTM D 4546 at 200 psf (except soil types A-1 to A-4) One test per five borings or fraction thereof
- Effective Resilient Modulus of Roadbed Soils, \( M_R \), for design of flexible pavements and Effective Modulus of Subgrade Reaction, \( K \), for design of rigid pavements
- Depth from finished subgrade of bore hole or test pit shall be four-foot minimum, with every fourth one (minimum of one) at nine feet.
- All borings shall be sampled using a "California" style thin-wall type of sampler AASHTO T 206
- Boring logs shall include boring number, number of blows per foot, moisture conditions, free water, and anomalous conditions
- A map showing location or limits of different soil types

In addition, the Geotech shall investigate and recommend solutions to problems of:

- Swell potential of cohesive soils
- Frost heave in silty soils
- Potential ground water problems
- Presence of sulfates
- Any other matter that may adversely affect the design and life of the pavement.

Soil samples shall be taken based on the proposed subgrade elevation. All borings shall be taken at 250' maximum intervals along local and collector streets, private streets, and fire lanes and 200' maximum along arterials. One boring shall be made for each 15,000 square feet of parking lot. A minimum of one boring is required in all parking lots. If more than one soil type is encountered in the boring, they shall be logged and tested separately. The pavement shall be designed for the soil exhibiting the lowest subgrade support values.

5.04 Pavement Design Portion of the Report

5.04.1 Flexible Pavement  The report shall include the following minimum information.

- Design nomograph showing the line connecting M_R-ESAL-SN
- Map showing location of each different pavement section and soil type
- Design calculations for each pavement section
- Swell potential discussion
- Discussion of any unusual design or construction problems or requirements
- Related information indicated in Section 5.03

5.04.2 Rigid Pavement  The report shall contain the following information.

- Design nomographs showing the lines connecting ESAL, slab thickness, and K-Effective Modulus of Subgrade Reaction
- Map showing locations of each different pavement section and soil types
- Discussion of any unusual design or construction problems or requirements
- Design calculations for each pavement section.
- Swell potential discussion
- Discussion of any unusual design or construction problems or requirements
- Related information indicated in Section 5.03

5.05 Subgrade Characteristics

5.05.1 Swell Potential  All soil groups, excluding A-1 through A-4, shall be tested to determine swell or settlement potential. Tests shall be run on the "California Spoon"
samples in accordance with ASTM D 4546 at a surcharge of 200 psf. The swell tests shall be plotted and the percent swell/settlement and swell pressure (psf) shall be determined and reported. Test results which are suspected of being too high or too low for the soil type shall not be considered in the design of the pavement, but shall be reported. Any deletion of data shall be justified in the report.

As a minimum, the report shall stipulate the following: the required depth of moisture treatment of the subgrade shall be determined by the highest percentage of swell as recorded as a whole number as indicated in Table 5.0 below:

Moisture treatment shall achieve a moisture content and compaction as specified in Section 20.06.8 COMPACTION.

Soils with >5% swell shall also require swell mitigation per Section 22.00, STABILIZED SUBGRADE, in addition to moisture treatment.

<table>
<thead>
<tr>
<th>Swell Potential *</th>
<th>Depth of Moisture Treatment</th>
<th>Depth of Chemical Stabilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 3% swell</td>
<td>moisture treat to a depth of 1'</td>
<td>---</td>
</tr>
<tr>
<td>&gt; 3% &lt; 5% swell</td>
<td>Moisture treat to depth of 2.5' or</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>Moisture treat to a depth of 1.5'</td>
<td>Stabilization treat to a depth of 1'</td>
</tr>
<tr>
<td>&gt; 5% swell</td>
<td>Moisture treat to a depth of 1.5'</td>
<td>Stabilization treat to a depth of 1'</td>
</tr>
</tbody>
</table>

* Indicated highest percentage of swell as recorded to the nearest whole number

NOTE: From the top of finished grade, moisture treatment shall not go deeper than 30" without written direction from the engineer.

5.05.2 Resilient Modulus

5.05.2.01 For soil types, A-1, A-3, A-2-5, A-2-7, A-4, and A-5 Resilient Modulus, $M_R$ shall be determined by R-Value conversion. R-Value shall be determined in accordance with AASHTO T 190. The following formula based on Colorado Department of Transportation, "Roadway Design Manual" shall be utilized to convert Hveem "R" to $M_R$.

$$M_R = (0.75) 10^Z; \text{ where } Z = 0.0142R + 3.4098$$
5.05.2.02 For soil types A-2-4 and A-2-6:  \( M_R = 1.67 \, q_u \)

For soil type A-6:  \( M_R = 1.61 \, q_u \)

For soil type A-7-6:  \( M_R = 2.35 \, q_u \)

For Claystone:  \( M_R = 1.26 \, q_u \)

Where \( q_u = \) Unconfined Compressive Strength (remolded) in psf, AASHTO T 208; and where \( M_R \) is in psi

The above values may be multiplied by a coefficient of 1.33, if one of the following applies: a subdrain system is provided; subgrade permeability is greater than 1,000 ft. per year; it is a Low Density Rural roadway section with drainage ditches; or the subgrade is gneiss or granite in nature.

Remarks - Note unusual conditions or other data that would be considered necessary to properly interpret the results.

5.05.2.03 Effective Modulus of Subgrade Reaction For rigid pavement design, laboratory soil resilient Modulus MUST be converted to Modulus of Subgrade Reaction based on the formula:  \( k = M_R/19.4 \) or Figure 3.3 or 3.4 of the AASHTO Guide. Figure 3.6 of the AASHTO Guide must also be applied with \( LS = 2.5 \) to obtain the Effective Modulus of Subgrade Reaction, \( k \), before entering this value into the appropriate rigid pavement design nomograph, N-5.3 or N-5.4, or computer program.

5.06 Traffic - Equivalent Single Axle Loads (ESAL)

5.06.1 ESAL is defined as total number of equivalent 18,000 lb. single axle load applications for the design lane during a 20-year design period. The design period for pavements within the Core and Transition Zones of TOD’s and Urban Centers is 30-years. Calculated ESALs must be equal to or greater than the Minimum ESALs listed in Tables 5.1 and 5.1A below. The City Engineer may increase the minimum ESAL at any location, if in his opinion traffic conditions warrant.
# Table 5.1

**Minimum ESAL (X10^6)**

<table>
<thead>
<tr>
<th></th>
<th>Single-Family Residential</th>
<th>Multifamily Residential</th>
<th>Commercial and Business</th>
<th>Industrial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arterials</td>
<td>2.2</td>
<td>2.2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4-Lane Collector</td>
<td>1.5</td>
<td>1.5</td>
<td>2.2</td>
<td>2.2</td>
</tr>
<tr>
<td>2-Lane Collector</td>
<td>0.2</td>
<td>0.2</td>
<td>0.4</td>
<td>1.1</td>
</tr>
<tr>
<td>Low Density Rural</td>
<td>0.07</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Local Street</td>
<td>0.06</td>
<td>0.07</td>
<td>0.2</td>
<td>0.7</td>
</tr>
<tr>
<td>Private Street or Drive</td>
<td>0.06</td>
<td>0.07</td>
<td>0.2</td>
<td>0.7</td>
</tr>
<tr>
<td>Fire Lane</td>
<td>--</td>
<td>0.07</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Parking, Cars Only</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>Parking, All Other</td>
<td>0.04</td>
<td>0.04</td>
<td>0.07</td>
<td>0.07</td>
</tr>
</tbody>
</table>

*To deviate to less than the minimum indicated ESAL an axle-load analysis must be approved by the City Engineer.*

# Table 5.1a

**Minimum ESAL (X10^6)** *(Urban Centers and TODs)*

<table>
<thead>
<tr>
<th>Inside TOD</th>
<th>Single-Family Residential</th>
<th>Multifamily Residential</th>
<th>Commercial and Business</th>
<th>Industrial</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Edge Zone</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boulevard - 6 Lanes</td>
<td>3.3</td>
<td>3.3</td>
<td>4.5</td>
<td>--</td>
</tr>
<tr>
<td>Multiway Boulevard; Median/Center Turn Lane - 4-Lane</td>
<td>2.25</td>
<td>2.25</td>
<td>3.3</td>
<td>--</td>
</tr>
<tr>
<td>Main Street; Median/Center Turn Lane - 4-Lane</td>
<td>2.25</td>
<td>2.25</td>
<td>3.3</td>
<td>--</td>
</tr>
<tr>
<td>Main Street; Median/Center Turn Lane - 2-Lane</td>
<td>0.3</td>
<td>0.3</td>
<td>0.6</td>
<td>--</td>
</tr>
<tr>
<td>Couplet - 2 Lanes</td>
<td>0.3</td>
<td>0.3</td>
<td>0.6</td>
<td>--</td>
</tr>
<tr>
<td><strong>Transition Zone</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main Street; Median/Center Turn Lane - 4-Lane</td>
<td>--</td>
<td>2.25</td>
<td>3.3</td>
<td>--</td>
</tr>
<tr>
<td>Main Street; Median/Center Turn Lane - 2-Lane</td>
<td>--</td>
<td>0.3</td>
<td>0.6</td>
<td>--</td>
</tr>
<tr>
<td>Main Street; Parallel Parking - 2-Lane</td>
<td>--</td>
<td>0.3</td>
<td>0.6</td>
<td>--</td>
</tr>
<tr>
<td>Main Street; Angled Parking - 2-Lane</td>
<td>--</td>
<td>0.3</td>
<td>0.6</td>
<td>--</td>
</tr>
<tr>
<td>Couplet - 2 Lanes</td>
<td>--</td>
<td>0.3</td>
<td>0.6</td>
<td>--</td>
</tr>
<tr>
<td>Local Urban - 2 Lanes</td>
<td>--</td>
<td>0.3</td>
<td>0.6</td>
<td>--</td>
</tr>
<tr>
<td>Residential Parkway - 2 Lanes</td>
<td>--</td>
<td>0.3</td>
<td>0.6</td>
<td>--</td>
</tr>
<tr>
<td>Neighborhood - 2 Lanes</td>
<td>--</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Core Zone - Concrete Only</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main Street; Parallel Parking - 2-Lane</td>
<td>--</td>
<td>0.3</td>
<td>0.45</td>
<td>--</td>
</tr>
<tr>
<td>Main Street; Angled Parking - 2-Lane</td>
<td>--</td>
<td>0.3</td>
<td>0.45</td>
<td>--</td>
</tr>
<tr>
<td>Local Urban - 2 Lanes</td>
<td>--</td>
<td>0.3</td>
<td>0.45</td>
<td>--</td>
</tr>
<tr>
<td>Residential Parkway - 2 Lanes</td>
<td>--</td>
<td>0.3</td>
<td>0.45</td>
<td>--</td>
</tr>
</tbody>
</table>

*To deviate to less than the minimum indicated ESAL an axle-load analysis must be approved by the City Engineer.

**Rigid ESALs Used in the Core Zone**
5.06.2 Roadway zoning classifications are based on the projected land use of the areas served by the subject segment of roadway. Residential roadways service only areas with a minimum of 80% residential zoned property. Commercial and Industrial classifications service areas with 20% or more of the land to be used as Commercial or Industrial. If less than 80% of the area served is residential, the Classification will be either Commercial or Industrial. If any of the non-residential area served is Industrial, the classification will be Industrial. If none of the non-residential area served is Industrial, the Classification will be Commercial. Any classification with a calculated ESAL of $1.4 \times 10^6$ or more will be considered to be an arterial.

Pavement design traffic studies are a method of determining 20-year design ESALs (30-year design ESALs within Core Zones of TOD’s and Urban Centers). ESAL calculations in traffic studies shall be based on the AASHTO "Guide for Design of Pavement Structures," latest edition. The traffic study, when required, shall be submitted with the pavement design and subject to review and acceptance.

Parking Areas For parking areas, traffic loads from Table 5.1 may be assumed.

Residential If a traffic study for a residential roadway is not available, traffic loads can be determined using Equation 2:

$$\text{ESAL}_{20} = 62,000 + 80 \, R \quad \text{Equation 2}$$

Where $R$ = number of residential density units serviced by the street

Commercial For roadways where any individual commercial site is 10 acres or more, traffic loading shall be determined by an approved traffic study only. For commercial roadways with sites less than 10 acres, traffic loading can be calculated using Equation 3:

$$\text{ESAL}_{20} = 62,000 + 80 \, R + 260,000 \, \text{C}_A \quad \text{Equation 3}$$

Where: $\text{C}_A$ = Commercial Acres serviced by the street

Industrial For roadways where any individual industrial site is 10 acres or more, traffic loading shall be determined by an approved traffic study only. The City may require a traffic study for any industrial roadway. For industrial roadways with sites less than 10 acres, traffic can be calculated using equation 4:

$$\text{ESAL}_{20} = 260,000 \, \text{C}_A + 400,000 \, \text{I}_A \quad \text{Equation 4}$$

Where: $\text{I}_A$ = Industrial Acres serviced by the street.
5.07 Minimum Pavement Sections and Default Sections

If the calculated pavement sections, outside of TOD and Urban Center developments, indicate thinner sections than the Minimum Pavement Sections listed in Table 5.2a below, the Minimum Pavement Sections shall govern. The City Engineer may increase the minimum pavement section at any location if, in his opinion, conditions warrant. All asphalt roadways will be paved with a minimum of two (2) lifts, regardless of minimal thickness.

Table 5.2a

<table>
<thead>
<tr>
<th>MINIMUM PAVEMENT SECTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESAL (X10^6)</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>&gt; 1.8</td>
</tr>
<tr>
<td>0.5 - 1.8</td>
</tr>
<tr>
<td>0.2 - 0.5</td>
</tr>
<tr>
<td>Less than 0.2</td>
</tr>
<tr>
<td>Parking Areas only</td>
</tr>
<tr>
<td>50' ea. Side of RTD Bus Stop*</td>
</tr>
</tbody>
</table>

*This extra depth pavement is to be placed in the outside lane only. The City reserves the right to review location and length of the bus stop with RTD and change the size and location of the extra-depth pavement.

Default pavement sections are listed in Table 5.2b. These default sections are allowed only for parking lots, private drives or fire lanes located in non-TOD and non Urban Center developments. A Default Letter must be approved prior to using the default sections (See Section 5.11.1).

Table 5.2b

<table>
<thead>
<tr>
<th>DEFAULT SECTIONS ALLOWABLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parking Lots</td>
</tr>
<tr>
<td>Auto Parking Only</td>
</tr>
<tr>
<td>P1 5.5&quot; A.C.</td>
</tr>
<tr>
<td>P2 3&quot; A.C. +8&quot; A.B.C.</td>
</tr>
<tr>
<td>P9 4&quot; A.C. + 8.5&quot; A.B.C.</td>
</tr>
<tr>
<td>P3 5.5&quot; Concrete</td>
</tr>
</tbody>
</table>

Note: The P in default Sections P1 through P14 stands for pavement. It is a "shorthand" way of identifying exactly which of the 14 default sections is being specified. Use the P number and the description under each P number when using the default letter (see Section 5.11.1).
5.08 Pavement Materials

5.08.1 Asphalt Cement Concrete (AC) shall be plant mix hot bituminous pavement (also referred to as HBP). Use of other than AC, PCC, or gravel base requires submittal of appropriate test data for approval. Materials and construction shall comply with Section 24.00, HOT MIX ASPHALT, Section 31.00, CONCRETE PAVEMENT, or Section 23, STREET CONSTRUCTION AGGREGATES.

5.08.2 Alternate paving materials will be allowed at the discretion of the City Engineer as follows.

Both sides of the street must be of the same material.

Minimum lengths for any one type of pavement material shall be as specified in Table 5.3 below.

5.08.3 Arterial/arterial, boulevard/boulevard, multi-way boulevard/multi-way boulevard intersections shall be PCC beginning 250' behind each PCR and extending through the entire intersection.

<table>
<thead>
<tr>
<th>STREET TYPE</th>
<th>MINIMUM LENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arterial, Boulevard, Multi-way Boulevard</td>
<td>1/4 mile</td>
</tr>
<tr>
<td>Collector, Main Street – 4 and 2 Lane w/ Median, Residential Parkway</td>
<td>one block, if longer than 500'</td>
</tr>
<tr>
<td>Local access, Main Street – 2 Lane, One Way Couplet, Local Urban, Neighborhood</td>
<td>one block, if longer than 300'</td>
</tr>
<tr>
<td>Cul-de-sac*</td>
<td>300’</td>
</tr>
<tr>
<td>Parking Lot</td>
<td>no restrictions</td>
</tr>
</tbody>
</table>

*Must be same material as intersecting street if less than 300' long.

5.08.4 Alternate paving materials are (see Section 5.00.5 for requirements regarding TOD and Urban Center developments):

- Asphaltic Cement Concrete (AC) for surface course
- Portland Cement Concrete (PCC) for surface course
- Aggregate base courses plus AC or PCC
- Chemically treated or stabilized subgrade plus AC or PCC
- Other material as approved by the City Engineer
5.09 Pavement Design Procedure

5.09.1 Flexible Pavement

- Determine the street classification, zoning, and ESAL.
- Choose Nomograph N5.1 or N5.2 depending on street classification.
- Using Mₚ and ESAL, determine SN.
- Using the strength coefficients from Table 5.4, calculate the thickness of the various pavement layers by the following formula. Keep in mind the Minimum Pavement Sections (Table 5.2) govern when thinner sections are indicated.

$$SN = a_1D_1 + a_2D_2 + \ldots + a_nD_n$$

$a_1, a_2 = $ strength coefficients

$D_1, D_2, = $ thickness of pavement layers

**Table 5.4**

<table>
<thead>
<tr>
<th>COMPONENTS</th>
<th>COEFFICIENT (a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot Bituminous Pavement</td>
<td>0.40</td>
</tr>
<tr>
<td>Existing Bituminous Pavement</td>
<td>0.30</td>
</tr>
<tr>
<td>Aggregate Base Course</td>
<td>0.12</td>
</tr>
<tr>
<td>Treated Subgrade*</td>
<td>*0.12</td>
</tr>
</tbody>
</table>

* In accordance with Section 22

In TOD and Urban Centers where there is a flexible pavement section greater than 9 inches warranted, a composite section of flexible pavement shall be used. Following the AASHTO guide section 3.1.4, a drainage coefficient for base and subbase layers shall be used in conjunction with the Current COA calculation. The current COA Calculation is as follows:

$$SN = a_1D_1+a_2D_2+a_3D_3\ldots$$

Where:

$SN = $ Structural Number, $a_x = $ Strength coefficients (COA Table 5.4) and $D_x = $ Thickness

The modified Calculation used in the TOD Zones uses a drainage coefficient for the base and subbase layers.

$$SN = a_1D_1+a_2D_2m_2+a_3D_3m_3\ldots$$

Where:
SN = Structural Number, $a_s$ = Strength coefficients (COA Table 5.4), $m_s$ = Drainage coefficient and $D_s$ = Thickness

Drainage Coefficients are from AASHTO Table 2.4 and are presented below.

### AASHTO Table 2.4

<table>
<thead>
<tr>
<th>Quality of Drainage</th>
<th>Percent of Time Pavement Structure is exposed to Moisture Levels Approaching Saturation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Less than 1%</td>
</tr>
<tr>
<td>Excellent</td>
<td>1.40 - 1.35</td>
</tr>
<tr>
<td>Good</td>
<td>1.35 - 1.25</td>
</tr>
<tr>
<td>Fair</td>
<td>1.25 - 1.15</td>
</tr>
<tr>
<td>Poor</td>
<td>1.15 - 1.05</td>
</tr>
<tr>
<td>Very Poor</td>
<td>1.05 - 0.95</td>
</tr>
</tbody>
</table>

An analysis of the drainage quality shall be conducted on a case by case basis and a determination of the quality will be presented in the soils report for the flexible pavement section.

### 5.09.2 Rigid Pavement (Portland Cement Concrete, PCC)

- Determine ESAL for the 20-year design period (30-year for TOD / Urban Centers’ Core and Transition Zones).
- Determine effective K-value of subgrade soils.
- Use Nomograph in Figure N5.3 or N5.4 depending on street classification.
- Submit a jointing plan conforming to S19.1, et seq. See Section 2.05.1.19.
5.09.3 Alternatives to the use of the above-mentioned nomographs may be presented for approval as follows: computer printouts that present results in accordance with the equations shown on the respective nomographs and the AASHTO Guide will be allowed for review. The printout must reiterate all design parameters. The report must justify to the satisfaction of the City Engineer any deviation from the design parameters specified herein.


5.09.4.01 Reliability (R)

- 95% for arterials, boulevards, multi-way boulevards, all fire lanes, all commercial and industrial roadways
- 90% for local roadways, main streets (2- lane, 2 and 4-lanes with medians), one way couplet streets, local urban streets, neighborhood streets, residential parkways and collector roadways and parking lots other than commercial and industrial. Except local roadways and private drives where the area to be served by the roadway is 90% or more developed, R = 85% may be used (this does not include the TOD and Urban Center street sections).

5.09.4.02 Overall Standard Deviation ($S_o$)

- .45 for flexible pavements
- .35 for rigid pavements

5.09.4.03 Design Serviceability Loss

<table>
<thead>
<tr>
<th>Flexible</th>
<th>Rigid</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2</td>
<td>2.5</td>
<td>Local roadways, main street (2- lane, 2 and 4-lanes with medians), one way couplet streets, local urban streets, neighborhood streets, residential parkways and collector roadways, other than commercial and industrial, private drives, and parking lots</td>
</tr>
<tr>
<td>1.7</td>
<td>2.0</td>
<td>Arterials, boulevard, multi-way boulevard, fire lanes, all commercial and industrial roadways</td>
</tr>
</tbody>
</table>

5.09.4.04 Concrete Elastic Modulus ($E_c$)

$3.6 \times 10^6$ psi
5.09.4.05  Mean Concrete Modulus of Rupture (S’c)

600 psi

5.09.4.06  Load Transfer Coefficient (J)

If monolithic or tied curb and gutter are placed on both sides of the pavement use 3.6, otherwise use 4.2.

5.09.4.07  Drainage Coefficient (C_d)

1.0

5.09.4.08  Loss of Support (LS)

2.5 for use in Figure 3.6 of the AASHTO Guide to correct the Effective Modulus of Subgrade Reaction, K, for Potential Loss of Support.

5.10  Miscellaneous

5.10.1  Field Copies  It is to the submitter's benefit to provide the Contractor with an approved copy of the Pavement Design Report to reduce confusion and delays in the field.

5.10.2  Jointing Details  Pavement Design Report submittals for Rigid Pavement alternates shall include an approved jointing detail. See standard details S19.1 et seq. and Section 31.10.

5.11  Forms, Nomographs, Sample

5.11.1  Default Letter  This letter is required to be signed by the owner of the property. Fill in the blanks to show the name of the subdivision, filing number, lot, and block, as well as street address. Indicate the alternates selected from among the applicable alternates shown in table 5.2b. This table is also shown on the page “Default Sections for Fire Lanes and Private Drives” following the “Default Letter” page. Include the P number of the alternates selected as well as the description of the alternate. The P stands for pavement.

5.11.2  Request For Alternate Pavement Thickness  This request letter is required to be signed by the owner of the property. Show the name of the subdivision, filing number, lot, and block, as well as street address. This form provides a format for the
actual letter and may have to be modified to some extent in most cases to accommodate the individual project. Any waiver of design criteria will be considered for private drives and parking lots only. Public streets and fire lanes will not be eligible for waivers of the design criteria contained in these specifications.

5.11.3 **Nomograph N-5.1** Flexible Pavement Design Chart for Arterials and all Commercial and Industrial sites.

5.11.4 **Nomograph N-5.2** Flexible Pavement Design Chart for Local and Collector Streets except Commercial and Industrial sites.

5.11.5 **Nomograph N-5.3** Rigid Pavement Design Chart for Arterials and all Commercial and Industrial sites.

5.11.6 **Nomograph N-5.4** Rigid Pavement Design Chart for Local and Collector Streets except Commercial and Industrial sites.

5.11.7 **Sample of the Title page and Approval Block** The preparer of the report must follow the format indicated on this sample. Geotechnical and Pavement Design Reports submitted with incomplete information on the title page shall not be accepted.
City Engineer
City of Aurora, Public Works Department
15151 E. Alameda Parkway, Ste. 3200
Aurora, CO 80012

Subject: Request for Default Pavement Section for Parking lot and Private Drive(s) or Fire lanes(s)

Name of Development: ________________________________________________________________

Subdivision, lot, and block: _______________________________________________________
Street Location: ________________________________________________________________

Dear Sir:

The subject residential or commercial site has 2.5 Acres or less, or a parking area less than or equal to 2.0 Acres. As owner of the property, I hereby request to be allowed to use the Default Pavement Sections in accordance with Section 5.00.4 of the "City of Aurora Roadway Design and Construction Specifications."

Our selected alternates from the attached table are:
Auto Parking only P ________________________________ (1)

Private Drives or Fire lanes P ________________________________ (1)

We understand this Default Pavement Section may require greater maintenance or earlier reconstruction than a designed pavement. We agree that the City of Aurora accepts no responsibility or liability for the use of the Default Pavement Section.

(Reviewing Engineer)

Sincerely,

Date

(property owner's signature) (City Engineer)

(typed or printed name) Date

Notes: (1) P stands for pavement. See Table 5.2b or see the page following this “Default Letter” page.
(2) For concrete section: A jointing plan per S19.1 - S19.4 must be submitted for review prior to paving.
DEFAULT SECTIONS FOR FIRE LANES AND PRIVATE DRIVES:

Assumptions and Recommendations
R-value = 30, Mr = 5,000, k = 15
Reliability = 90
Initial Serviceability = 4.2 (A.C.), 4.5 (CONC)
Terminal Serviceability = 2.0

Alternative Sections Allowable

<table>
<thead>
<tr>
<th>Parking Lots</th>
<th>Private Drives and Fire Lanes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto Parking only</td>
<td>Single Family Drives</td>
</tr>
<tr>
<td>P1 5.5” A.C.</td>
<td>P4 5.5” A.C.</td>
</tr>
<tr>
<td>P2 3” A.C. + 8” A.B.C.</td>
<td>P5 3” A.C. + 8” A.B.C.</td>
</tr>
<tr>
<td>P3 5.5” Conc.</td>
<td>P6 5.5” Conc.</td>
</tr>
</tbody>
</table>

Note: The P stands for pavement.
REQUEST FOR ALTERNATE PAVEMENT THICKNESS

_____________________
(Date)

City Engineer
City of Aurora, Public Works Department
15151 E. Alameda Parkway, Ste. 3200
Aurora, CO  80012

Subject: ________________________________________________________________
(Project or Subdivision Name)

Dear Sir:

__________________________ requests that the following pavement sections be approved for the
(Company/Property Owner)

above-referenced __________________________ project: __________________________.
(Zoning/Use) (Name)

Subdivision, lot, block: ____________________________________________________

All new asphalt paving to be ____________ full depth asphalt (or ____________ asphalt and
(thickness) (thickness)

___________ base course), per ____________________________
(thickness) (Geotechnical Firm)

Report #_________ dated ________________.

As Owner of this Property, ____________________________ is aware that
(Company/Property Owner)

this pavement design does not meet the criteria established by the City of Aurora for this application.

The attached soils report references the characteristics of the soil and recommends the above section.

In addition, ____________________________ shall hold the City of Aurora harmless for the
(Company/Property Owner)

performance and maintenance of this design.

Sincerely,

__________________________  ____________________________  ____________________________
(Authorized Signature)  Date  (Reviewing Engineer)  Date

__________________________  ____________________________
(Type Authorized Signatory’s Name)  (City Engineer)  Date

__________________________
(Company/Owner)
ARterials
All Commercial & Industrial
Design chart for flexible pavements

NOMOGRAPh SOLVES:

\[ \log_{10} W_{18} = Z_R S_0 + 9.36 \log_{10} (SN+1) - 0.20 + \frac{\log_{10} \left( \frac{\Delta \text{PSI}}{4.2 - 1.5} \right)}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 \log_{10} M_R - 8.07 \]

\[ N = 5.1 \]
LOCAL & COLLECTOR
EXCEPT COMMERCIAL & INDUSTRIAL

Design chart for flexible pavements
Fig. 3.6 Correction of effective modulus of subgrade reaction for potential loss of subbase support (6).
**ARTERIALS**
**ALL COMMERCIAL & INDUSTRIAL**

Design chart for rigid pavements

<table>
<thead>
<tr>
<th>Design Slab Thickness, D (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
</tr>
<tr>
<td>11 1/2</td>
</tr>
<tr>
<td>11 1/2</td>
</tr>
<tr>
<td>10 1/2</td>
</tr>
<tr>
<td>9 1/2</td>
</tr>
<tr>
<td>8 1/2</td>
</tr>
<tr>
<td>7 1/2</td>
</tr>
<tr>
<td>7 3/4</td>
</tr>
<tr>
<td>7 3/4</td>
</tr>
<tr>
<td>6 1/2</td>
</tr>
<tr>
<td>6 1/2</td>
</tr>
</tbody>
</table>

**k. Effective Modulus of Subgrade Reaction (pci)**

<table>
<thead>
<tr>
<th>Estimated Total 18 kip Equivalent Single Axle Load (ESAL) Applications, W18 (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50                                                                      10 5                  1.0 0.5 0.1 0.05</td>
</tr>
<tr>
<td>40                                                                      10 5                  1.0 0.5 0.1 0.05</td>
</tr>
<tr>
<td>30                                                                      10 5                  1.0 0.5 0.1 0.05</td>
</tr>
<tr>
<td>20                                                                      10 5                  1.0 0.5 0.1 0.05</td>
</tr>
<tr>
<td>10                                                                      10 5                  1.0 0.5 0.1 0.05</td>
</tr>
</tbody>
</table>

Determine thickness by reading the nearest line to the left of your data point.

\[ N = 5.3 \]
LOCAL AND COLLECTOR
EXCEPT COMMERCIAL OR INDUSTRIAL

Design chart for rigid pavements

Determine thickness by reading the nearest line to the left of your data point.

\[ N = 5.4 \]
SAMPLE OF TITLE PAGE AND APPROVAL BLOCK

Geotechnical and Pavement Design Report
Subdivision Name, Filing No. ____, Lot ____ , Block ____
Aurora Engineering Drawing Number (EDN): __________

Prepared By:
Firm/Consultant’s Name
Full Address, Including Zip Code
Phone: _______________ Fax: _________________
Contact Name: ____________________________

Prepared For:
Owner’s Name
Full Address, Including Zip Code
Phone: _______________ Fax: _________________
Contact Name: ____________________________

2” – 2 ½” (Leave space for Reviewing Engineer’s comments)

Approved For One Year From This Date

City Engineer ___________________________ Date
SUBMITTAL CHECKLIST for
PAVEMENT GEOTECHNICAL DOCUMENTS

Geotechnical and Pavement Design Reports submitted with incomplete information on the title page shall not be accepted. If civil plans are approved, review time for all Geotech submittals is 5 working days.

GEOTECHNICAL AND PAVEMENT DESIGN REPORT [2-3 copies]
- Two (2) copies of the report (with original signatures) must be submitted IN PERSON at the Engineering Services counter, room 3218 of the City of Aurora Municipal Center.
- Each copy of the report shall have the stamp and original signature of, and be dated by a registered Professional Engineer [Geotech].
- The report shall be typed on 8 1/2” x 11” paper and properly bound with durable covers. DO NOT HARD BIND.
- Title of the report: Geotechnical and Pavement Design Report
- Subtitle of the report: Subdivision Name and Filing Number (include the Lot and Block numbers if the report does not apply to the entire filing.)
- COA Engineering Drawing Number [EDN] If civil plans are approved.
- Name of Applicant, full address (including zip code), telephone number and fax number, name of contact person. [Applicant is the designated contact for all purposes.]
- Name of Geotech, full address (including zip code), telephone number and fax number, name of contact person.
- Name of the Owner, full address (including zip code), telephone number and fax number, name of contact person.
- A 2” to 2 1/2” blank space for the City reviewing engineer’s comments.
- A City approval block, in the dimensions shown on the Sample Title Page.

DEFAULT LETTER [Does NOT require accompanying Geotechnical Report]
- Two (2) copies of the letter (with original signatures) must be submitted IN PERSON at the Engineering Services counter, room 3218 of the City of Aurora Municipal Center.
- This letter is required to be signed by the owner of the property.
- Fill in the blanks to show the name of the subdivision, filing number, lot, and block, as well as street address (if applicable).
- Name of Applicant, full address (including zip code), telephone number and fax number, name of contact person. [Applicant is the designated contact for all purposes.]
- Name of the Owner, full address (including zip code), telephone number and fax number, name of contact person.

REQUEST FOR ALTERNATE PAVEMENT THICKNESS [Requires accompanying Geotechnical Report]
- Two (2) copies of the request (with original signatures) must be submitted IN PERSON at the Engineering Services counter, room 3218 of the City of Aurora Municipal Center.
- This letter is required to be signed by the owner of the property.
- Show the name of the subdivision, filing number, lot, and block, as well as street address (if applicable).
- Name of Applicant, full address (including zip code), telephone number and fax number, name of contact person. [Applicant is the designated contact for all purposes.]
- Name of the Owner, full address (including zip code), telephone number and fax number, name of contact person.
7.00 CONSTRUCTION REQUIREMENTS
7.01 SCOPE
7.02 LICENSES
7.03 PERMITS
7.04 WORK HOURS
7.05 AUTHORITY OF THE PROJECT MANAGER
7.06 AUTHORITY OF THE PUBLIC IMPROVEMENT OBSERVER
7.07 CONSTRUCTION OBSERVATIONS
7.08 DEFECTIVE MATERIALS AND WORK
7.09 PROTESTS
7.10 INSPECTION FACILITIES
7.11 INITIAL ACCEPTANCE
7.12 WARRANTY PERIOD
SECTION 7.00 CONSTRUCTION REQUIREMENTS

7.01 Scope

This section specifies the requirements for permits, licenses, and construction observation required for public improvement construction work and designated private construction work. Requirements stated in this section shall be supplemented by, and be in compliance with, any additional requirements or conditions required by City Codes, specifications, or administrative requirements.

City Offices
Aurora Municipal Center
15151 East Alameda Parkway.
Aurora, Colorado 80012

<table>
<thead>
<tr>
<th>City Contacts</th>
<th>Room</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building – Permits, Licenses and Certificates</td>
<td>2400</td>
<td>303-739-7420</td>
</tr>
<tr>
<td>Cashier's Office</td>
<td>1300</td>
<td>303-739-7091</td>
</tr>
<tr>
<td>Contractor Business Licenses</td>
<td>1100</td>
<td>303-739-7057</td>
</tr>
<tr>
<td>Dry Utility Inspections - Utility Company Permits</td>
<td>2400</td>
<td>303-739-7420</td>
</tr>
<tr>
<td>Public Improvements Permits, Fees and Inspections</td>
<td>2400</td>
<td>303-739-7420</td>
</tr>
<tr>
<td>Life Safety Inspection</td>
<td>2400</td>
<td>303-739-7420</td>
</tr>
<tr>
<td>Traffic Services</td>
<td>3200</td>
<td>303-739-7333</td>
</tr>
<tr>
<td>Water and Sewers - Extension Agreements</td>
<td>3600</td>
<td>303-739-7375</td>
</tr>
</tbody>
</table>

13636 East Ellsworth Ave., Aurora, Colorado 80012

<table>
<thead>
<tr>
<th>City Contacts</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey</td>
<td>303-326-8015</td>
</tr>
</tbody>
</table>
7.02 Licenses

7.02.1 Any company, contractor, or firm engaging in construction work of public improvements shall have a contractor's license. Said license shall be applicable to the type of work being performed such as:

- Right-of-Way - Concrete
- Right-of-Way - Asphalt
- Right-of-Way - Trenching (Utility Construction)
- Right-of-Way - Earthwork.

Permits and licenses for public utility companies shall be required unless otherwise indicated in their franchise agreement. Utility company contractors shall comply with the applicable licensing and bonding requirements. Contractors Licenses shall be obtained from the Building Division.

7.02.2 Public improvement construction work shall be supervised by an individual who has a Supervisor Certificate which is applicable to the type of work being performed. Supervisor Certificates shall be obtained from the Building Division.

7.02.3 Contractors engaging in the maintenance or construction of private water and sewer lines shall have either a Class D5 Excavators License (Drain Layers and Caisson Drillers License) or a Class A Plumbers License. Such licenses are valid only for work on private property and can be obtained from the Building Division.

7.02.4 A Contractor Business License is required and shall be obtained from the Business Licensing Division on the first floor of the Aurora Municipal Center.

7.03 Permits

7.03.1 Permits are required for the following.

- Any public improvement construction or any other work in the public right of way
- The grading fill or excavation of any property
The construction or repair of any private utilities including storm drainage, sanitary sewer, water service lines, and fire suppression lines

The construction and paving of private streets and parking lots.

7.03.2 Permits shall be obtained before any work is authorized or allowed. Permits will be issued only to a contractor actually performing the work and licensed and bonded for the type of work. For City contracts, permits may be issued to a general contractor only when such contractor and his subcontractors are in compliance with licensing and bonding requirements.

7.03.3 Permits are issued only after:

- the Public Works Engineering Division has approved the plans for the specific improvements to be constructed
- the Water Department has issued an Extension Agreement to the property owner for the proposed public utilities
- all applicable fees have been paid.

Permits for roadway and parking lot paving are issued after pavement design reports are submitted to and approved by the Public Works Engineering Division. Additionally, paving permits require prior acceptance or approval of any newly-constructed utilities which are under the proposed paving. This acceptance or approval requires the submittal and approval of the applicable utility compaction test reports. Compaction test reports are to be submitted to the City Materials Testing Laboratory.

7.03.4 A complete set of approved drawings, specifications, and a valid permit shall be on the job site and available to the construction observer at all times.

7.04 Work Hours

7.04.1 Work between sundown and sunrise may be authorized by the Project Manager if adequate lighting is available and noise will not disturb nearby residents or businesses. (Section 94-107 of City Code.)

7.04.2 When Public Improvement Observers or other City personnel are required to work overtime or on legal holidays (New Year's Day, Martin Luther King, Jr. Day, Presidents’ Day, Memorial Day, Independence Day, Labor Day, Veterans’ Day, Thanksgiving Day, and Christmas Day), it shall be at the Contractor's expense. Public Improvement Observers normally work an eight-hour day from 7:30 a.m. to
4:00 p.m. Monday through Friday. Other days or hours will be considered overtime and will be at the Contractor's expense. A minimum charge of four hours will be charged for any overtime work requested and performed on weekends and legal holidays. The Contractor's payment for all overtime work shall be made by check to the City of Aurora.

**7.05 Authority of the Project Manager**

The Project Manager is designated by the City Manager to exercise all authority on behalf of the City to ascertain that all construction of facilities is equal to or better than the minimum construction requirements set forth in the project specifications. The Project Manager shall be represented by a Public Improvement Observer who will observe work performed under a permit issued for construction, including all materials to be incorporated in the work, excavation, bedding, backfill, and all construction methods and practices. The Project Manager shall have the sole authority to issue, in writing, deviations from the provisions of the project specifications or changes to previously-approved drawings.

**7.06 Authority of the Public Improvement Observer**

Public Improvement Observers are assigned by the Project Manager to assist the Contractor in complying with the approved project specifications. Observers have the authority to reject inferior materials or defective workmanship and to suspend work not in accordance with the City "Roadway Design and Construction Specifications" until such time as corrections are made and approved. The Public Improvement Observers are not authorized to alter any provisions or to issue instructions contrary to the project specifications, or to make any changes to approved drawings.

**7.07 Construction Observations**

7.07.1 The Contractor shall obtain the Observer's approval of any material before placement and before beginning any work.

7.07.2 The Contractor shall call for observation giving 24-hours minimum notice. Observation may be requested from the Public Improvements Permits Office at 303-739-7420. For utility company observation, please call Public Works Department at 303-739-7420.

7.07.3 In the event that any of the work or material fails to meet any of the requirements of the specifications, written notice of the rejection shall be given to the Contractor, and work shall be halted until corrective action is taken.
7.07.4 Periodic construction observation is only an aid to the Contractor and in no way reflects any responsibility on the part of the City for quality or quantity control, and in no way implies acceptance of the work, or any part thereof, by the City.

7.08 Defective Materials and Work
Whenever materials and/or work are found to be defective, the Contractor, at his expense, shall promptly remove such defective materials and construction from the job site and replace all defective portions to the satisfaction of the Project Manager. In the event the Contractor fails to remove defective items from the job site within ten days of written notice, the Project Manager may arrange for such removal at the expense of the Contractor. Work performed or covered without observation is subject to rejection.

7.09 Protests
If the Contractor considers any work demanded of him by the Observer to be outside the requirements of the approved specifications, he will immediately ask for a written decision or instruction and shall proceed to perform the work to conform with the Observer's ruling. If the Contractor considers such instructions unsatisfactory, he will, within 24 hours after their receipt, file a written protest with the Project Manager stating his objections and the reasons therefore. Unless protests or objections are made in the manner specified and within the time limits stated herein, the Contractor hereby waives all grounds for protests.

7.10 Inspection Facilities
The Contractor shall furnish all reasonable facilities and shall assist the Observer as necessary for the proper inspection of materials to be used and workmanship involved in the construction.

7.11 Initial Acceptance
When the final clean-up has been performed, the Contractor will notify the Observer that all work has been completed and schedule an inspection. The observer will perform all necessary inspections and notify the Contractor of any noted defects. Until the NOTICE OF INITIAL ACCEPTANCE is issued, the Project Manager may direct that the newly-constructed public improvements shall be barricaded to prevent public use of the improvements.

The NOTICE OF INITIAL ACCEPTANCE OR SUBSTANTIAL COMPLETENESS which begins the warranty period will be issued when the following items are completed.

7.11.1 All major work elements have been accepted by the Observer.
7.11.2 A "Release and Indemnification" statement has been delivered to the Public Improvements Permits Office.

7.11.3 Compaction and Materials Testing Reports, in compliance with the applicable specifications and the requirements of Section 32.00, *MATERIALS TESTING*, have been delivered to and approved by the City's Materials Testing Laboratory.

7.12 **Warranty Period**

The warranty period is for one year from the date of initial acceptance or substantial completion unless otherwise specified or mutually agreed upon in writing.
20.00 EARTHWORK
20.01 SCOPE
20.02 CLEARING AND GRUBBING
20.03 TOPSOIL
20.04 WATERING
20.05 REMOVAL OF STRUCTURES AND OBSTRUCTIONS
20.06 EXCAVATION AND EMBANKMENT
20.07 RESET STRUCTURES, FENCES, AND GUARDRAIL
20.08 TRACKING MUD ON CITY STREETS
20.09 MEASUREMENT AND PAYMENT
SECTION 20.00 EARTHWORK

20.01 Scope

The intent of this section is to specify materials, methods, and standards to be used in the construction of embankments or excavations for roads, drainage channels, structures, or other purposes as indicated on the drawings or contract documents. The work shall include excavation, embankment, grading, compaction, clearing and grubbing, removal of topsoil, trees, stumps, vegetation, removal and/or resetting of minor obstructions, subgrade preparation, and any other work incidental for the construction of excavations and embankments. All workmanship and materials shall be in accordance with the requirements of these specifications, and in conformity with the lines, grades, quantities, and the typical cross section shown on the plans or as directed by the Project Manager. When used in these specifications, AASHTO shall refer to the American Association of State Highway and Transportation Officials, ASTM shall refer to the American Society for Testing and Materials, and CDOT shall refer to the Colorado Department of Transportation.

20.02 Clearing and Grubbing

20.02.1 General

This work shall consist of clearing, grubbing, removing, and disposing of all vegetation and debris within the limits of project and such other areas as may be indicated on the plans or required by the work, except such objects as are designated to remain or are to be removed in accordance with other sections of these specifications. This work shall also include the preservation from injury or defacement of all vegetation and objects designated to remain.

20.02.2 Construction

The Project Manager will establish construction lines and designate all trees, shrubs, plants, and other objects to remain. The Contractor shall preserve all objects designated to remain.

All surface objects and all trees, stumps, roots, and other protruding obstructions not designated to remain shall be cleared and/or grubbed, including mowing, as required, except non-perishable solid objects which will be a minimum of 2' below subgrade. Perishable objects shall be removed to a depth of 3' below the existing ground or subgrade, whichever is lower.

Except in areas to be excavated, stump holes and other holes from which obstructions are removed, shall be backfilled with suitable materials and compacted.
in accordance with these specifications. Materials and debris shall be disposed of in a manner acceptable to the Project Manager. Burning will not be permitted.

The Contractor shall make all necessary arrangements for obtaining suitable disposal locations. If disposal is to be at other than established dump sites, the Project Manager may require the Contractor to furnish, in writing, permission from the property owner on whose property the materials and debris are placed. Branches on trees or shrubs shall be removed as directed. Branches of trees extending over the roadbed shall be trimmed to give a clear height of 20' above the roadbed surface. All trimming shall be done by skilled workmen and in accordance with good tree surgery practices.

The Contractor shall scalp areas where excavation or embankment is to be made, except that mowed sod need not be removed where the embankment to be constructed is 4' or more in height below subgrade elevation. Scalping shall include the removal of materials such as brush, roots, sod, grass, residue of agricultural crops, sawdust, and other vegetable matter from the surface of the ground.

Hedges shall be pulled or grubbed in such a manner as to assure complete and permanent removal. Scattered hedge or shrubs not classified as hedge shall be removed as specified for hedge. Sod not required to be removed shall be thoroughly disked before construction of embankment.

20.03 Topsoil

20.03.1 General This work shall consist of excavating suitable topsoil from stockpiles, approved pits, or from the natural groundcover on designated portions of the project. It shall include the placing of topsoil upon constructed cut and fill slopes after grading operations are completed. All work shall be in accordance with these specifications and in reasonably close conformity with the lines and thickness shown on the plans or as directed.

20.03.2 Materials Topsoil shall consist of loose, friable loam reasonably free of admixtures of subsoil, refuse, stumps, roots, rocks, brush, weeds, or other material which would be detrimental to the proper development of vegetative growth.

20.03.3 Construction Materials selected for topsoil and lying within the limits of the project shall be excavated and stockpiled along the project at locations designated. Excavated topsoil shall be placed directly upon constructed cut and fill slopes
without the use of stockpiles whenever conditions and the progress of construction will permit.

Topsoil shall not be placed until the areas to be covered have been properly prepared and grading operations in the area have been completed.

Topsoil shall be placed and spread at locations and to the thickness shown on the plans and shall be keyed to the underlying materials by the use of harrows, rollers, or other equipment suitable for the purpose.

Water shall be applied to the topsoil at the locations and in the amounts designated. Water shall be applied in a fine spray by nozzles or spray bars in such manner that it will not wash or erode the topsoil areas.

20.04 Watering

20.04.1 General This work shall consist of wetting, water for landscaping, and the application of dust palliatives to soils and aggregates in accordance with these specifications and in conformity with the plans.

20.04.2 Materials All water used shall be free of any mineral salts or contaminating material which might result in expansion of materials after placement. In case the water source proposed for use by the Contractor is not of known quality and chemical content, samples of the water shall be submitted for tests and shall be approved prior to use. When water is to be metered for measurement, the Contractor shall use an approved metering device.

20.04.3 Construction

20.04.3.01 Wetting Sprinkling equipment shall be of a type which insures uniform and controlled distribution of water without ponding or washing. Water added during finishing operations shall be uniformly applied by spraying across the full width of the course by means of controllable pressures and spray bars or nozzles.

20.04.3.02 Dust Palliative The Contractor shall be required to furnish and apply a dust palliative on portions of the project and on haul roads at the locations and in the amounts as may be called for on the plans or as directed. Dust palliative may consist of water or a dilution of water and emulsified asphalt, or other approved substance. Dust palliative shall be of the type and proportions called
20.04.3.03 **Landscaping** The Contractor will be required to furnish water for seeding, mulching, planting, transplanting, sodding, soil sterilization, and any other landscaping work, when called for on the plans or when designated.

20.05 **Removal of Structures and Obstructions**

20.05.1 **General** This work shall consist of the removal, wholly or in part, and satisfactory disposal of all foundations, fences, signs, structures, sidewalk, curbing, old pavements, traffic signal materials, abandoned pipelines, and any other obstructions which are not designated or permitted to remain, except for the obstructions to be removed and disposed of under other items in the contract. It shall also include the salvaging of designated materials and backfilling the resulting trenches, holes, and pits.

When the proposal does not include pay items for removal of structures and obstructions as set out in this section, such work shall be performed under Section 20.06, EXCAVATION AND EMBANKMENT. This work shall also include sawing or cutting concrete or asphalt in reasonably close conformity with the dimensions and details on the plans or as directed, to create planes of weakness in order to facilitate controlled breaking for removal.

20.05.2 **Construction** The Contractor shall raze, remove, and dispose of all foundations, signs, structures, fences, old pavements, abandoned pipelines, traffic signal materials, and other obstructions, any portion of which are within the project limits except utilities and those for which other provisions have been made for removal.

Traffic signals and related materials shall include all attachment hardware and other included materials such as, but not limited to, mast arms and span wire.

Concrete adhering to sign posts shall be removed. Pedestals and bases shall be removed to 1' below the surrounding ground or subgrade.

Where portions of structures are to be removed, the remaining portions shall be prepared to fit new construction. The work shall be done in accordance with plan details, and in such manner that materials to be left in place shall be protected from damage. All damage to portions of structure to remain in place shall be repaired by the Contractor at his expense. Reinforcing steel projecting from the remaining
structure shall be cleaned and aligned to provide bond with new extension. Dowels as required by plans are to be securely grouted with approved grout. Removal of sign panel shall include all work necessary to remove the panel and its attachment hardware from the existing installation.

Where culverts or sewers are to be left in place and plugged, the ends shall be filled with Class III concrete. Culvert and sewer ends are to be sufficiently filled to prevent future settlement of embankments.

Materials used in detour structures for the project, which are supplied by the Contractor, shall be considered to be the property of the Contractor. After the detour is abandoned, he shall completely remove the detour structure and shall dispose of materials as specified.

20.05.3 Removal of Bridges, Culverts, and Other Drainage Structures  Bridges, culverts, and other drainage structures in use by traffic shall not be removed until satisfactory arrangements have been made to accommodate traffic.

Unless otherwise directed, the substructures of existing structures shall be removed down to 1' below natural stream bottom or ground surface. Where such portions of existing structures lie wholly or in part within the limits for a new structure, they shall be removed as necessary to accommodate the construction of the proposed structure. Steel, precast concrete, and wood bridges as specified, shall be carefully dismantled without unnecessary damage. Steel members to be salvaged shall be match marked with waterproof paint.

20.05.4 Removal of Pipe  Unless otherwise provided, all pipe shall be carefully removed, cleaned, and every precaution taken to avoid breaking or damaging the pipe. Pipes to be relaid shall be removed and stored when necessary so that there will be no loss or damage before relaying.

In removing manholes, catch basins, and inlets, any live sewers connected with them shall be properly reconnected, and satisfactory bypass service shall be maintained during such operations.

20.05.5 Removal of Pavements, Sidewalks, Curbs, Etc.  Portland cement concrete (PCC) or asphaltic concrete that is to remain shall be cut in a straight, true line with a vertical face. PCC or asphaltic concrete may be cut with a cutting wheel, saw, or
broken to the directed point of removal. The Contractor shall be responsible for the cost of removal and replacement of all excess breaks.

If the Contractor cannot maintain a straight, true break line by other means, the Project Manager shall order sawing.

The sawing shall be done carefully, and all damages to PCC or asphaltic concrete to remain in place, due to Contractor's operations, shall be repaired by the Contractor at his expense. The minimum depth of saw cut in concrete shall be 2”.

20.05.6 Salvage  All salvageable material shown on the plans shall be removed, without unnecessary damage, in sections or pieces which may be readily transported, and shall be stored by the Contractor in locations designated by the Project Manager. The Contractor shall be required to replace any materials lost from storage or damaged by negligence or by use of improper methods.

20.05.7 Disposal  The Contractor shall make all necessary arrangements for obtaining suitable disposal locations and the cost involved shall be included in the work. If disposal is to be at other than established dump sites, the Project Manager may require the Contractor to furnish written permission from the property owner on whose property the materials are placed. Broken concrete or asphalt shall not be disposed in the City except as provided in Section 20.06.6 when approved by the Project Manager.

20.05.8 Backfill  Except in areas to be excavated, all cavities left by structure removal shall be backfilled with suitable material and compacted in accordance with these specifications. Jetting or ponding will not be allowed.

20.06 Excavation and Embankment

20.06.1 General  This work shall consist of excavation, disposal, shaping, or compaction of all material encountered within the limits of the work including excavation for ditches and channels, and not being removed under some other item, necessary for the construction of the project in accordance with the specifications and in reasonably close conformity with the lines, grades, and typical cross sections shown on the plans or as staked by the Project Manager.

20.06.2 Excavation  All excavation will be classified as rock excavation, unclassified excavation, or borrow, as hereafter described.
20.06.2.01 Rock Excavation  Rock excavation shall consist of igneous, metamorphic, and sedimentary rock which cannot be excavated without blasting and all boulders or other detached stones each having a volume of 2 cubic yards or more, as determined by physical or visual measurements.

20.06.2.02 Unclassified Excavation  Unclassified excavation shall consist of the excavation of all materials of whatever character is required for the work, obtained within the right-of-way, or designated sites close to the project area, including surface boulders and excavation for ditches and channels.

20.06.2.03 Borrow  Borrow shall consist of approved material obtained from outside the right-of-way, required for the construction of embankment or other portions of the work.

20.06.3 Embankment Material  Embankment material shall consist of approved material acquired from excavations, hauled and placed in embankments in reasonably close conformity with the line, grades, thickness, and typical cross sections shown on the plans or established.

The type of relative compaction required shall be as called for on the plans or as designed.

When the source of embankment materials is not designated on the plans, approval of the source will be contingent on the material having a resistance value of at least 15 or as shown on the plans when tested by the Hveem Stabilometer, and a maximum dry density of not less than 95 pounds per cubic foot.

20.06.4 Construction

20.06.4.01 General  The excavation and embankments shall be finished to reasonably smooth and uniform surfaces. Variation from the subgrade plan shall not be more than 0.08' for soil, nor more than 0.50' for rock. Materials shall not be wasted without permission of the Project Manager. Excavation operations shall be conducted so that material outside of the limits of slopes will not be disturbed. Prior to beginning grading operations in any area, all necessary clearing and grubbing and topsoil in that area shall have been performed in accordance with Section 20.02, CLEARING AND GRUBBING, and SECTION 20.03, TOPSOIL.
The Contractor shall notify the Project Manager with sufficient time before beginning excavation so that the necessary cross sections may be taken. The Contractor shall not excavate beyond the dimensions and elevations established, and material shall not be removed prior to the staking and cross sectioning of the site.

When the Contractor's excavating operations encounter remains of prehistoric people's dwelling sites or artifacts of historical or archaeological significance, the operations shall be temporarily discontinued. The Project Manager will contact archaeological authorities to determine the disposition thereof. When directed, the Contractor shall excavate the site in such manner as to preserve the artifacts encountered and shall remove them for delivery to the custody of the proper state authorities. Such excavation will be considered and paid for as extra work.

The Contractor shall at all times take precautions for the protection of culverts, irrigation crossings, mail boxes, driveway approaches, valve boxes, manholes, survey monuments, underground or overhead utility lines, and all other public or private installations that may be encountered during construction. The Contractor shall be responsible for the repair of any installations damaged due to his work. Manholes and valve boxes shall be observed by the Project Manager for displacements and introduction of foreign matter. It shall be the Contractor's responsibility to correct any displacement and to remove any foreign matter resulting from his work.

20.06.4.02 Minimizing Swell Potential For all soil groups, excluding A-1 through A-4, the required depth of moisture treatment of the subgrade shall be determined by the highest percentage of swell (ASTM D 4546 at a surcharge of 200 lbs/s.f.) as indicated in the table below.
Table 20.06.4.02
Moisture Treatment Requirements

<table>
<thead>
<tr>
<th>Swell Potential *</th>
<th>Depth of Moisture Treatment</th>
<th>Depth of Chemical Stabilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 3% swell</td>
<td>moisture treat to a depth of 1’</td>
<td>---</td>
</tr>
<tr>
<td>&gt; 3% &lt; 5% swell</td>
<td>moisture treat to a depth of 2.5’ or</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>moisture treat to a depth of 1.5’</td>
<td>Stabilization treat to a depth of 1’</td>
</tr>
<tr>
<td>&gt; 5% swell</td>
<td>moisture treat to a depth of 1.5’</td>
<td>Stabilization treat to a depth of 1’</td>
</tr>
</tbody>
</table>

* Indicated highest percentage of swell as recorded to the nearest whole number.

**NOTE:** From the top of finished grade, moisture treatment shall not go deeper than 30” without written direction from the engineer.

Moisture treatment shall achieve a moisture content in accordance with Table 20.2 Compaction and Moisture for Various Soil Types.

Soils with >5% swell shall also require swell mitigation per Section 22, STABILIZED SUBGRADE, in addition to moisture treatment.

20.06.5 Excavation

20.06.5.01 *Rock* Unless otherwise specified, rock shall be excavated to a minimum depth of 3’ below subgrade within the limits of the roadbed and the excavation backfilled with material designated on the plans or approved.

20.06.5.02 *Unclassified* Where material encountered within the limits of the work is considered unsuitable by the Project Manager, such material shall be excavated as directed by the Project Manager and replaced with suitable material. All excess or unsuitable excavated material, including rock and boulders, that cannot be used in embankments may be placed on the fill-side slopes in a satisfactory manner or otherwise disposed of as approved by the Project Manager.

Wherever shown on the plans or considered necessary, intercepting ditches shall be made above the top of cut slopes and carried to outlets near the ends of the cuts. In order to blend the intersection of cut slopes with the slope of the adjacent natural ground surfaces in a uniform manner, the tops of all cut slopes shall be flattened and rounded.

Excess quantities of excavation not necessary for the construction of the embankments, unless otherwise specified on the plans or in the special
provisions, shall become the property of the Contractor and shall be disposed of as specified in Section 20.05.7. The Project Manager may allow disposal by widening and flattening fill slopes, if right-of-way conditions permit and if no damage results.

20.06.5.03 Borrow Borrow material should not be placed until after the excavation has been placed in the fill. If the Contractor places more borrow than is required and thereby causes a waste of excavation, the amount of such waste will be deducted from the borrow volume. Borrow areas shall be finished so that water will not collect or stand therein, unless otherwise specified. The Project Manager shall be notified 14 days in advance of opening any material sources to allow time for testing.

20.06.6 Embankment Embankment construction shall consist of constructing roadway embankments, including preparation of the areas upon which they are to be placed; the construction of dikes; the placing and compacting of approved material within project areas where unsuitable material has been removed; and the placing and compacting of embankment material in holes, pits, and other depressions within the project area. Only approved materials shall be used in the construction of embankment and backfills.

Free-running water shall be drained from the material before the material is placed. Rocks, broken concrete, or other solid materials more than 6” in greatest dimension shall not be placed in embankment areas less than 1' deep measured from the subgrade. Materials less than 150 pounds may be placed in fills over 1' deep provided there remains 1' minimum cover measured from the subgrade, with the approval of the Project Manager.

If embankment can be deposited on one side only of abutments, wingwalls, piers, or culvert headwalls, care shall be taken that the area immediately adjacent to the structure is not compacted to the extent that it will cause overturning of or excessive pressure against the structure. The fill adjacent to the end bent of a bridge or to a box culvert shall not be placed higher than the bottom of the back wall of the bent or floor slab of the box until the superstructure is in place. When embankment is to be placed on both sides of a concrete wall or box-type structure, operations shall be so conducted that the embankment is always at approximately the same elevation on both sides of the structure.
Roadway embankment of earth material shall be placed in horizontal layers not exceeding 8” (loose measurement) and shall be compacted as specified before the next layer is placed. Effective spreading equipment shall be used on each lift to obtain uniform thickness prior to compacting. As the compaction of each layer progresses, continuous leveling and manipulating will be required to assure uniform density. Water shall be uniformly added or removed if necessary, in order to obtain the required density.

Placing of occasional boulders of sizes larger than the maximum layer thickness may be authorized by the Project Manager. Each layer shall be leveled and smoothed with suitable leveling equipment and by distribution of spalls and finer fragments of earth.

Cross hauling or other action as appropriate will be ordered when necessary to insure that the best available material is placed in critical areas of embankments, including the top 2’ of all embankments.

Frozen materials shall not be used in the construction of embankments.

During the construction of the roadway, the roadbed shall be maintained in such condition that it will be well drained at all times.

**20.06.7 Benching** Embankment material that is to be placed and compacted adjacent to existing embankment or existing slopes steeper than 5:1 shall be continuously benched as the new embankment material is placed up in layers. Each bench shall be keyed a minimum of 3’ into the existing ground and shall begin at the intersection of existing ground and the vertical sides of the previous cut. The configuration of the benches shall be as shown on the plans or at least 4’ in height. Materials from the benching shall be compacted with the embankment material. Placement of embankment materials shall begin at the low point of slopes. Materials which have been loosened shall be recompacted with the embankment materials.

Any deviation of grade tolerances in excess of 0.08' in cross section and 0.08' in 16' measured longitudinally shall be corrected by loosening, adding or removing the material, reshaping, moisture conditioning, and re-compacting. Deviations in excess of this tolerance shall be corrected by the Contractor, at the Contractor's expense, in a manner satisfactory to the Project Manager.
20.06.8 Compaction  All material in embankments shall be compacted to the specified relative compaction. The moisture content of the soil at the time of compaction shall be as specified.

Within the areas indicated on the plans and to the designated depth below subgrade, for the full width of roadway in all cut sections, earth shall be thoroughly scarified and the moisture content increased or reduced, as necessary, to bring the moisture to the content specified. This scarified layer shall then be compacted to the relative compaction specified. The remainder of the area up to subgrade elevation shall be constructed of suitable material placed at the moisture content specified and compacted to the percent relative compaction specified. Maximum dry density of all soil types encountered or to be used will be determined in accordance with AASHTO T99 or AASHTO T180. The percent of relative compaction and moisture content shall be as shown in the following table for the various classes of soil and type of compaction.

Table 20.06.8
COMPACTION AND MOISTURE FOR VARIOUS SOIL TYPES

<table>
<thead>
<tr>
<th>Soil Classification (AASHTO M 145)</th>
<th>AASHTO T99 Minimum Relative Compaction (Percent)</th>
<th>AASHTO T180 Minimum Relative Compaction (Percent)</th>
<th>Moisture % of Optimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-6 &amp; A-7</td>
<td>95</td>
<td>--</td>
<td>0, +2</td>
</tr>
<tr>
<td>A-1 through A-5</td>
<td>--</td>
<td>95</td>
<td>-2, +2</td>
</tr>
</tbody>
</table>

Base or subbase shall not be placed upon the subgrade or any previously-placed layer of the pavement section until compaction tests are taken and approved by the Project Manager. Testing shall include, but not be limited to, trenches for water, sanitary, storm, telephone, gas, electric, and around manholes, valve boxes, and inlets. If the subgrade or base does not have the specified density and moisture content at the time of placing the next pavement layer, the Project Manager shall require scarifying, wetting or drying, and re-rolling. If the specified compaction cannot be obtained, a new pavement design shall be determined and approved by the City Engineer. The compaction requirements of this section shall apply under curb and sidewalk.

If more than 24 hours has elapsed between the time compaction tests are taken and the time the next layer in the pavement section is placed, the area shall be retested.
Additional testing will not be required if a prime coat is applied within the 24-hour period, provided the prime coat is in good condition and not over two weeks old.

Compaction tests shall be taken under the direct supervision of a Geotechnical Engineer. The Geotechnical Engineer shall take sufficient compaction tests to assure himself that the street is ready for surfacing, as the case may be, and shall so state on his compaction report. Compaction testing exposed to the elements will only be valid for a 24-hour period without protection from the elements and will require retesting. Compaction reports shall be signed and sealed and dated by the Geotechnical Engineer.

20.06.9 Proof Rolling  Proof rolling with a heavy rubber-tired roller will be required as designated on plans or when ordered. Proof rolling shall be done after specified compaction has been obtained. Areas found to be weak and those areas which fail a proof roll shall be ripped, scarified, wetted or dried if necessary, and re-compacted to the requirements for density and moisture at the Contractor's expense. The proof roller shall be a pneumatic-tired vehicle with tire pressure of at least 100 psi capable of applying ground loads of not less than 18,000 pounds per axle, provided by the Contractor. Complete coverage of the proof roller will be required. Rollers shall be operated between two and six miles per hour.

20.07  Reset Structures, Fences, and Guardrail

20.07.1 General  This item shall consist of removing, relaying, resetting, or adjusting structures, fences, guardrail, signs, pipe, end sections, traffic signals, and related materials. All designated items shall be carefully removed and every precaution taken to avoid damage. Coordinate relocation of permanent traffic devices with the Traffic Division. The Contractor will be required to replace or repair any material damaged due to his operations at his own expense. The work shall include the backfilling of any resulting trenches, holes, or pits.

20.07.2 Construction  Pipe to be relaid and structures to be reset shall be thoroughly cleaned. Removal sites shall be neatly backfilled with suitable material and compacted in accordance with these specifications.

Materials in good condition from removed structures or fences may be used in the rebuilding operations. All removed material not reused shall be salvaged or disposed of as directed by the Project Manager.
Where fences are to be rebuilt or reset, it will be the Contractor's responsibility to supply and install any new materials required to restore the fence to acceptable condition. Unless otherwise stated in the Special Conditions, the Contractor may reuse any existing material that is salvageable. The quality of construction of the reset fence shall equal or exceed that of the existing fence.

Unserviceable material from structures shall be replaced with new material of dimensions similar to those used in building the original structure. Replacement parts and new materials, including concrete footings, necessary to restore these structures to service at new locations, shall be provided and installed by the Contractor as part of this item.

All new materials and replacement parts shall be of similar quality to those used in the original structure or as specified. Gates designated or noted on plans to be reset shall be removed and restored for service at the new locations indicated.

Mailboxes complete with supporting structures are to be removed and temporarily reset at points near their original location to be easily accessible for mail delivery service. Immediately upon completion of surfacing operations, the boxes shall again be reset to a height of 42” to 48” at the locations designated. A supporting structure may contain one or more mailboxes.

Resetting of all traffic control signs and traffic signaling devices will conform to Section 50.00 and be coordinated with the Traffic Services Division.

Adjusting structures shall include, but not be limited to, manhole rings and covers, inlet gratings and frames, water valve boxes, water meters, gate posts, and other structures and facilities. Construction operations shall include any raising, lowering, moving, removing masonry or concrete, adding brickwork, masonry or concrete, and resetting grates, frames or rings and covers to fit the new construction. At no time shall manholes and valve boxes be covered up or buried. Valve boxes and manholes are to be maintained fully accessible at all times for emergency and maintenance operations by City personnel. Work on water services shall be subject to observation and testing by the owners. Damage to any fire hydrant or any part of the system due to Contractor's operations shall be repaired at the Contractor's expense.
20.08 Tracking Mud on City Streets

Pursuant to Sections 138-440 and 138-442 of the Aurora Municipal Code, the Stormwater Permittee shall locate, install, and maintain all erosion control and water quality BMPs as indicated in the approved Erosion and Sediment Control Plan. The Stormwater Permittee shall take appropriate preventive measures to prevent dirt and mud from being tracked or deposited onto paved sections via multiple BMPs. All sediment, mud, and construction debris that may be tracked, deposited, or accumulated on paved sections, in the flowlines, private property, and/or public rights-of-way of the City as a result of the construction project shall be cleaned up. Daily clean up will be required on all paved sections which have mud tracked on them due to construction.

20.09 Measurement and Payment

20.09.1 Clearing and Grubbing Measurement will be by one or more of the following alternate methods as specified in the contract documents: per acre basis or lump sum basis. When the contract document contains a clearing and grubbing item on a lump-sum basis, measurement of the area will not be made. When measurement is specified on a per-acre basis, the work to be paid for will be the number of acres and fractions thereof acceptably cleared and grubbed, including scalping and hedge removal, within the limits shown on the plans or staked by the Project Manager. The contract price per acre or lump sum shall be full compensation for furnishing all labor and equipment necessary to complete the work.

Exclusion When the contract document does not contain an item for clearing and grubbing, the work will not be paid for directly but shall be considered as a subsidiary obligation of the Contractor and the price included in the price of excavation or borrow.

20.09.2 Topsoil Topsoil shall not be measured and paid for separately but shall be considered as a subsidiary obligation of the Contractor and the price included in the price for the excavation or borrow.

20.09.3 Watering Water for wetting shall not be measured and paid for separately but shall be considered as a subsidiary obligation of the Contractor and the price included in the price for excavation or borrow.
Water for landscaping and water used to dilute emulsified asphalt, asphalt rejuvenating agent, or soil sterilant shall not be measured and paid for separately but shall be included in the price for the item being bid.

Water for dust palliative, when included in the contract document, shall be measured by the M Gal. (1,000 gallons) and shall be paid for at the contract price per M Gal. The contract price per M Gal. shall be full compensation for all labor, materials, and equipment necessary for the application of dust palliative.

**Exclusion** When the contract does not contain an item for dust palliative, the work will not be paid for directly but shall be considered as a subsidiary obligation of the Contractor and the price included in the price of excavation, embankment, or borrow.

**20.09.4 Removal of Structure and Obstructions** When the contract stipulates that payment will be made for removal of obstructions on a lump-sum basis, the pay item, *removal of obstructions*, will include all stipulated structures and obstructions encountered within the right-of-way in accordance with the provisions of this section. Where the contract stipulates that payment will be made for the removal of specific items on a unit basis, measurement will be made by the unit stipulated. The accepted quantities will be paid for at the contract unit price for each of the pay items listed below that appear in the contract document. Payment shall be full compensation for removing, hauling, and disposal of such items, excavation, and subsequent backfill. The price shall also include salvage of materials removed, their custody, preservation, storage and disposal when called for in the plans, special provisions, or contract documents.

Payment will be made under:

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Removal of Structures and Obstructions</td>
<td>Lump Sum</td>
</tr>
<tr>
<td>Removal of (specified item)</td>
<td>Each, Linear Feet, Square Yards</td>
</tr>
<tr>
<td>Plug (specified type)</td>
<td>Each</td>
</tr>
</tbody>
</table>

**Exclusion** When the contract does not contain an estimated quantity or lump-sum item for removal or structures and obstructions, the work will not be paid for directly but shall be considered as a subsidiary obligation of the Contractor and the price included in the price of excavation, or borrow.
Sawing concrete or asphalt, when ordered under Section 7.05, shall not be measured or paid for.

The adjustment and/or resetting of water valves, street signs, traffic signs, or mail boxes shall not be measured or paid for directly but shall be considered as a subsidiary obligation of the Contractor and the price included in the price of excavation or borrow.

Backfill shall not be paid for separately but shall be included in the work.

20.09.5 Excavation and Borrow  Measurement of excavation and borrow shall be on a cubic yard basis. Excavations shall be measured in its final position after compaction. All volumes shall be based on neat lines on the cross section.

No allowances shall be made for shrinkage, swell, subsidence due to compaction of the existing ground, or any other losses. The Project Manager will not adjust the earthwork quantities specified in the contract unless a change in the cross section is ordered by the Project Manager. The accepted quantities shall be paid for at the contract price per cubic yard.

The contract price per cubic yard shall include full compensation for all labor, materials, and equipment necessary to complete the work.

Exclusions Separate measurement and payment will not be made for topsoil, compaction, applying water, scarifying, subgrade compaction, or any other operation necessary to complete the work or to achieve specified densities.

Placing and compacting embankment shall not be measured and paid for directly, but the work shall be considered as a subsidiary obligation of the Contractor and the price included in the price of excavation and borrow. Proof rolling, when required, shall not be measured and paid for.

20.09.6 Reset Structures, Fences, and Guardrails  The quantity to be measured when items are reset or adjusted on an "each" basis shall have the actual number of those items restored for service at the new location, completed and accepted.

The quantity to be measured where items are reset or adjusted on a "linear foot" basis shall be the actual number of linear feet of the items completed and accepted, and measured end to end. The quantity to be measured for "re-lay pipe" shall be the
number of linear feet of re-laid pipe measured end to end, in place, competed and accepted.

Resetting of structures, fences, guardrail, signs, and related materials shall include all work necessary to remove the items from their existing location to the new location, and shall include all mounting hardware, footings, and all other work necessary to complete the reset item.

The accepted quantities, measured as provided in the foregoing, will be paid for at the contract price per each or per lineal foot as indicated in the proposal. The contract price shall include full compensation for furnishing all labor, materials, and equipment necessary to complete the work.

**Exclusions**  Concrete footings, if required, will not be paid for separately but shall be included in the work. Adjustment and/or resetting of water valves, mail boxes, etc. shall not be measured or paid for directly but shall be considered as a subsidiary obligation of the Contractor and the price included in the price of excavation or borrow.

Backfill shall not be paid for separately but shall be included in the work.

Except as otherwise indicated on the plans or in the special conditions, collars and connecting devices will not be measured and paid for separately but shall be included in the work.
21.00  STRUCTURE EXCAVATION AND BACKFILL
21.01  GENERAL
21.02  MATERIALS
21.03  CONSTRUCTION
21.04  MEASUREMENT AND PAYMENT
SECTION 21.00 STRUCTURE EXCAVATION AND BACKFILL

21.01 General
This work shall consist of the excavation and disposal of excess material so developed, backfill, and filter material required for the construction of major structures, all in accordance with these specifications and in reasonably close conformity with the lines, grades, and typical cross section shown on the plans or established. All excavation and backfill for structures below the designed slope or subgrade line as shown on the plans shall be included under this item. Unless otherwise specified, structure excavation shall include all pumping, bailing, draining, sheeting, bracing, and incidentals required for proper execution of the work.

21.02 Materials
Structure backfill shall be composed of materials from excavations, borrow pits, or other sources. Type of material shall be COA Type 4 (structural) per Table 23.1 or as specified on the plans. The material installed in place will be tested for acceptance. Filter material shall be as shown on the plans or as designated. The material installed in place will be tested for acceptance.

21.03 Construction

21.03.1 Structure Excavation and Backfill Poor foundation material shall be removed, as directed by the Project Manager, below the normal designated elevation and paid for as structure excavation. Suitable surplus excavated material shall be used in the construction of embankments, and all unsuitable material shall be wasted. Material removed below designed elevation shall be replaced with approved material.

Where rock, hardpan, or other unyielding material is encountered, it shall be removed below the designed grade for a minimum depth of 12". The extra-depth excavation shall be backfilled with approved material.

Backfilling shall consist of placing materials in horizontal, uniform layers brought up uniformly on all sides of the structure. The thickness of each layer of backfill shall not exceed 6" before compacting to the required density. Structure backfill shall be compacted to the density specified in Section 20.06, EARTHWORK, or as shown on the plans.

The excessive use of water during backfilling operations will not be permitted.

Compaction equipment or methods that produce horizontal or vertical earth pressures, which may cause excessive displacement or may damage structures, shall not be used.
Backfill material shall not be deposited against the back of concrete abutments, concrete retaining walls, or the outside walls of cast-in-place concrete structures until the concrete has developed a strength of not less that 2500 pounds per square inch in compression.

Unless otherwise indicated in the plans or directed, all sheeting and bracing used in making structure excavation shall be removed by the Contractor prior to backfilling.

21.03.2 Filter Material Filter material shall be placed behind bridge abutments, wing walls, and retaining walls as shown on the plans. When shown on the plans, wall-drain outlets shall be backed with sacked filter material.

Filter material shall be placed in horizontal layers along with and by the same methods specified for structure backfill.

21.04 Measurement and Payment

Measurement of structural excavation, backfill, and filter material shall be on a cubic-yard basis. Structural excavation shall be measured in its original position. Backfill and filter material shall be measured in its final position after compaction. Unless otherwise indicated on the plans, quantities will be computed to neat line cross sections, 18 inches outside and parallel to the outline of the structure. No allowance shall be made for shrinkage, swell, subsidence due to compaction of the existing ground, or any other losses.

Quantities for backfill and filter material shall be the calculated volume of material lying within the prism shown on the plans, from which will be deducted the volume occupied by the structure. Acceptable quantities of structure excavation, structure backfill, or filter material shall be paid for at the contract price per cubic yard. The contract price per cubic yard shall include full compensation for furnishing all labor, materials, and equipment necessary to complete the work. Compaction, haul, water, and all other work necessary to complete the above items shall not be measured and paid for separately but shall be included in the structural excavation or backfill unit price.

Exclusions When the contract does not contain an item for structure excavation, structure backfill, or filter material, the work will not be paid for directly but shall be considered as a subsidiary obligation of the Contractor.

Structure excavation and structure backfill will not be paid for directly for minor structures such as inlets, manholes, pipes, culverts, headwalls, vaults, etc., but shall be considered as a subsidiary obligation of the Contractor.
22.00 STABILIZED SUBGRADE
22.01 DESCRIPTION
22.02 PURPOSE
22.03 MATERIALS
22.04 EQUIPMENT
22.05 CONSTRUCTION SUBMITTALS
22.06 STABILIZED MIX DESIGN
22.07 PROCESSING MATERIALS
22.08 COMPACTION
22.09 FINISHING AND CURING
22.10 TOLERANCES
22.11 CONFORMITY WITH PLANS AND SPECIFICATIONS
22.12 MEASUREMENT
22.13 TESTING AND INSPECTION
22.14 PAYMENT
22.15 CHEMICAL STABILIZATION
22.16 MECHANICALLY STABILIZED SUBGRADE
SECTION 22.00  STABILIZED SUBGRADE

22.01  Description
This work consists of the Contractor constructing one or more courses of a mixture of subgrade soil, approved stabilizing agent and water in substantial conformity with the design line, grades, thicknesses, and typical cross sections shown on the approved plans and the approved pavement thickness design.

22.02  Purpose
The purpose of the work shall be to provide a structural section on which paving materials can be placed and to meet design specifications, while at the same time, protecting the underlying moisture conditioned subgrade soils.

22.03  Materials

22.03.1  Stabilizing Agents  The pre-approved stabilizing agents are listed in Table 22.03.1 below. Various combinations of these materials may also be used, subject to a suitable mix design. Other agents may be used with prior written approval of the Project Manager. However, in the event that stabilized subgrade is used for the purpose of swell mitigation, either lime or a combination of lime and fly ash should be used as a stabilizing agent. Additional swell mitigation options are outlined in Table 22.13.

<table>
<thead>
<tr>
<th>Agents</th>
<th>Must conform to requirements of</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lime</td>
<td>ASTM C 977, C110</td>
</tr>
<tr>
<td>Fly Ash (C and F)</td>
<td>ASTM C 618</td>
</tr>
<tr>
<td>Cement Kiln Dust</td>
<td>ASTM D 5050</td>
</tr>
<tr>
<td>Portland Cement</td>
<td>ASTM C 114</td>
</tr>
</tbody>
</table>

High-calcium quicklime shall conform to the requirements of ASTM C 977 and rate of slaking test shall produce a temperature rise of 20°C in 30 seconds and 35°C in 3 minutes per ASTM C110. 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 F. Class F fly ash shall only be allowed in conjunction with lime or other stabilizing agents.

All stabilizing agents shall come from the same source as used in the design. If the source is changed, a new design must be submitted for the Project Manager's approval. Each lot of stabilizing agent furnished shall have the supplier's certificate of compliance.

### 22.03.2 Water

Water used for mixing or curing shall be from a potable source. Non-potable water shall be tested in accordance with and meet the requirements of AASHTO T 26.

### 22.03.3 Subgrade

The subgrade to be stabilized shall be free of roots, sod, weeds, wood, construction debris, ice, snow, or other frozen materials, deleterious matter, and stones larger than 3 inches. Material in the stabilized zone shall have a soluble sulfate content of less than 0.2 percent. If the subgrade soils have a soluble sulfate content exceeding 0.2 percent, the mix design shall be addressed to the specific methodology used to prevent adverse sulfate reactions.

### 22.03.4 Sealant

Emulsified asphalt is the only pre-approved sealant; no other sealant may be utilized without prior written approval of the Project Manager. Emulsified asphalt used for a bituminous seal shall conform to requirements in Table 22.03.4 below.

<table>
<thead>
<tr>
<th>Sealant</th>
<th>Type</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emulsified Asphalt</td>
<td>SS-1</td>
<td>ASTM D 977</td>
</tr>
<tr>
<td>Emulsified Asphalt</td>
<td>SS-1h</td>
<td>ASTM D 977</td>
</tr>
<tr>
<td>Emulsified Asphalt</td>
<td>CSS-1</td>
<td>ASTM D 2397</td>
</tr>
<tr>
<td>Emulsified Asphalt</td>
<td>CSS-1h</td>
<td>ASTM D 2397</td>
</tr>
</tbody>
</table>

### 22.04 Equipment

All equipment shall be subject to approval by the Project Manager. All equipment and machinery shall be kept in good working order, free of leaks and properly muffled.

#### 22.04.1 Dry Application Equipment

Equipment for spreading dry stabilizing agent shall be of an approved screw-type spreader box, mixer, or other semi enclosed equipment which is equipped with a metering device. Spreading of stabilizing agents by aggregate spreaders or motor-graders will not be allowed.
22.04.2 Slurry Application Equipment  A distributor or truck applicator shall be used and be capable of continuous agitation to keep the slurry mixture uniform. The applicator shall be capable of uniformly metering the stabilizing agent during application.

22.04.3 Mixing Equipment  Mixing equipment shall be of sufficient size to adequately mix the stabilizing agent into the soil and to pulverize the mixture according to the requirements of 22.07. The size of the mixer shall be adequate to mix and pulverize the mixture to a minimum depth of 12 inches in a single pass. Blades, discs, and similar equipment are not allowed without prior written approval of the Project Manager.

22.04.4 Compaction Equipment  Compaction equipment shall be in good working order and of sufficient size and effective force to achieve the required compactive effort as prescribed in 22.08.

22.05 Construction Submittals

At least 15 days prior to commencing stabilization work, the Contractor shall furnish the following information to the Project Manager:

1. The source and supplier of stabilizing agent and certifications, including purity of stabilizing agent, from the manufacturer's testing Project Manager indicating that the stabilizing agent meets the appropriate requirements.
2. Description of the proposed construction equipment, construction methods, expected production rates and planned sequence of construction.
3. A mix design giving the percentage of stabilizing agent, source of the agent, properties and any special considerations.

For each day's work, the Contractor shall furnish the following information to Project Manager by the following day:

A. Certified truck weight tickets of stabilizing agent, delivered or used at the site.
B. A summary of the amount of stabilizing agent used each day, areas stabilized and first mixed, areas second mixed and compacted, and areas with curing completed.

22.06 Stabilized Mix Design

Mix designs shall be performed under the supervision of and signed by a Professional Engineer registered in the State of Colorado. Laboratory agencies shall meet the requirements of ASTM, D 3740, ASTM D 3666, D 1077, and ASTM E 329 where applicable.
Mix design shall comply with the following requirements in Table 22.06 below:

Table 22.06
STABILIZATION MIX DESIGN REQUIREMENTS

<table>
<thead>
<tr>
<th>Stabilization Agent</th>
<th>Minimum pH</th>
<th>Maximum Plasticity Index (%)</th>
<th>Maximum Swell Potential (%)</th>
<th>Minimum Unconfined Compressive Strength (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lime</td>
<td>12.3</td>
<td>10</td>
<td>1.0</td>
<td>160</td>
</tr>
<tr>
<td>Fly Ash</td>
<td>N/A</td>
<td>10</td>
<td>1.0</td>
<td>160</td>
</tr>
<tr>
<td>Cement Kiln Dust</td>
<td>N/A</td>
<td>10</td>
<td>1.0</td>
<td>160</td>
</tr>
<tr>
<td>Portland Cement</td>
<td>N/A</td>
<td>10</td>
<td>1.0</td>
<td>160</td>
</tr>
<tr>
<td>Lime-Fly Ash</td>
<td>12.3</td>
<td>10</td>
<td>1.0</td>
<td>160</td>
</tr>
</tbody>
</table>

Note:
1. When lime is used, the pH should be no less than 12.3 as measured after completion of initial mixing with stabilizing agent and at ambient temperature.
2. Testing of pH is to be done in accordance with Eades-Grim pH test method (ASTM C 977 APPENDIX).
3. Plasticity Index is to be less than 10, per AASHTO T 89 and T 90 unless a greater value is acceptable by the ENGINEER. When lime is used, the Plasticity Index shall be reported from the initial to final construction to all interested parties and shall not be used for acceptance purposes.
4. Swell Potential to be less than 1.0 percent at 200 psi, ASTM D 4546, after treatment.
5. Minimum of 160 psi (M_r > 34,800 psi, where M_r = 10,000+124q_U) in five (5) days of moist curing at 100°F (38°C). Testing in accordance with ASTM D 1633 Method A for pozzolanic agents and ASTM D 5102 Procedure B for Hydrated Lime.
6. The design stabilizing agent percentage shall be increased by 0.5 percent to account for waste, inert materials, and construction variability.

22.07 Processing Materials

It is the primary requirement of this specification to secure a completed subgrade structural section containing a uniform stabilized mixture. The mixture is to have a uniform density and moisture content, free from loose or segregated areas, well bound for its full depth, well cured, and with a surface suitable for placing subsequent courses.

It shall be the responsibility of the Contractor to regulate the sequence of his work, to use the proper amount of stabilizing agent, maintain the work, and rework the courses, as necessary, to meet the requirements.

22.07.1 Application   The subgrade shall not be treated when the ambient air temperature falls below freezing or the subgrade material is below 40°F, or when weather predictions suggest that subgrade material temperature may fall below 40°F within 24 hours, unless prior written approval of the Project Manager has been issued. Prior to beginning any treatment, the subgrade shall also be constructed and finished to a smooth and uniform surface that is in conformity to the grade and typical section specified. Variation from the subgrade plan elevation specified shall not be more than ± 0.08 ft. The in-place density shall be at least 95% of maximum
Stabilized Subgrade

dry density as determined by ASTM D 698, Standard Proctor Density, and within 0 to 3% of optimum moisture content.

Stabilizing agent shall be applied at the minimum rate specified by the mix design for the depth of stabilized subgrade shown on the plans. The rate shall be determined from a design using the on-site soils and shall meet the requirements found in 22.06. Rate of application shall be verified using area/quantity calculations or testing of stabilized subgrade. Stabilizing agent shall be spread only on that area where the first mixing operations can be completed during the same working day. Lime slurry shall not be left exposed to the air for more than four hours without initial mixing.

The Project Manager or Geotech reserves the right to require variation of the rate of application of stabilizing agent from the mix design application rates during the progress of construction as necessary to maintain the desired characteristics of the stabilized subgrade.

Stabilizing agent shall be applied using the following methods:

22.07.1.01 Slurry Placement  The distribution of stabilizing agent shall be attained by successive applications over a measured section of subgrade until the proper amount of agent has been spread. The amount spread shall be the amount required for mixing to the specified depth, which will result in the percentage determined in the design. When quicklime is used in place of hydrated lime the amount of quicklime used will be determined by the certified lime purity for each load supplied as follows:

Quicklime delivered X % purity * 1.32 = A

Quicklime delivered *X % inert material = B

A + B = total hydrated lime available

22.07.1.02 Dry Placement (used for Fly Ash, cement kiln dust, and Portland cement)

The amount of stabilizing agent spread shall be the amount required for mixing to the specified depth, which will result in the percentage specified by the design.

The stabilizing agent shall be distributed in such a manner that scattering by wind will be minimal. Agents shall not be applied when wind conditions, in
the opinion of the Project Manager, are detrimental to a proper application. The blended material shall be sprinkled or watered until moisture content is as specified in subgrade stabilization design.

After spreading of stabilizing agent and during mixing, water shall be added to hydrate the agent and to reduce dusting. The combination of stabilizing agent, soil and water shall be called the mixture.

**22.07.1.03 High Sulfate Treatment** Where sulfates are over 0.2 percent the Geotech must address the method of treatment.

Note: When a double treatment of lime is required, the first 50 percent of the agent shall be placed, moisture treated and allowed to mellow or cure for up to three weeks, as determined by the Geotech. The last half of the lime shall then be applied.

**22.07.2 Mixing** No stabilization shall take place when precipitation may cause damage to the subgrade, as determined by the Project Manager. Mixing shall be continuous. The full depth of the treated subgrade material shall be mixed with an approved mixing machine to the specified depth below the bottom of the pavement structure and/or curb. The mixing machine shall make a sufficient number of passes to adequately achieve 100 percent of the material passing the one-inch sieve and 60 percent passing the 1/4-inch sieve. Water shall be added to the subgrade during mixing to provide a moisture content of at least 3 percent above the optimum moisture of the mixture or as specified in subgrade stabilization design.

Mixing and remixing will be performed, as necessary, to assist the stabilizing agent-soil reaction and produce a homogeneous mixture. Mixing and remixing shall continue until the combination of stabilizing agent and subgrade material is free of streaks or pockets of stabilizing agent.

**22.07.3 Mellowing (Lime or Lime/Fly Ash Only)** The water content of the subgrade mixture shall be maintained at a moisture content above the optimum moisture content for a minimum of two days and until the PI meets the required subgrade stabilization design criteria. Remixing will be done as necessary to assist the reaction, as determined by the Project Manager. Application of moisture shall be performed as necessary during the mellowing period; the material shall maintain a moisture content of at least 3 percent above the optimum moisture content. The stabilized material shall not be subjected to traffic. If during the mellowing period
the material is not in a semi-loose state, the chemical reaction process may slow down and, therefore, require additional time and/or mixing as determined by the Project Manager or Geotech.

22.07.4 Final Mixing (Lime or Lime/Fly Ash Only)  Final mixing of the treated subgrade shall not occur if the temperature of the soil to be stabilized is below 40°F. The treated subgrade shall be maintained at a temperature of 40°F or above until the treated material has been compacted.

The material shall be uniformly mixed by an approved method to meet the following requirements when tested dry by laboratory sieves:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Minimum Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-inch sieve</td>
<td>100</td>
</tr>
<tr>
<td>No. 4 sieve</td>
<td>60</td>
</tr>
</tbody>
</table>

22.08 Compaction

Compaction of the mixture, for the full depth of the stabilized subgrade shown on the plans, shall begin as soon as practical after final mixing. Stabilized subgrade with cementitious stabilization agent shall be completed within 90 minutes of the time cementitious stabilization agent or 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 subgrade stabilization 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 mixture shall be between 0 to 3 percent above the optimum moisture content. The optimum moisture content shall be determined in accordance with ASTM D 698 or ASTM D 558, as specified in subgrade stabilization design.

Initial compaction shall be done 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 Geotech or Project Manager.

All irregularities, depressions, or weak spots which develop, as determined by the Project Manager, shall be corrected immediately by scarifying the areas affected, adding or removing
materials as required, and reshaping and recompacting by moisture conditioning and rolling. Adding additional stabilized material to an initial cured section, resulting in lamination and potential slip plane, is not allowed. The surface of the course shall be maintained in a smooth condition, free from undulations and ruts, until other work is placed thereon or the work is accepted. Should the material, due to any reason or cause, lose the required stability, density, and finish before the next course or pavement is placed, it shall be corrected and refinished at the sole expense of the Contractor, as directed by the ENGINEER.

22.09 Finishing and Curing

After the final layer of stabilized subgrade has been compacted, the shape of the surface shall be maintained by blading. The surface shall be smooth and conform to the required lines, sections, and grades, in accordance with the plans and thoroughly cured, or to within a minimum of 0.1 foot above the finished subgrade elevation to allow for trimming to final grade prior to placement of surface coarse. The completed section shall then be finished by rolling with suitable pneumatic tired equipment with sufficiently light effort to prevent hairline cracking.

Curing may be accomplished by periodic water application to maintain moisture content preventing sloughing or cracking in the surface of the stabilized subgrade to a depth no greater than 0.1 foot, or by the utilization of a bituminous seal. When bituminous seal (Section 22.02.4) is utilized, the minimum application will be at the rate of 0.12 gallons per square yard, as directed by the Geotech and approved by the Project Manager.

The completed section shall be maintained at a temperature of 40°F or above until the treated material has been cured for a minimum of five days before further courses are added or any traffic is permitted, unless otherwise permitted by the Project Manager. The moisture cured duration may be reduced if a non-yielding surface is obtained to support construction traffic and either the next layer of stabilized soils are placed or the pavement layer is constructed, as approved by the Project Manager.

If the surface of the finished layer is above the approved plan elevation tolerance specified in this section, the excess material shall be trimmed, removed, and disposed of. Any low areas will be replaced with the subsequent surface courses. No loose material shall be left in place after trimming. After trimming the stabilized subgrade surface shall be rolled again with a steel wheel or pneumatic tired roller to seal the surface.

22.10 Tolerances

22.10.1 Thickness Stabilized zone thickness shall be verified by the use of phenolphthalein and shall be performed at intervals of approximately every 500 feet.
in each lane. When the measurement of the thickness is deficient by more than 1 inch from the plan thickness, two additional locations shall be measured randomly within the deficient area and used in determining the average thickness. When the average thickness is deficient by more than 1 inch, the entire area shall be reprocessed to meet the design parameters or the roadway design section must be re-evaluated (Section 22.11).

22.10.2 Grade  Prior to placement of surface course, any deviation in excess of 1/2 inch in cross-section and 1/2 inch in 10 feet measured longitudinally shall be corrected. Variations in excess of this tolerance shall be corrected by the Contractor, at the Contractor's expense, in a manner satisfactory to the Project Manager. Thickness requirements shall be met in areas corrected for grade.

22.10.3 Strength  The stabilized subgrade must develop a laboratory compressive strength of at least 160 psi at 5 days. Samples shall be molded from stabilized soil within 1.5 hours of final mixing with the material compacted per ASTM D 558 or ASTM D 698, as specified in subgrade stabilization design, at the field moisture content.

22.10.4 Stabilizing Agent Percentage  The percentage of stabilizing agent placed in the mixture shall be determined by the appropriate AASHTO chemical determination and/or by calculation of stabilizing agent used for the volume of subgrade material stabilized. When the test result is deficient by more than 1 percent, the entire area shall be re-treated at the Contractor's expense.

22.11 Conformity with Plans and Specifications

When thickness and/or strength criteria fail to meet design parameters, even after all possible attempts have been made to correct said deviations, remediation will be required as listed in Table 22.11. Evaluation of the roadway pavement section will be made by the Geotech with written approval of Project Manager. The pavement structural section shall be adjusted to compensate for any deficiency in the stabilized subgrade thickness and strength, at the Contractor's expense. Placement of subsequent surface course will not occur until the stabilized subgrade has been accepted in writing by both the Geotech and the Project Manager.
Table 22.11

<table>
<thead>
<tr>
<th>Deficiency</th>
<th>Remediation</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 25% of design thickness</td>
<td>Evaluate Roadway design section</td>
</tr>
<tr>
<td>&gt; 25% of design thickness</td>
<td>remove and replace</td>
</tr>
<tr>
<td>&lt; 25% of required strength</td>
<td>Evaluate Roadway design section</td>
</tr>
<tr>
<td>&gt; 25% of required strength</td>
<td>remove and replace</td>
</tr>
</tbody>
</table>

22.12 Measurement

22.12.1 The area of stabilized subgrade shall be measured by the plan quantities completed, in place, and accepted. No separate measurement of depth or area, except as required for thickness testing shall be performed.

22.12.2 The quantity of stabilizing agent accepted and used shall be measured by the ton of fly ash, Portland cement, cement kiln dust, or hydrated lime used (or the calculated dry hydrated lime content of the lime slurry).
22.13 Testing and Inspection

Testing and inspection shall be performed in accordance with Table 22.13

**TABLE 22.13**

SCHEDULE FOR MINIMUM MATERIALS SAMPLING AND TESTING

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Test Standard</th>
<th>Minimum Frequency of Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling</td>
<td>AASHTO T 87</td>
<td>per 1,000 square yards</td>
</tr>
<tr>
<td>Sample Preparation</td>
<td>ASTM D 3551</td>
<td></td>
</tr>
<tr>
<td>Maximum Dry Density and</td>
<td>ASTM D 698 (Lime)</td>
<td>As directed by Project Manager (minimum one per soil type)</td>
</tr>
<tr>
<td>Optimum Moisture Content</td>
<td>ASTM D 558 (Cement)</td>
<td></td>
</tr>
<tr>
<td>In Place Soil Density</td>
<td>ASTM D 1556 ASTM D 2167 ASTM D 2922</td>
<td>One test for each 200 lane feet</td>
</tr>
<tr>
<td>In Place Moisture Content</td>
<td>ASTM D 2216 ASTM D 3017</td>
<td>(not less than one test per day)</td>
</tr>
<tr>
<td>PH</td>
<td>ASTM C 110 ASTM C 977 APPENDIX</td>
<td>One test per 1,000 square yards</td>
</tr>
<tr>
<td>Swell</td>
<td>ASTM D 4546 Method B</td>
<td>As directed by Project Manager</td>
</tr>
<tr>
<td>Unconfined Compressive</td>
<td>ASTM D 5102 (Procedure B)</td>
<td>One set of four cylinders per 1,000 square yards. Sealed and moist cured at 100°F for 5 days.</td>
</tr>
<tr>
<td>Strength (Lime)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compressive Strength</td>
<td>ASTM D 1633 (Method A)</td>
<td>One set of four cylinders per 1,000 square yards. Sealed and moist cured at 100°F for 5 days.</td>
</tr>
<tr>
<td>Cementitious Agents</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atterberg Limits</td>
<td>AASHTO T 89 &amp; T 90</td>
<td>One test per 1,000 square yards</td>
</tr>
<tr>
<td>Thickness</td>
<td>As directed by Project Manager</td>
<td>One test every 500 feet per lane</td>
</tr>
<tr>
<td>Percentage of Agent</td>
<td>AASHTO T 232 see Section 22.10.4</td>
<td>One test per 1,000 square yards</td>
</tr>
</tbody>
</table>

22.14 Payment

Payment shall be made at the contract unit price per square yard based upon plan quantities for the stabilization. Stabilizing agent shall be paid for by the ton. The price shall be full compensation for furnishing all material and for all preparation of the subgrade material removed and replaced, proof rolling of secondary grade, delivering, placing, mixing, and compacting these materials, all labor, equipment, tools, and incidentals necessary to complete this item, including curing. Stabilized subgrade found deficient in thickness shall be removed and
replaced. Or at the option of the Project Manager, the pavement structural section shall be adjusted to compensate for any deficiency in the stabilized subgrade thickness and strength at the Contractor's expense as noted in Section 22.11.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Payment</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.1</td>
<td>Processing of Stabilized Subgrade</td>
<td>$/yd²</td>
</tr>
<tr>
<td>22.2</td>
<td>Stabilizing agent</td>
<td>$ / Ton</td>
</tr>
</tbody>
</table>

### 22.15 Chemical Stabilization

Chemical stabilization shall not be used to eliminate or control frost.
<table>
<thead>
<tr>
<th>Swell Mitigation for Soils Greater Than 5%</th>
<th>Over-excavation &amp; Replacement with Non-Expansive Soils</th>
<th>12&quot; Treated Subgrade Composite Section (&quot;d&quot;)</th>
<th>12&quot; Treated Subgrade Composite Section (&quot;d&quot;)</th>
<th>Type 2 or 2A Aggregate Base Course (ABC) Composite Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mitigation Details</td>
<td>Replacement with any A-2 to A-6 soil group with less than 2% swell, LL &lt; 30, PI &lt; 15, ( M_r &gt; 5000 ) or R-Value &gt; 30 or ( q_U &gt; 3000 ) psf.</td>
<td>Report includes treated (lime, lime/fly ash) subgrade as part of the pavement section design. Where the treated material has a compressive strength &gt; 160 psi, pH &gt; 12.3, PI &gt; 10, and a swell percentage &lt; 1.0</td>
<td>Report does NOT include treated (lime, lime/fly ash) subgrade as part of the pavement section design. Not to be considered as part of pavement structure. However, PI &lt;= 10 and swell &lt;= 1.0% is still required.</td>
<td>All sections are designed for ORIGINAL soil conditions and include a 12&quot; ABC section for mitigation (&quot;a&quot;), except locals; see below. Requires minimum 12&quot; depth subgrade moisture treatment and compaction (below ABC) of a minimum 12&quot;. Requires the use of a geo-fabric between native material and ABC</td>
</tr>
<tr>
<td>Pavement Section</td>
<td>Use full-depth or composite section designed for select fill soil conditions.</td>
<td>Composite section, consisting of HMAP and treated subgrade soil, designed for original soil conditions, including a HMAP section, which shall be a minimum: [ \text{ESAL}(10^6) &gt; 1.8 ] ( 0.5 \text{-} 1.8 ) ( 6\text{-}1/2&quot; ) ( &lt; 0.5 ) ( 4&quot; )</td>
<td>Full depth section designed for ORIGINAL soil conditions.</td>
<td>Minimum requirements All Locals 4&quot; HMAP and 15&quot; ABC or, 5&quot; HMAP and 12&quot; ABC. Collectors 6&quot; HMAP and 12&quot; ABC section per original soil conditions. Arterial 7&quot; HMAP and 12&quot; ABC section per original soil conditions.</td>
</tr>
<tr>
<td>Trench Drains (&quot;b,&quot; &quot;c&quot;)</td>
<td>Required if imported soils are more permeable than existing soil by one order of magnitude or more and mitigation measure does not extend to back of sidewalk, curb and gutter section.</td>
<td>Required if mitigation measure does not extend to back of sidewalk, curb and gutter section.</td>
<td>Required if mitigation measure does not extend to back of sidewalk, curb and gutter section.</td>
<td>Required.</td>
</tr>
</tbody>
</table>

"a" – The pavement design must incorporate the minimum sections defined in the "Pavement Section" above. If desired, substitutions of 3" ABC for 1" HMAP may be done for sections exceeding the minimum depths defined above. 
"b" – Trench drains are required parallel to all arterials and collectors, unless the road is certified by a Geotechnical Engineer to be free of failure potential from swelling soils and landscape irrigation. 
"c" – Do not install trench drains if curb and gutter are not tied to the roadway, i.e., shoulders with roadside ditches. 
"d" – Treated subgrade shall be constructed only when soil temperature is > 40°F and ambient temperature is > 40°F. 

Moisture treatment per Section 5.03 is required.
22.16 MECHANICALLY STABILIZED SUBGRADE

22.16.1 DESCRIPTION Item includes mechanically stabilized subgrade of base/subbase course and/or subgrade improvement in the construction of paved or unpaved roadways. Design details for geogrid reinforcement, such as geogrid type, fill thickness, pavement cross-section and associated details, shall be as shown on the contract drawings. The work consists of:

22.16.1.1 Purpose The purpose of the work shall be to provide a stabilized paving platform section on which paving materials can be placed. This item shall not be used to retain moisture in the subgrade, unless retaining moisture in the section can be assured. This specification shall be used for a construction platform and not as a means of mitigating swell.

22.16.2 MATERIALS

22.16.2.1 Definitions

A. Mechanically Reinforced – Placement of a geogrid immediately over a soft subgrade soil in order to improve the bearing capacity and mitigate deformation of the subgrade soil. The goal of this application may be to reduce deeper excavation requirements, improve construction efficiency, reduce the amount of aggregate subbase/base material required, provide a stiff working platform for pavement construction, or a combination of the above.

B. Geogrid – A biaxial polymeric grid formed by a regular network of integrally connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock, or earth to function primarily as reinforcement.

C. Multi-Layer Geogrid – A geogrid product consisting of multiple layers of grid which are not integrally connected throughout.

D. Extruded Geogrid – A geogrid product formed by extrusion of a polypropylene or polypropylene/polyethylene copolymer sheet followed by its perforation with a precise arrangement of holes and subsequent stretching, or drawing, into the finished product.

E. Woven Geogrid – A geogrid product formed by weaving discrete strips of polymer into a network. These geogrids usually require a protective coating to protect the polymer from pre-mature degradation.

F. Minimum Average Roll Value (MARV) – Value based on testing and determined in accordance with ASTM D4759-92.

G. True Initial Modulus in Use – The ratio of tensile strength to corresponding zero strain. The tensile strength is measured via ASTM D6637 at a strain rate of 10 percent per minute. Values shown are MARVs. For multi-layer geogrid products, rib tensile
testing shall be performed on the multi-layer configurations, as prescribed by ASTM D6637.

H. Junction Strength – Breaking tensile strength of junctions when tested in accordance with GRI-GG2 as modified by AASHTO Standard Specification for Highway Bridges, 1997 Interim, using a single rib having the greater of three junctions or a minimum of eight-inch machine direction sample and tested at a strain rate of ten percent per minute based on this gauge length. Values shown are MARVs. For multi-layer geogrid products, junction strength testing shall be performed across junctions from each layer of grid individually, and the results shall not be assumed as additive from single layers to multiple layers.

I. Flexural Stiffness (also known as Flexural Rigidity) – Resistance to bending force measured via ASTM D1388-96, Option A, using specimen dimensions of 864 millimeters in length by one aperture in width. Values shown are MARVs. For multi-layer geogrid products, flexural stiffness testing shall be performed directly on the multi-layer configuration without using any connecting elements other than those used continuously throughout the actual product. The results shall not be assumed as additive from testing performed on a single layer of the multi-layer product.

J. Aperture Stability Modulus (also known as Torsional Rigidity or Torsional Stiffness) – Resistance to in-plane rotational movement measured by applying a 20 kg-cm (2.0 m-N) moment to the central junction of a 9-inch by 9-inch specimen restrained at its perimeter. Values shown are MARVs. For multi-layer geogrid products, torsional stiffness testing shall be performed on each layer of grid individually and results shall not be assumed as additive from single layers to multiple layers.

K. Granular Fill Material – The preferred gradation for base reinforcement application is well-graded crushed aggregate fill with a maximum particle size (100 percent passing) of 1-1/2 inches and less than ten percent fines (passing the #200 sieve). Recycled concrete may be used only with polypropylene geogrids in accordance with FHWA 2001.

22.16.3 MANUFACTURERS All manufacturers will be considered provided they meet the submittal process as per Item 22.16.6 and per Table 22.16.4.

22.16.4 GEOGRID MATERIAL PROPERTIES Structural Soil Reinforcement Geogrid – The geogrid shall be integrally formed and deployed as a single layer having the following characteristics according to Table 22.16.4 (ALL VALUES ARE MINIMUM AVERAGE ROLL VALUES UNLESS A RANGE OR CHARACTERISTIC IS INDICATED):
### TABLE 22.16.4 – GEOGRID STRUCTURAL PROPERTIES

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Units</th>
<th>Type 1</th>
<th>Type 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aperture Stability Modulus at 20 cm-kg</td>
<td>Kinney (2001)</td>
<td>m-N/deg</td>
<td>0.32</td>
<td>0.65</td>
</tr>
<tr>
<td>(2.0 m-N)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rib Shape</td>
<td>Observation</td>
<td>N/A</td>
<td>Rectangular or Square</td>
<td>Rectangular or Square</td>
</tr>
<tr>
<td>Rib Thickness</td>
<td>Callipered</td>
<td>In</td>
<td>0.03</td>
<td>0.05</td>
</tr>
<tr>
<td>Nominal Aperture Size</td>
<td>L.D. Callipered</td>
<td>In</td>
<td>1.0 to 1.5</td>
<td>1.0 to 1.5</td>
</tr>
<tr>
<td>Junction Strength</td>
<td>GRI-GG2-2000 (^1)</td>
<td>ratio</td>
<td>NOTE 1</td>
<td>NOTE 1</td>
</tr>
<tr>
<td>Flexural Rigidity</td>
<td>ASTM D1388-96 (^2)</td>
<td>Mg-cm</td>
<td>250,000</td>
<td>750,000</td>
</tr>
<tr>
<td>Minimum Tensile Strength @ 2% Strain:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- MD(^3)</td>
<td>ASTM D6637-01 (^4)</td>
<td>Lb/ft</td>
<td>280</td>
<td>410</td>
</tr>
<tr>
<td>- CMD(^3)</td>
<td></td>
<td>Lb/ft</td>
<td>450</td>
<td>620</td>
</tr>
<tr>
<td>Minimum Tensile Strength @ 5% Strain:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- MD(^3)</td>
<td>ASTM D6637-01 (^4)</td>
<td>Lb/ft</td>
<td>580</td>
<td>810</td>
</tr>
<tr>
<td>- CMD(^3)</td>
<td></td>
<td>Lb/ft</td>
<td>920</td>
<td>1,340</td>
</tr>
</tbody>
</table>

A. **NOTES:**

B. 1. The ratio of Junction Strength/Ultimate Tensile Strength must meet or exceed 75%.

C. 2. Resistance to bending force measured via ASTM D-5732-95, using specimens of width two ribs wide, with transverse ribs cut flush with exterior edges of longitudinal ribs (as a “ladder”), and of length sufficiently long to enable measurement of the overhang dimension.

D. 3. MD = machine direction (along roll length); CMD = cross-machine direction (across roll width).

E. 4. True resistance to elongation when initially subjected to a load determined in accordance with ASTM D6637 without deforming test materials under load before measuring such resistance or employing “secant” or “offset” tangent methods of measurement so as to overstate tensile properties.

Geotextile materials shall not be considered as an alternative to geogrid materials for subgrade improvement or base/subbase reinforcement applications. A geotextile may be used in the cross-section to provide separation, filtration or drainage. However, no structural contribution shall be attributed to the geotextile.
22.16.5 EXECUTION

22.16.5.1 Examination  The Contractor shall check the geogrid upon delivery to verify the proper material has been received. The geogrid shall be inspected by the Contractor to be free of flaws or damage occurring during manufacturing, shipping, or handling.

22.16.6 DELIVERY, STORAGE, AND HANDLING

22.16.6.1 Storage and Protection

22.16.6.1.1 Prevent excessive mud, wet concrete, epoxy, or other deleterious materials from coming in contact with and affixing to the geogrid materials.

22.16.6.1.2 Store at temperatures above minus 20 degrees F (minus 29 degrees C).

22.16.6.1.3 Rolled materials may be laid flat or stood on end.

22.16.6.1.4 Geogrid materials should not be left directly exposed to sunlight for a period longer than the period recommended by the manufacturer (as per ASTMD D4355).

22.16.6.2 Preparation  The subgrade soil elevation shall be prepared at the proper elevation and alignment as directed by the Engineer or as indicated on the construction drawings.

22.16.6.3 Installation

22.16.6.3.1 The geogrid shall be installed in accordance with the installation guidelines provided by the manufacturer or as directed by the Engineer.

22.16.6.3.2 The geogrid may be temporarily secured in place with ties, staples, pins, sand bags, or backfill as required by fill properties, fill placement procedures, or weather conditions, or as directed by the Engineer.

22.16.6.4 Granular Fill

22.16.6.4.1 Compaction – Standard compaction methods may be used unless the soils are very soft. In these cases, static, instead of vibratory compaction, is prudent, particularly over silty subgrades. Compaction is then achieved using a light roller. Keeping fill moisture content near optimum will make compaction more efficient. Water spray is most effective with sand fill. Compact aggregate fill to project specifications, after it has been graded smooth and before it is subject to accumulated traffic.
22.16.6.2 Vehicle Operation Over Geogrids – A minimum loose fill thickness of six-inches is required prior to operation of tracked vehicles over the geogrid. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the fill and damaging the geogrid. When underlying substrate is trafficable with minimal rutting, rubber-tired equipment may pass over the geogrid reinforcement at slow speeds (less than 10 mph) when integrally-formed geogrids are used. This shall not be allowed with coated geogrids and sharp turning movements shall be avoided.

22.16.6.5 Inspection

22.16.6.5.1 The Project Manager or Project Manager’s representative may randomly inspect geogrid before, during, and after (using test pits) installation.

22.16.6.5.2 Any damaged or defective geogrid (i.e., frayed coating, separated junctions, separated layers, tears, etc) will be repaired/replaced in accordance with Item 22.16.6.6.

22.16.6.6 Repairs

22.16.6.1 Any roll of geogrid damaged before, during, and after installation shall be replaced by the CONTRACTOR at no additional cost to the Project.

22.16.6.2 Proper replacement shall consist of replacing the affected area adding three-feet (one-meter) of geogrid to either side of the affected area.

22.16.7 SUBMITTALS

22.16.7.1 Submittal Procedure – 15 days prior to bid letting

22.16.7.1.1 Submit geogrid product sample approximately four-inches by seven-inches, or larger, three days prior to installation.

22.16.7.1.2 Submit geogrid product data sheet, certification, and/or independent full scale laboratory testing from the manufacturer indicating the geogrid product supplied meets the requirements of Table 22.16.4.

22.16.7.1.3 Submit manufacturer’s installation instructions and general recommendations.

22.16.7.1.4 A list of five comparable projects that are similar in terms of size and application, within the State of Colorado where the results of using the specific geogrid material can be verified after a minimum of one year of service life.
22.16.7.1.5 Additional information as requested by the Engineer to fully evaluate the product.

22.16.7.2 Quality Assurance  Pre-Construction Conference – Prior to the installation of the geogrid, the Contractor shall arrange a meeting at the site with the geogrid material supplier and, where applicable, the geogrid installer. The Project Manager and the Engineer shall be notified at least three days in advance of the time of the meeting. A representative of the geogrid supplier shall be available on an “as needed” basis during construction.

22.16.8 CONSTRUCTION PLATFORM DESIGN  Construction platform design shall be performed under supervision of and signed and sealed by a professional geotechnical engineer licensed in the State of Colorado. The recommended procedure shall be derived by the Giroud-Han Method (ASCE, August 2004).

Appropriate partial safety factors shall be applied to results obtained using geogrids having properties or characteristics outside the range of rigorous model validation (Giroud and Han, 2004). This method has been endorsed by numerous departments of transportation and government agencies, such as the Federal Highway Administration and the Army Corps of Engineers.

For general guidance purposes only, Table 16.7.8.1 and 22.16.8.2 present a guide for estimating subgrade soil strength and minimum construction platform recommendations based on a range of subgrade strengths, respectively. A piping ratio analysis ($D_{15}^{\text{fill}}/D_{85}^{\text{subgrade}}$) shall be performed to determine the need of a separation fabric. If the piping ratio is less than five, then no separation fabric is required. If the piping ratio is greater than or equal to five, then a separation fabric is required below the geogrid. Final determination of the construction platform shall be approved by the Engineer.
### TABLE 22.16.8.1
Guide for Estimating Subgrade Soil Strengths (Fine Grained Soils)

<table>
<thead>
<tr>
<th>Estimate Consistency by:</th>
<th>Tested By:</th>
<th>Correlates to:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard Penetration Test (blows/ft)</td>
<td>Dynamic Cone Penetrometer (mm/blow)</td>
</tr>
<tr>
<td></td>
<td>SC, SM, SP</td>
<td>CL</td>
</tr>
<tr>
<td>Very Soft</td>
<td>Man standing sinks &gt; 3”</td>
<td>&lt;2</td>
</tr>
<tr>
<td>Soft</td>
<td>Man walking sinks = 2-3”</td>
<td>2-4</td>
</tr>
<tr>
<td>Medium</td>
<td>Man walking sinks = 1”</td>
<td>4-8</td>
</tr>
<tr>
<td>Stiff</td>
<td>Pickup truck ruts = 1/2-1”</td>
<td>8-15</td>
</tr>
<tr>
<td>Very Stiff</td>
<td>Loaded dump truck ruts = 1-3”</td>
<td>15-30</td>
</tr>
<tr>
<td>Hard</td>
<td>Insignificant rutting by loaded dump truck</td>
<td>&gt;30</td>
</tr>
</tbody>
</table>


### TABLE 22.16.8.2
Recommended Aggregate Fill Thickness
Feel / CBR Value with Geogrid Mechanical Reinforcement

<table>
<thead>
<tr>
<th>Soil Strength</th>
<th>CBR</th>
<th>Type 1 Geogrid</th>
<th>Type 2 Geogrid</th>
<th>Unreinforced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feel</td>
<td>approx.</td>
<td>37”</td>
<td>34”</td>
<td>52”</td>
</tr>
</tbody>
</table>

Notes:
1. Soil Strength is based in Table 22.16.7.1. The soil strength used is general for these purposes.
2. Results of aggregate fill thickness were derived using the published Giroud-Han (2004) Methodology. Average values for fill thickness are used. Aggregate fill was assumed to have a minimum R-value of 30.
3. Type 1 and Type 2 geogrid structural properties used were a minimum as derived from Table 22.16.4
22.16.9 Payment  Payment shall be made at the contract unit price per square yard based upon plan quantities for the stabilization. The price shall be full compensation for furnishing all material and for all preparation of the subgrade, delivering, installation, and incidentals necessary to complete this item. Paving platform found deficient shall be removed and replaced. At the option of the Project Manager the pavement structural section shall be adjusted to compensate for any deficiency in the paving platform thickness and strength at the Contractor’s expense as noted in Item 22.16.5.6. Granular fill will be paid for at the contract unit price per ton. Unit price will be held constant regardless of deviation from actual quantities.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Payment</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.3</td>
<td>Geogrid</td>
<td>$/yd²</td>
</tr>
<tr>
<td>22.4</td>
<td>Separation fabric</td>
<td>$/yd²</td>
</tr>
<tr>
<td>22.5</td>
<td>Granular fill</td>
<td>$/ton</td>
</tr>
</tbody>
</table>
23.00 STREET CONSTRUCTION AGGREGATES
23.01 SCOPE
23.02 MATERIALS
23.03 CONSTRUCTION REQUIREMENTS FOR BASE COURSE MATERIAL
23.04 MEASUREMENT AND PAYMENT
23.01 Scope
This specification specifies materials and methods to be used for the construction of aggregate bases and subbases for streets, parking lots, walks, drainways, and other work requiring the use of aggregates. The work covered shall include general requirements that are applicable to aggregate base course. All workmanship and materials shall be in accordance with the specifications, and in conformity with the lines, grades, depths, quantity requirements, and the typical cross section shown on the plans, or as directed by the Project Manager.

23.02 Materials
Aggregates shall be crushed stone, crushed slag, crushed gravel, or natural gravel which conforms to the requirements of AASHTO M 147 as herein supplemented. Aggregate shall meet the grading requirements specified below. The type used shall be specified on the plans or special provisions. The maximum liquid limit (LL) shall be as shown in Table 23.1.

Table 23.1
CLASSIFICATION TABLE FOR AGGREGATES

<table>
<thead>
<tr>
<th>Use</th>
<th>Type 1 (Course-Graded)</th>
<th>Type 2 (Normal)</th>
<th>Type 2A (Normal)</th>
<th>Type 3 (Non-Permeable)</th>
<th>Type 4 (Structural)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sieve</td>
<td>Percentage by Weight Passing Square Mesh Sieve</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6&quot;</td>
<td>100</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>2&quot;</td>
<td>95-100</td>
<td>--</td>
<td>--</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>1 1/2&quot;</td>
<td>--</td>
<td>--</td>
<td>100</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>1&quot;</td>
<td>--</td>
<td>100</td>
<td>90-100</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>--</td>
<td>--</td>
<td>60-90</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>40-85</td>
<td>50-85</td>
<td>45-75</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>No. 4</td>
<td>30-60</td>
<td>35-65</td>
<td>30-60</td>
<td>75-100</td>
<td>30-100</td>
</tr>
<tr>
<td>No. 10</td>
<td>--</td>
<td>25-50</td>
<td>20-50</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>No. 40</td>
<td>--</td>
<td>15-30</td>
<td>10-30</td>
<td>60 MAX.</td>
<td>60 MAX.</td>
</tr>
<tr>
<td>No. 200*</td>
<td>3-15</td>
<td>3-15</td>
<td>3-12</td>
<td>15-40</td>
<td>5-20</td>
</tr>
<tr>
<td>LL (max.)</td>
<td>35</td>
<td>25</td>
<td>25</td>
<td>35</td>
<td>35</td>
</tr>
</tbody>
</table>

* Percent passing No. 200 determined by Wash Test (ASTM C 117).
Fraction passing No. 200 shall not be greater than 2/3 of the fraction passing No. 40.
For Type 2 and 2A aggregate base course, the plasticity index (PI) shall not exceed 15 when the aggregate is tested in accordance with AASHTO T 89 and T 90, respectively. The liquid limit of the Type 2 and 2A material shall not exceed 30. The R value, AASHTO T 96, is a minimum of 78 at 300 psi with less than 10 point difference between 100 psi and 300 psi exudation. Los Angeles abrasion shall not exceed 45%.

At least two weeks in advance of the beginning of placing any aggregates, the Contractor shall submit suitable samples of the proposed material to an approved Materials Testing Laboratory for tests to determine the compliance with the requirements of this specification. The results of all tests shall be submitted to the Project Manager for approval prior to the placement of any aggregate material. Tests shall be at the Contractor's expense.

Under certain conditions, the Project Manager may allow the substitution of Type 1 aggregate for Type 2 or Type 2A aggregate. The Project Manager will consider the substitution if the liquid limit of the Type 1 material does not exceed 30, the R Value, AASHTO T 96, is a minimum of 78, at least 300 psi with less than a 10 point difference between 100 psi and 300 psi exudation pressure. The depth is at least 2 times the maximum size of the coarse aggregate. If Type 1 material is used, it shall be overlaid with a minimum of 4" of Type 2 or Type 2A material.

### 23.03 Construction Requirements for Base Course Material

**23.03.1 Placing** The base course material shall be placed on the previously prepared subgrade at the locations and in the proper quantities to conform to the typical cross sections as shown on the plans and as directed by the Project Manager. The material shall be placed without segregation. Any segregated areas shall be removed and replaced with uniformly graded material at the Contractor's expense. Blue tops shall be used on all new construction.

The base material may be placed in lifts of up to 6", providing that after compaction, uniform density is obtained throughout the entire depth of the lift. If the required depth exceeds 6", it shall be placed in two or more lifts of approximately equal thickness. If uniform density cannot be obtained by 6" lifts, the maximum lift shall not exceed 4" in final thickness.

**23.03.2 Compaction** Rolling will be continued until the base material has been compacted to not less than 95% of maximum density as determined by AASHTO T 180, Method D (Modified Proctor). Water shall be uniformly applied as necessary during compaction to obtain moisture content within 1% of optimum and to aid in
consolidation. The surface of each layer shall be maintained during the compaction operations in such a manner that a uniform texture is produced and the aggregates are firmly keyed.

The finished base course surface shall be smooth and free of ruts and irregularities and true to grade and crowned as shown on the plans or as directed by the Project Manager. The final surface shall be finished with a smoothness tolerance of 1/4" measured vertically from the surface to a ten-foot straightedge laid parallel to the survey line or 3/8" perpendicular to the survey line. The Project Manager shall make allowance for rounding at the crown line. The base course shall be maintained in this condition by watering, drying, rolling, or blading, as necessary or as the Project Manager may direct, until the surfacing is placed.

In-place field density determination shall be made in accordance with AASHTO T 191 or T 205. The use of AASHTO T 224 to correct for oversize particles may be required. The use of a nuclear density gage will be allowed when correlated with one of the above test methods.

### 23.04 Measurement and Payment

#### 23.04.1 Aggregate Base Course

Aggregate base course shall be measured by the square yard of the types and to the compacted depths called for on the plans. Water, when used for placing and compacting aggregate base, will not be measured or paid for separately, but shall be included in the work.

Accepted quantities of aggregate base course of the dimensions and types specified shall be paid for at the contract price per square yard, complete, in place, or as specified in the contract documents.
24.00 HOT MIX ASPHALT PAVEMENT
24.01 DESIGN INTENT
24.02 MATERIALS
24.03 MIX DESIGN AND PLANT PRODUCED MIXTURE REQUIREMENTS
24.04 MIXTURE DESIGN SUBMITTALS
24.05 EQUIPMENT
24.06 MANUFACTURE
24.07 TACK COAT
24.08 PLACEMENT
24.09 LONGITUDINAL JOINTS
24.10 TRANSVERSE JOINTS
24.11 SEGREGATION
24.12 COMPACTION
24.13 PRODUCTION TOLERANCES
24.14 CONFORMITY WITH PLANS AND SPECIFICATION
24.15 TESTING AND INSPECTION
24.16 MEASUREMENT AND PAYMENT
24.17 STONE MASTIC ASPHALT PAVEMENT
SECTION 24.00 HOT MIX ASPHALT PAVEMENT

24.01 Design Intent

These specifications include general requirements applicable to all types of plant mixed hot mix asphalt pavements (HMAP). This work consists of one or more courses of asphalt mixture constructed on a prepared foundation in accordance with specifications. The design intent is to provide pavement with adequate thickness and quality to provide a serviceable life of 20 years. It is also the intent to provide construction in accordance with these specifications with a high standard of practice. This item shall include all labor, equipment, and materials to manufacture, place and compact asphalt cement concrete for pavement purposes.

<table>
<thead>
<tr>
<th>TEST PROCEDURE DEFINITIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM</td>
</tr>
<tr>
<td>AASHTO</td>
</tr>
</tbody>
</table>

24.02 Materials

The hot mix asphalt shall be composed of a mixture of aggregate, filler, hydrated lime and asphalt cement. Some mixes may require polymer modified asphalt cement. Some mixes may allow up to 25% reclaimed asphalt pavement (RAP).

24.02.1 Aggregate

Aggregates for HMAP shall be of uniform quality, composed of clean, hard, durable particles of crushed stone, crushed gravel, or crushed slag. Excess of fine material shall be wasted before crushing. The material shall not contain clay balls, vegetable matter, or other deleterious substances and shall meet the following requirements.
**TABLE 24.02.1.1- AGGREGATE PROPERTIES**

<table>
<thead>
<tr>
<th>Aggregate Test Property</th>
<th>Coarse: Retained on #4</th>
<th>Fine: Passing the #4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine Aggregate Angularity, AASHTO T 304 Method A</td>
<td></td>
<td>40% Min. 45% Min.</td>
</tr>
<tr>
<td>Traffic Level 1 &amp; 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic Level 3 to 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two Fractured Faces, ASTM D-5821</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Top and Middle Lifts</td>
<td>80% Min. 70% Min.</td>
<td></td>
</tr>
<tr>
<td>Bottom Lifts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LA Abrasion, AASHTO T 96</td>
<td>45% Max.</td>
<td></td>
</tr>
<tr>
<td>Flat and Elongated (Ratio 5:1)%, AASHTO M 283</td>
<td>10% Max.</td>
<td></td>
</tr>
<tr>
<td>Adherent Coating (Dry Sieving) ASTM D 5711</td>
<td>0.5% Max.</td>
<td></td>
</tr>
<tr>
<td>Sand Equivalent. AASHTO-T 176</td>
<td></td>
<td>45% Min.</td>
</tr>
</tbody>
</table>

Reclaimed Asphalt Pavement material (RAP) shall be used only where specifically allowed and shall be of uniform quality and gradation with a maximum size no greater than the nominal aggregate size of the mix. Reclaimed Asphalt Pavement (RAP) is allowed in hot mix asphalt (HMA) up to a maximum of 25 percent for all lifts other than the top lift, provided all specifications for HMA are met. Fine Aggregate Angularity requirements shall apply only to the virgin fraction of the fine aggregate. The RAP shall not contain clay balls, vegetable matter, or other deleterious substances. Mixtures with RAP shall not be used in the top lift of any asphalt pavement.

The Contractor shall supply a Performance Graded Binder which meets the AASHTO MP-1 specifications for one temperature grade lower for both the high and low end than that specified in the Contract if RAP content is greater than 15 percent. For example, if the Contract originally specified a PG 64-22, the Contractor shall supply a binder meeting the AASHTO MP-1 specifications for a PG 58-28.

The HMAP gradation for the Proposed Design Job Mix gradation shall be wholly within the control point gradation range set forth in the following Table 24.2.1.2. The allowable job mix gradation for production shall be the design job mix gradation with the tolerances of section 24.13.2 applied, provided that when
the tolerances are applied, the gradation remains within the control point
gradation range set forth in Table 24.2.1.2. The Proposed Design Job Mix and
the final allowable job mix gradation for production shall report all sieve sizes
listed in Table 24.2.1.2.

**TABLE 24.02.1.2 – GRADATION RANGE**
(Percent by Weight Passing Square Mesh Sieves, AASHTO T 11 & T 27)

<table>
<thead>
<tr>
<th>Mixture Grading</th>
<th>SX (1/2&quot; nominal)</th>
<th>S (3/4&quot; nominal)</th>
<th>SG (1&quot; nominal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sieve Size</td>
<td>Control Points</td>
<td>Restricted Zone*</td>
<td>Control Points</td>
</tr>
<tr>
<td>11/2&quot;</td>
<td></td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>1&quot;</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>100</td>
<td>90-100</td>
<td></td>
</tr>
<tr>
<td>1/2&quot;</td>
<td>90-100</td>
<td>@</td>
<td></td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>@</td>
<td>@</td>
<td>@</td>
</tr>
<tr>
<td>#4</td>
<td>@</td>
<td>@</td>
<td>@</td>
</tr>
<tr>
<td>#8</td>
<td>28-58</td>
<td>39.1</td>
<td>23-49</td>
</tr>
<tr>
<td>#16</td>
<td>@</td>
<td>25.6-31.6</td>
<td>@</td>
</tr>
<tr>
<td>#30</td>
<td>@</td>
<td>19.1-23.1</td>
<td>@</td>
</tr>
<tr>
<td>#50</td>
<td>@</td>
<td>15.5</td>
<td>@</td>
</tr>
<tr>
<td>#200**</td>
<td>2.0-8.0</td>
<td>2.0-7.0</td>
<td>1.0-7.0</td>
</tr>
</tbody>
</table>

* The restricted zone is a guideline only. It is recommended that mix design gradations go above
the restricted zone boundaries, on the "fine" side.

** These limits shall include the weight of lime at 1.0%.

@ These sieve sizes used only to determine the final allowable Job Mix Formula (JMF) in
accordance with 24.13.

Voids in Mineral Aggregate (VMA) shall be based on tests of the Bulk Specific
Gravity of the Compacted Mix (AASHTO T-166) and Aggregate (T 84 & T 85),
and calculated according to AASHTO PP 19. All mixes shall meet the minimum
VMA specified in Table 24.2.1.3, below.
TABLE 24.02.1.3 MINIMUM VMA, %

<table>
<thead>
<tr>
<th>Nominal Maximum*</th>
<th>Air Voids ++</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.5%</td>
</tr>
<tr>
<td>1&quot;</td>
<td>12.5</td>
</tr>
<tr>
<td>¾&quot;</td>
<td>13.5</td>
</tr>
<tr>
<td>½&quot;</td>
<td>14.5</td>
</tr>
</tbody>
</table>

* Nominal Maximum Particle Size is defined as one sieve size larger than the first sieve to retain more than 10%, but shall not exceed the 100% passing size. The Nominal Maximum Particle Size can vary during mix production even when the 100% passing size is constant.

++ Minimum VMA criteria apply to the mix design only. The minimum VMA criteria shall be linearly interpolated based on actual air voids. See Section 24.13 for tolerances.

24.02.2 Performance Graded Asphalt Binders – (Asphalt Cements) The Contractor shall provide to the Project Manager acceptable 'Certifications of Compliance' of each applicable asphalt cement grade from the supplier. Upon non-conformance with the specifications, the asphalt cement may be rejected as directed by the Project Manager. When production begins, the Contractor shall, upon request, provide to the Project Manager a one-quart can of each specified asphalt cement. Additionally, when requested, the Contractor shall provide the refinery test results that pertain to the asphalt binders used during production.

Asphalt Cement binder shall meet the requirements of the Superpave Performance-Graded Binders (PG) as presented in Table 24.2.2.1 below.
### TABLE 24.02.2.1 – PROPERTIES OF PERFORMANCE GRADED BINDERS

<table>
<thead>
<tr>
<th>Property</th>
<th>PG 58-28</th>
<th>PG 64-22</th>
<th>PG 76-28</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic Level: Recommended Usage</td>
<td>1 and 2</td>
<td>2 through 5</td>
<td>3 through 5</td>
</tr>
<tr>
<td>Flash Point Temperature, °C, AASHTO T 48</td>
<td>230 Min.</td>
<td>230 Min.</td>
<td>230 Min.</td>
</tr>
<tr>
<td>Viscosity at 135°C, Pas, ASTM D 4402</td>
<td>3 Max.</td>
<td>3 Max.</td>
<td>3 Max.</td>
</tr>
<tr>
<td>Dynamic Shear, Temperature °C, where C'/Sin δ @ 10 rad/sec. ≥ 1.00 Kpa, AASHTO TP 5</td>
<td>58°C</td>
<td>64°C</td>
<td>76°C</td>
</tr>
<tr>
<td>Rolling Thin Film Oven Residue Properties, AASHTO T 240</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass Loss, %, AASHTO T 240</td>
<td>1.00 Max.</td>
<td>1.00 Max.</td>
<td>1.00 Max.</td>
</tr>
<tr>
<td>Dynamic Shear, Temperature °C, where G'/Sin δ @ 10 rad/sec. ≥ 2.20 Kpa, AASHTO TP 5</td>
<td>58°C</td>
<td>64°C</td>
<td>76°C</td>
</tr>
<tr>
<td>Elastic Recovery 25°C, % Min.*</td>
<td>N/A</td>
<td>N/A</td>
<td>50 Min.</td>
</tr>
<tr>
<td>Pressure Aging Vessel Residue Properties, Aging Temperature 100°C AASHTO PP1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dynamic Shear, Temperature °C, where G'/Sin δ @ 10 rad/sec. ≤ 5,000 Kpa, AASHTO TP 5</td>
<td>19°C</td>
<td>25°C</td>
<td>28°C</td>
</tr>
<tr>
<td>Creep Stiffness, @ 60 sec. Test Temperature in °C, AASHTO TP 1</td>
<td>-18°C</td>
<td>-12°C</td>
<td>-18°C</td>
</tr>
<tr>
<td>S, Mpa, AASHTO TP 1</td>
<td>300 Max.</td>
<td>300 Max.</td>
<td>300 Max.</td>
</tr>
<tr>
<td>m-value, AASHTO TP 1</td>
<td>0.300 Min.</td>
<td>0.300 Min.</td>
<td>0.300 Min.</td>
</tr>
<tr>
<td>**Direct Tension Temperature in °C, @ 1.0 mm/min., Where Failure Strain &gt;1.0%, AASHTO TP 3</td>
<td>-18°C</td>
<td>-12°C</td>
<td>-18°C</td>
</tr>
</tbody>
</table>

* Elastic Recovery by Task Force 31, Appendix B Method
** Direct tension measurements are required when needed to show conformance to AASHTO MP.1
24.02.3 Additives – Hydrated Lime  Lime shall be added at the rate of 1% by dry weight of the aggregate and shall be included in the amount of material passing the No. 200 sieve. Hydrated lime for aggregate pretreatment shall conform to the requirements of ASTM C 207, Type N. In addition, the residue retained on a 200-mesh sieve shall not exceed .8% when determined in accordance with ASTM C 110. Drying of the test residue in an atmosphere free from carbon dioxide will not be required.

24.02.4 Tack Coat  The emulsified asphalt, for Tack Coat shall be CSS-1h or SS-1h and conform to AASHTO M208 or M140, respectively.

24.03 Mix Design and Plant Produced Mixture Requirements
The mix design materials shall be those listed in Section 24.2 and used for the project. No substitutions are allowed during production.

The Project Manager shall indicate on MGPEC Form #9 the project specific criteria concerning mix design method, traffic level, asphalt cement type, mixture grading, and maximum amount of RAP allowed. This information shall be provided on MGPEC Form #9, 'Requirements for Hot Mix Asphalt Pavement (HMAP)'

Grading SG (1-inch nominal aggregate) shall only be designed using the 150mm Superpave molds. Hveem Stability and Lottmans are not required for Grading SG mixtures. Grading S and SX shall be designed using 100mm Superpave molds when using the Superpave design method.

24.03.1 Superpave Mixture Design Method  The Contractor shall submit a Proposed Design Job Mix for each mixture required by the Contract. The design shall be determined using AASHTO T 312 for the Superpave Method of Mixture Design. Guidance is provided in "Superpave Level 1 Mix Design" SP-2 published by the Asphalt Institute. Mix designs shall meet the following requirements of Table 24.3.1:
<table>
<thead>
<tr>
<th>Traffic Level</th>
<th>Traffic Loading, Total 18 kip ESALs Over Design Life (Usually 20 Years)</th>
<th>0</th>
<th>1 &amp; 2 &amp; 3</th>
<th>4 &amp; 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Non Vehicular or Paths</td>
<td>1) &lt;300,000</td>
<td>2) 300,000 to &lt;1.0 Million</td>
<td>3) 1.0 to &lt;3.0 Million</td>
</tr>
<tr>
<td>Initial gyrations, $N_{initial}$</td>
<td>(For Information Only)</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>$N_{initial}$ Air Voids,</td>
<td>(For Information Only)</td>
<td>&gt;8.5</td>
<td>&gt;9.5</td>
<td>&gt;11.0</td>
</tr>
<tr>
<td>Design gyrations, $N_{design}$</td>
<td>(Air Void: 3.5% to 4.5%)</td>
<td>50</td>
<td>75</td>
<td>100</td>
</tr>
<tr>
<td>Hveem Stability</td>
<td>AASHTO T 246 (Grading S &amp; SX only)</td>
<td>N/A</td>
<td>28 Min.</td>
<td>30 Min.</td>
</tr>
<tr>
<td>Voids Filled with Asphalt, MS-2</td>
<td></td>
<td>70-80</td>
<td>65-78</td>
<td>65-75</td>
</tr>
<tr>
<td>Design Air Voids, % (See Notes 1, 2), MS-2</td>
<td></td>
<td>3.0 to 5.0</td>
<td>3.0 to 5.0</td>
<td></td>
</tr>
<tr>
<td>Lottman, Tensile Strength Ratio, % Retained, AASHTO T 283, Method B</td>
<td></td>
<td>80 Min.</td>
<td>80 Min.</td>
<td>80 Min.</td>
</tr>
<tr>
<td>Lottman, AASHTO T 283 Dry Tensile Strength, psi</td>
<td></td>
<td>30 Min.</td>
<td>30 Min.</td>
<td>30 Min.</td>
</tr>
<tr>
<td>VMA % AASHTO PP 19 (See Notes 1, 2)</td>
<td>Minimum VMA criteria apply to the mix design only (Table 24.2.1.3). The minimum VMA criteria shall be linearly interpolated based on actual air voids.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note 1: Maximum Theoretical Specific Gravity of mix by AASHTO T 209.

Note 2: Refer to Section 24.13 for production tolerances.
24.04 Mixture Design Submittals

24.04.1 General Requirements  The Contractor shall submit all mixture designs, Certificates of Compliance, and laboratory data to the Project Manager for approval at least seven calendar days before construction is to begin. The mix design (Proposed Design Job Mix) must be approved by the Project Manager prior to the start of construction.

Mixture designs shall be performed in a materials laboratory under the direct supervision of and shall be stamped and signed by a Professional Engineer licensed in Colorado and practicing in this field. In addition, the Contractor shall submit, as part of the mixture design, laboratory data documents to verify the following:

1. Source of materials.
2. Gradation, specific gravity, source and description of individual aggregates and the final blend.
3. Aggregate physical properties.
4. Source and Grade of Performance Graded Binder.
5. Proposed Design Job Mix: aggregate and additive blending, final gradation shown on 0.45 power graph, optimum asphalt content.
6. Mixing and compaction temperatures used.
7. Mixture properties determined at a minimum of four asphalt contents and interpolated at optimum and graphs showing mixture properties versus asphalt content.

The Project Manager reserves the right to verify the Contractor's mix design for each hot asphalt pavement grading utilizing materials actually produced and stockpiled. If requested, the Contractor shall provide a sufficient quantity of each aggregate, mineral filler, RAP, and additive for the required laboratory tests, if required by the Project Manager. The Project Manager may request a Certificate of Conformance or Certificate of Compliance at any time on any material used.

24.04.2 Change in Source or Grade  Should a change in the source of Lime occur, or more than one temperature grade change on either the high or low end of Performance Graded Asphalt Binders (Asphalt Cements) occur, a one point verification test (at optimum asphalt content) of the mix must be performed to verify that the applicable criteria shown on Table 24.2.1.3 (VMA), is met. If this testing shows noncompliance, a new Design Job Mix shall be established and approved by the Project Manager before the new Performance Graded Asphalt
Binders or Lime source is used. Any change in aggregate type or source will require a new mix design. The one point verification test may be performed on lab mixed samples or on plant mixed samples.

### 24.04.3 Mix Production Verification

Production verification shall occur prior to the start of the project. The production verification shall be performed by LABCAT Level C certified technicians to verify the volumetric properties of the mix. If the mix has been produced for another project within the last 90 days, data from that project can be submitted for this verification. Volumetric properties of the mix verification testing shall be within the following tolerances compared to the Proposed Design Job Mix. The mix verification test reports shall be submitted to the Project Manager prior to mix placement.

**TABLE 24.04.3 MIX DESIGN VERIFICATION TOLERANCES**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Voids</td>
<td>3.0 – 5.0</td>
</tr>
<tr>
<td>VMA</td>
<td>+/- 1.2%</td>
</tr>
<tr>
<td>Asphalt Cement Content</td>
<td>+/-0.3%</td>
</tr>
<tr>
<td>Stability</td>
<td>Applicable minimum</td>
</tr>
</tbody>
</table>

The tolerances in this table are for mix design verification only. See Section 24.13 for production tolerances.

### 24.04.4

The Project Manager may require a pre-paving meeting of all parties involved in supply, haul, lay down inspection, quality control and quality acceptance of HMAP. Areas of responsibility and contact names and numbers should be shared

### 24.05 Equipment

#### 24.05.1 Mixing Plant

The mixing plant shall be capable of producing a uniform material, have adequate capacity, and be maintained in good mechanical condition. Defective parts shall be replaced or repaired immediately if they adversely affect the proper functioning of the plant or plant units, or adversely affect the quality of the HMAP.

Dust, smoke, or other contaminants shall be controlled at the plant site to meet all air quality requirements in the "Colorado Air Quality Control Act," Title 25, Article 7, CRS and regulations promulgated there under.

Acceptable safety equipment, approved by the Project Manager, shall be provided by the Contractor to accommodate sampling and testing.
24.05.2 Hauling Equipment  Trucks used for hauling HMAP material shall have tight, clean, smooth beds thinly coated with a minimum amount of paraffin oil, lime solution, or other approved release agent. Petroleum distillates such as kerosene or fuel oil will not be permitted. Each truck shall be equipped with a cover of canvas or other suitable material used to protect the mixture from the weather and excessive temperature loss or cooled layers of mix in the truck.

24.05.3 Bituminous Pavers  Self-propelled pavers shall be provided for full lane width paving, and shall be equipped with a screed assembly, heated if necessary, capable of spreading and finishing the HMAP material in full lane widths applicable to the typical section and thicknesses shown in the Contract. Pavers used for shoulders, patching and similar construction, not requiring fine grade control, shall be capable of spreading and finishing courses of HMAP material in widths shown in the Contract.

The paver shall have an automatic distribution system that will place and spread the mixture uniformly in front of the screed.

The paver shall be capable of operating at forward speeds consistent with uniform and continuous laying of the mixture. Stop and go operations of the paver shall be avoided. The screed or strike-off assembly shall produce the specified finished surface without tearing, shoving, or gouging the mixture. Self-propelled pavers shall be equipped with automatic screed controls with sensors capable of sensing grade from an outside reference line, and maintaining the screed at the specified longitudinal grade and transverse slope. The sensor shall be constructed to operate from either or both sides of the paver and shall be capable of working with the following devices when they are required for the situation:

(1) Ski-type device at least 30 feet in length.

(2) Short ski or short shoe.

(3) Adequate length of control line and stakes, if no other type of geometric control is present.

The controls shall be capable of maintaining the screed at the specified transverse slope within plus or minus 0.1 percent. Automatic mode should be used where possible. If the automatic controls fail or malfunction, the equipment may be operated manually for the remainder of the normal working day, provided specified results are obtained.
If the Contractor fails to obtain and maintain the specified surface tolerances, the paving operations shall be suspended until satisfactory corrections, repairs, or equipment replacements are made.

Placement of HMAP on a waterproofed bridge deck shall be accomplished with equipment that will not damage the membrane or protective covering.

**24.06 Manufacture**

**24.06.1 Preparation of Aggregates** Heating and drying of the aggregates shall be accomplished without damaging the aggregate. Hydrated lime shall be added to achieve complete and uniform coating of the aggregate, in accordance with one of the following methods:

a) Lime Slurry Added to Aggregate: The hydrated lime shall be added to the aggregate in the form of slurry and then thoroughly mixed in an approved pug mill. The slurry shall contain a minimum of 70 percent water by weight.

b) Dry Lime Added to Wet Aggregate: The dry hydrated lime shall be added to wet aggregate (a minimum of three percent above saturated surface dry) and then thoroughly mixed in an approved pug mill.

The lime-aggregate mixture may be fed directly into the hot plant after mixing or it may be stockpiled for not more than 90 days before introduction into the plant for mixing with the asphalt cement. The hydrated lime may be added to different sized aggregates and stockpiled by adding 75 percent of the lime to the aggregate passing the No.4 sieve and 25 percent to the aggregate retained on the No. 4 sieve.

**24.06.2 Mixing** The dried aggregates and asphalt cement shall be combined in the mixer in the quantities required to meet the design job mix. The materials shall be mixed until the aggregate is completely and uniformly coated, and the asphalt cement is uniformly distributed throughout the aggregate. Baghouse fines shall be fed back to the mixing plant in a uniform and continuous manner to maintain uniformity in the mixture. The Baghouse fines, feeder, auger, and related equipment, shall be in good working condition and operated in accordance with manufacturer's recommendation. If the Project Manager determines that non-uniform operation of the equipment is detrimental to the mixture, it may suspend all paving operations until the Contractor takes appropriate action.

The minimum temperature of the mixture when discharged from the mixer shall be as shown in the following table:
TABLE 24.06.2.1- MIXTURE DISCHARGE TEMPERATURES

<table>
<thead>
<tr>
<th>Asphalt Grade</th>
<th>Minimum Discharge Temperature</th>
<th>Maximum Discharge Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>PG 58-28</td>
<td>275°F</td>
<td>305°F</td>
</tr>
<tr>
<td>PG 64-22</td>
<td>290°F</td>
<td>320°F</td>
</tr>
<tr>
<td>PG 76-28</td>
<td>320°F</td>
<td>350°F</td>
</tr>
</tbody>
</table>

HMAP mix shall be produced at the lowest temperature within the specified temperature range that produces a workable mix and provides for uniform coating of aggregates (95 percent minimum in accordance with AASHTO T 195), and that allows the required compaction to be achieved.

HMAP mix may be stored provided that any and all characteristics of the mixture are not altered by such storage. If storing or holding of the mixture causes segregation, excessive heat loss, or adversely affects the quality of the finished product, corrective action shall be taken. Unsuitable mixture shall be disposed of at the Contractor’s expense.

When placing hot bituminous mixture over bridge decks covered by waterproofing membrane, the minimum temperature of the mixture, when rolling operations begin, shall be 250°F. The job mix temperature may be increased up to 30°F to obtain this temperature.

24.06.3 Hauling  Each truck shall use covers to protect the mix during transport in cold weather, dust storms or if precipitation is imminent. The Project Manager can reject any mix which shows an excess or deficiency of asphalt cement, damage due to burning or overheating, an improper gradation, or thermal segregation with cold areas 30°F below the minimum discharge temperature.

24.07 Tack Coat

Prior to placement of HMAP, a tack coat shall be applied to all existing concrete and asphalt surfaces. The material shall be in accordance with 24.2.4. The emulsified asphalt shall be diluted 1:1 with water and applied at 0.10 ± 0.01 gallons per square yard of diluted material. The Project Manager may direct other application rates to match the age of condition of the surface.

The surface to receive the tack coat shall be dry and cleaned by sweeping, or another approved method, until dust, debris, and foreign matter are removed. The tack coat shall then be applied uniformly by squeegee, brooms, or distributor. Prior to paving, all water must have evaporated from the tack coat. Contaminated areas shall be cleaned and tack coat shall be reapplied.
24.08 Placement

Hot mix asphalt shall be placed only on approved, properly constructed surfaces that are free from loose material, water, frost, snow or ice. The hot mix asphalt and tack coat shall be placed in accordance with the temperature limitations of Table 24.8 and only when weather conditions permit the pavement to be properly placed and finished as determined by the Project Manager. Placement temperature as stated shall be increased by 5°F for each 10 miles per hour wind velocity to a maximum increased minimum placement temperature of 70°F.

**TABLE 24.08 MINIMUM AIR AND SURFACE TEMPERATURES LIMITATIONS FOR MIX PLACEMENT**

<table>
<thead>
<tr>
<th>Compaction Layer Thickness</th>
<th>Top Layer of Pavement*</th>
<th>Lower Layers*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PG 58-28</td>
<td>PG 58-28</td>
</tr>
<tr>
<td></td>
<td>PG 76-28</td>
<td>PG 76-28</td>
</tr>
<tr>
<td>&lt;2 inches (not recommended)</td>
<td>60°F</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>75°F</td>
<td>N/A</td>
</tr>
<tr>
<td>2 inches to &lt;3 inches</td>
<td>50°F</td>
<td>40°F</td>
</tr>
<tr>
<td></td>
<td>65°F</td>
<td>50°F</td>
</tr>
<tr>
<td>3 inches or more</td>
<td>50°F</td>
<td>40°F</td>
</tr>
<tr>
<td>SG mix only</td>
<td>50°F</td>
<td>40°F</td>
</tr>
</tbody>
</table>

* Air temperature is taken in the shade. Surface temperature is taken on the subgrade or base. The Project Manager may not waive the above temperature limitations for PG 76-28.

The mixture shall not be placed at a temperature lower than 245°F for mixes containing PG 58-28 or PG 64-22 asphalt, and 290°F for mixes containing polymer modified asphalt. Mix which is too cold or damaged by weather will be rejected.

The mixture shall be laid upon an approved surface, spread and struck off to obtain the required grade and elevation after compaction. The minimum lift thickness shall be at least three times (preferably four times) the nominal particle size. The mixture should be placed approximately 25 percent thicker than the existing surrounding mat thickness to account for compaction. Raking is discouraged and will not be allowed except to correct major problems of grade and elevation. Casting or raking that causes any segregation will not be permitted.

On areas where the use of mechanical spreading and finishing equipment is impracticable, the mixture shall be carefully dumped, spread, raked, screeded, and luted by hand tools to the required compacted thickness plus 25 percent. Carefully move or minimally work the HMAP
mix with the use of rakes, lutes, or shovels to avoid segregation. Mixtures made with modified asphalt cement require more rapid completion of handwork areas than for normal mixtures. Hauling and placement sequences shall be coordinated so that the paver is in constant motion. Excessive starting and stopping shall not be allowed. A construction joint shall be placed any time the paver stops, and the screed drops enough to cause a surface dip in violation of section 24.13.1, Surface Tolerances; or the mat temperature falls below that allowed in section 24.12, Compaction. Bituminous pavers shall be used to distribute the mixture either over the entire width or over such partial width as may be practicable. Echelon paving will be permitted.

### 24.09 Longitudinal Joints

The longitudinal joints in both a new pavement and an overlay pavement layer shall offset the joint in the layer immediately below by a minimum of 6 inches. The joints in any pavement layer shall not fall in a wheel track or path. The joints in the top layer of new pavement, not built on top of an existing pavement, shall be located on lane lines, or as shown on the plans. Longitudinal joints shall be minimized, where feasible, with wide paving pulls or echelon paving. Joints shall not cross any centerline, lane line, or edge line unless approved by the Project Manager. The Contractor shall submit, prior to paving, a joint plan and pavement marking plan showing locations and the methods to establish a field control line. The Project Manager must approve such plans prior to paving. The Contractor shall use a continuous string line to delineate longitudinal joints during paving as shown on the joint plan. All string lines shall be removed at the end of each day's paving.

The free edge of the paved pass shall be laid as straight as possible, to the satisfaction of the Project Manager. This joint, if cold, shall be tack coated prior to placement of adjacent paving.

The new compacted mat shall overlap the previously placed mat no more than 1.5 inches. Excess overlap or thickness shall not be raked or cast onto the new mat, but shall be wasted by pulling back and removing. The hot edge shall be blocked or bumped in a smooth line consistent with the previous longitudinal edge. Minor raking will only be allowed to correct major grade problems or provide mix around manholes and meter covers. The longitudinal joint shall be rolled from the hot side and overlap the joint by approximately 6 inches on the cold side.

### 24.10 Transverse Joints

The Contractor shall submit, prior to paving, a joint plan showing locations and the methods to be used to construct transverse joints. The Project Manager must approve such plans prior to paving.
In areas where the use of mechanical spreading and finishing equipment is impracticable, the mixture shall be carefully dumped, spread, raked, screeded, and luted by hand tools to meet the elevation of the adjacent pavement. Placing of the HMAP shall be continuous with a minimum of transverse joints, and rollers shall not pass over the unprotected end of a freshly laid mixture. Transverse joints shall be formed by cutting back on the previous run to expose the full depth of the course. Tack coat material shall be applied to contact surfaces of all joints just before additional mixture is placed against the previously compacted material.

The end of transverse joints shall be located so they will be constructed with a full head of mix in front of the screed. When butt joints are constructed, runoff boards shall be used to support the roller on the downstream side of the joint. All tapered sections, rounded edges and segregated areas shall be removed to achieve a vertical face at the butt joint before paving is restarted. When a tapered joint is required for traffic access, the ramp shall be removed back to a full depth from the segregated section before paving is restarted.

When restarting paving operations, the paver screed shall be placed on the starter block on the completed side of the transverse joint. The starter block should be approximately 25% of the thickness of the existing completed mat, so that adequate grade and compaction can be achieved on starting the paving operation. The screed should be nulled (angle removed) when on starting blocks and an up angle of attack set. Proper head of mix should be introduced into the paver prior to starting. The new compacted (downstream) side of the joint may be up to 3/16 inches higher than the old (upstream) side. Raking of this joint shall not be allowed except to correct major grade problems. The surface tolerance at the transverse joint must be verified with a 10-foot straight edge before the paver is more than 100 feet from the joint. If the surface tolerance is not within the 3/16”, the contractor shall make corrections before proceeding.

24.11 Segregation

The asphalt mixture shall be transported and placed on the roadway without segregation. All segregated areas shall be removed immediately and replaced with specification material before the initial rolling. If more than 50 square feet of segregated pavement is removed and replaced in any continuous 500 linear feet of paver width lay down, operations shall be discontinued until the source of the segregation has been determined and corrected.

The Project Manager will visually determine areas that are segregated, and may also use density and gradation measures to help in this determination. The Project Manager will visually determine the extent of the segregation. The Contractor will not be allowed additional compensation for correction of segregated areas.
24.12 Compaction

The temperature of the mixture immediately behind the screed shall be at least 245°F for PG 58-28 or PG 64-22 binder and 290°F for PG 76-28 binder. The breakdown compaction shall be completed before the mixture temperature drops 20°F.

The HMAP shall be compacted by rolling. The number, weight, and type of rollers furnished shall be sufficient to obtain the required density and surface texture while the mixture is in a workable condition. Compaction shall begin immediately after the mixture is placed and be continued until the required density is obtained. Final compaction shall be obtained using steel wheel rollers.

If the required density is not achieved and the surface temperature falls below 185°F, or there is obvious surface distress or breakage, no further compaction effort will be permitted unless approved by the Project Manager. **Price Reduction criteria in Section 24.14 shall still apply in such cases.** The criteria for mixtures containing PG 76-28 asphalt cements shall be 235°F. These minimum compaction temperatures may be adjusted according to the asphalt cement supplier recommendations. Adjusted minimum compaction temperatures must be shown on the approved mix design or on other asphalt cement supplier documents, to be available on the job site. Pavement operations shall be suspended when density requirements are not met, and the problem shall be resolved prior to continuing paving operations.

All roller marks shall be removed with the finish rolling. Use of vibratory rollers with the vibrator on will not be permitted on bridge decks.

The Contractor shall establish a rolling pattern or procedure during the beginning of paving operations, which will achieve the required compaction and surface tolerances. This procedure may be re-evaluated by the Contractor and Project Manager throughout the paving operations.

All HMAP paving shall be compacted to 94.0 ± 2 percent of Maximum Theoretical (Rice) Density, (AASHTO T 209: Maximum Specific Gravity of Bituminous Paving Mixtures). The average (mean) of the 3 most recent production AASHTO T 209 Rice values shall be used in calculating Relative Compaction according to AASHTO T 166.

The Contractor shall core the pavement, as required by the Project Manager, for field density tests in accordance with AASHTO T 230, Method B), or for field calibration of nuclear density equipment in accordance with the ASTM D 2950. At a minimum, cores for nuclear density equipment calibration shall be taken at the beginning of placement of each pavement layer or change of mixture materials or gradation. Untested areas during placement will also require cores to be taken to verify compaction.
Along forms, curbs, headers, walls, and all other places not accessible to the rollers, the mixture shall be thoroughly compacted with mechanical tampers.

Any mixture that becomes loose and broken, mixed with dirt, or is in any way defective, shall be immediately removed and replaced with fresh hot mixture and compacted to conform to the surrounding area.

24.13 Production Tolerances

24.13.1 Surface Tolerances  The variation between any two contacts with the surface shall not exceed 3/16 inch in 10 feet for full lane width paving. For patching surface tolerances the variation shall not exceed ½ inch in 10 feet. All humps or depressions exceeding the specified tolerance shall be corrected by removing defective work and replacing it with new material or by overlaying (patching) as directed by the Project Manager. The final pavement surface shall not vary from the specified cross section by more than 1 inch at any point. Irregularities exceeding the specified tolerance shall be corrected at the Contractor's expense. Transverse measurements for variations shall exclude breaks in the crown sections. Roadway smoothness testing will not be measured and paid for separately, but shall be included in the work.

The final surface pavement adjacent to concrete gutter shall be finished from 1/8 inch to 3/8 inches above the lip of the gutter into which it drains. Any surface pavement that is above the lip more than 3/8 inch shall be removed and replaced to the specified height. Any pavement surface that is below the lip of the gutter shall be corrected as directed by the Project Manager. This provision does not apply to "tipped" or standard median gutter but does apply to median "catch" gutters used on superelevated roadways.

Before the surface course is placed, the Contractor shall adjust all manholes, valve boxes, and survey range boxes to within 1/8 inch and ½ inch below finish grade of the asphalt surface. The Contractor shall notify the Project Manager of the timing of adjustments to all manholes and valve boxes so he may observe. The Contractor shall remove any foreign matter introduced into all manholes and valve boxes during construction. It shall also be the Contractor's responsibility to insure proper compaction around all manholes and valve boxes after they have been raised. At no time shall manholes and valve boxes be covered up or buried. Valve boxes and manholes are to be maintained fully accessible at all times for emergency and maintenance operation by City personnel. The cost of adjusting valve boxes,
manholes, and survey range boxes shall be included in the work, unless otherwise specified in the Special Conditions or Proposal. The Contractor shall be responsible for any cost incurred by the City to provide access to the covered manholes or valve boxes. Valve boxes, manholes, and survey range boxes shall be clean when work is completed. Manhole rings shall be adjusted to match the slope of the roadway.

24.13.2 Job Mix Formula Tolerances  Production test results that deviate from the design job mix by more than shown in the following table are subject to Section 24.14:

<table>
<thead>
<tr>
<th>Item</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passing No. 3/8” and Larger 1</td>
<td>6%</td>
</tr>
<tr>
<td>Passing No. 4 and No.8</td>
<td>5%</td>
</tr>
<tr>
<td>Passing No. 30 to No. 50</td>
<td>4%</td>
</tr>
<tr>
<td>Passing No. 200 2</td>
<td>2%</td>
</tr>
<tr>
<td>Air Voids</td>
<td>*</td>
</tr>
<tr>
<td>VMA</td>
<td>1.2%</td>
</tr>
<tr>
<td>Hveem Stability</td>
<td>See footnote #3</td>
</tr>
<tr>
<td>Asphalt Content</td>
<td>0.3%</td>
</tr>
<tr>
<td>Asphalt Content, Mixes with &gt;10% RAP</td>
<td>0.4%</td>
</tr>
</tbody>
</table>

1. When the tolerances are applied to the job mix formula, the gradation may not fall outside the control point gradation range set forth in Table 24.2.1.2.
2. There is 1.0 percent tolerance for the maximum sieve size.
3. Hveem Stability must meet the minimum value specified in table 24.3.2.
   * Allowable air void range is 3% minimum to 5% maximum.

When disagreements concerning determination of specification compliance occur, only valid tests from both the Project Manager and Contractor will be considered. The Project Manager shall determine validity. Generally, valid tests are those in which sampling and testing have been performed according to referenced procedures and the results are within stated precision statements. When disagreements occur with asphalt content and gradation tests results, solvent extracted aggregate testing shall take precedence over burn off oven-extracted aggregate, which shall take precedence over cold feed belt testing.
24.14 Conformity with Plans and Specification

24.14.1 General All work performed and all materials furnished shall conform to the lines, grades, cross sections, dimensions, and material requirements, including tolerances, shown in the contract.

For those items of work where working tolerances are not specified, the Contractor shall perform the work in a manner consistent with reasonable and customary manufacturing and construction practices.

When the Project Manager finds that the materials furnished, the work performed, or the finished product does not conform with the contract, but that reasonably acceptable work has been produced, the Project Manager shall determine the extent of the work to be accepted and remain in place. Cost reduction, when allowed, shall be accomplished by adjusting pay quantities as indicated herein and applying contract unit prices to the reduced quantities. If the work is to be accepted, the Project Manager shall:

A. Document the basis for acceptance by "Cure Notice" which may provide for an appropriate adjustment in the payment quantity for such work or materials not otherwise provided for in this section.

B. Notify the Contractor in writing that the payment may be adjusted in accordance with this section when "P" is 25 or less, or require appropriate remediation being performed.

C. In lieu of cost (quantity) adjustment, permit correction or replacement of the finished product provided the correction or replacement does not adversely affect the work or the Project Manager.

When the Project Manager determines that the material furnished, work performed, or the finished product is not in conformity with the contract and has resulted in inferior or unsatisfactory product, the finished product or materials shall be removed and replaced or otherwise corrected by, and at the expense of, the Contractor.

Materials shall be sampled and tested by a qualified testing laboratory in accordance with the sampling, testing schedules, and procedures contained in the Section 32.00 Materials Testing. The approximate maximum quantity represented by each sample shall be as set forth in the testing schedule. An additional number of samples, in relation to the quantity of materials represented, may be selected and tested at the Project Manager discretion. The quantity represented by five consecutive random samples shall constitute a lot, whenever production schedules
and material continuity permits. When it is necessary to represent short production runs, significant material changes, or other unusual characteristics of the work, the Project Manager may establish a lot consisting of the quantity represented by any number of consecutive random samples from one to seven inclusive. Testing results that are determined to have sampling or testing errors, as determined by the Project Manager, shall not be used.

24.14.2 Cost Reduction Formula  Materials or work shall only be evaluated for price adjustment when deviations from specifications occur on any of the individual tests for the lot. The several individual test values shall be averaged and the percentage of cost (quantity) reduction for the lot shall be determined by applicable formula. This shall apply only when a cost reduction factor for the element is listed in Table 24.14.1.

24.14.2.01 When the Lot is Represented by Three Through Seven Tests  The formula in (a) and (b) below shall be used.

a) \[ P = (X_n + \bar{a}R - T_u) * F \]
   Shall be used if a maximum limit only is specified or; when the average of the several test values is above the midpoint of the specification band or above the job-mix formula value.

b) \[ P = (T_L + aR - X_n) * F \]
   Shall be used if the minimum limit only is specified or; when the average of the several test values is below the midpoint of the specification band or below the job-mix formula value.

24.14.2.02 When the Lot is Represented by Fewer Than Three Tests. The materials shall be evaluated for cost (quantity) reduction by the following procedure: Lots represented by two tests shall be divided into two separate lots represented by one test each, as determined by the Project Manager. Each lot that deviates from the specifications shall be cost adjusted by one of the following formulae.

a) \[ P = 0.76 * (T_o - T_u) * F \]
   When a maximum limit only is specified or the test value is above the maximum specified limit.

b) \[ P = 0.76 * (T_L - T_o) * F \]
   When a minimum limit only is specified or the test value is below the minimum specified limit.
Where:
- $P$ is the percentage of reduction in payment quantity.
- $X_n$ is the average of the several test values from samples taken from the lot, with "n" indicating the number of values.
- $a$ is a variable factor to be used if "n" changes according to the following:

<table>
<thead>
<tr>
<th>when &quot;n&quot; is</th>
<th>&quot;a&quot; equals</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0.45</td>
</tr>
<tr>
<td>4</td>
<td>0.38</td>
</tr>
<tr>
<td>5</td>
<td>0.33</td>
</tr>
<tr>
<td>6</td>
<td>0.30</td>
</tr>
<tr>
<td>7 or greater</td>
<td>0.28</td>
</tr>
</tbody>
</table>

- $R$ is the difference between the highest and lowest values in the group of several test results from the lot.
- $T_u$ is the upper or maximum tolerance limit permitted by the specifications.
- $T_L$ is the lower or minimum tolerance limit permitted by the specifications.
- $T_o$ is the test value of the test that deviates from the specifications.
- $F$ is the cost reduction factor to be applied for each element as shown in the following table:

**TABLE 24.14.2.02**

<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>FACTOR &quot;F&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 percent size sieve</td>
<td>1</td>
</tr>
<tr>
<td>1/2 inch sieve and larger</td>
<td>1</td>
</tr>
<tr>
<td>3/8 inch sieve, #4, #8, #30 sieves No. 50</td>
<td>3</td>
</tr>
<tr>
<td>No. 200 sieve</td>
<td>6</td>
</tr>
<tr>
<td>Density of Hot Mix Asphalt</td>
<td>8</td>
</tr>
<tr>
<td>Asphaltic Cement Binder content (all asphalt-aggregate mixtures)</td>
<td>20</td>
</tr>
<tr>
<td>Total air voids</td>
<td>30</td>
</tr>
<tr>
<td>Voids in mineral aggregate</td>
<td>20</td>
</tr>
<tr>
<td>Stability</td>
<td>5</td>
</tr>
</tbody>
</table>
If "P" is less than ten or a negative quantity, the material shall be accepted as being in conformity. In cases where one or more elements show a positive "P" value, such positive values shall be added and the resulting sum shall be used to determine whether the material is in conformity. If the total "P" value is between 10 and 25, the Project Manager may require correction or may accept the material at a reduced cost. If "P" is greater than 25, the Project Manager may:

1) Require complete removal and replacement with specification material at no additional cost to the City;
2) Require corrective action to bring the material into conformity at no additional cost to the City;
3) Where finished product is found to be capable of performing the intended purpose and the value of the finished product is not affected, permit the Contractor to leave the material in place with an appropriate cost adjustment to be based on the Project Manager evaluation but not less than that which would have occurred had an adjustment been made where "P" = 25.

If asphaltic cement content, aggregate sieve analysis, or compaction deviates from the specification requirements and the total "P" is three or greater, the reduction shall apply to the contract cost (quantity) multiplied by 0.60 for aggregate base course and Hot Bituminous Pavement mixtures.

The Contractor shall not have the option of accepting a cost reduction in lieu of intentionally producing material not meeting specification. Continued production of non-specification material shall not be permitted. Material that is defective as identified by visual inspection shall be isolated and rejected without regard to sampling sequence or location within a lot.

24.14.3 Cost Reduction for Thickness Deficiencies: If the cores indicate a thickness deficiency, additional cores will be taken by the Contractor to be given to the Project Manager so that price reductions can be determined per Lot. A Lot encompasses 250 linear lane feet or the quantity between tests, and a price reduction shall be determined at the unit cost of the HMAP. The following chart is for new construction only. It is not to be used for overlays.
TABLE 24.14.3 – PRICE REDUCTION – THICKNESS*

<table>
<thead>
<tr>
<th>% Price Reduction</th>
<th>0%</th>
<th>10%</th>
<th>20%</th>
<th>&gt; 30%</th>
<th>&gt; 40%</th>
<th>Remove &amp; Replace</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness Deficiency</td>
<td>0 – 0.50”</td>
<td>0.51” – 0.75”</td>
<td>0.76” – 1.00”</td>
<td>&gt; 1.01” – 1.25”</td>
<td>&gt; 1.26” – 1.50”</td>
<td>&gt;1.51” or greater</td>
</tr>
</tbody>
</table>

* Price reductions are not applicable to developer projects, as a financial deterrent, but may be used as a determination for acceptance.

24.15 Testing and Inspection

If any materials furnished or work performed by the Contractor fails to fulfill the specification requirements, such deficiencies shall be reported to the Project Manager and the Contractor immediately. Preliminary written field reports of all tests taken and observation results shall be given to the Contractor or Developer immediately after they are performed. Field reports shall be forwarded to the Project Manager no later than 1 week following the testing.

Reports of all tests taken, including failing tests, shall be reported to the Project Manager, to the Developer and to the Contractor no later than one week following the sampling. Density test results will be reported to the inspector(observer at the time the testing occurs as well as a written copy.

Testing of Hot Mix Asphalt Pavement shall be performed in accordance with Table 9.15. The tests shall be performed under the general supervision of and signed by a Professional Engineer registered in the State of Colorado. Laboratories shall be inspected by either AASHTO or accredited A2LA or equivalent in the elements listed on Table 24.15. Technicians taking samples and conducting compaction tests must have a LABCAT Level A certification or equivalent. Technicians conducting tests of asphalt content and gradation must have a LABCAT Level B certification or equivalent. Technicians performing voids testing must have a LABCAT Level C certification or equivalent.
**TABLE 24.15**
**SCHEDULE FOR MINIMUM MATERIALS SAMPLING AND TESTING FOR ITEM 9- HOT MIX ASPHALT PAVEMENT**

<table>
<thead>
<tr>
<th>Test</th>
<th>Standard</th>
<th>Minimum Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling</td>
<td>AASHTO T168, ASTM D 979 and ASTM D3665</td>
<td>Every 1000 tons or one test for each day for less than 1000 tons</td>
</tr>
<tr>
<td>Density</td>
<td>AASHTO T 166, T 238, T 230</td>
<td>One test for each 250 linear feet per lane</td>
</tr>
<tr>
<td>Thickness (Core)</td>
<td>ASTM D3549</td>
<td>One test for each 1000 linear feet per Lane, 2 minimum</td>
</tr>
<tr>
<td>Air Voids &amp; VMA</td>
<td>AASHTO T 166, AASHTO T 166 &amp; AASHTO PP 19</td>
<td>Every 1000 tons or one test for each day for less than 1000 tons</td>
</tr>
<tr>
<td>Gradation</td>
<td>AASHTO T 27, T 11</td>
<td>Every 1000 tons or one test for each day for less than 1000 tons</td>
</tr>
<tr>
<td>Hveem/Marshall Stability</td>
<td>AASHTO T 246</td>
<td>Every 1000 tons or one test for each day for less than 1000 tons</td>
</tr>
<tr>
<td>Asphalt (AC) Content</td>
<td>AASHTO T 164 or other methods agreed upon between Project Manager and the Contractor</td>
<td>Every 1000 tons or one test for each day for less than 1000 tons</td>
</tr>
<tr>
<td>Maximum Theoretical</td>
<td>AASHTO T 209</td>
<td>Every 1000 tons or one test for each day for less than 1000 tons</td>
</tr>
<tr>
<td>Specific Gravity (Rice)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lottman Stripping, TSR &amp; Dry Density</td>
<td>AASHTO T 283 , Method B</td>
<td>As requested by the Project Manager</td>
</tr>
</tbody>
</table>

Inspectors shall be responsible for checking temperatures of mix in the truck and on pavement, segregation, rolling patterns and other construction means and methods that affect the performance of the pavement system. The Contractor shall provide assistance in sampling and testing at all facilities and at the job site.

### 24.16 Measurement and Payment

**24.16.1 Plant Mix Bituminous Pavement**  Plant mix bituminous pavement shall be measured by the square yard at the compacted depths specified on the plans or as directed by the Project Manager. Accepted quantities of hot bituminous pavement shall be paid for at the contract price per square yard of the type, grading, and thickness specified, complete and in place according to Section 24.14 Conformity with Plans and Specification. The contract price per square yard shall include full compensation for all labor, materials, and equipment necessary to complete the work. If the final pavement surface varies from the theoretical cross section by
more than specified tolerances, 25% of the payment due for the entire pavement width and for the full depth of the pavement and base shall be withheld until corrections are made.

24.16.2 Tack Coat Emulsified asphalts and liquid asphalts shall be measured by the gallon. Emulsions will be measured prior to the addition of water. Blotter material shall be measured by the ton.

Emulsified asphalt and liquid asphalt shall be paid for at the contact price per gallon. Blotter material shall be paid for at the contract price per ton. Blotter material required because the Contractor placed bituminous material in excess of the rate specified by the Project Manager shall be at the Contractor's expense. The contract price per gallon for emulsified asphalt or liquid asphalt and the contract price per ton for blotter material shall include full compensation for all labor, materials, and equipment necessary to complete the work.

24.17 STONE MASTIC ASPHALT PAVEMENT
This work includes placing a Stone Mastic Asphalt (SMA) pavement as directed.

Mixture design and field control testing of SMA shall be performed using the Superpave (AASHTO T- 269, 100 Gyrations) and a portion of Marshall Method (AASHTO T245, 50 Blow).

A minimum of two weeks prior to the proposed use of any Stone Mastic Asphalt pavement on the project, a pre-paving conference will be conducted. At that time, the contractor shall submit to the Project Manager, a mix design meeting the appropriate specification requirements for one of the following:

The Superpave SMA mix design shall conform to the requirements of Table 24.16:
TABLE 24.17.1
SCHEDULE FOR MINIMUM MATERIALS SAMPLING AND TESTING
FOR STONE MASTIC ASPHALT PAVEMENT

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Value for SMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Voids, percent at: N(Design)</td>
<td>AASHTO T-269</td>
<td>3.0 – 4.0</td>
</tr>
<tr>
<td>Lab compaction (Revolutions) N(Design)</td>
<td>AASHTO T-312, 100</td>
<td></td>
</tr>
<tr>
<td>Accelerated Moisture Susceptibility, tensile strength Ratio, (Lottman), minimum</td>
<td>AASHTO T-283, Method B</td>
<td>70</td>
</tr>
<tr>
<td>Minimum Dry Split Tensile Strength, psi (kPa)</td>
<td>AASHTO T-283, Method B</td>
<td>30</td>
</tr>
<tr>
<td>Grade of Asphalt Cement</td>
<td>PG 76-28</td>
<td></td>
</tr>
<tr>
<td>Voids in the Mineral Aggregate (VMA) %, minimum</td>
<td>AASHTO T-166</td>
<td>17</td>
</tr>
</tbody>
</table>

Note: The formula for VMA can be developed as follows based on the weight volume relationship. It is recommended that the bulk specific gravity of aggregate be used for calculating VMA.

\[
VMA = \left\{\frac{V_T - V_{Agg\ (bulk)}}{V_T}\right\} \times 100
\]

TABLE 24.17.2
SUPERPAVE SMA MIXING AND COMPACTION TEMPERATURES

<table>
<thead>
<tr>
<th>Superpave Binder Grade</th>
<th>Laboratory Mixing Temperature, °C (°F)</th>
<th>Laboratory Compaction Temperature, °C (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PG 58-28</td>
<td>154 (310)</td>
<td>138 (280)</td>
</tr>
<tr>
<td>PG 64-22</td>
<td>163 (325)</td>
<td>149 (300)</td>
</tr>
<tr>
<td>PG 76-28</td>
<td>163 (325)</td>
<td>149 (300)</td>
</tr>
</tbody>
</table>

A minimum of one percent hydrated lime by weight of the combined aggregate shall be added to the aggregate for all Stone Mastic Asphalt.

The SMA mix design must be approved by the Project Manager before any pavement is placed on the project. In addition, the Contractor shall provide field control testing during production of the SMA mix and for the demonstration control strip. The Contractor shall perform the following tests and provide the results to the Project Manager during production:
### TABLE 24.17.3
SUPERPAVE TESTING FREQUENCY

<table>
<thead>
<tr>
<th>SUPERPAVE MIX PROPERTY</th>
<th>FREQUENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Theoretical Specific Gravity (Rice)</td>
<td>Every 1000 tons or one test for each day for less than 1000 tons</td>
</tr>
<tr>
<td>% Voids in the total mix @ N/design</td>
<td>Every 1000 tons or one test for each day for less than 1000 tons</td>
</tr>
<tr>
<td>VMA (% Voids in the Mineral Aggregate) @ N/design</td>
<td>Every 1000 tons or one test for each day for less than 1000 tons</td>
</tr>
<tr>
<td>Lottman, AASHTO T-283</td>
<td>1/5000 tons or fraction thereof</td>
</tr>
<tr>
<td>Dry Tensile Strength, AASHTO T-283</td>
<td>1/5000 tons or fraction thereof</td>
</tr>
<tr>
<td>Stability, Marshall Compactor</td>
<td>Every 1000 tons or one test for each day for less than 1000 tons</td>
</tr>
<tr>
<td>% AC &amp; Aggregate Gradation ASTM D-6302 (Ignition)</td>
<td>Every 1000 tons or one test for each day for less than 1000 tons</td>
</tr>
</tbody>
</table>

The mineral filler for SMA shall be stored in a separate silo and added automatically in the correct proportion. The mineral filler addition equipment shall be electronically or mechanically interlocked to the aggregate feed sensors so that the proper amount of mineral filler is added whenever SMA is produced.

The SMA mineral filler shall be added at the same point the asphalt cement is added to the aggregate.

Tack coat between the existing pavement and Stone Mastic Asphalt pavement shall be placed at a rate between 0.14 and 0.23 liters per square meter (0.03 and 0.05 gallons per square yard).

Before proceeding with SMA placement, the Contractor shall demonstrate the ability to produce and place a satisfactory mix. The actual work may proceed when a full lane width demonstration control strip, having a minimum length of 1000 feet has been successfully placed. The Contractor shall determine properties (VMA, Voids, in-place density, and Marshall Stability) of the project produced mix that is used in the demonstration control strip and provide the results to the Engineer. No other SMA production or placement will be allowed until densities are determined. If the material in the demonstration control strip is not in close conformity with the specifications, the demonstration control strip will be removed and replaced at the Contractors expense. The Project Manager will designate the location of the control strip.

Stone Mastic Asphalt (SMA) will be measured by the Ton of work completed and accepted.

Mix design, furnishing, hauling, preparing, and placing all materials, including aggregates, asphalt cement, limestone dust, hydrated lime, tack coat, and approved demonstration control
strip; labor, equipment tools, setting of lines and guides where specified, and all other work necessary to complete the item will not be paid for separately but shall be included in the work.

### Table 24.17.4
**Master Range Table for Stone Matrix Asphalt**

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent by Weight Passing Square Mesh Sieves</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4.75 mm (#4) nominal</td>
</tr>
<tr>
<td>25 mm (1”)</td>
<td></td>
</tr>
<tr>
<td>19.0 mm (3/4”)</td>
<td></td>
</tr>
<tr>
<td>12.5 mm (1/2”)</td>
<td>100</td>
</tr>
<tr>
<td>9.5 mm (3/8”)</td>
<td>100</td>
</tr>
<tr>
<td>4.75 mm (#4)</td>
<td>90-100</td>
</tr>
<tr>
<td>2.36 mm (#8)</td>
<td>28-65</td>
</tr>
<tr>
<td>1.18mm (#16)</td>
<td>22-36</td>
</tr>
<tr>
<td>600 μm (#30)</td>
<td>18-28</td>
</tr>
<tr>
<td>300 μm (#50)</td>
<td>15-22</td>
</tr>
<tr>
<td>150 μm (#100)</td>
<td>10-15</td>
</tr>
<tr>
<td>75 μm (#200)</td>
<td>12-15</td>
</tr>
</tbody>
</table>
25.00 ASPHALT PLANING
25.01 SCOPE
25.02 GENERAL
25.03 STOCKPILE OF MATERIAL
25.04 EQUIPMENT
25.05 CONSTRUCTION METHODS
25.06 MEASUREMENT AND PAYMENT
SECTION 25.00 ASPHALT PLANING

25.01 Scope
This specification specifies equipment and methods to be used for the cold planing of existing pavement surfaces to the specified depth and the removal and disposal of the planed material.

25.02 General
The Contractor shall provide a planed and finished surface free from gouges, sooting, oil film, and other imperfections. The completed planed surface shall have a uniform textured appearance. The existing asphalt shall be planed to the depth specified ±1/4" with a 2% crown unless otherwise specified.

The planing depth shall be measured at the existing outside edge of the gutter pan on both sides of the roadway to establish a new elevation prior to overlaying. Additional planing depth may be required near the roadway centerline to achieve the desired roadway cross section.

25.03 Stockpile of Material
Stockpiling of planed materials or cuttings will not be permitted on the project site. All planed materials shall be delivered and stockpiled as directed by the Project Manager and shall become the property of the City, unless otherwise specified or directed.

25.04 Equipment
A cold planing machine shall be used by the Contractor to perform the planing operation. The equipment shall be sufficient to maintain adequate depth of cut and slope within specified tolerance. The equipment shall be capable of accurately and automatically establishing a finish profile grade along each edge of the machine within 1/4" of the specified depth.

The planing machine shall be equipped with an integral loading mechanism to immediately remove the bulk of the materials being cut from the surface of the roadway and discharge into a truck. The machine shall be equipped with a means to control the dust created by the cutting action and shall meet all local, state, and federal air pollution laws.

The Contractor shall provide adequate backup equipment (mechanical street sweepers, loaders, water truck, etc.) and personnel to insure that all cuttings are cleaned up and removed from the roadway daily.
25.05 Construction Methods

25.05.1 The Project Manager may require that the pavement planing operation be referenced from an independent grade control at his discretion.

25.05.2 In any area where the pavement has not been planed full width, leaving a vertical edge greater than 1" in the longitudinal or transverse direction, this edge shall be sloped at a maximum rate of 1" depth per 1’ horizontal.

25.05.3 The planing machine shall be removed when approaching manholes, inlets, valve boxes, and other obstructions that have not been lowered. Asphalt around these obstructions shall be removed by other means to the required depth prior to placement of the overlay. If overlay operations are not performed immediately after planing, the Project Manager may require the installation and removal of a temporary HBP transition. However, overlay must be completed within seven days of the planing operation. Allowable transition taper shall be not greater than 1/4" vertical rise per 1’ horizontal. Such tapers shall be removed to the required depth prior to the placement of the overlay. Where traffic must utilize the planed roadway prior to completion of the overlay, the Project Manager may require the installation and removal of temporary HBP transitions around appurtenances and obstructions.

25.05.4 Curbs, gutters, drainage structures, and other surfaces shall be cleaned of debris at the completion of the project and before opening to traffic.

25.05.5 The Contractor shall prevent the spread of dust and debris during the performance of the work. Where equipment comes into contact with tree branches or other plant material, the Contractor shall exercise caution to avoid damage to trees, shrubs, and other plant material. All trimming shall be performed as directed by the Project Manager.

25.06 Measurement and Payment

Planing shall be measured by the square yard for each depth specified. The Contract unit price per square yard shall include all labor and equipment to complete the work as specified including delivering and stockpiling or disposal of the planed material as directed.
27.01 GENERAL

27.01.1 PURPOSE Surface treatments referred to and used per this section are to be applied to asphalt concrete pavements only. The purpose of these treatments is to seal major and minor cracks in the pavement surface thereby preventing water infiltration into the pavement structure and subgrade thus prolonging the pavement life.

When surface treatments are applied by contract, Contractor shall be responsible for full compliance with all portions of these specifications unless otherwise noted.

Specifications contained in this section shall supplement specifications in Section 24.00 Hot Bituminous Pavement.

27.01.2 DEFINITIONS The surface treatments referred to in this section are generally defined below:

SLURRY SEAL – A minimal surface treatment consisting of bituminous emulsion and fine aggregate material.

CHIP SEAL – A surface treatment consisting of bituminous emulsion and aggregate material sized at least ¼ inch usually covered with a fog seal.

CAPE SEAL – A surface treatment consisting of a chip seal treatment covered by a slurry seal treatment.

HOT CHIP SEAL – A surface treatment consisting of a chip seal treatment covered by a hot chip seal application.

CRACK SEAL – A surface treatment consisting of bituminous sealant and possibly aggregate used to fill and seal larger surface cracks.

27.01.3 GENERAL CONSTRUCTION REQUIREMENTS The following construction requirements shall apply to construction of all surface treatments within this section, unless otherwise specified or directed by the Project Manager. Modifications or additions to these requirements may be contained within the specification for each treatment.

27.01.3.01 Surface Preparation

27.01.3.01.1 General Immediately prior to applying any surface treatment, the street surface and gutters shall be cleaned of all loose material, silt spots, oil spots, vegetation, and other objectionable material for the full width of the area to be treated. Dust and other material in depressions or other places not removed by mechanical sweepers shall be swept with hand...
brooms or removed by use of flushers. The Project Manager may require washing of the pavement where other methods of cleaning do not provide an acceptable surface. Material removed from the surface shall not be mixed with the cover aggregate. Bituminous material shall not be spread until the area to receive a surface treatment application has been cleaned to the satisfaction and approval of the Project Manager.

All vegetation shall be removed from the area to receive a surface treatment prior to placement of any surface treatment. This work shall be performed within two weeks of the surface treatment. All dead or remaining vegetation shall be removed prior to sweeping of the area and application of surface treatment. Vegetation may be removed by burning when in the opinion of the Project Manager such burning causes no safety hazard or air pollution nuisance.

27.01.3.02 Manholes, Valve Boxes and Survey Monuments, etc.

27.01.3.02.1 Protection and Cleaning Manholes, valve boxes, survey monuments, inlets, etc, shall be protected and covered in a suitable manner prior to application of any surface treatment. This covering shall be removed immediately after the surface treatment is applied or as specified for each surface treatment or as directed by the Project Manager. All covering material shall be disposed of in a lawful manner. All manholes, valve boxes, survey monuments, inlets, etc, shall be cleaned to the satisfaction of the Project Manager when work is completed.

27.01.3.02.2 Locates All manholes, valve boxes, and survey monuments within the project area shall be located prior to construction to the satisfaction of the Project Manager. All appropriate utilities and representatives shall be contacted and met as necessary to fully identify and locate all such items within the work area. Work shall not commence until all such items have been located to the satisfaction of the Project Manager. When surface treatment work is performed by contract, Contractor shall comply with this section at no additional cost to the City.

27.01.3.03 Quality Control

27.01.3.03.1 Materials Samples of the aggregate and asphalt emulsion used in surface treatments shall be obtained at the Project Manager’s discretion.
Gradation and sand equivalent tests may be run on the aggregate and consistency and residual asphalt content tests on the emulsion. Samples of material may be taken directly from the mixing and/or application unit(s). Test results will be compared to specifications. Initial tests will be run at the expense of the City. For surface treatment work that is performed by contract, Contractor shall assist the Project Manager in obtaining samples of the aggregate and asphalt emulsion used in the project at the Project Manager’s discretion.

Each load of emulsified asphalt shall be accompanied by a certification of Analysis and Compliance. Emulsions shall show no separation after mixing.

The Project Manager may use the recorders and measuring facilities of the unit to determine application rates, asphalt emulsion content, mineral filler, and additive.

**27.01.3.03.2 Noncompliance** If any two (2) consecutive tests fail on any stockpile material, the job shall be stopped. If any two (2) successive tests on the approved material from the same machine fail, the use of that machine shall be suspended. When surface treatment work is performed by contract, it shall be Contractor’s responsibility, at their own expense, to prove to the Project Manager’s satisfaction that the material problems have been corrected and that the machine is operating within manufacturer specifications.

**27.01.3.04 STORAGE SITE REQUIREMENTS** Job materials and equipment may be stockpiled and stored at locations near the job site. A list of sites to be used for this purpose and written permission from the property owner shall be submitted to the Project Manager for approval at least ten (10) days prior to any use. The proposed truck route for ingress and egress to such sites shall also be submitted to the Project Manager for approval. Using such job-site storage requires the following:

A. Obtaining written permission from the property owner, which shall include a brief description of the area of the property to be used, the length of time the property will be used for this purpose, any access restrictions (i.e. times of day), and the name and phone number of the property owner. A copy of the written permission shall be submitted
to the Project Manager at least one week prior to delivery of material to the site.

B. Keeping stockpiles and equipment confined to the approved area.

C. Providing security for job materials and equipment and for public safety at the site.

D. Keeping all access roads clean and in good condition.

E. Returning site to original condition.

When surface treatment work is performed by contract, Contractor shall be responsible for compliance with all requirements of this section. Contractor shall hold the City of Aurora and all its employees and representatives harmless from any injury or damage to property occurring as a result of Contractor’s operations on property used for this purpose.

**27.01.3.05 Traffic Control**

**27.01.3.05.1 General** Traffic shall be directed through the project with signs, barricades, flag persons or pilot cars as necessary to protect the work and safety of the public.

Roadway traffic shall be maintained safely, adequately, and continuously on all portions of existing roads, detours, and cross roads affected by surface treatment work in accordance with the provisions of Section 50.00 Traffic Control. Whenever traffic signal power lines and/or loop detection lines are located within the limits of a proposed construction area, the Traffic Engineer shall be contacted a minimum of 48 hours in advance to have the lines located to insure continuity of the signal.

When surface treatment work is performed by contract, Contractor shall be responsible for all traffic control in the construction area and compliance with all requirements of this section.

**27.01.3.05.2 Street Closures** Traffic may be detoured if detours are properly erected and maintained, as approved by the Traffic Engineer. All detours must be requested with the proper permits, as they apply to street closures and traffic detours. This includes but is not limited to, proper notification to all authorities that may be affected by any street closure, such as Fire and Rescue, Law Enforcement Agencies and
Ambulance Services. A detailed Traffic Control Plan, showing the detour route is required. When streets are approved for closing, they shall not be closed prior to 7:00 a.m. or after 5:00 p.m. unless otherwise approved by the Project Manager and Traffic Engineer. Residents on streets to be closed shall be notified a minimum of two working days in advance with written notices (English & Spanish) distributed to each residence or business. Street signs advising of the closing shall be placed a minimum of 24 hours in advance of the operation. When surface treatment work is performed by contract, this shall be the responsibility of the Contractor.

**27.01.3.05.3 Temporary Pavement Markers** Temporary raised pavement markers shall be placed at the direction of the Project Observer, and shall be placed prior to the surface treatment operation. Tabs shall be placed at 40’ intervals on straight sections. At all turn lane tapers and curved markings, the tabs shall be placed at 25’ intervals. After the treatment has been placed and prior to any covering operation, the paper over the reflective tabs shall be removed from every other tab placed. After all cover operations are completed, all adhesive tabs shall be exposed. Any temporary markings shall conform to the existing City striping plans.

**27.01.3.05.4 Traffic Control Devices** All “Traffic Control” devices must meet the Manual of Uniform Traffic Control Devices (MUTCD) specifications and guidelines, and be approved by the Project Manager. Traffic control devices shall include cones, barricades and any such means as approved or required by the Traffic Engineer. When flaggers are required, they shall have no other duty than to direct traffic. Sufficient flaggers for traffic control shall be provided as directed by the Traffic Engineer.

Any and all traffic control devices shall be clean, in good working order and properly placed according to the approved traffic control plan prior to and during daily operations. If, in the opinion of the Project Manager and/or the Traffic Engineer, the traffic control measures are in any way inadequate, operations shall be stopped until proper traffic control measures are in place.
When surface treatment work is performed by contract, Contractor shall furnish, place and maintain all traffic control devices at Contractor’s expense and shall be responsible for compliance with the requirements of this section.

27.01.3.06 Notification

27.01.3.06.1 Notification Requirements All notices and signs required in this section shall be distributed and posted at a minimum of 48 hours in advance of the surface treatment operation. This includes, but is not limited to, notification forms, no parking and tow away signs and other means as deemed necessary by the Project Manager. If work does not occur on the specified day, new notification shall be distributed 48 hours in advance of the work. Car towing operations will only be authorized by the City after 24 hours of the above advance notice and posting of no parking signs.

27.01.3.06.2 Notification Forms Forms for resident and business notification shall be submitted to the Project Manager for approval prior to the start of construction and shall contain the following information at a minimum in both Spanish and English:

- Name, address and telephone number of the Contractor
- Description of the work (chip seal, slurry seal, etc.)
- Dates of the work (range of dates)
- Parking and/or access alternatives
- A contact person and local phone number for citizens’ questions (24 hour availability). If work is performed by contract, this contact person shall be supplied by Contractor.

A local telephone number must be located on the flyer and this telephone shall be manned 24/7 until the contract is completed. The Project Manager shall approve all notices prior to distribution.

27.01.3.06.3 Signs Signage for the purpose of public notification of impending work shall be furnished. These areas will be identified prior to the start of construction and as designated by the Project Manager. Public notification signs shall be affixed at locations approved by the Project
Manager at each end of the proposed construction areas. Signs shall be posted a minimum of FIVE WORKING DAYS in advance of the surface treatment. All signs shall be approved by the Traffic Engineer.

Signs shall be constructed of 0.100 gauge aluminum, alodine coated in accordance with ASTM-B209, 48"x 48" minimum with black lettering on an orange background. Signs shall be mounted and anchored using a suitable assembly. Details of the proposed signs and mounting apparatus shall be submitted to the Project Manager for review and approval.

Signs shall contain the following information at a minimum, type of operation, the scheduled week of work, and the phrase “ALTERNATE ROUTES ARE ADVISED”.

Any missing or defaced signs shall be replaced within 24 hours.

"NO PARKING” signs shall be placed a minimum of 24 hours in advance of any surface treatment operations on all streets to be treated.

“Fresh Oil” signs shall be posted in sufficient number and proper locations to adequately notify the public of such fresh oil.

Any other signs as required by the Traffic Engineer shall be placed.

When surface treatment work is performed by contract, Contractor shall supply and maintain all signs at Contractor’s expense.

27.01.3.07 Limitations on Work Times  Work on all arterial, collector, and cross streets shall not be allowed between the hours of 6:00 to 8:30 a.m. and 3:30 to 7:00 p.m. with exception of weekend work, Saturday and Sunday, or as directed by the Project Manager.

Limitations on work due to weather shall be as specified for each surface treatment type or as directed by Project Manager.

27.02 SLURRY SEAL

27.02.1 SCOPE  The bituminous slurry seal surface shall consist of properly proportioned and mixed mineral aggregate, asphalt emulsion, and water, spread evenly on the surface, as specified herein and as directed by the Project Manager. The slurry,
when cured, shall have a homogenous appearance, fill all cracks, adhere firmly to the existing asphalt surface, and provide a skid-resistant texture. The scope of this work consists of constructing a bituminous slurry seal surface on a prepared surface in accordance with these specifications and as shown on the plans or directed by the Project Manager.

Slurry mixes are divided into Type I, Type II, and Type III. Each type has unique emulsion and gradation requirements. Application of each type shall be specified by Project Manager. General uses are:

<table>
<thead>
<tr>
<th>TABLE 27.02.1</th>
<th>SLURRY MIX TYPES AND ASSOCIATED USES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I</td>
<td>Parking Areas, Rural and low volume Residential Streets</td>
</tr>
<tr>
<td>Type II</td>
<td>Residential and Low Volume Collectors Streets</td>
</tr>
<tr>
<td>Type III</td>
<td>High Volume Collector and Arterial Streets</td>
</tr>
</tbody>
</table>

27.02.2 MATERIAL REQUIREMENTS

27.02.2.01 Asphalt Emulsion  CQS-1hL (Cationic Quick Setting Emulsified Asphalt with 1% Latex Polymer). CQS-1hL shall be an emulsified blend of asphalt, water, styrene-butadiene rubber (SBR) latex and emulsifiers. The emulsion shall be pump absorbable and suitable for use in slurry seal mixing and spreading equipment and suitable for application through a distributor truck. The emulsion shall contain a minimum of one percent (1.0%) up to three percent (3.0%) by weight of styrene-butadiene rubber (SBR) polymer solids based on weight of residual asphalt. The percentage of polymer used will be determined by the type of application and traffic volume. The polymer shall be added as SBR latex by high shear mixing by co-milling or post-milling. The emulsified asphalt shall conform to the following requirements:

27.02.2.01.1 Tests on Emulsion

<table>
<thead>
<tr>
<th>TABLE 27.02.2.01.1</th>
<th>SLURRY SEAL EMULSION TEST REQUIREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, Saybolt Furol, 77°F, s</td>
<td>Min 50 Max</td>
</tr>
<tr>
<td>Storage stability test, 24-h, %*</td>
<td>1</td>
</tr>
<tr>
<td>Particle charge test</td>
<td>positive</td>
</tr>
<tr>
<td>Sieve test, %*</td>
<td>0.1</td>
</tr>
<tr>
<td>Distillation B</td>
<td>60</td>
</tr>
<tr>
<td>Residue, %</td>
<td></td>
</tr>
<tr>
<td>Polymer Content, %</td>
<td></td>
</tr>
</tbody>
</table>
27.02.2.01.2 Tests on Residue  The following test shall be completed on emulsion residue from oven evaporation test (ASTM D244 § 21 to 27) B:

**TABLE 27.02.2.01.2**

<table>
<thead>
<tr>
<th>SLURRY SEAL RESIDUE TEST REQUIREMENTS</th>
<th>Min</th>
<th>Max</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penetration, 77°F, 100g, 5s</td>
<td>40</td>
<td>90</td>
<td>ASTM D5</td>
</tr>
<tr>
<td>Penetration, 77°F, 100g, 5s</td>
<td>40</td>
<td></td>
<td>ASTM D113</td>
</tr>
<tr>
<td>Solubility in trichloroethylene, %</td>
<td>97.5</td>
<td></td>
<td>ASTM D113</td>
</tr>
<tr>
<td>Solubility in trichloroethylene, %</td>
<td>40</td>
<td></td>
<td>ASTM D113</td>
</tr>
</tbody>
</table>

A  This test requirement on representative samples is waived if successful application of the material has been achieved in the field.

B  Distillation to 500°F (D244 §11 to 15) shall be the reference method for percent distillate and percent residue. Residue by evaporation at 325°F (D244 §21 to 27) shall be the reference method to obtain material for tests on residue. Residue from distillation shall not be used for tests on residue due to polymer degradation at 500°F.

27.02.2.01.3 Emulsion Storage  Suitable storage facilities and containers for the asphalt emulsion shall be provided and shall be equipped to prevent water from entering the emulsion. If necessary, suitable heat shall be provided to prevent freezing.

27.02.2.02 Aggregate  The mineral aggregate shall be washed, hard, durable, clean rock and free from coatings or deleterious material, and clay balls. All of the aggregate shall be crushed gray granite with 100% fractured faces. The aggregate shall have a loss of no greater than 20% when tested with the LA Abrasion procedure as defined by ASTM C131, grade C or D. Only one type of aggregate shall be used and shall conform to the following gradations. The aggregate shall be gray in color.

Oversized granular material and or the presence of clay balls will require the project to be stopped. The total aggregate, including mineral filler, shall be tested and conform to the following requirements:

**TABLE 27.02.2.02**

<table>
<thead>
<tr>
<th>AGGREGATE SPECIFICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate Sampling</td>
</tr>
<tr>
<td>Unit Weight of Aggregate; 0-5% moisture by Rodding Procedure</td>
</tr>
<tr>
<td>Gradation</td>
</tr>
<tr>
<td>Resistance to Degradation</td>
</tr>
<tr>
<td>Soundness of Aggregate</td>
</tr>
<tr>
<td>Sand Equivalent Value</td>
</tr>
</tbody>
</table>
A. The reference method for preparation of the sample shall be as follows: The aggregate shall be oven dried at 140°F to a constant weight and allowed to cool to room temperature. Two percent (2.0%) of water based on weight of the aggregate shall be mixed with the aggregate and the aggregate-water mixture shall be sealed in a moisture proof and water proof container for a minimum of 24 hours. Complete using ASTM D2419 Procedure B.

27.02.2.02.1 Aggregate Gradation  Requirements for target mix design based on the Slurry Type specified.

**TABLE 27.02.2.02.1**

<table>
<thead>
<tr>
<th>SLURRY SEAL AGGREGATE GRADATION</th>
<th>TYPE I</th>
<th>TYPE II</th>
<th>TYPE III</th>
<th>Stockpile Tolerances</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIEVE SIZE</td>
<td>% PASSING</td>
<td>% PASSING</td>
<td>% PASSING</td>
<td>Stockpile Tolerances</td>
</tr>
<tr>
<td>3/8”</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>1/4”</td>
<td>100</td>
<td>90-100</td>
<td>70-90</td>
<td>+/- 4%</td>
</tr>
<tr>
<td>No.4</td>
<td>100</td>
<td>90-100</td>
<td>70-90</td>
<td>+/- 4%</td>
</tr>
<tr>
<td>No.8</td>
<td>90-100</td>
<td>65-90</td>
<td>45-70</td>
<td>+/- 4%</td>
</tr>
<tr>
<td>No.16</td>
<td>65-90</td>
<td>45-70</td>
<td>28-50</td>
<td>+/- 4%</td>
</tr>
<tr>
<td>No.30</td>
<td>40-65</td>
<td>30-50</td>
<td>19-34</td>
<td>+/- 4%</td>
</tr>
<tr>
<td>No.50</td>
<td>25-42</td>
<td>18-36</td>
<td>12-25</td>
<td>+/- 4%</td>
</tr>
<tr>
<td>No.100</td>
<td>15-30</td>
<td>10-24</td>
<td>7-18</td>
<td>+/- 3%</td>
</tr>
<tr>
<td>No.200*</td>
<td>10-20</td>
<td>5-15</td>
<td>5-15</td>
<td>+/- 2%</td>
</tr>
</tbody>
</table>

*Materials finer than No. 200 sieve will be determined by washing.

Aggregates used on the job site shall be within the specifications and within the stockpile tolerance of the aggregate used in the mix design.

27.02.2.02.2 Mineral Filler  Mineral fillers, such as Portland cement, limestone dust, lime, and fly ash shall be considered as part of the blended aggregate, and shall be used in the amount required. They shall meet the gradation requirements of ASTM D242. Mineral fillers shall be used for one or more of the following reasons only: to improve the gradation of the aggregate; to control the time of break of the emulsion; to provide improved stability and workability of the slurry; or to increase the durability of the cured slurry. (Use only materials as specified in the mix design)

27.02.2.02.3 Stockpiling of Aggregate  Precautions shall be taken to insure that stockpiles are carefully mixed just prior to use to insure uniform distribution of the moisture, and that they do not become contaminated with over-sized seed rock, clay, silt, or excessive amounts of moisture. The stockpile shall be kept in areas that drain readily. Segregation of the aggregate will not be permitted. If oversize material is present,
screening through a ¼” screen will be required prior to delivery to the slurry machine.

27.02.03 Water All water used in making the slurry shall be potable and free of dissolved materials that may affect the mix characteristics or finished characteristics of the product. The effect of moisture content on the specific weight of the aggregate, and the moisture content of the aggregate being used, shall be taken into account in calibrating the machine to deliver asphalt in the correct proportion.

27.02.04 Additives Additives may be used to accelerate or retard the break-set of the slurry seal or to improve the resulting finished surface. The use of the additives in the slurry mix (or individual materials) shall be made initially in quantities predetermined by the mix design with adjustments if required, after approval by the Engineer.

27.02.05 Laboratory Testing Sources of all materials shall be selected and identified. All materials shall be pre-tested by a qualified laboratory as to their suitability for use in slurry and conformance with project specifications. For materials placed by contract, Contractor shall be responsible for compliance with this section at Contractor’s expense.

27.02.06 Laboratory Report The laboratory report shall show the results of tests performed on the individual materials, comparing their values to those required by this specification. The report shall provide the following information:

<table>
<thead>
<tr>
<th>Test Description</th>
<th>Maximum Value</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet Track Abrasion Test - 6 day soak*</td>
<td>75g/ft² max</td>
<td>ISSA T100</td>
</tr>
<tr>
<td>Sand Adhesion by Loaded Wheel Tester</td>
<td>50g/ft² max</td>
<td>ISSA T109</td>
</tr>
<tr>
<td>Asphalt Content (based on dry aggregate)</td>
<td>7.5% - 13.5%</td>
<td>ISSA A105</td>
</tr>
</tbody>
</table>

*1 hour soak test not allowed as a substitute

27.02.07 Mix Design Submittals

27.02.07.1 General Before work commences, a mix design, signed and stamped by a Professional Engineer licensed to practice Civil Engineering, covering the specific materials to be used shall be submitted to the Project Manager. This design shall be prepared by an independent
laboratory qualified in slurry seal mix design and testing. Once the materials are selected, no substitution will be permitted unless first tested and approved by the laboratory preparing the mix design. The report shall include the laboratory testing results and laboratory reports per Sections 27.02.5 and 27.02.6.

27.02.07.2 Mix Design The qualified laboratory shall develop the job mix design and present certified test results to the Project Manager. Compatibility of the aggregate and emulsion shall be verified by the mix design. All component materials used in the mix design shall be representative of the material proposed for use on the project.

27.02.07.2.01 Specifications The Project Manager shall review the design mix and all materials and methods prior to use. The component materials shall be within the following limits.

<table>
<thead>
<tr>
<th>TABLE 27.02.07.2.01 COMPONENT MATERIAL MIX LIMITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residual Asphalt</td>
</tr>
<tr>
<td>Type I: 10 - 16%</td>
</tr>
<tr>
<td>Type II: 7.5 - 13.5%</td>
</tr>
<tr>
<td>Type III: 6.5 - 12%</td>
</tr>
<tr>
<td>(Based on dry weight of aggregate)</td>
</tr>
<tr>
<td>Mineral Filler</td>
</tr>
<tr>
<td>0% to 3% by dry weight of aggregate</td>
</tr>
<tr>
<td>Additive</td>
</tr>
<tr>
<td>As required to provide the specified properties</td>
</tr>
<tr>
<td>Water</td>
</tr>
<tr>
<td>As required to produce proper mix consistency.</td>
</tr>
<tr>
<td>(Total mix liquids should not exceed the loose aggregate voids. ISSA T106 shall be used to check optimum liquids.)</td>
</tr>
</tbody>
</table>

27.02.07.2.02 Trial Mix Characteristics A sufficient number of variations of the mix design shall be shown to provide the applicator with an indication of the effects of changing filler rate, additive rate, etc.

<table>
<thead>
<tr>
<th>TABLE 27.02.07.2.02 TRIAL MIX CHARACTERISTICS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mix Characteristics</td>
</tr>
<tr>
<td>No excess free liquids in mix No excessively dry or stiff mix</td>
</tr>
<tr>
<td>ISSA T113/3.5</td>
</tr>
<tr>
<td>Mix Time at 77°F</td>
</tr>
<tr>
<td>180 seconds minimum</td>
</tr>
<tr>
<td>ISSA T113/3.6</td>
</tr>
<tr>
<td>Mix Time at 100°F</td>
</tr>
<tr>
<td>120 seconds minimum</td>
</tr>
<tr>
<td>ISSA T113/3.6</td>
</tr>
<tr>
<td>Set Time at 77°F</td>
</tr>
<tr>
<td>Displacement</td>
</tr>
<tr>
<td>30 minutes maximum</td>
</tr>
<tr>
<td>ISSA T113/3.7</td>
</tr>
<tr>
<td>Clear blot</td>
</tr>
<tr>
<td>30 minutes maximum</td>
</tr>
<tr>
<td>ISSA T113/3.8</td>
</tr>
</tbody>
</table>
Cured Trial Mix Evaluation (24hr-77°F cured mix from ISSA T113/3.6 - 30 second mix)

A sufficient number of variations shall be shown to provide the applicator with an indication of the effects of changing filler rate, additive rate, etc.

**TABLE 27.02.2.07.2.02.1**
CURED TRIAL MIX EVALUATION REQUIREMENTS

<table>
<thead>
<tr>
<th>Surface Examination</th>
<th>No tackiness</th>
<th>No shininess</th>
<th>ISSA T113/4.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fines Flotation</td>
<td>No fines flotation</td>
<td>ISSA T113/4.2</td>
<td></td>
</tr>
<tr>
<td>Internal Adhesion</td>
<td>95% minimum coating, all size particles securely held in mix, asphalt/aggregate segregation</td>
<td>ISSA T113/4.3</td>
<td></td>
</tr>
</tbody>
</table>

Wet Stripping Test modified to a 10 minute boiling period (ISSA T114) (24hr 77°F cured mix from ISSA T113/3.6 - 30 second mix)

A sufficient number of variations shall be shown to provide the applicator with an indication of the effects of changing filler rate, additive rate, etc.

**TABLE 27.02.2.07.2.02.2**
WET STRIPPING REQUIREMENTS

<table>
<thead>
<tr>
<th>Coated aggregate</th>
<th>ISSA T114</th>
<th>95% minimum coating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrity</td>
<td></td>
<td>report: solid, broken, crumbly, etc.</td>
</tr>
<tr>
<td>Cohesion Values at 77°F</td>
<td>ISSA T139</td>
<td>30 min</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12 minimum</td>
</tr>
<tr>
<td></td>
<td></td>
<td>60 min (report this value)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 hr (report this value)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 hr (report this value)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>24 hr solid spin (26 in-lb)</td>
</tr>
</tbody>
</table>

**27.02.2.07.3 Job Mix Recommendation and Comments**  The laboratory shall calculate the minimum slurry application rate for large stone embedment based on measured maximum aggregate size retained on #4 sieve and bulk dry density by rodding procedure.

The laboratory shall report the quantitative effects of moisture content on the unit weight of the aggregate (bulking effect). The laboratory report must clearly show the proportions of aggregate, mineral filler (min. and max.), water (min. and max.), additive(s) (usage), and asphalt based on the dry aggregate weight.
A complete laboratory analysis and test report accompanied by abraded and unabraded slurry test samples shall be submitted to the Project Manager a minimum of two weeks prior to use. The Project Manager shall be allowed to observe all testing.

27.02.3 CONSTRUCTION REQUIREMENTS

27.02.3.01 Public Notice Public notification shall comply with Section 27.01. When slurry seal work is performed by contract, Contractor shall be responsible for compliance with all requirements for public notification.

27.02.3.02 Work Limitations In addition to the limitations in Section 27.01, slurry shall not be applied when any of the following weather conditions exist:

- When there is any danger the finished product will freeze before it cures completely.
- When the pavement and/or air temperature is 55°F or below.
- When precipitation is possible prior to complete cure of the mix.
- In the period following precipitation while puddles of water remain on the surface to be coated.

Slurries that cure by evaporation shall not be placed during periods of abnormally high humidity, or when precipitation may fall within a few hours of placement.

27.02.3.03 Equipment

27.02.3.03.1 General All equipment, tools, and machines used in the performance of this work shall be maintained in satisfactory working order at all times. Any equipment found to be defective and potentially affecting the quality of the slurry application shall be replaced.

27.02.3.03.2 Slurry Mixing Equipment The slurry mixing machine shall be a double shafted continuous flow mixing unit, capable of delivering accurate predetermined proportions of aggregate, water, and asphalt emulsion to a revolving spiraled multi-blade mixer tank, and of discharging the thoroughly-mixed product on a continuous basis. The aggregate shall be pre-wetted immediately prior to mixing with the emulsion. The mixing unit shall be capable of thoroughly blending all ingredients together without violent action. The mixing machine shall
be equipped with suitable means of accurately metering each individual material being fed into the mixer. The units shall be equipped with approved devices so that the machine can be accurately calibrated and the quantities of materials used during any one period estimated. The mixing machine shall be equipped with a water pressure system, and fog type spray bar adequate for completely fogging the surface with up to 0.055 gallons per square yard (depending on conditions and as directed by the Project Manager), immediately ahead of the spreading equipment. The machine shall be capable of mixing materials at preset proportions regardless of the speed of the machine engine, and without changing machine settings.

27.02.3.03.3 Proportioning Devices  Individual volume or weight controls for proportioning each material to be added to the mix, i.e., aggregate, mineral filler, emulsified asphalt, and water shall be provided and properly marked. These proportioning devices are usually revolution counters, gate valves, or similar devices and are used in material calibration and regulating of materials output.

27.02.3.03.4 Slurry Spreading Equipment  The spreader box shall be equipped to prevent loss of slurry seal from all sides and with a flexible rear strike-off. It shall have mechanical mixing augers in both the front and rear of the box. It shall be capable of producing a uniform surface along its full width. It shall have suitable means for side tracking to compensate for deviations in pavement geometry. Any type of drag used shall be approved by the Engineer and kept in a completely flexible condition at all times. The box shall be kept clean and buildup of asphalt and aggregate shall not be permitted.

27.02.3.03.5 Surface Preparation Equipment  Suitable Power brooms, power blowers, air compressors, and hand brooms for cleaning the base surface and cracks therein shall be supplied.

27.02.3.03.6 Auxiliary Equipment  Hand squeegees, shovels, and other equipment necessary to perform this work shall be provided in suitable condition.
27.02.3.04 Surface Preparation

27.02.3.04.1 Tack Coat  A tack coat will be required when the surface is extremely dry and raveled, concrete, brick, or as otherwise determined by the Project Manager.

When a tack coat is required, the tack coat shall consist of two part emulsion, to two parts water. The emulsion to be used shall be the same emulsion used for the specific surface treatment. Tack coat emulsion shall be applied with an asphalt distributor capable of applying the tack coat evenly across the pavement surface at a rate of 0.05 to 0.10 gallons per square yard. The application rate shall range between 0.05 and 0.10 gallons of the diluted emulsion per square yard of surface area. Tack shall be evenly distributed across the pavement surface. The tack coat shall be allowed to break prior to application of the surface treatment.

The distributor, when not spreading, shall be parked so that the spray bar or mechanism will not drip bituminous materials onto the surface of the street, gutters or private property. During all applications, the surface of adjacent structures shall be protected in such a manner as to prevent their being spattered or marred. Any areas inaccessible to the distributor shall be sprayed by hand. All sidewalks, gutters or other surfaces where spatter is excessive, in the opinion of the Project Manager, shall be immediately cleaned to the satisfaction of the Project Manager.

27.02.3.05 Application of Materials

27.02.3.05.1 Composition  The amount of asphalt emulsion to be blended with the aggregate shall be determined in the laboratory, subject to final adjustment in the field to allow for absorption by the existing surface. The amount of water added must be controlled accurately to insure production of product that can be readily applied, yet remain a completely stable slurry.
TABLE 27.02.3.05.1
MATERIAL APPLICATION RATES

<table>
<thead>
<tr>
<th>SLURRY MIX TYPE</th>
<th>LOCATION</th>
<th>APPLICATION RATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I</td>
<td>Parking Areas, Rural and low volume Residential Streets</td>
<td>8-12 lb/yd²</td>
</tr>
<tr>
<td>Type II</td>
<td>Residential and Low Volume Collector Streets</td>
<td>16-20 lb/yd²</td>
</tr>
<tr>
<td>Type III</td>
<td>High Volume Collector and Arterial Streets</td>
<td>20-30 lb/yd²</td>
</tr>
</tbody>
</table>

Proper water content shall be determined by an appropriate consistency test on freshly made slurry using ISSA T 106 procedures.

**27.02.3.05.1.01 Mix Stability** The slurry mixture shall be sufficiently stable during the entire mixing/spreading period so that premature breaking of the material in the spreader box does not occur. The mixture shall be homogenous during and following mixing and spreading; it shall be free of excess water or emulsion and free of segregation of the emulsion and aggregate fines from the coarse aggregate. Total time of mixing, from introduction of emulsion to spreading shall be two minutes or less.

**27.02.3.05.1.02 Quantities** For estimating purposes, the following proportions and application rates are assumed:

<table>
<thead>
<tr>
<th>Dry Aggregate Spread Rate</th>
<th>18 - 20 lb./SY</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Mineral Filler *</td>
<td>1.00%</td>
</tr>
<tr>
<td>% Asphalt Content *</td>
<td>8.0%</td>
</tr>
</tbody>
</table>

* By dry weight of aggregate

A test strip of 60 square yards shall be placed in the area designated by the Project Manager. The test section shall be placed using the same equipment and methods to be used on the job. Slurry mixtures placed in test strips shall conform to design mix with minor variations to obtain crack filling, bond to pavement, and desired skid resistant texture. In the event the materials do not meet the requirements for fluidity, non-segregation, or surface texture, a new job mix shall be formulated and tested. Work shall not proceed before approval of a design mix, application rates, and acceptance of the test strip.
27.02.3.05.2 Application of Slurry Mix

27.02.3.05.2.01 General The surface shall be fogged with water directly preceding the spreader if required. The slurry mixture shall be of the desired consistency as it leaves the mixer, and no additional elements shall be added. A sufficient amount of slurry shall be carried in all parts of the spreader at all times so that complete coverage is obtained. No lumping, balling, or unmixed aggregates shall be permitted. No segregation of the emulsion and aggregate fines from the coarse aggregate will be permitted. If the coarse aggregate settles to the bottom of the mix, the slurry will be removed from the surface. No excessive breaking of the emulsion will be allowed in the spreader box. No streaks, as caused by oversized aggregate, will be left in the finished pavement. Rippling of the finished surface is undesirable and shall be minimized.

27.02.3.05.2.02 Joints No excessive build-up or unsightly appearance shall be permitted on longitudinal or transverse joints. Burlap drags or other type drags may be required at the discretion of the Project Manager. When drags are used, they must be kept relatively clean and free of excessive build-up. Joints shall be straight and have a neat appearance.

27.02.3.05.2.03 Hand Work Approved squeegees shall be used to spread slurry in areas not accessible to the slurry mixer. Every effort shall be made to minimize segregation during hand work. Material shall be placed as close to final position as practicable to reduce the amount of hand work. Care shall be exercised as to leave a pleasing appearance.

27.02.3.05.2.04 Lines Care shall be taken to insure straight lines along curbs, shoulders, and joints. No runoff on these areas will be permitted. Lines at intersections will be kept straight to provide a good appearance. At no point shall the limits of the slurry mix be spread greater than two inches beyond the lip of curb.

27.02.3.05.2.05 Curing Slurry surfacing shall be completed within a time frame to allow opening of the roadway, parking lot, or other resurfaced
area within normal working hours, while providing sufficient cure time. The goal is a 4 hour break time for traffic.

**27.02.3.05.2.06 Machine Speed** In order to minimize rippling, slurry machines shall not be permitted to travel in excess of 220 ft/min. This speed may be further reduced by the Project Manager if excessive rippling of the surface, due to machine speed, occurs.

**27.02.3.05.2.07 Rolling** Slurry Seal shall be rolled by a self propelled, 10-ton pneumatic roller with a tire pressure of 50 PSI (3.4 ATMS), equipped with a water spray system. The surface areas shall be subjected to a minimum of two (2) full coverage passes by the roller. Rolling shall not commence until the slurry has cured enough so that it will not pick up on the tires of the roller.

**27.02.3.06 Manholes, Valve Boxes and Survey Monuments** All shall be protected as specified in Section 27.01

**27.02.3.07 Quality Control** In addition to the requirements of Section 27.01, samples of materials and of the finished slurry surface shall be furnished as directed by the Project Manager during progress of the work at no expense to the City. Test reports shall be required as additional materials arrive. The Project Manager will conduct testing as required during the project.

**27.02.3.08 Storage Site Requirements** On or near job site storage may be approved by the Project Manager. Selected sites and permissions to use said sites shall comply with Section 27.01.

**27.02.3.09 Traffic Control** All traffic control shall conform to Section 27.01.

**27.02.4 BASIS OF PAYMENT** The accepted quantities of slurry seal will be paid for at the contract prices for the slurry seal mix used, which includes all material components of the mix, including additives, and required testing for design, minus any reduction for noncompliance with approved aggregate and emulsion application rates. There will be no separate payment for additional additives used. Payment shall include all equipment, labor, materials, overhead, incidentals, mobilization, and traffic control required to complete the work as described in the specifications.

Application rates shall be set to match the approved mix design. The range of acceptable aggregate, and emulsion rates are shown in Section 27.02.3.05 of this
specification. These ranges may be modified by the Project Manager but in no case shall the ranges exceed plus or minus 10% of the application rates of the approved mix design. At the conclusion of the project, emulsion, mineral filler and aggregate tickets will be compared with the area of slurry seal placed to determine the average coverage rates for the project. Any material delivery tickets in excess of the maximum application rates will be subject to nonpayment. If the material delivery tickets indicate that the average application rates were below the minimum application rates, the final payment will be reduced as shown below:

<table>
<thead>
<tr>
<th>TABLE 27.02.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>TABLE OF PRICE REDUCTION FACTORS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Amount Below Minimum Application Rate, Aggregate or Emulsion</th>
<th>Percentage Reduction in Final Payment for Aggregate or Emulsion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 3%</td>
<td>10%</td>
</tr>
<tr>
<td>3 – 5%</td>
<td>15%</td>
</tr>
<tr>
<td>5 - 7%</td>
<td>20%</td>
</tr>
<tr>
<td>7 – 10%</td>
<td>To be negotiated</td>
</tr>
<tr>
<td>10%+</td>
<td>No pay</td>
</tr>
</tbody>
</table>

Quantity run sheets of placed material shall be supplied to the Project Manager daily.

Weight tickets for cover coat aggregate and gallons of CQS-1hL actually used on the project shall be furnished to the Project Manager. Such tickets shall serve as a check on the application rate. The Project Manager shall be notified prior to delivery of materials so that a representative may be present to collect delivery receipts. In lieu of the weight tickets for aggregate application rate verification, Contractor may submit verified spread rates by calibration of equipment used. This calibration shall be done at the start of the job and on a monthly basis or as directed by the Project Manager.

**Contractor is solely responsible for assuring proper spread rates by means of equipment calibration submitted.**

Quantities for payment will be calculated based on length and width of roadway and approved application rate. Payment will be made under:

<table>
<thead>
<tr>
<th>PAY ITEMS</th>
<th>PAY UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slurry Seal</td>
<td>Square Yard</td>
</tr>
</tbody>
</table>
27.03 CHIP SEAL

27.03.1 SCOPE This item shall consist of furnishing all labor, materials, and equipment necessary to complete, in place, the application of polymerized emulsified asphalt and a cover coat of aggregate to street surfaces.

27.03.2 MATERIAL REQUIREMENTS

27.03.2.01 Asphalt Emulsion Polymerized cationic rapid set emulsified asphalt (CRS-2P), or equivalent, shall be an emulsified blend of polymerized asphalt, water, emulsifiers, and polymer. The asphalt cement shall be polymer modified prior to emulsification and shall contain a minimum of 3% styrene-butadiene-styrene (SBS) block copolymer by weight of asphalt cement. The emulsion, standing undisturbed for a minimum of 24 hours, shall show no milky white separation, but shall be smooth and homogeneous throughout. The emulsion shall be pumpable and suitable for application through a distributor truck. The CRS-2P shall conform to the following specifications.

27.03.2.01.1 Tests on Emulsion

<table>
<thead>
<tr>
<th>Emulsion Test</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, Saybolt Furol, 122°F,s</td>
<td>80</td>
<td>400</td>
<td>ASTM D88</td>
</tr>
<tr>
<td>Storage Stability Test, 24-h,%(a)</td>
<td></td>
<td>1</td>
<td>ASTM D244</td>
</tr>
<tr>
<td>Demulsibility, 36 ML, 0.8% dioctyl sodium sulfosuccinate, % (c)</td>
<td>40</td>
<td></td>
<td>ASTM D244</td>
</tr>
<tr>
<td>Particle Charge Test</td>
<td>Positive</td>
<td></td>
<td>ASTM D244</td>
</tr>
<tr>
<td>Sieve Test, %(a)</td>
<td>0.1</td>
<td></td>
<td>ASTM D244</td>
</tr>
<tr>
<td>Distillation: (b)</td>
<td></td>
<td></td>
<td>ASTM D244</td>
</tr>
<tr>
<td>Oil Distillate, by Volume of Emulsion, %</td>
<td>3</td>
<td></td>
<td>ASTM D244</td>
</tr>
<tr>
<td>Residue, %</td>
<td>60</td>
<td></td>
<td>ASTM D244</td>
</tr>
</tbody>
</table>

a) This test requirement on representative samples is waived if successful application of the material has been achieved in the field.

b) Residue by evaporation at 325 °F shall be the reference method to obtain material for tests on residue. Residue from distillation shall not be used for tests on residue due to polymer degradation at 500 °F.
27.03.2.01.2 Tests on Residue

### TABLE 27.03.2.01.2

<table>
<thead>
<tr>
<th>Residue Test</th>
<th>Requirement</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penetration, 77°F, 100g, 5s</td>
<td>70</td>
<td>150</td>
</tr>
<tr>
<td>Ductility, 77°F, 5 cm/min, cm</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>Ductility, 39.5°F, 5 cm/min, cm</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Solubility in Trichloroethylene, %</td>
<td>97.5</td>
<td></td>
</tr>
<tr>
<td>Toughness, in-lb</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>Tenacity, in-lb</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Elastic Recovery, 77°F, 10cm, 1h, %</td>
<td>80</td>
<td></td>
</tr>
</tbody>
</table>

- **c)** This test requirement on representative samples is waived if successful application of the material has been achieved in the field.
- **d)** Residue by evaporation at 325°F shall be the reference method to obtain material for tests on residue. Residue from distillation shall not be used for tests on residue due to polymer degradation at 500°F.
- **e)** The Demulsibility test shall be made within 30 days from the date of shipment.
- **f)** Distillation shall be determined by AASHTO test T 59, oven evaporation method.
- **g)** The asphalt cement shall be polymerized prior to emulsification.
- **h)** Contractor shall supply samples for testing upon request of the City.
- **i)** The material shall be accepted at the distributor.

A one-quart sample of the final emulsion shall be submitted upon request. The source of the base asphalt, polymer, additives, and supplier shall be stated on the sample and shall not change during the course of construction.

27.03.2.01.3 Emulsion Storage  Suitable storage facilities and containers for the asphalt emulsion shall be provided and shall be equipped to prevent water from entering the emulsion. If necessary, suitable heat shall be provided to prevent freezing.

27.03.2.02 Aggregate Cover Coat Material (Chip Seal)  The chip, or aggregate cover coat, shall be washed, hard, durable, clean rock and free from coatings or deleterious material and clay balls. The presence of oversized material and/or clay balls shall be grounds for the project to be stopped. All of the aggregate shall be crushed gray granite with 100% fractured faces. The aggregate shall have a loss of no greater than 20% when tested with the LA Abrasion procedure as defined by ASTM C131, grade C or D. Only one type of aggregate shall be used and shall conform to the following gradations. The aggregate shall be gray in color.
**27.03.2.02.1 Gradation** The total cover aggregate shall be tested and conform to the following gradation:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>½” Chip Seal</th>
<th>3/8” Chip Seal</th>
<th>¼” Chip Seal</th>
</tr>
</thead>
<tbody>
<tr>
<td>¹/₄”</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>5/8”</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>½”</td>
<td>95-100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>⅜”</td>
<td>0-60</td>
<td>95-100</td>
<td>100</td>
</tr>
<tr>
<td>¼”</td>
<td>0-10</td>
<td>0-35</td>
<td>95-100</td>
</tr>
<tr>
<td>No. 8</td>
<td>0-3</td>
<td>0-3</td>
<td>0-3</td>
</tr>
<tr>
<td>No. 200</td>
<td>0-1.2</td>
<td>0-1.2</td>
<td>0-1.2</td>
</tr>
</tbody>
</table>

**27.03.2.02.2 Bituminous Film** When tested in accordance with (ASTM D 1664), the aggregate shall have a retained bituminous film above 95%. Aggregates that do not meet this requirement may be used for surface treatments and seal coats provided a satisfactory chemical additive or wetting agent is used to provide a water-resistant film. Use of chemical additives or wetting agents is subject to prior approval by the Project Manager.

**27.03.2.02.3 Moisture Content** The cover coat material shall be moistened with water to eliminate or reduce any dust coating of the aggregate. This will eliminate surface tension between the aggregate and the emulsified oil which improves the bond. The moisture content of the cover aggregate at the time of application shall not exceed 2% of the weight of dry aggregate.

**27.03.2.02.4 Stockpiling of Aggregate** Precautions shall be taken to insure that stockpiles are carefully mixed just prior to use to insure uniform distribution of the moisture, and that they do not become contaminated with over-sized seed rock, clay, silt, or excessive amounts of moisture. The stockpile shall be kept in areas that drain readily. If oversize material is present, screening will be required prior to delivery to the spreader.

**27.03.2.03 Laboratory Testing** Sources of all materials shall be selected and identified. All materials shall be pre-tested by a qualified laboratory as to their suitability for use in chip seal and conformance with project
specifications. For materials placed by contract, Contractor shall be responsible for compliance with this section at Contractor’s expense.

27.03.2.04 Laboratory Report The laboratory report shall show the results of tests performed on the individual materials, comparing their values to those required by this specification.

27.03.3 CONSTRUCTION REQUIREMENTS

27.03.3.01 Public Notice Public notification shall comply with Section 27.01. When chip seal work is performed by contract, Contractor shall be responsible for compliance with all requirements for public notification.

27.03.3.02 Work Limitations In addition to the work limitations specified in Section 27.01, no construction of a chip seal application shall occur when either the ambient or pavement surface temperature fall below the table below or when the pavement is moist or when the weather is or may be detrimental. Detrimental weather is defined as rain showers, cool temperatures, moist pavements, threat of rain showers, or other environmental factors which could affect the performance of the chip seal. Emulsion application rate shall be adjusted accordingly, depending on current temperatures within the material application specifications.

<table>
<thead>
<tr>
<th>TEMPERATURE</th>
<th>1/2&quot; Chipseal</th>
<th>3/8&quot; Chipseal</th>
<th>¼&quot; Chipseal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Temperature (minimum)</td>
<td>≥65°F</td>
<td>≥65°F</td>
<td>≥60°F</td>
</tr>
<tr>
<td>Ambient Temperature (daily high)</td>
<td>≥70°F</td>
<td>≥70°F</td>
<td>≥65°F</td>
</tr>
</tbody>
</table>

27.03.3.03 EQUIPMENT

27.03.3.03.1 General The size and condition of all equipment shall be approved prior to construction. Should any equipment be unsatisfactory for whatever cause, the equipment shall be removed and replaced without delay or cost. The equipment shall conform to the following minimum requirements.

27.03.3.03.2 Bituminous Distributor: A minimum of two (2) like distributors shall be used. The distributors shall be self-powered and capable of providing a uniform application rate of emulsion varying from .05-1.00 gallons per square yard over a variable width up to twenty feet in a
single pass. The uniformity of the distributors shall not vary by more than two-hundredths (0.02) gallons per square yard. The distributors shall be equipped with a variable power unit for the pump and full circulation spray bars, which are adjustable laterally and vertically. The nozzle angle and bar height shall be set to provide one hundred percent of double coverage in a single pass. Where multiple passes are required to complete the full width, the four inches adjacent to the second pass may be left with fifty percent coverage so that the next pass will complete the full application rate specified. Distributors shall be self-powered and include computerized application controls, a tachometer, pressure gauges, accurate volume devices, calibrated tank, and a thermometer for measuring temperatures of the emulsion in the tank. Necessary precautionary measures shall be taken to prevent diesel fuel or other cleaning solvents from contaminating bituminous material.

27.03.3.03.3 Aggregate Spreader  The aggregate spreader shall be self-propelled and supported by at least four tires on two axles capable of providing a uniform application rate of aggregate from five to fifty pounds per square yard over a variable width up to twenty feet in a single pass. The uniformity of this machine shall not vary by more than one pound per square yard. The aggregate spreader shall be equipped with the means of applying the cover coat material to the surface with computerized application controls so that the required amount of material will be deposited uniformly over the full width of the bituminous material. A computerized rate control aggregate spreader shall be required. Other types of aggregate spreaders may be used provided they accomplish equivalent results and are previously approved.

27.03.3.03.4 Rollers  A minimum of two (2) rubber-tired rollers shall be used on the project unless otherwise requested by the Project Manager. The pneumatic tired rollers shall be self-propelled and the gross load adjustable to apply 200 to 350 pounds per inch of rolling width, as directed. Tire pressures or contact pressures may be specified for the pneumatic tire rollers. Tire pressures on each roller shall not vary more than plus or minus 2.0 psi. The wheels on the rollers shall be equipped with adjustable scrapers, which shall be used when necessary to clean the wheel surface. Depending on the speed of the chip seal operation and the width of coverage, additional rollers may be required. At no
time shall the rollers travel more than ten miles per hour. The rollers shall be maintained in good condition and be operated by experienced roller operators.

27.03.03.5 Sweepers  A rotary broom or other approved sweeping or blowing equipment meeting applicable U.S. Environmental Protection Agency Standards shall be used to windrow excess material to be picked up. A minimum of two (2) vacuum designed sweepers having only negative air pressure at the road surface capable of removing excess aggregate and debris material shall be used on this project. The body hoppers of the vacuum sweepers shall have a minimum capacity of ten cubic yards, and the negative air pressure at the intake shall be rated at forty six inches of negative water pressure. Sweepers shall meet applicable U.S. Environmental Protection Agency Standards. No mechanical pick-up brooms will be allowed on the project.

27.03.04 SURFACE PREPARATION  All surface preparations and cleaning shall be covered in Accordance with Section 27.01.

27.03.05 APPLICATION OF MATERIALS

27.03.05.1 General  The specific emulsion and cover aggregate application rate shall be determined using factors such as surface temperature, traffic volume, existing road condition, and time of year. The application rate may be modified at any time during the course of the construction upon approval by the Project Manager. The following table provides general application rates.

<table>
<thead>
<tr>
<th>TABLE 27.03.05.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHIP SEAL MATERIAL APPLICATION RATES</td>
</tr>
<tr>
<td>Material</td>
</tr>
<tr>
<td>CRS-2P-Chipseal</td>
</tr>
<tr>
<td>CRS-2P-Fogseal</td>
</tr>
<tr>
<td>Aggregate</td>
</tr>
</tbody>
</table>

Test Section - A 200 square yard test section shall be placed to determine actual application rates of aggregates and emulsion.

27.03.05.2 Emulsion Application  Bituminous material shall be applied by means of a pressure distributor in a uniform, continuous spread over the section to be treated and within the temperature range of 125 -185º F. The quantity of bituminous material to be used per square yard shall be
as specified. The distributor shall be moving forward at the proper application speed at the time the spray bar is opened. If the cut-off is not positive, the use of paper may be required at the end of each spread. The paper shall be disposed of in a lawful manner. Any skipped areas or deficiencies shall be corrected. Junctions of spreads shall be carefully made to assure a smooth riding surface.

The length of spread of bituminous material shall not be in excess of that which trucks loaded with cover coat material can immediately cover.

The spread of bituminous material shall not be more than four (4) inches wider than the width covered with aggregate from the spreading device and shall not spread onto the concrete gutter pan. Under no circumstances shall operations proceed in such a manner that the bituminous material be allowed to chill, set up, dry or otherwise impair retention of the cover coat. Application rate shall be sufficient to prevent streaked appearance in the final surface.

The distributor, when not spreading, shall be parked so that the spray bar or mechanism does not drip bituminous materials onto the surface of the street, gutters or private property. During all applications, the surface of adjacent structures shall be protected in such a manner as to prevent their being spattered or marred. Any areas inaccessible to the distributor shall be sprayed by hand. All sidewalks, gutters or other surfaces where spatter is excessive, in the opinion of the Project Manager, shall be immediately cleaned to the satisfaction of the Project Manager.

**27.03.3.05.3 Aggregate Application** Immediately following the application of bituminous material, aggregate cover material shall be spread in quantities as designated. Spreading shall be accomplished in such a manner that the tires of the trucks or aggregate spreader at no time contact the uncovered and newly applied bituminous material. The aggregate shall not be applied in such a thickness as to cause blanketing.

If directed by the Project Manager, the cover coat material shall be moistened with water, not to exceed 2% by weight, to eliminate or reduce the dust coating of the aggregate; however, excess dust will be a cause for rejection of the aggregate. Immediately after the cover coat is spread, any deficient areas shall be covered by additional material.
27.03.3.05.4 Armor Coat (Fog Seal) Application  Three days after the application of the chip seal, or as directed by the Project Manager, all excess aggregate shall be swept from the roadway and adjacent areas and then a fog seal of diluted CRS-2P applied to all areas chip sealed. The CRS-2P emulsion shall be diluted 40 percent with water. The application rate shall comply with the minimums in the table above or as deemed necessary by the Project Manager.

27.03.3.06 Rolling  Rolling shall begin with a minimum of two self-propelled, pneumatic-tired rollers. Rolling shall proceed in a longitudinal direction, beginning at the outer edges of application and working toward the center. Each pass shall overlap the previous pass by one-half of the width of the front wheel or roll. There shall be a minimum of three (3) passes with the pneumatic-tired rollers over the entire surface prior to moving ahead. One pass will be considered the number of trips to cover the entire surface from one side of the street to the other and for the length being worked. The first rolling of the aggregate shall be made before the asphalt emulsion breaks (roller shall complete the first rolling within approximately two and one-half (2 ½) minutes of the emulsion spray application). In no event shall traffic be allowed on the treated surface until all rolling has been completed.

27.03.3.07 Sweeping  After the application of the cover coat material excess material shall be removed from the entire surface, sidewalks and adjacent streets by means of approved brooms and or street sweepers within 24 hours. Excess aggregate that is clean may be stockpiled and re-used in subsequent locations at the discretion of the Project Manager. The Project Manager may reject aggregate that has been previously applied by visual observation of the stockpile.

27.03.3.08 Manholes, Valve Boxes and Survey Monuments  Locating, protecting and cleaning for manholes, valve boxes, survey monuments, etc. shall conform to Section 27.01.

27.03.3.09 Quality Control  In addition to the requirements of Section 27.01, samples of materials and of the finished chip seal surface shall be furnished as directed by the Project Manager during progress of the work at no expense to the City. Test reports shall be required as additional materials arrive. The Project Manager will conduct testing as required during the project.
27.03.3.10 STORAGE SITE REQUIREMENTS On or near job site storage may be approved by the Project Manager. Selected sites and permissions to use said sites shall comply with Section 27.01.

27.03.3.11 TRAFFIC CONTROL In addition to the requirements of Section 27.01, 4x4 warning signs shall be provided, posted and maintained for a period of seven (7) days at the beginning of chip sealed streets and at 1,500 foot intervals in both directions. The signs shall warn drivers to slow down, loose gravel and shall be lighted. Temporary Raised Pavement Markers shall be installed as needed and shall conform to the requirements in Section 27.01.

27.03.4 BASIS OF PAYMENT Chip seal will be measured and paid for by the square yard of street surface properly sealed and accepted by the Project Manager. The area for payment will be the measured width of the street from lip to lip of gutters multiplied by the length of chip seal coat applied.

The unit price bid per square yard shall include furnishing, storing, weighing, heating, hauling, distributing, rolling, maintaining the bituminous, cover coat materials, all labor, equipment, tools, materials, and incidentals necessary to complete the work in accordance with the plans and specifications, as directed by the Project Manager.

The range of acceptable aggregate, and emulsion rates are shown in Section 27.03.3.06.1 of this specification. At the conclusion of the project, emulsion and aggregate tickets will be compared with the area of chip seal placed to determine the average coverage rates for the project. If the material delivery tickets indicate that the average application rates were below the minimum application rates, the final payment will be reduced as shown below:

| TABLE 27.03.4 | TABLE OF PRICE REDUCTION FACTORS |
|  | Amount Below Minimum Application Rate, Aggregate or Emulsion | Percentage Reduction in Final Payment for Aggregate or Emulsion |
|  | 1 – 5 % | 10% |
|  | 5 – 10% | 20% |
|  | 10%+ | To be negotiated |

Weight tickets for cover coat aggregate and gallons of CRS-2P actually used on the project shall be furnished to the Project Manager. Such tickets shall serve as a check on the application rate. The Project Manager shall be notified prior to
delivery of materials so that a representative may be present to collect delivery receipts. In lieu of the weight tickets for aggregate application rate verification Contractor may submit verified spread rates by calibration of equipment used. This calibration is to be done at the start of the job and on a monthly basis or as directed by the Project Manager.

Contractor is solely responsible for assuring proper spread rates by means of equipment calibration submitted.

Payment will be made under:

<table>
<thead>
<tr>
<th>PAY ITEMS</th>
<th>PAY UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chip Seal</td>
<td>Square Yard</td>
</tr>
</tbody>
</table>

27.04 CAPE SEAL

27.04.1 SCOPE This item shall consist of all labor, equipment, material, supplies, raised markers, signage, traffic control, and other incidentals necessary to provide a Cape Seal satisfactory to the Project Manager. The work shall consist of placing a standard chip seal followed by an application of an additional cover coat of standard slurry seal.

Chip seal and slurry seal layers of a cape seal application shall be paired as indicated in the following table, unless otherwise approved by the Project Manager.

### TABLE 27.04.1
CHIP SEAL AND SLURRY SEAL LAYERS for CAPE SEAL APPLICATION

<table>
<thead>
<tr>
<th>Chip Seal Type</th>
<th>Slurry Seal Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>¼” Aggregate</td>
<td>Type I</td>
</tr>
<tr>
<td>3/8” Aggregate</td>
<td>Type I or Type II</td>
</tr>
<tr>
<td>½” Aggregate</td>
<td>Type II or Type III</td>
</tr>
</tbody>
</table>

27.04.2 MATERIAL REQUIREMENTS

27.04.2.01 Tack Coat A tack coat may be required by the Project Manager between the existing surface and the chip seal layer or between the chip seal layer and the slurry seal layer, or both. If a tack coat is required, the material, equipment and application shall conform to Section 27.01.

27.04.2.02 Chip Seal Layer Materials used in the chip seal layer of a cape seal application shall comply with all requirements of Section 27.03.2.
27.04.2.03 Slurry Seal Layer  Materials used in the slurry seal layer of a cape seal application shall comply with all requirements for Section 27.02.2.

27.04.3 CONSTRUCTION REQUIREMENTS

27.04.3.01 Work Limitations  In addition to the work limitations specified in Section 27.01, no construction of a cape seal application shall occur when either the ambient or pavement surface temperature fall below the table below or when the pavement is moist or when the weather is or may be detrimental. Detrimental weather is defined as rain showers, cool temperatures, moist pavements, threat of rain showers, or other environmental factors which could affect the performance of the cape seal. Emulsion application rate shall be adjusted accordingly depending on current temperatures within the material application specifications.

| TABLE 27.04.3.01 |
| CAPE SEAL TEMPERATURE LIMITATIONS |
| TEMPERATURE | 1/2" Cape Seal | 3/8" Cape Seal | ¼" Cape Seal |
| Surface Temperature (minimum) | ≥ 65°F | ≥ 65°F | ≥ 60°F |
| Ambient Temperature (daily high) | ≥ 70°F | ≥ 70°F | ≥ 65°F |

27.04.3.02 Chip Seal Layer  Construction of the chip seal layer of a cape seal application shall comply with all requirements of Section 27.03.3 with the following exceptions:

FOG SEAL  – Application of a fog seal coat to the chip seal layer of a cape seal application is not required.

MATERIAL APPLICATION RATES  – Material application rates shall be as specified below in Section 27.04.3.04.

27.04.3.03 Slurry Seal Layer  Construction of the slurry seal layer of a cape seal application shall comply with all requirements of Section 27.02.3.

APPLICATION OF SLURRY MIX  – In addition to the requirements of Section 27.02.3, the slurry seal layer shall be applied within two weeks of completion of the chip seal layer application. The chip seal surface shall be broomed prior to application of the slurry seal layer in accordance with Section 27.03.3.

MATERIAL APPLICATION RATES  – Material application rates shall be as specified below in Section 27.04.3.04.

WEATHER LIMITATIONS  – Weather limitations shall be as specified in Section 27.04.3.01.
27.04.3.04 Material Application Rates  Specific emulsion and aggregate application rates shall be determined using factors such as surface temperature, traffic volume, existing road and weather conditions, and time of year. Application rates may be altered at any time during the course of the work with approval of the Project Manager. General application rates are as follows:

**TABLE 27.04.3.04**

<table>
<thead>
<tr>
<th>Material</th>
<th>1/2&quot; Chipseal</th>
<th>3/8&quot; Chipseal</th>
<th>1/4&quot; Chipseal</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRS-2P Chip seal Emulsion</td>
<td>0.40-0.45 Gal/SY</td>
<td>0.35-0.40 Gal/SY</td>
<td>0.29-0.33 Gal/SY</td>
</tr>
<tr>
<td>Cover Aggregate</td>
<td>24lbs./SY min</td>
<td>22lbs/SY min</td>
<td>20lbs/SY min</td>
</tr>
<tr>
<td>Type I Slurry</td>
<td>N/A</td>
<td>8-12 lb/SY</td>
<td>8-12 lb/SY</td>
</tr>
<tr>
<td>Type II Slurry</td>
<td>16-20 lb/SY</td>
<td>16-20 lb/SY</td>
<td>N/A</td>
</tr>
<tr>
<td>Type III Slurry</td>
<td>20-30 lb/SY</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

27.04.4 BASIS OF PAYMENT  Cape seal will be measured and paid for by the square yard of street surface properly sealed and accepted by the Project Manager. The area for payment will be the measured width of the street from lip to lip of gutters multiplied by the length of cape seal applied.

The unit price bid per square yard shall include furnishing, storing, weighing, heating, hauling, distributing, rolling, maintaining the bituminous, cover coat materials, all labor, equipment, tools, materials, and incidentals necessary to complete the work in accordance with the plans and specifications, as directed by the Project Manager.

The range of acceptable aggregate, and emulsion rates are shown in Section 27.04.3.04 of this specification. At the conclusion of the project, emulsion and aggregate tickets will be compared with the area of cape seal placed to determine the average coverage rates for the project. If the material delivery tickets indicate that the average application rates were below the minimum application rates, the final payment will be reduced as shown below:

**TABLE 27.04.4**

<table>
<thead>
<tr>
<th>Amount Below Minimum Application Rate, Aggregate or Emulsion</th>
<th>Percentage Reduction in Final Payment for Aggregate or Emulsion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 5 %</td>
<td>10%</td>
</tr>
<tr>
<td>5 – 10%</td>
<td>20%</td>
</tr>
<tr>
<td>10%+</td>
<td>To be negotiated</td>
</tr>
</tbody>
</table>
Weight tickets for cover coat aggregate and gallons of emulsion actually used on the project shall be furnished to the Project Manager. Such tickets shall serve as a check on the application rate. The Project Manager shall be notified prior to delivery of materials so that a representative may be present to collect delivery receipts. In lieu of the weight tickets for aggregate application rate verification Contractor may submit verified spread rates by calibration of equipment used. This calibration is to be done at the start of the job and on a monthly basis or as directed by the Project Manager.

Contractor is solely responsible for assuring proper spread rates by means of equipment calibration submitted.

Payment will be made under:

<table>
<thead>
<tr>
<th>PAY ITEMS</th>
<th>PAY UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cape Seal</td>
<td>Square Yard</td>
</tr>
</tbody>
</table>

27.05 HOT CHIP SEAL

27.05.1 SCOPE  This work shall furnish all labor, equipment, material, supplies, raised markers, signage, traffic control, and other incidentals necessary to provide a Hot Chip Seal satisfactory to the Project Manager. The work shall consist of placing a standard chip seal followed by an application of an additional cover coat material (hot chip) placed by an asphalt paver.

27.05.2 MATERIAL REQUIREMENTS

27.05.2.01 Chip Seal Layer  Materials used in the chip seal layer of a hot chip seal application shall comply with all requirements of Section 27.03.2.

27.05.2.02 Fog Seal  A fog seal will be required by the Project Manager between the chip seal layer and the hot chip seal layer.

27.05.2.03 Hot Chip Layer  The aggregate of the hot chip seal layer of a hot chip application shall consist of washed, hard, durable, clean rock and free from coatings or deleterious material and clay balls. The presence of oversized material and/or clay balls shall be grounds for the project to be stopped. All of the aggregate shall be crushed gray granite with 100% fractured faces. The aggregate shall have a loss of no greater than 20% when tested with the LA Abrasion procedure as defined by ASTM C131, grade C or D. Only one type of aggregate shall be used and shall conform to the gradations below.
The hot chip seal layer shall conform to the following gradations based on percent passing. A mix design shall be submitted for approval that conforms to the following:

**TABLE 27.05.2.03**

<table>
<thead>
<tr>
<th>HOT CHIP SEAL AGGREGATE GRADATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sieve Size</td>
</tr>
<tr>
<td>¾”</td>
</tr>
<tr>
<td>½”</td>
</tr>
<tr>
<td>3/8”</td>
</tr>
<tr>
<td>¼”</td>
</tr>
<tr>
<td>No. 4</td>
</tr>
<tr>
<td>No. 8</td>
</tr>
<tr>
<td>No. 200</td>
</tr>
<tr>
<td>Asphalt Content (PG 64-22)</td>
</tr>
</tbody>
</table>

Mix Design submittals shall conform to Section 24.04 of City of Aurora Roadway Design & Construction Specifications.

**27.05.3 CONSTRUCTION REQUIREMENTS**

**27.05.3.01 Work Limitations** In addition to the work limitations specified in Section 27.01, no construction of a hot seal application shall occur when either the ambient or pavement surface temperature fall below the table below or when the pavement is moist or when the weather is or may be detrimental. Detrimental weather is defined as rain showers, cool temperatures, moist pavements, threat of rain showers, or other environmental factors which could affect the performance of the hot chip seal. Emulsion application rate shall be adjusted accordingly depending on current temperatures within the material application specifications.

**TABLE 27.05.3.01**

<table>
<thead>
<tr>
<th>HOT CHIP SEAL TEMPERATURE LIMITATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEMPERATURE</td>
</tr>
<tr>
<td>Surface Temperature (minimum)</td>
</tr>
<tr>
<td>Ambient Temperature (daily high)</td>
</tr>
</tbody>
</table>

**27.05.3.02 Chip Seal Layer** Construction of the chip seal layer of a hot chip application shall comply with all requirements of Section 27.03.3 with the following exceptions:

**MATERIAL APPLICATION RATES** – Material application rates shall be as specified below in Section 27.05.3.03.
WEATHER LIMITATIONS – Weather limitations shall be as specified in Section 27.05.3.01.

27.05.3.03 Hot Chip Seal Layer

27.05.3.03.1 Public Notice All notification measures shall comply with Section 27.01.

27.05.3.03.2 Quantities of Materials Application rates of hot chip layer materials used in a hot chip seal application shall be as specified below in Section 27.05.3.04.

27.05.3.03.3 Work Limitations In addition to the requirements of Section 27.01, hot chip layer material shall not be applied on a wet surface, or when the air temperature is below 50º F or the pavement temperature is below 50º F, unless otherwise specified, or when weather conditions would prevent the proper construction of the hot chip layer.

27.05.3.03.4 EQUIPMENT

27.05.3.03.4.01 General The size and condition of all equipment shall be approved prior to construction. All equipment deemed unsatisfactory by the Project Manager, for whatever cause, shall be removed and replaced without delay or cost. The equipment shall conform to the following minimum requirements.

27.05.3.03.4.02 Asphalt Paver The hot chip seal shall be placed by a type of paver used for the placement of hot asphalt material. The paver shall be self-contained, power propelled units provided with an adjustable activated screed, heated and capable of spreading and finishing course material on variable widths of surface up to 18 feet.

27.05.3.03.4.03 Rollers A minimum of two steel wheel rollers will be used to seat the Hot Chipseal. The steel drum rollers shall be double drum rollers with a loaded rate of five tons. At no time shall the rollers travel more than ten miles per hour.

27.05.3.03.4.04 Sweepers A minimum of two vacuum designed sweepers having only negative air pressure at the road surface capable of removing excess aggregate and debris material shall be used on
this project. The body hoppers of the vacuum sweepers shall be a minimum capacity of ten cubic yards, and the negative air pressure at the intake shall be rated at forty six inches of negative water pressure. Sweepers shall meet applicable U.S. Environmental Protection Agency Standards. No mechanical pick-up brooms will be allowed on the project.

27.05.3.03.5 Surface Preparation  The street shall be swept and cleaned before hot chip seal applications. The surface and gutter shall be cleaned and all debris removed for the full width to be treated immediately prior to application of the bituminous material. Dust and other material in depressions or other places not removed by mechanical sweepers shall be swept with hand brooms or removed by use of flushers. The Project Manager may require washing of the pavement where other methods of cleaning do not provide an acceptable surface. Material removed from the surface shall not be mixed with the cover aggregate. Bituminous material shall not be spread until the area to receive chip seal application has been cleaned to the satisfaction and approval of the Project Manager.

All vegetation shall be removed from the surface to be sealed prior to any hot chip seal placement. Vegetation shall be removed no earlier than two weeks prior to application of the hot chip seal layer. Any dead or remaining vegetation shall be removed before sweeping and applying the hot chip seal layer. Vegetation may be removed by burning when in the opinion of the Project Manager such burning causes no safety hazard or air pollution nuisance.

27.05.3.03.6 Application of Hot Chip Seal Layer  The hot chip seal layer shall be applied within two weeks of the chip seal layer application and after the loose material has been swept up. The hot chip seal material shall have a minimum temperature of 275 °F. The hot chip seal shall be applied over the entire chip seal surface and struck off to the established grade and proper elevation. Application rate of this material shall be as specified in Section 27.05.3.04

A minimum of two steel wheel rollers making two or more passes shall follow immediately to seat and cool the material.
27.05.3.03.7 QUALITY CONTROL  The hot chip seal layer of a hot chip seal application shall conform to testing and inspection requirements of Section 24.15 of City of Aurora Roadway Specifications.

27.05.3.03.8 MANHOLES, VALVE BOXES AND SURVEY MONUMENTS  Manholes, valve boxes and survey monuments in the area of the hot chip seal layer shall be protected and cleaned in Accordance with Section 27.01.

27.05.3.03.9 TRAFFIC CONTROL  All traffic control for application of the hot chip seal layer of a hot chip seal application shall comply with Section 27.01.

27.05.3.04 Application of Materials  Specific emulsion and aggregate application rates shall be determined using factors such as surface temperature, traffic volume, existing road and weather conditions, and time of year. Application rates may be altered at any time during the course of the work with approval of the Project Manager. General application rates are as follows:

<table>
<thead>
<tr>
<th>Material</th>
<th>1/2&quot; Chipseal</th>
<th>3/8&quot; Chipseal</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRS-2P Chipseal</td>
<td>.30-.40 Gal/SY</td>
<td>.28-.34 Gal/SY</td>
</tr>
<tr>
<td>Cover Coat Aggregate</td>
<td>22 – 28 lbs/SY</td>
<td>20 – 26 lbs/SY</td>
</tr>
<tr>
<td>Hot Chip seal</td>
<td>85 lbs/SY Minimum</td>
<td>75 lbs/SY Minimum</td>
</tr>
</tbody>
</table>

27.05.4 BASIS OF PAYMENT  Hot chip seal will be measured and paid for by the square yard of street surface properly sealed and accepted by the Project Manager. The area for payment will be the measured width of the street from lip to lip of gutters multiplied by the length of hot chip seal applied.

The unit price bid per square yard shall include furnishing, storing, weighing, heating, hauling, distributing, rolling, maintaining the bituminous, cover coat materials, all labor, equipment, tools, materials, and incidentals necessary to complete the work in accordance with the plans and specifications, as directed by the Project Manager.

The range of acceptable aggregate, and emulsion rates are shown in Section 27.05.3.04 of this specification. These ranges may be modified by the Project Manager but in no case shall the ranges exceed plus or minus 10% of the application rates of the approved mix design. At the conclusion of the project,
emulsion and aggregate tickets will be compared with the area of hot chip seal placed to determine the average coverage rates for the project. If the material delivery tickets indicate that the average application rates were below the minimum application rates, the final payment will be reduced as shown below:

<table>
<thead>
<tr>
<th>Amount Below Minimum Application Rate, Aggregate or Emulsion</th>
<th>Percentage Reduction in Final Payment for Aggregate or Emulsion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 5 %</td>
<td>10%</td>
</tr>
<tr>
<td>5 – 10%</td>
<td>20%</td>
</tr>
<tr>
<td>10%+</td>
<td>To be negotiated</td>
</tr>
</tbody>
</table>

Weight tickets for cover coat aggregate and gallons of emulsion actually used on the project shall be furnished to the Project Manager. Such tickets shall serve as a check on the application rate. The Project Manager shall be notified prior to delivery of materials so that a representative may be present to collect delivery receipts. In lieu of the weight tickets for aggregate application rate verification, Contractor may submit verified spread rates by calibration of equipment used. This calibration is to be done at the start of the job and on a monthly basis or as directed by the Project Manager. **Weight tickets for hot chip material placement are required for payment.**

**Contractor is solely responsible for assuring proper spread rates by means of equipment calibration submitted.**

Payment will be made under:

<table>
<thead>
<tr>
<th>PAY ITEMS</th>
<th>PAY UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chip Seal Layer</td>
<td>Square Yard</td>
</tr>
<tr>
<td>Hot Chip Seal Layer</td>
<td>Square Yard</td>
</tr>
</tbody>
</table>

### 27.06 CRACK SEAL

#### 27.06.1 SCOPE
The intent of this specification is to specify materials and methods used for crack filling existing pavement surfaces throughout the City of Aurora. This work shall furnish all labor, equipment, material, supplies, raised markers, signage, traffic control, and other incidentals necessary to provide and place crack seal material satisfactory to the Project Manager. All work and materials shall be in accordance with the requirements of these specifications.
27.06.2 MATERIAL REQUIREMENTS  Hot poured crack sealant shall conform to the requirements of ASTM D3405. Crack sealant material shall be supplied pre-blended, pre-reacted, and prepackaged. If supplied in solid form the sealant material shall be cast in a plastic or other dissolvable liner having the capability of becoming part of the crack sealing liquid. The sealant shall be delivered in the manufacturer’s original sealed container. Each container shall be legibly marked with the manufacturer’s name, the trade name of the sealer, the manufacturer’s batch or lot number, the application temperature range, the recommended application temperature, and the safe heating temperature. Each container or portion of shall be saved and matched to the daily check-out log. These records will be used as basis of payment.

27.06.3 CONSTRUCTION REQUIREMENTS

27.06.3.01 Public Notice  Signage for the purpose of public notification of impending work shall be furnished at all entrances to the work area the morning in advance of crack seal operations. Signs shall remain in place until removal is approved by the Project Manager. All signs shall conform to Section 27.01.

27.06.3.02 Work Limitations  Crack fill materials shall not be placed during periods of adverse weather conditions or at times when the materials will not adhere to the cracked surface as directed by the manufacturer. Crack fill materials shall not be placed during such times or when directed by the Project Manager.

27.06.3.03 Equipment  The equipment for heating the material shall be an indirect heating type double boiler using oil or other heat transfer medium and shall be capable of constant agitation. The heating equipment shall be capable of controlling the sealant material temperature within the manufacturer’s recommended temperature range and shall be equipped with a calibrated thermometer capable of ±5 °F accuracy from 200°F to 600 °F. This thermometer shall be located so the Project Observer can safely check the temperature of the sealant material. The machine shall be equipped with level indicators or other device that can accurately measure the quantity of material in the crack filling machine at any one time. All crack filling equipment shall be maintained in safe and working condition at all times. If, in the opinion of the Project Observer, the crack filling machine is not suitable for use and the above indicators are not operational, the Project Observer may require the equipment be removed from the jobsite and replaced with fully operational equipment.
27.06.3.04 **Surface Preparation** Cracks shall be cleaned and dried for the entire crack depth as much as practicable using such methods as brushing and air-blowing as required to provide a crack free from all debris, dust, loose material and moisture.

27.06.3.05 **Application of Material**

**27.06.3.05.1 General** Crack fill material shall be heated and placed in accordance with manufacturer’s recommendations. All cracks greater than one-quarter inch including transverse and longitudinal cracks shall be filled. These cracks shall be filled with hot poured joint and crack sealant flush with the pavement surface. Immediately following the filling of the crack, excess sealant shall be leveled off at the wearing surface by squeegee, a shoe attached to the applicator wand, or other suitable means approved by the Project Manager. The squeegeed material shall be centered on the cracks and shall not exceed 3 inches in width or 1/16 inch in depth. Areas of alligator cracking shall not be sealed.

**27.06.3.05.2 Application of Crack Fill Material** Cleaned cracks shall be filled with sealant from the bottom to the surface and level in a manner, which does not result in sealant bridging or entrapped air pockets. With deep cracks, settlement of the sealant may occur and a second layer of sealant material shall be applied. Crack filler shall be placed in such a manner as to minimize overfilling of the cracks. Suitable equipment, such as squeegees, shall be used to remove excess crack filling material from the roadway surface.

A liquid specifically designed to prevent tracking of freshly applied crack seal material, such as “Glenzoil 20 Plus” or other suitable surface treatment as approved by the Project Manager, shall be applied to all cracks filled.

27.06.3.06 **TRAFFIC CONTROL** All necessary precautions shall be observed when placing crack filler material. All necessary traffic control devices and warning signs shall be supplied as required by the Traffic Engineer. Minimum requirements shall include, but not be limited to, an arrow board mounted on a truck or other approved vehicle following the material placement personnel and a chase vehicle following no greater than 50 feet behind the arrow board. Proper safety clothing for all of their employees on the project shall be
provided in accordance with the Manual on Uniform Traffic Control Devices, including, but not limited to, safety vests, warning signs and barricades. Materials shall not be placed until these requirements are met.

Arrow boards pulled behind a mobile vehicle are required on all arterial streets in conjunction with a flagger walking with the sealing unit. Flaggers shall have no other duty than to direct traffic. Sufficient flaggers for traffic control shall be provided as directed by the Traffic Engineer.

27.06.4 BASIS OF PAYMENT Crack sealant shall be paid for as installed at the unit price per pound of product, including a tracking prevention liquid, such as Glenzoil 20 plus or equal and traffic control. Each crack sealant container or portion of shall be saved and matched to the daily check-out log. These records will be used as basis of payment

Payment will be made under:

<table>
<thead>
<tr>
<th>PAY ITEMS</th>
<th>PAY UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crack Fill</td>
<td>Pound</td>
</tr>
</tbody>
</table>
29.00 THERMOPLASTIC PAVEMENT MARKINGS
29.00 DESCRIPTION
29.01 MATERIALS
29.02 PHYSICAL PROPERTIES
29.03 APPLICATION
29.04 MEASUREMENT AND PAYMENT
29.00 THERMOPLASTIC PAVEMENT MARKINGS

29.00 Description:
This work shall consist of furnishing and installing thermoplastic pavement markings to specified street segments after all designated street resurfacing is completed.

29.01 Material:
The material manufacturer shall have the option of formulating the material according to their own specifications; however, the solid resin shall comprise a minimum of 8% by weight of the entire material formulation which shall only consist of 100% percent maleic-modified glycerol ester of resin. The physical and chemical properties contained in this specification shall apply regardless of the type of formulation used. The material upon heating to the application temperature shall not exude fumes that are toxic, or injurious to persons or property.

Glass beads (Pre-Mix) shall be free from air inclusions:
Refractive Index 1.50 Minimum
Spheres, % 80 Minimum
AASHTO M247 Type I

The beads used in the formulation shall be smooth, clear and free from air inclusions and scratches that might affect their function as a reflecting media.

29.02 PHYSICAL PROPERTIES:
29.02.1 Specific Gravity The specific gravity of the thermoplastic traffic line material shall not be less than 1.95 nor more than 2.15.

29.02.2 Composition The pigment, beads and filler shall be uniformly dispersed in the resin. The material shall be free from all skins, dirt and foreign objects and shall comply with requirements according to Table 1.

<p>| TABLE 1 COMPOSITION |</p>
<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>BY WEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binder</td>
<td>18.0% Min.</td>
</tr>
<tr>
<td>Glass Beads</td>
<td>35.0% Min.</td>
</tr>
<tr>
<td>Titanium Dioxide</td>
<td>8.0% Min.</td>
</tr>
<tr>
<td>Calcium Carbonate &amp; Inert Filler</td>
<td>SEE NOTE</td>
</tr>
</tbody>
</table>

NOTE: Amount of calcium carbonate and inert fillers shall be at the option of the manufacturer, providing all other requirements of the specification are met. The
total silica used in the formulation shall be in the form of spherical glass traffic beads.

The binder shall consist of a mixture of synthetic resins, at least one of which is solid at room temperature, and high boiling point plasticizers. At least one-third of the binder composition shall be the solid maleic-modified glycerol ester of resin and shall be no less than 8% by weight of the entire material formulation. The binder shall not contain petroleum based hydrocarbon resins or similar derivatives.

29.02.3 Other Ingredients  The other ingredients shall meet the following requirements:

29.02.3.1 Titanium Dioxide:  ASTM D 476-Type 2

29.02.3.2 Color - The thermoplastic material after heating for four hours at 218 C (425 F) and cooled to 25 C (77 F) shall meet the following:

29.02.3.2.1 White:  Daylight reflectance (45 to 0 deg.). 75% Min.

29.02.3.2.2 Drying Time - When applied at a temperature range of 211 +/- 7 C (412 +/- 12.5 F) and thickness of 2.28mm (.090 in.) the material shall set to bear traffic in not more than two minutes when the air temperature is 10 C (50 F) and not more than 15 minutes when the air temperature is 32 C (90 F).

29.02.3.2.3 Bond Strength - After heating the thermoplastic material for four hours at 218C (425 F), the bond strength to Portland concrete shall exceed 180 psi (1.24 MPa).

29.02.3.2.4 Impact Resistance - After heating the thermoplastic material for four hours at 218 C (425 F) and tested, the impact resistance shall be a minimum of 10 inch pounds.

29.02.3.2.5 Softening Point - After heating the thermoplastic material for four hours at 218 C (425 F) and testing in accordance with ASTM D36, the materials shall have a softening point of 102.5 +/- 9.5 C (215 +/- 15 F).

29.02.3.2.6 Yellowness Index - The white thermoplastic material shall not exceed a yellowness index of 0.15.
29.03 Application:

The thermoplastic material shall be applied to the pavement by an extrusion method.

The finished lines shall have well defined edges and be free of waviness. All of the equipment necessary to the preheating and application of the material shall be so designed that the temperature of the material can be controlled within the limits defined by the material manufacturer.

The minimum thickness of thermoplastic lines as viewed from a lateral cross section shall be not less than .080 inch at the edges nor more than .100 inch at the center.

The pavement surface shall be clean and dry (no moisture within 48 hours) and at a minimum temperature of 50 degrees F.

Drop on flotation type glass beads shall be applied to the thermoplastic line immediately after extrusion at a rate consistent with manufacturer recommendations.

29.04 Measurement and Payment:

Payment shall be based on linear foot of 4” wide striping, to include all labor, equipment, materials and traffic control required to complete striping at each location as directed. A listing of streets for thermoplastic striping will be furnished to the Contractor prior to June 1, 2002.
30.00 CONCRETE WORK
30.01 SCOPE
30.02 MATERIALS
30.03 CONCRETE PROPORTIONING
30.04 MIXING CONCRETE
30.05 READY-MIXED CONCRETE
30.06 PLACING CONCRETE
30.07 FORMS
30.08 REINFORCING STEEL
30.09 JOINTS
30.10 PUMPING CONCRETE
30.11 COLD WEATHER PROTECTION
30.12 HOT WEATHER CONCRETING
30.13 CURING CONCRETE
30.14 FINISHING
30.15 MISCELLANEOUS
30.16 MEASUREMENT AND PAYMENT
SECTION 30.00 CONCRETE WORK

30.01 Scope
This section covers all concrete work to include, but not limited to, footings, structure walls, slab, beams, thrust blocks, curb and gutter, sidewalk, inlets, manhole, drainage works and structures.

30.02 Materials

30.02.1 Cement All cement used in concrete work shall be Portland cement conforming to all requirements of AASHTO M 85. Portland cement shall be Type II "low alkali" or cement and shall conform to ASTM C 150 and ASTM C 595, respectively. Type II or Type IIA shall be used except that high-early strength, Type III (or IIIA), may be used in concrete for anchors and thrust blocks at the Contractor's option. Use of other types requires the approval of the Project Manager.

30.02.2 Admixtures The use of calcium chloride in the production of Portland cement concrete is prohibited. Air-entraining admixtures shall conform to AASHTO M 154, latest edition. Water-reducing and set-controlling admixtures shall conform to AASHTO M 194 according to the following types: Type A, Water Reducing; Type B, Retarding; Type D, Water Reducing and Retarding; and Type E, Water Reducing and Accelerating. Written approval of the Project Manager shall be obtained prior to the use of any admixture except air-entrained admixtures. Application of admixtures shall be as per manufacturer's specifications.

30.02.3 Water The water used for concrete shall be clean and free from sand, oil, acid, alkali, organic matter, or other deleterious substances. Water from public supplies, or which has been proven to be suitable for drinking, is satisfactory.

30.02.4 Fine Aggregate

30.02.4.01 Composition Fine aggregate shall be washed, hard, durable and uncoated particles of natural or manufactured sand or a combination thereof. It shall be free from frozen material, salt, alkali, vegetable matter, or other objectionable material.

Fine aggregate for Portland cement concrete (PCC) shall conform to the requirements of AASHTO M 6. The minimum sand equivalent, as tested in
accordance with AASHTO T 176 shall be 80 unless otherwise specified. The fineness modulus shall not be less than 2.3 nor greater than 3.1 unless otherwise approved.

30.02.4.02 Deleterious Substances The maximum percentage of deleterious substances shall not exceed the following values.

**TABLE 30.1**
FINE AGGREGATE DELETERIOUS SUBSTANCES

<table>
<thead>
<tr>
<th>Material</th>
<th>AASHTO</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material finer than 200 mesh sieve</td>
<td>T 11</td>
<td>3% by weight</td>
</tr>
<tr>
<td>Shale(a)</td>
<td>Petrographic analyses</td>
<td>1% by weight</td>
</tr>
<tr>
<td>Coal and lignite(a)</td>
<td>T 113</td>
<td>0.25% by weight</td>
</tr>
<tr>
<td>Clay lumps and friables particles</td>
<td>T 112</td>
<td>3% by weight</td>
</tr>
<tr>
<td>Alkali reactivity</td>
<td>ASTM C 1260 Using Water bath</td>
<td>&lt; 0.1% @ 16 days</td>
</tr>
</tbody>
</table>

\(a\) If the aggregate has a specific gravity less than 2.40

The sum of the percentages of the above deleterious substances shall not exceed 5% by weight.

Sodium sulfate soundness T 104 10% loss by weight

All fine aggregate shall be free from injurious amounts of alkali and organic impurities.

30.02.4.03 Grading Fine aggregate shall be well graded and conform to the following:

Percent by Weight

<table>
<thead>
<tr>
<th>Percent by Weight</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Passing 3/8&quot;</td>
<td>100</td>
</tr>
<tr>
<td>Passing No. 4 sieve</td>
<td>95-100</td>
</tr>
<tr>
<td>Passing No. 16 sieve</td>
<td>50-80</td>
</tr>
<tr>
<td>Passing No. 50 sieve</td>
<td>10-30</td>
</tr>
<tr>
<td>Passing No. 100 sieve</td>
<td>2-10</td>
</tr>
</tbody>
</table>
30.02.5 Coarse Aggregate

30.02.5.01 Composition Coarse aggregate shall be washed and shall consist of crushed limestone, trap rock, granite, washed gravel, or other approved inert materials or combinations thereof having clean, hard, strong, durable pieces, free from frozen material, salt, alkali, vegetable matter, or other objectionable material either free or as an adherent coating (AASHTO M 80).

30.02.5.02 Deleterious Substances The maximum percentage of deleterious substances shall not exceed the following values.

<table>
<thead>
<tr>
<th>TABLE 30.2</th>
<th>COARSE AGGREGATE DELETERIOUS SUBSTANCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material finer than 200 mesh sieve</td>
<td>AASHTO T 11</td>
</tr>
<tr>
<td>Lightweight fragments (specific gravity &lt; 2.4)</td>
<td>AASHTO T 113</td>
</tr>
<tr>
<td>Coal and lignite (specific gravity &lt; 2.4)</td>
<td>AASHTO T 113</td>
</tr>
<tr>
<td>Clay lumps and friable particles</td>
<td>AASHTO T 112</td>
</tr>
<tr>
<td>Alkali reactivity</td>
<td>ASTM C 1260 Using Water bath</td>
</tr>
</tbody>
</table>

The sum of the percentages of the above deleterious substances shall not exceed 5% by weight.

Sodium sulfate soundness | T 104 | 12% loss by weight |

30.02.5.03 Grading Coarse aggregate shall be well graded between the limits specified and shall conform to the following requirements.

<table>
<thead>
<tr>
<th>TABLE 30.3</th>
<th>GRADING COARSE AGGREGATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Maximum Size of Aggregate (in inches)/No.</td>
<td>Percentages by weight Passing Standard Laboratory Sieve Having Square Openings</td>
</tr>
<tr>
<td></td>
<td>1 ½”</td>
</tr>
<tr>
<td>1 ½” No. 467</td>
<td>95 to 100</td>
</tr>
<tr>
<td>1” No. 57</td>
<td>--</td>
</tr>
<tr>
<td>¾” No. 67</td>
<td>--</td>
</tr>
</tbody>
</table>
30.02.5.04 Other Requirements  When tested in accordance with AASHTO T 96, the percentage of wear shall not be more than 45%.

30.02.6 Reinforcing Steel

30.02.6.01 Bars  Reinforcing steel bars shall conform to the requirements of the STANDARD SPECIFICATION FOR DEFORMED AND PLAIN BILLET-STEEL BARS FOR CONCRETE REINFORCEMENT of the ASTM. Bars shall be new billet steel conforming to AASHTO M 31 of the grade shown on the plans.

30.02.6.02 Welded Wire Fabric  Wire fabric for concrete reinforcement shall conform to the requirements of AASHTO M 55. The use of wire mesh from "rolls" is not allowed.

30.02.7 Joint Materials  Joint materials shall conform to AASHTO specifications according to type as follows.

- Concrete joint sealer, hot-poured elastic M 301
- Preformed expansion joint fillers (bituminous type) M 213
- Preformed sponge rubber and cork expansion joint fillers M 153
- Preformed expansion joint fillers - nonextruding and resilient bituminous M 33

30.02.8 Curing Compound  White-pigmented, liquid, membrane-forming compounds shall conform to AASHTO M 148, Type 2, Class B.

30.02.9 Fly Ash  Fly ash may be substituted for cement in all classes of concrete up to an amount not exceeding 20% by weight. The fly ash shall conform to AASHTO M 295, Class C or Class F except as modified below.

- Loss on ignition  2.5% maximum
- Strength activity index with Portland cement, at 28 days, percent of control  85% minimum
- Autoclave expansion or contraction  0.5% maximum

Class C fly ash will not be permitted where sulfate resistant cement is required. Fly ash shall not be used with Type IP cement.

The use of fly ash will not be an excuse for deviating from air content requirements of the specifications.
30.03 Concrete Proportioning

30.03.1 The proportions of materials to be used shall produce a workable concrete having a slump of 1” to 4”, with air content and minimum 28-day compressive strength as indicated in Section 30.03.3. Minimum cement content shall be 550 lbs. (six sacks) per cubic yard with a maximum water/cement ratio = 0.45. Where "Water Tight" concrete is specified, the water/cement ratio shall not exceed 0.40.

30.03.2 An approved air-entraining agent (AASHTO M 154) shall be used in all concrete except Class III.

30.03.3 The class of concrete specified shall conform to the following:

<table>
<thead>
<tr>
<th>CLASS OF CONCRETE SPECIFICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maximum Size Coarse Aggregate</strong></td>
</tr>
<tr>
<td>Class I</td>
</tr>
<tr>
<td>Class IA</td>
</tr>
<tr>
<td>Class IB</td>
</tr>
<tr>
<td>Class II</td>
</tr>
<tr>
<td>Class III</td>
</tr>
</tbody>
</table>

30.03.4 Minimum Class of Concrete  Written approval of the Project Manager is required prior to using Class II or Class III concrete. Class I or Class 1A will be used in sidewalk, curb and gutter, slope paving, curb cuts, cross pans, driveways, retaining walls, storm drainage structures, slabs, and structural members. For sections greater than 6" thick, Class IB concrete may be used.

30.03.5 Mix Design  The Contractor shall submit design mix proportions, laboratory trial mix, and aggregate data for each class of concrete being placed on the project. The test data shall show the mix design proportions, slump, air content, unit weight, water/cement ratio, and 28-day compressive strength results, as tested under laboratory conditions. The design mix proportions must produce at least 100% of the required 28-day laboratory compressive strengths. Each design shall establish
the mix proportions and sources of all ingredients. Aggregate test data shall include gradations - #200, sand equivalent, fineness modulus, specific gravities, absorptions, and LA Abrasion test results. The Contractor shall be responsible for the design mix proportions and all subsequent adjustments necessary to produce the specified concrete.

The Contractor shall submit a new design mix based on the above requirements when a change occurs in the mix proportions, source or type of cement, fly ash, or aggregate, or failure of field tests to meet specifications.

Review of the design mix by the Project Manager does not constitute acceptance of the concrete. In accordance with ACI 301 and 318, standard supplier design mixes may be approved in lieu of the above. Submittal of appropriate test data will be required. Acceptance will be based solely on test results of the concrete placed on the project.

30.03.6 Enforcement of Strength Requirements  
Strength requirements shall be in accordance with ACI 214, Section 4.2. The strength level of the concrete will be considered satisfactory so long as the averages of all sets of three consecutive strength test results equal or exceed the specified strength, f’c, and no individual strength test result falls below the specified strength f’c by more than 500 psi. Should the strength level be unsatisfactory, the Project Manager shall have the right to require changes in mix proportions to apply on the remainder of the work. In the event of failure of test specimens for any portion of the work, the Project Manager may require that portion of the structure be removed and replaced at the Contractor’s expense.

30.04 Mixing Concrete  
All concrete shall be thoroughly mixed in a batch mixer of an approved type and capacity for a period of not less than two minutes after all the materials, including water, have been placed in the drum. During the period of mixing, the drum shall be operated at the speed specified by the manufacturer of the equipment. The entire contents of the mixer shall be discharged before recharge, and the mixer shall be cleaned frequently. The concrete shall be mixed only in such quantities as are required for immediate use. No retempering of concrete shall be permitted. Hand-mixed concrete shall not be permitted except by written approval of the Project Manager.
30.05 Ready-Mixed Concrete

At the option of the Contractor, ready-mixed concrete may be used in lieu of concrete mixed at the job. The use of ready-mix concrete in no way relieves the Contractor of sole responsibility for proportioning, mixing, delivering, or placing concrete as specified. Ready-mixed concrete shall conform to all the requirements of these specifications and AASHTO M 157. The Project Manager shall have free access to the mixing plant at all times. Ready-mixed concrete shall be continuously mixed or agitated from the time the water is added until the time of use. The concrete shall be completely discharged from the truck mixer or truck agitator within 90 minutes after the cement comes in contact with the mixing water, or with the aggregates (retempered concrete shall not be allowed). The organization supplying ready-mixed concrete shall have sufficient plant and transportation facilities to assure continuous delivery of concrete at the required rate. When requested by the Project Manager, the Contractor shall collect delivery or batch tickets from the ready-mix driver for all concrete used on the project and turn them over to the Project Manager. Batch tickets shall provide the following information: weight and type of cement, weights of fine and coarse aggregates, weight (or gallons) of water, including surface water on aggregates, quantity (cu. yds.) of batch, times of batching and discharging of the concrete, name of batch plant, name of Contractor, type, name and amount of admixture, date, and truck number.

30.06 Placing Concrete

30.06.1 Placing Before depositing concrete, debris shall be removed from the space to be occupied by the concrete, and the forms including any existing concrete surfaces shall be thoroughly wetted. Concrete shall not be placed until all forms and reinforcing steel have been observed by the Project Manager. Concrete shall be handled from the mixer to the place of final deposit as rapidly as possible by methods which prevent separation or loss of ingredients. To avoid rehandling, it shall be deposited in the forms as nearly as practical in its final position. It shall be deposited in continuous layers, the thickness of which generally shall not exceed 12”. Concrete shall be placed in a manner that will avoid segregation and shall not be dropped freely more than 5’. If segregation occurs, the Project Manager may require the concrete to be removed and replaced at the Contractor’s expense. Concrete shall be placed in one continuous operation, except where keyed construction joints are shown on the plans or as approved by the Project Manager. Delays in excess of 45 minutes may require removal and replacement of that pour, as determined by the Project Manager. Concrete will not be placed until the subgrade compaction requirements have been met.
30.06.2 Vibrating  Concrete shall be thoroughly compacted or vibrated. All concrete shall be compacted by internal vibration using mechanical vibrating equipment, with the exception that concrete in floor slabs, sidewalks, or curb and gutter, not poured against a form, shall be either tamped or vibrated. Care shall be taken in vibrating concrete to vibrate only enough to bring a continuous film of mortar to the surface. Vibration shall stop before any segregation of the concrete occurs. Mechanical vibrators shall be an approved type as specified in ACI 309, Chapter 3. Vibrators shall not be used to move or spread the concrete. Any evidence of lack of consolidation or over consolidation shall be regarded as sufficient reason for requiring the removal of the section involved and its replacement with new concrete at the Contractor's expense. The Contractor shall be responsible for any defects in the quality and appearance of completed work.

The rate of vibration shall be not less than 5,000 vibrations per minute for surface vibrators and 9,000 vibrations per minute for internal vibrators. The amplitude of vibration shall be sufficient to be perceptible on the surface of the concrete more than 1 foot from the vibrating element. The Contractor shall furnish a tachometer or other suitable device for measuring and indicating the actual frequency of vibrations.

Vibrators shall not rest on new pavements or side forms. Power to the vibrators shall be so connected that vibration will cease when the forward or backward motion of the machine is stopped.

30.06.3 Workability  The consistency of concrete shall be kept uniform for each class of work and shall be checked by means of slump tests or Kelly ball tests. Concrete shall at all times be of such consistency that it can be worked into corners and angles of the forms and around joints, dowels, and tie-bars, by the construction methods used without excessive spading, segregation, or undue accumulation of water or laitance on the surface. If by accident, intention, or error in mixing, any concrete fails to conform to the proportions of the approved mix design; such concrete shall not be incorporated in the work, but shall be discarded off the project site as waste material at the Contractor's expense. NO WATER MAY BE ADDED AT THE JOB SITE WITHOUT THE PERMISSION OF THE PROJECT MANAGER. If permission is obtained and water is added at the job site, slump tests shall be run and test cylinders cast following the addition of the water.
30.07 Forms

Forms shall conform to the shape, lines, and dimensions, as shown on the plans. Approved flexible forms shall be used for construction where the radius is 150' or less. Unexposed surfaces shall have forms of No. 2 common (or better) lumber. Forms shall not be disturbed until the concrete has adequately hardened. The Contractor or his superintendent shall be present at the time forms are removed and shall be responsible for the safety of this operation at all times. In no case shall the minimum time between placing concrete and removal of forms be less than the following.

**TABLE 30.5**

<table>
<thead>
<tr>
<th>TIME BETWEEN PLACING CONCRETE AND REMOVAL OF FORMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curb and gutter</td>
</tr>
<tr>
<td>Side forms for footings and slabs</td>
</tr>
<tr>
<td>Side forms for walls, beams, and columns</td>
</tr>
<tr>
<td>Forms under structural beams and slabs requiring shoring</td>
</tr>
</tbody>
</table>

30.08 Reinforcing Steel

30.08.1 Shop Drawings  Before fabrication of the reinforcement, the Contractor shall prepare or have prepared complete bending, fabrication, and setting drawings and bar lists covering all required reinforcement steel. Such drawings and bar lists shall be submitted to the Project Manager for his review of general conformity to specified requirements. The review of the shop drawings by the Project Manager in no way relieves the Contractor of sole responsibility for correct placement of reinforcing steel.

30.08.2 Placing  Reinforcing steel, before being placed, shall be thoroughly cleaned of coatings that will destroy or reduce bond. A light coating of rust may be allowed by the Project Manager. Reinforcement shall be carefully formed to the dimensions indicated on the plans. It shall not be bent or straightened in a manner that will injure the material. **THE USE OF HEAT IN BENDING BARS SHALL NOT BE PERMITTED.** Bars with kinks or bends not shown on the plans shall not be used.
Reinforcing steel shall be accurately placed and secured against displacement by using annealed iron wire of not less than No. 18 gauge, or suitable clips, at intersections, and where necessary, reinforcing steel shall be supported by metal chairs or spacers, precast mortar blocks, or metal hangers. Reinforcing bars shall not be spliced at points of maximum stress. Splices, where permitted, shall be as specified in ACI 318. All reinforcing steel shall be placed in the position and at the spacings shown on the plans with the tolerances specified in ACI 301, Section 3.3.

**30.08.3 Cover**  The minimum clear cover for reinforcing steel shall be as specified in ACI 301, Section 3.3, and as shown below, unless otherwise shown on the plans.

### TABLE 30.6
**MINIMUM COVER FOR REINFORCING STEEL**

<table>
<thead>
<tr>
<th>Description</th>
<th>Minimum Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottom bars on soil-bearing foundations and slabs</td>
<td>3 inches</td>
</tr>
<tr>
<td>Bars adjacent to surfaces exposed to weather on earth backfill</td>
<td></td>
</tr>
<tr>
<td>Bars 3/4&quot; in diameter or larger</td>
<td>2 inches</td>
</tr>
<tr>
<td>Bars 5/8&quot; in diameter or smaller</td>
<td>1 1/2 inches</td>
</tr>
<tr>
<td>Interior surfaces: slabs, walls, joists with 1 3/8&quot; diameter or smaller bars</td>
<td>3/4 inches</td>
</tr>
</tbody>
</table>

**30.08.4 Placing Welded Wire Fabric**  Wire fabric in cross pans and curb cuts shall be placed as shown in the plans and details. The fabric shall be fully supported on precast mortar blocks or other approved supports prior to placing the concrete. The use of welded-wire fabric from "rolls" is not allowed.

**30.09 Joints**

**30.09.1 Expansion Joints**  Expansion joints in combination curb and walk, vertical curb and gutter, channels, or any other place that is designed or can be expected to carry water shall be recessed 1/2" and shall be sealed with an approved one-component, moisture-curing, non-priming, gun-grade, elastomeric polyurethane joint sealant meeting the requirements of ASTM C920, Type S, Grade NS, Class 25, Use NT and M. It shall be applied in accordance with the manufacturer’s instructions within seven days of the placement of the concrete. Expansion joints shall be provided at the following locations:
• at each end of curb return
• at both edges of the driveway
• between back of sidewalk and driveway slab or service walk
• between new concrete and existing masonry buildings
• as shown on the drawings
• as directed by the Project Manager
• between new and existing concrete
• 1/2" joints every 200' in sidewalk

30.09.2 **Contraction Joints**  Transverse joints shall be placed at maximum intervals of 10' to control random cracking. The joints shall be formed, sawed, or tooled to a minimum depth of 1/4 of the total thickness. If divider plates are used, the maximum depth of plates shall not be greater than 1/2 the total thickness. The joints shall be finished with a jointer having a width no greater than 5/16" and depth not less than 3/4". A maximum joint width at the finished surface shall be no greater than 5/16".

30.09.3 **Tool Joints**  Tool joints shall be spaced as follows:

• Not more than 10' nor less than 5' apart in curb and gutter
• Not more than 5' nor less than 3' apart in sidewalk
• In driveways at least two joints equally spaced at not greater than 10' intervals, as applicable
• Joints will be placed at 10' intervals for the 8' and 10' bike paths unless otherwise authorized by the Project Manager
• As directed by the Project Manager

30.10 **Pumping Concrete**

Methods, materials, and equipment to be used in placing concrete by pumping shall conform to ACI 304. A separate mix design will be required in accordance with paragraph 30.03.5.

30.11 **Cold Weather Protection**

When concrete is placed with ambient temperatures below 40°F, the Contractor shall provide satisfactory methods and means to protect the mix from injury by freezing. The aggregates, or water, or both, shall be heated in order to place the concrete at temperatures between 50°F and 90°F. Placing of concrete may be started in the morning if the Contractor desires, but shall be discontinued at 3:00 p.m. of the same day if freezing weather threatens. The concrete or
aggregates shall be protected during transit, mixing, and before and after placing, as directed by the Project Manager, to retain all heat possible in the concrete mix. After the concrete has been placed, the Contractor shall provide sufficient protection such as blankets, canvas, framework, heating apparatus, etc., to enclose and protect the structure and maintain the temperature of the concrete at not less than 50°F until at least 60% of the 28-day field strength has been attained. Except as provided above, cold weather concreting shall be in accordance with ACI 306. If in the opinion of the Project Manager, the protection provided is inadequate, concreting shall cease until conditions or procedures are satisfactory to the Project Manager.

30.12 Hot Weather Concreting
Except by written authorization, concrete shall not be placed if the temperature of the plastic concrete cannot be maintained at 90°F or lower. The placement of concrete in hot weather shall comply with ACI 305.

30.13 Curing Concrete
White-pigmented curing compound conforming to Section 30.02.8 shall be used unless another method conforming to ACI 308, Chapter 2, is approved by the Project Manager in writing. All concrete, regardless of temperature, weather, or season, shall be protected from premature drying for a period of not less than seven days. Where concrete is being protected from freezing, the time period for water curing shall be one day less than that of the frost protection. The application rate of curing compound shall be as per manufacturer's recommendation (not greater than 150 sq. ft./gal.). Curing will not be required longer than 72 hours if high-early strength concrete is used. It shall be the Contractor's responsibility to protect the concrete being cured from the elements, traffic, and vandalism. Those surfaces covered by forms shall be similarly treated after the forms are removed. Inadequate protection by the Contractor shall be cause for suspension of concreting operations and replacement of the affected concrete at no expense to the City.

30.14 Finishing

30.14.1 General Exposed faces of curbs and sidewalks shall be finished to true line and grade as shown on the plans. The surface shall be floated to a smooth but not slippery finish. Sidewalk and curb shall be broomed and edged, unless otherwise directed by the Project Manager. The use of steel trowels is not recommended in the finishing processes unless approved by the Project Manager. After completion of brooming and before concrete has taken its initial set, all edges in contact with the forms shall be tooled with an edger having a 3/8" radius.
No dusting or topping of the surface, or sprinkling with water, to facilitate finishing shall be permitted. Finishing agents may be used as directed by the manufacturer to aid in finishing.

30.14.2 Types of Finish

30.14.2.01 Class 1 - Ordinary Surface Finish. Immediately following the removal of the forms, all fins and irregular projections shall be removed from all surfaces except from those which are not to be exposed. On all surfaces, the cavities produced by form ties honeycomb spots, broken corners or edges, and other defects, shall be thoroughly cleaned, moistened with water, and carefully pointed and trued with a mortar consisting of cement and fine aggregate, and the surface left sound, smooth, even, and uniform in color. Mortar used in pointing shall be not more than 30 minutes old. All construction and expansion joints in the completed work shall be left carefully tooled and free of all mortar and concrete. The joint filler shall be left exposed for its full length with clean and true edges. All concrete surfaces shall be given a Class 1 finish. Additional finish classes may be specified by the plans for designated surfaces.

30.14.2.02 Class 2 - Broom Finish. All curb and gutter, sidewalk, and cross pan unless otherwise specified.

30.14.2.03 Class 3 - CDOT Class 5, Masonry Coating Finish.

30.14.2.04 Class 4 - Special. See plans and special provisions.

30.14.3 Markings Concrete used in curb and gutter, sidewalk, curb cuts, driveways, inlets, bicycle paths, retaining walls, and slope paving, shall have the name of the Contractor and the year of construction impressed therein using letters not less than 1" high and 3/8" deep. Impressions shall be made in concrete at the beginning and end of each pour and in each driveway. Structures shall have the year constructed impressed therein using letters 3" high and 1/2" deep. The Contractor shall place the date stamp at the end of his work at the point where it joins existing work. If only a portion of sidewalk, or curb & gutter is being constructed, the new slab shall be marked at one end.

30.14.4 Final Surface Test All work shall be true to line and grade as established by the Project Manager. Prior to acceptance of the work, the Contractor shall test the surfaces with a 10-foot straightedge. Any areas higher than 1/4", but not higher
than 1/2", above the correct surface thus indicated, shall be ground to the correct surface by the Contractor at his expense. When the deviation exceeds the foregoing limits, the Contractor shall remove and replace that portion of the work at his expense, as directed by the Project Manager. Protection of freshly poured concrete shall be provided by the Contractor. The Contractor shall erect and maintain suitable barricades and employ watchmen as may be necessary to exclude (pedestrian or vehicular) traffic from the newly constructed concrete until it has sufficiently cured and will not be affected by the traffic. The Contractor shall have sufficient materials available to protect the unhardened concrete against damage by rain or hail. When rain is imminent, the unhardened concrete shall be immediately covered with tarps, plastic sheeting, or other suitable material, and planks or forms shall be placed along the edge of the work to hold the protective materials in place. Concrete pavement damaged by rail or hail will be removed and replaced as directed, at no additional cost, by the Project Manager.

30.14.5 Repairs  If, after stripping of forms, any concrete is found to be not formed as shown on the drawings, or is out of alignment or level, or shows a defective surface, it shall be considered as not conforming with these specifications. The defective area shall be removed and replaced by the Contractor at his expense unless the Project Manager gives written permission to patch the defective area. Patching, if allowed, shall be done as described in the following paragraphs.

Ridges and bulges shall be removed by grinding. Honeycombed and other defective concrete that does not affect the integrity of the structure shall be chipped out and the vacated areas shall be filled in a manner acceptable to the Project Manager. The repaired area shall be patched with a non-shrink, nonmetallic grout, with a minimum compressive strength of 4,000 psi in 28 days. All repair areas shall be treated with an epoxy bonding agent before the repair filling is placed.

Bolt-holes, tie-rod holes, and minor imperfections as approved by the Project Manager shall be filled with dry-patching mortar composed of one part Portland cement to two parts of regular concrete sand (volume measurement), and only enough water so that after the ingredients are mixed thoroughly the mortar will stick together upon being molded. Mortar repairs shall be placed in layers and thoroughly compacted by suitable tools. Care shall be taken in filling rod and bolt holes so that the entire depth of the hole is completely filled with compacted mortar. The mortar mix proportions described above are approximate.
An approved mix shall be prepared to insure that the grout has a 28-day compressive strength equal to that of the area to which it is placed. All costs for mix design and testing shall be paid by the Contractor. Those areas with excessive deficiencies, as determined by the Project Manager, shall be removed and replaced at the Contractor's expense.

### 30.15 Miscellaneous

#### 30.15.1 Backfilling

When side forms are removed and the concrete has gained sufficient strength (minimum compressive strength of 2,500 psi), the space adjoining the concrete shall be promptly backfilled with suitable material, properly compacted, and brought flush with the surface of the concrete and adjoining ground surface. In embankments the backfill shall be level with the top of the concrete for at least 2' and then sloped as shown on the drawings or as directed by the Project Manager.

#### 30.15.2 Repairing Existing Pavement

Existing pavement which is damaged or removed during construction shall be repaired to the satisfaction of the Project Manager by the Contractor at his expense.

#### 30.15.3 Repairs of Existing Sidewalks

Where repairs are made in existing sidewalks, all edges of the old sidewalk allowed to remain shall be saw cut to a minimum depth of 2". No rough edges will be permitted where new construction joins old. Unless directed by the Project Manager, no section less than 5' in length shall be placed or left in place. Where new sidewalk construction abuts existing sidewalks, the work shall be accomplished so that no abrupt change in grade results.

#### 30.15.4 Removal of Existing Concrete

Removal and replacement of existing concrete features (curb and gutter, sidewalk, curb cuts, cross pans, etc.) beyond the limits shown on the plans, or required by the Project Manager, shall be at the Contractor's expense.

#### 30.15.5 Opening to Traffic

Walks shall not be opened to pedestrian traffic for at least 24 hours after placement. Curb cuts, curb and gutter, and cross pans shall not be opened to vehicular traffic for at least seven days after placement or until concrete has attained 2/3 of 28-day field strength. The Contractor shall maintain suitable barricades and signage in accordance with MUTCD.
30.16 Measurement and Payment

Measurement for concrete work is determined by the type of work performed. Curb and gutter are to be measured per linear foot not to include curb cuts, inlets, or cross pans. Detached sidewalks shall be measured per linear foot, not to include curb cuts or inlets.

Combination curb, gutter, and sidewalks are to be measured per linear foot not to include curb cuts, inlets, and curb ramps. Curb cuts are to be measured on a square foot basis from the front lip of the gutter to the back of the curb cut and to the outside of the flares. Curb ramps are to be measured per each to include all work behind back of curb and from P.C.R. to P.C.R. Mid-block curb ramps are to be measured per each to include all work from edge to edge and behind the back of curb. Median noses are to be measured as a median curb and gutter with no additional measurement for the concrete required in the nose itself. Cross pans shall be measured on a square footage basis to include curb and gutter in the returns. Slope paving shall be measured by the square foot of exposed concrete surface, including the horizontal top.

Payment for slope paving will include toe wall, weep holes, and redwood headers. Foundation walls, interior and exterior, and structural slabs shall be measured by the cubic yard or the square yard as specified in the contract.

Concrete work shall be paid for at the contract unit price as bid in the contract. The contract price shall include the cost of furnishing all labor, equipment, and materials necessary to complete the work.

Exclusion Thrust blocks and kickers required in the installation of pressure lines shall be considered part of that work and their cost included in the unit price of the pressure lines.

Unless indicated otherwise in the Contract, the cost of furnishing and installing reinforcing steel, welded wire fabric, joints and joint filler, dowels, and curing materials shall be included in the price of the concrete.
31.00 CONCRETE PAVEMENT
31.01 SCOPE
31.02 MATERIALS
31.03 BATCHING
31.04 MEASURING AIR CONTENT
31.05 FORMS
31.06 PLACING CONCRETE
31.07 CONSOLIDATING AND FINISHING
31.08 INTEGRAL CURB
31.09 CURING
31.10 JOINTS
31.11 STRUCTURES
31.12 PROTECTION AND OPENING TO TRAFFIC
31.13 SLIP FORM PAVING
31.14 SUBGRADE PREPARATION
31.15 TESTING AND ACCEPTANCE
31.16 PAY REDUCTION FACTORS
SECTION 31.00 CONCRETE PAVEMENT

31.01 Scope
The work covered by this section consists of furnishing all labor, equipment, and materials and in performing all operations in connection with the construction of air-entrained Portland cement concrete pavement for streets, alleys, and parking lots. Section 30.00, CONCRETE WORK shall apply, except where a conflict between CONCRETE WORK and CONCRETE PAVEMENT exists. In such a case, the specifications for CONCRETE PAVEMENT shall govern.

31.02 Materials
Concrete shall be composed of Portland cement, air-entraining agent, aggregates, and water. Other admixtures to be used shall first be reviewed by the Project Manager prior to use. These materials shall be furnished only from sources of supply reviewed by the Project Manager before shipments are started. Such sources shall be able to produce materials of the quality and in the quantity required.

31.02.1 Portland Cement
The use of other than Type II cement shall be reviewed by the Project Manager prior to use. Cement shall conform to the requirements of AASHTO M 85 for Portland cement Type I, Type II, Type III, Type IV, or Type V, or for air-entraining Portland cement Type IA, Type IIA, or Type IIIA. Cement which for any reason has become partially set or which contains lumps of caked cement shall be rejected. Either packaged or bulk cement may be used. Fly ash may be used as specified in Section 30.00, CONCRETE WORK.

31.02.2 Aggregates
All aggregates for concrete shall meet the ASTM C-33. Aggregates shall be so handled that moisture content and gradation are reasonably uniform and do not change appreciably from batch to batch or hour to hour. No aggregates shall be used which have become contaminated or intermixed. Frozen aggregates or aggregates containing frozen lumps shall be thawed before use.

31.02.3 Joints
31.02.3.01 Expansion Joints
See Section 30.02.7 and S19.1 et seq.

31.02.3.02 Pre-Molded Joint Material
Pre-molded parting strips, when called for on the plans, shall be 1/16" to 3/16" thick and of the width shown on the plans. They shall consist of strips which have been formed from layers of felt or shredded felt, cane, wood, or other suitable fibers, securely bound together.
and uniformly impregnated with a suitable binder. They shall not permanently deform by ordinary handling during hot weather, or become hard and brittle in cold weather.

31.02.3.02 Joint Sealant All joints shall be sealed with an approved one-component, moisture-curing, non-priming, gun-grade, elastomeric polyurethane joint sealant meeting the requirements of ASTM C920, Type S, Grade NS, Class 25, Use NT and M. It shall be applied in accordance with the manufacturer’s instructions within seven days of the placement of the concrete and Standard Detail S19.1 et seq.

31.02.4 Curing

31.02.4.01 Sheeting Materials Waterproof paper, polyethylene film, and white burlap-polyethylene sheeting shall conform to AASHTO M 171.

31.02.4.02 Membrane Curing Compound Membrane curing compounds shall be the white-pigmented type and conform to AASHTO M 148, Type 2, Class B.

31.03 Batching
Measurement and batching of cement, fine and coarse aggregates shall be by weight on scales accurate to within 0.5%. Bulk cement and cement from fractional sacks shall be weighed.

31.03.1 Proportioning Concrete The concrete shall have a minimum 28-day compressive laboratory strength of 5,200 psi (4,000 psi field) and a laboratory modulus of rupture of 700 psi in 28 days (550 psi field). Proportions of cement, water, and aggregate shall be determined in accordance with ACI Standard 211.1. Mixes shall comply with the following table.

Table 31.1
PROPORTIONS FOR NORMAL WEIGHT CONCRETE

<table>
<thead>
<tr>
<th>Nominal Size of Coarse Aggregate (inches)</th>
<th>Minimum Cement Content (lb./cu. yds.)</th>
<th>Water/Cement Ratio (lb./lb. maximum)</th>
<th>Total Air Content (% by volume)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ½</td>
<td>610</td>
<td>0.45</td>
<td>5% ± 1</td>
</tr>
<tr>
<td>1</td>
<td>610</td>
<td>0.45</td>
<td>6% ± 1</td>
</tr>
</tbody>
</table>
The entrained air shall be obtained either by using air-entraining cement or an air-entraining agent. Mix design, including lab test results showing compliance with compressive strength and modulus of rupture requirements, shall be submitted to the Project Manager for review ten days before paving begins. The maximum size of aggregate shall not exceed 1/4 of the slab thickness. The maximum water content shall include the surface water on the aggregate.

**31.03.2 Consistency** The slump of the concrete shall be 1/2" to 2" (internal vibration) and 1 1/2" to 3" (surface vibration).

**31.03.3 Ready-Mixed Concrete** Ready-mixed concrete shall be proportioned, mixed, and transported in accordance with AASHTO M 157. Concrete shall be placed in accordance with Section 30.00, CONCRETE WORK.

**31.03.4 Job-Mixed Concrete** Job-mixed concrete shall be mixed in a drum mixer capable of combining the aggregates, cement, and water into a thoroughly mixed and uniform mass within the specified time, and capable of discharging the material without segregation. The entire contents of the drum shall be discharged before recharging. Each mixer shall have attached in a prominent place, a manufacturer’s plate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of drum or mixing blades. The volume of the mixed materials per batch shall not exceed the manufacturer’s guaranteed capacity (110% of rated capacity) of the mixer.

**31.03.5 Time of Mixing** The mixing of each batch shall continue for not less than one minute after all materials, except water, are in the mixer. All mixing water shall be introduced into the drum before 1/4 of the mixing time has elapsed. The mixer shall rotate at the rate recommended by its manufacturer. The mixer shall be provided with a batch timing device which shall be subject to inspection and adjustment by the Project Manager at any time.

**31.04 Measuring Air Content**

The air content of freshly-mixed concrete shall be checked by an independent agency as often as necessary (at least twice daily) to insure uniform air content in conformance with ACI and ASTM specifications. Concrete with air content above or below the amount specified in Section 31.03.1 shall be corrected by adjustments in the mix design or quantities of air-entraining admixture being used.
31.05 Forms

31.05.1 General  Forms may be made of wood or metal and shall have a depth equal to or greater than the prescribed edge thickness of the pavement. Each section of form shall be straight and free from bends or warps.

The maximum deviation of the top surface shall not exceed 1/8" in 10', or the inside face not more than 1/4" in 10'. The method of connection between sections shall be such that the joint thus formed is tight and free from movement in any direction.

Forms shall be of such cross section and strength and so secured as to resist the pressure of the concrete when placed and the impact and vibration of any equipment which they support without springing or settlement.

Approved flexible forms shall be used for construction where the radius is 150' or less.

All roadway paving over 50 feet in length shall be accomplished using a self-propelled, string controlled slip form paver. Screeds or forms shall not be the primary means of placing and controlling concrete paving, except when permitted by the City Engineer.

31.05.2 Setting Forms  The subgrade under the forms shall be compacted and shaped so that the form when set will be uniformly supported for its entire length at the specified elevation. The supply of forms shall be sufficient to permit their remaining in place for at least 12 hours after the concrete has been placed. All forms shall be cleaned and oiled each time they are used.

31.05.3 Grade and Alignment  The alignment and grade elevations of the forms shall be checked by the Contractor immediately ahead of concrete placement and necessary corrections will be made. Any forms that have been disturbed or subgrade that has become unstable shall be corrected, and forms reset and rechecked. Any variations in grade and alignment shall be reviewed by the Project Manager prior to placing the concrete.

31.06 Placing Concrete

The concrete shall be mixed in quantities required for immediate use and shall be deposited on the subgrade to the required depth and width of the construction lane in successive batches and in a continuous operation without the use of intermediate forms or bulkheads. The concrete shall be placed as uniformly as possible in order to minimize segregation. While being placed, the
Concrete pavement shall be vibrated to prevent the formation of voids or honeycomb pockets. The concrete shall be especially well consolidated against the forms and along all cold joints. Care shall be taken in the distribution of the concrete to deposit a sufficient volume along the outside form lines so that the curb section can be consolidated and finished simultaneously with the slab. At the start of a day’s run, or whenever placing concrete adjacent to existing concrete, the surface of the existing concrete shall be thoroughly wetted immediately prior to placing the new concrete. No concrete shall be placed around manholes or other structures until they have been brought to the required grade and alignment and expansion joints have been installed. Placement of concrete will cease when rain is threatening. Protection of freshly poured concrete shall be provided by the Contractor. The Contractor shall erect and maintain suitable barricades and employ watchmen as may be necessary to exclude (pedestrian or vehicular) traffic from the newly constructed concrete pavement until it has sufficiently cured that it will not be affected by the traffic. The Contractor shall have sufficient materials available to protect the unhardened concrete against damage by rain or hail. When rain is imminent, the unhardened concrete shall be immediately covered with tarps, plastic sheeting, or other suitable material, and planks or forms shall be placed along the edge of the work to hold the protective materials in place. Concrete pavement damaged by rail or hail will be removed and replaced as directed, at no additional cost, by the Project Manager.

### 31.06.1 Cold Weather Concreting

Except by specific written authorization, concreting shall cease when descending air temperature in the shade and away from artificial heat falls below 40°F. It shall not be resumed until the ascending air temperature in the shade and away from artificial heat rises to 35°F.

When concreting is permitted during cold weather, the temperature of the mix shall be not less than 60°F, not more than 80°F, at the time of placing. Aggregates or water or both may be heated, but the water shall not be hotter than 175°F and aggregates shall not be hotter than 150°F. Before concreting is started, ice, snow, and frost must be removed from forms, rebar, and subgrade.

When concrete is being placed in cold weather and the temperature may be expected to drop below 35°F, a supply of straw, insulated curing blankets, or other suitable material shall be provided along the line of work. Prior to any time when the air temperature may be expected to reach the freezing point during the day or night, the material so provided shall be spread over the concrete to a sufficient depth to prevent freezing of the concrete. Concrete shall be protected from freezing temperatures until it is at least five days old. Concrete injured by frost action shall be removed and replaced at the Contractor’s expense. Additional cement, Type A
or Type E mixtures (AASHTO M 194) may be used to accelerate setting in cold weather subject to the review of the Project Manager. The use of calcium chloride additives shall NOT be allowed.

31.06.2 Hot Weather Concreting  Concrete shall not be placed if the temperature of the concrete exceeds 90°F. To facilitate the placement of concrete in hot weather, the aggregates or water or both may be cooled.

31.07 Consolidating and Finishing

31.07.1 General  The pavement shall be struck off and consolidated with a mechanical finishing machine. Hand finishing will be allowed only on irregular or confined areas when approved by the Project Manager. When a mechanical finishing machine is used, the concrete shall be struck off at such a height that after consolidating and final finishing, it shall be at the elevation as shown on the plans, with not more than 1/4" variation when measured with a 10' straight-edge.

The finishing machine shall be provided with a screed which shall consolidate the concrete by pressure and vibration. Minimum vibratory requirements are that the eccentric diameter be 1 7/8 inch, a frequency of 7,000 to 9,000 vibrations per minute and be spaced a maximum of 18 inches mounted longitudinally. The concrete shall be brought to a true and even surface, free from rock pockets. The edge of the screeds along the curb line may be notched out to allow for sufficient concrete to form the integral curb.

Hand-finishing tools shall be kept available for use in case the finishing machine breaks down. Paving progress shall immediately cease until the finishing machine has been repaired. When hand finishing is used, the pavement shall be struck off and consolidated by a hand mechanical vibrating device to the elevation as shown on the plans, with not more than 1/4" variation when measured with a 10' straightedge. When the forward motion of the vibrating device is stopped, the vibrator shall be shut off; it shall not be allowed to idle on the concrete. Delays in excess of 15 minutes in vibrating and tamping shall be cause for stopping paving until finishing operations have caught up with the paving.

31.07.2 Scraping and Straight-Edging  The pavement shall be scraped with a straightedge 10' long (minimum), equipped with a handle to permit it to be operated from the edge of the pavement. The straight-edge shall be operated so that any excess water and laitance are removed from the surface of the pavement. Prior to
the concrete taking its initial set, irregularities shall be corrected by adding or removing concrete. All disturbed places shall be floated with a wooden or metal float not less than 3' long and not less than 6" wide and again straight-edged. The pavement surface shall have no depression in which water will stand.

The use of the long-handled float shall be confined to a minimum. It may be used with the straightedge to correct surface texture, but shall not be used to float the entire surface of the pavement.

31.07.3 Edging  Before final finishing is completed and before the concrete has taken its initial set, the edges of the slab and curb shall be carefully finished with an edger, having a 3/8” radius.

31.07.4 Final Surface Finish  A burlap drag shall be used as the final finishing method for concrete pavement. The drag shall be at least three feet in length and wide enough to cover the entire pavement width. It shall be kept clean and saturated during use. It shall be laid on the surface of the pavement and dragged. The curb shall have the same final finish as the pavement. The finish surface of the concrete pavement and curb shall have a uniform gritty texture, free from excessive harshness, and true to the grades and cross section shown on the plans. The Project Manager may require changes in the final surface texture.

31.08 Integral Curb

When integral curbs are required along the edges of all street paving, depressed curbs shall be provided at all driveway entrances and at such other locations as designated by the Project Manager.

The integral curb shall be constructed with, or immediately following, the finishing operation. Special care shall be taken so that the curb construction does not lag the pavement construction and form a “cold joint.”

In placing curb concrete, sufficient consolidation shall be done to secure an adequate bond with the paving slab and eliminate all voids in the curb.

The finished surface of the curb and gutter shall be checked by the use of a 10’ straight-edge and corrected if necessary.
31.09 Curing

31.09.1 General Concrete shall be cured by protecting it against loss of moisture, rapid temperature change, rain, flowing water, and mechanical injury for a period of not less than five days from the beginning of the curing operation. Curing shall conform to Section 30.13.

31.10 Joints

31.10.1 General Longitudinal and transverse joints shall be per detail S19.1, et seq. and the recommendations of the Portland Cement Association and the American Concrete Paving Association. In the event of a discrepancy, the more stringent requirements shall apply.

31.10.2 Expansion Joints Expansion joints shall be provided as shown on the plans, around manholes, valve boxes, inlets, other structures, and as directed by the Project Manager. Expansion joints shall conform to the specification in Section 30.02.7. They shall extend the entire width of the pavement and from the subgrade to ½ inch below the surface of the pavement.

Under no circumstances shall any concrete be left above the expansion material or across the joint at any point. Any concrete spanning the ends of the joint next to the forms shall be carefully cut away after the forms are removed. Before the pavement is opened to traffic, the groove above the filler shall be cleaned and sealed with specified joint sealing material.

31.10.3 Sawed Joints Sawing of the joints shall begin as soon as the concrete has hardened sufficiently to permit sawing without excessive raveling. Any procedure for sawing joints that result in premature and uncontrolled cracking or raveling shall be revised immediately by adjusting the time interval between the placing of the concrete and cutting of the joints. The sawing of any joint shall be omitted if a crack occurs at or near the joint location before the time of sawing. Sawing shall be discontinued if a crack develops ahead of the saw. If necessary, the sawing operations shall be carried on both day and night, regardless of weather conditions. A standby saw shall be available in the event of breakdown.

31.10.4 Construction Joints Construction joints shall be placed whenever the placing of concrete is suspended for more than 30 minutes.
31.10.5 Plastic-Parting Strip Joint  The joint material shall be inserted with a mechanical device that places the material in a continuous strip, except where intervening structures break the continuity of paving. Splices in the joint material will be permitted providing they are effective in maintaining the continuity of the joint material.

31.10.6 Joint Sealing  Joints shall be filled to a level such that, upon cooling, the sealer shall be slightly below the concrete surface about 1/8" (1/4" maximum). Any excess material should be removed from the pavement surface before opening to traffic.

TABLE 31.2
SUGGESTED LOCATION OF LONGITUDINAL JOINTS
(TYPE E OR L - SEE S19.2 AND S19.3)

<table>
<thead>
<tr>
<th>ROADWAY CLASSIFICATION</th>
<th>LOCATION OF LONGITUDINAL JOINT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Type 1</td>
<td>BOC, 7’, 11’, 11’, 7’, BOC</td>
</tr>
<tr>
<td>Local Type 3</td>
<td>BOC, 9.5’, 11’, 11’, 9.5’, BOC</td>
</tr>
<tr>
<td>Two-Lane Collector</td>
<td>BOC, 12.5’, 11’, 11’, 12.5’, BOC</td>
</tr>
<tr>
<td>Four-Lane Collector</td>
<td>BOC 6.5’, 11’, 11’, 11’, 11’, 6.5’, BOC</td>
</tr>
<tr>
<td>Four-Lane Arterial</td>
<td>BOC¹, 7.5’, 12’, 12’, 14’, 12’, 12’, 7.5’, BOC¹</td>
</tr>
<tr>
<td>Six-Lane Arterial</td>
<td>BOC¹, 14.5’, 12’, 13.5’, BOC¹</td>
</tr>
<tr>
<td></td>
<td>BOC¹, 13.5’, 12’, 14.5’, BOC¹</td>
</tr>
</tbody>
</table>

¹ Monolithic C & G are not allowed without an approved revised joint pattern.

Note: Location of joints may vary due to local conditions, traffic, bike paths, etc.

BOC = Back of Curb

31.11 Structures  
All manholes, catch basins, or structures of a permanent nature encountered in areas to be paved shall be raised or lowered to the elevation of the surface of the new pavement and the specified expansion material placed around each structure for the full depth of the slab.

31.12 Protection and Opening to Traffic  
The Contractor shall protect the pavement against all damage prior to final acceptance of the work. Traffic shall be excluded from the pavement by erecting and maintaining barricades and signs until the concrete is at least 14 days old, or has attained a flexural strength of 550 psi when tested in accordance with AASHTO T 23 or T 97. The pavement shall not be used at any time within this period for transporting or operating equipment. As a construction expedient, the subgrade planer, concrete finishing machine, and similar equipment may be permitted to ride...
upon the edges of previously constructed slabs provided the concrete is more than 72 hours old and the equipment have rubber-tired wheels to run on the finished slab. The pavement shall be cleaned and tabbed for lane stripes (or painted) immediately before opening to traffic.

31.13 Slip Form Paving

31.13.1 General When the concrete pavement exceeds 50 lineal feet the Contractor shall use a slip-form paver and the construction methods described in the preceding section of the specifications shall not be applicable. All reference in the preceding sections of this specification referring to forms shall be deleted. Use of a vibrating screed is not allowed.

31.13.2 Grade After the grade or base has been placed and compacted to required density, the grade and areas which are to support the paving machine shall be cut to the proper elevation by means of a fine-grading machine. The fine-grading machine shall be of sufficient weight, and shall be either self-propelled or towed by sufficient power, to trim the compacted material without gouging or tearing the surface. The machine shall have cutting edges or surface shavers controlled from an independent control reference wire by means of an automatic control device. The machine may accomplish the fine grading by means of successive passes with each pass controlled from the independent reference line through the automatic control. Motor graders will not be used for shaping of the base except for small areas or areas of irregular shape where the use of a fine grade would be impracticable. If the density of the base is disturbed by the grading operations, it shall be corrected by additional compaction before concrete is placed. If any traffic is allowed to use the prepared grade, the grade shall be checked and corrected immediately ahead of the placing of the concrete.

31.13.3 Placing Concrete All concrete shall be placed with a self-propelled, string-controlled paving machine with internal vibrators designed to spread, consolidate, screed, and float-finish the freshly-placed concrete in one complete pass of the machine in such manner that a minimum of hand finish will be necessary to provide a dense and homogenous pavement in conformance with the plans and specifications. The machine shall vibrate the concrete for the full width and depth of the strip of pavement being placed. Such vibrations shall be accomplished with vibrating tubes or arms working in the concrete, and vibrating pan operating on the surface of the concrete. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms. The forms shall trail behind the paver for a distance such that no appreciable slumping of the concrete will occur.
The concrete shall be held at a uniform consistency, having a slump of not more than 2 inches. The slip-form paver shall be operated with as nearly a continuous forward movement as possible, and all operations of mixing, delivering, and spreading concrete shall be so coordinated as to provide uniform progress with stopping and starting of the paver held to a minimum. If for any reason it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall also be stopped immediately. No tractive force shall be applied to the machine, except that which is controlled from the machine.

### 31.14 Subgrade Preparation

The subgrade shall be in a moist condition at the time the concrete is placed. It shall be thoroughly wetted a sufficient time in advance of the placing of the concrete to insure that there will be no puddles or pockets of mud when the concrete is placed but shall not be allowed to dry out before the concrete is placed.

Immediately prior to placing the concrete, the subgrade and forms shall be tested for conformity with the cross section shown on the plans by means of an approved template or string line method. Forms shall be checked for grade. If necessary, material shall be removed or added, as required, to bring all portions of the subgrade to the correct elevation. It shall then be thoroughly compacted and again tested with the template.

Concrete shall not be placed on any portion of the subgrade which has not been tested for correct grade and cross section. The subgrade shall be cleared of any loose material. All soft and yielding material and other portions of the subgrade which will not compact readily when rolled or tamped shall be removed as directed and replaced with suitable material, placed and compacted as specified.

Prior to placing concrete, the testing agency shall submit to the Project Manager a report under the seal of a Professional Engineer stating that the forms are to proper grade, the subgrade is at proper depth and cross slope, and the subgrade is properly prepared and compacted.

### 31.15 Testing and Acceptance

#### 31.15.1 Test Specimens

The Contractor shall furnish the concrete necessary for casting test beams and cylinders. One set of 4 beams and 6 cylinders shall be made for each 300 cubic yards, or fraction thereof, of pavement placed, but not less than two sets of beams and cylinders for any one day’s work, plus any additional beams or cylinders ordered by the Project Manager. The beams and cylinders shall be cured by the method specified in AASHTO T 23. A qualified independent testing agency
shall furnish the molds and test the specimens. Each specimen shall be marked with the date, time, location, batch, and any other pertinent information.

31.15.2 Thickness  The Project Manager may require core tests for determining actual thickness and for outlining areas of deficient thickness. Cores shall be taken as directed. The length of the thickness deficiency will be taken as half way between the core showing the deficiency and the nearest acceptable core. Deduction for deficiency in thickness shall be made according to the following table.

<table>
<thead>
<tr>
<th>Deficiency in Thickness</th>
<th>Proportional Part of Contract Price Allowed</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00 in. to 0.25 in.</td>
<td>100 percent</td>
</tr>
<tr>
<td>0.26 in. to 0.50 in.</td>
<td>Ratio ((\frac{\text{actual thickness}}{\text{specified thickness}})^2)</td>
</tr>
<tr>
<td>Greater than 0.50 in.</td>
<td>Remove and Replace</td>
</tr>
</tbody>
</table>

The Contractor, at his expense, may take additional cores to further define the area of thickness deficiency. The area so determined will not be taken as less than one full panel, as defined by transverse joints and the width of one pass of the paver. It will include the curb and sidewalk if poured integrally with the paving.

31.15.3 Strength Tests  Unless otherwise approved by the Project Manager, beams shall have a minimum field modulus of rupture at 28 days of 550 psi when tested in accordance with AASHTO T 177.

31.15.4 Final Surface Test  Prior to acceptance of the pavement, the Project Manager may require the Contractor to test the surface of the finished pavement with a 10’ straight-edge. Any areas higher than 1/4", but not higher than 3/8" above the correct surface (as indicated by such test) shall be ground to the required surface by the Contractor at his expense. When the deviation exceeds 3/8", the pavement shall be removed and replaced by the Contractor at his expense. Final surface testing may be completed using a profilograph, with the written permission of the Project Manager.
31.16 Pay Reduction Factors

The pay factors for concrete which is allowed to remain in place at a reduced price shall be according to Table 31.4. The average 28-day compressive strength of three cylinders representing the concrete used in the corresponding pavement area will be used to determine if the concrete meets the required strength. The pay factor shall be applied to the unit bid price for the quantity of concrete in that portion of the pavement area represented by the test cylinders. The pay factor for air content shall apply to the load represented by the out-of specification test result. Price reductions for air content, strength, and thickness deficiency shall be applied independently.

<table>
<thead>
<tr>
<th>Deviations From Specified % Air ±</th>
<th>Pay Factor</th>
<th>Below Required Compressive Strength (psi)</th>
<th>Pay Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1-0.2%</td>
<td>98%</td>
<td>1-100</td>
<td>98%</td>
</tr>
<tr>
<td>0.3-0.4%</td>
<td>96%</td>
<td>101-200</td>
<td>96%</td>
</tr>
<tr>
<td>0.5-0.6%</td>
<td>92%</td>
<td>201-300</td>
<td>92%</td>
</tr>
<tr>
<td>0.7-0.8%</td>
<td>84%</td>
<td>301-400</td>
<td>84%</td>
</tr>
<tr>
<td>0.9-1.0%</td>
<td>75%</td>
<td>401-500</td>
<td>75%</td>
</tr>
<tr>
<td>over 1.0%</td>
<td>Reject</td>
<td>Over 500</td>
<td>Evaluate</td>
</tr>
</tbody>
</table>

When concrete is more than 500 psi below the required compressive strength, it will be evaluated to determine whether it is to be removed, corrective measures are to be taken, or it is to be accepted at 75% pay factor. The evaluation will include performance of a structural analysis by the City or its consultant. All costs of performing the evaluation shall be at the Contractor’s expense.

On developer/private funded projects, the difference between the unit price cost and the pay reduction factor cost shall be transferred to the City prior to initial acceptance of the project.
32.00 MATERIALS TESTING
32.01 SCOPE
32.02 RESPONSIBILITIES OF THE TESTING AGENCY
32.03 TESTING
32.04 RESPONSIBILITIES OF THE CONTRACTOR OR DEVELOPER
32.05 PERSONNEL QUALIFICATIONS
SECTION 32.00 MATERIALS TESTING

32.01 Scope

The requirements of this section shall apply to all testing agencies and required materials testing services for soils, asphalt, and concrete.

32.02 Responsibilities of the Testing Agency

32.02.1 General  All materials and operations shall be tested in accordance with these specifications and as directed by the Project Manager. 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 the project, as required by these specifications and as directed by the Project Manager. If any materials furnished or the work performed by the Contractor fails to fulfill the specification requirements, such deficiencies shall be reported to the Project Manager and the Contractor immediately. Preliminary written field reports of all tests and observation results shall be given to the Contractor or Developer immediately after they are performed. Field reports shall be made available to the Project Manager by the testing agency. Final reports shall be forwarded to the Project Manager no later than one week following the testing. Results of all tests taken, including failing tests, shall be reported.

Reports shall bear the seal and signature of a Professional Engineer registered in the State of Colorado and competent in the required testing practice. All test reports shall show the location where the test was performed or where the work or batch represented by the test was placed. Test reports shall include all information specified in the AASHTO or ASTM test procedure used. Improperly completed reports will not be accepted. A Certificate of Occupancy will not be issued until all final reports indicating compliance with these specifications are reviewed and placed on file by the City. The testing agency personnel are not authorized to stop work, to revoke, alter, relax, enlarge, or release any requirements of the specifications, or to approve, accept, or reject any portion of the work.
32.03 Testing

32.03.1 General All testing methods and procedures performed by the testing agency personnel shall be in accordance with the applicable AASHTO and ASTM requirements and procedures (see Tables 32.1-7). Test reports shall include the AASHTO and ASTM test designations of all tests taken. All testing and retesting services shall be at the expense of the Contractor or Developer, except on City contracts. Initial testing on City contracts shall be at the City’s expense; all retesting due to failing tests shall be at the Contractor’s expense.

When changes in materials or proportions are encountered during construction, or when the work fails to pass tests or fails to meet the specifications, additional tests shall be taken as directed by the Project Manager. Failure of the Contractor or Developer to furnish satisfactory test data shall be sufficient cause for rejection of the work in question.

32.03.2 Soil Testing

32.03.2.01 All testing shall be according to AASHTO or ASTM as designated in Table 32.1 and Table 32.2.

32.03.2.02 When density and moisture content are determined by a nuclear device, a sand cone density test shall be taken daily or at the discretion of the Project Manager or the City. If the results of the sand cone tests do not agree with the nuclear tests, use of that nuclear device shall be immediately discontinued until the cause of the disagreement is determined and corrected.

32.03.2.03 A moisture-density determination shall be taken for each soil type encountered. For A-6 and A-7 soils, AASHTO T 99 shall apply. All other soils use AASHTO T 180.
### Table 32.1
**SCHEDULE FOR MINIMUM MATERIALS SAMPLING AND TESTING FOR EMBANKMENT**

<table>
<thead>
<tr>
<th></th>
<th>AASHTO</th>
<th>ASTM</th>
<th>Minimum Frequency of Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SOILS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sampling</td>
<td>T 86</td>
<td>D 420</td>
<td>One test per soil type</td>
</tr>
<tr>
<td>Soil Classification</td>
<td>M 145</td>
<td>D 3282</td>
<td>One test per soil type</td>
</tr>
<tr>
<td>Liquid Limit</td>
<td>T 89</td>
<td></td>
<td>One test per soil type</td>
</tr>
<tr>
<td>Plastic Limit</td>
<td>T 90</td>
<td></td>
<td>One test per soil type</td>
</tr>
<tr>
<td>Material Finer than 75um Sieve</td>
<td>T 11</td>
<td>D 698</td>
<td>One test per soil type</td>
</tr>
<tr>
<td></td>
<td>T 88</td>
<td>D 1557</td>
<td></td>
</tr>
<tr>
<td>Moisture Density (Proctor)</td>
<td>T 99</td>
<td></td>
<td>One test per soil type</td>
</tr>
<tr>
<td></td>
<td>T 180</td>
<td>D 1557</td>
<td></td>
</tr>
<tr>
<td>In-Place Density</td>
<td>T 238</td>
<td>D 2922</td>
<td>One test for each 200 lane feet per layer or every 200 cu. yds. (not less than one test per day)</td>
</tr>
<tr>
<td>Nuclear</td>
<td>T 239</td>
<td>D 3017</td>
<td></td>
</tr>
<tr>
<td>Sand Cone</td>
<td>T 191</td>
<td>D 1556</td>
<td>One test for every tenth nuclear method in-place density test</td>
</tr>
</tbody>
</table>

### Table 32.2
**SCHEDULE FOR MINIMUM MATERIALS SAMPLING AND TESTING FOR AGGREGATE BASE COURSE**

<table>
<thead>
<tr>
<th></th>
<th>AASHTO</th>
<th>ASTM</th>
<th>Minimum Frequency Of Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AGGREGATE BASE COURSE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sampling</td>
<td>T 2</td>
<td>D 75</td>
<td>One test per every 1,000 tons or fraction thereof</td>
</tr>
<tr>
<td>Moisture Density</td>
<td>T 180</td>
<td>D 1557</td>
<td>One test per every 1,000 tons or fraction thereof</td>
</tr>
<tr>
<td>Atterberg limits</td>
<td>T 89 &amp; T 90</td>
<td>D 2922</td>
<td>One test per every 1,000 tons or fraction thereof</td>
</tr>
<tr>
<td>Gradation</td>
<td>T 27 &amp; T 11</td>
<td>D 1557</td>
<td>One test per every 1,000 tons or fraction thereof</td>
</tr>
<tr>
<td>In-place density</td>
<td>T 238 &amp; T 239</td>
<td>D 1557</td>
<td>One test for each 200 lane feet per layer or every 200 cu. yds.</td>
</tr>
<tr>
<td>Thickness</td>
<td></td>
<td></td>
<td>One test for each 200 lane feet per layer or every 200 cu. yds.</td>
</tr>
<tr>
<td>Resilient Modulus</td>
<td>T 294</td>
<td></td>
<td>Upon request</td>
</tr>
</tbody>
</table>
### Table 32.3
**SCHEDULE FOR MINIMUM MATERIALS SAMPLING AND TESTING FOR BITUMINOUS PAVING MIXTURES**

<table>
<thead>
<tr>
<th></th>
<th>AASHTO</th>
<th>ASTM</th>
<th>Minimum Frequency of Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ASPHALT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sampling</td>
<td>T 168</td>
<td>D 979</td>
<td>D 3665</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>One test per every 1,000 tons or fraction thereof (not less than one test per day)</td>
</tr>
<tr>
<td>Hveem properties</td>
<td>T 245</td>
<td>D 1559</td>
<td>D 1561</td>
</tr>
<tr>
<td></td>
<td>T 247</td>
<td></td>
<td>One test per every 1,000 tons or fraction thereof (not less than one test per day)</td>
</tr>
<tr>
<td></td>
<td>T 166</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-place density</td>
<td></td>
<td>D 1188</td>
<td>D 2950</td>
</tr>
<tr>
<td></td>
<td></td>
<td>One test for each 250 linear lane feet per layer of in-place HBP</td>
<td></td>
</tr>
<tr>
<td>Asphalt content</td>
<td>T 164</td>
<td>D 2172</td>
<td>D 3203</td>
</tr>
<tr>
<td></td>
<td>T 269</td>
<td></td>
<td>One test per every 1,000 tons or fraction thereof (not less than one test per day)</td>
</tr>
<tr>
<td></td>
<td>TP 53</td>
<td>PS 90</td>
<td></td>
</tr>
<tr>
<td>Maximum Specific Gravity of HBP</td>
<td>T 209</td>
<td>D 2041</td>
<td>One test per every 1,000 tons or fraction thereof (not less than one test per day)</td>
</tr>
<tr>
<td>Air voids and VMA</td>
<td>T 269</td>
<td>D 3203</td>
<td>One test per every 1,000 tons or fraction thereof (not less than one test per day)</td>
</tr>
<tr>
<td>Thickness</td>
<td></td>
<td>D 3549</td>
<td></td>
</tr>
<tr>
<td>Aggregate Gradation</td>
<td>T 27</td>
<td>C 136</td>
<td>One test per every 1,000 tons or fraction thereof (not less than one test per day)</td>
</tr>
</tbody>
</table>

### Table 32.4
**SCHEDULE FOR MINIMUM MATERIALS SAMPLING AND TESTING FOR PORTLAND CEMENT CONCRETE**

<table>
<thead>
<tr>
<th></th>
<th>AASHTO</th>
<th>ASTM</th>
<th>Minimum Frequency of Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CONCRETE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sampling</td>
<td>T 141</td>
<td>C 172</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>One set per 50 cu. yds.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>One set per 100 cu. yds. (paving)</td>
</tr>
<tr>
<td>Compressive strength</td>
<td></td>
<td>C 39</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>One set per 50 cu. yds.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>One set per 300 cu. yds. (paving)</td>
</tr>
<tr>
<td>Temperature</td>
<td></td>
<td>C 1064</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>One test per 50 cu. yds.</td>
</tr>
<tr>
<td>Slump</td>
<td>T 119</td>
<td>C 143</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>One set per 25 cu. yds.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>One set per 50 cu. yds. (paving)</td>
</tr>
<tr>
<td>Air content</td>
<td>T 196</td>
<td>C 173</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T 121</td>
<td>C 138</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>One set per 25 cu. yds.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>One set per 50 cu. yds. (paving)</td>
</tr>
<tr>
<td>Thickness</td>
<td></td>
<td>C 174</td>
<td>One test per 500 linear lane feet (paving)</td>
</tr>
</tbody>
</table>
### Table 32.5
**SCHEDULE FOR MINIMUM MATERIALS SAMPLING AND TESTING FOR SLURRY SEAL**

<table>
<thead>
<tr>
<th>Test Type</th>
<th>AASHTO</th>
<th>ASTM</th>
<th>Minimum Frequency of Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residue after distillation</td>
<td>T 59</td>
<td></td>
<td>One test for each 5,000 sq. yds. or fraction thereof (not less than one test per day)</td>
</tr>
<tr>
<td>Extraction and Gradation</td>
<td>T 164</td>
<td>T 30</td>
<td>One test for each 5,000 sq. yds. or fraction thereof (not less than one test per day)</td>
</tr>
<tr>
<td>Application Rate</td>
<td></td>
<td></td>
<td>One test for each 5,000 sq. yds. or fraction thereof (not less than one test per day)</td>
</tr>
</tbody>
</table>

### Table 32.6
**SCHEDULE FOR MINIMUM MATERIALS SAMPLING AND TESTING FOR STABILIZED SUBGRADE**

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Test Standard</th>
<th>Minimum Frequency of Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling</td>
<td>AASHTO T 87</td>
<td>Per 1,000 square yards</td>
</tr>
<tr>
<td>Maximum Dry Density and Optimum Moisture Content</td>
<td>ASTM D 3551</td>
<td>As directed by Project Manager (minimum one per soil type)</td>
</tr>
<tr>
<td>In Place Soil Density</td>
<td>ASTM D 1556 ASTM D 2167 ASTM D 2922</td>
<td>One test for each 200 lane feet (not less than 1 test per day)</td>
</tr>
<tr>
<td>In Place Moisture Content</td>
<td>ASTM D 2216 ASTM D 3017</td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>ASTM C 110 ASTM C 977 APPENDIX</td>
<td>One test per 1,000 square yards</td>
</tr>
<tr>
<td>Swell</td>
<td>ASTM D 4546 Method B</td>
<td>As directed by Project Manager</td>
</tr>
<tr>
<td>Unconfined Compressive Strength (Lime)</td>
<td>ASTM D 5102 (Procedure B)</td>
<td>One set of 4 cylinders per 1,000 square yards. Sealed and moist cured at 100°F for 5 days.</td>
</tr>
<tr>
<td>Compressive Strength Cementitious Agents</td>
<td>ASTM D 1633 (Method A)</td>
<td>One set of 4 cylinders per 1,000 square yards. Sealed and moist cured at 100°F for 5 days.</td>
</tr>
<tr>
<td>Atterberg Limits</td>
<td>AASHTO T 89 &amp; T 90</td>
<td>One test per 1,000 square yards</td>
</tr>
<tr>
<td>Thickness</td>
<td>As directed by Project Manager</td>
<td>One test every 500 feet per lane</td>
</tr>
<tr>
<td>Percentage of Agent</td>
<td>AASHTO T 232 See Section 22.10.4</td>
<td>One test per 1,000 square yards</td>
</tr>
</tbody>
</table>

**32.03.2.04** In addition to the requirements of Section 32.03, all reports shall include elevation or depth below finish grade at which test was taken. Results shall
report densities (maximum dry and relative) to nearest 0.1 lb/cu. ft., moisture content (optimum and in place) to nearest 0.1%, and compaction (relative and required) to nearest 0.1%. The most recent adjusted manufacturer’s calibration curve must be available upon request. The manufacturer’s calibration curve shall be adjusted as required by ASTM D 2950.

32.03.3 Asphalt Testing

32.03.3.01 All testing shall be according to AASHTO or ASTM as designated in Table 32.3.

32.03.3.02 In-Place Density: A minimum of one test for each 250 linear lane feet per layer of in-place HBP or fraction thereof.

32.03.3.03 Aggregate Gradation A minimum of one test per 1,000 tons or fraction thereof.

32.03.3.04 In addition to the requirements of Section 32.03, all reports shall include densities to the nearest 0.1 lb. per cu. ft. and compaction to the nearest 0.1%. If a nuclear device is used, the report shall contain the method used (i.e., back scatter, direct transmission, etc.)

32.03.3.05 In-place pavement thickness shall be determined as follows: The pavement shall be cored at 500' intervals or fraction thereof, in each 12' lane (nominal), with a minimum of three cores in any area. The Project Manager may require additional cores to define deficient areas.

32.03.4 Concrete Tests

32.03.4.01 All testing shall be according to AASHTO or ASTM as designated in Table 32.4.

32.03.4.02 Sampling and testing shall be required on all concrete work including curb, sidewalk, pans, pavement, slope paving, retaining walls, inlets, manholes, or any other structures.

32.03.4.03 Maximum time between sampling and casting cylinders shall not exceed 45 minutes. If the concrete cannot be taken to the laboratory and cylinders cast within 45 minutes, the cylinders shall be cast in the field. Cylinders shall be transported to the laboratory within 24 hours of casting but after the concrete has hardened (see AASHTO T 23).
Concrete cylinders shall be broken according to the following table.

### Table 32.7
**CONCRETE CYLINDER BREAKS**

<table>
<thead>
<tr>
<th>NUMBER OF CYLINDERS</th>
<th>BREAK INTERVAL (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FIELD CURED SERIES</strong> (4-Cylinders)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>14*</td>
</tr>
<tr>
<td><strong>LABORATORY CURED SERIES</strong> (6 Cylinders)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>28</td>
</tr>
<tr>
<td>2</td>
<td>45*</td>
</tr>
</tbody>
</table>

* or as directed by the Project Manager

One laboratory cured series shall be taken for each 50 cubic yards of concrete placed or fraction thereof.

**32.03.4.05** Slump AASHTO: T 119. Air: AASHTO T 196 or T 121. Test shall be taken for each 25 cubic yards of concrete placed or fraction thereof. A minimum of three slump and air tests shall be taken per day or as directed by the Project Manager. Slump and air tests shall be taken with each cylinder series.

**32.03.4.06** If samples of fresh concrete have not been obtained and tested, a minimum of three cores shall be taken per AASHTO T 24 and broken. Air content, ASTM C 451, and cement content, AASHTO T 178, shall also be determined. Concrete in the portion of the structure from which the core was taken will be considered adequate if the average strength of the cores is equal to a minimum of 80% of the specified strength (f’c) and if the strength of no single core is less than 75% of f’c. All core holes shall be completely filled with a concrete meeting the same mix design criteria.

**32.03.4.07** In addition to the requirements of Section 32.03, all reports shall include the type of structure; cylinders; data on obtaining, transporting, storing, curing, time between sampling and casting cylinders; supplier, batch ticket I.D., finisher and contractor.
32.04 Responsibilities of the Contractor or Developer

32.04.1 General The Contractor or Developer shall provide at his expense the required testing services except on City contracts. Initial testing on City contracts shall be at the City’s expense. All retesting shall be at the Contractor’s expense. The use of a testing agency’s services does not relieve the Contractor or Developer of the responsibility to furnish the required materials and to perform the required construction in full compliance with specifications. Passing test results do not constitute acceptance of the work or materials represented by the test. The Contractor is responsible for quality control of his work.

32.04.2 Testing Agency Access and Assistance The Contractor or Developer shall allow the testing agency access to the job site at all times; furnish any labor required to assist the testing agency in obtaining and handling samples at the source of material and at the project; provide and maintain, for the sole use of the testing agency, adequate facilities for safe storage and proper curing of concrete test specimens the project site as required by AASHTO T 23.

32.04.3 Mix Designs When requested by the Project Manager, the Contractor or Developer shall furnish asphalt mix designs or concrete mix designs meeting the requirements of these specifications. Concrete mix designs shall be performed according to the provisions of ACI-211 or ACI-304. A separate mix design shall be provided if pumped concrete is used.

32.05 Personnel Qualifications

32.05.1 The person responsible for the quality control testing shall be a Registered Professional Engineer in the state of Colorado and practicing in this field.

32.05.2 Technician shall be certified as a Level II or higher NICET in the specific area where they perform tests, i.e., soils, concrete, asphalt.

32.05.3 The technician taking samples and performing tests must possess one or more of the following qualifications.

- Technicians taking samples and conducting compaction tests must have a Level IIA certification from LabCAT or equivalent.
- Technicians conducting tests of asphalt content and gradation must have a Level IIB certification from LabCAT or equivalent.
- Technicians taking concrete samples and conducting field tests must have a Field certification from ACI or equivalent.
• Technicians conducting tests of Portland cement concrete for compressive strength shall possess a certification from ACI Laboratory Grade I or equivalent.

• Technicians conducting tests of Portland cement concrete for flexural strength and to determine mixture design characteristics shall possess a certification from ACI Laboratory Grade II or equivalent.

• Technicians determining asphalt mixture volumetric and strength characteristics must have a Level II C certification from LabCAT or equivalent.
33.00  FLOWABLE BACKFILL
33.01  SCOPE
33.02  MIX DESIGN
33.03  MATERIALS AND PRODUCTION
33.04  PLACEMENT
33.05  EXCESS EXCAVATION
33.06  FLASH FILL
SECTION 33.00 FLOWABLE BACKFILL

33.01 Scope
This section specifies requirements for design, materials, production, and placement of low strength, flowable pozzolanic backfill. Flowable backfill is an alternative to conventional compacted earth backfill. Typical applications for this type of backfill are:

- Utility trenches
- Bridge abutments, retaining walls, etc.
- Structural fill (foundation subbase, subfooting, pipe bedding, etc.)

33.02 Mix Design
A mix design shall be prepared in a testing laboratory by a Colorado Licensed Professional Engineer competent in the field of materials engineering. In lieu of a mix design, documentation of field test data may be submitted. Samples of the mix, with its formula, shall be made available to the City for testing prior to construction. City reviewed mixes may be considered prequalified for subsequent usage. Flowability and strength requirements when tested in accordance with ASTM D 4832 shall be as follows:

- Slump: 7" minimum
- 28-day strength: 30-90 psi
- 90-day strength: 35-95 psi

33.03 Materials and Production
Flowable backfill shall be produced from a job mix formula as specified above.

When coarse aggregate is used, 100 percent shall pass the 1-inch sieve, and it shall comprise not more than 40 percent of the total aggregate content. Other aggregate products such as aggregate base, crushed rock, pea gravel, or reject sand which has not more than 20 percent passing the No. 200 sieve and is free of organic material and other deleterious substances, may be accepted by the Project Manager if a flowable, workable mix can be produced without segregation of the aggregate.

33.04 Placement
Before depositing flowable backfill, debris shall be removed from the space to be occupied by the flowable backfill. Flowable backfill shall be held low enough from the pavement surface to
allow adequate trench patching depth per Detail S10.2. Vibratory or other compaction equipment shall be used only when necessary to fill inaccessible voids.

Flowable backfill shall be allowed to cure for 24 hours before placing permanent pavement on it. Traffic shall not be allowed on flowable backfill during the first 6 hours after placement. Temporary pavement or fill can be used after a six hour initial set.

33.05 Excess Excavation
All excess excavation material shall be removed from the job site at the Contractor's expense and shall become the property of the Contractor.

33.06 Flash Fill
Use of Flash fill or flow fill will only be allowed with the permission of the Materials Testing Laboratory, or the Project Manager, or the Public Improvements Observer for backfilling of utility trenches. In no case will Flash fill or flow fill be allowed to come in contact with or within one foot of a metal utility line.
34.00 RELATED CONSTRUCTION AND SPECIFICATIONS
34.01 UTILITY CONSTRUCTION
34.02 STORM DRAINAGE SPECIFICATIONS
34.03 MINIMUM STORM DRAINAGE PIPE SIZE
34.04 TRENCHLESS TECHNOLOGY
SECTION 34.00 RELATED CONSTRUCTION AND SPECIFICATIONS

34.01 Utility Construction
All utility construction within the city shall conform to the requirements in the "City of Aurora Public Utility Improvements Rules and Regulations Regarding Standards and Specifications," latest edition. The above utility standards and specifications shall by reference be a part in whole of these standards and specifications and shall be purchased separately. Where utilities are to cross concrete pavements, saw cuts shall be at existing joints so whole panels shall be removed, unless otherwise approved by the City Engineer. No new joints shall be made.

34.02 Storm Drainage Specifications
All design criteria and regulations governing storm drainage and storm water within the city shall conform to the requirements in the "City of Aurora Storm Drainage Design & Technical Criteria," latest edition. The above storm drainage standards and specifications shall by reference be a part in whole of these standards and specifications and shall be purchased separately.

34.02.1 Storm sewers placed in arterial roadways within the C.O.A. right-of-way shall be either RCP, Class III or higher or PVC, pipe stiffness of 46 psi minimum. Other alternate pipe materials will not be considered for use in arterial roadways.

34.03 Minimum Storm Drainage Pipe Size
The minimum diameter of storm pipe allowed within public right-of-way shall be 18 inches.

34.04 Trenchless Technology
Trenchless technology refers to subsurface, horizontal excavation used as an alternative to trenching for installation of utility lines. Pipes, conduits, sleeves, cables, and wires will be collectively referred to as utility lines in this section. This section applies primarily to directional boring. It also applies to pneumatic missiling, micro-tunneling, augering and pipe ramming, or jacking. Utility companies, Contractors, and others using trenchless technology in City rights-of-way or other City properties such as parks, drainage ways parking lots, etc., shall be licensed and bonded with the City. A utility construction permit may also be required. For information, refer to Section 7, CONSTRUCTION REQUIREMENTS, and Section 36.0, ROAD CUTS.

34.04.1 Location of Existing Utilities
Prior to construction, all existing underground utilities shall be physically located. It is advised to obtain design locates when
planning bore alignments. It may not be allowable to waive clearance and depth requirements solely due to unknown conflicts if design locates were not performed.

All underground utilities shall be marked on the surface five feet on both sides of the proposed bore alignment by the utility owners. Contact the Utility Notification Center of Colorado at 1-800-922-1987 for locating service and a listing of tier 2 utilities. Contact the City of Aurora Water Department for water, sanitary and storm sewer locates; the Public Works Department for traffic signal locates; and the Parks Department for irrigation system locates. Contact adjacent property owners for locating private water service lines, sanitary service lines, and sprinkler systems. Depth determination of existing utilities shall be done by carefully potholing.

34.04.2 Size and Alignment of Bores  Bore hole diameter and the amount of void space remaining around the utility line shall be minimized to prevent surface subsidence. Alignment and depth of bores shall be designed to accommodate the many different underground utilities which use relatively narrow corridors and cross each other.

34.04.2.01 Size of Bores  Bore hole diameter shall not exceed 1-1/2 times the utility line diameter for smaller utilities less than seven inches in diameter. For larger utility lines and multiple lines using the same bore hole, approval of construction methods and bore diameter by the City Engineer shall be required.

34.04.2.02 Alignment and Depth of Bores  Bore hole alignment shall be parallel for longitudinal street bores and perpendicular for street crossings. A bore hole shall not meander more than one foot to either side of the approved proposed alignment. A bore hole shall not encroach within one foot, horizontal or vertical, of another utility facility. The minimum depth of private utility lines (gas, electric, communication) shall be 30 inches.

34.04.3 Drilling Operations

34.04.3.01 Water  Water used for the drilling operation shall not be obtained from City fire hydrants without a meter. A meter can be obtained from the City's Water Shop at 13645 E. Ellsworth Avenue (phone 303-326-8120) to be used on hydrants. The Water Department personnel at the Water Shop will provide direction on use and proper methods for filling tanks so as not to cause a cross connection that could contaminate the City's water supply.
34.04.3.02 **Emergencies** The Fire Department shall be notified immediately (phone 911) whenever gas or electric lines are damaged by the drill. The utility owner and the City observer should be notified whenever any utility line is damaged. Failure to make these notifications may be cause to revoke license and permit.

34.04.3.03 **Mud Containment and Clean Up** Drilling mud shall be ponded or contained in a manner which does not allow it to flow onto sidewalks, into traveled lanes, or down the gutter across driveways and cross pans. It is prohibited to allow mud to be tracked onto City streets. It is also prohibited to wash drilling mud into, or allow it to flow into storm sewer inlets. Citations will be issued for these violations. The City observer may temporarily allow the Contractor to pond mud in the gutter with the use of hay bales or sand bags as long as it is barricaded and does not impede traffic. In the event drilling mud should leak from the bore hole to the surface, the area shall be barricaded from vehicular and pedestrian travel immediately before resuming drilling operation. Complete clean up of drilling mud with hydro-vacuuming equipment is required at the end of each day.

34.04.4 **Restoration and Miscellaneous** Pavement, sidewalk, other items of infrastructure, and landscaping that are damaged during construction shall be replaced or repaired.

34.04.4.01 Surface improvements that are undermined from adjacent bore/splice pits more than one foot horizontally shall be replaced or repaired.

34.04.4.02 Structures that are raised by more than 1/4 inch due to pressure from drilling mud, e.g., humped pavement or faulted sidewalk stones, shall be replaced or repaired.

34.04.4.03 Bore holes that are greater than three inches in diameter that are abandoned without conduit shall be filled with an approved grout or flowable backfill material.

34.04.4.04 Conduit that is wasted between the bore hole collar at grade and the splice pit at depth shall be removed, not abandoned in place.
34.04.4.05 Lids and covers on hand holes, pull/splice/junction boxes, and other below-grade utility vaults shall be adjusted to grade prior to backfilling. Buried facilities with concealed covers are prohibited.

34.04.4.06 Asphalt Pavement Repairs See Section 36.00 for requirements.
35.00  RIPRAP AND FILTER BLANKET
35.01  RIPRAP
35.02  CONSTRUCTION REQUIREMENTS
35.03  MEASUREMENT AND PAYMENT
SECTION 35.00 RIPRAP AND FILTER BLANKET

35.01 Riprap

All materials and construction methods shall conform to Urban Storm Drainage Criteria Manual (USDCM), Volume 1, "Major Drainage." Per USDCM, Table MD-7 – “Classification and Gradation of Ordinary Riprap”, riprap shall be designated as follows.

**TABLE 35.1**
CLASSIFICATION AND GRADATION OF ORDINARY RIPRAP

<table>
<thead>
<tr>
<th>Riprap Designation</th>
<th>% Smaller Than Given Size by Weight</th>
<th>Intermediate Rock Dimensions (Inches)</th>
<th>$d_{50}^*$ (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type VL</td>
<td>70-100 50-70 35-50 2-10</td>
<td>12 9 6 2</td>
<td>6**</td>
</tr>
<tr>
<td>Type L</td>
<td>70-100 50-70 35-50 2-10</td>
<td>15 12 9 3</td>
<td>9**</td>
</tr>
<tr>
<td>Type M</td>
<td>70-100 50-70 35-50 2-10</td>
<td>21 18 12 4</td>
<td>12**</td>
</tr>
<tr>
<td>Type H</td>
<td>100 50-70 35-50 2-10</td>
<td>30 24 18 6</td>
<td>18</td>
</tr>
<tr>
<td>Type VH</td>
<td>100 50-70 35-50 2-10</td>
<td>42 33 24 9</td>
<td>24</td>
</tr>
</tbody>
</table>

*$d_{50} = \text{Mean particle size (intermediate size) by weight.}$

** Mix VL, L and M riprap with 35% topsoil (by volume) and bury it with 4 to 6 inches of topsoil, all vibration compacted, and revegetate.

35.02 Construction Requirements

Slopes to be protected by riprap shall be free of brush, trees, stumps, and other objectionable material and be dressed to a smooth surface. All soft or spongy material shall be removed to the depth shown on the plans, or as directed by the Project Manager, and replaced with approved...
material. All slopes and embankments not in the right-of-way of roadways shall be compacted at optimum moisture to a minimum 90% of the maximum density as determined by AASHTO Test T 180. All slopes and embankments in the right-of-way of roadways shall be compacted in accordance with the latest revision of Section 20.06, EARTHWORK.

35.02.1 Dumped Riprap  Stone for riprap shall be placed on the prepared slope or area in a manner which will produce a reasonably well-graded mass of stone with the minimum practicable percentage of voids. The entire mass of stone shall be placed so as to be in conformance with the lines, grades, and thickness shown on the plans. Riprap shall be placed to its full course thickness at one operation and in such a manner as to avoid displacing the underlying material. Placing of riprap in layers, or by dumping into chutes, or by similar methods likely to cause segregation will not be permitted.

The larger stones shall be well distributed and the entire mass of stone shall conform to the gradation specified in Section 35.01, RIPRAP. All material going into riprap protection shall be so placed and distributed that there will be no large accumulations of either the larger or smaller sizes of stones.

Unless otherwise authorized by the Project Manager, the riprap protection shall be placed in conjunction with the construction of the embankment with only sufficient lag in construction of the riprap protection as may be necessary to allow for proper construction of the portion of the embankment protected, and to prevent mixture of embankment and riprap. The Contractor shall maintain the riprap protection until accepted; any material displaced by any cause shall be replaced to the lines and grades shown on the plans at no additional cost to the City.

35.02.2 Hand-Placed Riprap  Hand-placed riprap shall conform to all the requirements of Section 35.02.1, DUMPED RIPRAP. Hand-placed riprap shall be required when the depth of riprap is less than two times the nominal stone size, or when required in the special conditions.

After the riprap has been dumped, hand placing or rearranging of individual stones by mechanical equipment shall be required to the extent necessary to secure a uniform surface and the specified depth of riprap.
35.02.3 **Wire-Enclosed Riprap** The drawings and special conditions will show details of wire-enclosed riprap and specify the construction materials and procedures to be used.

35.02.4 **Grouted Riprap** Grouted riprap shall not be used.

35.02.5 **Grouted Boulders** Grouted boulders shall conform to the requirements of Urban Drainage and Flood Control District’s requirements under Major Drainage, Section 4.4.1.2. The boulders shall be placed on the prepared grade to the dimensions shown on the plans. The boulders shall be thoroughly moistened before grouting.

Grout shall not be placed when the temperature is below 35°F or at 35°F and falling. It shall be protected from freezing and cured as specified in Section 30.00, CONCRETE WORK.

35.02.6 **Filter Blanket** Filter fabric is not a complete substitute for granular bedding. Per USDCM Table MD-12, granular bedding shall be required as follows.

**TABLE 35.2**

<table>
<thead>
<tr>
<th>Riprap Designation</th>
<th>Minimum Bedding Thickness (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Fine Grained Soils</strong></td>
</tr>
<tr>
<td></td>
<td>Type I</td>
</tr>
<tr>
<td>VL, L</td>
<td>4</td>
</tr>
<tr>
<td>M</td>
<td>4</td>
</tr>
<tr>
<td>H</td>
<td>4</td>
</tr>
<tr>
<td>VH</td>
<td>4</td>
</tr>
</tbody>
</table>

* May substitute one 12-inch layer of Type II bedding. Substitution of one layer of Type II bedding shall not be permitted at drop structures. Use of a combination of filter fabric and Type II bedding at drop structures is acceptable, see Section 4.4.4.1 of the USDCM, Volume I, Major Drainage, for use of filter fabric at drop structures.

** 50% or more by weight retained on the #40 sieve.

When required, a filter blanket shall be placed on the prepared slope or area to the full specified thickness of each layer in one operation, using methods which will not cause segregation. The surface of the finished layer should be reasonably even and free from mounds or windows. Additional layers of filter material, when required, shall be placed in the same manner, using methods which will not cause mixture of the material in the different layers.
35.03 Measurement and Payment

Measurement of riprap shall be on a square-foot basis of the specified thickness as shown on the plans.

In the event the riprap is placed outside the specified limits, the Contractor may be required to remove and dispose of the excess riprap at his expense.

Rip rap shall be paid for at the contract unit price per square foot. The contract price per square foot for the riprap shall include full compensation for furnishing all labor, materials, and equipment necessary to complete the work.
36.00 ROAD CUTS

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36.02 LICENSE 1
36.03 PERMITS 1
36.04 NOTIFICATION AND INSPECTION REQUIREMENTS 1
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SECTION 36.00 ROAD CUTS

36.01 Scope
This section is designed to help the contractor, engineer, project manager, HOA, or utility company to understand what restorations will be required if a new or existing street, or Right-of-Way in the City of Aurora is cut. The Public Works Director is authorized under the Aurora City Code and the Colorado Revised Statutes (“C.R.S.”) 38-5.5-106 to set standards for public roadways in the City of Aurora. The following standards are adopted to maintain the esthetics, ride quality, structural integrity, safety and life cycle of new and existing City of Aurora Roadways.

36.02 License
All contractors working in the City of Aurora’s public right-of-way are required to be licensed and bonded by the City of Aurora.

36.03 Permits
All contractors working in the City of Aurora’s public right-of-way, including Landscapers and HOAs (excludes work that does not require excavation or construction of above grade facilities), are required to obtain a permit from the Public Improvement Inspections Permit Counter, Suite 2400, prior to any site construction. For all work other than city projects, the contractor doing the work is responsible for pulling the permit, unless otherwise specified by state law, license agreement, or franchise agreement (Comcast, Xcel Energy). Emergency repairs of utilities to restore a service disruption may begin without a permit as long as the city is notified of the extent of the work, and a permit is obtained the next working day. Permits for irrigation line installation and repair shall be based on waterline trench fees for lines three-inch and larger and on service line installation on lines less than three-inches in diameter.

36.04 Notification and Inspection Requirements
The contractor is required to notify and request inspection a minimum of 24 hours before beginning work. Failure to call for inspection is grounds for rejection, removal and replacement of work. Inspections are to be scheduled through the Public Improvement Inspections Permit Counter at 303-739-7420. Inspectors’ work hours are Monday through Friday 7:30 AM to 4:00 PM. Inspection work outside of these hours, on weekends and holidays, will be billed as overtime at the current overtime rate. When inspectors are on standby outside of normal working hours, the Contractor will be billed at overtime rates. There is a minimum charge of 4
hours for weekends and holidays. Work on weekends or Monday holidays, must be requested by close of business on Thursday.

36.05 Road Cut Definition

A road cut is defined as any excavation, break, removal, hole, or displacement of a roadway surface caused by or resulting from: physical removal, mechanical removal, subsurface investigations, or changes in subgrade moisture attributable to construction activities, construction traffic, or utility related movement such as breaks, settlement or heaving.

36.06 Disturbed Roadway Definition

A disturbed roadway is defined as any roadway, or roadway surface that is displaced, cut, heaved, settled, cracked, or eroded as a result of construction related activities, including but not limited to, repairs or failures of utilities. Road surfaces include but are not limited to dirt, gravel, millings, asphalt, and concrete.

36.07 Requirements and Exceptions

All road cuts or other roadway disturbances within the City of Aurora’s public right-of-way shall be repaired or restored according to the standards specified in this Section 36.00. There might be additional requirements specified elsewhere in the Roadway Design and Construction Specifications.

Any exceptions to these standards for road cut restorations must be approved in writing by the City Engineer or his assignee.

36.08 Small Trench Cut in an Existing Roadway

This section is generally reserved for small road cuts from utility locates, water line repairs, sewer line repairs, electrical line repairs, gas main, phone lines, fiber optic lines, cable lines or service line repairs with damage to asphalt pavement areas less than 500 square feet. Unless pre-approved, all small trenches must be closed and temporarily resurfaced by the end of the workday. Trenches in existing roadways shall be backfilled with compacted native materials or with a pre-approved flowable fill material, and the surface restored to use by the end of the workday through the use of hot patch asphalt, cold-mix asphalt or steel plate. (Plating is not allowed between October 15, and April 15.)

Final surface restoration shall be completed within 48 hours of temporary surface placement excluding curing of concrete. For roadways where concrete is involved, high early strength concrete may be required. For damaged or disturbed concrete pavements, sidewalks, curbs,
gutters, cross pans, fillets, handicap ramps, etc., the entire panel must be removed and replaced, unless a variance is granted by the City Engineer or his assignee.

If more than 500 square feet of existing roadway is disturbed (from single street cuts on arterial or collector streets to multiple street cuts on local streets) within a single block, the construction area shall be milled and overlaid by the end of the project or as directed by the City Engineer. The mill and overlay shall encompass all of the disturbed asphalt areas in a generally rectangular shape. See Subsection 36.10 for additional requirements. Standard trench patching shall be required immediately following the initial road cut(s). Should the disturbed pavements be limited to a small or single area, the City Engineer or the Public Improvement Inspections Manager may reduce the required pavement areas.

### 36.09 Trenches Crossing a Roadway

Unless otherwise approved in writing by the City Engineer, all trenches crossing a roadway shall be perpendicular to the direction of travel. The sides of the trench shall be saw cut smooth a minimum of two-foot from the edge of the trench. The road surface shall be replaced in accordance with Standard Detail S10.2, matching the existing pavement grade and maintaining proper drainage. In concrete roads, the pavement thickness is the same as existing but the panel must be doweled into the existing pavement as shown in the standard details. Unless otherwise approved, all cuts in asphalt road surfaces that are less than 3-years old shall be milled and overlaid with approved materials ten-feet on both sides of the trench for local roadways and a minimum of 100-feet on both sides of the trench for collector and arterial roadways.

### 36.10 Trenches within a Roadway

**36.10.1** Longitudinal trenches within a roadway shall be straight and will generally be a consistent distance from either the centerline of the road or flow line, as specified. Meandering will not be allowed. All pavements shall be saw cut with a minimum of two-foot beyond the edge of the trench prior to patching. If the distance between the edge of the trench and the lip of gutter, cross pan or edge of pavement is less than 6 feet, all pavement to the lip of gutter, cross pan or edge of pavement shall be removed and replaced. At a minimum, removed asphalt pavements shall be in accordance with Standard Detail S10.2.

**36.10.2** Pavements within arterials and collectors shall have the final repairs completed within 24 hours of the completion of the work requiring road cut unless the City Engineer grants an exception in writing. All permanent repairs and temporary patches will restore the pavement to existing or **better conditions** than existed prior
to construction. Temporary patches in arterial and major collectors are to be completed by the end of each working day.

36.10.3 Final repairs of pavements within local streets shall be completed within 5 days of the completion of the work requiring road cut unless the City Engineer grants an exception in writing. At no time, will more than 800 feet of trench be allowed to be un-restored or temporarily patched. All patches are to restore the pavement to existing or better condition than existed prior to construction.

36.10.4 In collector and arterial roadways whose surface is more than 3-years old, a minimum 12-foot wide mill and overlay to a depth of 2 inches is required for the length of the trench before the end of construction. Where the trench straddles two or more traffic lanes, both lanes will be milled and overlaid to a depth of 2-inches for the length of the trench before the end of construction or as specified by the City Engineer or his assignee.

36.10.4.1 Local streets shall be patched in accordance with Standard Detail S10.1 and S10.2. Where multiple trench cuts occur in the street, the construction area shall be milled and overlaid by the end of the project or as directed by the City Engineer. The mill and overlay shall encompass all of the disturbed asphalt areas in a generally rectangular shape.

36.10.5 In collector and arterial roadways whose surface is less than 3-years old, the half of the roadway disturbed by construction shall be milled and overlaid to a depth of 2 inches for the length of the trench before the end of construction or as specified by the City Engineer or his assignee. This restoration section shall extend from the centerline of the roadway to the lip of the gutter or pan. Should the road surface on both sides of the centerline be damaged as a result of construction activities, the entire surface of the roadway shall be milled and overlaid as directed by the City Engineer or his assignee.

36.10.5.1 Local streets shall be patched in accordance with Standard Detail S10.1 and S10.2. Where multiple trench cuts occur in the street, the construction area shall be milled and overlaid by the end of the project or as directed by the City Engineer. The mill and overlay shall encompass all of the disturbed asphalt areas in a generally rectangular shape.

36.10.6 At no time will more than 800 feet of road be disturbed and unavailable for the public use unless approved in writing by the City Engineer.
36.10.7 All final road restorations shall be completed within 24 hours for arterials and 4-lane collectors, 48 hours for 2-lane collectors and 5 days for locals. Failure of the contractor to perform the required restorations on time may result in the work being done through the city with the project owner/contractor responsible for all costs. Failure to remit payment for those charges within 30 days of written notice may incur additional finance charges, project acceptance delays and collection fees.

36.11 Potholes for Locates or Subsurface Investigations in Asphalt Pavements

Unless otherwise approved in writing by the City Engineer, potholes for utility locates shall be done by means of a 3 to 6-inch diameter core drill through the existing roadway surface. Cuts in asphalt roadways with a surface disturbance less than 1-square foot shall be repaired using pre-approved pavement materials with an infrared surface treatment. Should there be more than 5 surface cuts, including any previous cuts, or a single disturbed area greater than 1-square foot, or should the area require extensive repair, the entire disturbed area shall be milled to a depth of 2 inches and re-paved per City Standards. Paving shall be a minimum of 50 feet in length and a minimum of 12 feet in width or as directed by the Public Improvement Inspections observer.

All small subsurface excavations are to be backfilled using a pre-approved flowable fill material. The use of sand, soil, pea gravel, bedding material, or any other material that is not pre-approved for this type of application by the Aurora Materials Testing Laboratory or cannot flow to fill the entire void, will not be allowed.

36.12 Potholes For Locates or Subsurface Investigations in Concrete Pavements

Unless otherwise approved by the City Engineer in writing, potholes for utility locates shall be done by means of a 3 to 6 inch diameter core drill through the concrete surface. Cores larger than 6 inches in diameter or open excavations shall be repaired as directed by the Public Improvement Inspections observer. Cores in concrete pavement shall be plugged using a pre-approved fast setting pavement concrete. More than 5 cuts in a concrete pavement, including any previous cuts, or a single disturbed area greater than 1 square foot, shall require the entire panel to be removed and replaced. For sidewalks, curbs, gutters, fillets, handicap ramps and other small concrete placements, the Public Improvement Inspections observer shall determine the extent of replacement if only one small core is performed. Should the concrete section/panel have more than one core, including any previous core, the entire section/panel shall be removed and replaced unless otherwise directed in writing by the City Engineer or his assignee.
All small subsurface excavations are to be backfilled using a pre-approved flow fill material. The use of sand, soil, pea gravel, bedding material, or any other material that is not pre-approved by the Aurora Materials Testing Laboratory or cannot flow to fill the entire void to prevent settlement and provide proper load bearing character, will not be allowed.

36.13 Amount of Unpaved Roadway Trench

Unless otherwise approved by the City Engineer in writing, at no time shall more than 800-feet of a trench or trenches be without final restoration and useable by the public. Situations other than a temporary surface patch, approved by the Public Improvement Inspections observer, due to weather or the need to gain access for final tie in work must be approved in writing by the City Engineer or his assignee prior to the road surface being cut. Before paving, the contractor or the project owner shall demonstrate passing compaction density tests by the use of written field test notes from the Geotech doing the testing and passing a proof roll as specified in Section 20.06.9 of the City of Aurora Roadway Specifications. Official testing on the roadway surface and subsurface conditions need to be delivered to the Aurora Materials Testing Laboratory within 7 days of installation and restoration.

36.14 Trenchless Technology – Bores and Missiles

Trenchless construction using missiles, rams, unguided bores, or any other type of limited control device is not allowed in the City of Aurora right-of-way. Only machines with fully controlled boring head are permitted.

The individual contractor shall warranty the work for a period of 10 years for heave or settlement. In areas where the exact depth and location of sewer mains or services is not known, the contractor shall pothole to determine the depth or shall have a TV video survey done of the sewer line or service, prior to construction. The contractor shall again video survey the sewer line or service after construction is complete to demonstrate the lines have not been damaged. A videotape of the before and after conditions shall be submitted to the city within 30 days of completing boring operations.

36.15 Traffic Signal Restoration

Any and all damage, to traffic signal poles, lines, and loop detectors shall be immediately reported to the Public Improvement Inspections observer. Unless otherwise approved by the City Engineer or City Traffic Engineer, all repairs shall be made immediately. If additional active traffic control is required due to the damage caused by construction activity, it shall be at the expense of the contractor who damaged the facility.
36.16 Traffic Signage and Pavilion Markings Restoration

Unless otherwise specified by the City Traffic Engineer, all signage and striping shall be restored to existing or better condition within 24 hours. Missing or damaged markings and signs that may pose a serious risk to the traveling public shall be repaired or restored immediately.

36.17 Public Safety

The contractor is responsible for maintaining a clean, neat and safe work site at all times. The safety of the public is the first and foremost concern of the City. The contractor shall take all steps to protect the health, life, property and safety of the public, City staff and contracting staff. To that end, the following shall be adhered to when working in a City roadway:

1. Traffic control plans shall be submitted to and approved by the City Traffic Engineer at the time a permit is requested. Prior to any work in the City roadway, the approved plan shall be implemented.

2. Any and all holes in City right-of-way will be backfilled at the end of the working day. If the work is scheduled to extend beyond a single day, the construction area may be kept open with approval of the City Traffic Engineer. If allowed to remain open, the construction area shall be secured from public access through the use of construction fences, concrete barricades, or lighted barricades (panel, barrel or sawhorse). No work will be allowed in arterial roadways between the hours of 6:00 AM and 8:30 AM, and 3:30 PM to 6:30 PM.

3. All trenches in excess of 2-feet deep, in or adjacent to an active roadway shall be secured from the traveling public by the use of temporary concrete barricades.

4. Work hours will be in accordance with Section 146-1802 of the City Code. Work hours will typically be limited to 7:00 AM to 5:00 PM for heavy construction unless work is being done on an emergency basis to restore lost utility service to existing customers or done within a busy collector or arterial where the City Traffic Engineer has imposed restrictions on work hours.

5. At no time will an excavation remain open over a weekend without the express written approval of the City Engineer or City Traffic Engineer.

6. At no time will an excavation be allowed to remain open endangering the public, contractors or City staff.

36.18 Minimum Pavement Standards

All pavement materials, construction methods, construction practices and materials testing shall be in conformance with the Roadway Design & Construction Specifications latest edition.

36.19 Smoothness Criteria

Unless otherwise specified, surface variation of pavement repairs will not deviate by more than 3/16-inch in 10 feet. Settlement adjacent to newly repaired road cuts will be considered damage
incidental to the road cut and must be included in the approved repair. In the event the proper smoothness or matching of existing pavement cannot be maintained due to existing roadway wear or condition, the damaged pavement section shall be repaired or removed and replaced as directed by the Public Improvement Inspections observer.

36.20 Warranty Period

Unless otherwise approved by the City Engineer in writing, all repairs will be warranted against defects in material, workmanship or settlement for a minimum of one year from the date of initial acceptance in accordance with Section 7.12 of the Roadway Design & Construction Specifications. Repairs to property associated with utility repair, maintenance or installation shall be for a minimum of two years per Section 138-113 of the City Code.

36.21 Landscaping and Irrigation within Public Right-of-Way

Unless otherwise specified by a franchise agreement or license agreement, all construction related work in public right-of-way will be permitted. Damages to the right-of-way or City owned facilities, such as, but not limited to, signs, street lights, signal lights wiring, conduits, walkways, bike paths, retaining walls, inlets, or curb and gutters, will be the financial responsibility of the Contractor or HOA associated with the work.
40.00 SEEDING
40.01 SCOPE
40.02 MATERIALS
40.03 CONSTRUCTION REQUIREMENTS
40.04 PERMISSIBLE PLANTING TIMES
40.05 MAINTENANCE
40.06 SEED GERMINATION INSPECTION
40.07 MEASUREMENT AND PAYMENT
SECTION 40.00 SEEDING

40.01 Scope
Seeding shall consist of furnishing and drilling-in, placing, or sowing seed at locations shown on the plans, or as designated, in conformity with the requirements of these specifications.

40.02 Materials

40.02.1 Seed All seed shall be furnished in bags or containers clearly labeled to show the name and address of the supplier, the seed name, the lot number, net weight, the percent of weed seed content, and the guaranteed percentage of purity and germination. All brands furnished shall be free from such noxious seeds as Russian or Canadian thistle, European bindweed, Johnson grass and leafy spurge. The Contractor shall furnish to the Project Manager signed statements 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. Seed which has become wet, moldy, or otherwise damaged in transit or in storage will not be acceptable.

Seed and seed labels shall conform to all current state and federal regulations and will be subject to the testing provision of the Association of Official Seed Analysis.

If seed available on the market does not meet the minimum purity and germination percentages specified, the Contractor must compensate for a lesser percentage of purity and germination by furnishing sufficient additional seed to equal the specified product. Product comparison shall be made on the basis of pure live seed in pounds. Seed shall conform to the mixtures indicated below, or as approved by the Project Manager.

<table>
<thead>
<tr>
<th>Pure Live Seed Per Acre</th>
<th>Lbs./Acre</th>
<th>% Germination</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MIXTURE A</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smooth Brome Grass</td>
<td>12</td>
<td>80</td>
</tr>
<tr>
<td>Crested Wheat (Fairway Strain)</td>
<td>8</td>
<td>85</td>
</tr>
<tr>
<td>Blue Grama</td>
<td>4</td>
<td>80</td>
</tr>
<tr>
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**MIXTURE B**

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<tr>
<td>Bluestem</td>
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<td>90</td>
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<tr>
<td>Rye Grass</td>
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**MIXTURE C**

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<td>95</td>
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<tr>
<td>Blend and Fescue</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

40.02.2 **Fertilizer and Organic Matter**  
Treble super phosphate (18-46-0) will be used on all soil to be seeded. The rate of application shall be 250 lbs./acre. Organic matter is defined as compost, peat moss, and aged manure mixtures, or any combination of the above materials. The rate of application shall be 3 cu. yd. per 1000 sq. ft. to be seeded.

40.03 **Construction Requirements**

Preparatory to seeding, all irregularities in the ground surface, except the saucers for trees and shrubs, shall be removed. The surface shall then be brought to the desired line and grade. Fertilizer and organic matter shall be used wherever there is not any suitable topsoil that can be moved back in place after the earthwork is complete. The organic matter and fertilizer shall be applied uniformly to the soil and rototilled or disked 6" into the soil to be seeded. Necessary measures shall be taken to prevent the formation of low places and pockets where water will stand. Immediately prior to seeding, the ground surface shall be lightly tilled or hand worked into an even and loose seed bed having no lumps or stones over 3".

Seeding may be accomplished by means of mechanical power-drawn drills followed by packer wheels, broadcast-type seeders, or another method if approved by the Project Manager.

Mechanical power-drawn drills shall have depth bands set to maintain a planting depth of at least 1/4". All seed sown by broadcast-type seeders shall be "raked in" or otherwise covered with soil to a depth of at least 1/4" and rolled to obtain a firm seed bed. Water shall be applied when necessary.

Seed shall not be drilled or sown during windy weather or when the ground is frozen or otherwise untillable. When a seed drill is used, it shall be set to space the rows not more than 7"
apart. Hand method of broadcasting seed will be permitted only on small areas not accessible to the machine method.

Seed of different sizes for mixtures to be drilled shall be sown from at least two separate hoppers adjusted or set to provide the coverage of the planted mixtures specified.

To protect newly-seeded areas mulch shall be applied. Mulch shall be applied at a rate of 2 1/2 tons per acre and shall be attached by an approved method suitable for the type of mulch used. Mulch shall be spread uniformly, in a continuous blanket, after seeding is complete. Mulch shall be clean, weed and seed free, long stemmed grass or hay, or long stemmed straw of oats, wheat or rye. At least 50% of mulch, by weight, shall be ten inches or longer. Mulch shall be spread by hand or blower-type mulch spreader. Mulching shall be started on the windward side of relatively flat areas or on the upper part of a steep slope and continued uniformly until the area is covered. The mulch shall not be bunched. Immediately following spreading, the mulch shall be anchored to the soil by a v-type wheel land packer or a scalloped-disk land packer designed to force mulch into the soil surface a minimum of 3 inches. All seeded areas shall be mulched after seeding on the same day as the seeding.

If observation indicates that strips wider than the specified space between the planted rows have been left, or other areas skipped, the Project Manager may require immediate resowing of seed in such areas at the Contractor's expense.

40.04 Permissible Planting Times

Normally, grass seeding shall be accomplished in one or another of two planting seasons within a specified time. Seeding shall be performed between September 1 and October 1, or March 1 and June 15. Any deviation from these dates must be with written consent of the Project Manager.

40.05 Maintenance

The Contractor shall be responsible for maintaining and watering seeded areas for a period of six weeks after the time of seeding. Areas in which there is not a satisfactory stand at the expiration of the first four weeks of this period shall be reseeded. Sprinkling of the seeded areas shall be carefully done in such manner as to avoid standing water surface wash, or scour. Areas seeded and so maintained shall be protected against damage by vehicle and pedestrian traffic by the use of barriers and appropriate warning signs.
40.06  Seed Germination Inspection

The warranty period for the seed mix shall begin at the time of final completion and extend for the duration of forty-five (45) days. During this time, when germination is complete and plants are visible, the engineer will perform a germination inspection. At this time, any areas which are thin, weak, dead, or more than five (5%) percent in weeds, shall be rototilled and reseeded. All washouts shall be reseeded immediately after the germination inspection. No partial acceptances shall be made.

40.07  Measurement and Payment

Seeding shall be measured by the acre for the seed mixture called for on the plans.

Accepted quantities of the dimensions and seed type specified will be paid for at the contract price per acre, complete, in place, or as specified in the contract. The contract price per acre shall include full compensation for all furnished labor, material, and equipment necessary to complete the work and to maintain seeded areas as specified.
41.00 SODDING
41.01 SCOPE
41.02 MATERIALS
41.03 CONSTRUCTION
41.04 GUARANTEE
41.05 INSPECTIONS
41.06 MEASUREMENT AND PAYMENT
SECTION 41.00 SODDING

41.01 Scope
The Contractor shall provide all labor, equipment, and material necessary to furnish and install all sod as required by the drawings and specifications.

41.02 Materials

41.02.1 Sod Sod shall be a blended bluegrass sod or a bluegrass alternate mix and shall match existing sod. Sod shall be free from diseases and weeds, have a healthy appearance, have a soil mat of uniform depth, and be between 1" to 2".

41.02.2 Fertilizer and Organic Matter Treble super phosphate will be used on the soil to be sodded. The rate of application shall be 10 pounds per 1000 sq. ft.

Organic matter shall be defined as compost, peat moss, aged manures, aged sawdust, or any combination of the above materials. The rate of application shall be 10 pounds per 1000 sq. ft.

41.03 Construction
Preparatory to sodding, the top 6" of the surface shall be tilled and brought to the desired line and grade. Fertilizer and organic matter shall be used wherever there is not any suitable topsoil that can be moved back in place after the earthwork is complete. Fertilizer and organic matter shall then be applied uniformly at the rate specified and be rototilled or disked 6" into the soil. The Contractor shall lightly sprinkle the sod bed just prior to laying the sod. Sod shall be laid together tightly with no gaps and rolled to a smooth and even surface free of bumps and depressions. Immediately after installation, the sod shall be thoroughly watered. Settled sod areas shall be pulled, regraded, and relaid.

41.04 Guarantee
The Contractor shall guarantee the life and good health of the sod installed by him for a period of 45 days from the date of approval of the work. Any areas deemed by the Project Manager to be thin, weak, or dead shall be resodded at the Contractor's expense, according to these specifications, prior to the end of the guarantee period. During the guarantee period, the Contractor shall be responsible for any required erosion control, mowing, weeding, and watering of the sod bed.
41.05 Inspections

When the Contractor is prepared for one of the required inspections, he shall give the Project Manager 24-hour notice for the Project Manager to visit the site and perform the inspection. This does not preclude the right of the Project Manager to make informal construction observation at any time during the work of this section. The required inspections for which the Contractor must notify the Project Manager are as follows.

41.05.1 Sodding Inspection  When sodding operations are complete, the Contractor shall notify the Project Manager and request a "sodding inspection" for approval in order to begin the guarantee period. Any areas deemed by the Project Manager to be thin, weak, or dead shall be replaced at this time. No partial acceptances shall be made.

41.05.2 End-of-Guarantee Inspection  Three days prior to the end of the guarantee period, the Contractor shall notify the Project Manager and request an "end-of-guarantee inspection." The Project Manager shall inspect the sod for coverage and health at this time. Any areas deemed by the Project Manager to be thin, weak, or dead shall be replaced at this time. No partial acceptances shall be made.

41.06 Measurement and Payment

Measurement of sod shall be by the square foot. Sod shall be paid for at the contract price per square foot for the area properly installed and accepted, and shall include soil preparation, fertilizer, organic matter, sod, water, and any additional material or labor that may be required for the good and healthy growth of the sodded areas.
SECTION 42.00 MEDIAN COVER MATERIAL

42.01 General
This work shall consist of furnishing the materials, site preparation and material placement required for the installation of the median cover material specified, all in accordance with these Specifications and in reasonably close conformity with the lines, grades, and typical cross section shown on the plans.

42.02 Materials

42.02.1 Pre-Emergent  The pre-emergent shall by Oryzalin (Surflan AS), (3,5 dinitro-N4, N4-Dipropylsulfanilamide) at an application rate of 4 quarts per acre.

42.02.2 Weed Suppression Fabric  The weed suppression fabric shall be MIRAFI 140NS fabric or an equivalent approved by the Project Manager.

42.02.3 Rock for Median Cover  Rock for median cover shall consist of washed river rock. The percentage of wear, when tested in accordance with AASHTO T96, shall be no more than 70. The grading requirements shall be as follows:

- Passing 1 1/2” sieve 100%
- Passing 3/4” sieve 0-5%

42.02.4 Concrete for Median Cover  Class I concrete shall be used in accordance with Section 30.00, CONCRETE WORK. All other requirements for concrete construction contained in CONCRETE WORK shall apply unless stated otherwise in this Specification.

42.03 Construction Requirements

42.03.1 Median Cover Material, Rock

42.03.1.01 General  Median cover operations shall not be started until the underlying surface has been compacted and treated with pre-emergent. The fabric and rock shall be placed immediately after the soil surface has been treated. When completed, the median cover will be a consistent depth of 2”.

42.03.1.02 Pre-Emergent Application  All surface vegetation shall be removed from the area to be treated not more than 3 days before pre-emergent application.

Prior to pre-emergent application, the median shall be leveled and compacted to 95% density according to AASHTO T99 or T180, depending on the soil
type. The pre-emergent shall be applied according to the methods and precautions recommended by the manufacturer.

The Contractor shall comply with all Colorado statutes and all local ordinances or codes pertaining to the use and application of fungicides, insecticides, herbicides, or other agricultural chemicals.

Care shall be exercised to prevent the drift of powder, spray, or vapor which may damage crops, gardens, shrubs, or trees in the vicinity of the areas being treated. Chemicals 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 treatment areas attributable to carelessness or improper application of the pre-emergent.

42.03.2 Median Cover Material, Concrete

42.03.2.01 General Concrete median cover material is to be installed adjacent to the median turn bay as shown on Standard Detail S2.1 or as specified on the plans. Prior to installation, the median shall be graded and compacted to 95% density according to AASHTO T99 or T180, depending on the soil type.

42.04 Measurement and Payment

Rock median cover material shall be measured by the square yard. Work shall include removal of surface vegetation, compaction, weed suppression fabric, and pre-emergent.

Rock median cover material shall be paid for at the contract price per square yard, for material in place, in an area properly treated in accordance with the foregoing requirements and upon acceptance of the work performed.

The contract price per square yard shall include full compensation for furnishing all labor, materials, and equipment necessary to complete the work.

Concrete median cover material shall be measured by the square foot. Work shall include fine grading, compaction, furnishing, installation, and finishing the concrete all in accordance to specifications. Concrete median cover material shall be paid for at the contract price bid per square foot. The contract price per square foot shall include full compensation for all labor, materials, and equipment necessary to complete the work.
43.00  CHAIN LINK FENCE
43.01  SCOPE
43.02  MATERIALS
43.03  WORKMANSHIP
43.04  MEASUREMENT AND PAYMENT
SECTION 43.00  CHAIN LINK FENCE

43.01  Scope
This section covers all work necessary for complete installation of the chain link fence, in-place and ready for use.

43.02  Materials

43.02.1  General  All materials shall be products of recognized, reputable manufacture conforming to these Specifications. Materials shall carry a tag identifying the manufacturer and, in the case of fabric and barbed wire, the class of zinc coating. Used or rerolled materials, materials with a regalvanized finish, and open-seam posts are not allowed. After fabrication, all materials shall be hot-dip galvanized to a minimum zinc coating of 2.0 ounces per square foot of surface.

43.02.2  Fabric  No. 9 gauge wire conforming to ASTM A-392, woven in a 2" diamond mesh pattern, selvages twisted and barged. Galvanizing shall be Class 2. Fabric shall also be polyvinyl chloride (PVC) coated in accordance with ASTM F-668. Colors for PVC coatings shall be in accordance with ASTM F-934. See City Code Section 146-1731, 146-1741 – 1743 for additional requirements.

43.02.3  Posts  Standard lengths for setting in concrete in the ground unless Special Conditions indicate otherwise.

43.02.3.01  Line Post:  2-inch Inside Diameter Standard Pipe, 3.65 pounds per linear foot.

43.02.3.02  End, Corner, Line Brace Post and Line Post, and Line Post Sleeve:  2 1/2" I.D. Standard Pipe, 5.79 pounds per linear foot.

43.02.3.03  Gate Posts:  Up to 6 feet wide, 2 1/2" I.D. Standard Pipe, 5.79 pounds per linear foot. 6 to 13 feet wide, 3 1/2" I.D., 9.11 pounds per linear foot.

43.02.4  Top Rail  1 1/4" I.D. Standard Pipe, 2.27 pounds per linear foot.

43.02.5  Bottom Reinforcing Wire  Coil spring wire 0.177" minimum diameter. Tied to fabric at a maximum spacing of 24" with approved tie clips.
43.02.6 Fabric Ties  No. 9 gauge wire ties at a maximum spacing of one per foot of post height.

43.02.7 Fittings  Malleable steel, cast iron, or pressed steel to include extension arms for barbed wire, stretcher bars and clamps, clips, tension rods, brace rods, hardware, fabric bands, and fastenings. 45° bracket-type supports for the barbed wire. Bracket supports for line posts shall be of pressed steel attached to malleable iron bases with rivets; those for corner posts shall be malleable iron throughout.

43.02.8 Gates  Fabricate frames of standard weight pipe 1 1/2 " inside diameter, weight 2.72 pounds per linear foot. Provide gates with all necessary malleable iron fittings, braces, sag rods, hinges, and single or plunger-bar-type latches as required, and semi-automatic outer latches to secure gates in open position. Arrange latches and plunger bars for locking with padlocks. Brace gate diagonally with adjustable rods to prevent sagging in conformance with the manufacturer's standard practice and as approved.

43.03 Workmanship

43.03.1 Installation  Erect fencing in straight lines between angle points by competent workmen experienced in this type of construction. Erect in accordance with the manufacturer's recommendations as approved and in accordance with these Specifications. Post holes shall be a minimum depth of 3' below finished grade and shall be 10" in diameter. Space posts not more than 10' on centers and in true lines. Set posts plumb and to a depth of 2' - 9". Fill remainder of hole with concrete to extend around the posts to a point 2" above finished grade. The top surface shall have a crown watershed finish. Concrete shall be City of Aurora Class III. After concrete has set, install accessories; fasten chain link fabric to end posts with stretcher bars and clamps and line posts and top rail with wire or bands at approximately 14" centers. Brace gate posts diagonally to adjacent line posts to insure stability. Hang gates and adjust all hardware so that gates operate satisfactorily from open or closed position.

43.03.2 Cleanup  Upon completion of the fence installation, clean up all waste material resulting from the construction. Spread excavated earth from post holes on the adjacent area and grade smooth.
43.04 Measurement and Payment

Fence installation shall be measured by the number of linear feet installed.

Fence installation or resetting shall be paid for at the contract unit price per linear foot. The contract price per linear foot shall include full compensation for furnishing all labor, materials, and equipment necessary to remove, install, or reset specified fences.
SECTION 44.00 UTILITY LOCATION GUIDELINES

44.01 Guidelines

Proposed streetscapes shown in Figures 44.1 and 44.2 are conceptual only and are recommendations for planning purposes. Exact locations should be coordinated with the appropriate utility owners.
NOTES:

1. PROPOSED STREETSCAPE CONCEPTS REQUIRE GAS LINES IN EASEMENT BEHIND SIDEWALK. THE ALTERNATIVE IS TO INSTALL AT THE FRONT EDGE OF WALK.

2. LOCATIONS PRESUPPOSE FULL STREET R.O.W. AT TIME OF UTILITY INSTALLATION.

3. IN INSTANCES WHERE OVERHEAD LINES WILL BE CONSTRUCTED, LOCATION OF POLES SHALL BE BEHIND WALKS IN R.O.W.

4. FIRE HYDRANTS ARE SPACED AT APPROXIMATELY 250' INTERVALS, ALTERNATING SIDES OF THE ARTERIAL. SEE STANDARD 208-1 FOR DETAILS.

5. STORM SEWERS IN THE STREET ARE USUALLY LARGE DIAMETERS (36" OR GREATER). SMALL DIAMETER STORM SEWERS WILL USUALLY BE PLACED IN LINE WITH INLETS.

6. ELECTRIC FEEDERS REQUIRE A MINIMUM OF 5' OF SEPARATION FROM ALL OTHER UTILITIES BECAUSE OF HEAT. IF THE DOUBLE TRENCH METHOD IS USED (COMMON NEAR SUBSTATIONS) THE TRENCHES ARE SEPARATED BY 3 FEET.

7. JOINT TRENCHES FOR TELEPHONE, CABLE TV, AND ELECTRIC DISTRIBUTION ARE PREFERRED. ALL UNDERGROUND CABLE AND CONDUIT STRUCTURES REQUIRE ABOVE GROUND CABINETS VARYING IN SIZE FROM 12" ROUND CABINETS TO 6'x6' CABINETS. POCKET EASEMENTS WILL BE NECESSARY TO ACCOMMODATE LARGE ABOVE GROUND STRUCTURES.

8. STREET LIGHTS ARE REQUIRED ALONG ALL PUBLIC STREETS IN AND ADJACENT TO NEW DEVELOPMENTS. MAST STREET LIGHTS ARE LOCATED BEHIND THE CURB FOR DETACHED SIDEWALKS OR BEHIND THE SIDEWALK WHEN SIDEWALKS ARE ATTACHED.

**FIGURE 44-1
SIX LANE ARTERIAL**
*MEDIAN MAY BE RAISED OR IT MAY BE PAINTED (AND NOT RAISED). 

NOTES:

1. PROPOSED STREETSCAPE CONCEPTS REQUIRE GAS LINES IN EASEMENT BEHIND SIDEWALK. THE ALTERNATIVE IS TO INSTALL AT THE FRONT EDGE OF WALK.

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6. ELECTRIC FEEDERS REQUIRE A MINIMUM OF 6' OF SEPARATION FROM ALL OTHER UTILITIES BECAUSE OF HEAT. IF THE DOUBLE TRENCH METHOD IS USED (COMMON NEAR SUBSTATIONS) THE TRENCHES ARE SEPARATED BY 3 FEET.

7. JOINT TRENCHES FOR TELEPHONE, CABLE TV, AND ELECTRIC DISTRIBUTION ARE PREFERRED. ALL UNDERGROUND CABLE AND CONDUIT STRUCTURES REQUIRE ABOVE GROUND CABINETS VARYING IN SIZE FROM 12" ROUND CABINETS TO 8' X 8' CABINETS. POCKET EASEMENTS WILL BE NECESSARY TO ACCOMMODATE LARGE ABOVE GROUND STRUCTURES.

8. STREET LIGHTS ARE REQUIRED ALONG ALL PUBLIC STREETS IN AND ADJACENT TO NEW DEVELOPMENTS. MOST STREET LIGHTS ARE LOCATED BEHIND THE CURB FOR DETACHED SIDEWALKS OR BEHIND THE SIDEWALK WHEN SIDEWALKS ARE ATTACHED.

FIGURE 44-2
FOUR LANE ARTERIAL
TRAFFIC CONTROL
DESCRIPTION
PRIOR TO CONSTRUCTION
DURING CONSTRUCTION
AFTER CONSTRUCTION
TRAFFIC SIGNALS
SECTION 50.00 TRAFFIC CONTROL

50.01 Description
Traffic Control shall consist of furnishing and maintaining all barricades, signs, traffic control devices, detours, temporary pavement, or personnel to conduct traffic safely through the construction site, the conformity with these specifications and the Manual on Uniform Traffic Control Devices (MUTCD) and the Colorado Supplement thereto. Traffic control shall include accommodating the needs of pedestrians at sites.

50.02 Prior to Construction

50.02.1 The Contractor shall contact Traffic Operations Division at least 48 hours before starting work on any arterial street, or within 400 ft. of a traffic signal, to secure locations of any underground facilities. The Contractor shall be responsible for the cost of repair to any such facilities damaged by his construction. Phone Numbers are: Traffic Operations Division 303-739-7319, Signal Locates 303-326-8200, Fax 303-739-7485.

50.02.2 Unless provided in the plans, the Contractor shall submit a traffic control plan to Traffic Operations Division for approval at least 48 hours before the start of work. Failure to provide a traffic control plan or obtain permission from Traffic Operations Division may result in immediate work stoppage. If the Contractor desires to revise an approved traffic control plan, the revision proposal shall be submitted to Traffic Operations Division for review.

50.02.3 Unless otherwise indicated on the plans, when construction is likely to interfere with or damage an official traffic control sign or device, the Contractor shall notify Traffic Operations Division 48 hours in advance to have the sign or device retrieved or relocated. Once construction has been completed, Traffic Operations Division shall require two working days notice for resetting the signs or devices prior to opening the project to traffic. The Contractor will be responsible for any repairs or replacement of any sign or device missing or damaged.

50.03 During Construction

50.03.1 The Contractor shall not interfere with traffic between the hours of 7:00 a.m. to 8:30 a.m. and 3:30 p.m. to 6:00 p.m. on weekdays or at any time on weekends or holidays without permission from Traffic Operations Division.

50.03.2 The Contractor shall provide a traffic control person, other than the Project Superintendent, when called for in the plans or in the special conditions, or when
determined necessary by Traffic Operations Division. The Traffic Control Person shall

- Have traffic control as their primary duty;
- Carry a valid Traffic Control Supervisor certificate and a valid Flagging certificate (recognized by the Colorado Department of Transportation);
- Be on the job site at all times during working hours. Check all traffic control devices before and after the a.m. and p.m. rush hours, and periodically throughout the remainder of the day and night;
- Verify that all traffic control devices are in accordance with the Manual on Uniform Traffic Control Devices, including the Colorado Supplement, and that all traffic control devices are properly positioned and operating according to the approved traffic control plans, or as directed by Traffic Operations Division;
- Maintain two-way traffic on existing pavement unless otherwise specified by Traffic Operations Division;
- Be on call 24 hours per day and provide home and emergency phone numbers to Traffic Operations Division;

50.03.3 When traffic control is required within a signalized intersection involving an arterial, there shall be a minimum of two off-duty uniformed City of Aurora police officers required. On all other signalized intersections, only one off-duty uniformed City of Aurora police officer will be required, unless otherwise specified by Traffic Operations Division. Requests for officers may be made through the Secondary Employment Office of the Aurora Police Department at 303-739-6269 or 303-739-6268, at least five days before needed. The Contractor is to specify dates, hours, and the number of officers required. Cost of officers will be at the Contractor's expense.

50.03.4 The Contractor shall not allow construction equipment, personal vehicles, or construction materials to remain on or near the traveled lanes or at any location that may interfere with the safe movement of traffic.

50.03.5 The cut or fill resulting from construction adjacent to traffic lanes shall be temporarily sloped and shall have vertical hazard panel delineators with steady-burn lights at the intervals specified on the traffic control plan, immediately behind grading and removal operations, in order to safeguard the traveling public. Any cut or fill 2" or greater in depth within 5' of a travel lane will require vertical panels for edge-line delineation.
50.03.6 The Contractor shall provide access, acceptable to the property owners, to existing driveways of businesses and homes in the project area.

50.03.7 The Contractor shall remove all dirt, mud, and debris from the travel lanes daily.

50.03.8 Construction traffic control signs or devices not in use shall be removed from the pedestrian walkway (sidewalk). Laying the sign down in a horizontal position or turning the sign parallel is not permitted on the sidewalk. For locations that do not have sufficient right-of-way available to store the sign(s) or device(s), they must be picked up or moved to an approved storage area. Signs that are placed in the medians must be dismantled or laid down. Turning of the sign(s) is not permitted. Sign(s) or device(s) left out facing traffic after work hours will be confiscated. The Contractor will be responsible for the cost of removing the sign(s) or device(s), at a minimum charge of $35.00 per sign or device, and will be responsible for picking up the confiscated material.

50.03.9 Directional Arrow Boards Any four or six-lane arterial street lane closure that exceeds one hour will require one directional arrow board per direction closed. Requirements on all other streets will be determined by Traffic Operations Division.

50.03.10 Open Pits and Trenches Open pits and trenches will not be allowed on city streets or sidewalks without advance approval from Traffic Operations Division. They will be backfilled daily or they may be covered with steel plates. Note: steel plates (3/4 inch thick minimum) may not be used once the temperature reaches the freezing zone or any time in the winter.

50.03.11 Installation and removal of temporary signing and striping shall be the responsibility of the Contractor.

50.04 After Construction

The Developer/Contractor shall be responsible for all final street marking and signing as shown on the signing and striping plans. The signing and striping shall be in place prior to opening the project area to traffic. The Developer/Contractor shall notify Traffic Operations Division at least two business days prior to opening the project area to traffic to inspect the signing and striping for completeness. Any deficiencies shall be corrected before opening the project area to traffic.

Installation and removal of any existing or temporary striping and signing shall be the responsibility of the Contractor.
50.05 Traffic Signals

When a construction project includes the relocation of any traffic signal equipment or construction of a new signalized intersection, the work will be done by a qualified signal contractor to the specifications of Traffic Operations Division.
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LOCAL STREET TYPE 2

LOCAL STREET TYPE 2 ALTERNATE
RESIDENTIAL CUL-DE-SAC LESS THAN 250' IN LENGTH ONLY.
LOCAL TYPE 3

LOW DENSITY RURAL

NOTE:
AT CUL-DE-SACS WITH 5 LOTS OR LESS, DRAINAGE DITCHES MAY BE REDUCED TO FIT TYPICAL SECTION INTO A 50' R.O.W.
STANDARD

FOUR LANE COLLECTOR

TWO LANE COLLECTOR

ALTERNATIVE TWO LANE COLLECTOR

CITY OF AURORA, COLORADO

COLLECTOR ROADWAY CLASSIFICATIONS AND TYPICAL CROSS SECTIONS

S1.3
STANDARD

FOUR LANE ARTERIAL: RAISED MEDIAN
MEDIAN TURN LANE WIDTH = 10'

FOUR LANE ARTERIAL: PAINTED MEDIAN
MEDIAN TURN LANE WIDTH = 10'

CITY OF AURORA, COLORADO

ARTERIAL ROADWAY CLASSIFICATIONS AND TYPICAL CROSS SECTIONS

S1.5
TYPICAL ALLEY CROSS SECTION
RESIDENTIAL: CONCRETE

*POLYPROPYLENE FIBERMESH 11/2 LBS. PER CU. YD. -- 3/4" LONG FIBERS IN PLACE OF WIRE MESH ON RESIDENTIAL ALLEYS ONLY.

TYPICAL ALLEY CROSS SECTION
COMMERCIAL OR INDUSTRIAL: CONCRETE

NOTES:
1. SEE S19.1 FOR JOINT SAWING PATTERN.
2. ALL REINFORCEMENT STEEL SHALL BE IN SHEETS. LAP ALL JOINTS A MINIMUM OF 6".
*12' AUXILIARY LANE WHERE REQUIRED BY TRAFFIC ENGINEER.

SMITH RD.
WEST OF PICADILLY RD.

SMITH RD.
EAST OF PICADILLY RD.

USE 4-LANE COLLECTOR STD EXCEPT NO WALK ON THE NORTHERLY SIDE OF THE STREET. SECTION WHOLLY CONTAINED IN THE 100' R.O.W. FROM UPPR.
SPECIAL ARTERIAL AT
AIRPORT BOULEVARD
ALAMEDA AVENUE TO 40TH AVENUE

*ALAMEDA AVENUE TO COLFAX AVENUE    34'  -  20'  -  34'
COLFAX AVENUE TO SMITH ROAD           36'  -  16'  -  36'
SMITH ROAD TO 32ND AVENUE             34'  -  20'  -  34'
32ND AVENUE TO I-70                   36'  -  16'  -  36'
I-70 TO 40TH AVENUE                   36'  -VARIIES-  36'

CITY OF AURORA, COLORADO

S1.8
AIRPORT BOULEVARD
TYPICAL CROSS SECTIONS
NEIGHBORHOOD – 2 LANES

*MAY BE REDUCED OR ELIMINATED WHERE PRIVATE IMPROVEMENTS ENCROACH WITHIN THIS ZONE. BUILDING FOUNDATIONS SHALL NOT EXTEND INTO PUBLIC RIGHT-OF-WAY.

**GENERALLY, THE LANDSCAPED TREE LAWN SHALL HAVE A TRANSVERSE SLOPE OF 2%. HOWEVER, ON A CASE BY CASE BASIS THIS TRANSVERSE SLOPE MAY BE INCREASED TO A MAXIMUM OF 4:1 WITH PRIOR APPROVAL FROM THE CITY ENGINEER.

NOTE:
25' CLEAR MINIMUM PAVED SURFACE SHALL BE PROVIDED EVERY 150' OF ROAD LENGTH FOR EMERGENCY VEHICLE SETUP, SEE STD. S23.1
LOCAL URBAN – 2 LANES

*MAY BE REDUCED OR ELIMINATED WHERE PRIVATE IMPROVEMENTS ENCROACH WITHIN THIS ZONE. BUILDING FOUNDATIONS SHALL NOT EXTEND INTO PUBLIC RIGHT-OF-WAY.

NOTE:
25' CLEAR MINIMUM PAVED SURFACE SHALL BE PROVIDED EVERY 150' OF ROAD LENGTH FOR EMERGENCY VEHICLE SETUP, SEE STD. S23.1
ONE WAY COUPLE - 2 LANES

**MAY BE REDUCED OR ELIMINATED WHERE PRIVATE IMPROVEMENTS ENCROACH WITHIN THIS ZONE. BUILDING FOUNDATIONS SHALL NOT EXTEND INTO PUBLIC RIGHT-OF-WAY.
MAIN STREET - PARALLEL PARKING - 2 LANES

*MAY BE REDUCED OR ELIMINATED WHERE PRIVATE IMPROVEMENTS ENCROACH WITHIN THIS ZONE. BUILDING FOUNDATIONS SHALL NOT EXTEND INTO PUBLIC RIGHT-OF-WAY.
MAIN STREET – ANGLED PARKING – 2 LANES

*MAY BE REDUCED OR ELIMINATED WHERE PRIVATE IMPROVEMENTS ENCROACH WITHIN THIS ZONE. BUILDING FOUNDATIONS SHALL NOT EXTEND INTO PUBLIC RIGHT-OF-WAY.
RESIDENTIAL PARKWAY — 2 LANES

* MAY BE REDUCED OR ELIMINATED WHERE PRIVATE IMPROVEMENTS ENCROACH WITHIN THIS ZONE. BUILDING FOUNDATIONS SHALL NOT EXTEND INTO PUBLIC RIGHT-OF-WAY.

** GENERALLY, THE LANDSCAPED TREE LAWN SHALL HAVE A TRANSVERSE SLOPE OF 2%. HOWEVER, ON A CASE BY CASE BASIS THIS TRANSVERSE SLOPE MAY BE INCREASED TO A MAXIMUM OF 4:1 WITH PRIOR APPROVAL FROM THE CITY ENGINEER.

NOTE:
25' CLEAR Minimum PAVED SURFACE SHALL BE PROVIDED EVERY 150' OF ROAD LENGTH, SEE STD. S23.1. 24' FLOWLINE TO FLOWLINE ALLOWED WITH THIS SECTION.
MAIN STREET – MEDIAN – 2 LANES
MEDIAN TURN LANE WIDTH = 10.0'

* MAY BE REDUCED OR ELIMINATED WHERE PRIVATE IMPROVEMENTS ENCROACH WITHIN THIS ZONE. BUILDING FOUNDATIONS SHALL NOT EXTEND INTO PUBLIC RIGHT-OF-WAY.

** SEE NOTE 2

NOTES:
1. 25' CLEAR MINIMUM PAVED SURFACE SHALL BE PROVIDED EVERY 150' OF ROAD LENGTH, SEE STD. S23.1. 24' FLOWLINE TO FLOWLINE ALLOWED WITH THIS SECTION.
2. ALTERNATIVE SECTION: PAINTED MEDIAN IN LIEU OF RAISED MEDIAN. MEDIAN WIDTH SHALL BE 12 FEET AND THE RIGHT-OF-WAY WIDTH SHALL BE 92 FEET.
STANDARD

MAIN STREET - MEDIAN - 4 Lanes

Median Turn Lane Width = 10.0'

*May be reduced or eliminated where private improvements encroach within this zone.

Building foundations shall not extend into public right-of-way.

CITY OF AURORA, COLORADO

S1.16

URBAN CENTER & TOD
TRANSITION OR EDGE ZONE
ROADWAY CLASSIFICATIONS
AND TYPICAL CROSS SECTIONS
MULTIWAY BOULEVARD - 4 LANES
MEDIAN TURN LANE WIDTH = 10.0'

* 8' DIMENSION IS FOR PARALLEL PARKING
16' DIMENSION IS FOR ANGLED PARKING

** MAY BE REDUCED OR ELIMINATED WHERE PRIVATE IMPROVEMENTS ENCROACH WITHIN THIS ZONE. BUILDING FOUNDATIONS SHALL NOT EXTEND INTO PUBLIC RIGHT-OF-WAY.

NOTE:
25' CLEAR MINIMUM PAVED SURFACE SHALL BE PROVIDED EVERY 150' OF ROAD LENGTH, SEE STD. S23.1. WHEN PARALLEL PARKING OPTION IS USED, 24' FLOWLINE TO FLOWLINE IS ALLOWED FOR THIS SECTION.
Boulevard - 6 Lanes
Median Turn Lane Width = 11.0'

*MAY BE REDUCED OR ELIMINATED WHERE PRIVATE IMPROVEMENTS ENCROACH WITHIN THIS ZONE. BUILDING FOUNDATIONS SHALL NOT EXTEND INTO PUBLIC RIGHT-OF-WAY.

**GENERALLY, THE LANDSCAPED TREE LAWN SHALL HAVE A TRANSVERSE SLOPE OF 2%. HOWEVER, ON A CASE BY CASE BASIS THIS TRANSVERSE SLOPE MAY BE INCREASED TO A MAXIMUM OF 4:1 WITH PRIOR APPROVAL FROM THE CITY ENGINEER.
**MEDIAN FINISH DETAIL**

**MEDIAN FINISH DETAIL**

**SECTION A-A**

**SECTION B-B**

ALL 5" PCC SHALL HAVE CONTRACTION JOINTS
5' MAXIMUM (SEE S7.3) AND EXPANSION JOINTS
AT 50' MAXIMUM. MEDIAN CURB JOINTS AND CONTRACTION
JOINTS SHALL BE COLINEAR AND PERPENDICULAR TO
THE ROADWAY CENTER LINE. CONCRETE WIDER THAN
5' SHALL HAVE LONGITUDINAL CONTRACTION JOINTS EVERY 5'.
SPACING SHALL BE SYMMETRICALLY CENTERED ON THE MEDIAN.

NOTE: FOR ANY TYPE OF CONSTRUCTION WITHIN
AN EXISTING MEDIAN, THE CONTRACTOR SHALL
REPLACE THE MEDIAN COVER MATERIAL WITH 5" PCC
SURFACE FROM MEDIAN NOSE TO THE SPLASH BLOCK RETURN.

* AS SHOWN ON THE DRAWINGS AND
DETERMINED BY THE TRAFFIC ENGINEER
PRIOR TO CONSTRUCTION.
\[ Y = \frac{WX^2}{D^2} \]

D = LENGTH OF FLARE (FEET)
W = MAXIMUM OFFSET (FEET)
X = DISTANCE ALONG BASELINE (FEET)
Y = OFFSET FROM BASELINE (FEET)

NOTE:
PARABOLIC FLARE & MEDIAN NOSE TO BE CONSTRUCTED WITH FLEXIBLE FORMS.

COORDINATE WITH PARKS, RECREATION & OPEN SPACE DEPT. FOR SPLASH BLOCK/CURB.

FOR SECTION B-B SEE S2.1
\[ Y = \frac{WX^2}{D^2} \]

\( D = \text{LENGTH OF FLARE (FEET)} \)
\( W = \text{MAXIMUM OFFSET (FEET)} \)
\( X = \text{DISTANCE ALONG BASELINE (FEET)} \)
\( Y = \text{OFFSET FROM BASELINE (FEET)} \)

\text{NOTE:}
\text{PARABOLIC FLARE & MEDIAN NOSE TO BE CONSTRUCTED WITH FLEXIBLE FORMS.}

\text{COORDINATE WITH PARKS, RECREATION & OPEN SPACE DEPT. FOR SPLASH BLOCK/CURB.}

FOR NOSE LOCATION SEE S2.4

NOSE AND FIRST 6.5' IS MONOLITHIC POUR

DRAINAGE SLOTS IF REQUIRED SEE S7.1, NOTE 2

FOR SECTION B-B SEE S2.1
DRAINAGE SLOT DETAIL

NOSE DETAIL

SECTION A-A

NOSE LOCATION DETAIL

CROSS STREET

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<td>2-LANE COLLECTOR</td>
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NOTES

1. If the 12" maximum angle is exceeded when using the 150' length, a new length shall be used based on the 12" maximum angle.

2. Construction plans shall include complete details for the median.

DETAIL

NO SCALE

SECTION C-C

NO SCALE

L_1 + L_2 = Length of turn lane shown on plans or set by traffic engineer prior to construction.
CURVE DATA

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<tr>
<td>R</td>
<td>415.73’</td>
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<tr>
<td>L</td>
<td>95.85’</td>
</tr>
<tr>
<td>T</td>
<td>48.14’</td>
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<tr>
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5" PCC SURFACE, CROWN OR SLOPE TO DRAIN. 0.5% MINIMUM SLOPE, 25% MAXIMUM SLOPE. CLASS II FINISH.

SLOPE TO DRAIN VARIES

MEDIAN LANDSCAPING CONTACT PARKS, RECREATION & OPEN SPACE DEPT. FOR CONCRETE COLORING, MEDIAN COVER, SPLASH BLOCK REQUIREMENTS & CONCRETE THICKNESS REGTS RELATED TO MAINTENANCE EQUIPMENT ACCESS.

MEDIAN FINISH DETAIL
SECTION A-A

MEDIAN FINISH DETAIL
SECTION B-B

ALL 5” PCC SHALL HAVE CONTRACTION JOINTS AT 5’ MAXIMUM SPACING (SEE S7.3) AND EXPANSION JOINTS AT 50’ MAXIMUM SPACING. MEDIAN CURB JOINTS AND CONTRACTION JOINTS SHALL BE COLINER AND PERPENDICULAR TO THE ROADWAY CENTER LINE. CONCRETE WIDER THAN 5’ SHALL HAVE LONGITUDINAL CONTRACTION JOINTS EVERY 5’. SPACING SHALL BE SYMMETRICALLY CENTERED ON THE MEDIAN.

NOTE: FOR ANY TYPE OF CONSTRUCTION WITHIN AN EXISTING MEDIAN, THE CONTRACTOR SHALL REPLACE THE MEDIAN COVER MATERIAL WITH 5” PCC SURFACE FROM MEDIAN NOSE TO THE SPLASH BLOCK RETURN.

* AS SHOWN ON THE DRAWINGS AND DETERMINED BY THE TRAFFIC ENGINEER PRIOR TO CONSTRUCTION.
NOTES:
1. REFER TO CITY OF AURORA DETAIL S9.4 FOR TRUNCATED DOME DETAILS AND SECTION INFORMATION.
2. 1% MINIMUM, 5% MAXIMUM LONGITUDINAL SLOPES WITH PARABOLIC CREST ON RAMPS TO AVOID LARGE GRADE BREAKS. SEE NOTE 3.
3. PEDESTRIAN RAMPS SHALL MEET ADA REQUIREMENTS.
4. BEGIN TRANSITION OF FULL-HEIGHT SPLASH BLOCK TO ZERO-HEIGHT SPLASH BLOCK. MATCH SLOPE OF MOWER ACCESS RAMP.

CITY OF AURORA, COLORADO

URBAN CENTER & TOD
PEDESTRIAN REFUGE

S2.7
11' MEDIAN
PEDESTRIAN REFUGE
WITH MOWER ACCESS

16' MEDIAN
PEDESTRIAN REFUGE
WITH MOWER ACCESS
NOTES:
1. REFER TO CITY OF AURORA DETAIL S9.4 FOR
   TRUNCATED DOME DETAILS AND SECTION
   INFORMATION.
2. 1% MINIMUM, 5% MAXIMUM LONGITUDINAL SLOPES WITH
   PARABOLIC CREST ON RAMPS TO AVOID LARGE
   GRADE BREAKS. SEE NOTE 3.
3. PEDESTRIAN RAMPS SHALL MEET ADA REQUIREMENTS.
4. BEGIN TRANSITION OF FULL-HEIGHT SPLASH BLOCK TO
   ZERO-HEIGHT SPLASH BLOCK. MATCH SLOPE OF
   MOWER ACCESS RAMPS.
5. PROVIDE IRRIGATION SLEEving AS NEEDED.
NOTES:
1. ALL CONCRETE TO BE FIBER-REINFORCED. 4000# MIX WITH INTEGRAL COLOR. FIBER MESH TO BE ADDED TO CONCRETE MIX AT A RATE OF 1.5 LBS PER CUBIC YARD. FOR OMAHA TAN COLOR, ADD 1 LB OF #5084 PER 94 LBS OF CEMENT.

2. CONTRACTOR SHALL RAISE ALL EXISTING VALVE BOXES AND UTILITY FACILITIES TO AN APPROPRIATE RELATIONSHIP WITH THE NEW FINISH GRADES.

3. SEE SECTION 20.06.B IN THE ROADWAY DESIGN AND CONSTRUCTION SPECIFICATIONS TO DETERMINE IF STANDARD PROCTOR OR MODIFIED PROCTOR SHOULD BE USED FOR DENSITY MEASUREMENTS AND REQUIRED COMPACTION REQUIREMENTS.
1. IF NO SPECIAL CONCRETE PATTERNS ARE PROVIDED WITH THE ADJACENT DEVELOPMENT, PROVIDE A LONGITUDINAL CONTRACTION JOINT AT EIGHT FEET FROM THE RIGHT-OF-WAY LINE.
STANDARD

SIDEWALK CHASE ELEVATION

SECTION A-A
FLOW TO GUTTER
(NOTE: MOUNTABLE CURB & GUTTER SECTION IS SIMILAR.)

SECTION B-B

NOTES
1. 18"#4 REBAR: WELD ONE BAR NEAR EACH END OF TUBE; SUPPLY AT LEAST TWO BARS PER TUBE, MORE IF CONTRACTOR DEEMS APPROPRIATE. REBAR IS USED TO SUPPORT AND ALIGN TUBE UNTIL CONCRETE IS PLACED.
2. HEIGHT OF SIDEWALK CHASE SHALL MATCH CURB HEIGHT, I.E., HEIGHT FROM FLOWLINE TO TOP OF CURB.
3. T = THICKNESS OF WALK.

MULTIPLE CHASE
WHEN OPENINGS ARE LARGER THAN 12"

CITY OF AURORA, COLORADO

SIDEWALK CHASE
S3.2

2 OF 2
NOTE: SPECIAL DETAIL REQUIRED FOR RADII OVER 25'

1/2" EXPANSION JOINT
@ PCR (TYP.)

NOTE: SPECIAL DETAIL REQUIRED FOR RADII OVER 25'

2'

FL. TO MATCH GRADE OF PARALLEL STREET.

CONTRACTION JOINTS FOR CROSSPANS LONGER THAN 18' SHALL BE EVENLY SPACED @ 12'-18'.

GUTTER APRON AND CROSSSPAN SHALL BE 10" THICK AND HAVE THE SAME REINFORCEMENT

PLAN

** WHEN CROSSPANS AND FILLETS ARE NOT POURED MONOLITHIC, #6X18" SMOOTH RODS ON 12" CENTERS WITH ONE END GREASED SHALL BE USED.

<table>
<thead>
<tr>
<th>PAN LENGTH (LIP TO LIP)</th>
<th>WIRE FABRIC CALLED FOR</th>
<th>REPLACE WITH GRADE 60 REBAR HAVING AN AREA OF</th>
</tr>
</thead>
<tbody>
<tr>
<td>36'</td>
<td>6x6-W4xW4</td>
<td>0.10 SQ. IN./FT. (#4@18&quot;E.W.)</td>
</tr>
<tr>
<td>45'</td>
<td>6x6-W5.5xW5.5</td>
<td>0.13 SQ. IN./FT. (#4@18&quot;E.W.)</td>
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<tr>
<td>64'</td>
<td>6x6-W7.5xW7.5</td>
<td>0.20 SQ. IN./FT. (#4@12&quot;E.W.)</td>
</tr>
<tr>
<td>84'</td>
<td>2-6x6-W5.5xW5.5</td>
<td>0.26 SQ. IN./FT. (#4@9&quot;E.W.)</td>
</tr>
</tbody>
</table>

NOTE:
GUTTER APRONS AND PANS SHALL BE REINFORCED AS SHOWN IN THE TABLE ABOVE.

SECTIONS A-A, B-B & C-C ARE ON STD S4.2

CITY OF AURORA, COLORADO

CITY ENGINEER

DATE

S4.1

CROSSSPAN

TYPE 1

1 OF 2
CROWN SHALL BE TRANSITIONED OUT OF THE STREET.

SECTION A-A

WIRE FABRIC, SEE TABLE ON STD S4.1

CHAIRS, OR OTHER APPROVED SUPPORT.

SECTION B-B

1/2" EXPANSION JOINT

THE TRANSITION FROM 10" THICK APRON TO 6" THICK RAMP IS 24" FROM FLOWLINE TOWARD BACK OF RAMP AND FROM PCR TO PCR.

SECTION C-C

END OF CURB RAMP

CURB RAMP
TOP OF CURB

EXPANSION JOINT

10" APRON

RODS*

FL

EXPANSION JOINT

45°

NOTE: GUTTER APRON AND CROSSSPAN SHALL BE 10" THICK AND HAVE THE SAME REINFORCEMENT. SEE STD. S4.1

SECTIONS A-A, B-B, & C-C ARE ON STD. S5.2

* WHEN CROSSPANS AND FILLETS ARE NOT POURED MONOLITHIC, #6X18" SMOOTH RODS ON 12" CENTERS WITH ONE END GREASED SHALL BE USED.
NOTE: GUTTER APRON AND CROSSSPAN SHALL BE 10" THICK AND HAVE THE SAME REINFORCEMENT. SEE STD. S4.1
SECTIONS A-A, B-B, & C-C ARE ON STD. S6.2
SECTION A-A

SECTION B-B

SECTION C-C

CITY OF AURORA, COLORADO

CROSS PAN

TYPE 2 AT TEE INTERSECTION

S6.2
VERTICAL CURB & GUTTER (SPILL)

VERTICAL CURB & GUTTER (CATCH)

MOUNTABLE CURB AND GUTTER

NOTES

1. THREE NO. 4 REBARS SHALL BE USED IN ALL CURB RETURNS WITH 25' OR LARGER RADI. THE REBAR SHALL BE USED FROM BEGINNING TO END OF THE CURB RETURN.

2. AT EACH LOW POINT OF EACH MEDIAN CURB, A DRAINAGE SLOT SHALL BE INSTALLED – SEE DRAINAGE SLOT DETAIL ON S2.4.

3. SLIP FORM TEMPLATE FOR VERTICAL CURB AND GUTTER SHALL NOT BE ALLOWED FOR POURING STANDARD MEDIAN CURB.

4. WHERE CONCRETE PAVEMENT IS USED, PLANS SHOULD SHOW MONOLITHIC CURBS.
STANDARD MEDIAN CURB

MEDIAN CATCH CURB

NOTES
1. SEE S2.1–S2.3 FOR LOCATION OF REQUIRED SPLASH BLOCKS. CONTRACTION JOINTS IN SPLASH BLOCKS SHALL MATCH MEDIAN CURB JOINTING.
2. SEE S2.4 FOR DRAINAGE SLOTS AND MONOLITHIC NOSE.
3. SEE S7.1 FOR LOCATION OF DRAINAGE SLOTS.
4. WHERE CONCRETE PAVEMENT IS USED, PLANS SHOULD SHOW MONOLITHIC CURBS.

CITY OF AURORA, COLORADO

STANDARD MEDIAN CURBS

S7.2
SIDEWALK

NOTE: WHEN WALK IS ADJACENT TO A CURB CUT, MATCH THICKNESS AND REINFORCING WITH CURB CUT. (SEE S7.4)

1/8" R (TYP.)

1/8"

1 1/2" MIN

* 1.5" IF TEMPLATES ARE NOT USED
CONTRACTION OR
WEAKENED PLANE
JOINT

1/2" PREFORMED JOINT MATERIAL.
(SEE NOTE)

EXPANSION JOINT

NOTE: IN GUTTER FLOWLINES RECESS EXPANSION JOINT 1/2" AND SEAL WITH FLEXIBLE SEALANT.

SEE STD. S19.1 THRU S19.4 FOR TYP. CONC.
PAVEMENT JOINT DETAILS
NOTES:
1. BACK OF CURB CUT EXTENDS TO BACK OF WALK. IF NO WALK IS PRESENT, EXTEND BACK OF CURB CUT TO BACK OF FUTURE WALK (SEE S1.1 TO S1.5).
2. END OF CURB CUT SHALL NOT BE CONSTRUCTED WITHIN 5' OF A PROPERTY LINE OR 20' OF AN INTERSECTING STREET R.O.W. UNLESS APPROVED BY THE DIRECTOR OF PUBLIC WORKS.
3. TRAFFIC ENGINEER SHALL APPROVE LOCATION OF CURB CUT BEFORE CONSTRUCTION.
4. WIRE FABRIC TO BE CONTINUOUS IN CURB CUT AND ADJACENT WALK EXCLUDING SINGLE FAMILY CURB CUTS.
5. WALK ACROSS DRIVEWAY SHALL BE SAME THICKNESS WITH SAME REINFORCEMENT AS CURB CUT.

CROSS-SECTION THROUGH CURB CUT

* APT. BLDGS. WITH LESS THAN 5 UNITS MAY USE 6" THICKNESS.

CITY OF AURORA, COLORADO
CURB, GUTTER AND WALK CURB CUTS

S7.4
NOTES:
1. BACK OF CURB CUT EXTENDS TO BACK OF WALK. IF NO WALK IS PRESENT, EXTEND BACK OF CURB CUT TO BACK OF FUTURE WALK (SEE S1.1 TO S1.5).
2. END OF CURB CUT SHALL NOT BE CONSTRUCTED WITHIN 5' OF A PROPERTY LINE OR 20' OF AN INTERSECTING STREET R.O.W. UNLESS APPROVED BY THE DIRECTOR OF PUBLIC WORKS.
3. TRAFFIC ENGINEER SHALL APPROVE LOCATION OF CURB CUT BEFORE CONSTRUCTION.
4. WIRE FABRIC TO BE CONTINUOUS IN CURB CUT AND ADJACENT WALK EXCLUDING SINGLE FAMILY CURB CUTS.
5. WALK ACROSS DRIVEWAY SHALL BE SAME THICKNESS WITH SAME REINFORCEMENT AS CURB CUT.

CROSS-SECTION THROUGH CURB CUT

* APT. BLDGS. WITH LESS THAN 5 UNITS MAY USE 6" THICKNESS.
EXPANSION JOINT AT 50' 
SEE DETAIL BELOW

PLAN VIEW

CONTRACTION JOINT (TYP.)

2'-0" MIN.  2'-0" MIN.
3"

SEE S4.1 FOR WIRE FABRIC REINFORCING.

SECTION A-A

"6" IN PARKING AREAS ONLY.

DETAIL

EXPANSION JOINT

1/8" TO 3/8" LIP

CITY OF AURORA, COLORADO

PRIVATE
LONGITUDINAL CONCRETE PAN

S7.6
NOTES:
1. THE CONCRETE WALKWAY SHALL BE THE FULL WIDTH OF THE TRACT.

2. THE LONGITUDINAL SLOPE SHALL NOT BE LESS THAN 1%. FOR TERRAIN EXCEEDING 6%, BUT LESS THAN 18%, A COMBINATION OF STEP AND LANDING CAN BE INCORPORATED INTO THE LEFT SIDE OF THE WALKWAY (FACING DOWNHILL) IN SUCH A MANNER AS TO MATCH THE EXISTING TERRAIN AS CLOSELY AS POSSIBLE. GRADES IN EXCESS OF 18% SHALL REQUIRE A SPECIAL DESIGN TO BE APPROVED BY THE DIRECTOR OF PUBLIC WORKS.

3. THE CONSTRUCTION PLANS FOR THE DEVELOPMENT SHALL INCLUDE COMPLETE DETAILS FOR THE WALKWAY.

4. THE WALKWAY SHALL NOT BE USED FOR DRAINAGE OVERFLOW.

5. CONTRACTION OR WEAKENED PLANE JOINT AT 10' INTERVALS AND EXPANSION JOINT PER SIDEWALK CONSTRUCTION.
1. In accordance with CRS43-2-107(2) and the Uniform Federal Accessibility Standards, ramps shall be provided at all corners of street intersections where there is existing or proposed sidewalk and curb ramps shall also be provided at walk locations at mid-block in the vicinity of hospitals, medical centers, athletic stadiums, and at "T" intersections of two-lane streets.

2. All work shall be done in accordance with the "Roadway Design & Construction Specifications" of the City of Aurora.

3. Special designs are required when grades are over 4% or where the angle of the intersection is less than 75° or more than 105°, or for radii of greater than 25 feet, or where traffic signals are required at an intersection.

4. The entire ramp area shall be poured monolithically, 6 inches thick from PCR to PCR.

5. Minimum width of ramps shall be 6 feet and ramp slopes shall not be steeper than 12:1.

6. Normal gutter flow line and profile shall be maintained through the apron area.

7. A 1/2-inch expansion joint shall be required where the concrete ramp joins any structure, and at both PCR's.

8. Drainage structures shall not be placed in line with ramps. Location of the ramp shall take precedence over location of the drainage structure, except where existing drainage structures are being utilized in the new construction.

9. Truncated dome warning panels shall be installed on each curb ramp. 3-24"x24" "cast-in-tact" detectable warning panels with truncated domes (or approved equal) shall be placed as shown in the ramp according to manufacturer's recommended process. Color of panels shall be "brick red." Seal butted joints between panels with like colored sealant.
TRANSITION FROM 10" THICK APRON TO 6" THICK RAMP IS 24" FROM FLOWLINE TOWARD BACK OF RAMP AND FROM PCR TO PCR.

CORNER OF LOCAL TYPE 1, 2 & 3 AND LOCAL TYPE 1, 2 & 3 W/ CROSSSPAN

SCALE: 1"=5'

CITY OF AURORA, COLORADO

CITY ENGINEER

DATE

CURB RAMPS

S9.2
CORNER OF
LOCAL TYPE 1, 2 & 3 AND LOCAL TYPE 1, 2 & 3

SCALE: 1"=5'
STANDARD

LOCAL TYPE 1,2

CONCRETE PEDESTRIAN CURB

GRADE BREAK
DO NOT TOOL

1/2" EXPANSION JOINT
@ PCR (TYP.)

* 3-24"X24" CAST IN TACT
DETECTABLE WARNING
PANELS WITH TRUNCATED
DOMES. (OR APPROVED
EQUAL)

CORNER OF
COLLECTOR AND LOCAL TYPE 1,2 & 3
SCALE: 1"=5'

SECTION A-A
TRUNCATED DOME WARNING PANELS
NO SCALE

SECTION B-B
NO SCALE

CITY OF AURORA, COLORADO
CURB RAMPS
S9.4
THREE #4 REBARS SHALL BE USED IN ALL CURB RETURNS WITH 25' OR LARGER RADII, REBAR SHALL BE FROM PCR TO PCR (SEE DETAIL S7.1)

TRUNCATED DOME WARNING PANELS (SEE DETAIL S9.4)

FL
20' RADIUS

12.1 MAX

3.1 MAX

11.5' RADIUS

GRADE BREAK
DO NOT TOOL

GRADE BREAK
DO NOT TOOL

CONCRETE PEDESTRIAN CURB

1/2" EXPANSION JOINT
© PCR (TYP.)

CORNER OF
COLLECTOR AND COLLECTOR

SCALE: 1"=5'

CITY OF AURORA, COLORADO

CURB RAMPS

S9.5

CITY ENGINEER

3/10/10

DATE
THREE #4 REBARS SHALL BE USED IN ALL CURB RETURNS WITH 25' OR LARGER RADII, REBAR SHALL BE FROM PCR TO PCR COLLECTOR (SEE DETAIL S7.1)

TRUNCATED DOME WARNING PANELS (SEE DETAIL S9.4)

1/2" EXPANSION JOINT @ PCR (TYP.)

CONCRETE PEDESTRIAN CURB

SCALE: 1"=5'

CORNER OF
6 LANE ARTERIAL AND COLLECTOR

CITY OF AURORA, COLORADO

CURB RAMPS

S9.6
STANDARD

CONCRETE PEDESTRIAN CURB

GRADE BREAK

EXPANSION JOINT

DO NOT TOOL (TYP)

11'5"

CONCRETE PEDESTRIAN CURB

EXPANSION JOINT

MATCH TOP OF CURB HEAD ELEV. TO TOP OF SIDEWALK ELEV. (TYP.)

12:1

MAX

2' (TYP)

CONCRETE PEDESTRIAN CURB

EXPANSION JOINT

GRANITE

DO NOT TOOL (TYP)

5' WALK

CONCRETE PEDESTRIAN CURB

EXPANSION JOINT

AS NEEDED

EXPANSION JOINT (TYP.)

TRUNCATED DOME WARNING PANELS
(SEE DETAIL S9.4)

6'

MID-BLOCK RAMP

CITY OF AURORA, COLORADO

CURB RAMPS

S9.7

icient engineer 3/10/10

DATE
1. Ramp depth shall be based on the width of the widest sidewalk coming into the corner. Five foot walks shall have a minimum ramp depth of 6'. Wherever 6" vertical curb & gutter is used, this ramp depth shall be a minimum of 8.5'. All 8' and 10' walks shall have minimum ramp depths of 8.5' and 10.5' respectively.

2. The back of the ramp shall be concentric with the flowline radius from PCR to PCR.

3. Sidewalk radii shall be 100' for arterials, 75' for collectors, and 50' for local streets.

4. There are other street combinations that are not shown which shall be constructed to the above criteria.

**Layout of Detached Sidewalks to Ramps at Street Corners**

**City of Aurora, Colorado**

**Curb Ramps**

S9.8
CORNER OF
PUBLIC STREET TO PRIVATE STREET OR ENTRANCE
SCALE: 1"=5'

CITY OF AURORA, COLORADO
CURB RAMPS
S9.9
INTERSECTION OF ZEBRA CROSS-WALK AND FLOWLINE (TYPICAL)

1/2" EXPANSION JOINT @ PCR (TYP)

12:1
(MAX)
(TYP)

CL RAMP TO BE RADIAL

MIDPOINT OF RETURN

CONCRETE PEDESTRIAN CURB

2%)

DIRECTIONAL RAMPS SHALL BE USED FOR ALL RETURNS WITH RADII 25' OR GREATER.

DIRECTIONAL RAMP

TYPICAL 2'X10' ZEBRA CROSSWALK STRIPING

TRUNCATED DOME WARNING PANELS (SEE DETAIL S9.4)

SEE TE-14 FOR LOCATION OF ZEBRA CROSS-WALKS

CITY OF AURORA, COLORADO

CITY ENGINEER

DATE
NOTE: REFER TO CITY OF AURORA DETAIL S9.4 FOR TRUNCATED DOME DETAILS AND SECTION INFORMATION

1. PLACE SIGNAL POLE IN BOX-OUT WITH 1/2" EXPANSION JOINT

CITY OF AURORA, COLORADO

URBAN CENTER & TOD CURB RAMPS ATTACHED/DETACHED WALKS

S9.11

CITY ENGINEER DATE

kevin Wegenius 3/10/10
NOTES:
1. IF COLORED PAVING IS NOT USED, THEN CONTINENTAL STRIPING MUST BE USED, SEE TE-14
2. STRIPING AND STOP SIGN LOCATION SHALL MEET CURRENT MUTCD STANDARDS.
3. PLACE SIGN POST WITHIN 4"ØX12", SCH. 40, PVC PIPE WITHIN SIDEWALK. PLACE PIPE FLUSH WITH TOP OF CONCRETE WALK.
NOTE:
REFER TO CITY OF AURORA DETAIL S9.4
FOR TRUNCATED DOME DETAILS AND
SECTION INFORMATION
NOTE: CONTRACTORS PATCHING ASPHALT TRENCHES WITHIN 6' OF AN EXISTING PATCH OR Lip OF GUTTER SHALL REMOVE AND REPLACE EXISTING ASPHALT TO THE EDGE OF THE EXISTING PATCH OR LIP OF GUTTER.

FINAL EDGES SHALL BE CUT STRAIGHT WITH SAW AND TACKED PRIOR TO PATCHING

EXISTING A.C. PAVING

ORDINARY BACKFILL PLACED IN MAXIMUM ONE-FOOT LIFTS OR FLOWABLE FILL

BEDDING SECTION, BELOW THIS POINT, REFER TO STANDARD DETAIL 100 AND SECTION 11.00 OF THE PUBLIC UTILITY IMPROVEMENTS RULES AND REGULATIONS REGARDING STANDARDS & SPECIFICATIONS

<table>
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<th>SOIL CLASSIFICATION (AASHTO M145)</th>
<th>MIN. RELATIVE COMPACtion</th>
<th>STANDARD</th>
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<tbody>
<tr>
<td>A-1, A-3, A-2-4, A-2-5</td>
<td>95%</td>
<td>AASHTO T180*</td>
</tr>
<tr>
<td>ALL OTHERS</td>
<td>95%</td>
<td>AASHTO T99**</td>
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*ASTM D1557
**ASTM D698
### STREET CLASSIFICATION

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<tr>
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<td>10 1/2&quot;</td>
<td>4</td>
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<td>COLLECTOR</td>
<td>9&quot;</td>
<td>3</td>
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<tr>
<td>LOCAL</td>
<td>8&quot;</td>
<td>3</td>
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</table>

MAXIMUM LIFT DEPTH – 3"
MINIMUM LIFT DEPTH – 1 1/2"

THICKNESS OF EACH LIFT BELOW THE TOP SHALL NOT VARY MORE THAN 3/8"

TOP LIFT SHALL CONFORM TO SECTION 24.00
HOT MIX ASPHALT PAVEMENT.

NOTE:
WHERE EXISTING PAVEMENTS ARE THicker THAN THE DIMENSIONS IN THE ABOVE TABLE, THEN THE ASPHALT PATCH SHALL BE THE EXISTING ASPHALT THICKNESS PLUS ONE INCH.
DEPRESS RING 1/8" TO 1/2" BELOW ADJACENT FINISHED STREET GRADE

FINAL ASPHALT LIFT, OVERLAY OR GRADE ADJUSTMENT

18" MIN.

EXISTING BASE COURSE

ASPHALT PATCH

CONCRETE GRADE RING TO MATCH SLOPE OF FINISHED GRADE

GRADE RING

ASPHALT PATCH

STRAIGHT CUT AROUND RING

MANHOLE
NOTES:
2. ALL BEARING SURFACES TO BE MACHINED.
3. LETTERING ON COVER AS REQUIRED (STORM).
4. TOTAL MINIMUM WEIGHT APPROXIMATELY 272 LBS.
5. AURORA STANDARD—NEENAH R-1706-1S, OR EQUAL.
6. LIFTING NOTCH SHALL NOT EXTEND PAST INSIDE FACE OF RING SEAT.
7. MINIMUM FRAME WEIGHT—114 LBS; MINIMUM LID WEIGHT—158 LBS.
8. SEE SECTION 12.00 OF THE PUBLIC UTILITIES IMPROVEMENTS RULES AND REGULATIONS REGARDING STANDARDS & SPECIFICATIONS.

CITY OF AURORA, COLORADO

24" TYPE R INLET
RING & COVER

S12.1
SECTION B-B SEE S12.5 FOR TYPICAL END VIEW

OUTFALL PIPE (TYP.)

SECTION A-A SEE S12.3 FOR REGULAR INLET, S12.4 FOR INLET WITH END WINGS

FACE OF CURB

MEET SHAPE OF MOUNTABLE CURB & GUTTER HERE

60" TRANSITION GUTTER FOR NEW CONSTRUCTION; OR, TO NEXT JOINT FOR EXISTING CONDITIONS

1-1/4" DIA. ROD STATION POINT 4'-4" MIN.

DIRECTION OF FLOW

TRANSITION GUTTER TO PROVIDE NECESSARY FALL AROUND CURB RETURNS

INLET STATION POINT AND TOP BACK OF CURB ELEVATION (TO BE SHOWN ON PLAN VIEW)

INLET RING & COVER TO CONFORM TO STANDARD DETAIL S12.1

NOTE: CHANNEL AND ALL OTHER EXPOSED STEEL SHALL BE GALVANIZED (AASHTO M111). CHANNEL SHALL BE EXTENDED 5" INTO THE WALL ON EACH SIDE.

BENDING DIAGRAM

CURB FACE ASSEMBLY

CITY OF AURORA, COLORADO

CURB OPENING INLET

S12.2

CURB OPENING INLET

TYPE R MODIFIED

2 OF 11

DATE
SECTION A-A
REGULAR INLET
NOT TO SCALE

NOTE:
ALL CONSTRUCTION JOINTS SHALL HAVE A 2" X 4" KEYWAY.

TOP SHALL BE MONOLITHIC POUR TO BACK OF WALK

BACK OF WALK

FOR 5' WALK EXTEND EVERY THIRD #5 BAR FROM INLET TOP INTO WALK TO WITHIN 3" FROM BACK OF WALK.
8' & 10' SIDEWALKS SHALL BE POURED SEPARATE FROM INLET DECKS AND BE SEPARATED BY 1/2" EXPANSION JOINT.

(SEE DETAILS 12.9 & 12.10 FOR DIMENSIONS OF INLET & WALK)
SECTION B-B
TYPICAL END VIEW

INLET RING AND COVER TO CONFORM TO STANDARD DETAIL S12.1

STEPS SHALL BE AS SPECIFIED IN DETAILS 105 AND 106 OF CITY OF AURORA PUBLIC UTILITY IMPROVEMENTS RULES AND REGULATIONS REGARDING STANDARDS AND SPECIFICATIONS: WATER, SANITARY, STORM SEWER.

ALL #4 REBAR SHALL BE GRADE 40.

ALL #5 AND LARGER REBAR SHALL BE GRADE 60.
TYPICAL END VIEW
REFER TO STANDARD S 12.5
FOR REINFORCING INFORMATION
AND NOTES
PLAN
TRANSITION MOUNTABLE CURB & GUTTER TO CURB OPENING INLET

NOTE:
ALL CONSTRUCTION THIS POINT BACK SHALL CONFORM TO S12.1−S12.5.

THROAT CONFIGURATION DETAIL
CURB OPENING INLET WITH MOUNTABLE CURB & GUTTER

NOTE:
REFER TO S12.1−S12.5 FOR COMPLETE CONSTRUCTION DETAILS.

THROAT CONFIGURATION DETAIL
CURB OPENING INLET WITH VERTICAL CURB & GUTTER

CITY OF AURORA, COLORADO
CURB OPENING INLET
TYPE R MODIFIED
DETAIL FOR MINIMUM SLOPE OF FLOWLINE ALONG CURB

<table>
<thead>
<tr>
<th>FROM - TO</th>
<th>SLOPE DESCRIPTION</th>
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<tbody>
<tr>
<td>1 – 2</td>
<td>EXISTING OR CORRECTED SLOPE OF THE FLOWLINE</td>
</tr>
<tr>
<td>2 – 3</td>
<td>VERTICAL TRANSITION OF THE FLOWLINE</td>
</tr>
<tr>
<td>3 – 4</td>
<td>THE SLOPE OF THE FLOWLINE SHALL BE PARALLEL WITH THE STREET</td>
</tr>
<tr>
<td>4 – 5</td>
<td>TRANSITION OF THE SLOPE UP TO THE INTERSECTION WITH 1.27% SLOPE</td>
</tr>
<tr>
<td>5 – 6</td>
<td>MINIMUM SLOPE OF 1.27% ALONG CURB FLOWLINE</td>
</tr>
<tr>
<td>6 – 7</td>
<td>EXISTING OR CORRECTED SLOPE OF THE FLOWLINE</td>
</tr>
</tbody>
</table>

NOTE: FOR RETROFITTING WHERE REPLACING PREVIOUS INLET WITH NEW INLET

CITY OF AURORA, COLORADO
SPECIAL RETROFIT CURB OPENING INLET TYPE R MODIFIED

City Engineer Date
EXPANSION JOINTS SHALL EXTEND FROM THE SIDES OF INLETS TO BACK OF SIDEWALK

FOR DETAILED INFORMATION ABOUT THE INLET DECK AND SIDEWALK, SEE STANDARD DETAIL S12.3

SIDEWALK DIMENSIONS AT INLET
FOR INLET LENGTH (L) UP TO 12' LOCALS, 15' COLLECTORS, AND 18' 6 LANE ARTERIALS (SEE DETAIL S9.7)

EXPANSION JOINTS SHALL EXTEND FROM THE SIDES OF INLETS TO BACK OF SIDEWALK

12" WALL FOR INLETS OVER 15'
FOR DETAILED INFORMATION ABOUT THE INLET DECK AND SIDEWALK, SEE STANDARD DETAIL S12.3

NOTE: CIVIL PLANS SHALL ALLOW ADEQUATE SPACE ON LOTS FOR DRIVEWAYS AND POSSIBLE HYDRANTS, METER PITS, AND CONDUIT.

SIDEWALK DIMENSIONS AT INLET
FOR INLET LENGTH (L) UP TO 30'

SCALE 1"=10'
<table>
<thead>
<tr>
<th>INLET LENGTH</th>
<th>X=5'</th>
<th>X=5'</th>
<th>X=8'</th>
<th>X=10'</th>
</tr>
</thead>
<tbody>
<tr>
<td>L=3'</td>
<td>5' 3&quot;</td>
<td>5' 7&quot;</td>
<td>8' 1&quot;</td>
<td>10' 1&quot;</td>
</tr>
<tr>
<td>L=5'</td>
<td>5' 5&quot;</td>
<td>5' 8&quot;</td>
<td>8' 3&quot;</td>
<td>10' 3&quot;</td>
</tr>
<tr>
<td>L=10'</td>
<td>6' 5&quot;</td>
<td>6' 2&quot;</td>
<td>8' 8&quot;</td>
<td>10' 9&quot;</td>
</tr>
<tr>
<td>L=15'</td>
<td>7' 3&quot;</td>
<td>7' 1&quot;</td>
<td>9' 6&quot;</td>
<td>11' 6&quot;</td>
</tr>
<tr>
<td>L=20'</td>
<td>7' 3&quot;</td>
<td>7' 3&quot;</td>
<td>10' 2&quot;</td>
<td>12' 3&quot;</td>
</tr>
</tbody>
</table>
| L=30'        | 7' 3" | 7' 3" | 10' 2"| 12' 3"

**COLLECTOR @ 6 LANE ARTERIAL — WITH A 14' 6" RADIUS AT BACK OF WALK, X & Y EQUAL 10' FOR ANY LENGTH OF INLET.**

**= RADIUS AT BACK OF WALK (SEE DETAIL S9.8)**

**NOTES: 5' SIDEWALKS SHALL BE POURED MONOLITHICALLY WITH INLET DECK. 8' AND 10' SIDEWALKS SHALL BE POURED SEPARATE FROM INLET DECKS AND SEPARATED BY 1/2" EXPANSION JOINT.**

**THESE STREET COMBINATIONS ARE BY FAR THE MOST COMMON. THERE ARE OTHER POSSIBLE STREET COMBINATIONS NOT PRESENTED HERE. IN THESE CASES, THE INLET AND WALK LAYOUT SHALL FOLLOW DETAIL S9.8.**

**SIDEWALK DIMENSIONS AT INLET**
INLET DECK IS SHOWN WITHOUT CURB OPENING

NOTES

1. PROVIDE A 1 1/2" DEEP CONTROL JOINT THROUGH THE INLET DECK AT EACH INTERMEDIATE WALL PER S7.3 OF THE "ROADWAY DESIGN & CONSTRUCTION SPECIFICATIONS". THE JOINT SHALL EXTEND FROM THE BACK OF THE DECK TO THE FACE OF THE GUTTER PAN.

2. INLET DECK REINFORCEMENT STEEL SHALL BE CONTINUOUS WITH SPlice LENGTHS OF NO LESS THAN 18". INTERMEDIATE WALL STEEL SHALL TIE INTO THE OUTSIDE WALLS AND FLOOR PER STANDARD DETAILS.

3. ALL INTERMEDIATE WALL CONSTRUCTION SHALL CONFORM TO STANDARD CONSTRUCTION SPECIFICATION AS SHOWN IN STANDARD DETAILS #400, 1 THRU 7 UNLESS OTHERWISE NOTED.
RURAL, LOW DENSITY ROADWAY

SCALE 1"=10'

DRAINAGE PROVISION PER APPROVED REPORT DIMENSION TO ACCOMMODATE 2 YEAR STORM

Sanitary Sewer Line

Water Line

FH WHEN REQUIRED BY UTILITY OR FIRE DEPT.

1. ACTUAL PAVEMENT SECTION DETERMINED BY APPROVED PAVEMENT DESIGN REPORT

LOW DENSITY, SINGLE FAMILY RESIDENTIAL, 30 ACRE MINIMUM DEVELOPMENT, MAXIMUM TWO DWELLING UNITS PER ACRE, MINIMUM LOT SIZE 0.4 ACRES [CODE SEC. 126-36, C(4)]
PRIVATE DRIVEWAY DETAIL

NO SCALE

RURAL LOW DENSITY ROADWAY

12' 4'

GRAVEL SHOULDER

RCP FLARED END SECTION (TYPICAL) OR CONCRETE HEADWALL

R.O.W.

PAVEMENT DEPTH 3" AC. & 6" AGG. BASE OR 5" CONC.

WIDTH AS APPROVED BY TRAFFIC ENGINEER (12" MINIMUM)

<table>
<thead>
<tr>
<th>PIPE</th>
<th>MIN. COVER</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCP/NRCP</td>
<td>1.00'</td>
</tr>
<tr>
<td>CMP (16 GA.)</td>
<td>2.00'</td>
</tr>
<tr>
<td>HDPE (40 psi)</td>
<td>2.00'</td>
</tr>
<tr>
<td>PVC (46 psi)</td>
<td>2.00'</td>
</tr>
</tbody>
</table>

SECTION A-A

PIECE (18"MIN.) OR CONCRETE PAN PER APPROVED DRAINAGE REPORT. PIPE LENGTH = W + 8d.

ALL PIPE SHALL COMPLY WITH APPLICABLE AASHTO STANDARDS.
FOR PIPES LARGER THAN 18", SUBMIT MIN. COVER DEPTHS & PIPE THICKNESS FOR REVIEW

CITY OF AURORA, COLORADO

RURAL
LOW DENSITY ROADWAY

2 OF 5
S13.2
ARTERIAL OR COLLECTOR STREET INTERSECTION

25' R

3'

16' 11' 11'

12' 12'

140'

100'

RURAL LOW DENSITY ROADWAY

SEE S13.4

NO SCALE

① WHEN REQUIRED BY C.O.A. TRAFFIC ENGINEER

CITY OF AURORA, COLORADO

RURAL LOW DENSITY ROADWAY

S13.3

3 OF 5

3.0.02

CITY ENGINEER

DATE
1. THE INTERIOR OF THE MEDIAN ISLAND (BACK OF MEDIAN CURB TO BACK OF MEDIAN CURB) SHALL NOT BE PART OF THE PUBLIC RIGH-OF-WAY. IT SHALL BE A TRACT OF LAND OWNED AND MAINTAINED BY THE HOA OR METROPOLITAN DISTRICT.

2. WHEN CROSSPANS ARE REQUIRED, SEE NOSE DETAIL AT CROSSPANS ON STANDARD DETAIL S14.2.
ARterial street intersection

1. The interior of the median island (back of median curb to back of median curb) shall not be part of the public right-of-way. It shall be a tract of land owned and maintained by the HOA or Metropolitan District.
NOTE:
STREET TYPES MAY BE DIFFERENT, BUT STREET WIDTHS AT THE CURB EXTENSIONS AND THE CONCEPTS ASSOCIATED WITH THE TRANSITIONS BACK TO THE NORMAL STREET SECTIONS APPLY IN ALL CASES.
SECTION B-B

2" PVC

GALVANIZED 16d NAIL
1" FROM THE END
OF 2" PVC

6x6, W2.9xW2.9
WELDED WIRE FABRIC

30d NAIL—2 EACH END
8" C.C. AND 4’ CENTERS
ALONG LENGTH

HEADER ANCHOR

SLOPE VARIES 1:1 MAXIMUM

2" PVC WEEP HOE. 10’ O.C.
(CENTERED IN PANEL)

1.5 cf OF 1 1/2” ROCK WRAPPED
IN MIRAFL AROUND WEEP HOLE.
EXTEND PIPE 4” INTO GRAVEL.

SECTION A-A

NOTE: FACE OF SLOPE PAVING TO BE ALTERNATING EXPOSED AGGREGATE FINISHED
CONCRETE PANELS. INSTALL 2X4 (SELECT HEART OR BETTER GRADE) REDWOOD
HEADERS BETWEEN 10’ PANELS TO MATCH SIDEWALK JOINTS. HEADERS WILL
REMAIN IN PLACE.

CITY OF AURORA, COLORADO

SLOPE PAVING

S16.1
1. At no time shall the distance between bollards be greater than 5'.
2. All bollards, except for removable post, shall be filled with concrete.
3. All bollards shall be galvanized steel.
4. Bollards are to be set 5' to 7' back of sidewalk.
5. Channel width = tract width (unless otherwise approved.)
STANDARD

POST SPACING 7'-0" O.C.

1/8" G (TYP.)

RAILS-1-1/4" DIA. SCH. 40 PIPE
STAGGER EXPANSION JOINTS
POSTS-2-1/2" DIA. SCH. 40 PIPE
EXPANSION JOINT, SEE S18.2

C.O.A. CLASS II CONCRETE w/
CROWN WATERSHED FINISH

SEE S18.2 FOR ALTERNATIVES
OF POST MOUNTING TYPES

CROWNED FOOTING

BIKEPATH OR SIDEWALK

HEIGHT OF RAILING IS
MEASURED FROM THE
SURFACE OF THE BIKE-
PATH OR SIDEWALK

MINIMUM HEIGHT OF RAILING
TO BIKEPATH OR
TO SIDEWALK

4'-6" WHEN ADJACENT TO BIKEPATH OR
3'-6" WHEN ADJACENT TO SIDEWALK

1 1/2" MIN. CLEAR

1/4"X 2-7/8" DIA. PLATE

EBW

CAP (TYP.)

SEE NOTE 5

NOTES:
1. ALL POSTS AND RAILING SHALL BE
SCHEDULE 40 HOT-DIP GALVANIZED PIPE.
2. RAILING SHALL BE WELDED
(ALL AROUND) TO POSTS AND SHARP
Corners ground smooth.
3. ALL RAILING SYSTEMS SHALL HAVE A
PRIMER AND FINISH COAT (3 MILS EACH)
OF TYPE I, ZINC DUST/ZINC OXIDE
LINSEED OIL PAINT, OR APPROVED EQUAL.
(COLOR: BLACK)
4. ALTERNATIVE MOUNTING
SHALL BE REQUIRED WHERE
SOIL OR SLOPE CONDITIONS
ARE UNSUITABLE.
5. THIS HANDRAIL IS ADA
COMPLIANT & SHALL BE
INSTALLED ADDITIONALLY WHEN
REQUIRED, SEE DETAIL S18.4.
6. MAXIMUM CLEAR OPENING
BETWEEN RAILS AND BETWEEN
BOTTOM RAIL OR PATH IS
1'-3"

CITY OF AURORA, COLORADO

PEDESTRIAN/BICYCLE
RAILING
(ADA STANDARD)

S18.1

CITY ENGINEER
DATE

Ronald Seigle 21-02
1-1/4" SCHEDULE 40 PIPE

1" SCHEDULE 40 PIPE

21' SPACING BETWEEN EXPANSION JOINTS

NOTES:
EXPANSION JOINTS TO BE WELDED TO ONE SIDE ONLY.

POST

1/8" G

1/2" x 8" x 9"

PLATE

3" G

SCH.40 PIPE

1/2" x 8" x 9"

PLATE

1" BOLT HOLE (TYP)

TOP-MOUNTED BRACKET

NOTE:
ALTERNATIVE ANCHOR BOLT MAY BE 3/4" x 9" x 3", EMBEDDED 6" INTO CONCRETE.

SIDE-MOUNTED BRACKET

3/4" x 10" H.S. THREADED RODS DRILL & EPOXY 8" INTO CONCRETE

3/16" G

3/8" x 8" PLATE

1/2" x 8" x 12"

PLATE

PEDESTRIAN/BICYCLE RAILING

CITY OF AURORA, COLORADO

S18.2

2 OF 4

CITY ENGINEER DATE

Ron C. Dauphney 2-1-02
ALTERNATE EXPANSION JOINT

EXPANSION JOINT DETAIL

CITY OF AURORA, COLORADO

PEDESTRIAN/BICYCLE CROSSING

S18.3
NOTES:

1 – THIS HANDRAIL IS REQUIRED BY THE AMERICANS WITH DISABILITIES ACT (ADA), 1990. IT SHALL BE INSTALLED ALONG PUBLIC WALKWAYS AT LOCATIONS WHERE THE GRADE EXCEEDS 5% (SLOPE 1:20) AT THE ENTRANCE TO A BUILDING. FOR ADDITIONAL DESIGN CRITERIA, REFER TO ADA HANDBOOK, DEC. 1991, ACCESSIBILITY GUIDELINES, APPENDIX B, PUBLISHED BY US GOVERNMENT PRINTING OFFICE.

2 – ALSO, SEE SECTION 4.02.6.
TYPICAL JOINT LAYOUT FOR STREET CROSS SECTION

8' to 12'

Transverse Joints (sawed)

Longitudinal Construction Joints (sawed)

TYPICAL JOINT LAYOUT FOR ALLEY CROSS SECTION
A EXPANSION JOINT
POURED JOINT MATERIAL
1/8" BELOW SURFACE
PREFORMED JOINT MATERIAL

C TRANSVERSE CONTRACTION JOINT
(TRANSVERSE WEAKENED PLANE JOINT)
1/8" MIN.
20 MIL. POLYETHYLENE PLASTIC PARTING STRIP

E LONGITUDINAL CONTRACTION JOINT
(LONGITUDINAL WEAKENED PLANE JOINT)
T/4 + 1/2" MIN.

T0 TRANSVERSE CONSTRUCTION JOINT
REQUIRED WHEN POUR HAS BEEN INTERRUPTED MORE THAN 30 MINUTES, PLACE THIS JOINT AT THE END OF A POUR TO BE PLACED 1/3 OF THE TRANSVERSE CONTRACTION JOINT SPACING.
SEALANT, 3/4" X 1" GROOVE
1:4 SLOPE
FORMED OR WITH METAL KEYWAY
SEE C

GENERAL NOTES
■ BARS SHALL BE DEFORMED REINFORCING BARS, GRADE 40 OR BETTER @ 30" O.C. UNLESS NOTED OTHERWISE. NO. 4 WHEN T=8" & NO. 5 WHEN T>8"

T SEE PLANS FOR DIMENSION T, THICKNESS OF CONCRETE PAVEMENT.

THE COST OF ALL JOINTING BARS (JOINT MATERIAL, SAWING, ETC.) IS TO BE INCLUDED IN THE BID PRICE FOR CONCRETE PAVEMENT.

■ PLASTIC STRIP SHALL BE INSTALLED AT THE TIME OF PLACING OF THE CONCRETE AND SHAL BE LEFT IN PLACE. PLASTIC STRIP SHALL BE 1/8" BELOW THE SURFACE AND VERTICAL TO THE CONCRETE PAVEMENT BEFORE FINISHING AND TEXTURING. SPlicing SHALL BE WITH ENDS BUTTED.

CONSTRUCTION JOINT GROOVES SHALL BE ACCOMPLISHED BY FORMING, SAWING OR AS DIRECTED, TO THE DIMENSION SHOWN.

SEE S19.3
SAWED JOINT

1/4" POUR JOINT MATERIAL
1/4" AIR
1/4" MIN.
T/4 OR + 1/2" (SEE JOINT DETAILS)
NO JOINT MATERIAL

* NYLON ROPE OR OPEN CELL POLYURETHANE STRAND

LONGITUDINAL CONSTRUCTION JOINT

1/4" X 1" GROOVE
3/4" OF SEALANT
TYPICAL METAL KEYWAY
1:4 SLOPE
T/5
T/10
15" 15"

TO BE USED WHEN TRAFFIC LANE IS ADDED SEPARATELY OR FOR INTERSECTIONS, TAPERS OR SPEED CHANGE LANES.

ALTERNATE LONGITUDINAL CONSTRUCTION JOINT DESIGNS MAY BE USED IF APPROVED.

MANHOLE BOXOUT

SEE GENERAL NOTES ON S19.2, SHEET 2 OF 4

CITY OF AURORA, COLORADO

CONCRETE PAVEMENT

JOINT DETAILS

S19.3
GENERAL NOTES:

THE TYPICAL JOINT LAYOUT SHOWN IS INTENDED TO BE USED AS A STANDARD. THE DEVELOPER/CONTRACTOR SHALL PREPARE A PAVEMENT JOINT LAYOUT FOR REVIEW BY THE PROJECT MANAGER PRIOR TO APPROVAL OF THE PAVEMENT DESIGN REPORT. FOR ALL CONCRETE ROADWAYS, PRIVATE STREETS AND PARKING LOTS A COPY OF THE JOINT LAYOUT SHALL BE AVAILABLE AT THE CONSTRUCTION SITE DURING PAVING OPERATIONS.

LONGITUDINAL JOINTS SHALL COINCIDE WITH LANE MARKINGS, IF POSSIBLE. SEE TABLE 31.2. ALL LONGITUDINAL JOINTS SHALL BE TYPE "E" OR "L."

TRANSVERSE JOINTS SHALL EXTEND THROUGH THE CURB AND GUTTER OR CURB-GUTTER AND WALK (COMBINATION). AS GENERAL RULES: JOINT SPACING SHALL NOT EXCEED 2-1/2' PER INCH OF PAVEMENT THICKNESS (15' MAXIMUM, 12' PREFERRED); CONCRETE PANELS SHALL NOT HAVE TRANSVERSE JOINT SPACING EXCEEDING 1.25 TIMES THE LONGITUDINAL JOINTS SPACING. TRIANGULAR CORNERS (POINTS) OF LESS THAN 60° SHALL NOT BE ALLOWED.

IMMEDIATELY AFTER SAWING, JOINTS SHALL BE CLEANED OF CEMENT SLURRY WITH A PRESSURIZED WATER JET OR OTHER ACCEPTABLE METHOD. SAWED JOINTS SHALL BE DRY, CLEAN OF ALL SCALE, DIRT, DUST, CURING COMPOUND, AND OTHER FOREIGN MATTER. THE SIDEWALLS OF THE JOINT TO BE SEALED SHALL THEN BE THOROUGHLY SANDBLASTED AND BLOWN CLEAN OF LOOSE SAND BY HIGH PRESSURE AIR JUST PRIOR TO PLACING THE BACKER ROD AND THE Poured JOINT SEALANT.

THE CONTRACTOR SHALL, UNLESS OTHERWISE SHOWN ON THE PLANS, USE A BOXOUT AT MANHOLES AND SIMILAR ROADWAY APPURTENNANCES. AN EXPANSION JOINT WILL BE REQUIRED BETWEEN CURB OPENING INLETS AND CONCRETE PAVEMENT.

PREFERRED TRANSVERSE JOINT LOCATIONS ARE: AT THE MIDPOINT OF ROUND BOXOUTS OR APPURTENNANCES; OR AT THE CORNER OF RECTANGULAR BOXOUTS OR APPURTENNANCES.

WHERE A LONGITUDINAL JOINT IS LOCATED ONE FOOT OR MORE CLEAR OF AN APPURTENNANCE EDGE, A BOXOUT MAY BE USED. WITH LESS THAN THIS CLEARANCE, USE THE "TYPICAL 2' RADIAL JOINT" AS SHOWN IN THE DETAILS. USE OF SQUARE OR ROUND BOXOUT, OR BOND BREAKER, IS APPROPRIATE WHEN THE APPURTENNANCE IS CENTERED ON A LONGITUDINAL JOINT.

THE FINAL FINISH REQUIREMENTS OF CDOT SPECIFICATIONS. SUBSECTION 412.12(D) SHALL APPLY EXCEPT THAT TRANSVERSE TINED GROOVES WILL NOT BE REQUIRED WHERE THE PROFILE GRADE IS FLATTER THAN 5%. TINED GROOVES WILL NOT BE REQUIRED WITHIN 2 FEET OF CURB FACES.
SEE TRANSVERSE CONSTRUCTION JOINT, STD. S19.2

SEE PLANS FOR DIMENSION "T", THICKNESS OF CONCRETE PAVEMENT.

CITY OF AURORA, COLORADO

TRANSITION SECTION BETWEEN PORTLAND CEMENT CONCRETE AND ASPHALT PAVING SECTIONS

CITY ENGINEER  DATE

2-1-02 S20.1
STANDARD

LID SIDE

7 5/16" DIA.
5 3/4" DIA.
3 1/2"

AURORA RANGE POINT

(2) CLOSED PICKHOLE
7/16"
1 1/8"

1/2" RAISED LETTERING (RECESSED FLUSH)

LID TOP

8 9/16" DIA.
7 9/16" DIA.
6 5/16" DIA.

BOX

6 3/8" DIA.
6 1/8" DIA.
6 5/8" DIA.
9" DIA.

10"
4"x4"x6' HORIZ. CROSS BRACE

4"x4"x8' VERT. POST

4"x4"x4' LATERAL BRACE (HIDDEN)
4"x4"x6'. FOOTING CROSS BRACE

8'-0"

4'-0"

6'-8"

4'-4"

6'-0"

4'-0"

4"x4"x6' FOOTING CROSS BRACE

(2) 4"x4" DIAGONAL BRACES. CUT TO FIT AS SHOWN

"T" BRACE—FRONT AND BACK (TYP. AS SHOWN)

"L" BRACE (TYP. AS SHOWN)

SIGN: 4'x8'x3/4" EXTERIOR PLYWOOD

STRAP BRACE (TYP. AS SHOWN)

(2) 2"x4" BRACES NAILED IN PLACE AS SHOWN ON NEAR SIDE FLUSH WITH FRONT OF 4"x4" VERT. POSTS & HORIZ. CROSS BRACES

4"x4"x4' "V" BRACE CENTERED

8'-0"

4'-0"

23" 30"

45"

AS AN ALTERNATIVE, SUPPORT POSTS MAY BE EMBEDDED IN THE GROUND.
NOTE:
1. A minimum width of 25' paved surface shall be provided every 150' along streets. This may be provided by striped out "no parking" areas, driveways, curb extensions or other unobstructed design features.

2. If pedestrian crosswalks are located at midblock, provide handicap ramps and crosswalk in accordance with the MUTCD. The midblock emergency setup may also be located at this location.

NOTE:
REFER TO CITY OF AURORA DETAIL S9.4 FOR TRUNCATED DOME DETAILS AND SECTION INFORMATION.
EXTEND CONCRETE 20' BEYOND END OF TAPER FOR BUS PULLOUT WHERE ASPHALT PAVEMENT IS USED IN STREETS.

1/2" EXPANSION JOINT

10.0' (TYP)

CONCRETE PULLOUT AND ADJACENT THROUGH LANE

CONTRACTION JOINT (TYP)

NOTE: BIKE LANE MUST MEET COA BICYCLE FACILITY DESIGN GUIDELINES

HARDSCAPE B.O.C. TO R.O.W.

EXTEND CONCRETE 20' BEYOND END OF TAPER FOR BUS PULLOUT WHERE ASPHALT PAVEMENT IS USED IN STREETS.

1/2" EXPANSION JOINT

5.0'

EDGE OF INSIDE THROUGH LANE

VERTICAL CURB & GUTTER SEE STD. S7.1

50' MIN DISTANCE FROM INTERSECTION CURB RETURN CURVE (PCR) AND BEGIN TAPER FOR BUS PULLOUT

CITY OF AURORA, COLORADO

BUS STOP INTERACTION WHERE REQUIRED IN TOD'S

S24.1
<table>
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<tr>
<th>LIST OF TRAFFIC DETAILS</th>
<th>No. of Sheets</th>
<th>Page</th>
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<td>TRAFFIC SIGNAL CONSTRUCTION STANDARD NOTES</td>
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<td>TE-0</td>
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<tr>
<td>19 CONDUCTOR CABLE WIRING AND COLOR CODE</td>
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<tr>
<td>FOUNDATION FOR SIGNAL POLE WITH BOLT DOWN BASE</td>
<td>1</td>
<td>TE-1</td>
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<td>FOUNDATION FOR EMBEDDED SIGNAL POLE</td>
<td>1</td>
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<td>PEDESTAL POLE FOUNDATION</td>
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<td>TE-3</td>
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<tr>
<td>M-I CABINET FOUNDATION WITH FOOT PAD</td>
<td>1</td>
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<tr>
<td>P-I CABINET FOUNDATION WITH FOOT PAD</td>
<td>1</td>
<td>TE-5</td>
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<tr>
<td>MAST ARM DESIGN DETAILS</td>
<td>5</td>
<td>TE-6</td>
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<tr>
<td>STRAIN POLE (WOOD OR STEEL) AND SPAN WIRE AND TETHER DETAILS</td>
<td>1</td>
<td>TE-7</td>
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<tr>
<td>STRAIN POLE WITH DOWN GUYS</td>
<td>1</td>
<td>TE-8</td>
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<tr>
<td>POLE MOUNTED VEHICULAR &amp; PEDESTRIAN SIGNAL HEADS</td>
<td>4</td>
<td>TE-9</td>
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<tr>
<td>CONDUIT PLACEMENT</td>
<td>4</td>
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<tr>
<td>LOOP DETECTORS, STOP LINE, LEFT AND RIGHT TURNS</td>
<td>5</td>
<td>TE-11</td>
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<tr>
<td>SIGNING FOR SCHOOL CROSSWALKS &amp; REDUCED SPEED LIMITS THROUGH SCHOOL AND SAFETY ZONES</td>
<td>2</td>
<td>TE-12</td>
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<tr>
<td>STEEL SIGN TUBING INSTALLATION</td>
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<tr>
<td>&quot;ZEBRA&quot; CROSSWALKS, CROSSWALK DETAILS, STRIPING SPACING &amp; OTHER MARKINGS</td>
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<td>TE-14</td>
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<tr>
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<td>TE-15</td>
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<tr>
<td>TYPICAL STREET LIGHT PLACEMENT INTERSECTION, STREET LIGHT POLE LOCATIONS, TOD – URBAN</td>
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<td>TE-18</td>
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<tr>
<td>CENTERS PEDESTRIAN WALKWAY LIGHTING PLAN, PEDESTRIAN LIGHTING POLES</td>
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TRAFFIC SIGNAL CONSTRUCTION STANDARDS
CITY OF AURORA

All traffic signals maintained by the City of Aurora must be constructed in accordance with the details shown on sheets TE-1 through TE-15 as well as the following:

A) Cabinets and Cabinet Foundations
1) All conduits shall be cut off with no more than ½ inch extending above concrete base.
2) AC and DC conductors shall be in separate conduits. Telephone/interconnect line shall be included with the DC cables. A separate 2 inch conduit will be used for the power feed.
3) Cabinet ground rod shall be a 5/8 inch 8 foot copper rod located in the home run pull box.
4) Ground wire shall be a #6 AWG solid copper.
5) Power wiring shall be #6 AWG copper stranded and insulated, black for the hot and white for the neutral.
6) Wiring shall be labeled indicating point of service.
7) Field wiring shall be terminated using insulated spade connectors, with a maximum of two (2) #14 AWG wires per connector.
8) All field wiring shall be labeled by phase and direction. This includes signal, pushbutton, detection, and opticom wiring.
9) Cabinet base shall be level extending approximately 18 inches above and 18 inches below ground.
10) Cabinet needs to be leveled, so that the door opens freely without binding.
11) Cabinet shall be caulked around base with silicon caulk to make watertight.

B) Pull boxes
1) Pull boxes shall be set on a minimum of 8 inches of 3/4 inch crushed gravel for drainage.
2) Conduits in pull boxes shall be stubbed up a minimum of 4 inches above the gravel at a 90-degree angle from level and flush with each other. Conduit shall be cut off approximately 6 inches below the pull box lid.
3) Pull box cover bolts shall be in place and the drain holes for bolts shall be opened.
4) Pull boxes shall be one inch above and parallel to the ground except when installed in concrete.
5) Pull boxes installed in concrete shall be flush with finished concrete and have expansion material around the outside of pull box.
6) Wire in pull boxes shall not be tangled or twisted. Wire shall be neat with a maximum of a 1-foot loop and be tagged, indicating direction and termination point.
7) Pull string shall be provided in all conduits. Any unused conduits shall be capped and have a locating line (metallic conductor) installed.
8) No wire splices shall be allowed in pull boxes, except for loops, which must be soldered and sealed with shrink tube. Loops shall be tagged, with phase and direction. (see TE-11 5 of 5)
9) Any necessary cuts to a pull box shall be done with a cutting tool without structural damage to the pull box.

C) Wiring
1) Each pole shall have its own separate home run, with a minimum of 19-conductor IMSA signal cable. No splices will be allowed between the cabinet and the destination pole. Wiring shall be terminated in accordance with attached color code.
2) All signal wiring in pole boxes shall be identified with phase toping by direction, per Aurora City color code.
3) Each push button shall be fed with a separate black 2 conductor shielded cable.
4) A 4 conductor IMSA signal cable shall service each pedestrian (Walk/ Don't Walk) head.
5) All holes for side of pole signal installation shall be drilled 1 ¾ inches and a rubber grommet installed.
6) Wiring in hand holes shall have 12 to 18 inches of slack that can be pulled out for inspection or rearrangements.
7) Each signal head shall be fed with a 7 conductor IMSA signal cable.
8) Street lights shall be serviced by a 12/2 UF cable that must be continuous and without splices from each luminaire to the power source.
9) Illuminated street name signs shall be serviced by a 14/2 cable (with ground) which must be continuous and without splices from the base of the signal pole to the power source. The power cable from the illuminated street name signs will be spliced to the 14/2 cable in the hand hole at the base of the signal pole. (see TE-6.2)
# Standard

## Main Street

<table>
<thead>
<tr>
<th>Signal Type</th>
<th>Legend Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid Green</td>
<td>M.S. Green</td>
</tr>
<tr>
<td>Solid Amber</td>
<td>M.S. Amber</td>
</tr>
<tr>
<td>Solid Red</td>
<td>M.S. Red</td>
</tr>
<tr>
<td>Solid Blue</td>
<td>M.S. L/T Green Arrow</td>
</tr>
<tr>
<td>Blue W/Black TR.</td>
<td>M.S. L/T Amber Arrow</td>
</tr>
<tr>
<td>Green W/White TR.</td>
<td>M.S. Walk</td>
</tr>
<tr>
<td>Red W/White TR.</td>
<td>M.S. Don't Walk</td>
</tr>
<tr>
<td>Blue W/Red TR.</td>
<td>M.S. R/T Green Arrow</td>
</tr>
<tr>
<td>Amber W/Red TR.</td>
<td>M.S. R/T Amber Arrow or L/T Red Arrow</td>
</tr>
</tbody>
</table>

## Side Street

<table>
<thead>
<tr>
<th>Signal Type</th>
<th>Legend Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green W/Black TR.</td>
<td>S.S. Green</td>
</tr>
<tr>
<td>Amber W/Black TR.</td>
<td>S.S. Amber</td>
</tr>
<tr>
<td>Red W/Black TR.</td>
<td>S.S. Red</td>
</tr>
<tr>
<td>Solid Black</td>
<td>S.S. L/T Green Arrow</td>
</tr>
<tr>
<td>Black W/White TR.</td>
<td>S.S. L/T Amber Arrow</td>
</tr>
<tr>
<td>Blue W/White TR.</td>
<td>S.S. Walk</td>
</tr>
<tr>
<td>Black W/Red TR.</td>
<td>S.S. Don't Walk</td>
</tr>
<tr>
<td>White W/Black TR.</td>
<td>S.S. R/T Green Arrow</td>
</tr>
<tr>
<td>White W/Red TR.</td>
<td>S.S. R/T Amber Arrow or L/T Red Arrow</td>
</tr>
</tbody>
</table>

**Note:** All hand hole terminations shall be identified as follows:

- **Red**: North
- **Orange**: East
- **Green**: South
- **Blue**: West
- **Yellow**: Identifies a Ped
- **Yellow**: Identifies a Push Button
- **White**: Identifies a Left Turn
- **Purple**: Identifies a Right Turn
- **Brown**: Identifies Spare Conductors

---

**City of Aurora, Colorado**

**Traffic Engineer**

**Date**

**Director of Public Works**

**Date**

19 Conductor Cable Wiring and Color Code

**TE-CO**
ANCHOR BOLT
2" PVC CONDUIT FOR POWER
3" PVC CONDUIT STUB OUT TO PULL BOX
1/2" PREMOLDED JOINT FILLER
FOOT PAD OR SIDEWALK (CLASS 1 CONCRETE)

TOP VIEW

30" FOOT PAD OR SIDEWALK
5 1/4"
13 1/2"
24"

STUB OUT TO PULL BOX
2" PVC CONDUIT
3" PVC CONDUIT

CLASS 1 CONCRETE
18" MIN.
FINISHED GRADE
8" MIN.
FOOT PAD
SIDEWALK OR 6" MIN.

FRONT VIEW

SIDE VIEW

M-1 CABINET FOUNDATION WITH FOOT PAD
STANDARD

3 11/16"  48"  3 11/16"

3" PVC CONDUIT STUB OUT TO PULL BOX

2" PVC CONDUIT POWER USE ONLY
ANCHOR BOLTS

1/2" PREMOLDED JOINT FILLER

FOOT PAD OR SIDEWALK
(CLASS 1 CONCRETE)

TOP VIEW

36" 18 1/2"  8 3/4"

30" FOOT PAD OR SIDEWALK

FRONT VIEW

SIDES VIEW

CLASS 1 CONCRETE

FINISHED GRADE

SIDEWALK OR 6" MIN. FOOT PAD

P-1 CABINET FOUNDATION WITH FOOT PAD

CITY OF AURORA, COLORADO

DATE

TE-5
2% SLOPE — DEFLECTED CONDITION

17'-6" UNDEFLICTED CONDITION
17'-3" DEFLECTED CONDITION

2'-9"

2% SLOPE

15' FOR ARMS < 40'
20' FOR ARMS > 40'

80'± 2' CL RADIUS FOR ARMS LESS THAN 55'
70'-80'± 2' CL RADIUS FOR ARMS GREATER THAN OR EQUAL TO 55'

MAST ARM DESIGN

CITY OF AURORA, COLORADO

MAST ARM DESIGN

TE-6.1

1 OF 5
NOTES: 1. ILLUMINATED STREET NAME SIGN CABLE IS SPLICED TO 14/2 UF POWER CABLE IN HAND HOLE AT EACH POLE AS SHOWN. IN ADDITION, THE POWER CABLE FROM EACH POLE IS BROUGHT BACK TO THE ELECTRIC P. O. S. AND FUSED AT THAT POINT.

2. STREET LIGHT AND POLE EXTENSION ARE STANDARD. IF SITE-SPECIFIC CONDITIONS PRECLUDE POLE EXTENSION, A REMOVABLE CAP SHALL BE INSTALLED ON TOP OF THE POLE.
NOTE: CONDITION SHOWN INDICATES MAXIMUM LOADING FOR MASTARMS FROM 15'-25' FEET IN LENGTH. ACTUAL LENGTH AND LOADING MAY VARY BY LOCATION.
NOTE: CONDITION SHOWN INDICATES MAXIMUM LOADING FOR MASTARMS FROM 30'-50' FEET IN LENGTH. ACTUAL LENGTH AND LOADING MAY VARY BY LOCATION.
NOTE: CONDITION SHOWN INDICATES MAXIMUM LOADING FOR MAST ARMS FROM 65'-70' FEET IN LENGTH. ACTUAL LENGTH AND LOADING MAY VARY BY LOCATION.
STANDARD

TETHER WIRE ATTACHMENT

NOTE:
STEEL POLES SHALL BE PAINTED WITH ALUMINUM PAINT, ANCHOR PAINT NO. 1005 OR APPROVED EQUAL.

CIRCUIT FEED

SADDLE CLAMP

3/8" SPAN WIRE

PIPE AS NECESSARY

BACKPLATE

SIGNAL HEAD

SEE TETHER DETAIL ABOVE

16'-6" MIN. TO STREET SURFACE

STRAIN POLE (WOOD OR STEEL)

CITY OF AURORA, COLORADO

Dish Vanesscamp 1/7/2000

TRAFFIC ENGINEER

1/7/2000

DIRECTOR OF PUBLIC WORKS

TE-7

STRAIN POLE (WOOD OR STEEL) AND SPAN WIRE AND TETHER DETAILS

N:\PWO\DRAFT\STANDARD\TRAF-STD\TE-7
3/8" GW SPAN (TYPICAL)

NO. 10 SOLID COPPER (GREEN)
GROUND CONDUCTOR BONDED TO
SIGNAL SPAN AND BACK GUY SPAN

WHEN IN THE VICINITY OF OVERHEAD ELECTRICAL
CONDUCTORS THE ENGINEER MAY DIRECT THE
INSTALLATION OF A 50 kV FIBERGLASS STRAIN
INSULATOR (JOSLYN NO. 500-12 OR EQUIVALENT) IN THE
BACK SPAN IN LIEU OF THE NO. 10 SOLID COPPER
GROUNDING JUMPER AT THE TOP OF THE POLE.

STEEL POLE
DRILL HOLE FOR
EYEBOLT GUY WIRE
ATTACHMENT

3/8" GALV. UTILITY
GRADE GUY SPAN

W O O D P O L E

MIN. 18" HOLE
FOR WOOD POLE

S I D E W A L K

MIN. 6' DEPTH
FOR WOOD POLE

S E A N C H

ALTERNATE LOCATION APPLICATION

WOOD POLE

MIN. 18" HOLE
FOR WOOD POLE

SIDWALK

MIN. 6' DEPTH
FOR WOOD POLE

EXPANDING OR
SCREW TYPE
ANCHOR AS
REQUIRED

DEADMAN ASSEMBLY
EYE BOLT, TURN BUCKLE,
STEEL ROD, EXPANDING
BOTTOM PLATE OR
EQUIVALENT AND CONCRETE.

CITY OF AURORA, COLORADO

STRAIN POLE WITH
DOWN GUYS

TE-8

N:\PWD\DRAFT\STANDARD\TRAFF-STD\TE-8
rev 10/30/2008
POLE MOUNTED
VEHICULAR & PEDESTRIAN
SIGNAL HEADS

CITY OF AURORA, COLORADO

POLE CAP

USE 13' POLE IF LOCATION IS UNLIKELY TO EVER WARRANT A LEFT HAND TURN ARROW

STANDARD

CORNER
5 SEC 12

15' POLE
R10-3BL

PUSH BUTTON

16'' ± (TYP)

3'-6"

13' POLE

8' MIN.

CORNER
3 SEC 12

MEDIAN

N:\PKD\DRAFT\STANDARD\TRAF-STD\TE-9-4
rev 10/30/2008

TE-9
4 OF 4

DIRECTOR OF PUBLIC WORKS
DATE

TRAFFIC ENGINEER
DATE

10/30/08

10/30/08
NOTE: 1. MAINTAIN MINIMUM TRENCH WIDTH REQUIRED TO INSTALL CONDUIT.
2. PULL BOXES SHALL BE INSTALLED EVERY 100' OR AT CONDUIT TURNING JUNCTIONS.
3. PULL BOXES SHALL BE INSTALLED ON COURSE GRAVEL BACKFILL FOR DRAINAGE (6'' MIN.)
4. "FLOW FILL" SHALL CONFORM TO THE CITY OF AURORA ROADWAY DESIGN & CONSTRUCTION SPECIFICATIONS.
5. CONDUITS TERMINATED IN PULL BOXES SHALL BE SWEEP UP AND END 6' 4" BELOW PULL BOX LID.

CITY OF AURORA, COLORADO
Dick Havercamp 11/7/2000
TRAFFIC ENGINEER

OR Foza 11/7/2000
DIRECTOR OF PUBLIC WORKS
STANDARD TRAFFIC

SPECIFICATIONS/DATA
PC AND PG STYLE ASSEMBLIES

COVER (TRAFFIC SIGNAL LOGO–CODE 46)

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>SIZE</th>
<th>DIMENSIONS (IN.)</th>
<th>WT. LBS</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEAVY DUTY (HA) LOCKING COVER</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMALL (PC)</td>
<td>12 7/8</td>
<td>12 7/8</td>
<td>3/4</td>
</tr>
<tr>
<td>MEDIUM (PG)</td>
<td>23 1/4</td>
<td>13 3/4</td>
<td>2</td>
</tr>
<tr>
<td>LARGE (PG)</td>
<td>30 1/2</td>
<td>17 1/2</td>
<td>2</td>
</tr>
</tbody>
</table>

BOXES (STACKABLE)

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>SIZE</th>
<th>DIMENSIONS (IN.)</th>
<th>WT. LBS</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPEN BOTTOM (BA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMALL (PC)</td>
<td>14 3/4</td>
<td>14 3/4</td>
<td>12</td>
</tr>
<tr>
<td>MEDIUM (PG)</td>
<td>25 1/2</td>
<td>12</td>
<td>11 3/4</td>
</tr>
<tr>
<td>LARGE (PG)</td>
<td>32 1/4</td>
<td>19 1/4</td>
<td>12</td>
</tr>
</tbody>
</table>

SPECIFICATIONS

UNDERGROUND ENCLOSURES SHALL BE QUAZITE AS MANUFACTURED BY HUBBELL OR APPROVED EQUAL. COVERS SHALL BE CONCRETE GRAY COLOR AND RATED FOR NO LESS THAN 15,000 LBS OVER A 10"X10" AREA. ENCLOSURES SHALL BE CONCRETE GRAY IN COLOR AND RATED FOR 15,000 LBS (SM) OR 22,500 LBS (MED/LG). BOTH COVERS AND ENCLOSURES SHALL BE DESIGNED AND TESTED TO TEMPERATURES OF –50°F. COVERS SHALL HAVE A MINIMUM COEFFICIENT OF FRICTION OF 0.5. BOXES SHALL BE STACKABLE FOR EXTRA DEPTH.
GENERAL NOTES:

1. Pull Box—Special shall be a Water Valve Stem Type pull box made of aluminum or steel. The pull box shall have the capability of accepting riser rings for the future overlays. The lid shall have the word "TRAFFIC" printed on it and shall be of the same material as the box.

2. Pull boxes shall have 3/4" to 1" diameter holes drilled or torched 3" from the top to accept a rubber tube. The number of tubes shall be as shown on the plans or as directed by the engineer.

3. Care shall be taken during backfill compaction to prevent collapse of the tubes.

4. Connect loop lead-ins to home run cable in nearest pull box. (DO NOT splice in water valve box.)

5. Pull box lid is to be sealed water tight by calking.

6. Pull box is to be located in an area of the street not heavily traveled if possible as centered a minimum of 12" from the gutter pan.

7. A concrete ring (12" minimum radius and 10" minimum depth) shall be installed around the pull box. The rubber tube must extend beyond the concrete to the asphalt joint.

8. Final grade of lid to be 1/4" below asphalt.

9. Wire mesh to stop 3" inside concrete

PULL BOX—SPECIAL
WATER VALVE STEM TYPE

TE-10
NOTES:

1. CALL COA TRAFFIC SERVICES AT (303) 739-7300 FOR EXACT FIELD LOCATIONS.

2. ALL PAVEMENT SHALL BE REPAIRED ACCORDING TO SPECIFICATIONS CONTAINED IN THE CITY OF AURORA ROADWAY DESIGN AND CONSTRUCTION SPECIFICATIONS.

3. ALL LANDSCAPING SHALL BE RETURNED TO THE CONDITIONS EXISTING PRIOR TO CONSTRUCTION.

4. ALL CONDUITS SHALL CONTAIN PULL STRINGS AND BE CAPPED TO PREVENT FOREIGN MATERIAL FROM ENTERING.

5. CONTACT ALL UTILITY OWNERS FOR LOCATION OF THEIR FACILITIES BEFORE EXCAVATING.

6. ALL CONDUIT SHALL BE SCHEDULE 80.
NOTES:

1. DASHED LINES INDICATE LOCATION OF LOOP DETECTORS.

2. LEAD IN CONNECTORS SHALL BE DETERMINED IN THE FIELD BY THE TRAFFIC ENGINEER.

3. APPROXIMATE LOCATIONS OF LEAD CONNECTORS SHALL BE RECORDED BY TRAFFIC SUPER.

FACE OF MEDIAN CURB

LOOP DETECTORS

SEE 3 OF 5 FOR LATERAL POSITIONING

STANDARD APPROACH

CITY OF AURORA, COLORADO

Dick Henshaw 1/7/2000
TRAFFIC ENGINEER DATE

DR Hogan 1/7/2000
DIRECTOR OF PUBLIC WORKS DATE

LOOP DETECTORS
STOP LINE & LEFT TURN

TE-11

1 OF 5
1. Dashed lines indicate location of loop detectors.

2. Lead in connectors shall be determined in the field by the traffic engineer.

3. Approximate locations of lead connectors shall be recorded by traffic super.

---

**NOTES:**

**DUAL LEFT TURN LANES**

**AUXILIARY RIGHT TURN LANE**

---

**LOOP DETECTORS**

**DOUBLE LEFT TURN LANES**

**AUXILIARY RIGHT TURN LANE**

---

CITY OF AURORA, COLORADO

Dick Havenenga 1/7/2000

Traffic Engineer

Dir. of Public Works 1/7/2000

Date

TE-11

2 of 5
LATERAL POSITIONING OF STOP LINE DETECTORS

TYPICAL RUNNING SPEED DETECTOR

LOOP DETECTORS
DOUBLE LEFT TURN LANES
AUXILIARY RIGHT TURN LANE
LOOP DETECTOR LEAD-IN INSTALLATION

NOTES:
1. PNEUMATICALLY REMOVE DIRT, DEBRIS AND WATER FROM SAW CUT.
2. WIRE TO BE 14-AWG STRANDED PVC INSULATED IN .030" POLYETHYLENE TUBING. (REF. IMSA 51-5)
3. SEALANT TO BE PRECO/GOLD LABEL FLEX.
4. "HOMERUN" WIRE SHALL BE BELDEN TYPE 8720 OR AN APPROVED SUBSTITUTE.
5. GENTLY TAMPER WIRE WITH BLUNT WOOD TOOL TO AVOID DAMAGE TO INSULATION. DO NOT USE SHARP OBJECT.
6. LOOP DETECTOR WIRE LEAD-IN SHALL BE TWISTED (ONE TWIST PER FOOT MIN.) FROM PULL BOX (WHERE SPliced) TO CABINET.
7. ALL VEHICLE DETECTORS INSTALLED IN CONJUNCTION WITH ROADWAY IMPROVEMENT PROJECTS SHALL BE INSTALLED BEFORE THE FINAL LIFT OF ASPHALT.

CITY OF AURORA, COLORADO

Traffic Engineer: [Signature] 3/16/07
Director of Public Works: [Signature] 3/16/07

SAW-CUT AND LOOP DETECTOR INSTALLATION DETAILS

TE-11
5 OF 5
NOTE:
1. PLACEMENT OF SIGNS & ACTUAL SPEED LIMITS VARY.
2. SHADED SIGN □ INDICATES FLUORESCENT YELLOW-GREEN BACKGROUND.
SIGN POST INSTALLATION SHALL FOLLOW THE MANUFACTURER'S INSTRUCTIONS AND THESE SPECIFICATIONS:

NOTE: ALL TUBINGS ARE #12 U.S. GAGE WALL THICKNESS.

1. DRIVE ANCHOR POST AND ANCHOR SLEEVE INTO THE GROUND TOGETHER, LEAVING ONE HOLE EXPOSED FOR BOLT CONNECTION. FOR HAND INSTALLATION, DRIVE CAP OF PROPER SIZE SHALL BE USED TO PREVENT DAMAGE TO TUBING. SIDEWALK SHALL BE Poured AROUND ANCHOR SLEEVE OR EXISTING SIDEWALK SHALL BE CORE DRILLED AND SEALED AROUND THE SLEEVE.

2. INSERT SIGN POST INTO ANCHOR ASSEMBLY APPROXIMATELY 6" TO 8" AND BOLT IN PLACE.

3. INSTALLED SIGN AND POST SHALL BE PLUMB AND FREE OF VERTICAL AND LATERAL MOVEMENT.
NOTES:
1) "ZEBRA" STRIPES REPLACE PARALLEL WALK LINE IN SAME DIMENSION; i.e., 10'-0" OUT TO OUT.

2) "ZEBRA" STRIPES ARE 10'-0"x2'-0"

3) CONTACT TRAFFIC OPERATIONS PHONE NUMBER 303-326-8200 FOR CURRENT APPROVED PAVEMENT MARKING MATERIAL AND METHODOLOGY.

4) "ZEBRA" STRIPES SHALL BE CENTERED ON THE CURB RAMP(S)

EMPHASIZE:
ONE "ZEBRA" STRIPE IS CENTERED IN EACH TRAVEL LANE WITH ADDITIONAL "ZEBRA" STRIPE STRADDLING EACH PROJECTED LANE LINE TO LEAVE WHEEL PATHS BETWEEN STRIPES.

CITY OF AURORA, COLORADO

TRAFFIC ENGINEER  3/10/10

DIRECTOR OF PUBLIC WORKS  3/11/2010

"ZEBRA" CROSSWALK STRIPING

TE-14  1 of 3
STANDARD

BOULEVARD LANES

MAIN STREET
(4 LANES)

MAIN STREET
(2 LANES)

12’ TRAVEL LANES

11’ TRAVEL LANES

10’ TRAVEL LANES

ASPHALT

LANE LINES
SYMBOLS AND LEGENDS
CROSSWALKS

TEMPORARY = LESS THAN ONE YEAR = PAINT
TEMPORARY = ONE YEAR OR MORE = THERMOPLASTIC
PERMANENT = THERMOPLASTIC

CONCRETE

LANE LINES SOLID = EPOXY
SKIP DASH = TAPE 380I-5
SYMBOLS, LEGENDS, AND CROSSWALKS = PREFORMED COLD PLASTIC L380IES

CITY OF AURORA, COLORADO

TRAFFIC ENGINEER

DATE

DIRECTOR OF PUBLIC WORKS

DATE

CROSSWALK DETAILS

STRIPING SPACING

TE-14

2 OF 3
CONTINENTAL MARKINGS (EDGE AND TRANSITION ZONES)
SPACING OF LINES DETERMINED BY TRAVEL LANE WIDTH (SEE TE-14 SHEET 2 OF 3)

10.0' (TYP)

STANDARD MARKINGS (MIN. REQUIREMENTS FOR ALL CROSSWALKS)

8.0' MIN

2.0' (TYP)

STRIPIING MUST MEET LATEST MUTCD STANDARDS. COLORED AND/OR PATTERED CONCRETE (INCLUDING PAVERS) MAY BE USED FOR CROSSWALKS IF APPROVED BY THE CITY. A LICENSE AGREEMENT WILL BE REQUIRED FOR MAINTENANCE OF THESE COLORED/PATTERNED CROSSWALKS. COLORS SHALL NOT BE THE SAME AS TRUNCATED DOMES WITHIN THE HANDICAP RAMPS.

THIS TYPE OF STRIPIING FOR CROSSWALK SHALL ONLY BE USED WHEN SPECIAL CROSSWALK PAVEMENTS ARE USED.
**STANDARD**

**CASE 1-2** lane undivided local/collector
Stop controlled minor street

![Diagram](image)

**CASE 2-4** lane undivided collector
Stop controlled minor street

<table>
<thead>
<tr>
<th>DESIGN SPEED</th>
<th>25 mph</th>
<th>30 mph</th>
<th>35 mph</th>
<th>40 mph</th>
<th>45 mph</th>
<th>50 mph</th>
</tr>
</thead>
<tbody>
<tr>
<td>a (ft)</td>
<td>240</td>
<td>290</td>
<td>335</td>
<td>385</td>
<td>430</td>
<td>480</td>
</tr>
<tr>
<td>b (ft)</td>
<td>280</td>
<td>335</td>
<td>390</td>
<td>445</td>
<td>500</td>
<td>555</td>
</tr>
<tr>
<td>c (ft)</td>
<td>360</td>
<td>415</td>
<td>475</td>
<td>530</td>
<td>590</td>
<td></td>
</tr>
</tbody>
</table>

**CORNER SIGHT DISTANCE** measured from a point on the centerline of the approach lane of the minor road at least 14.5 feet back from the edge of the major road pavement or flowline and measured from a height of eye of 3.5 feet on the minor road to a height of object of 3.5 feet on the major road. Method of calculation for distance figures based on 2004 AASHTO guidelines.

**INTERSECTION SIGHT DISTANCE**. Intersections should be planned and located to provide as much sight distance as possible. In achieving a safe roadway design there should be sufficient sight distance for the driver on the minor roadway to cross or turn onto the major roadway without requiring approaching traffic to reduce speed by more than 30% of its initial speed. Minimums for different speeds are shown for passenger type vehicles at intersections with stop controls. Other types of vehicles, other lane configurations, and other forms of traffic control have different intersection sight distance requirements.

**CONSIDERATION SHOULD ALSO BE GIVEN TO MAINTAINING ADEQUATE SIGHT DISTANCE FOR VEHICLES TURNING LEFT FROM THE MAJOR ROADWAY ONTO THE MINOR ROADWAY. PLANTINGS IN THE MEDIAN SHOULD BE ARRANGED SUCH THAT THEY DO NOT RESTRICT VISIBILITY.**

---

**CITY OF AURORA, COLORADO**

**TRAFFIC ENGINEER**

**DATE**

**DIRECTOR OF PUBLIC WORKS**

**DATE**

**SIGHT DISTANCE REQUIREMENTS**

**TE-15**

Sheet 1 of 3
### DESIGN SPEED

<table>
<thead>
<tr>
<th></th>
<th>25 mph</th>
<th>30 mph</th>
<th>35 mph</th>
<th>40 mph</th>
<th>45 mph</th>
<th>50 mph</th>
</tr>
</thead>
<tbody>
<tr>
<td>e (ft)</td>
<td>360</td>
<td>375</td>
<td>400</td>
<td>435</td>
<td>465</td>
<td>500</td>
</tr>
<tr>
<td>f (ft)</td>
<td>375</td>
<td>400</td>
<td>440</td>
<td>485</td>
<td>535</td>
<td>585</td>
</tr>
<tr>
<td>g (ft)</td>
<td>315</td>
<td>375</td>
<td>440</td>
<td>500</td>
<td>565</td>
<td>625</td>
</tr>
<tr>
<td>h (ft)</td>
<td>350</td>
<td>420</td>
<td>490</td>
<td>560</td>
<td>630</td>
<td>700</td>
</tr>
</tbody>
</table>

**Corner Sight Distance**

Corner sight distance measured from a point on the centerline of the approach lane of the minor road at least 14.5 feet back from the edge of the major road pavement or flowline and measured from a height of eye of 3.5 feet on the minor road to a height of object of 3.5 feet on the major road. Method of calculation for distance figures based on 2004 AASHTO Guidelines.

**Intersection Sight Distance**

Intersections should be planned and located to provide as much sight distance as possible. In achieving a safe roadway design, there should be sufficient sight distance for the driver on the minor roadway to cross or turn onto the major roadway without requiring approaching traffic to reduce speed by more than 30% of its initial speed. Minimums for different speeds are shown for passenger type vehicles at intersections with stop controls. Other types of vehicles, other lane configurations, and other forms of traffic control have different intersection sight distance requirements.

**Consideration**

Consideration should also be given to maintaining adequate sight distance for vehicles turning left from the major roadway onto the minor roadway. Plantings in the median should be arranged such that they do not restrict visibility.

---

**City of Aurora, Colorado**

Traffic Engineer: [Signature] [Date: 4/20/2010]

Director of Public Works: [Signature] [Date]
REGULATORY SIGN VISIBILITY ZONE – SEE TABLE FOR REQUIRED DISTANCE MEASURED FROM DRIVER’S EYE POSITION IN CURB LANE TO FACE OF SIGN

LOCATION OF FIRST TREE OR OTHER OBJECT APPROACHING REGULATORY SIGN

STOP OR YIELD SIGN

CLEAR ZONE – MINIMUM 50’

R.O.W.

<table>
<thead>
<tr>
<th>DESIGN SPEED</th>
<th>20 mph</th>
<th>25 mph</th>
<th>30 mph</th>
<th>35 mph</th>
<th>40 mph</th>
<th>45 mph</th>
<th>50 mph</th>
</tr>
</thead>
<tbody>
<tr>
<td>REQUIRED DISTANCE</td>
<td>115 ft</td>
<td>155 ft</td>
<td>200 ft</td>
<td>250 ft</td>
<td>305 ft</td>
<td>360 ft</td>
<td>425 ft</td>
</tr>
</tbody>
</table>

NOTES

1. A REGULATORY SIGN VISIBILITY ZONE IS REQUIRED ON ALL LOCAL, COLLECTOR, AND/OR ARTERIAL STREETS APPROACHING A STOP OR YIELD REGULATORY SIGN.

2. IN ADDITION TO THE REQUIREMENTS OF TE-15 SHEETS 1 AND 2, AND THE REQUIREMENTS OF THE REGULATORY SIGN VISIBILITY ZONE AS SHOWN ABOVE, A CLEAR ZONE OF A MINIMUM OF 50’ IS REQUIRED AS SHOWN ABOVE.

3. TREES OR OTHER OBJECTS NORMALLY PLACED IN THE REGULATORY SIGN VISIBILITY ZONE OR CLEAR ZONE SHALL BE INSTALLED AT A NEW LOCATION TO BE DETERMINED BY THE PLANNING DEPARTMENT, LANDSCAPE ARCHITECT, 303-739-7250.
STANDARD

STREET LIGHT POLE LOCATIONS
MAJOR ARTERIAL — MEDIAN LIGHTING
(NOTE: WHEN MEDIAN WIDTH IS LESS THAN 10 FEET, MOVE TO OUTSIDE.)

STREET LIGHT POLE LOCATIONS
MAJOR ARTERIAL — OUTSIDE LIGHTING
(NOTE: ARTERIAL STREET WITH HIGH LEVELS OF NIGHT TIME
PEDESTRIAN ACTIVITY SHOULD CONFORM TO 160' OR LESS SPACING.)

STREET LIGHT POLE LOCATIONS
COLLECTOR ROADWAY

CITY OF AURORA, COLORADO

TRAFFIC ENGINEER

DIRECTOR OF PUBLIC WORKS

TYPICAL STREET LIGHT POLE LOCATIONS

TE-18.2
STANDARD PEDESTRIAN LIGHTING PLAN

DETAIL PLAN

* SPACING INTERVAL BASED ON MOUNTING LUMINAIRE HEIGHT AND LUMEN OUTPUT.

** SEE TE-18.2
STANDARD.

HEMISPHERICAL STYLE CUTOFF
70 WATT
HIGH PRESSURE SODIUM
10'-15' HEIGHT

SPHERE VICTORIAN
50, 70 WATT
HIGH PRESSURE SODIUM
10'-15' HEIGHT

ACORN VICTORIAN
50, 70 WATT
HIGH PRESSURE SODIUM
10'-15' HEIGHT

NOTE: ACTUAL POLE AND BASE STYLE WILL BE DETERMINED BY XCEL.
PRE-1999 STANDARD DETAILS

The attached Pre-1999 Standard Details may be applied only to locations, as approved by the Director of Public Works, where deviation from the current standards is necessary to match existing improvements or other similar justification. When approved, the Pre-1999 Standard Details shall be included in the plan details for the project. Proposed utilization of the Pre-1999 Standard Details shall be indicated on the initial submittal of engineering drawings or before in order to allow time for consideration of the issue. Any modification to Pre-1999 Standard Details shall be clearly indicated at the time of initial submittal.

LIST OF PRE-1999 STANDARD DETAILS

<table>
<thead>
<tr>
<th>Description</th>
<th>No. of Sheets</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROADWAY CLASSIFICATIONS AND TYPICAL CROSS SECTIONS</td>
<td>3</td>
<td>OS1</td>
</tr>
<tr>
<td>CURB &amp; GUTTER, COMBINATION CURB, GUTTER &amp; WALK</td>
<td>2</td>
<td>OS7</td>
</tr>
<tr>
<td>CURB RAMPS</td>
<td>7</td>
<td>OS9</td>
</tr>
<tr>
<td>CURB OPENING INLET WITH COMB. CURB, GUTTER &amp; WALK</td>
<td>1</td>
<td>OS12</td>
</tr>
</tbody>
</table>
STANDARD

EXPRESSWAY

PRINCIPAL ARTERIAL CLASS I

PRINCIPAL ARTERIAL CLASS II

CITY OF AURORA, COLORADO

USE OF THIS STANDARD DETAIL REQUIRES APPROVAL FROM THE DIRECTOR OF PUBLIC WORKS

ROADWAY CLASSIFICATIONS AND TYPICAL CROSS Sections OS1.1
NOTE:
VERTICAL CURB AND GUTTER MAY BE USED ON LOCAL - TYPE I & II ROADWAYS.

LOCAL - TYPE II

NOTE:
AT CUL-DE-SACS WITH 5 LOTS OR LESS, DRAINAGE DITCHES MAY BE REDUCED TO FIT TYPICAL SECTION INTO A 50' R.O.W.

LOW DENSITY RURAL
VERTICAL CURB & GUTTER

STREETS

2'-0"  1 1/2"

3/4"

1 1/2" R

SEE NOTES 1 & 3

1/2"

MEDIAN CURB & GUTTER TYPE I

1 1/2" R

1 1/2" R

STANDARD

4 1/2"

4 1/2"

MEDIAN CATCH CURB & GUTTER

2'-0"

1/2"

1 1/2" R

1 1/2" R

MESH—SEE S7.4

CURB & GUTTER AT DRIVEWAY

NOTES

1. THREE NO. 4 REBARS SHALL BE USED IN ALL CURB RETURNS WITH 25' OR LARGER RADIUS. THE REBAR SHALL BE USED FROM BEGINNING TO END OF THE CURB RETURN.

2. AT EACH LOW POINT OF EACH MEDIAN CURB, A DRAINAGE SLOT SHALL BE INSTALLED—SEE DRAINAGE SLOT DETAIL ON S2.4.

3. SLIP FORM TEMPLATE FOR VERTICAL CURB AND GUTTER SHALL NOT BE ALLOWED FOR POURING STANDARD MEDIAN CURB.

4. TYPE I MEDIAN CURB AND GUTTER WILL ONLY BE ALLOWED TO MATCH EXISTING CURB.

*May be used only where no sidewalk is planned and by approval of director of public works.

CITY OF AURORA, COLORADO

USE OF THIS STANDARD DETAIL REQUIRES APPROVAL FROM THE DIRECTOR OF PUBLIC WORKS

OS7.1
STANDARD STREETS

4'-6" TO 8'-0" SIDEWALK

2% SLOPE TO BACK OF CURB

ATTACHED OR DETACHED WALK

CONTRACTION OR
WEAKENED PLANE
JOINT

1/8" MIN

1/8" R
(TYP.)

1/2"

1/2"

1/2"

1/2"

1/2"

EXPANSION JOINT

1/2" PREFORMED
JOINT MATERIAL.
(SEENOTE)

NOTE: IN GUTTER FLOWLINES Recess EXPANSION
JOINT 1/2" AND SEAL WITH FLEXIBLE
SEALANT

COMBINATION CURB, GUTTER, & WALK

CITY OF AURORA, COLORADO

USE OF THIS STANDARD DETAIL
REQUIRES APPROVAL FROM THE DIRECTOR
OF PUBLIC WORKS

CURB, GUTTER AND WALK
SIDEWALK AND CONSTRUCTION
JOINTS
1. IN ACCORDANCE WITH CRS 43-2-107(2) AND THE UNIFORM FEDERAL ACCESSIBILITY STANDARDS, RAMPS SHALL BE PROVIDED AT ALL CORNERS OF STREET INTERSECTIONS WHERE THERE IS EXISTING OR PROPOSED SIDEWALK & CURB. RAMPS SHALL ALSO BE PROVIDED AT WALK LOCATIONS IN MID-BLOCK IN THE VICINITIES OF HOSPITALS, MEDICAL CENTERS, ATHLETIC STADIUMS, AND AT "I" INTERSECTIONS.

2. ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS OF THE CITY OF AURORA.

3. SIDEWALKS SHALL BE RAMPS WHERE A DRIVEWAY CURB IS EXTENDED ACROSS THE WALK.

4. DETAILS SHOWN IN THIS PLAN SHALL APPLY TO ALL CONSTRUCTION OR RECONSTRUCTION OF STREETS, CURBS OR SIDEWALKS IN THE CITY OF AURORA.

5. SPECIAL DESIGNS ARE REQUIRED WHEN GRADES ARE OVER 4% OR WHERE THE ANGLE OF THE INTERSECTION IS LESS THAN 75° OR MORE THAN 105°.

6. CURB, GUTTER, RAMPS, AND WINGS SHALL BE POURED MONOLITHICALLY, 6" THICK.

7. MINIMUM WIDTH OF RAMPS SHALL BE 4' AND MAX. SLOPE ON SURFACE SHALL NOT EXCEED 1" PER FOOT.

8. MAINTAIN BACK OF WALK ELEVATION AT 2% ABOVE TOP OF CURB.

9. CONCRETE FOR SIDEWALK RAMPS SHALL BE CLASS "1".

10. NORMAL GUTTER FLOWLINE AND PROFILE SHALL BE MAINTAINED THROUGH THE RAMP AREA.

11. PARKING SHALL BE ELIMINATED A MINIMUM OF 20 FEET BACK OF PEDESTRIAN CROSSWALK. SECTION 37-2(2)b3 OF THE AURORA CITY CODE.

12. A 1/2" EXPANSION JOINT SHALL BE REQUIRED WHERE THE CONCRETE RAMP JOINS ANY RIGID PAVEMENT OR STRUCTURE.

13. DRAINAGE STRUCTURES SHALL NOT BE PLACED IN LINE WITH RAMPS. LOCATION OF THE RAMP SHALL TAKE PRECEDENCE OVER LOCATION OF THE DRAINAGE STRUCTURE, EXCEPT WHERE EXISTING DRAINAGE STRUCTURE ARE BEING UTILIZED IN THE NEW CONSTRUCTION.

14. ALL PAVEMENT MARKING SHALL BE IN ACCORDANCE WITH THE LATEST EDITION OF THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES FOR STREETS AND HIGHWAYS.

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**ISOMETRIC VIEW**

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CITY OF AURORA, COLORADO

USE OF THIS STANDARD DETAIL REQUIRES APPROVAL FROM THE DIRECTOR OF PUBLIC WORKS

CURB RAMPS FOR PHYSICALLY HANDICAPPED

REV. 8-94

OS9.1

1 OF 7
CITY OF AURORA, COLORADO

USE OF THIS STANDARD DETAIL REQUIRES APPROVAL FROM THE DIRECTOR OF PUBLIC WORKS

CURB RAMPS FOR PHYSICALLY HANDICAPPED OS9.3

DETACHED WALK TO ATTACHED WALK
20' & 25' RADIUS

SCALE: 1" = 5'

REV. 8-94
STANDARD

CROSSWALK

1/2" UP
SEE S9.2

CROSSWALK

STOP BAR

GRADE BREAK
DO NOT TOOL

12:1 MAX.

10' STRAIGHT FORM TO ATTACHED WALK ONLY

RADIUS

8 1/2

8

2

2

OPTIONAL 10' STRAIGHT FORM TO 8' BIKE PATH ONLY

1/2" EXPANSION

JSTO @ P.C.R.

(TYP.)

2

BICYCLE PATH TO ATTACHED WALK

25' RADIUS

SCALE: 1"=5'

CITY OF AURORA, COLORADO

USE OF THIS STANDARD DETAIL REQUIRES APPROVAL FROM THE DIRECTOR OF PUBLIC WORKS

CURB RAMPS FOR PHYSICALLY HANDICAPPED

OS9.4

REV. 8-94

4 OF 7
COMBINATION CURB, GUTTER AND WALK

SCALE: 1" = 5'

CITY OF AURORA, COLORADO
USE OF THIS STANDARD DETAIL REQUIRES APPROVAL FROM THE DIRECTOR OF PUBLIC WORKS
EXPANSION JOINT AT P.C.R. (TYP.)

SLOPE T.C. ELEV. TO MATCH SLOPE OF WALK

1/2" LIP SEE DETAIL S9.2

TAPER TOP OF CURB TO FL. IN 1'

GRADE BREAK DO NOT TOOL

WARP WALK TO TOP OF CURB ELEVATION

APPLIES ONLY TO LOCATIONS WHERE WALK WILL NOT BE CONTINUED AROUND CURB RETURN IN THE FUTURE.

SECTION A-A

SEE DETAIL S9.2

SECTION B-B

NOTE: TO BE USED ONLY WHEN R.O.W. IS NOT ADEQUATE FOR A NORMAL HANDICAP RAMP AND NO PRIVATE SIDEWALKS CONNECT TO IT.

CITY OF AURORA, COLORADO

USE OF THIS STANDARD DETAIL REQUIRES APPROVAL FROM THE DIRECTOR OF PUBLIC WORKS

CURB RAMPS FOR PHYSICALLY HANDICAPPED

REV.8-94
PLAN
TRANSITION COMB. CURB, GUTTER & WALK TO CURB OPENING INLET

SEE NOTE

NOTE: ALL CONSTRUCTION THIS POINT BACK SHALL CONFORM TO S12.1 - S12.5.

THROAT CONFIGURATION DETAIL
CURB OPENING INLET WITH COMB. CURB, GUTTER & WALK

SEE NOTE

NOTE: REFER TO S12.2 FOR COMPLETE CONSTRUCTION DETAILS.

THROAT CONFIGURATION DETAIL
CURB OPENING INLET WITH VERTICAL CURB & GUTTER

SEE NOTE

CITY OF AURORA, COLORADO
USE OF THIS STANDARD DETAIL REQUIRES APPROVAL FROM THE DIRECTOR OF PUBLIC WORKS

CURB OPENING INLET
TYPE R MODIFIED
OS12.6

6 OF 7