



DESIGN & CONSTRUCTION MANUAL

PUBLIC WORKS DEPARTMENT

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DESIGN CRITERIA FOR PUBLIC IMPROVEMENT PROJECTS

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TABLE OF CONTENTS
DESIGN CRITERIA

Page

PROCEDURE FOR PUBLIC IMPROVEMENT PROJECT PLAN SUBMITTAL

A. GENERAL	DC/P-1
B. PUBLIC IMPROVEMENTS FUNDED BY PRIVATE DEVELOPERS.....	DC/P-1

GENERAL PLAN REQUIREMENTS FOR PUBLIC IMPROVEMENT PROJECTS

A. GENERAL	DC/1-1
B. REQUIRED NOTES	DC/1-1
C. APPROVAL BLOCK.....	DC/1-6
D. PRIVATE IMPROVEMENTS.....	DC/1-6

DESIGN CRITERIA FOR SANITARY SEWERS AND APPURTENANCES

A. DESIGN FACTORS.....	DC/2-1
B. SEWER DESIGN.....	DC/2-1
C. MAXIMUM SIZE	DC/2-1
D. MINIMUM SIZE.....	DC/2-1
E. MATERIALS OF CONSTRUCTION.....	DC/2-2
F. MINIMUM SLOPE	DC/2-2
G. INCREASING PIPE SIZE.....	DC/2-3
H. HIGH VELOCITY PROTECTION.....	DC/2-3
I. ALIGNMENT.....	DC/2-3
J. MANHOLE CONSTRUCTION.....	DC/2-3
K. MANHOLES	DC/2-3
L. SEWER LOCATIONS	DC/2-3
M. CLEANOUTS AND LAMPHOLES	DC/2-3
N. PROTECTION OF WATER SUPPLIES	DC/2-3
O. AERIAL CROSSINGS.....	DC/2-4
P. UNSEWERED DWELLINGS	DC/2-4
Q. MAXIMUM SCOPE	DC/2-4
R. STUB LINES.....	DC/2-4
S. LIFT STATIONS.....	DC/2-4
T. LOW PRESSURE FORCE MAIN.....	DC/2-4

DESIGN CRITERIA FOR STREET IMPROVEMENTS

A. GENERAL	DC/3-1
B. FUNCTIONAL CLASSIFICATION OF STREETS.....	DC/3-1
C. STREET DESIGN STANDARDS.....	DC/3-3
D. RIGHT-OF-WAY GRADING	DC/3-4
E. TANGENT LENGTH	DC/3-4
F. OFF-CENTER STREET LOCATIONS.....	DC/3-4
G. CONNECTIONS TO EXISTING PAVEMENTS.....	DC/3-4
H. MINIMUM ANGLE OF INTERSECTION	DC/3-4
I. SIDEWALKS	DC/3-4
J. STORM DRAINAGE.....	DC/3-4

DESIGN CRITERIA FOR STREET IMPROVEMENTS (Continued)

<u>K. CUL-DE-SACS</u>	DC/3-4
<u>L. TEMPORARY TURN-AROUNDS</u>	DC/3-4
<u>M. MONUMENT BOXES</u>	DC/3-4
<u>N. SIGHT DISTANCES</u>	DC/3-5
<u>O. UNDERDRAINS</u>	DC/3-6
<u>P. OTHER DESIGN CRITERIA</u>	DC/3-6
<u>Q. DRIVEWAY ELEVATIONS</u>	DC/3-6
<u>R. DRIVEWAY WIDTHS</u>	DC/3-6
<u>S. SIGNAGE</u>	DC/3-6
<u>T. PRIVATE STREETS</u>	DC/3-6
<u>DRIVEWAY DESIGN CRITERIA</u>	

DESIGN CRITERIA FOR STORM DRAINAGE FACILITIES

<u>A. GENERAL</u>	DC/4-1
<u>B. MINIMUM STANDARDS OF ANALYSIS</u>	DC/4-1
<u>C. MINIMUM STANDARDS OF DESIGN</u>	DC/4-2
<u>D. EASEMENTS</u>	DC/4-10
<u>E. STORMWATER DETENTION</u>	DC/4-10

REQUIREMENTS FOR PUBLIC IMPROVEMENT PROJECT PLAN PREPARATION

<u>A. INTRODUCTION</u>	DC/6-1
<u>B. GENERAL</u>	DC/6-1
<u>C. TITLE SHEET</u>	DC/6-2
<u>D. GENERAL LAYOUT SHEET</u>	DC/6-2
<u>E. PLAN AND PROFILE SHEETS</u>	DC/6-4
<u>F. STREETS</u>	DC/6-4
<u>G. STORM DRAINAGE</u>	DC/6-5
<u>H. SANITARY SEWER</u>	DC/6-6
<u>I. WATER LINE</u>	DC/6-6
<u>J. CROSS-SECTION SHEETS</u>	DC/6-6
<u>K. STANDARD AND SPECIAL DETAIL SHEETS</u>	DC/6-7
<u>L. CONSTRUCTION RECORD DRAWINGS</u>	DC/6-7

PRIVATE IMPROVEMENT DESIGN CRITERIA

<u>A. GENERAL</u>	DC/7-1
<u>B. PARKING LOT CONSTRUCTION</u>	DC/7-1
<u>REQUIREMENTS FOR PARKING LOT CONSTRUCTION PLANS</u>	DC/7-4

PRIVATE IMPROVEMENT PLAN PREPARATION

<u>A. INTRODUCTION</u>	DC/8-1
<u>B. GENERAL</u>	DC/8-1
<u>C. PARKING LOT PLANS</u>	DC/8-1

STREET LIGHTING CONSTRUCTION DESIGN CRITERIA

<u>A. GENERAL</u>	DC/9-1
<u>B. CATEGORIES OF STREETS & PROCEDURES</u>	DC/9/1
<u>C. DESIGN PROCESS</u>	DC/9-1

D. DESIGN CONDITIONS	DC/9-2
E. AREA CLASSIFICATION	DC/9-3
F. ROADWAY CLASSIFICATION	DC/9-3
G. RECOMMENDED AVERAGE MAINTAINED ILLUMINATION.....	DC/9-4
H. CALCULATIONS OF AVERAGE ILLUMINANCE, MINIMUM ILLUMINANCE, UNIFORMITY RATIO, & CUTOFF	DC/9-4

LIST OF DESIGN AIDS

DA 3-1.....	MINIMUM STOPPING SIGHT DISTANCE FOR CREST VERTICAL CURVE
DA 3-2.....	MINIMUM STOPPING SIGHT DISTANCE FOR SAG VERTICAL CURVE
DA 4-1.....	RAINFALL DURATION-INTENSITY CURVES
DA 4-2.....	NOMOGRAPH FOR FLOW IN ROUND PIPE-MANNING'S FORMULA
DA 4-3A.....	HEADWATER DEPTH FOR C.M. PIPE CULVERTS WITH INLET CONTROL
DA 4-3B.....	HEADWATER DEPTH FOR C.M. PIPE-ARCH CULVERT WITH INLET CONTROL
DA 4-4.....	HEADWATER DEPTH FOR BOX CULVERTS WITH INLET CONTROL
DA 4-5A.....	OVERLAND FLOW (INLET) TIME NOMOGRAPH
DA 4-5B.....	CHANNEL FLOW TIME NOMOGRAPH
DA 4-6.....	NOMOGRAPH FOR FLOW IN TRIANGULAR CHANNELS
DA 4-7A.....	VALUES OF ROUGHNESS COEFFICIENT "N" FOR USE IN MANNING FORMULA
DA 4-7B.....	ENERGY LOSSES
DA 4-8.....	RAINFALL TIME TO CONCENTRATION NOMOGRAPH
DA 4-9.....	MINIMUM GAGE REQUIREMENTS (CIRCULAR CMP CULVERT PIPE)
DA 4-10.....	MINIMUM GAGE REQUIREMENTS (ARCH CMP CULVERT PIPE)
DA 8-1.....	PARKING LOT DETAILS

PROCEDURE FOR PUBLIC IMPROVEMENT PROJECT PLAN SUBMITTAL

- A. General. All developers and engineering consultants submitting plans for public improvement projects to the City for review are required to follow the procedures outlined in this section. No public improvement projects may be constructed in the City of Raytown without prior approval of the Public Works Department Engineering Division.

The majority of all public improvement projects are funded by either private Developer, benefit district, or the City at large. The procedure to follow, and the amount of time involved, in approving plans is dependent on the source of funding for the project.

All submittals to the Public Works Department should be sent through the Community Development Department.

- B. Public Improvements. The plan review process is as follows:

1. The first submittal should contain four sets of plans, draft easements, and a preliminary plat showing all proposed easements being granted by the plat (the final plat should be submitted in lieu of the preliminary if it is available). This and all subsequent submittals are dated and recorded in a project status log.
2. The normal time for review of the first submittal is 10 working days. In the case of abnormally large sets of plans (greater than 20 sheets) or of extremely complicated drawings, a longer time may be required for review.
3. The plans will be routed by Community Development through the appropriate City departments and/or divisions to obtain a complete review of all facilities that may be affected by the construction. They will also be reviewed to confirm conformance with City standards and design criteria. In each review, comments and necessary revisions will be noted on the plans (first submittal check set). Subsequent to the review of the plans, the consulting engineer will be notified by telephone that the submittal is ready for return and may be picked up in the Community Development office.
4. The consultant will be required to make all necessary corrections and/or revisions as noted on the check set of plans. Upon completion of the corrections and/or revisions the consultant will submit a new set of plans (second submittal check set) to the Community Development Department. Review time is approximately 10 working days. Revised sheets shall contain a revision block with identifying notations and date of revisions. Accompanying the second submittal should be the first submittal check set, and any necessary application forms such as Missouri Department of Natural Resources sewer extension permit, Missouri Department of Transportation permits, City of Raytown Grading Permit, Right-Of-Way Permit, etc. All previous check sets must accompany each re-submittal. If the check sets are not submitted with the revised plans, they shall be returned to the consultant without action until such time as they are included with the submittal.

5. The third and any subsequent submittals shall contain all previous checksets and the mylar of the cover sheet for the City Engineer's signature. Four full sets of plans need to be submitted to the Community Development Department. Two additional General Layout sheets also need to be provided with the final submittal.
6. Once a submittal is approved, the City Engineer will verify that all necessary state permits are obtained and all plats and easements are filed and recorded before signing the mylar cover sheet for the plans. This mylar cover sheet with the City Engineer's signature and date shall be utilized for all further cover sheets in bid documents sent out for proposals.
7. Public improvement plans and engineering reports are approved initially for one year after the date signed on the mylar cover sheet next to the City Engineer's signature. After one year, the plans or report shall become null and void and must be re-submitted prior to approval of construction of that project. Such plans and/or reports shall be re-submitted to the Community Development office in accordance with the foregoing outlined procedure and requirements.
8. The design engineer shall send one set of plans to each of the private and public utilities companies having territorial jurisdiction in the area of the improvement upon notification that the plans have been approved.

GENERAL PLAN REQUIREMENTS FOR PUBLIC IMPROVEMENT PROJECTS

- A. GENERAL. All plans and reports submitted shall be prepared by, or under the direction of and sealed by a professional engineer, licensed in the state of Missouri, and shall be reviewed by the City for compliance with the minimum design requirements as established in the Design Criteria Manual for Public Improvement Projects as approved by Ordinance of the City of Raytown and with all other applicable City codes and standards.

Attention is directed to the design engineer that whenever extraordinary or unusual problems are encountered in conjunction with a proposed project, additional information and analysis beyond the minimum requirements of these standards and criteria will be required.

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

- B. REQUIRED NOTES. The following general notes will be required as a minimum on all plans submittals for public improvement projects. These notes are not meant to be all-inclusive, and in certain situations the City Engineer may require the use of additional notes.

Water Mains --- Direct to the appropriate Water Utility.

Sanitary Sewers

- A. Development plans are approved initially for one (1) year, after which they automatically become void and must be updated and re-approved by the City Engineer before any construction will be permitted.
- B. The City of Raytown plan review is only for general conformance with City of Raytown design criteria and the City code. The City is not responsible for the accuracy and adequacy of the design, or dimensions and elevations, which shall be confirmed and correlated at the job site. The City of Raytown through approval of this document assumes no responsibility other than as stated above for the completeness and/or accuracy of this document.
- C. The contractor shall have one (1) signed copy of the plans (approved by the City of Raytown) with a City approval stamp on the title sheet and one (1) copy of the appropriate Design and Construction Standards and Specifications at the job site at all times.
- D. Construction of the improvements shown or implied by this set of drawings shall not be initiated or any part thereof undertaken until the City Engineer is notified of such intent and all required and properly executed bonds and contract agreements are received and approved by the City Engineer.

- E. The City of Raytown technical specifications, latest edition, shall govern construction of this project.
- F. All existing utilities indicated on the drawings are according to the best information available to the engineer; however, all utilities actually existing may not be shown. Utilities damaged through the negligence of the contractor to obtain the location of it shall be repaired or replaced by the contractor at their expense.
- G. All backfill shall be mechanically tamped. Backfill within the right-of-way shall be to 95% compaction of optimum moisture.
- H. All excavation beneath existing and proposed streets shall be backfilled with half-inch clean rock or approved equal.
- I. All wye connections and stublines shall be laid on 1.00% grade unless approved otherwise.
- J. All water required for the construction of this project shall be purchased from the privately owned Raytown Water Company or the Jackson County Public Water District #2 through the use of a fire hydrant water meter. Meters can be obtained from the Raytown Water Company for a \$300 deposit and billed for the water usage or the Public Water District #2 for a \$300 deposit, \$25 non-refundable and billed for the water usage. Contact each water company for the updated fee amounts.
- K. Contractor shall not be allowed to work Sunday. Holiday or Saturday work shall be as approved by the City Engineer with a written request 48 hours in advance.
- L. Relocation of any water line, sewer line or service line thereof required for the construction of this project shall be the responsibility of the contractor and shall be at his/her expense.
- M. The contractor shall install and properly maintain a mechanical plug at all connection points with existing lines until such time that the new line is tested and approved.
- N. To prevent damage to main sewer line, all blasting (approved by blasting permit) required for laterals stub lines shall be performed during blasting for the main line.
- O. A pre-blast survey of all properties within 600 feet shall be approved by the Fire Department and the Public Works Department prior to the initiation of blasting operations.

Streets and Storm Drainage

- A. Development plans and drainage reports are approved initially for one (1) year, after which they automatically become void and must be updated and re-approved by the City Engineer before any construction will be permitted.

- B. The City of Raytown plan review is only for general conformance with Raytown design criteria and the City code. The City is not responsible for the accuracy and adequacy of the design, or dimensions and elevations, which shall be confirmed and correlated at the job site. The City of Raytown, through approval of this document, assumes no responsibility other than as stated above for the completeness and/or accuracy of this document.
- C. The contractor shall have one (1) signed copy of the plans (approved by the City of Raytown) with a City approval stamp on the title sheet and one (1) copy of the appropriate Design and Construction Standards and Specifications at the job site at all times.
- D. Construction of the improvements shown or implied by this set of drawings shall not be initiated or any part thereof undertaken until the City Engineer is notified of such intent, and all required and properly executed bonds and contract agreements are received and approved by the City Engineer
- E. The City of Raytown technical specifications, latest edition shall govern construction of this project.
- F. All existing utilities indicated on the drawings are according to the best information available to the engineer; however, all utilities actually existing may not be shown. Utilities damaged through the negligence of the contractor to obtain the location of it shall be repaired or replaced by the contractor at his expense.
- G. All backfill shall be mechanically tamped. Backfill within the right-of-way shall be to 95 percent (95%) compaction at optimum moisture.
- H. All excavation beneath streets for drainage pipe less than 4'-0" in diameter shall be backfilled with half-inch clean rock or approved equal.
- I. All sidewalks shown shall be built as a part of this project and contractor shall be responsible for sidewalk ramp construction to ADA requirements.
- J. A minimum of one (1) compaction test and a maximum of two (2) compaction tests shall be performed by a qualified testing laboratory for every 1000 feet of street construction. Soil samples for such tests shall be collected by laboratory technicians. The contractor shall pay for all testing laboratory expenses.
- K. All water required for the construction of this project shall be purchased from the privately owned Raytown Water Company or the County Public Water District #2 through the use of a fire hydrant water meter. Meters can be obtained from the Raytown Water Company for a \$300 deposit and billed for the water usage or the Public Water District #2 for a \$300 deposit, \$25 non-refundable and billed for the water usage. Contact each water company for the updated fee amounts.
- L. Contractor shall not be allowed to work Sundays. Holiday or Saturday work shall be as approved by the City Engineer with a written request 48 hours in advance.

- M. Relocation of any water line, sewer line or service line thereof required for the construction of this project shall be the responsibility of the contractor and shall be at their expense.
- N. If precast concrete storm sewer structures are to be used on this project, the contractor shall, subsequent to review by the design engineer, submit shop drawings and have them approved by the City Engineer prior to fabrication of the structures. Failure to do so shall be cause for rejection.
- O. A certification that all concrete to be used on the project will not contain fly ash or other pozzolans shall be submitted to the City Engineer prior to placing any concrete.
- P. Monument boxes conforming to Standard Detail 13-5 shall be installed at all quarter section corners as involved in the street construction.
- Q. Where a new street is to connect to an existing street, all deteriorated or cracked asphalt within five feet (5') of the connection point shall be removed to a depth where sound material is found. If full depth pavement removal is required, the subgrade shall be recompact to 95 percent (95%) of standard maximum density.
- R. **Erosion control measures will be required to be installed prior to any grading or construction activities.**
- S. **All projects, which disturb an accumulative area of more than one acre, will be temporarily seeded and mulched to the requirements of Section 7200 "*Seeding and Sodding*" immediately after street construction (paving) is complete.**

- C. APPROVAL BLOCK. A signature block shall be required on the cover sheet of all plans or reports submitted for review and approval. All plans require the signature of the City Engineer and the date of such signing for formal approval by the City.

The general form of the approval block shall be as follows:

APPROVED		
Public Works Director/City Engineer	Date	City Seal
APPROVED FOR ONE YEAR FROM THIS DATE		

- D. PRIVATE IMPROVEMENTS. Private improvements, if any, shown on public improvement plans, shall be clearly defined and marked as such. These improvements will not be maintained by the City of Raytown and, as such, an appropriate note shall be included on the drawings. These improvements nonetheless shall be designed and constructed to City standards.

DESIGN CRITERIA FOR

SANITARY SEWERS AND APPURTENANCES

- A. DESIGN FACTORS. Sanitary sewers shall be designed for the ultimate tributary population. Due consideration should be given to current zoning regulations and approved planning and zoning reports where applicable. Sewer capacities shall be adequate to handle the anticipated maximum hourly quantities of sewerage and industrial waste together with reasonable consideration given to infiltration/inflow.
- B. SEWER DESIGN. Sewers shall be designed for the total tributary area using the following minimum criteria:
Interceptors and Trunk Lines = 0.01 cfs/acre
Laterals and Sub-mains = 0.02 cfs/acre
- Using this criteria all pipes are to be sized flowing full.
- C. MAXIMUM SIZE. The diameter of sewers proposed shall not exceed the diameter of the existing or proposed outlet, whichever is applicable.
- D. MINIMUM SIZE. No public sewer shall be less than eight (8) inches in diameter. Stublines for service connections shall not be less than four (4) inches in diameter and shall be extended at a 45-degree angle to the main sewer line.
- E. MATERIALS OF CONSTRUCTION. Sanitary sewers shall be constructed of pipe material resistant to or protected from bacterial degradation, acid and alkaline solutions, normal sewer temperature variation, abrasion, and industrial wastes or other materials that may be transmitted by the collection system.

The following types of commercial pipe are approved for gravity sanitary sewer systems constructed in the City of Raytown:

*PVC Pipe ASTM D3034, Type PSM Polyvinyl (Chloride), SDR 35; PVC material shall conform to ASTM D1784 and shall have a cell classification of 12454-B, 12454-C, 12364-C, or 13364-B. The minimum pipe stiffness for pipe used for stublines shall be SDR 26.

For PVC Pipe the minimum stiffness allowed for depths of:

SDR 35, for less than 15 feet below finish grade.

SDR 26, for 15 feet to 20 feet below finish grade.

SDR 21, for 20 feet to 25 feet below finish grade.

DIP, for greater than 25 feet below finish grade.

*Reinforced Concrete Pipe ASTM C76, Class II (Wall B or C)

*Ductile Iron Pipe ANSI A21.51; ASTM A536, Grade 60-42-10; thickness Class 50, unless otherwise required by the City Engineer.

The use of thermoplastic pipe shall be limited to residential or commercial areas as approved by the City Engineer and shall not be used for pipelines exceeding 15 inches in diameter unless otherwise approved.

- F. MINIMUM SLOPE. All sewers shall be designed to give mean velocities when flowing full of not less than 2.0 feet per second.

All velocity and flow calculations shall be based on the Manning Formula using an N value of 0.013. The following slopes shall be minimum for the size indicated.

	MINIMUM SLOPE IN PERCENT
SEWER SIZE	FULL AND HALF FULL FLOW
8"	0.60
10"	0.28
12"	0.22
15"	0.15
18"	0.12
21"	0.10
24"	0.08
27"	0.065
30"	0.058

Exceptions to these minimum slopes shall be made at the upper end of the lateral sewers serving under 30 houses and more than 10 houses. Said sewers shall have a minimum slope of 0.76 percent. All sewers larger than 30 inches in diameter shall have the slope approved by the City Engineer.

Where lateral sewers serve less than 10 houses, the minimum slope shall not be less than 1 percent (1%) unless otherwise approved by the City Engineer.

Minimum basement floor (MBF) elevations shall be shown on the plans for each proposed lot, calculated as the flowline at the stub, plus the length of the stubline to the right-of-way line times 2%, plus 3.5 feet.

- G. INCREASING PIPE SIZE. When a sewer joins a larger one, the invert of the larger sewer should be lowered sufficiently to maintain a continuous energy gradient.
- H. HIGH VELOCITY PROTECTION. In situations where flow is continuous and grit is a problem, or where velocities greater than 15 feet per second are possible, special provisions shall be made to protect against abrasion damage to the pipe and manhole. Such protection may be attained utilizing ductile iron pipe.
- I. ALIGNMENT. All sewers shall be laid with straight alignment between manholes.
- J. MANHOLE CONSTRUCTION. Manholes shall be installed at the end of each line; at all changes in grade, size, or alignment; at all intersections; and at a distance not greater than four hundred feet (400') for sewers eighteen inches (18") or less in diameter and not greater than

five hundred feet (500') for larger sewers. Service lines shall connect 5' away from the manhole or more.

- K. MANHOLES. The construction of all manholes shall conform to the details shown on Standard Details 31-1, 31-2, 31-3 & 31-4. The maximum depth of any manhole shall not exceed 20 feet unless approved by the City Engineer.

The minimum horizontal clear distance within the barrel of standard manholes should not be less than four feet (4'). Manholes with connecting pipe diameters greater than 24 inches (24") shall have a minimum inside clear dimension of five feet (5'). Wall sections deeper than 16 feet shall be 5 inches minimum thickness.

Drop manholes should be avoided as much as possible. However, an outside drop pipe shall be provided for a sewer entering a manhole at an elevation of twenty-four (24) inches or more above the manhole invert. The outside drop pipe shall be protected against breaking or settling by the use of concrete encasement. When PVC pipe is used for the drop pipe, gravel may be substituted for the concrete encasement around the drop pipe and fittings. The drop pipe shall have the same nominal diameter as that of the incoming sewer.

Without utilizing drop manholes, the difference in elevation between the invert of any incoming sewer and the invert of the outgoing sewer should not exceed twenty-four (24) inches except where required to match crowns. When a sewer joins a larger one, the crown of the smaller sewer shall not be lower than the crown of the larger one. The minimum drop through manholes shall be 0.2 feet for manholes with greater than 45-degree turns and 0.1 feet for straight-through trough and up to 45-degree turns.

Where manholes are to be built in close proximity to streets, the top of manhole elevation shall be set within the following limits:

Minimum Elevation	1/4" per foot rise above top back of curb
Maximum Elevation	1/2" per foot rise above top back of curb

All other sanitary sewer lines (sewer lines across unplatted land, etc.) shall have the tops of manholes set flush with the existing ground elevation. The top of all manholes shall be located 1.0 foot above the 100-year flood plain.

Any variation from the above top of manhole criteria will require a letter of explanation to be submitted with the drawings and be subject to approval by the City Engineer.

- L. SEWER LOCATIONS. Sanitary sewers shall be located within street or alley rights-of-way (outside pavement limits) unless topography dictates otherwise. When located in easements on private property, access shall be provided to all manholes. A manhole shall be provided at each street or alley crossing. End lines shall be extended to provide access from street or alley rights-of-way where possible. Imposed loading shall be considered in all locations. Not less than eight feet (8') of cover shall be provided over top of pipe in street and alley rights-of-way and five feet (5') in all other areas unless otherwise approved by the City Engineer.

- M. CLEANOUTS AND LAMPHOLES. **Cleanouts and lampholes will not be permitted.**

N. PROTECTION OF WATER SUPPLIES. There shall be no physical connection between a public or private potable water supply system and a sewer, or appurtenance thereto, which would permit the passage of any wastewater or polluted water into the potable water supply.

1. Horizontal Separation: Sewer mains shall be laid at least 10 feet horizontally from any existing or proposed water main. The distances shall be measured edge to edge. In cases where it is not practical to maintain a 10-foot separation, the engineer may allow deviation on a case-by-case basis for a sewer closer to a water main, provided that the water main is in a separate trench or on an undisturbed earth shelf located on one side of the sewer at such an elevation that the bottom of the water main is at least 18 inches above the top of the sewer.
2. Crossings: Sewers crossing water mains shall be laid to provide a minimum vertical distance of 18 inches between the outside of the water main and the outside of the sewer. This shall be the case where the water main is either above or below the sewer. The crossing shall be arranged so that the sewer joints will be equidistant and as far as possible from the water main joints. Where a water main crosses under a sewer, adequate structural support shall be provided for the sewer to prevent damage to the water main.
3. Special Conditions: When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the sewer shall be designed and constructed equal to water pipe, and shall be pressure tested to assure water tightness prior to backfilling.

No water pipe shall pass through, or come in contact with, any part of a sewer or a sewer manhole.

- O. AERIAL CROSSINGS. Adequate support shall be provided at all joints in pipes utilized for aerial crossings. Only ductile-iron pipe with restrained joints shall be used unless otherwise approved by the City Engineer.
- P. UNSEWERED DWELLINGS. All existing addresses that will be provided access to the sewer that previously did not have sewer service available shall be identified. This identification shall include the approximate distance from the dwelling to the sewer.
- Q. MAXIMUM SLOPE. The City Engineer for approval or alternate design considerations shall review all sewers, which are designed to flow at 15 feet per second or greater.
- R. STUB LINES. Stub lines will not be permitted in manholes, and shall be a minimum 5' away from the manhole. Stub lines will be provided for all service lines requiring street crossings. Service lines for properties not requiring street crossings shall be laid to the right-of-way line.
- S. LIFT STATIONS. All lift stations shall be manufactured by Smith and Loveless, Inc., or approved equal, and shall be wetwell mounted. The lift station must meet firm pumping capacity and shall be designed in accordance with the design criteria as specified under Sewer Design. The City Engineer must approve any variation from the specified lift station or design.
- T. LOW PRESSURE FORCE MAIN. Low-pressure force mains are not recommended. If a low-pressure force main is necessary, the engineer must submit plans and specifications along with a cost/benefit analysis prior to approval. The City Engineer must approve all low-pressure force mains.

DESIGN CRITERIA FOR STREET IMPROVEMENTS

- A. GENERAL. Proposed street improvements within the City shall conform to the pattern as established in the Raytown Comprehensive Plan as adopted by the City of Raytown.

Street improvements within the City of Raytown shall be designed to conform with all applicable codes, regulations, and ordinances as established by the City of Raytown. Plans for said improvements shall be submitted to the City Engineer for approvals, and all plans shall include all information as may be required or described hereafter.

- B. FUNCTIONAL CLASSIFICATION OF STREETS. In fulfilling the goal of creating a "safe and efficient transportation system," the City must define geometric design standards for streets and highways which would afford both adequate traffic mobility and suitable access to abutting property.

The Raytown Comprehensive Plan states that "The framework for roadways in Raytown should support the proposed distribution of land uses. It is important that the proposed high intensity land uses have adequate access to major roadways in the City..." Therefore, design standards must be defined by functional classification; i.e., expressways, primary arterials, secondary arterials, primary collectors, secondary collectors, and residential streets:

The development of a street system based on functional classes has numerous benefits, including the following:

- The arterials can be designed to safely accommodate the high traffic volumes and high speeds.
- Traffic control is simplified.
- The pavement of designated streets can be designed to carry the high number of repetitions and heavy wheel loads. Other streets can be designed for a low number of repetitions and light wheel loads. Consequently, total maintenance costs are reduced.
- Residential areas are not subject to through traffic, which makes them more desirable and safer places to live. Commercial office and retail land uses are concentrated in fewer but larger and better-designed developments. Strip development is reduced.

Implementation of design criteria based on functional class will help ensure that the traffic capacity and level of service is maintained. This, in turn, will help preserve the regional accessibility (market area) of private development and help stabilize land use patterns and property values. Thus, preservation of the levels of service on all functional classes of the City's street system is mutually advantageous to the public and private sectors.

Typical cross sections of these classifications are shown on Standard Details 13-1, 13-2, 13-2a, and 13-4.

Expressway: Expressways in Raytown are highways with access control and at-grade signalized intersections. They are designed strictly for the safe and efficient movement of large volumes of traffic at relatively high speeds. Intersections are typically spaced at least one mile apart. M-350 highway is the only expressway within the municipal limits of Raytown. It was constructed and is maintained by the Missouri State Department of Transportation. It is proposed that to create unique subdistricts along M-350, a system of frontage roads be considered along the expressway.

Arterial: Arterials are intended for longer trips through or across communities. They are designed for operating speeds of thirty to forty miles per hour. Access management is important to control the number of driveways and streets, as each added street or driveway forms a point of friction to the traffic stream that reduces the effectiveness of the roadway. Parking should not be permitted on arterials during any time of the day. Arterials should be spaced one to two miles apart, though this is not consistently applied in the City. In Raytown, arterials are differentiated between primary and secondary arterials.

Primary Arterial: These are four lane undivided roadways.

Secondary Arterial: These are three lane roadways with a center turning lane.

Collector: Collectors provide direct property access and movement within residential, commercial, and industrial areas. These streets “collect” traffic from residential streets and move it to arterials and expressways. They should be located at a spacing of a half mile or less. Collectors are designed for minimum operating speeds of twenty-five to thirty miles per hour. Every major street, which is not an arterial or expressway, is designated a collector. Collectors are differentiated between primary and secondary collectors.

Primary Collector: These would be four lane roadways though the two extreme lanes could be committed to parking where required.

Secondary Collector: These would be two lane roadways with higher speed capacities than residential streets.

Residential: The major purpose of the residential street is to provide direct traffic access to abutting land. Residential streets can and do exist within residential, commercial, and industrial areas. Traffic movement on residential streets is incidental and involves traveling to or from a collector facility. Therefore, trip length on the local street is short, and as a result, both traffic volumes and operating speeds are usually low. Generally, through traffic is deliberately discouraged.

C. STREET DESIGN STANDARDS.

	PRIMARY ARTERIALS	SECONDARY ARTERIALS	COLLECTORS	LOCAL STREETS
NUMBER OF TRAFFIC LANES	4-6	2-5	2-5	2
WIDTH OF TRAFFIC LANES	12'	12'	12'	12'
LEFT TURN LANES	DOUBLE AT SIGNALS	SINGLE (OR CONTINUOUS)	N/A	N/A
MINIMUM R/W WIDTH (FT)	120 FT	100 FT	60 FT	50 FT
DESIGN VOLUME (VPD) RANGE	23,000-42,000	12,000-28,000	1,500-12,000	LESS THAN 1,500
MINIMUM DESIGN SPEED (MPH)	50 MPH	45 MPH	40 MPH	30 MPH
OPERATING SPEED MPH	45 MPH	40 MPH	35 MPH	25 MPH
STOPPING SIGHT DISTANCE (FT)	400-475 FT	325-400 FT	275-325 FT	200 FT
MINIMUM RADII HORIZONTAL CURVE	750 FT	500 FT	250 FT	200 FT
SIDEWALKS	5 FT BOTH SIDES	5 FT BOTH SIDES	5 FT BOTH SIDES	4 FT ONE SIDE
CURB & GUTTER	CG-1	CG-1	CG-1	CG-1 or CG-2
STREET THICKNESS (CONCRETE)	10 INCHES	10 INCHES	8 INCHES	6 INCHES
STREET THICKNESS (ASPHALT)	12 INCHES	12 INCHES	10 INCHES	8 INCHES
ON STREET PARKING	PROHIBITED	PROHIBITED	PERMITTED	PERMITTED
MAXIMUM GRADE (PERCENT) *	5%	6%	8%	10%
MINIMUM GRADE	.8%	.8%	.8%	.8%
CURB RADII (FT)	50 FT	50 FT	30 FT	25 FT
MINIMUM SPACING OF SIMILAR ROADWAYS	1 MILE	1/2 MILE	400 FT	300 FT
INTERSECTION ** ROW LINE TO NEAR EDGE OF CURB CUT	250 FT	200 FT	100 FT	50 FT MINIMUM 75 FT DESIRABLE

* The maximum grade may be exceeded only upon written approval of the City Engineer. Such approval will be granted only in unusual cases where the grades within the acceptable limits cannot be obtained.

** Curb cuts are not allowed on controlled access routes. For other major arterials, minimum distance to curb cuts shall be 200 feet.

- D. RIGHT-OF-WAY GRADING. Within the limits of the right-of-way, the finished grade shall slope from 1/4-inch vertical to 1 foot horizontal (1/4" vert.: 1' horiz.) minimum, to one-half-inch vertical to one foot horizontal (1/2" vert.: 1' horiz.) maximum measured above the back of the curb. These gradients may be varied only upon written approval of the City Engineer.
- E. TANGENT LENGTH. The minimum tangent length between reverse curves shall be 50 feet for local streets and 100 feet for all other classification of streets. No tangent will be required for radii longer than 500 feet. Because the minimum radii requirements for horizontal curves exceed 500 feet, tangents are not required for arterial roads.
- F. OFF-CENTER STREET INTERSECTIONS. Off center street intersections shall be separated by a minimum centerline to centerline dimension of 150 feet.
- G. CONNECTIONS TO EXISTING PAVEMENTS. Where new street construction is to connect to an existing street, a minimum of five feet of the existing pavement is to be removed to subgrade. This subgrade is to be prepared with that of the new improvement and repaved with the new construction. Existing pavement is to be removed at a saw cut for entire width of street from curb face to curb face. If full-depth pavement removal is required, the subgrade shall be re-compacted to 95 percent of standard density.
- H. MINIMUM ANGLE OF INTERSECTION. It is desirable for all intersections to meet at approximately a 90° angle. Skewed intersections should be avoided and in no case should the angle be less than 75°.
- I. SIDEWALKS. Sidewalk construction shall typically follow the requirements in Standard Detail 21-4, 21-5, 21-6, 21-7, & 21-8. Sidewalk must meet ADA standards. Residential sidewalks will be on at least one side of the road and a minimum of 5 feet wide with a 5-foot minimum grass median. Collector and arterial sidewalks will be on both sides and will be a minimum of 5 feet wide with a 5-foot minimum grass median.
- J. STORM DRAINAGE. All storm drainage works constructed in connection with street improvements shall be designed in accordance with the City of Raytown Design Criteria for Storm Sewers and Appurtenances as approved by ordinance.
- K. CUL-DE-SACS. At locations where streets are to be terminated and a vehicular connection between adjacent streets is not required a cul-de-sac may be permitted. Such cul-de-sac shall be constructed with a minimum radius of 39 feet to the back of the curb.
- L. TEMPORARY TURNAROUNDS. At locations where streets are to be temporarily terminated which will be extended at a later date, and said street extends beyond the intersection of an adjacent street more than five (5) lots, a temporary cul-de-sac shall be constructed with a minimum radius of 35 feet. The temporary cul-de-sac shall be constructed of asphaltic concrete with a minimum depth of six (6) inches. Curb and gutter will not be required. The cul-de-sac shall be constructed within the limits of a permanent construction easement.
- M. MONUMENT BOXES. Monument boxes conforming to Standard Drawings shall be installed at all quarter section corners as an element of the street construction.

N. SIGHT DISTANCES.

- A. Stopping Sight Distance--Sight distance is the length of roadway ahead visible to the driver. The minimum sight distance available on a roadway should be sufficiently long to enable a vehicle driving at or near the design speed to stop before reaching a stationary object in its path.

Stopping sight distance represents the sum of the brake reaction distance and the braking distance. These distances are measured from the height of the driver's eye to the height of the object (3.50 feet and 0.5 feet above the road surface, respectively). Design controls for stopping sight distances vary slightly for crest vertical curves and sag vertical curves, and are dependent on the algebraic difference in the grades as well as the design speed. Design Aide 3-1 and 3-2 illustrate the minimum stopping sight distances to be used in design of roadways.

- B. Intersection Sight Distance--Sight distances at intersections vary from stopping sight distance. The intersection sight distance should be sufficient to permit a vehicle on the minor leg of the intersection to cross the traveled way without requiring the approaching through traffic to slow down. To allow this, an area free of visual obstruction is required at every corner of an intersection. This area is known as the sight triangle.

An obstruction to vision shall be defined as an obstacle (i.e., a parked vehicle, a wall or commercial sign, bush or hedge, guardrail or fence, etc.) which forms a restriction to an assumed line of sight measured from the driver's eye height to a target some distance along the cross street.

Every effort shall be made to select intersection locations so that the maximum sight distance is possible. As an element of this, location of intersections shall always consider the grade changes along the adjacent street in terms of possible sight obstructions.

- C. Sight triangle requirements vary based on the type of intersecting streets and are summarized in the following table. All measurements are taken from the point of intersection of the extended curb lines of each intersecting street. The values in the table are dependent on the travel speed of the vehicles on the intersecting street and on the typical vehicle, which will approach the intersection. The standard assumed height of the driver's eye for a passenger vehicle is 3.75 feet above the roadway surface (6.0 feet above the pavement for a single unit truck or large semi). This relates to the line of sight required to detect an approaching vehicle on the cross street (regarded as a point 4.25 feet above the roadway surface).

Major Road Type	Required Clear Distance (ft)
Arterial	215
Collector	170
Residential	130

All corner lots within the City limits of Raytown (except those in the Central Business District) shall have a sight triangle free of visual obstructions from a point 50 feet back

along the minor leg as measured from the point of intersection of the extended curb lines of each intersecting street to a point that varies with the street type and is stated in table above. Such an area shall be and remain free of visual obstructions higher than two and a half feet (2.5') and lower than ten feet (10') above the roadway surface. Within the Central Business District, the sight distance triangle shall conform as closely as possible to the above specification for sight distance, as approved by the City Engineer.

- O. UNDERDRAIN. In areas that have known subsurface moisture problems, underdrains will be required. They shall be built as shown in Standard Detail 40-11.
- P. OTHER DESIGN CRITERIA. All other street design elements not contained within this criterion shall be in accordance with the most current edition of "A Policy on Geometric Design of Highways and Streets" authored by the American Association of State Highway and Transportation Officials (AASHTO) or other applicable AASHTO design guides.
- Q. DRIVEWAY ELEVATIONS. Driveways shall attain top of curb elevation within the right-of-way. Driveway grades within right-of-way shall be 8% maximum until curb height is reached. Break over grades for crest drives shall be 8% maximum and sag drives shall be 12% maximum. Driveway elevation shall not be more than 6" above or below the normal shoulder elevation at the right-of-way line, to allow for a smooth sidewalk profile.
- R. DRIVEWAY WIDTHS: Residential driveways shall be related to the width of the lot at the building line. A lot of 70' or greater at the building line shall have a minimum width of 10' and a maximum width of 30' but cannot exceed 35% of the lot width at the building line. A lot less than 70' in width at the building line shall have a minimum driveway width of 10' and a maximum of 20'. A lot having two (2) driveway access points (i.e. circle drive) must have at least 100' width at the right-of-way line. See "Driveway Criteria".
- S. SIGNAGE. Street name and regulatory traffic signs conforming to the Standard Drawings shall be furnished and installed at the appropriate locations in connection with the street improvement. All regulatory signage shall be in conformance with MUTCD requirements and shall be approved by the City Engineer.
- T. PRIVATE STREETS. All streets and roadways within any development, which are classified as "Private Streets", shall conform to the standards and specifications for public streets, as stipulated in the Technical Specifications and Design Criteria for Public Improvement Projects for the City of Raytown.

DESIGN CRITERIA FOR STORM DRAINAGE FACILITIES

- A. GENERAL. This section sets forth the minimum technical criteria for the analysis and design of drainage systems in the City of Raytown. All development plans submitted for approval to the City of Raytown must be accompanied by an adequate storm drainage system analysis and design in accordance with the criteria as hereinafter described. **All developments shall be designed to meet the requirements of the current APWA Section 5600 specifications.**
- B. MINIMUM STANDARDS OF ANALYSIS. Unless otherwise approved by the City Engineer, the following criteria will be utilized to determine the adequacy of any storm drainage facility design submitted for approval.
- A. Methodology of Analysis. In determining the amount of storm-water runoff resulting from a development and the amount of flow at various points throughout the drainage system, it is important for the designer to relate the methodology to be utilized in their calculations to the proportionate size of the tributary watershed areas. In developments where the area contributing runoff is one hundred (100) acres or less, the Rational Method of calculating the quantity of runoff shall be utilized. Developments where the area contributing runoff exceeds one hundred (100) acres shall be designed using the unit hydrograph method (SCS).
- B. Criteria for Drainage System. All calculations relating to runoff analysis shall be based upon the proposed land use and shall take under consideration any contributing runoff from areas adjacent to the development site. Storm water runoff analysis from adjacent existing developed areas shall be based upon current land usage and topographical features. Property adjacent to the study area which is undeveloped shall be considered as fully developed in accordance with the most probable anticipated future land use. Such land use shall be determined from the City Comprehensive Plan and the City zoning map. In the event that the future land use of a specific undeveloped property cannot be adequately projected from available information, the average runoff coefficient (C) to be used shall not be less than 0.65 for use in the Rational Method or an appropriate equivalent value as approved by the City Engineer for any other method. The most likely flow pattern to be utilized for an undeveloped area shall be based upon existing natural topographical features.

Average land slopes in both developed and undeveloped areas may be utilized to calculate runoff rates. The exception to this shall be in areas with existing well-defined drainage patterns and slopes, in which case the actual slope shall be used.

Existing runoff flow rates and velocities at locations of discharge from adjacent upstream developments shall be utilized in drainage system design. Drainage facilities shall be designed to minimize the velocity of overland flow so as not to cause erosion damage. In areas where excessive velocities exist, adequate dissipating structures shall be provided as required to result in velocities appropriate for the type of erosion control to be utilized.

The primary function of roadways within a development shall be reserved for the conveyance of traffic. The use of these facilities as a storm runoff facility shall be restricted to the requirements established and set forth in these design criteria.

The utilization of on-site or on-stream detention and natural drainage ways is recommended and encouraged where feasible. The release rate of which shall equal 1.8 cfs per acre, or less. Relocation of existing natural drainage ways will not be approved unless such relocation has been substantiated as a result of a thorough and complete analysis of the resultant consequences.

The designer shall consider all problem areas of his design and analysis to prevent the transfer of these problems from one location to another. All points of drainage outfall shall be designed to preclude creation of downstream flooding problems and hazards to the public. Approval will not be given to any project that involves the construction of any structure or the placement of fill material which will hinder or impair surface or subsurface drainage from surrounding areas.

- C. MINIMUM STANDARDS OF DESIGN. Storm water runoff shall be carried by enclosed systems or open channels on the basis of criteria established in this section and subject to the final determination and approval of the City Engineer.

Enclosed drainage systems shall be used to collect and convey drainage on, across and through public right-of-way. The enclosed system shall extend at least to the limits of the right-of-way and energy dissipating structures shall be provided at the outlet to limit velocities to seven (7) feet per second and/or as needed to prevent erosion damage.

Where enclosed storm drainage is located along side property lines, it shall remain enclosed to the rear property line or an existing channel at least thirty (30) feet beyond the rear corner of the adjacent buildings. A surface swale shall be designed over this area to contain additional runoff from a 100-year storm. At the point of intersection with an open channel, energy-dissipating structures shall be provided to limit velocity to the capacity of the receiving channel or seven feet per second whichever is less. Storm drainage systems can not be designed larger than the capacity of the downstream system.

Existing open channels, natural or improved, may remain along the rear or side of properties when the design provides adequate protection to the adjacent property. Such protection shall be through the provision of a 100-year floodplain setback and a minimum clearance from the top of bank to any building of 30 feet.

The use of open channels is generally acceptable for conveying storm runoff from tributary watersheds if the runoff cannot be contained in a 72-inch (72") diameter pipe. All open channels shall be analyzed for a minimum of 500 feet downstream of the development or to a point where the increased runoff from the development has no adverse impact on downstream structures.

Overflow Systems: Each conveyance element of the storm water drainage system (whether enclosed or open) shall include an overflow system having sufficient hydraulic capacity

when combined with the capacity of the conveyance elements to convey the peak discharge generated by a 100 year return period storm without damage to land or buildings, defined as follows:

100 year stage; plus one foot freeboard, at an elevation equal to or greater than the lowest elevation at which water may enter any proposed or existing building or structure.

Complete side and rear drainage systems meeting the criteria established previously shall be provided along the boundaries of new subdivisions or developments by the Developer or property owner

A. Design Storm Frequencies. Enclosed and open channel conveyance system components shall be designed for the following return period storms, irrespective of the land use in which the system is located or the land use in the drainage area tributary to the system:

a. In-System Capacity:

- Floodway in 100 year Flood Plain 100 year
- Bridges, Pipes, and Culverts
 - Crossing Arterial Streets 50 year
- All Other System Components 10 year Residential, 25 year Commercial

b. Overflow Channels: The combined capacity of the overflow channel and in system conveyance element shall be sufficient to convey the 100 year storm at all locations; except that an overflow depth not exceeding seven (7) inches at the lowest point of the traveled way will be permitted where culverts cross streets.

c. Storm drainage systems having more than one land use or zoning classification tributary to the system, shall be designed on the basis of the highest runoff producing land use comprising 30 percent (30%) or more of the total tributary area.

B. Runoff Computation. The rational method of calculating storm water quantities, $Q = KCIA$, shall be used with the following definitions of terms and arbitrary values:

Q is the quantity of runoff in cubic feet per second and is the basis for design of the storm drainage system.

K is a dimensionless coefficient to account for antecedent precipitation.

C is the weighted coefficient of runoff from the tributary area and shall have the following values where applicable:

AVERAGE SURFACE USE				
			PERCENT IMPERVIOUS	PERCENT PERVIOUS
	LAND USE / ZONING	"C"		
a.	BUSINESS			
	Downtown Areas	0.90	95	5
	Neighborhood Areas	0.80	85	15
b.	RESIDENTIAL			
	Single-Family Areas	0.50	35	65
	Multi-Family Areas	0.65	60	40
	Churches & Schools	0.75	75	25
c.	INDUSTRIAL			
	Light Areas	0.65	60	40
	Heavy Areas	0.80	80	20
	Parks, Cemeteries	0.35	10	90
	Playgrounds	0.35	10	90
	Railroad Yard Areas	0.45	25	75
d.	UNDERDEVELOPED AREAS			
	Permanent Unimproved Areas, Greenbelts, etc.	0.30	0	100
	Temporary Unimproved Areas that can be considered as fully developed in the future	0.65	60	40
e.	ALL SURFACES			
	Impervious: Asphalt, concrete, roofs, etc.	.90	100	0
	Turfed	.30	0	100
	Wet Detention Basins	.90	100	0

As an alternate to the above coefficients or for areas not specifically listed above (planned building groups, shopping centers, trailer parks, etc.), a composite runoff coefficient based on the percentage of the different types of surfaces involved shall be used.

I is intensity of rainfall in inches per hour and shall be determined for the yearly frequency stipulated previously and as specified from the intensity duration curves included as a part of this criteria.

TC Time of concentration (*TC*) equals the overland flow time to the most upstream inlet or other point of entry to the system plus the time of flow in the system upstream from the point under consideration. ($TC = Ti + Tt$)

Ti (inlet time) shall be calculated utilizing the following formula or determined graphically from Design Aid 4-5A but shall not be less than 5.0 minutes or greater than 15.0 minutes:

$$T_i = \frac{1.8 (1.1 - C) D^{1/2} (\text{minutes})}{S^{1/3}}$$

Where; T_i = inlet time, minutes

C is the Rational Method runoff coefficient.

D is the overland flow distance parallel to slope.

S is the slope of the tributary area surface perpendicular to contour in percent.

T_t (Travel time) shall be calculated as the length of travel in the channelized system divided by the velocity of flow. Velocity shall be calculated by Manning's equation assuming all system elements are flowing full without surcharge. Travel time may be determined graphically from Design Aid 4-5B in lieu of calculation.

When the upstream channel is unimproved, it shall be assumed that future construction of drainage system improvements will increase the velocity of flow. Velocity used for calculating T_t shall be:

Average Channel Slope (Percent)	Velocity (fps)
<2	7
2 to 5	10
>5	15

A is the area in acres contributing to the drainage system. All upstream tributary areas are to be considered as fully developed as zoned or planned at the time of design.

- C. Antecedent Precipitation. "K" represents the frequency factor used to account for antecedent precipitation and shall have the following values:

Storm Return Period (Years)	K*
10	1.0
25	1.1
50	1.2
100	1.25

* The product of $K \times C$ shall not exceed 1.0.

- D. Pipe Sizing. Pipe sizes in integrated underground systems shall be determined in accordance with the Manning's Formula

$$Q = \frac{A(1.486)}{n} R^{2/3} S^{1/2}$$

where; R = hydraulic radius (R = A/P) in feet.
 S = slope in feet per feet.
 P = wetted perimeter in feet.
 n = Manning's roughness coefficient.
 A = cross sectional area, ft²
 Q = discharge, ft³

Values of "n" to be used in the Manning Formula shall be as shown in Design Aid 4-7A.

The minimum size storm sewer shall be fifteen (15) inches in diameter.

Storm sewers and inlets shall be of sufficient capacity to adequately carry the anticipated runoff from the design storm. Capacity shall be rated at either inlet or outlet control, whichever condition indicates the least capacity. The drainage system and appurtenant storm inlets shall commence at all locations where the allowable street capacity for the conveyance of storm water runoff is exceeded or where there is a possibility of ponding.

All storm drainage systems shall be designed so as to maintain a minimum velocity of flow at the outlet of three (3) feet per second and a maximum velocity of fifteen (15) feet per second when flowing full. All systems discharging at a velocity in excess of five (5) feet per second shall be designed with an acceptable energy dissipating structure.

- E. Pipe Slope. Pipe slopes may not be greater than 15 percent (15%) and water velocities in pipe may not be greater than fifteen feet (15') per second without a variance from the City Engineer. If a variance is allowed, then pipe runs whose slope is 15 percent (15%) or greater and/or whose water velocity is 25 fps or greater, will be required to have concrete collars on every sixth joint unless the conditions necessitate a greater or lesser spacing. The City Engineer will review spacing calculations from the design engineer for these conditions. Proof of proper abrasion resistance in pipe must also be provided.
- F. Depth. All storm drainage lines shall have a minimum cover of eighteen inches (18") where practical. Cover may be decreased to avoid conflicts or on short laterals, as approved by the City Engineer. Special bedding and backfill may be required where cover is decreased below eighteen inches (18").
- G. Curb Inlets, Junction Boxes and Other Points of Entry. In general, curb inlets shall be installed at intersections and as required at intermediate points to limit gutter flow width during runoff occurring from the design peak discharge from the tributary watershed area to that which will not encroach on the following center widths of streets:

Arterial Streets	24 feet
Collector Streets	14 feet
Local Streets	10 feet

Because of the potential for street debris to clog inlets and to reflect potential cross section changes due to resurfacing, inlet capacity shall be rated at 80 percent of the theoretical inlet capacity unless otherwise approved by the City Engineer.

Design shall provide that the hydraulic gradient at any opening through which surface water may enter (or backflow from) the system is 0.5-foot or greater below the opening elevation. The hydraulic gradient elevation is defined as:

1. Channel invert elevation;
2. Plus depth (diameter) of outlet channel (pipe);
3. Plus " h " calculated in accordance with Design Aid 4-7B; except for structures where 50 percent or more of the discharge enters the system from the surface of the structure " h " shall be calculated as $= V^2/64$.

The hydraulic gradient elevation shall be calculated at the entrance to the outlet line of each structure.

The crown(s) of pipe(s) entering a structure shall be at or above the crown of the pipe exiting from the structure to provide a minimum fall of the invert in the structure of 0.2 feet for straight flow through the structure or 0.5 feet fall for all other types of flow (bends more than 22.5 degrees deflection angle, multiple lines entering, enlargement transition,...etc.) through the structure.

- H. Open Channels. Unless in a 100-year designated floodplain or a critical area as determined by the City Engineer, open channels shall be designed for the 10-year frequency storm. Open channels shall be sized to adequately carry the design rate of flow without damage. Whenever practical, the channel shall be characterized as slow flowing, be wide and shallow, and be natural in its appearance and functioning.

Channel capacities shall be computed using the Manning Formula for uniform flow.

Design flow rates shall be carried within the confines of the open channel with a minimum allowable freeboard of 1.0 foot measured from the water surface to the top of bank.

Pipe culverts, box culverts, and other structures entering channels shall not project into the normal waterway area.

Channel design shall include lining or treatment of the invert and sides as required to minimize erosion. Minimum treatment shall include seeding. Channel inverts and sides shall be lined in accordance with the following table:

Mean Flow Velocity	Type of Lining
Less than 3 F.P.S.	Seeded
3 to 5 F.P.S.	Sod, staked
5 to 10 F.P.S.	Stone riprap (15" Min. Thickness)
10 to 15 F.P.S.	Grouted stone riprap, gabion revetment or concrete paving
Over 15 F.P.S.	Concrete paving or sound in-situ rock

Lining materials having equivalent erosion control properties to those shown in the foregoing table may be used in lieu thereof with the approval of the City Engineer.

Channel sections shall be compatible with the type of lining and maintenance practical to be used. Side slopes shall be as flat as practical. Side slopes of 3:1 shall be considered a normal maximum. Under special circumstances where acceptable lining material is to be utilized, slopes of 2:1 may be considered. Such use in the channel design shall be only where approved by the City Engineer. Friction factors used in design shall consider the type of lining and are listed in Design Aid 4-7A.

Alignment changes shall be achieved by curves having a minimum radius of:

$$R = \frac{V W}{8D}$$

R = Minimum radius on centerline in feet.

V = Average velocity of flow in feet/sec.

W = Width of channel at water surface in feet.

D = Depth of flow in feet.

Lining height on the outside (concave) side of curves shall be increased by:

$$y = \frac{D}{4}$$

y = Increased vertical height of lining in feet.

Increased lining height shall be transitioned from y to zero feet over a minimum distance of:

30 (y) feet downstream from the point of tangency (p.t.).

10 (y) feet upstream from the point of curvature (p.c.).

I. Natural Channels. Shall conform to the criteria for improved channels except:

1. Mean flow velocity may be 5 feet/sec without lining.

2. Freeboard requirements may be satisfied by dedication of an easement to the freeboard elevation plus 1.0-foot vertically.

J. Culverts. Culverts under major & minor arterials (thoroughfares) shall have sufficient capacity to pass the runoff from the appropriate design storm considering 20% of the inlet opening plugged.

The following design criteria shall be utilized for all culvert design:

1. The culvert including inlet and outlet structures shall properly take care of water, bed-load and debris at all stages of flow.
2. Inlet. Culvert inlets shall be designed to minimize entrance and friction losses. Inlets shall be provided with either flared-end sections or headwalls with wingwalls. Projecting ends will not be acceptable. For large structures, provisions shall be made to resist possible structural failure due to hydrostatic uplift forces.
3. Outlets. Culvert outlets shall be designed to avoid sedimentation, undermining of the culvert, and erosion of the downstream channel. Outlets shall be provided with either flared-end sections or headwalls with wingwalls. Projecting outlets will not be acceptable. Additional outlet control in the form of riprap, channel shaping, etc., may be required where excessively high discharge velocities occur.
4. Slopes. Culvert slopes should be such that neither silting nor excessive velocities and scour occur. Generally, the minimum slope of culverts shall be limited to 0.005.
5. Headwater. Generally, the headwater to diameter ratio (HW/D) should not exceed those recommended as follows:

Storm Frequency	HW/D
10 Year	≤ 1.0
25 Year	≤ 1.2
50 Year	≤ 1.5
100 Year	≤ 1.5

6. Tailwater. The depth of tailwater at the outlet shall be subject to the criteria set forth for headwater.
7. Hydraulic Design. Culverts shall be analyzed to determine whether discharge is controlled by inlet or outlet conditions for design storm discharge. The value of the roughness coefficient (n) used shall not be less than those specified in Design Aid 4-7A.
8. Structural Design. The structural design of culverts, whether pipe or concrete box, shall be sufficient for the situation anticipated to be encountered at the site of the proposed work. Such design shall conform fully to all requirements set

forth in this criteria and in the technical specifications of the City of Raytown and shall be as approved by the City Engineer. Design Aids 4-9 and 4-10 are provided for determining the gauge requirements for corrugated metal pipe.

- D. EASEMENTS. Drainage easements shall be a minimum of fifteen feet (15') for enclosed structures and twenty feet (20') for open (paved or grass-lined) channels where they cross private property or as designated by the City Engineer.
- E. STORMWATER DETENTION. All developments shall be designed to meet the requirements of the current APWA Section 5600 specifications. All developments shall have a maximum release rate less than or equal to 1.8 cfs per acre.

The following design criteria for stormwater detention shall be in effect:

- A. Storage Volume Requirements. Storage volume shall be adequate to contain the differential volume of runoff that would result from the design storm occurring on a fully developed site over the maximum allowable release rate. The minimum rainfall event to be utilized in determining the detention storage volume shall be based upon the planned land usage and intensity within the tributary area. The intensity to be used for a residential development shall be a 10-year rainfall event while a commercial and industrial development shall use a 25-year rainfall event.
- B. Maximum Allowable Release Rate. In general, the maximum release rate shall be defined as 1.8 cfs per acre, or less. The rate of runoff occurring prior to the proposed development taking place shall be determined mathematically as the runoff resulting from a 10-year return-frequency rainfall calculated using the rational formula. Deviations from the use of this rainfall frequency in design calculations shall be only where approved by the City Engineer.
- C. Freeboard. The minimum elevation of the top of the detention storage basin storage basin embankment shall be at least one foot (1') above the water surface with the emergency spillway flowing at design, or a minimum of two feet (2') above the crest of the emergency spillway.
- D. Sediment Storage. A sediment storage volume of at least 5 percent (5%) of the total required temporary storage volume for runoff detention shall be provided.
- E. Outlet Control Works. Outlet control works shall not include any mechanical components or devices and shall function without requiring attendance or control during operation. Size and hydraulic characteristics shall be such that all water in detention storage is released to the downstream storm sewer system within twenty-four hours after the end of the design rainfall.
- F. Emergency Overflow. A method of emergency overflow shall be designed and provided to permit the safe passage of runoff generated from a one-hundred-year storm.

- G. Structure Integrity. The basin shall be designed with the capability of passing a one-hundred-year storm event from a fully developed watershed basin through the outlet works without causing failure of the embankment.
- H. Design Data Submittal. In addition to completed plans, the design engineer shall submit the following for all projects that include temporary detention facilities: rainfall hydrograph, capacity curve for proposed detention facility, discharge characteristics curve, and storage capacity inflow and outflow curves.
- I. Optional Detention Methods. Some possible types of detention facilities can be (but are not limited to) the following:
 - 1. Wet-bottom basins. The minimum normal pool elevation prior to the introduction of excess stormwater shall be four feet (4'). If fish are to be used to keep the basin clean, at least one quarter of the area of the permanent pool must have a minimum depth of ten feet (10'). For emptying purposes, cleaning of shoreline maintenance, facilities shall be provided or plans prepared for the use of auxiliary equipment to permit emptying and draining.
 - 2. Dry-bottom basins. Where possible these shall be designed to serve secondary purposes for recreation, open space or other types of use which will not be adversely affected by occasional or intermittent flooding. To facilitate interior drainage, concrete paved swales shall be required from the inflow to the outlet structures.
 - 3. Paved parking lots. Parking lots may be designed to provide temporary storage of stormwater on all or a portion of their surfaces to a maximum depth of nine inches. Outlets will be designed so as to empty the stored waters in such a time to create the least amount of inconvenient to the public. Minimum slopes of 1 percent and maximum slopes of 4 percent (4%) are to be utilized.

The minimum freeboard from the maximum water ponding elevation to lowest sill elevation of adjacent buildings to structures shall be one foot (1').

REQUIREMENTS FOR PUBLIC IMPROVEMENT PROJECT PLAN PREPARATION

- A. INTRODUCTION. The following criteria are established to provide a uniform system of plan preparation that will aid the engineer in preparing plans for work within the City of Raytown. It is not intended that the criteria be an iron-clad set of rules that would restrict the engineer from utilizing imaginative design; however, all items as described below shall be shown on the plans in some manner.
- B. GENERAL. All plans and specifications for public improvement construction within either publicly-financed districts or privately-financed developments shall be sealed by a professional engineer licensed in the state of Missouri and submitted to the office of the City Engineer for review. Subsequent to the review, the engineer will be notified of the approval of the plans as submitted, or of any necessary changes. (Refer to the section "Public Improvement Project Plan Submittal" for plan review procedures.)

Upon completion of the review and approval of the plans by the city engineer, four (4) sets of plans (as approved) must be submitted.

In addition, one set of approved plans shall be sent to each of the utility companies providing service in the proposed construction area.

The suggested plan sheet size is 24" x 36" with all sheets in a given set of plans being of the same size. Plan and profile shall be drawn on double or single plan and profile sheets to scales of one inch (1") equals fifty feet (20') horizontal by one inch (1") equals ten feet (10') vertical, unless otherwise approved by the City Engineer for special cases.

The plans shall consist of:

1. Title Sheet
2. General Layout Sheets
3. Grading Plan (Street and/or storm drainage improvement plans only unless otherwise required by the city engineer)
4. Erosion & Sediment Control plans, including all required elevations
5. Plan and Profile Sheets
6. Cross-Section Sheets (Street Improvement plans only unless otherwise required by the city engineer.)
7. Standard and Special Detail Sheets

Each sheet should contain a sheet number, including the individual sheet number and the total number of sheets, the engineer's seal, revision block, proper project identification and date.

Each respective type of development project (i.e. sanitary sewer, streets, water mains, etc.) shall be submitted on a separate set of plans unless otherwise allowed by the city engineer. Plans depicting the location and types of street name and regulatory signs shall be submitted

with the street improvement drawings for review. All required signage is to be furnished and installed in connection with the improvement at the developers expense.

When required by the City Engineer, plans depicting the location of street lights and all related appurtenances shall be submitted with the street improvement drawings for review of the appropriate power company. Such review shall be for the purpose of verifying easement locations to be indicated on the final plat. Plans for street light installation shall conform to all applicable standards of the power company having jurisdiction over the work.

Unless otherwise directed by the City Engineer, storm sewer construction details should be incorporated into street construction drawings

C. TITLE SHEET. The following items shall be included on the title sheet.

1. Name of project
2. City project number
3. Index of sheets included in plans
4. A location map adequately showing project location in relation to major streets (minimum scale of 1" = 2000')
5. General Description of project area (by Township, Range, & Section)
6. A summary of plan quantities of principal items, such as:
 - Pipe sizes and material, lengths, number of manholes, etc. (sanitary sewers)
 - Length of curb and gutter, square yardage or tonnage of asphaltic concrete pavement, etc. (streets)
 - Pipe sizes and material, lengths, number of inlets, etc. (storm sewers)
 - Pipe sizes and material, lengths, number of valves, etc. (water lines)Additionally, a separate column shall be provided for listing of "as-built" quantities once the project has been completed and accepted by the City.
7. The project control benchmark shall be identified as to location and elevation and be within one thousand (1000) feet of the boundary of the project; USGS datum. (Not required on water line plans). Horizontal control shall be State Plane Coordinate system.
8. Name, address, and telephone number of the consulting engineer and owner/developer.
9. List containing name and telephone number of each utility company and public agency listed below:

Electric Power	Gas Company	City Engineering Dept.
Cable Television	Water Company(s)	Missouri One-Call
Telephone	Sanitary Sewer	Local Highway Dept.
10. Approval block (see paragraph C of General Plan Requirements).
11. Signature and stamp of Professional Engineer registered in the state of Missouri.
12. Revision schedule.

D. GENERAL LAYOUT SHEET. The following items shall be included on the general layout sheet for all improvement projects.

1. A legend of symbols and abbreviations shall be shown which shall apply to all sheets.
2. North arrow and graphic scale. Scale of the general layout map shall be one inch (1") equals 100 feet (100'), unless otherwise approved.

3. Layout shall include names of subdivision, block designation, if any, lot designation, or proposed block and lots, all street names, and an accurate tie to at least one quarter section corner. An unplatted tract shall have an accurate tie to at least one quarter section corner.
4. Boundary line of project area.
5. A list of general notes to the contractor to include at least those notes indicated in the "Procedure For Public Improvement Project Plan Submittal" section of this manual.
6. Existing and final grading contours drawn at intervals not to exceed two feet (2'). Intervals of less than two feet (2') may be required by the City Engineer dependent on the character of the topography.

In addition, the following items shall be included on the general layout sheet for the particular type of improvement stated below.

Streets

1. Location of all existing and proposed streets and roadways within and adjacent to the project area (list City project).
2. Location of all existing and proposed drainage system improvements (list City project name and number).

Storm Drainage

1. Drainage calculation summary table containing the following information.
 - Pipe size and slope
 - Pipe capacity
 - Velocity (design & at capacity)
 - Time of concentration
 - Runoff coefficient
 - "K" factor (for antecedent precipitation)
 - Design storm (return frequency)
 - Incremental tributary acreage
 - Accumulative acreage
 - Rainfall intensity
 - Rainfall runoff
2. A site grading plan including the following information.
 - Property lines identified as to existing or proposed lot and block number
 - Elevation and location of nearest benchmark (U.S.G.S. datum)
 - Final grading spot elevations shown for all corners of each lot
 - One-hundred year floodplain line with elevation
 - Erosion control measures

Sanitary Sewer and Water Lines

1. Location of all existing (water or sewer) lines properly designated within or adjacent to the project area (list city project name and number).

2. Connection point or points to existing facilities (tied to a known point on existing facility) and the type of connection to be utilized.
3. Location of all proposed (water or sewer) lines and appurtenances with designation and sheet number on which they appear in plan and profile.
4. All lots located adjacent to drainage ways, channels or overflow channels shall include the lowest basement opening (LBO) for the lot calculated as one (1) foot above the 100-year flood plain elevation or 100-year storm elevation.
5. Preblast survey limits.

E. PLAN AND PROFILE SHEETS. The following items shall be included on the plan and profile sheets for all improvement projects.

1. North arrows and graphic scale.
2. Elevation and location of all applicable bench marks (USGS datum).
3. Location of State Plane monuments used for horizontal control.
4. Existing and proposed streets with names and widths.
5. Property lines properly identified as to existing or proposed lot, block and subdivision.
6. All existing and proposed utilities such as power, gas, oil, water, telephone, sewer, and other items shall be properly located in conformance with the best information available in the records of the owner of such facilities, or field location, and identified as to size, material, and type of construction.
7. All existing and known proposed improvements within 75 feet each side of centerline shall be shown at their proper locations. This shall include such existing items as paved streets, curbs and gutters, driveways, culverts, fire hydrants, utility poles, trees, shrubs, fences, walls, houses, and other such items, and shall be identified as to type, size, material, etc., as may be applicable. In case of new developments, some irrelevant items may be omitted.
8. All existing easement and right-of-way information recorded with the county.
9. Minor construction notes shall appear on the proper plan and profile sheets.
10. Locations and widths of existing and proposed sidewalks.

In addition, the following items shall be included on the plan and profile sheets for the particular type of improvement stated below.

F. STREETS.

1. Station and critical elevation (flowline, invert of pipe, etc.) of all utility or drainage appurtenances, existing and proposed.
2. Flow direction arrows, particularly at intersections.
3. Match lines and consecutive sheet number, beginning with cover sheet.
4. Station and elevation of all curb returns (at 1/5 points); horizontal P.C.'s, P.T.'s, etc.; high or low point of all vertical curves; existing and proposed.
5. Curb return radii, existing and proposed.
6. Complete horizontal curve data. (R, L, Tan)
7. Centerline stations of all non-single family residential driveways and all intersecting roadways.
8. Basis of plan view and profile elevations shall be the same, i.e., flowline, and top of curb, etc.

9. Existing grade above centerline shown as a dashed line; proposed finish grades or established street grades shown as a solid line.
10. All design elevations shall be centerline, top of curb, lip of gutter, or flowline (preferred) for 6" vertical curb and gutter; or lip of gutter, or flowline (preferred) for combination curb, gutter and walk. The basis for as-built information shall be the same as the design (both flowline or both top of curb, etc.). All design elevations shall be based on adjacent abutting streets and shall show existing profile a minimum of 150' beyond the boundary of the project.
11. Stationing continuous for the entire portion of the roadway shown in the plan view (100 feet minimum stationing), with the centerline station of all non-single family residential driveways and all intersecting roadways clearly labeled.
12. All existing curbs, gutters, sidewalks, and pavement adjacent to the proposed design (minimum distance of 100 feet). Basis for existing grades shall be field verified elevations at intervals not to exceed fifty (50) feet. Previously approved designs are not an acceptable means of establishing existing grades.
13. Station and elevation of all P.C.R.'s, horizontal P.C.'s, P.C.C.'s, etc.; existing and proposed.
14. Station and elevation of all vertical grade breaks, existing (as-built) and proposed. (The use of grade breaks with proposed construction is discouraged.)
15. Distance and grade or slope between grade breaks.
16. Vertical curves, where 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 (L) and K ($=L/A$). All vertical curves shall be symmetrical.
17. Design speeds and stopping sight distances for all vertical and horizontal curves.
18. Existing and proposed utilities. Field verified elevations and locations are required to be indicated on the plans for all utilities (existing or proposed) which will potentially affect the design and construction of the improvement.
19. The location and designation of all signs (regulatory and street name) to be installed in connection with the project.

G. STORM DRAINAGE.

1. Detailed alignment of the storm sewer along with all appurtenances, sizes of lines, conduit material and wall thickness, and other details relating to the storm drainage system including inlet and junction box (manhole) stations and top and invert elevations.
2. All existing drainage facilities and structures such as, but not limited to, irrigation ditches, roadside ditches, improved or unimproved drainage channels, gutter flow directions, culverts, etc. All pertinent information such as size, shape, slope, location, etc. of such facilities shall be included to facilitate review and approval of the plans.
3. Roadway section and grade including type of curb and gutter and gutter flow directions.
4. Erosion control and energy dissipation devices.
5. Proposed outfall point for runoff from the project area along with required easement information.
6. Routing and cumulative flows at various critical points along the drainage system for both the standard design storm and major storm runoff.

7. Critical minimum finished floor elevations of all buildings adjacent to the project for protection from major storm runoff.
8. Distances between storm sewer system components and other existing or proposed utilities within the right-of-way or drainage easement.

H. SANITARY SEWER.

1. Detailed alignment of the proposed sewer with the manhole designation, either by station and angle shown at each manhole or dimensioned ties to property lines at reasonable frequent control points to provide unquestionable locations of the sewer within street right-of-way or on private property.
2. The channel centerline of waterways within 50 feet either side of centerline of sewer shall be shown.
3. All manholes shall be shown with manhole designation station and invert elevations. Drop manholes shall be designated as such. Invert elevations shown shall be the invert of the pipe in and out of the manhole. Proposed finish grade elevation of top of manhole shall be shown. Distance between manholes shall be shown as well as the gradient, pipe size, and type of material.
4. Results of all rock borings shall be shown at the proper locations.
5. Accurate elevations of either the first-floor surface or the basement floor surface shall be shown, and identified, for all existing and/or proposed structures for all building sites to be served by the proposed sewer system.
6. A uniform system of line and manhole designation shall be used subject to the approval of the city engineer's office.
7. Station, slope and length of each stubline.
8. Profile shall show existing grade above centerline as a solid line, proposed finish grades or established street grades by dashed lines, and shall show the flow line of any drainage channel, either improved or unimproved, within 50 feet either side of center line. Each line shall be properly identified. The proposed sewer shall be shown as double solid lines properly showing the height of the pipe.
9. All utility crossings shall be shown on the profile view with approximate elevations given.

I. WATER LINES.

1. Alignment of the proposed water line dimensioned from curb lines or right-of-way lines.
2. Designation by station of all fire hydrants and line valves.
3. Results of all rock borings shall be shown at the proper locations.
4. All utility crossings shall be shown on the profile view with approximate elevations given.

J. CROSS-SECTION SHEETS. The following items shall be included on the cross-section sheets.

1. Street cross-section at each station showing existing grade by dashed lines and proposed grade by a solid line. Cross-sections to show existing grade lines a minimum of 10 feet beyond right-of-way lines. Show cut and/or fill quantities at each cross-section.
2. Center line elevation of top of pavement.

3. Cross-sections shall be shown at all intersecting streets and driveways.
4. Channel cross-sections shall be shown for all drainage channel improvements.
5. Additional cross-sections shall be shown as required to clearly describe the extent of the grading operations.

K. STANDARD AND SPECIAL DETAIL SHEETS. Detail sheets shall be included to show all details of appurtenances, materials, and construction whether or not covered by the Raytown, Missouri standards. Details shall conform to the City of Raytown standards and are to be drawn clearly and neatly with proper identifications, dimensions, materials, and other information necessary to ensure the desired construction.

L. CONSTRUCTION RECORD DRAWINGS. Construction record drawings shall be submitted to the city engineer upon completion of the project and prior to final acceptance of the project by the City of Raytown. The design engineer shall provide the city with one (1) set of reproducible, mylar prints and also in electronic format, as specified by the city engineer, for all public improvement projects. The drawing shall be corrected to show the project as constructed and shall accurately and completely denote all changes made during the course of the work. Each sheet within the plans shall be clearly marked as "Conforming to Construction Records" and shall include the date of revision and certifications by the engineer.

REQUIREMENTS FOR
PARKING LOT CONSTRUCTION PLAN PREPARATION

1. INTRODUCTION. The following criteria are being established to provide a uniform system of plan preparation for work within the City of Raytown relating to parking lot construction.
2. GENERAL. All plans for parking lot construction are to be prepared by a professional engineer licensed in the State of Missouri and submitted to the office of the City Engineer for review. Subsequent to the review, the engineer will be notified of the approval of the plans as submitted, or of any necessary changes.
3. CONTENTS OF THE PLANS. The following items shall be included on plans as submitted:
 1. North arrow and scale.
 2. General site layout to include building location (if applicable), street names, subdivision, block designation (if any), lot designation, or proposed block and lots, and an accurate tie to at least one quarter section corner. Unplatted tracts shall have an accurate tie to at least one quarter section corner.
 3. All existing property lines, lot lines, street right-of-way lines and easement lines, both permanent and temporary, shall be shown at their proper locations.
 4. All existing and proposed utilities such as power, gas, oil, water, telephone, sewer, and other items located in conformance with the best information available in the records of the owner of such facilities, or field location, and identified as to the size, material, and type of construction.
 5. Site contours, both existing and proposed.
 6. Limits of pavement showing perimeter curbing.
 7. Detail of curb.
 8. Section through pavement.
 9. Detail of driveway entrance.
 10. Storm drainage facilities including inlet location, pipe locations and routing, size, material, gauge, and gradient and related elevations. Connections to existing facilities shall be tied to a known point. Details of proposed inlets are to be shown on plans.
 11. Finish elevations of pavement surface.
 12. General construction notes as required.

PRIVATE IMPROVEMENT

DESIGN CRITERIA

- A. GENERAL Private improvement construction in the City of Raytown shall in all respects be designed to conform to applicable codes, regulations and ordinances as established by the City of Raytown. Plans for private improvements being made in conjunction with building construction shall be submitted through the Community Development Department. All street, roadway, driveway, and sidewalk construction, public or private, shall conform to the technical specifications and design criteria for public improvements as stipulated herein.

Private improvements that are not being constructed in conjunction with new building construction or an addition to an existing building shall submit plans to the Community Development Department for review and approval from the Public Works Department. Improvements for sanitary sewer line, storm sewer line and street construction shall conform to the design criteria of the City of Raytown and/or the applicable sections of the Uniform Building Code, latest edition. Improvements for water line shall conform to the Public Water District #2, Raytown Water Company, and the Raytown Fire District.

- B. PARKING LOT CONSTRUCTION Parking lot construction shall conform to the following design criteria and shall abide by all City of Raytown ordinances.

- A. Materials for Construction. The following materials are acceptable for parking lot construction in the City of Raytown:

1. Pavement. The pavement cross-section shall consist of full depth asphaltic concrete (minimum of four inches), a combination of asphaltic concrete surface (minimum of two inches) over a crushed rock base (minimum of six inches), or portland cement concrete pavement (minimum of five inches) with 10 gauge welded wire mesh on six (6) inch centers each way embedded two (2) inches from the bottom surface of the slab.
2. Driveway Entrances and Curbing Within Public Right-of-Way. These items shall meet the requirements of Section 1400, 2000, and 2100 of the Technical Specifications of the City of Raytown. They will be constructed of Class II air-entrained concrete.
3. Curbing. Parking lot curb shall be of 4000 psi, air-entrained concrete.

- B. Curb and Curb and Gutter. Concrete curbing shall be provided along the perimeter of parking areas and along drives connecting parking areas with public streets. Curbing shall have a six-inch vertical face above the surface of the pavement. Curbs shall be constructed as cast-in-place. In areas of the lot adjacent to proposed future expansion, asphaltic concrete curb may be used if approved by the City Engineer. The proposed future expansion shall be shown on the plans.

All work within public right-of-way shall conform to applicable City of Raytown standards. Driveway approaches shall be constructed with integral curb and gutter conforming to City of Raytown Type "CG-1" or "CG-2" curb and gutter. Transition to existing curb and gutter shall be made at saw joints in existing curb or at existing expansion joints. Construction and expansion joints, dimensions, elevations and surface finish shall match as closely as possible to that of existing adjacent curb and gutter. Expansion joints shall be placed where new curbing abuts existing curbing.

- C. Drainage Facilities. All parking areas shall be provided with adequate drainage facilities as approved by the City Engineer. Enclosed storm sewers shall be used to collect and convey drainage on, across and through public right-of-way. All effort will be made, within the limits of the existing topography, to prevent stormwater runoff from parking lots from exiting through driveway entrances. If the design engineer can justify the need for stormwater to exit through a drive entrance, the maximum flow of water allowed shall be governed by the design criteria for storm drainage facilities for the City of Raytown for gutter flow. If the flow is in excess of the gutter capacity then it must all be picked up by a curb inlet prior to entering public right-of-way.

Runoff calculations shall be in accordance with the Design Criteria for Storm Drainage Facilities of the City of Raytown. All calculations shall be submitted to the City Engineer for review and approval. Stormwater detention will be required to meet the Kansas City, American Public Works Association standards. Drainage structures located in the public right-of-way used and constructed as a portion of the storm drainage facilities for parking lots shall be in accordance with the Technical Specifications of the City of Raytown.

- D. Driveway Entrances. All commercial driveway entrances constructed within the public right-of-way shall be constructed of concrete with a minimum thickness of eight inches (8") (see detail in Section 2100). Each commercial or industrial property shall be allowed at least one driveway approach but may have more as long as the total maximum summation of the widths of all driveway approaches upon the property does not exceed 20 percent (20%) of the length of the real property that fronts the abutting City street. Should more than one driveway approach be desired, there shall not be less than 90 feet between the center lines of each driveway approach. In addition to the above, the following dimensions shall govern construction of driveway approaches:

1. Width of Driveway Approach

- a Commercial Driveway Approach - The width of commercial driveway approaches shall not exceed 30 feet or be less than 24 feet measured parallel to the center line of the street at the property lines for two-way driveway approaches; provided, however, that commercial property may be allowed to have a driveway approach not exceeding 52 feet, if said driveway approach does not exceed 20 percent of the length of the real property abutting the adjacent City street and a four foot raised median is placed within such driveway approach to divide the entrance and exit lane(s). The minimum width of a one-way driveway shall be 20 feet. See "Driveway Criteria".

- b Industrial Driveway Approach. The width of industrial driveway approaches shall not exceed 65 feet or be less than 24 feet measured parallel to the centerline of the street at the property lines for two-way approaches; provided that the minimum width for a one-way driveway shall be 16 feet. See “Driveway Criteria”.

2. Corner of Adjacent Property Line Offset.

Commercial or Industrial Driveway Approaches. When commercial or industrial driveway approaches are located at or near a street intersection, in no case shall the distance from the property corner at the intersection be less than 75 feet to the near line of the nearest driveway approach, as extended to the street curb or pavement edge. See “Driveway Criteria”.

No commercial or industrial driveway approach shall be constructed having a tangent length between the curb return and the property line extended, of less than 12-1/2 feet.

- 3. Driveway Offset. Either centerlines of opposing driveways shall align, or shall be offset no less than 75 feet. This condition shall not apply where a permanent median exists without break for these driveways.

4. Turning Radii.

- a Commercial Driveways. Commercial driveway approaches shall have a minimum radius of 15 feet. See “Driveway Criteria”.
- b Industrial Driveways. Industrial driveway approaches shall have a minimum radius of 25 feet. When a private improvement is determined to serve trucks with longer wheelbases, the City Engineer may require a greater minimum radius for driveway approaches. See “Driveway Criteria”.
- c Common Driveways. Driveways that are shared by adjacent property owners require that a common driveway (ingress/egress) easement be filed and on record at the County Register of Deeds office.

- E. Construction on Public Right-of-Way Under State Jurisdiction or Control. All construction within right-of-way under the control or jurisdiction of the state of Missouri shall be reviewed and approved by the appropriate state agency prior to submittal of the plans to the City of Raytown. Plans submitted to the City of Raytown for review shall reflect all changes or corrections as required by that state agency and also outlined on the approved state permit.

REQUIREMENTS FOR
PARKING LOT CONSTRUCTION PLAN PREPARATION

1. INTRODUCTION. The following criteria are being established to provide a uniform system of plan preparation for work within the City of Raytown relating to parking lot construction.
2. GENERAL. All plans for parking lot construction are to be prepared by a professional engineer licensed in the State of Missouri and submitted to the office of the City Engineer for review. Subsequent to the review, the engineer will be notified of the approval of the plans as submitted, or of any necessary changes.
3. CONTENTS OF THE PLANS. The following items shall be included on plans as submitted:
 1. North arrow and scale.
 2. General site layout to include building location (if applicable), street names, subdivision, block designation (if any), lot designation, or proposed block and lots, and an accurate tie to at least one quarter section corner. Unplatted tracts shall have an accurate tie to at least one-quarter section corner.
 3. All existing property lines, lot lines, street right-of-way lines and easement lines, both permanent and temporary, shall be shown at their proper locations.
 4. All existing and proposed utilities such as power, gas, oil, water, telephone, sewer, and other items located in conformance with the best information available in the records of the owner of such facilities, or field location, and identified as to the size, material, and type of construction.
 5. Site contours, both existing and proposed.
 6. Limits of pavement showing perimeter curbing.
 7. Detail of curb.
 8. Section through pavement.
 9. Detail of driveway entrance.
 10. Storm drainage facilities including inlet location, pipe locations and routing, size, material, gauge, and gradient and related elevations. Connections to existing facilities shall be tied to a known point. Details of proposed inlets are to be shown on plans.
 11. Finish elevations of pavement surface.
 12. General construction notes as required.

PRIVATE IMPROVEMENT

PLAN PREPARATION

- A. INTRODUCTION. The following criteria are being established to provide a uniform system of plan preparation for work within the City of Raytown related to private improvements.
- B. GENERAL. All plans for private improvements shall be prepared by a professional engineer, licensed in the state of Missouri, and submitted to the Community Development Department for review. Subsequent to the review, the engineer will be notified of the approval of the plans as submitted, or of any necessary changes.

Private improvements plans that involve sanitary sewer lines, storm sewer lines, or street construction shall be prepared in accordance with the plan preparation requirements detailed in Section 7 of the Design Criteria.

Private improvements involving parking lot construction shall meet the requirements outlined in Section 6 of the Design Criteria.

- C. PARKING LOT PLANS. The following items shall be contained on the plans submitted for review for the construction of a new parking lot or an addition to an existing parking lot.
- A. A location map, with north arrow, adequately showing project location in relation to major streets.
- B. General site layout to include:
- Building location (if applicable),
 - Street names, lot and block designation, and
 - An accurate tie to at least one-quarter-section corner. Unplatted tracts shall have an accurate tie to at least one-quarter-section corner.

All existing property lines, lot lines, street right-of-way lines and temporary and permanent easement lines shall be shown at their proper location. Street right-of-way lines and existing driveways shall be shown on both sides of the street that falls on the perimeter of the lot.

All existing and proposed utilities such as electric, gas, oil, water, telephone, sanitary sewer, storm sewer, and other applicable items located in conformance with the best information available in the records of the owner of such facilities, or field location, and identified as to size, material and type of construction.

- C. Include existing and proposed site contours for the site. Supplement the proposed contours with spot elevations at critical locations.

- D. Show limits of paving and perimeter curbing. Indicate the location of parking stalls, including handicapped parking, and show all dimensions, radii and other significant geometric details.
- E. The plans shall include a legend for the site layout detail and a sheet of standard details. The standard details shall include a profile view of the proposed curb(s), a section through the proposed pavement detailing pavement composition, a driveway entrance detail (use the City detail from Section 2100 if the entrance is from a public street), proposed drainage structures, and any other appropriate details as may be required for clarity or by request of the City Engineer.
- F. Storm drainage facilities shall be shown in both plan and profile view. These views shall show inlet and pipe locations, size, material, gage, slope of pipe, and all invert and top of structure elevations. Include on the plan sheets a drainage calculation summary table containing information on: pipe size and slope, pipe capacity, velocities, time of concentration, runoff coefficient, incremental and accumulated tributary acreage, rainfall intensity, and the total rainfall runoff.
- G. General construction notes as required.

STREET LIGHTING CONSTRUCTION

DESIGN CRITERIA

- A. GENERAL. Proposed street lighting construction in the City of Raytown shall in all respects conform to the technical criteria for analysis and design of street lighting as set forth in this section. Plans shall be submitted to the office of the City Engineer for approval and shall include all information as may be required or described hereinafter. Plans shall be submitted concurrently with the street plans using the same project number but under separate submittal.
- B. CATEGORIES OF STREETS AND PROCEDURES
- A. Local Residential Streets
- Street Plans or Plats: Developers are required to install street lights on all local residential and collector streets for which street plans have been approved. Appropriate City staff shall have flexibility in determining the extent and phasing of street light construction.
- B. All Other Collector Streets
- Street Plans or Plats: Developers are required to install street lights on all such types of streets which have street plans or plats approved. Appropriate City staff shall have flexibility in determining the extent and phasing of street light construction.
 - Arterials: City staff may initiate primary arterial street lighting requests for this type of street.
- C. DESIGN PROCESS The illumination design process involves the selection of the proper lighting equipment and the establishment of the geometry of the system in order to provide the most effective lighting system to satisfy the needs. The major steps of the design process are outlined as follows:
- **Existing Conditions** - Determination of roadway facility and land use area classifications.
 - **Selection of Illumination Level** - The recommended average intensity of horizontal illumination may be determined based upon the classifications of roadway facility and area type.
 - **System Characterization** - Detailed calculations using selected light source types and sizes and luminaire mounting height and spacing locations are employed in order to determine the average intensity of horizontal illumination. Based upon the selected equipment and geometrics, an isocandle diagram or computer program equivalent is employed to determine the minimum illumination level. The uniformity of illumination is checked by comparing the ratio of average maintained illumination to minimum maintained illumination, commonly referred to as the uniformity ratio, with the recommended criteria in order to determine optimal effectiveness of lighting system.

- D. DESIGN CONDITIONS Maximum spacing, consistent with good illumination design, should be emphasized. Luminaire supports are hazardous roadside objects and the total number should be minimized and/or strategically located behind sidewalks for safety considerations. Supports shall be set back as far as practical. Breakaway pole bases are required for Collector and Arterial street installations.

Determination of light source size, type, mounting height and spacing shall at least conform to the requirements outlined below be based upon the required illuminance levels when the luminaires are at their lowest output. This condition occurs just prior to lamp replacement and luminaire washing. Therefore, formulas calculating average illuminance shall include light loss factors relating lamp lumen depreciation and luminaire dirt depreciation.

A. Local Residential Streets

- Luminaires will be located at intersections of local residential streets, equally spaced along cul-de-sacs longer than 200 feet, at changes of alignment of 60° or more which are 200 feet or more from an intersection, with a minimum number of mid-block lights such that the spacing between lights is approximately 200 ft.
- 150 watt High Pressure Sodium (HPS) lamps
- Post-top luminaires and
- Spun aluminum poles for 14' mounting heights

B. Collector Streets

- 250 watt HPS lamps
- Cobra head style, cutoff luminaires; and flat glass, removable power doors
- 30' round, spun aluminum poles
- The collector standard street lights shall be used on all commercial collectors, apartment streets, reconstructed collectors, at the intersection of collector and residential street.
- On residential collectors in areas where standard post top luminaires are in place or proposed and for certain other non-primary thoroughfares as determined by the Engineering Division, use the following:
 - 100 or 150 watt HPS lamps
 - Post top luminaires; and
 - Spun aluminum poles for 14' mounting heights.

C. Arterial Streets

- 400 watt HPS lamps;
- Cobra head style, cutoff luminaires; and flat glass, removable power doors
- 40' round, spun aluminum poles

D. Freeway and Expressways

- 400 watt HPS lamps;
- Freeway-type luminaires; and
- Round galvanized steel or aluminum poles for 40' mounting height

- E. AREA CLASSIFICATION. The classification of urbanized areas shall be generally defined as follows:
- A. **Commercial.** That portion of a municipality in a business development where ordinarily there are large numbers of pedestrians during business hours. This definition applies to densely developed business areas outside, as well as within, the central part of a municipality. The area contains land use which attracts a relatively heavy volume of nighttime vehicular and/or pedestrian traffic on a frequent basis.
 - B. **Intermediate.** That portion of a municipality often characterized by a moderately heavy nighttime pedestrian activity such as in blocks having libraries, community recreation centers, large apartment buildings or neighborhood retail stores.
 - C. **Residential.** A residential development, or a mixture of residential and commercial establishments, characterized by a few pedestrians at night. This definition includes areas with single family homes, town houses, and/or small apartment buildings.
- F. ROADWAY CLASSIFICATION. The classification of roadways shall be generally defined as follows:
- A. **Freeway.** A divided major roadway with full control of access and with no crossings at grade. This definition applies to toll as well as non-toll roads.
 - B. **Expressway.** A divided major roadway for through traffic with partial control of access and generally with interchanges at major crossroads. Expressways for non-commercial traffic within parks and park-like areas are generally known as parkways.
 - C. **Arterial.** The part of the roadway system that serves as the principal network for through traffic flow. The routes connect areas of principal traffic generation and important rural highways entering the City.
 - D. **Collector.** The distributor and collector roadways serving traffic between major and local roadways. These are roadways used mainly for traffic movements within residential, commercial and industrial areas.
 - E. **Local.** Roadways used primarily for direct access to residential, commercial, industrial, or other abutting property. They do not include roadways carrying through traffic. Long local roadways will generally be divided into short sections by collector roadway systems.
 - F. **Alleys.** Narrow public ways within a block, generally used for vehicular access to the rear of abutting properties.

G. RECOMMENDED AVERAGE MAINTAINED ILLUMINATION (in footcandles).

	AREA CLASSIFICATION		
VEHICULAR ROADWAY			
CLASSIFICATION	Commercial	Intermediate	Residential
Freeway	0.6	0.6	0.6
Expressway	1.4	1.2	1.0
Major (Arterial)	2.0	1.4	1.0
Collector	1.2	0.9	0.6
Local	0.9	0.6	0.4
Alley	0.6	0.4	0.4

These are the recommended minimum values for average maintained horizontal illumination for the given type of roadway facility and land use area.

H. CALCULATIONS OF AVERAGE ILLUMINANCE, MINIMUM ILLUMINANCE, UNIFORMITY RATIO, and CUTOFF All calculations shall conform to the standard practice of the Illuminating Engineering Society of North America and can be done manually, electronically, or derived from tables and data provided by the manufacturer.

- A. **Spacing** - The spacing between the luminaires is the longitudinal distance if spaced in staggered or one-sided arrangement. This distance is one-half the longitudinal distance if luminaires are arranged in opposite spacing.
- B. **Light Loss** - The light loss factor represents the luminaire conditions at their lowest output level. The total factor is based upon the contribution of individual light loss factors such as lamp lumen depreciation, luminaire dirt depreciation, ambient temperature, in-service voltage, ballast, lumen component depreciation, physical surroundings & burnouts. The light loss factor can be determined by tables from the equipment manufacturer for the given luminaire type.
- C. **Coefficient of Utilization** - The coefficient of utilization is equal to the total of street side and house side coefficients of utilization as determined from the equipment manufacturer coefficient of utilization curves for the given luminaire type, placement and mounting height.
- D. **Minimum Illumination** - Minimum illumination is determined from the isofootcandle diagram or computer program equivalent from the equipment manufacturer for the given luminaire type, placement and mounting height.
- E. **Uniformity Ratio** - The uniformity ratio shall not exceed 4:1 and preferably should not exceed 3:1 except on residential streets, where 6:1 may be acceptable.
- F. **Cutoff** - The control of candlepower distribution shall be a true 90° cutoff.

DC9-009 ELECTRICAL SYSTEM. The electrical system shall comply with the standards as listed in the American National Standard Practice for Roadway Lighting, the National Electrical Code (NEC), and the National Electrical Safety Code (NESC).

SOURCE: IES Lighting Handbook, Illuminating Engineering Society of North America, 1981.

TRAFFIC IMPACT ANALYSIS

STUDY CRITERIA

A. GENERAL.

In order to adequately review development proposals, the city staff request that developers provide a traffic impact analysis to allow the staff to determine the need for street and highway improvements to serve the proposed use and address the traffic impact on the public street network. The following guidelines have been established to assist a professional engineer to provide the information needed for the staff to adequately analyze the development proposal.

B. ANALYSIS CONTENTS

The written report should address the following areas utilizing appropriate charts and graphics:

- a. A description of the development site, proposed land uses and intensities, and the area of influence of site traffic. An access plan for the development, including the proposed internal circulation and available sight distances at major entry points.
- b. Existing conditions and analysis:
 - i. Description of the existing conditions of perimeter streets and intersections and any other street in the area that will possibly be impacted. Information on existing street widths, number of lanes, intersection geometrics, locations of traffic signals and other types of traffic control, parking restrictions and transit routes should also be included.
 - ii. Twenty-four hour traffic counts on the perimeter streets and turning movements counts during morning and evening peak periods at the impacted intersections.
 - iii. Capacity and level of service analysis for the existing conditions of the perimeter streets and impacted intersections.
 - iv. Traffic accident data analysis for the influence area both for mid-block locations and intersections for the last three years.
- c. Calculation, analysis, and representation of the following future conditions.
 - i. Trip generation during the 24-hour and morning and evening peak periods, and peak hour of the generator for each land use category in the project should be calculated and shown. A trip table that includes type of

land use intensity, trip generation rates and trips generated should be prepared.

- ii. The distribution of generated traffic and assignment of that traffic to the street system during morning and evening peak periods and peak hour of the generator along with reasons for the assumed distribution.
- iii. Future 24 hour and peak period traffic volumes and assignments upon completion of the development by phases and for a 20 year horizon period based on regional growth/regional model.
- iv. Capacity analysis and levels of service for morning and evening peak periods and for the peak periods of the generator, if necessary.
- v. Street and access improvement plan with recommendations by development phases, identifying all needed improvements and the improvements that are the responsibility of the developer. These recommendations should be based on both the morning and evening peak hour projected volumes with an emphasis on the safety aspects of the designs.
- vi. Proposed driveway locations, geometrics, sight distances and turn restrictions taking into consideration the proximity of nearby intersections and anticipated queues based on arrival rates should be shown. Sight distance data at driveways using AASHTO procedures where horizontal and vertical alignments are critical should be included.
- vii. Impact of the development on the residential street network, signal warrants and mitigation techniques should be included wherever appropriate.
- viii. Concise summary of findings and recommendations for the approval.

C. ADDITIONAL INFORMATION

The following information may be requested to help analyze the report.

- a. Estimates of the cost of the recommended improvements and/or information on proposed street improvements in the area by the City, County or State Highway Department.
- b. A more intense analysis using network operational and simulation software such as SYNCHRO or CORSIM for special projects.

D. LEVELS OF ANALYSIS

The following guidelines are provided to help developers and their consultants determine the size of the area to study for a traffic impact analysis and the detail of the analysis that the city staff will request. There are three levels of analysis. Each one has a different emphasis and level of detail. Each development may have different or unique traffic issues and concerns that may require further study.

a. Level One - *ON SITE ANALYSIS*:

Issues: Placement and design of internal (one site) features such as parking layout, access to public streets, site circulation, intersection sight distance, pedestrian circulation, delivery and loading areas and internal public street layout.

Example: Small commercial or multi-family development, small residential subdivisions or an addition to an existing development that has a trip generation of 100 peak PM or less.

b. Level Two - *PROJECT AREA ANALYSIS*:

Issues: On site analysis (Level One) plus the impact of the development and its traffic on perimeter streets, adjoining developments, pedestrians and public transit facilities.

Example: Small to medium sized residential and commercial developments in new areas with peak PM trip generation in excess of 100.

c. Level Three - *CORRIDOR ANALYSIS*:

Issues: On site analysis (Level One) plus project analysis (Level Two) plus the impact of the proposed development on a larger study area and the street and highway system that is being impacted by the addition or improvement of arterial streets and by other large developments in the study area.

Example: Large commercial and residential developments.

TECHNICAL SPECIFICATIONS FOR PUBLIC IMPROVEMENT PROJECTS

Revised: August 2009

TABLE OF CONTENTS
TECHNICAL SPECIFICATIONS

	<u>Page</u>
<u>GENERAL PROVISIONS</u>	
<u>GP01 DEFINITIONS</u> -----	TS/GP-1
<u>GP02 REFERENCED STANDARDS</u> -----	TS/GP-1
<u>GP03 PERMIT FOR CONSTRUCTION</u> -----	TS/GP-2
<u>GP04 AUTHORITY OF THE ENGINEER</u> -----	TS/GP-2
<u>GP05 OBSERVATION OF THE WORK</u> -----	TS/GP-3
<u>GP06 HOURS OF WORK, WEEKEND OR HOLIDAY WORK</u> -----	TS/GP-5
<u>GP07 BONDS</u> -----	TS/GP-5
<u>GP08 CHANGES OF THE WORK</u> -----	TS/GP-5
<u>GP09 TRAFFIC CONTROL</u> -----	TS/GP-6
<u>GP10 DAMAGES</u> -----	TS/GP-6
<u>GP11 CLEANING UP</u> -----	TS/GP-6
<u>GP12 PROTESTS</u> -----	TS/GP-6
<u>GP13 ACCEPTANCE OF THE WORK</u> -----	TS/GP-6
<u>GP14 SHOP DRAWINGS AND ENGINEERING DATA</u> -----	TS/GP-7
 <u>SECTION 1000 - SITE PREPARATION</u>	
<u>1001 SCOPE</u> -----	TS/10-1
<u>1002 DEFINITIONS</u> -----	TS/10-1
<u>1003 UTILITY COORDINATION</u> -----	TS/10-2
<u>1004 LIMITS OF CONSTRUCTION</u> -----	TS/10-2
<u>1005 PROGRESS OF CONSTRUCTION</u> -----	TS/10-2
<u>1006 PROTECTION OF TREES AND SHRUBS</u> -----	TS/10-3
<u>1007 CONSTRUCTION STAKING</u> -----	TS/10-3
 <u>SECTION 1100 - GRADING</u>	
<u>1101 SCOPE</u> -----	TS/11-1
<u>1102 MATERIALS AND DEFINITIONS</u> -----	TS/11-1
<u>1103 CONSTRUCTION - GENERAL</u> -----	TS/11-2
<u>1104 EXCAVATION - GRADING</u> -----	TS/11-3
<u>1105 EMBANKMENT - GRADING</u> -----	TS/11-3
<u>1106 EMBANKMENT - BACKFILL AND COMPACTION</u> -----	TS/11-4
<u>1107 STRUCTURE BACKFILL</u> -----	TS/11-5
<u>1108 SHEETING AND SHORING</u> -----	TS/11-5
<u>1109 FINAL GRADING</u> -----	TS/11-5
<u>1110 CLEANUP</u> -----	TS/11-6
<u>1111 SETTLEMENT</u> -----	TS/11-6
<u>1112 TEMPORARY SURFACING</u> -----	TS/11-6
 <u>SECTION 1200 - SUBGRADE PREPARATION</u>	
<u>1201 SCOPE</u> -----	TS/12-1
<u>1202 DEFINITIONS</u> -----	TS/12-1
<u>1203 CONSTRUCTION REQUIREMENTS</u> -----	TS/12-1
<u>1204 MOISTURE CONTENT REQUIREMENTS</u> -----	TS/12-2
<u>1205 COMPACTION REQUIREMENTS</u> -----	TS/12-2
<u>1206 PROTECTION AND MAINTENANCE OF SUBGRADE</u> -----	TS/12-3
<u>1207 COMPACTION TESTING AND PROOF ROLLING</u> -----	TS/12-3
<u>1208 FLYASH SUBGRADE TREATMENT</u> -----	TS/12-4
<u>1209 CONSTRUCTION REQUIREMENTS</u> -----	TS/12-4

	Page
<u>SECTION 1300 - ASPHALTIC CONCRETE PAVEMENT</u>	
1301 SCOPE-----	TS/13-1
1302 GENERAL-----	TS/13-1
1303 SUBGRADE PREPARATION-----	TS/13-5
1304 TRANSPORTATION OF MIX-----	TS/13-5
1305 PLACING REQUIREMENTS-----	TS/13-5
1306 MECHANICAL PAVING MACHINES-----	TS/13-6
1307 COMPACTION REQUIREMENTS-----	TS/13-6
1308 BITUMINOUS TACK COAT-----	TS/13-7
1309 DENSITY AND SURFACE REQUIREMENT-----	TS/13-8
1310 PROTECTION OF PAVEMENT-----	TS/13-9
<u>SECTION 1400 - PORTLAND CEMENT CONCRETE PAVEMENT</u>	
1401 SCOPE-----	TS/14-1
1402 MATERIALS-----	TS/14-1
1403 CONSTRUCTION DETAILS-----	TS/14-1
1404 JOINTS-----	TS/14-2
1405 PLACING, FINISHING, CURING, AND PROTECTION-----	TS/14-4
1406 BACKFILL-----	TS/14-6
1407 JOINT SEALING AND CLEAN-UP-----	TS/14-7
1408 CONCRETE CURB-----	TS/14-7
1409 SURFACE TOLERANCES-----	TS/14-7
1410 THICKNESS TOLERANCES-----	TS/14-7
<u>SECTION 1500 - PAVEMENT MARKING</u>	
1501 GENERAL-----	TS/15-1
1502 HOT APPLIED TYPE-----	TS/15-1
1503 COLD APPLIED TYPE-----	TS/15-8
1504 PAINT APPLIED TYPE-----	TS/15-11
1505 MEASURING AND PREMARKINGS-----	TS/15-11
1506 REMOVAL OF EXISTING PAVEMENT MARKINGS-----	TS/15-11
1507 PLOWABLE REFLECTORS-----	TS/15-12
<u>SECTION 1600 - TRAFFIC CONTROL SIGNING</u>	
1601 SCOPE-----	TS/16-1
1602 GENERAL-----	TS/16-1
1603 MATERIALS-----	TS/16-1
1604 INSTALLATION-----	TS/16-5
1605 EXISTING SIGNS-----	TS/16-5
<u>SECTION 1700 - BIKE PATHS & SHARED LANES</u>	
1701 SCOPE-----	TS/17-1
1702 SIGNS-----	TS/17-1
1703 BIKE LANES-----	TS/17-1
1704 SHARED LANES-----	TS/17-1
1705 MATRIX-----	TS/17-2

	<u>Page</u>
<u>SECTION 2000 - CONCRETE</u>	
2001 SCOPE-----	TS/20-1
2002 GENERAL-----	TS/20-1
2003 MATERIALS-----	TS/20-1
2004 PRELIMINARY REVIEW-----	TS/20-1
2005 CONCRETE MIX DESIGNATIONS-----	TS/20-2
2006 LIMITING REQUIREMENTS-----	TS/20-2
2007 BATCHING AND MIXING-----	TS/20-3
2008 PLACEMENT-----	TS/20-3
2009 COLD WEATHER CONCRETING-----	TS/20-4
2010 HOT WEATHER CONCRETING-----	TS/20-4
2011 CURING AND PROTECTION-----	TS/20-4
2012 FORMS-----	TS/20-5
2013 FINISHING FORMED SURFACES-----	TS/20-5
2014 REPAIRING DEFECTIVE AND DAMAGED CONCRETE-----	TS/20-6
2015 REINFORCEMENTS-----	TS/20-6
2016 CONSTRUCTION JOINTS-----	TS/20-7
2017 EXPANSION AND CONTRACTION JOINTS-----	TS/20-7
2018 REINFORCED CONCRETE BOX FORMING SEQUENCE-----	TS/20-7
<u>SECTION 2100 - CONCRETE CURB, CURB & GUTTER, SIDEWALK, & DRIVEWAY ENTRANCES</u>	
2101 SCOPE-----	TS/21-1
2102 MATERIALS-----	TS/21-1
2103 GENERAL-----	TS/21-1
2104 GRADING AND SUBGRADE PREPARATION-----	TS/21-1
2105 EXPANSION AND CONTRACTION OR CONSTRUCTION JOINTS-----	TS/21-1
2106 FINISHING-----	TS/21-1
2107 REINFORCEMENT (CURB & GUTTER)-----	TS/21-1
2108 REINFORCEMENT (OTHER)-----	TS/21-1
<u>SECTION 2200 – STEEL BEAM GUARDRAIL</u>	
2201 SCOPE-----	TS/22-1
2202 MATERIALS-----	TS/22-1
2203 ERECTION-----	TS/22-1
<u>SECTION 2300 - TRAFFIC CONTROL</u>	
2301 GENERAL-----	TS/23-1
2302 STREET CLOSURES-----	TS/23-1
2303 EXISTING TRAFFIC SIGNS & FACILITIES-----	TS/23-1
2304 DETOURS-----	TS/23-1
2305 LOCAL & EMERGENCY TRAFFIC-----	TS/23-1
2306 PROTECTION OF PEDESTRIANS & VEHICULAR TRAFFIC-----	TS/23-2
2307 RESTRICTION OF PARKING-----	TS/23-2
2308 FLAGMEN-----	TS/23-2
2306 TRAFFIC CONTROL WITHIN & ABUTTING THE PROJECT-----	TS/23-2
2307 FLASHERS-----	TS/23-2
2308 TEMPORARY SURFACING-----	TS/23-2
<u>SECTION 2400 - PLANING</u>	
2401 SCOPE-----	TS/24-1
2402 EQUIPMENT-----	TS/24-1
2403 CONSTRUCTION DETAILS-----	TS/24-2

**SECTION 2500 - ASPHALT CRACK SEALING, IMPROVED STREET CHIP SEAL
SLURRY SEAL, & UNIMPROVED STREET SEAL**

<u>2501 SCOPE</u> -----	TS/25-1
<u>2502 CRACK SEALING</u> -----	TS/25-1
<u>2503 IMPROVED STREET CHIP SEAL</u> -----	TS/25-1
<u>2504 SLURRY SEAL</u> -----	TS/25-5
<u>2505 UNIMPROVED STREET SEALING</u> -----	TS/25-7
<u>2506 PROVISIONS FOR PUBLIC IMPROVEMENT CONVENIENCE DURING SEALING OPERATION</u> -----	TS/25-9

SECTION 3000 - SANITARY SEWERS

<u>3001 SCOPE</u> -----	TS/30-1
<u>3002 GENERAL</u> -----	TS/30-1
<u>3003 MATERIALS</u> -----	TS/30-1
<u>3004 ALIGNMENT</u> -----	TS/30-3
<u>3005 HANDLING</u> -----	TS/30-3
<u>3006 CLEANING</u> -----	TS/30-3
<u>3007 LAYING PIPE</u> -----	TS/30-3
<u>3008 JOINTING</u> -----	TS/30-3
<u>3009 TEMPORARY PLUGS</u> -----	TS/30-4
<u>3010 CONNECTIONS TO EXISTING PIPELINES AND STRUCTURES</u> -----	TS/30-4
<u>3011 WYE BRANCHES AND SADDLES</u> -----	TS/30-4
<u>3012 SERVICE CONNECTIONS</u> -----	TS/30-5
<u>3013 CONCRETE ENCASEMENT</u> -----	TS/30-5
<u>3014 WATER LINE CLEARANCES</u> -----	TS/30-5
<u>3015 SEWER MANHOLES</u> -----	TS/30-6
<u>3016 ACCEPTANCE TESTS FOR GRAVITY SEWERS</u> -----	TS/30-7
<u>3017 ACCEPTANCE TEST FOR MANHOLES</u> -----	TS/30-10
<u>3018 ACCEPTANCE TESTS FOR PRESSURE SEWAGE FORCE MAINS</u> -----	TS/30-11

SECTION 3100 - SANITARY SEWER MANHOLES

<u>3101 SCOPE</u> -----	TS/31-1
<u>3102 MATERIALS</u> -----	TS/31-1
<u>3103 STANDARD MANHOLES</u> -----	TS/31-2
<u>3104 CONSTRUCTION</u> -----	TS/31-2
<u>3105 DAMPPROOFING</u> -----	TS/31-2
<u>3106 CASTINGS</u> -----	TS/31-2
<u>3107 STUBLINES</u> -----	TS/31-3
<u>3108 CONNECTIONS TO EXISTING MANHOLES</u> -----	TS/31-3
<u>3109 PLASTIC MANHOLE STEPS</u> -----	TS/31-3
<u>3110 GRADE RINGS</u> -----	TS/31-3
<u>3111 ACCEPTANCE TESTING</u> -----	TS/31-3

SECTION 4000 - STORM SEWERS

<u>4001 SCOPE</u> -----	TS/40-1
<u>4002 REINFORCED CONCRETE PIPE</u> -----	TS/40-1
<u>4003 CORRUGATED METAL PIPE</u> -----	TS/40-1
<u>4004 SMOOTH INTERIOR CORRUGATED POLYETHELENE PIPE</u> -----	TS/40-4
<u>4005 CATCH BASINS, INLETS, AND JUNCTION BOXES</u> -----	TS/40-4
<u>4006 REINFORCED CONCRETE BOX CULVERTS</u> -----	TS/40-5
<u>4007 PAVED DITCHES AND RIPRAP</u> -----	TS/40-5
<u>4008 HEADWALLS, WINGWALLS, ENDWALLS, & END SECTIONS</u> -----	TS/40-5

	<u>Page</u>
<u>4009 RESTORATION OF SURFACE CONSTRUCTION</u>	TS/40-6
<u>4010 CONSTRUCTION DETAILS</u>	TS/40-6
<u>4011 DRAINAGE MAINTENANCE</u>	TS/40-10
<u>4012 DISPOSAL OF EXCESS EXCAVATED MATERIALS</u>	TS/40-11
<u>4013 SETTLEMENT</u>	TS/40-11

SECTION 4200 - STORM SEWER OPEN CHANNELS

<u>4201 SCOPE</u>	TS/42-1
<u>4202 MATERIALS</u>	TS/42-1
<u>4203 CONSTRUCTION DETAILS</u>	TS/42-3

SECTION 5000 - WATER LINES ----- to be coordinated with the appropriate water utility

SECTION 6000 - EXCAVATION, TRENCHING, AND BACKFILLING **(PIPELINE CONSTRUCTION)**

<u>6001 SCOPE</u>	TS/60-1
<u>6002 GENERAL REQUIREMENTS</u>	TS/60-1
<u>6003 CLASSIFICATION OF EXCAVATED MATERIALS</u>	TS/60-1
<u>6004 CLEARING</u>	TS/60-1
<u>6005 DEWATERING</u>	TS/60-2
<u>6006 SHEETING AND SHORING</u>	TS/60-2
<u>6007 ALIGNMENT AND GRADE</u>	TS/60-2
<u>6008 MINIMUM COVER (WATER MAINS)</u>	TS/60-2
<u>6009 STABILIZATION</u>	TS/60-3
<u>6010 TRENCH EXCAVATION</u>	TS/60-3
<u>6011 LIMITING TRENCH WIDTHS</u>	TS/60-3
<u>6012 UNAUTHORIZED TRENCH WIDTHS</u>	TS/60-3
<u>6013 MECHANICAL EXCAVATION</u>	TS/60-4
<u>6014 ARTIFICIAL FOUNDATIONS IN TRENCHES</u>	TS/60-4
<u>6015 PIPE BEDDING</u>	TS/60-4
<u>6016 PIPE INSTALLATION</u>	TS/60-5
<u>6017 TRENCH BACKFILL</u>	TS/60-6
<u>6018 STRUCTURE BACKFILL</u>	TS/60-7
<u>6019 DENSITY TESTING</u>	TS/60-7
<u>6020 TUNNEL AND CASING PIPE INSTALLATION</u>	TS/60-7
<u>6021 DRAINAGE MAINTENANCE</u>	TS/60-9
<u>6022 PROTECTION OF TRENCH BACKFILL IN DRAINAGE COURSES</u>	TS/60-9
<u>6023 DISPOSAL OF EXCESS EXCAVATED MATERIALS</u>	TS/60-9
<u>6024 SETTLEMENT</u>	TS/60-10

SECTION 6100 - BLASTING

<u>6101 GENERAL</u>	TS/61-1
<u>6102 PRE-BLASTING SURVEY</u>	TS/61-2
<u>6103 PUBLIC NOTIFICATION</u>	TS/61-3
<u>6104 WARNING SYSTEM</u>	TS/61-3
<u>6105 OVER-BLASTING</u>	TS/61-3
<u>6106 UTILITY NOTIFICATION</u>	TS/61-3
<u>6107 BLASTING SCHEDULE</u>	TS/61-3
<u>6108 BLASTING SIGNS, WARNINGS, AND ACCESS CONTROL</u>	TS/61-3
<u>6109 CONTROL OF ADVERSE EFFECTS</u>	TS/61-4
<u>6110 RECORDS OF BLASTING OPERATIONS</u>	TS/61-7
<u>6111 BLASTER</u>	TS/61-7

SECTION 6200 - TUNNELING, BORING AND JACKING (PIPELINES)

<u>6201 SCOPE</u> -----	TS/62-1
<u>6202 MATERIALS</u> -----	TS/62-1
<u>6203 CONSTRUCTION DETAILS</u> -----	TS/62-2

SECTION 7100 - CHAIN LINK FENCING

<u>7101 SCOPE</u> -----	TS/71-1
<u>7102 FENCE TYPE</u> -----	TS/71-1
<u>7103 MATERIALS</u> -----	TS/71-1
<u>7104 GATES</u> -----	TS/71-2
<u>7105 FENCE CONSTRUCTION</u> -----	TS/71-2

SECTION 7200 - SEEDING AND SODDING

<u>7201 SCOPE</u> -----	TS/72-1
<u>7202 GENERAL</u> -----	TS/72-1
<u>7203 MATERIAL</u> -----	TS/72-1
<u>7204 TIME OF SEEDING OR SODDING</u> -----	TS/72-2
<u>7205 APPLICATION OF FERTILIZER</u> -----	TS/72-3
<u>7206 PREPARATION OF SOD BED</u> -----	TS/72-3
<u>7207 PLACEMENT OF SOD</u> -----	TS/72-3
<u>7208 PREPARATION OF THE SEEDBED</u> -----	TS/72-3
<u>7209 PLACEMENT OF SEED</u> -----	TS/72-4
<u>7210 MULCHING</u> -----	TS/72-4
<u>7211 MAINTENANCE</u> -----	TS/72-4
<u>7212 GUARANTEE</u> -----	TS/72-5

SECTION 7300 - EROSION CONTROL

<u>7301 SCOPE</u> -----	TS/73-1
<u>7302 GENERAL</u> -----	TS/73-1
<u>7303 MATERIALS</u> -----	TS/73-1
<u>7303 MAINTENANCE</u> -----	TS/73-1

SECTION 8000 - MATERIALS TESTING

<u>8001 SCOPE</u> -----	TS/80-1
<u>8002 GENERAL</u> -----	TS/80-1
<u>8003 RESPONSIBILITIES OF THE CONTRACTOR OR DEVELOPER</u> -----	TS/80-1
<u>8004 RESPONSIBILITIES OF THE TESTING AGENCY</u> -----	TS/80-1
<u>8005 ASPHALT TESTING</u> -----	TS/80-1
<u>8006 CONCRETE TESTING</u> -----	TS/80-1
<u>8007 SOIL TESTING</u> -----	TS/80-2

LIST OF STANDARD DETAILS

<u>SD 13-1</u>	<u>TOTAL ASPHALT LOCAL STREET DETAIL</u>
<u>SD 13-2</u>	<u>TOTAL ASPHALT COLLECTOR STREET DETAIL</u>
<u>SD 13-3</u>	<u>TOTAL ASPHALT MINOR ARTERIAL STREET DETAIL</u>
<u>SD 13-4</u>	<u>TOTAL ASPHALT MAJOR ARTERIAL STREET DETAIL</u>
<u>SD 13-5</u>	<u>MONUMENT BOX DETAIL</u>
<u>SD 13-6</u>	<u>TYPICAL MEDIAN DETAIL (MINOR ARTERIAL)</u>
<u>SD 13-7</u>	<u>TYPICAL MEDIAN DETAIL (MAJOR ARTERIAL)</u>

<u>SD 14-1</u>	<u>CONCRETE PAVING - LOCAL STREET DETAIL</u>
<u>SD 14-2</u>	<u>CONCRETE PAVING - COLLECTOR STREET DETAIL</u>
<u>SD 14-3</u>	<u>CONCRETE PAVING - MINOR ARTERIAL STREET DETAIL</u>
<u>SD 14-4</u>	<u>CONCRETE PAVING - MAJOR ARTERIAL STREET DETAIL</u>
<u>SD 14-5</u>	<u>CONCRETE PAVING - JOINT DETAILS</u>
<u>SD 14-6</u>	<u>CONCRETE PAVING - JOINT SEALING DETAIL</u>
<u>SD 14-7</u>	<u>CONCRETE PAVING - ISOLATION JOINT DETAILS</u>
<u>SD 14-8</u>	<u>CONCRETE PAVING - JOINT LOCATIONS</u>

<u>SD 21-1</u>	<u>TYPE "CG-3" CURB AND GUTTER DETAIL (LAZY BACK)</u>
<u>SD 21-1A</u>	<u>TYPE "CG-2" CURB AND GUTTER DETAIL (ROLL BACK)</u>
<u>SD 21-2</u>	<u>TYPE "CG-1" CURB AND GUTTER DETAIL (UPRIGHT)</u>
<u>SD 21-3</u>	<u>TYPE "E" CONCRETE MEDIAN CURB & GUTTER</u>
<u>SD 21-4</u>	<u>4' SIDEWALK DETAIL</u>
<u>SD 21-5</u>	<u>5' SIDEWALK DETAIL</u>
<u>SD 21-6</u>	<u>8' BICYCLE TRAIL</u>
<u>SD 21-7</u>	<u>SIDEWALK DETAIL WITH ABUTTING RETAINING WALL</u>
<u>SD 21-8</u>	<u>SIDEWALK RAMP DETAIL</u>
<u>SD 21-9</u>	<u>COMMERCIAL & INDUSTRIAL ENTRANCE DRIVE DETAIL</u>
<u>SD 21-10</u>	<u>RESIDENTIAL DRIVE DETAIL</u>
<u>SD 21-11</u>	<u>RESIDENTIAL DRIVE AT NON-CURBED STREET</u>
<u>SD 21-12</u>	<u>PARKING LOT CURBING (TYPE B & C)</u>

<u>SD 30-1</u>	<u>CONCRETE ENCASEMENT DETAIL</u>
<u>SD 30-2</u>	<u>CONCRETE CRADLE DETAIL</u>
<u>SD 30-3</u>	<u>STANDARD DEEP TRENCH SERVICE RISER</u>
<u>SD 30-4</u>	<u>STANDARD DEEP TRENCH SERVICE RISER (IN ROCK)</u>
<u>SD 30-5</u>	<u>TAPPING SADDLE DETAIL</u>
<u>SD 30-6</u>	<u>CONCRETE COLLAR DETAIL</u>

<u>SD 31-1</u>	<u>STANDARD PRECAST MANHOLE DETAIL</u>
<u>SD 31-2</u>	<u>STANDARD DROP MANHOLE DETAIL</u>
<u>SD 31-3</u>	<u>STANDARD SHALLOW MANHOLE DETAIL</u>
<u>SD 31-4</u>	<u>CONNECTIONS TO EXISTING MANHOLES</u>
<u>SD 31-5</u>	<u>P.V.C. SEWER PIPE DETAILS</u>
<u>SD 31-6</u>	<u>GRADE RINGS</u>

LIST OF STANDARD DETAILS (CONTINUED)

<u>SD 40-1</u>	<u>STANDARD CURB INLET</u>
<u>SD 40-2</u>	<u>WALL SECTIONS (FOR CONCRETE CONSTRUCTION)</u>
<u>SD 40-3</u>	<u>STEEL FRAME DETAIL</u>
<u>SD 40-4</u>	<u>YARD INLET DETAIL</u>
<u>SD 40-5</u>	<u>STANDARD STORM SEWER PRECAST JUNCTION BOX</u>
<u>SD 40-6</u>	<u>SHALLOW JUNCTION BOX DETAIL</u>
<u>SD 40-7</u>	<u>AREA INLET DETAIL</u>
<u>SD 40-8</u>	<u>REINFORCED CONCRETE BOX</u>
<u>SD 40-9</u>	<u>HANDRAIL DETAIL</u>
<u>SD 40-10</u>	<u>TYPICAL END SECTION DETAIL</u>
<u>SD 40-10A</u>	<u>PRECAST END SECTION WITH TOE WALL</u>
<u>SD 40-11</u>	<u>UNDERDRAIN DETAIL</u>
<u>SD 50-8</u>	<u>END OF LINE ON CUL-DE-SAC</u>
<u>SD 60-1</u>	<u>EMBEDMENTS FOR CONDUITS</u>
<u>SD 60-2</u>	<u>ROADWAY CONDUIT CROSSING DETAIL (PUNCH METHOD)</u>
<u>SD 60-3</u>	<u>TRENCHING UNDER FUTURE STREET</u>
<u>SD 70-1</u>	<u>STREET PATCH DETAIL</u>
<u>SD 73-1</u>	<u>EROSION CONTROL SILT FENCE DETAIL</u>
<u>SD 73-2</u>	<u>EROSION CONTROL HAY BALE DETAIL</u>
<u>SD 73-3</u>	<u>EROSION CONTROL GRAVEL FILTER BAG</u>
<u>SD 73-4</u>	<u>ROCK CONSTRUCTION ENTRANCE</u>
<u>SD 80-1</u>	<u>CHANNELIZING DEVICES & HIGH LEVEL WARNING DEVICES</u>
<u>SD 80-2</u>	<u>END OF PAVEMENT TYPE III BARRICADE</u>
<u>SD 80-3</u>	<u>END OF PAVEMENT OBJECT MARKER</u>
<u>SD 80-4</u>	<u>TRAFFIC STREET SIGN DETAIL</u>

APWA EROSION & SEDIMENT CONTROL STANDARD DRAWINGS

ESC-01 through ESC-45

GENERAL PROVISIONS

The provisions in this section shall be considered as applicable to all parts of these specifications including all revisions or supplements.

GP01 DEFINITIONS. Whenever the following words, phrases, or abbreviations appear in these specifications, they shall have the following meanings:

1. City shall mean the City of Raytown, Missouri, a municipal corporation, acting by and through its duly elected governing body and its duly appointed officials.
2. Engineer shall mean the Public Works Director/City Engineer of the City of Raytown or his authorized representatives acting on behalf of the City.
3. Design Engineer shall mean a licensed engineer under contract to the developer or the City of Raytown for the purpose of preparing and sealing engineering design drawings for a specific public improvement project.
4. Inspector shall mean an authorized representative of the City Engineer who has been assigned to assure conformance to the requirements of these specifications by the contractor.
5. Contractor shall mean a person, partnership, or corporation duly licensed and bonded to the City of Raytown performing construction operations within the City of Raytown.
6. Bond shall mean performance and maintenance bonds and other instruments of security furnished by the contractor and his surety in accordance with these specifications.
7. Day shall mean a calendar day of twenty-four (24) hours measured from midnight to the next midnight.
8. Substantial Completion shall mean a finishing of the construction, in accordance with the contract documents as modified by any change orders agreed to by the Contractor and the City of Raytown MO, to the extent that the public entity can use or occupy the public works or use or occupy the specified area of the public works for the use for which it was intended.
9. Whenever the words *as directed*, *as required*, *as permitted*, or words of like meaning are utilized it shall be understood that the directions, requirements, or permission of the engineer is intended. Similarly, the words *approved*, *acceptable*, and *satisfactory* shall refer to approval of the engineer.

GP02 REFERENCED STANDARDS. Whenever references are made to standard specifications, methods of testing, materials codes, practices, and requirements it shall be understood that the latest revision of said references shall govern unless a specific revision is stated. Wherever any of the following abbreviations appear they shall have the following meaning:

AASHTO American Association of State Highway and Transportation Officials

ACI	American Concrete Institute
AISC	American Institute of Steel Construction, Inc.
ASA	American Standards Association
ISO	Insurance Services Office
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
ANSI	American National Standards Institute, Inc.
MODOT	Standard Specification for State Road and Bridge Construction, Missouri Department of Transportation, latest edition.

Where the words *these specifications* appear or where words of similar connotation are used it shall be understood that such reference refers to the Technical Specifications and Design Criteria for Public Improvement Projects of the City of Raytown.

GP03 PERMIT FOR CONSTRUCTION. No construction of any private street or public improvement project shall be undertaken until the following criteria and requirements have been fully met.

1. Contract plans and specifications have been submitted to and approved by the City Engineer.
2. A suitable performance and maintenance bond has been submitted and approved by the engineer and placed on file with the City.
3. A contract for City inspection, executed by the contractor/developer, and a copy of the bid proposal for construction has been submitted to and approved by the City Engineer.
4. City of Raytown Occupational Licenses for the contractor and all subcontractors.
5. Five (5) working days advance notification from the contractor prior to actual start of work must be received by the City Engineer.

Compliance with the above shall constitute a permit for construction activities. Work discovered underway not complying to these requirements shall be ordered to cease and shall not be allowed to commence until such requirements have been met.

GP04 AUTHORITY OF THE ENGINEER. The City Engineer is designated by the City of Raytown 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 these specifications. The engineer shall be represented by a project inspector to check any and all work performed, including all materials to be incorporated in the work, and all construction methods and practices. The engineer shall have the sole authority to issue, in writing; any deviations from the provisions of these specifications or changes to any previously approved drawing.

GP05 OBSERVATION OF THE WORK.

1. General:

- A. All materials and workmanship shall be subject to observation, examination, or test by the City of Raytown and the engineer or his representative at any and all times during construction and at any and all places where such construction is carried on. The City of Raytown shall have the authority to reject defective material and workmanship or require its correction. Unacceptable workmanship shall be satisfactorily corrected. Rejected material shall be promptly segregated and removed from the project area and replaced with material of the specified quality to the satisfaction of the engineer. If the contractor fails to proceed at once with correction of rejected workmanship or defective material, the City of Raytown may contract or otherwise have the defects remedied or rejected materials removed from the project area and charge the cost of the same against the contractor, without prejudice to any other rights or remedies of the City of Raytown.
- B. The contractor shall have available on the work site at all times one copy of the plans and these technical specifications. He shall give the work the constant attention necessary to facilitate the progress thereof and shall cooperate with the City Engineer, his inspectors, and other contractors in every way possible. The contractor shall designate and have on the work site at all times, as his agent, a competent superintendent capable of reading and thoroughly understanding the plans and specifications, who shall receive instructions from the engineer or his authorized representatives. The superintendent shall have full authority to execute the orders or directions of the engineer without delay and to supply promptly such materials, tools, plant equipment, and labor as may be required. Such superintendent shall be furnished irrespective of the amount of work sublet.
- C. The contractor shall at all times employ sufficient labor and equipment for prosecuting the several classes of work to full completion in the manner and time, as applicable, required by these specifications.

All workmen shall have sufficient skill and experience to perform properly the work assigned to them. Workmen engaged in special work or skilled work shall have sufficient experience in such work and in the operation of the equipment required to perform all work properly and satisfactorily.

Any person employed by the contractor or by any subcontractor who, in the opinion of the engineer, does not perform his work in a proper and skillful manner or is intemperate or disorderly shall, at the written request of the engineer, be removed forthwith by the contractor or subcontractor employing such person, and shall not be employed again in any portion of the work without the approval of the engineer.

Should the contractor fail to remove such person or persons as required above, or fail to furnish suitable and sufficient personnel for the proper prosecution of the work, the engineer may suspend the work by written notice until such order(s) is/are complied with.

- D. The contractor shall furnish promptly all materials reasonably necessary for any tests which may be required. All tests by the City of Raytown will be performed in such manner as not to delay the work unnecessarily and will be made in accordance with the provisions of the Technical Specifications.
- E. The contractor shall notify the City of Raytown sufficiently in advance of backfilling or concealing any facilities to permit proper observation. If any facilities are concealed without approval or consent of the City of Raytown, the contractor shall uncover for observation and recover such facilities all at his own expense, when so requested by the City of Raytown.
- F. Neither observing, testing, approval nor acceptance of the work in whole or in part, by the City of Raytown or its agents shall relieve the contractor or his sureties of full responsibility for materials furnished or work performed not in strict accordance with the specifications.
- G. Any change or deviation from the approved plans and specifications that has been approved by the engineer must be received by the inspector in writing prior to implementing the change. The inspectors are not authorized to alter any provisions or to issue instructions contrary to these specifications, or to make any revisions to any previously approved drawing.

2. Defective Work:

- A. The term "defective" is used in these documents to describe work that is unsatisfactory, faulty, not in conformance with the requirements of the specifications, or not meeting the requirements of any observation, test, approval, or acceptance required by law or the specifications.
- B. Any defective work may be disapproved or rejected by the City at any time before final acceptance even though it may have been overlooked and included in a previous pay estimate.
- C. Contractor shall furnish samples of questionable equipment or materials from completed work for testing purposes when required by the engineer. The contractor shall pay all costs in connection with the testing of equipment and materials proven to be defective.

3. Uncovering Work:

- A. If any work is covered without concurrence of the inspector it must, if requested by the inspector, be uncovered for his observation. Such work will be at the contractor's expense unless the contractor has given the inspector timely notice and the inspector has not acted within a reasonable time.
- B. Should it be considered necessary or advisable by the City of Raytown, at any time before final acceptance of the entire work to make an examination of work already completed by and previously approved to being covered up by uncovering the same, the contractor shall on request promptly furnish all necessary facilities, labor, and material. If such work is

found to be defective in any important or essential respect, the contractor shall defray all the expenses of such examination and of satisfactory reconstruction. If, however, such work is found to meet the requirements of the specifications, the actual cost of labor and materials necessarily involved in the examination and replacement, plus 15 percent of such cost to cover superintending, general expenses and profit, shall be allowed the contractor and he shall, in addition, if completion of the work of the entire contract has been delayed thereby, be granted a suitable extension of time on account of the additional work involved.

GP06 HOURS OF WORK, WEEKEND OR HOLIDAY WORK. Work on Saturdays or legal holidays shall be as approved by the City Engineer. Requests for permission to work on legal holidays shall be considered upon advance notification of a minimum of five (5) working days prior to the anticipated date of the work to be performed. Sunday work shall not be permitted under any circumstance. The use of artificial light to permit night work shall not be permitted except in emergency situations.

Work will not be permitted prior to 7:00 a.m. and all work shall be completed prior to 7:00 p.m. The only exception to this is that no work will be permitted after sunset or before sunrise. Additionally, no paving operations will be permitted to start after 3:00 p.m., which cannot be completed by 5:00 p.m. Requests for permission to work overtime (beyond 5:00) shall be made directly to the attending project inspector by 12:00 noon that day. **Requests for permission to work on Saturdays shall be received no later than 3:00 p.m. the Thursday prior to the Saturday in question.**

Legal holidays observed by the City of Raytown are New Year's Day, Martin Luther Kings' Day, Presidents' Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day including the following Friday, and Christmas. The actual days off for these holidays may vary and in certain situations additional days may be a part of the amount of time granted as an official holiday by the City of Raytown. It shall be the contractor's responsibility to obtain these days prior to the actual request for inspection services.

GP07 BONDS. A suitable performance and maintenance bond shall be furnished to the City of Raytown guaranteeing the proper completion and maintenance of the construction involved in the public improvement project. The performance bond shall be in an amount equivalent to the full cost of the improvement. The maintenance bond shall remain in effect for a period of two (2) years for all public improvement projects and shall be in an amount of twenty-five percent (25%) of the full cost of the improvement.

No project shall be accepted by the City prior to the submittal and acceptance of the maintenance bond by the City Engineer.

GP08 CHANGES IN THE WORK. Changes in the work from the approved project plans shall be made only upon the written consent of the City Engineer. All proposed changes must be submitted to the City Engineer (by the design engineer) to receive written approval by the City. The inspector prior to implementing the deviation shall receive said written approval. Any change in the work made without the consent of the City Engineer shall be subject to removal by the contractor at their expense.

GP09 TRAFFIC CONTROL. The flow of traffic in streets and access to private property shall be reasonably maintained at all times. The contractor shall provide a safe roadway, and shall erect and maintain warning signs, barricades and sufficient safeguards around all excavations, embankments, and obstructions. The contractor shall provide suitable warning lights or flares and shall keep them lighted from one-half hour prior to sunset until one-half hour after sunrise and all other times when visibility is limited. The contractor shall further provide such flagmen and watchmen as required by the engineer or inspector for the protection of the public. The design, placement and maintenance of traffic control devices shall correlate with and so far as possible conform to the system set forth in the most recent edition of the Manual on Uniform Traffic Control Devices for Streets and Highways. The roadway shall be properly maintained and the contractor shall coordinate his operations with the City Engineer in order that suitable arrangements may be made for detours, parking, and access to private property, etc. Whenever a street is closed or partially closed, the City of Raytown Public Safety Department shall be notified of the closing, and also when normal service is resumed. In the event it is determined that the contractor is not maintaining a safe roadway, the engineer may improve the roadway conditions at the contractor's expense.

GP10 DAMAGES. The contractor hereby expressly binds himself or itself to indemnify and save harmless the City of Raytown and its officers and employees against all suits or actions of every kind and nature brought or which may be brought, or sustained by any person, firm, or corporation, or persons, firms or corporations, in connection with or on account of the contractor's work or in consequence of any negligence in connection with same, or on account of any poor workmanship, or on account of any act of commission or omission of the contractor or his, its, or their agent or employees, or for any cause arising during the course of construction.

GP11 CLEANING UP. The contractor shall frequently clean up all refuse, rubbish scrap materials, mud and dirt clods from street, and debris as a result of his operations, so that at all times the site of the work shall present a neat, orderly, and workmanlike appearance. Upon completion of the work, the contractor shall remove from the site and any occupied adjoining property, all plants, buildings, rubbish, unused materials, form lumber, and other materials belonging to him or his subcontractor. Any costs incurred by the City due to failure by the contractor to clean up to the City's satisfaction will be charged to the account of the contractor or his surety.

GP12 PROTESTS. If the contractor considers any work demanded of him by the inspector to be outside the requirements of the specifications, he shall immediately ask for a written decision or instructions and shall proceed to perform the work to conform with the inspector's ruling. If the contractor considers such instructions unsatisfactory, he shall, within twenty-four (24) hours after their receipt, file a written protest with the engineer, stating his objections and the reasons therefore. Unless protests or objections are made in the manner specified and within the time limit stated herein, the contractor hereby waives all grounds for protest.

GP13 ACCEPTANCE OF WORK.

1. Partial Acceptance. The City reserves the right to accept and make use of any completed section of the work without obligating the City to accept the remainder of the work or any portion thereof; however, the warranty period shall start when the project is complete and the City has issued the Project Completion Certificate.

2. Substantial Completion. Upon completion of the entire infrastructure of the project and acceptance by the City so that the public entity may have use of, or occupy the public works for the use of which it was intended, the contractor may submit in writing to the City of Raytown a request for 'substantial completion' of the project. The City Engineer or his representative will then review the project for completeness. If in the opinion of the City the project is not yet ready for public use, the City will submit back to the Contractor a letter stating the reason for the denial of 'substantial completion' and a "punch list" of items to be completed and/or corrected. If in the opinion of the City the project is ready for public use, the City will submit back to the Contractor a letter stating that the project is 'substantially complete' with an effective 'substantial completion' date, a "punch list" of items that still need to be completed and/or corrected, and a number of working days to complete the "punch list" items. The City will then pay the Contractor the balance of the contract, less any liquidated damages or penalties, retaining 200% of the value of the items on the "punch list" until 'Final Acceptance'.
3. Final Acceptance. When the final clean up has been performed, the contractor shall notify the inspector in writing that all work has been completed. At the same time, the contractor shall notify the design engineer that the project has been completed and should forward to the engineer all changes he has noted on his plans during the course of the work. Upon receiving such notification, the design engineer shall compute any changes in the original contract amount and send a letter to the City verifying the final contract amount. Within a reasonable time the inspector shall perform all necessary inspection procedures on the completed work. The contractor shall receive written notification of any defects in the project. The Project Completion Certificate will be issued after all defects have been corrected and all fees for inspection services have been paid.

The City will re-inspect the project prior to the expiration of the maintenance bond. Any defects noted as a result of this inspection shall be corrected by the contractor at his expense upon written notification by the City.

GP14 SHOP DRAWINGS AND ENGINEERING DATA.

Engineering data covering all equipment and fabricated materials which will become a permanent part of the work shall be submitted to the Engineering Services Department for review. This data shall include drawings and descriptive information in sufficient detail to show the kind, size, arrangement, and operation of component materials and devices; the external connections, anchorages, and supports required; performance characteristics; and dimensions needed for installation and correlation with other materials and equipment.

All submittals, regardless of origin, shall be stamped with the approval of the contractor & identified with the City project number, contractor's name, & references to applicable specification paragraphs & drawings. Each submittal shall indicate the intended use of the item in the work. When catalog pages are submitted, applicable items shall be clearly identified. The current revision, issue number, and date shall be indicated on all drawings & other descriptive data.

The contractor's stamp of approval is a representation to the City and the City Engineer that the contractor accepts full responsibility for determining and verifying all quantities, dimensions, field construction criteria, materials, catalog numbers, and similar data, and that he has reviewed or coordinated each submittal with the requirements of the work.

Each submittal shall include a statement prepared by the originator of the drawings and data certifying compliance with the City technical specifications except for deviations that are specifically identified.

All deviations from the City technical specifications shall be identified on each submittal and shall be tabulated in the contractor's letter of transmittal. Such submittals shall, as pertinent to the deviations, indicate essential details of all changes proposed by the contractor (including modifications to other facilities that may be a result of the deviation) and all required piping and wiring diagrams.

The contractor shall accept full responsibility for the completeness of each submission, and, in the case of re-submission, shall verify that all exceptions previously noted by the City Engineer have been taken into account. In the event that more than one re-submission is required because of failure of the contractor to account for exceptions previously noted, the contractor may be required to reimburse the engineer for the charges of the engineer for review of the additional re-submissions.

Any need for more than one re-submission, or any other delay in obtaining the City Engineer's review of submittals, will not entitle the contractor to extension of the contract time unless delay of the work is directly caused by a change in the work authorized by a Change Order or by failure of Engineering to return any submittal within twenty-one (21) days after its receipt in the City Engineer's office.

The City Engineer's review of drawings and data submitted by the contractor will cover along general conformity to the drawings and specifications, external connections, and dimensions that affect the layout. The City Engineer's review does not indicate a thorough review of all dimensions, quantities, and details of the material, equipment, device, or item shown. The City Engineer's review of submittals shall not relieve the contractor from responsibility for errors, omissions, or deviations, nor responsibility for compliance with the City technical specifications.

Three (3) copies (or one reproducible copy) of each drawing and necessary data shall be submitted to the City Engineer. The engineer will not accept submittals from anyone but the contractor. Submittals shall be consecutively numbered in direct sequence of submittal and without division by subcontracts or trades. Re-submittals shall bear the number of the first submittal followed by a letter (A, B, etc.) to indicate the sequence of the re-submittal.

When the drawings and data are returned marked *NOT ACCEPTABLE* or *RETURNED FOR CORRECTION*, the corrections shall be made as noted thereon and as instructed by the City Engineer and three (3) corrected copies (or one corrected reproducible copy) resubmitted.

When corrected copies are resubmitted, the contractor shall, in writing, direct specific attention to all revisions and shall list separately any revisions made other than those called for by the City Engineer on previous submissions.

When the drawings and data are returned marked *EXCEPTIONS NOTED*, *NO EXCEPTIONS NOTED*, or *RECORD COPY*, no additional copies need be furnished. Distribution of acceptable submissions shall be as follows: Two (2) copies to the City and one (1) copy to the contractor.

SECTION 1000 - SITE PREPARATION

1001 SCOPE. This section covers the necessary clearing, grubbing, demolition, and other appurtenant work at the locations shown on the contract drawings.

1002 DEFINITIONS.

- a. Clearing. Clearing shall consist of the removal of all vegetable matter, such as trees, brush, down timber, rotten wood, sod, rubbish, and other objectionable combustible materials found on or above the surface of the site. It shall include the removal of wood buildings, fences, lumber, waste dumps, abandoned utilities, and trash, the salvaging of such materials as may be specified, and the disposal of the debris. The Contractor shall scalp all excavation and embankment areas. Scalping shall include the removal of material such as sod, grass, residue or agricultural crops and decayed vegetable matter from the surface of the ground without removing more earth than is necessary
- b. Grubbing. Grubbing shall consist of the removal of all stumps, roots, buried trees and brush, and other objectionable combustible materials appearing on or below the surface of the ground which has not been included under the definition of "*Clearing*" above. In all cases of grubbing, the vegetable matter shall be removed to a minimum depth of 12 inches below ground line or subgrade; whichever is lower, except as provided in the definition of "*Demolition*" below. When deleterious materials are encountered below ground line, which may be detrimental to the proposed improvement, these shall be removed to a depth necessary to provide adequate support for the proposed improvement
- c. Demolition. Demolition shall consist of the destruction and removal or incorporation into embankment all non-vegetable matter appearing above, on, or below the ground surface. This shall include, but not be limited to, all material derived from the demolition of portland cement concrete items such as base courses, curbs, curb and gutters, sidewalks, floors, steps, driveways, drainage structures of all sorts, guard fences, and other miscellaneous items such as foundations or walls of any sort, and iron or steel items, and asphaltic items such as pavement and base courses.

Items such as fences and guardrails shall be salvaged and relinquished to the appropriate owner or relocated, where indicated on the plans.

Relocation of signs, fences, guardrails, etc. shall be considered incidental to removal work except where such relocation is listed separately in the itemized Proposal.

All pipes, which are to be abandoned, shall be removed unless otherwise shown on the plans or approved by the Engineer.

In removing items such as portland cement concrete pavement, base courses, curbs, curb and gutters, sidewalks, and similar objects where portions of said objects are to be left in place, they shall be removed to an existing joint or to a new joint sawed to a minimum depth of two (2) inches or 1/4 the slab thickness, whichever is greater, with a true line and vertical face.

Sufficient portions of these objects shall be removed to provide for the proper grade and connection to the new work.

- d. Trees. Vegetable growth 6 inches in diameter and greater, measured 3 feet above ground shall be classified as a tree.
- e. Brush. Vegetable growth less 6 inches in diameter, measured 3 feet above ground shall be classified as brush.

1003 UTILITY COORDINATION. The contractor shall be responsible for protecting any improvement of any agency, public or private, in the vicinity of clearing, grubbing or demolition operations. When necessary, the contractor shall enlist the assistance of the affected agencies in the location of their utilities. The contractor will not be responsible for the cost to any agency for assistance in the location of its facilities, but he shall be responsible for the cost of all damage to such facilities arising from his carelessness or negligence.

1004 LIMITS OF CONSTRUCTION. In developed and semi-developed areas, the limits for clearing, grubbing, and demolition shall be as defined on the plans or specified in the Special Conditions but in no case shall work extend beyond the limits of the right-of-way, City property lines, or easements.

In undeveloped areas where improvements are limited or non-existent, clearing, grubbing, and demolition shall not extend beyond the right-of-way, City property lines, or easement unless otherwise shown on the contract drawings or specified in the Special Conditions.

1005 PROGRESS OF CONSTRUCTION.

- a. Clearing. Clearing shall proceed well in advance of the construction operation so as not to delay the progress of the work. The refuse resulting from clearing may be hauled to a waste site secured by the contractor or shall be burned or buried in such a manner as to meet all laws, regulations, and requirements of any governing authority regarding health, safety, and public welfare. When authorized by the Fire Department, the contractor may dispose of such refuse by burning on the site of the project, provided all requirements as determined by the Fire Department are met. Under no circumstances will the authorization to burn on the site relieve the contractor in any way from damages, which may result from his operations. In no case shall any materials be left on the project site, shoved into abutting properties, or buried in embankments or trenches on the site.
- b. Grubbing. **Erosion control measures shall be in place prior to the start of grubbing operations.** Grubbing shall parallel the clearing as nearly as the sequence of operations will permit. Except for the special circumstances enumerated below, all stumps, roots, and other objectionable matter within the construction area shall be removed to a minimum depth of twelve (12) inches below the subgrade or the original ground, whichever is lower. All stumps, roots, and other objectionable matter outside the limits of the construction area but within the right-of-way shall be cut off flush with the ground.

All stumps, roots, and other objectionable matter within the specified limits of embankments having a depth of two (2) feet or less shall be removed and disposed of. Piling and butts of

utility poles within the limits shall be removed to a minimum depth of two (2) feet below the subgrade or the original ground, whichever is lower.

All stumps, roots, and other objectionable matter found within borrow material to be used for embankment or fill material shall be removed.

All stumps, roots, and other objectionable matter found within the bottoms or sidewalls of excavation and trenching areas shall be completely removed from the respective bottom areas, and removed to a minimum depth of twelve (12) inches below the respective sidewalls.

- c. Demolition. Demolition work shall occur well in advance of the construction operation. Masonry and concrete walls, miscellaneous foundations, or other objects extending below ground shall be removed to a depth of at least twelve (12) inches below the original ground or the subgrade, whichever is lower.

When explosives are used in demolition, the contractor shall comply with the provisions of Specification Paragraph 6100 "Blasting".

In removing items such as portland cement concrete pavement, base courses, curbs, curb and gutters, gutters, sidewalks, and similar objects where portions of said objects are to be left in place, they shall be removed to an existing joint or to a new joint sawed to a minimum depth of one (1) inch with a true line and vertical face. Sufficient portions of these objects shall be removed to provide for the proper grade and connection to the new work.

All materials with the exception of those which are designated for salvage or which are used in the embankment in conformance with this specification, shall become the Contractor's property and shall be disposed of by him, outside the project limits unless otherwise indicated on the plans.

- 1006 PROTECTION OF TREES AND SHRUBS. During their construction operation, the contractor shall leave in place and protect from damage all trees, shrubbery, and flower beds unless shown on the drawings to be removed. Where trees existing on the project site are not to be removed, it shall be the responsibility of the contractor to trim low branches, which would interfere with the normal operation of his equipment. The trimming shall be performed in a professional manner prior to any machine operation.

- 1007 CONSTRUCTION STAKING. The contractor shall, unless otherwise provided for, set construction stakes establishing lines, slopes, profile grades in roadway work, and center line and bench marks (hubs) for structure work and appurtenances as he may deem necessary and shall furnish the contractor with all necessary information relating to lines, slopes and grades. These stakes and marks shall constitute the field control by and in accordance with which the contractor shall establish other necessary controls and perform the work.

The contractor shall be responsible for giving the engineer reasonable notice of intent to perform work in a particular area of the project in order to afford the contractor sufficient time to set construction stakes establishing, lines, slopes and profile grades. For roadway work, the contractor will set construction stakes establishing, lines, slopes and profile grades and will furnish the contractor with all necessary information relating to these lines, slopes and grades. These stakes

and marks will constitute the field control by and in accordance with which the contractor shall establish other necessary controls and perform the work. For structures, the contractor will stake and reference those centerlines and layout lines used as dimensional references on the plans and provide a bench mark (hubs) at each structure location. The contractor shall be responsible for all other lines, locations, alignment, grade elevations and any other necessary control by use of engineering instruments or other tools or methods as required to build the structure.

The contractor shall be responsible for the preservation of all stakes and marks, and if any construction stakes or marks are carelessly or willfully destroyed or disturbed by the contractor, the cost of replacing them may be charged against him and deducted from the payment for the work.

SECTION 1100 - GRADING

1101 SCOPE. This section covers the performance of all the work and appurtenances required for grading the project in coordination with all previous work performed at the locations shown on the contract drawings.

1102 MATERIALS AND DEFINITIONS.

- A. Grading. Grading shall be defined as meaning the performance of all excavation, embankment and backfill in connection with the construction of all improvements.
- B. Excavation. Excavation is defined as the removal of materials from the construction area to the lines and grades as shown on the contract drawings.

Unless otherwise provided for in the Special Conditions and included in the proposal, all excavation shall be Unclassified Excavation and the contractor shall satisfactorily remove and dispose of all materials encountered regardless of their nature.

When provided for in the Special Conditions and included in the proposal, the excavation may be classified according to the following categories.

1. Common Excavation. Suitable materials shall include all earth free of rock, sod, weeds, roots and other debris, and containing the soil characteristics and moisture content to obtain the required compaction.
 2. Rock Excavation. Rock excavation is defined as the removal of all rock ledges 6 inches or more in thickness, and detached rock or boulders having a volume of more than 1 1/2 cubic yards and shale occurring in its natural state, hard and unweathered. A rock ledge is defined as a continuous body of rock which may include thin interbedded seams of shale or other soft materials less than 12 inches thick. The vertical limit of each ledge shall be defined by interbedded seams of soft materials 12 inches in thickness. The beds of soft interbedded material 12 inches in thickness shall not be included in the measurement of "Rock Excavation" but shall be included in the measurement for "Common Excavation".
- C. Embankment or Backfill. Embankment or backfill is defined as the placing and compacting of material in the construction area to the lines and grades as shown on the contract drawings.

Material suitable for use as embankment shall be entirely imperishable and shall be determined as acceptable by the Engineer.

Materials suitable for earth embankment shall be free of waste material, contain less than ten (10) percent by volume of rock and gravel, and contain no particles having a dimension greater than three (3) inches.

Materials suitable for rock embankment shall be free of waste material and contain ten (10) percent or greater by volume of rock or gravel containing particles ranging in size from a minimum dimension of three inches (3") to a maximum of twenty-four inches (24").

Material not suitable for use as embankment material shall include, but shall not be limited to, frozen material, organic material, topsoil, rubbish, rock, broken concrete, brick, asphaltic concrete, and other debris and soil not containing the characteristics and moisture content to obtain the required compaction.

D. Structures. Structures, as used herein, refer to bridges, basins, street drainage structures, headwalls, retaining walls, and similar construction.

1103 CONSTRUCTION - GENERAL. The contractor shall adhere to any and all statutes regarding the notification of utilities prior to beginning any work within public right-of-way. Relocation or protection of any existing utilities, located in street right-of-way, shall be governed by the applicable section of these Specifications. The relocation and/or protection of any utility that is shown on the plans, that lies within a utility easement and is endangered by this construction shall be the responsibility of the contractor.

The contractor shall make every reasonable effort to protect private facilities. These facilities may not be shown on the plans. When these facilities are disturbed or damaged by work, the contractor shall make necessary arrangements for repairs to the facilities for continuous service prior to the close of that workday.

It shall be the responsibility of the contractor to protect all property lot corners and control monumentation. Should it be necessary to disturb such monument, whether stake, pin, bar, disk, box, or other, it remains the responsibility of the contractor to reference such markers prior to removal, reset them, and file such relocations or monumentation documents as the law may require. Any such references, removal, replacement and certification of monuments shall be performed by a surveyor, registered and licensed in the State of Missouri. A copy of all such certification documents shall be provided to the Engineer prior to completion to the project. Any monument destroyed or improperly reset by the contractor may be replaced by the Engineer to the standards required by law at the expense of the contractor.

Grading, excavation, and backfilling for all improvements, shall be made to the lines, grades, and cross section indicated by the plans.

In addition, to any erosion control measures shown on the plans, the contractor shall schedule and conduct his operation in such a manner and shall provide any necessary control facilities to protect downstream and adjacent properties, including structures, from pollution, sedimentation or erosion caused by the grading operations. Any pollution or damage occurring as a result of the work shall be the responsibility of the contractor.

During construction the graded area shall be maintained by the contractor in such condition that it will be well drained at all times. Roadway ditches, channel changes, inlet and outlet ditches and other ditches in connection with the roadway shall be cut and maintained to the required cross section. All drainage work shall be performed in proper sequence with other operations. All ditches and channels shall be kept free of debris or obstructions.

1104 EXCAVATION - GRADING. Excavation of every character and of whatever materials encountered within the construction limits shall be performed to the lines and grades indicated on the contract drawings.

All suitable material removed by excavation shall be used as far as practicable in the formation of embankments or elsewhere when and as directed by the Engineer. It shall be the responsibility of the contractor to handle excavation in any manner he sees fit, provided that suitable materials will be available when required. No additional compensation will be allowed for any special sequence of excavating or placing of such materials or any re-handling of materials.

Excavation materials in excess of the amount needed to complete the grading shall be considered as waste material, which shall be removed from the site by and at the expense of the contractor.

Any additional fill material required which is not available from excavation within the construction limits shall be supplied by the contractor at no expense to the owner unless provided for in the proposal and Special Conditions. All such material brought to the site and incorporated in the work shall be subject to the approval of the Engineer.

In the event during grading operations materials are encountered below grade or otherwise which are determined as being unsuitable or unstable by the Engineer or his representative they shall be removed to the depth required reaching stable material. The area involved shall then be backfilled with suitable material as determined by the Engineer and compacted to obtain the required density.

All roadway excavation in rock (shale, sandstone, limestone) shall be undercut no less than 12" for the full width of the roadway and backfilled with suitable soil or granular material. Undercut shall be unclassified excavation.

1105 EMBANKMENT - GRADING. The embankments shall be formed with suitable materials, as herein defined, procured from excavations made on the project site, or from borrow pits as required to complete the grading work.

Where embankments, regardless of height, are placed against hillsides or existing embankments, either of which have a slope steeper than one (1) vertical to six (6) horizontal, the existing slope shall be benched or stepped in approximately eighteen-inch (18") rises as the new fill is brought up in eight-inch (8") lifts. Benching shall be of sufficient width to permit operations of placing and compacting equipment. Each horizontal cut shall begin at the intersection of the original ground and the vertical sides of the previous cuts. Materials thus cut out shall be recompacted to the required density along with the new embankment material. Material cut out, bladed into place, and compacted shall not be measured and paid for directly but will be considered as incidental work.

The existing surface upon which embankment material is to be placed shall have all unstable and unsuitable material, such as topsoil, peat, mulch, coal seams, disintegrated shale, rubbish, logs or stumps, and unconfined saturated soils, removed to the depths shown before starting the embankment work.

Where embankments two feet (2') or less in depth are to be placed on areas covered by existing pavement, the existing pavement shall be removed and the cleared ground surface shall be compacted at optimum moisture to the specified density. Where embankments greater than two (2) feet in depth are to be placed on areas covered by existing pavement, the existing pavement shall be broken into pieces not larger than twenty-four inches (24") maximum dimension, left in place and the embankment started thereon.

Earth embankment shall be placed in successive horizontal layers distributed uniformly over the full width of the embankment area. Each layer of material shall not exceed twelve inches (12") in thickness (loose measurement) and shall be compacted to the density specified in paragraph 1106 before the next layer is placed thereon. As the compaction of each layer progresses, continuous blading will be required to level the surface and to ensure uniform compaction. Embankment construction shall not be performed when material contains frost, is frozen, or a blanket of snow prevents proper compaction.

Successive horizontal layers of rock embankment not exceeding two (2) feet in depth, shall be made by placing larger stones uniformly over the embankment area. Small stone fragments, sand, earth, or gravel shall be placed between the larger stones to fill all voids. Each layer shall be thoroughly compacted before the next layer is placed.

Large rocks shall be withheld from the top one-foot or more of the embankment and only crushed stone or earth used in this layer. The crushed stone shall be well graded to form a dense mass when compacted and maintained adequate cohesive and interlocking characteristics.

1106 EMBANKMENT - BACKFILL AND COMPACTION. Each successive lift of backfill material shall be rolled with a tamping or sheepsfoot roller, except as provided below for sand and gravel, making a sufficient number of trips over the entire surface to compact all material thoroughly and uniformly. Compaction shall be continued until 95% of maximum density is obtained at the optimum moisture content as determined by ASTM D698.

Sand and gravel, which cannot be compacted satisfactorily with a sheepsfoot roller, shall be rolled with a pneumatic-tired roller. Each lift shall be rolled until no further consolidation is evident.

All the work involved in either adding moisture to, or removing moisture from embankment materials shall be considered incidental to the completion of the grading operation.

Backfilling behind curb or curb and gutter shall be done within seven (7) days after being laid unless otherwise approved by the Engineer. All fill material placed behind the curb and gutter beneath and either side of sidewalks within the right-of-way shall be brought to 95% of maximum density at the optimum moisture content as determined by ASTM D698. The material used to fill the void behind curb or curb and gutter shall be free of rock and debris and shall be of a type that will leave no voids to pocket water and that will self-compact. Unless otherwise shown on the contract drawings, the finish grading from the back of the curb to the right-of-way line and/or utility easement line or construction easement line shall be performed to provide a smooth transition between existing yard grades at the right-of-way line and/or easement line to the curb so that positive drainage will exist.

The top portion of the backfill within right-of-way areas shall be finished with at least twelve (12) inches of topsoil corresponding to, or better than, those underlying adjoining sodded areas. The Engineer prior to placement shall approve topsoil, and unless otherwise directed, shall be material previously excavated and stockpiled for the purpose during excavating and grading operations.

Grades on areas to receive topsoil shall be established and maintained as a part of the grading operations. Immediately prior to dumping and spreading topsoil, the surface shall be loosened by discing or scarifying to a depth of two (2) inches to permit bonding of the topsoil to the underlying surface.

- 1107 STRUCTURE BACKFILL. Backfill around and outside of structures shall be deposited in layers not to exceed twelve (12) inches in uncompacted thickness and brought to 95% of maximum density at optimum moisture content as determined by ASTM D698. Compaction of structure backfill by rolling will be permitted provided the desired compaction is obtained and damage to the structure is prevented. Compaction of structure backfill by inundation with water will not be permitted.

Material for structure backfill shall be composed of earth only and shall contain no organic materials, broken concrete, stones, trash, or debris of any kind.

No tamped, rolled, or otherwise mechanically compacted backfill shall be deposited or compacted in water.

All backfill material shall consist of loose, earth having a moisture content such that maximum density of the compacted soil will be obtained. Moisture content shall be distributed uniformly and water for correction of moisture content shall be added sufficiently in advance that proper moisture distribution and compaction will be obtained.

Backfill around and outside of structures that will ultimately lie under proposed pavements shall be compacted to the requirements of Section 1205 "*Compaction Requirements*".

- 1108 SHEETING AND SHORING. Except where banks are cut back on a stable slope, excavation for structures shall be properly and substantially sheeted, braced, and shored, as necessary, to prevent caving or sliding, to provide protection for workmen and the work, and to provide protection for existing structures and facilities. Sheet piling, bracing, and shoring shall be designed and built to withstand all loads that might be caused by earth movement or pressure and shall be rigid, maintaining shape and position under all circumstances.

- 1109 FINAL GRADING. After other outside work has been finished, and backfilling and embankments completed and settled, all areas on the site of the work which are to be graded shall be brought to grade at the indicated elevations, slopes, and contours, including shoulder, berm, and sidewalk spaces. Use of graders or other power equipment will be permitted for final grading and dressing of slopes, provided the result is uniform and conforming to the lines and grades shown on the plans. The contractor shall repair any damaged surface and shall not use any equipment that will leave a marred surface.

- 1110 CLEANUP. Cleanup shall follow the work progressively and final cleanup shall follow immediately behind the finishing. The contractor shall remove from the site of the work all

equipment, tools, and discarded materials, and other construction items. The entire right-of-way or easement shall be left in a finished and neat condition. Cleanup shall be considered a subsidiary obligation of the grading work.

In the event the contractor does not promptly comply with the terms of such instructions, the City may have the defective work corrected or the rejected work removed and replaced and all direct and indirect cost of such removal and replacement, including compensation for additional professional services, shall be paid by the contractor. The contractor will also bear the expenses of repairing work of others destroyed or damaged by his correction, removal or replacement of defective work.

- 1111 SETTLEMENT. The contractor shall be responsible for all settlement of backfill, fills, and embankments, which may occur within two years after final completion of the contract under which the work was performed.

The contractor shall make, or cause to be made, all repairs or replacements made necessary by settlement within 30 days after notice from the Engineer.

- 1112 TEMPORARY SURFACING. If during construction activities it is deemed necessary to provide ingress and egress to the public by placement of temporary surfacing, the contractor shall do so at the direction of the City Engineer or his authorized representative. Temporary surfacing shall meet the requirements of the Missouri Department of Transportation classification, for aggregates. Larger aggregates (3/4" or 1") may be used if, in the opinion of the City Engineer additional stabilization is necessary. Temporary surfacing shall be supplied by the contractor at no expense to the owner unless provided for in the proposal and Special Conditions.

SECTION 1200 - SUBGRADE PREPARATION

1201 SCOPE. This section governs the furnishing of all labor, equipment, tools, and materials, and the performance of all work connected with subgrade preparation, prior to constructing pavements for streets, alleys, parking areas, sidewalks, drive approaches and the construction of concrete curb and curb and gutters. **This section does not include the construction of any base courses.**

1202 DEFINITIONS.

- A. Subgrade. Subgrade is defined as a well-graded and compacted surface, constructed as specified herein to the grades, lines, and cross-section shown, bladed and compacted to the specified density, preparatory to constructing pavements, or other improvements thereon.
- B. Subgrade Preparation. Subgrade preparation is the repeated operation of fine grading and compacting the subgrade until the specified lines, grades, and cross-sections have been obtained and the materials are compacted to the specified depth and density.

1203 CONSTRUCTION REQUIREMENTS.

- A. General. All underground work contemplated, including clearing, grubbing, and demolition, shall be completed in accordance with the requirements of Section 1100 "*Grading*" prior to commencement of any subgrade preparation.

Prior to beginning any work on street subgrade the contractor shall secure the services of a qualified testing agency to acquire samples of the material to be used for subgrade construction. These samples shall be analyzed to determine proctor values, liquid limits, and plasticity index. Copies of the analysis shall be provided to the City Engineer for review prior to commencing any subgrade preparation. If it is determined that fly ash modification is required the following guidelines shall be followed.

The contractors testing agency shall determine the areas to be modified, the amount of fly ash to be used (% by weight), and the depth to be tilled.

Construction of pavements on high plasticity soils shall be modified with class "C" fly ash, or replaced with lower plasticity soils. High plasticity soils shall be defined as soils with a liquid limit greater than 50 and a plasticity index greater than 30. (See section #1208)

The subgrade surface shall be brought to the specified lines, grades and cross-sections by repeatedly adding or removing material and compacting to the specified density with a suitable roller to perform these operations.

- B. Subgrade Treatment. Unless otherwise specified or shown on the contract drawings, the soil below grade line in cut sections shall be scarified, broken up, adjusted to a moisture content within the designated moisture range and compacted to the designated type of compaction.

When the depth of compaction in cut sections is shown to be more than six inches (6") material shall be removed to within six inches (6") of the lower limit of the compaction. The

layer of material left in place shall be scarified, broken up, adjusted to satisfactory moisture content and compacted to the designated type of compaction. This process shall be repeated until the cut section is compacted to the grade as shown on the contract drawings.

All roadway excavation in rock (shale, sandstone, limestone) shall be undercut no less than 12" for the full width of the roadway and backfilled with suitable soil or granular material. Undercut shall be unclassified excavation.

- C. Moisture Control Requirements. The moisture content of the soil at the time of compaction shall be as provided in a soils design report delivered to the City Engineer by the Contractor unless it is determined by the Engineer that the soil is unstable with that moisture content.

When the moisture content of the soil is not satisfactory to the Engineer, water shall be added or the material aerated, whichever is needed to adjust the soil to the proper moisture content. In no case, shall water be added without the consent of the Engineer.

- D. Compaction Control Requirements. Roadway embankment earth (fill) materials shall be placed in horizontal layers not exceeding twelve inches (12") unless otherwise approved by the Engineer and shall be compacted as specified in Section 1205 "*Compaction Requirements*" before the next layer is placed. Effective spreading equipment shall be used on each lift to obtain uniform thickness prior to compaction. Water shall be added or removed on the approval of the Engineer, in order to obtain the required density.

1204 MOISTURE CONTENT REQUIREMENTS. The moisture content of the soil at the time of compaction shall be uniform and shall be such that the soil can be compacted to the requirements of the type of compaction as designated on the contract drawings or as directed by the Engineer. A soils design report to be delivered to the City Engineer prior to construction.

1205 COMPACTION REQUIREMENTS.

- A. Pavements. The subgrade for pavements shall be compacted to a density of at least ninety-five percent (95%) of the maximum density for the material used for a depth of at least six inches (6") below the finished subgrade elevation and within the tolerance of the moisture for the type of material at ninety-five percent (95%) of maximum density, as determined by the standard proctor test (ASTM D698) for cohesive soils. Any further compacted layers shall be accomplished in the same manner as specified.

Subgrade compaction for curbs and pavements shall be accomplished by use of sheepsfoot rollers. The roller may be self-propelled, vibrating, or machine drawn. The sheepsfoot roller shall be fully loaded with liquid or solid ballast to produce adequate compactive energy to the tamping foot. The roller shall have a minimum drum diameter of 30" and a 6" minimum length of tamping feet.

Compaction of low plasticity or non-plastic, fine-grained material shall be considered adequate when additional passes of the roller do not bring the tamping feet closer to the surface of the lift, provided the entire weight of the roller is supported on the tamping feet and none by material directly in contact with the drum.

Construction of pavements on high plasticity soils shall be modified with hydrated lime or class "C" fly ash or replaced with lower plasticity soils. High plasticity soils shall be defined as soils with a liquid limit greater than 50 and a plasticity index greater than 30. Determination of the soil plasticity shall be provided by the contractor at the direction of the City Engineer.

Sand and gravel, which cannot be compacted satisfactorily with a sheepsfoot roller, shall be rolled with a pneumatic-tired roller. Each lift shall be rolled until no further consolidation is evident.

- B. Sidewalks. The subgrade for sidewalk pavements shall be compacted to a density equivalent to the density of the immediately surrounding soil in areas not requiring fill. In areas where fill is required, the subgrade shall be compacted to ninety-five percent (95%) of the maximum dry density as determined by ASTM D698 for cohesive soils or to seventy percent (70%) relative density as determined by ASTM D2049 for non-cohesive soils.
- C. Drive Approaches and Concrete Curb & Gutter. The subgrade for drive approaches and concrete curb and gutter shall be compacted to the same requirements as stated above in part a. Pavements.

- 1206 PROTECTION AND MAINTENANCE OF SUBGRADE. The newly finished subgrade shall be repaired from action of the elements. Any settlement or washing that occurs prior to the acceptance of the work shall be repaired and the specific lines, grades, and cross-section re-established.

The contractor shall protect all pavements, curbs, curb and gutters, and sidewalks from his subgrade operation with an earth cushion, timber planking, or both where tractors, graders, rollers, or other equipment are required to pass, or turn around. All resulting damage shall be repaired. Any damaged work which cannot be repaired to the satisfaction of the City Engineer, shall be replaced by the contractor at their own expense.

- 1207 COMPACTION TESTING AND PROOF ROLLING. At the option of the City Engineer, compaction testing may be required prior to placement of asphalt. The subgrade must successfully pass compaction testing by a nuclear density/moisture measuring device and proof rolling with a loaded tandem dump truck carrying a minimum load of 16 tons. If as a result of the testing/proof rolling, the City Engineer determines that further compaction is required; the contractor shall revise his methods or procedures as necessary to obtain density and stability.

1208 FLY ASH SUBGRADE TREATMENT

GENERAL

The purpose of this specification is to secure a completed section of treated material which contains a uniform mixture of fly ash and pulverized material with no loose or segregated areas, has a uniform density and moisture content, and is well bound for its full depth. It shall be the responsibility of the contractor to regulate the sequence of his work, to process a sufficient quantity of material to provide full depth as shown on the Plans, to use the proper amounts of fly ash, to maintain the work, and to rework areas as necessary to meet the requirements.

- A. The contractor shall secure the services of a qualified testing agency to perform on site testing. A qualified field technician shall monitor placement, mixing, moisture content and in place density. Copies of the test results shall be provided to the City Engineer for review prior to pavement placement. All costs incurred through the use of the testing agency shall be borne by the contractor-developer.
- B. A sample of the fly ash intended for use on the project will be submitted to the testing laboratory for the purpose of developing a fly ash proctor. The fly ash supplier will submit certified laboratory analysis indicating that fly ash used on the project conforms to A.S.T.M. C618, Class C, except the supplementary optional physical requirements in table 4 will not apply and the minimum calcium oxide (CaO) content of the fly ash shall be 25%. Fly ash shall be sampled and tested in accordance with A.S.T.M. C311.

Fly ash furnished by the contractor shall comply with the requirements of A.S.T.M. C618 class C. The minimum calcium oxide (CaO) content of the fly ash shall be 25%. Fly ash shall be stored and handled in closed waterproof containers prior to distribution on a roadway or fill. Fly ash that has been partially caked or set shall not be used. A certification indicating compliance to these specifications shall be attached to or be part of the scale ticket for each load delivered. The producer or his assigned representative shall sign the certification.

1209 CONSTRUCTION REQUIREMENTS

A. Preparation of Roadbed

The subgrade shall be trimmed as near as possible to finish subgrade elevations as shown on the plans. The contractor shall allow for potential swell of material to minimize waste during final trimming. This may require the subgrade to be trimmed to slightly below proposed finished grade depending on the soil characteristics.

B. Equipment

The machinery, tools, and equipment necessary for proper execution of the work shall be on the project and approved by the Engineer prior to beginning of construction operations. Pulveration of existing subgrade and blending of the mixture shall be accomplished by use of a drum-rotary type tiller equipped with an adjustable water proportioning system. Initial

compaction shall be achieved using a self-propelled sheepsfoot compactor having a minimum operating weight of twelve tons with a minimum centrifugal force of 24 tons. Rubber-tired or smooth-wheeled rollers shall be used for final compaction of the stabilized section. All machinery, tools and equipment used shall be maintained in satisfactory and workmanlike manner. Fly ash shall be stored and handled in closed weatherproof containers until immediately before distribution. Fly ash exposed to moisture prior to mixing with recycled material shall be discarded.

C. Application

The fly ash shall be spread in an approved manner at the rate specified. Care shall be taken to prevent the fly ash from flowing off the area to be treated. The fly ash shall be distributed at a uniform rate in such a manner as to minimize the scattering of fly ash by wind. Fly ash shall not be applied when wind conditions, in the opinion of the Engineer, are such that blowing fly ash becomes objectionable to adjacent property owners or significantly reduces the amount of fly ash incorporated into the work.

D. Moisture Control

The required moisture content will be established by the contractors testing agency based on laboratory tests on the materials and specific fly ash content to be used for the treatment. Water shall be introduced directly into the rotary mixing drum during the tilling procedure. Final moisture content of the mix, immediately prior to compaction shall be uniform and not exceed plus or minus three percentage points of the optimum moisture content of the mix. If the moisture content exceeds the specified limits, additional fly ash may be added to lower the moisture content to the required limits. Lowering the moisture content by aeration following addition of fly ash will not be allowed. If the moisture contents are below the specified limits, additional water shall be added and uniformly blended with the mixture. Additional fly ash added to lower the moisture content shall be at the expense of the Contractor.

E. Mixing

The pulverized subgrade material and fly ash shall be thoroughly mixed and the mixing continued until a homogenous, friable mixture of pulverized subgrade material and flyash meeting the specified size requirements is obtained. The subgrade material shall be pulverized through use of the specified equipment. Depth of pulverization shall be as designated. The pulverized subgrade material and fly ash shall be mixed thoroughly until a uniform mixture is obtained. All clods shall be reduced in size by mixing until the pulverized subgrade material-fly ash mixture meets the following size requirement when tested.

Sieve Size	Percent Retained
1"	0
½"	50

F. Compaction

Compaction of the mixture shall begin immediately after mixing and confirmation that the moisture content is within the specified range. The specified compaction shall be obtained within 1 hour after the incorporation of the fly ash. The material shall be sprinkled as necessary to maintain the specified moisture content. Compaction of the mixture shall begin at the bottom and shall continue until the entire depth of mixture is uniformly compacted to the specified density.

All non-uniform (too-wet, too dry or insufficiently treated) areas, which appear, shall be corrected immediately by scarifying the areas affected, adding or removing material as required and reshaping and recompacting.

The stabilized section shall be compacted to a minimum of 95% of the combined materials maximum dry density.

In addition to the requirements specified for density, the section shall be compacted to the extent necessary to remain firm and stable under construction equipment. After each section is completed, tests will be made by the testing agency field technician. If the material fails to meet the density requirements, the Engineer may require it be reworked as necessary to meet those requirements and/or require the Contractor to change his construction methods to obtain required density on the next section. Additional fly ash will be added to the areas that are reworked at no additional cost to the owner, and the amount required shall be determined by the testing agency field technician. Should the section, due to any reason or cause, lose the required stability, density and finish before the surface is placed or the work is accepted, it shall be reprocessed, recompacted and refinished at the sole expense of the Contractor. Reprocessing shall follow the same patterns as the initial stabilization including the addition of fly ash.

G. Finishing and Curing

Following the compaction of the stabilized section the treated section will be trimmed to the required lines and grade by means of equipment, which is automatically controlled with regard to grade. The surface shall then be compacted with a smooth wheel or pneumatic tired roller.

The Engineer may waive the use of automatically controlled equipment on projects containing narrow or irregular dimensions where operation of the automated equipment is impractical. Finishing of these areas may be as set forth above or the surface will be lightly scarified during finishing operations and bladed to a uniform grade and cross section to eliminate and imprints left by the equipment.

After the fly ash treated section has been finished as specified herein, the surface shall be protected against rapid drying by either of the following curing methods.

1. Maintain in a thorough and continuously moist condition by sprinkling.
2. Apply an asphaltic prime coat.

H. Weather Limitations

Fly ash mixing operations shall not be performed when the subgrade is frozen or when the ambient air temperature is less than 50 degrees F. The Contractor shall be responsible for protection and quality of the fly ash modified subgrade mixture under any weather conditions.

At cooler temperatures additional passes may be required to reduce the nominal size of the soil agglomerates to less than 1". Multiple passes of rollers may also be required to achieve specified densities in cooler weather conditions.

I. Proofrolling

Proofrolling with a loaded tandem dump truck carrying a minimum load of 16 tons will be required before acceptance of finish subgrade. Subgrade failures will be repaired by incorporating additional fly-ash into the subgrade. The use of fly-ash trimmings to correct areas of failure will not be permitted.

SECTION 1300 - ASPHALTIC CONCRETE PAVEMENT

1301 SCOPE. This section covers asphaltic concrete pavement for roadways and parking areas.

1302 GENERAL. Pavement shall be constructed to the lines, grades, dimensions, and details contained herein or as shown on the plans.

Except as modified herein, asphaltic concrete pavement shall conform to Division 600 of the latest edition of the American Public Works Association Specification Section 2200, shall be as follows:

Surface Course Mix --Type III, APWA 2205

Base Course Mix ----- Type II, APWA 2205 (Type I if approved by City Engineer)

Alternate mix designs may be used only where approved by of the City Engineer.

A. Composition of the Mix. Asphaltic concrete mixtures shall consist of Mineral Aggregate and Asphalt Cement within the following limits for the type specified.

	<u>Asphaltic Concrete Type</u>		
	<u>1</u>	<u>2</u>	<u>3</u>
	<u>Percent by Weight of Total Mixture</u>		
Asphalt Cement	4-6	4-7	4-7
<u>Aggregate-US Standard Square Sieve Size</u>	<u>Total Percent Passing by Weight</u>		
1 1/2"	100	-----	-----
1"	75-100	100	-----
3/4"	60-85	80-100	100
1/2"	-----	-----	85-100
3/8"	40-65	60-80	70-90
No. 4	30-50	48-65	50-75
No. 10	17-33	32-43	34-43
No. 40	-----	16-27	16-27
No. 80	5-12	7-15	7-16
No. 200	2-10	3-8	4-10

In addition to the above limits, the difference between the "Percent Passing Square Mesh Sieve" of successive sieve sizes shall not exceed 25 for Type 1 Asphaltic Concrete or 20 for Type 2,3 and 4 Asphaltic Concrete.

That fraction of material retained on the No. 4 Sieve shall be composed of particles with not less than 75 percent having two or more fractured faces, and not more than 20 percent by weight of that fraction shall be composed of flat or elongated particles (flat being a ratio of 1 to 3 between thickness and least width and a ratio of 1 to 3 between the least width and length).

That portion of the aggregate retained on the No. 10 Sieve shall be composed of at least 95 percent by weight of crushed aggregate.

The job-mix formula shall be within the limits specified above. The maximum permissible

variation from the job-mix formula shall be as follows. However, in no case shall the permissible variation be allowed to exceed the limits specified above.

	<u>Permissible Variation</u>	
	<u>Percent by Weight of Total Mix</u>	
U.S. Standard Sieve Size	<u>Type 1</u>	<u>Type 2,3,& 4</u>
No. 4 and larger	5.0	4.0
No. 10	4.0	3.0
No. 40	4.0	3.0
No. 200	2.0	1.0
Asphalt Cement	0.5	0.3

- B. Mix Design Criteria. Laboratory Test Specimen(s) of the Paving Mix, combined in proportions of the job-mix formula, shall be prepared and tested in accordance with ASTM D-1559.

Test requirements and criteria for the paving mixes under these specifications shall be as follows:

Marshall Stability, Types 2, 3, & 4 only	1500 lbs. minimum
No. of compaction blows	50
Flow, all mixtures	.08-16 inches
Air Voids: (Lab Specimen)	Percent
Base	1-8
Surface	1-5
Voids in Mineral Aggregate (Max Size)	Percent (Minimum)
1/2"	12
1"	13
3/4"	14
2"	15
3/8"	16

Mix designs for asphaltic concrete surface and base courses shall be submitted to the City Engineer for review and approval prior to placement. Work in progress without prior mix design approval by the City Engineer will be subject to removal at the expense of the Contractor.

- C. Sampling and Testing of the Mixture. Mixes shall be sampled in accordance with ASTM D-979. The mixtures will be tested for Bitumen content in accordance with ASTM D-2172. The recovered aggregate will be sieved in accordance with Methods of Test for Mechanical Analysis of Extracted Aggregate, AASHTO T-30. When recovered Bitumen is required for further testing it will be obtained according to ASTM D-1856.
- D. Mixture Temperature Requirements. To aid in determining the proper temperature of the completed batch, current viscosity data shall be provided and shall be available at the plant at all times. With information relative to the viscosity of the particular asphalt being used, the Engineer shall designate the temperature of the completed mix at the plant and at the paver, after discussing with the Contractor the hauling and placing conditions.

When the mix is produced in a batch-type plant, the aggregate shall be weighed accurately in the designated proportions to provide the specified batch weight. The temperature of the aggregate at the time of introduction into the mixer shall be as directed by the Engineer, with a tolerance of + or - 25 degrees F. In no case, however, shall the temperature of the mixture exceed 350 degrees F.

Continuous Mix or Drum Dryer Mixed plants shall, in general, be controlled in the same manner as batch-type plants. Details of control, differing because of the continuous mixing principle, shall be governed by instructions issued by the plant manufacturer, wherever these instructions are not contrary to these specifications.

E. Control of Mixing Time. The dry mixing period is the interval of time between the opening of the weigh box gate and the application of the asphalt. The wet mixing period is the interval of time between the application of all asphalt and the opening of the mixer gate for discharge. When it is applied by spray system, the wet mixing time shall begin with the start of the asphalt spray.

1. Batch-Type Plants. The length of time of both the dry and wet mixing periods shall be such to insure a uniformly and completely coated mix. Mixing period time shall not be altered unless so ordered by the Engineer. A dry mixing period of not less than five seconds shall precede the addition of asphalt to the mix. Excess wet mixing shall be avoided. Wet mixing shall continue as long as is necessary to obtain a thoroughly blended mix, but shall not exceed 75 seconds nor be less than 30 seconds.
2. Continuous Type Plants. The determination of mixing time shall be by a weight method under the following formula, unless otherwise required:

$$\begin{aligned}\text{Mixing Time (sec.)} &= \frac{\text{Pugmill Dead Capacity (lbs)}}{\text{Pugmill Output (lbs per sec)}}\end{aligned}$$

The weights shall be determined for the job from tests made by the Engineer.

F. Preparation of Asphalt Cement. The asphalt cement shall be heated at the paving plant to a temperature at which it can be uniformly distributed throughout the mix. It shall be delivered into the Contractor's tank at a temperature not exceeding 350 degrees F., and shall not be heated above this temperature for any operation of the paving plant.

The asphalt shall be heated so that it can be distributed uniformly throughout the batch. For mixing application, the specified temperature generally will be such that the asphalt viscosity is within the range of 75-150 seconds, Saybolt Furol. The material shall be sufficiently fluid to produce a complete coating on every particle of aggregate within the specified mixing time.

G. Preparation and Handling of Aggregate. Coarse and fine aggregate shall be stored at the plant in such a manner that the separate sizes will not become intermixed. Cold aggregates shall be carefully fed to the plant in such proportions that surpluses and shortages in the hot

bins will not cause breaks in the continuous operation. When loading aggregate into stockpiles, and into cars, barges, and trucks, the material shall be placed in such a manner as to prevent segregation of aggregate sizes. Stockpiles shall be built in uniform layers not exceeding 5 feet in depth.

Coarse and fine aggregate shall be sampled and tested upon arrival at the plant in accordance with the standard method specified in Section 1403(B). Samples of coarse and fine aggregate shall be submitted to an approved testing laboratory for testing, prior to the start of work, and as often thereafter as requested by the Engineer. When coarse aggregate grading is such that the material will tend to segregate during stockpiling or handling, it shall be supplied in two or more sizes. Each size of coarse aggregate required to produce the combined gradation specified shall be placed in individual stockpiles at the plant site and separated by bulkheads or other means approved by the Engineer. Likewise, when it is necessary to blend fine aggregates from one or more sources to produce the combined gradation, each source or size of fine aggregate shall also be placed in individual stockpiles. Aggregate from the individual stockpiles shall be fed through separate bins to the cold elevator feeders and they shall not be blended in the stockpile.

1. Drying. The aggregate shall be thoroughly dried and heated to provide a paving mix temperature within a tolerance of + or - 25 degree F., of that specified by the Engineer. The moisture content of the heated and dried aggregate shall not exceed 1.0 percent. The quantity of material fed through the dryer shall, in all cases, be held to an amount, which can be thoroughly dried and heated.
2. Screening. Aggregates shall be screened into sizes such that they may be recombined into a gradation meeting the requirements of the job-mix formula.
3. Hot Aggregate Storage. Hot-screened aggregate storage shall be accomplished in such a manner as to minimize segregation and loss of temperature of the aggregate.

H. Inspection and Control of Asphalt Mixing Plant.

1. Job Mix Formula. The Engineer may make frequent gradation analysis of the hot aggregates and of the completed mix to be certain that the materials being used and produced are within the tolerances of the job mix formula, and the specifications of the mix number being used. If the mix is found to be outside of the job-mix formula tolerances, or outside of the specifications limits as specified in Section 1404, correction shall be made in quantities measured from the hot bins and adjustments made at the cold bin feeders.
2. Sampling and Testing. Stockpiles and bins may be sampled for gradation analysis and examined for dust coating and for other purposes, in compliance with state requirements.

Gradation analysis of each hot bin will be performed and a combined analysis computed at least once for every four hours of plant operation if requested by the Engineer. At least one sample shall be taken from each 300 tons of the mix being

produced. Samples will be used to determine compliance with general and special requirements set forth in Section 1404.

When requested by the Engineer, the Contractor shall provide representative samples by taking aggregate from the discharge of the aggregate through each of the hot bin gates, or by drawing aggregate from each bin through the mixture chamber (without asphalt cement) into a truck or other receptacle.

- 1303 SUBGRADE PREPARATION. Subgrade preparation for pavement shall be as specified in Section 1200 "*Subgrade Preparation*".
- 1304 TRANSPORTATION OF MIX. The mix shall be transported to the jobsite in vehicles cleaned of all foreign material, which may affect the mix. The inside of the truck beds shall be lubricated with a thin oil to prevent the mix from adhering to the bed, but an excess of lubricant will not be permitted. Vehicles shall be provided with covers of sufficient size and weight to protect the load and to prevent cooling of the mix during transportation to the site in cold weather when required by the Engineer. The contractor shall provide a sufficient number of haul vehicles of the proper size, speed, and condition to ensure an orderly and continuous placement operation.
- 1305 PLACING REQUIREMENTS. The bituminous mixture shall be spread and finished reasonably true to crown and grade by a mechanical, self-propelled paving machine. Bituminous mixtures may be spread and finished by other methods only where machine methods are impractical as determined by the Engineer.

All bituminous mixtures shall be delivered to the paver at a temperature between 275°F and 325°F. Delivery of the material to the paver shall be at a uniform rate and in an amount well within the capacity of the paving and compacting equipment. No asphaltic concrete shall be placed on frozen or wet subgrade.

The maximum depth of any individual lift shall be five inches (5"). A minimum of one leveling course shall be placed prior to placement of the surface course for asphaltic pavements, which consist of a total depth of ten inches (10") or less. A minimum of two (2) leveling courses shall be placed for asphaltic pavements greater than 10 inches (10").

When bituminous materials are being applied, the surface of all structures, curb and gutters, and other roadway appurtenances shall be protected in a satisfactory manner to prevent them from being splattered with bituminous material or marred by equipment operation. In the event that any appurtenances become splattered or marred, the contractor shall, at his own expense, remove all traces of bituminous material and repair all damage, and leave the appurtenances in as good condition as they were before the work began.

All mixed material shall be delivered to the paver in time to permit completion of spreading, finishing, and compaction of the mixture during the daylight hours. **Nighttime work on projects will not be permitted unless authorized by the City Engineer and the Contractor provides flood lighting.**

Hot-mix asphalt paving shall not be placed when the ambient temperature is below 40°F for base pavements and 50°F for surface pavements or when there is frost in the subgrade or at any other

time when weather conditions are unsuitable for the type of material being placed without the expressed consent of the Engineer. When the ambient temperature falls below 55°F, precautions shall be taken to compact the mix before it cools too much to obtain the required density. In no case shall successive lifts of asphalt be placed until the previous lift has cooled to 175°F or less.

- 1306 MECHANICAL PAVING MACHINES. Mechanical pavers shall be capable of spreading the mix, within the specified tolerances, true to the line, grade, and crown indicated on the contract drawings.

Pavers shall be equipped with quick and efficient steering devices and shall be capable of traveling both forward and in reverse. They shall be equipped with hoppers and distributing screws electronically controlled which place the mix evenly in front of adjustable screens. They shall be equipped with a vibrating screed.

The screed shall include any strike-off device operated by cutting, crowding, or other action which is effective on mixes at workable temperatures without tearing, shoving, or gouging them and which produces a finished surface of an even and uniform texture. The screed shall be adjustable as to height and crown and shall be equipped with a controlled heating device for use when required.

Pavers shall be capable of spreading mixes without segregation or tearing. They shall also be capable of placing courses in thicknesses of from one-half (1/2) inch to at least three inches (3"), and from widths of eight feet (8') to at least thirteen feet (13'). Extensions and cut-off shoes shall permit changes in widths by increments of six inches (6"), or smaller.

- 1307 COMPACTION REQUIREMENTS. Rollers and other compactive devices shall be operated by competent and experienced roller personnel and shall be kept in operation continuously if necessary so that all parts of the pavement will receive substantially equal compaction. The Engineer shall order the mixing plant to cease operations at any time proper rolling is not being performed.

After spreading and strike-off and as soon as the temperature and mix conditions permit the compacting to be performed without excessive shoving or tearing, the mixture shall be thoroughly and uniformly compacted.

Compacting equipment shall consist of both steel-wheeled and pneumatic-tired rollers and shall be on the site of the work prior to placement of the pavement. The compaction equipment shall be self-propelled and capable of smooth starting, stopping and reversing without backlash. Generally, the number and weight of rollers shall be sufficient to compact the pavement mixture to the required density while it is still in a workable condition.

Two-axle tandem steel rollers shall weigh not less than eight tons (8 tons) or more than twelve (12) tons. Three-axle tandem steel rollers shall not weigh less than twelve tons (12 tons). Three-wheeled steel rollers shall weigh not less than eight tons (8 tons) or more than twelve tons (12 tons). All rollers shall be equipped with water tanks and sprinkling devices, which shall be used for wetting the rolls to prevent adherence of the placed material.

Light pneumatic-tired rollers shall be constructed to allow loading to provide a gross weight of at least two hundred and twenty-five pounds (225 lbs) per inch of tire tread. Heavy pneumatic-tired rollers shall be constructed to allow loading to provide a gross weight of not less than eight tons (8 tons) and not more than twelve tons (12 tons). The tires on the front and rear axles of all pneumatic-tired rollers shall have smooth treads and shall be staggered to provide complete coverage over the entire area over which the roller travels.

The selection of the type of roller to be utilized in breakdown rolling may be varied to suit mix characteristics and shall be acceptable to the Engineer. The final rolling of the top or surface course shall be accomplished with a steel roller unless otherwise approved by the Engineer. In the event a vibratory roller is used for finish rolling, it shall be operated with the vibratory unit in its off position.

Immediately after spreading, each course of the pavement mixture shall be compacted by rolling. The initial or "breakdown" rolling shall be accomplished with a smooth-wheeled roller. The pneumatic tired roller shall be used to knead and compact the pavement mixture following the initial rolling and preceding the final rolling. Care shall be exercised in the use of the pneumatic-tired roller to ensure that the pavement mixture is sufficiently cooled to avoid "picking-up" of the mixture on the tires of the roller, and also to ensure that the pneumatic-tired rolling is completed before the mixture becomes too cool to allow satisfactory finish rolling. Final, or finish rolling, shall be done with a smooth-wheeled roller.

During rolling, the roller wheels shall be kept moist with only sufficient water to avoid picking up the material. The speed shall not exceed three miles per hour (3 mph) for steel-wheeled rollers and five miles per hour (5 mph) for pneumatic-tired rollers.

The line of rolling shall not be changed suddenly or the direction of rolling reversed suddenly. If rolling causes displacement of the material, the affected areas shall be loosened at once with lutes or shovels and restored to the original grade of the loose material before being re-rolled. Heavy equipment or rollers shall not be permitted to stand on the finished surface before it has been compacted and has thoroughly cooled.

In laying a surface mix adjacent to any finished area, it shall be placed sufficiently high so that, when compacted, the finished surface will be true and uniform.

Any mixture that becomes loose, broken, mixed with foreign material, or which is in any way defective in finish or density, or which does not comply in all other respects with the requirements set forth herein, shall be removed, replaced with suitable material, and finished by and at the expense of the contractor in accordance with these specifications.

- 1308 BITUMINOUS TACK COAT. Prior to the distribution of bituminous materials, the contractor shall remove all loose materials from the surface by means of approved mechanical sweepers or blowers and/or hand brooms until it is as free from dust as is practicable. Side roads to receive bituminous treatment shall be shaped and bladed at the same time the sub-base is cleaned.

Contact surfaces of curbing, gutters, manholes, and similar structures shall be coated with a thin uniform coating of asphaltic material. The bituminous mixture shall be so placed so that after

compaction it will be one-fourth inch (1/4") above the edge of the contact surfaces of such structures.

Joints between old and new pavements or between successive days' work shall be made so as to ensure thorough and continuous bond between the old and new mixtures.

Prior to placing the new pavement against a cut joint or against old pavement, the contact surface shall be sprayed or painted with a thin uniform coat of asphalt material.

The tack coat shall be applied to the areas to be surfaced as soon as practicable after they have been prepared and are sufficiently dry at the rate of from 0.2 to 0.5 gallons/square yard at application temperature. Tack coat shall not be applied in the early morning nor in the late afternoon. Bituminous materials shall be applied by means of approved pressure distributors operated by skilled workmen.

The spray nozzles and spray bar shall be so adjusted and frequently checked that uniform distribution is ensured. The distribution shall cease immediately upon any clogging or interference of any nozzle and corrective measures taken before distribution is resumed. Hand sprays shall be used in tacking small patches or inaccessible areas that have been missed by the distributor.

The asphalt tack shall be entirely fogged over the base course and therefore require no sand blot. If, however, it has not been uniformly distributed, sufficient sand shall be spread over the surface to blot up the excess asphalt and prevent it from picking up. Prior to laying an intermediate or surface course, all loose or excess sand shall be swept from the base.

The contractor shall maintain the tack coat treatment and the surface of the sub-base intact until it has been covered by the surface course. Areas that have been damaged by traffic shall be repaired and shall receive applications of tack coat material in compliance with these specifications. The maintenance and repair of the tack coat shall be done at the contractor's expense.

- 1309 DENSITY AND SURFACE REQUIREMENT. The completed asphaltic concrete pavement shall have a density of greater than or equal to ninety-five percent (95%) of Standard established by the Marshall Density procedure, using a fifty-blow method.

All unsatisfactory work shall be repaired, replaced, or corrected. The surface of the final course shall be of a uniform texture and conform to line and grade shown on the plans.

Both density and thickness shall be carefully controlled during construction and shall be in full compliance with plans and specifications. During compaction, preliminary tests, as an aid for controlling thickness shall be made by means approved by the Engineer.

Upon request by the Engineer, representative samples of the compacted asphalt paving shall be obtained by the contractor under the supervision of the Engineer and shall be tested by a suitable independent or municipal testing laboratory as necessary to verify compliance with respective density requirements.

The Engineer shall approve selection of the independent testing laboratory, the number, timing, location and testing procedures for the representative samples. The testing laboratory shall submit

to the Engineer four (4) copies of each report covering the details and results of the tests. All costs for the testing laboratory and all other costs of testing shall be borne by the contractor, unless otherwise specified.

The surface of the final surface course shall not vary from a ten-foot (10') straight edge, applied parallel to the centerline, by more than one-fourth inch (1/4").

- 1310 PROTECTION OF PAVEMENT. The contractor shall protect all sections of newly compacted base and surface courses from traffic until they have hardened properly, or as directed by the Engineer.

SECTION 1400 - PORTLAND CEMENT CONCRETE PAVEMENT

1401 SCOPE. This section governs the furnishing of all labor, equipment, tools, and materials and the performance of all work necessary to construct portland cement concrete pavement.

1402 MATERIALS. Except as modified herein, all materials used for construction of portland cement concrete pavement shall conform to the requirements stipulated in applicable sections of this Technical Specification for Public Improvement Projects of the City of Raytown.

- a. Concrete. The concrete for the use in construction of Portland Cement Concrete pavement shall conform to the requirements established in Section 2000, "Concrete" with the following modifications.

Cement: Portland Cement shall conform to ASTM C150, Type II. Type III cement may be used only upon written approval of the City Engineer.

- b. Reinforcing Steel.

Bars: Bars shall conform to ASTM A615, A616, and A617.

Welded Steel Wire Fabric: ASTM A185.

Supporting Elements: Representative samples of supporting elements shall be submitted and approved by the Engineer prior to their use in the project.

- c. Expansion Joint Fillers. Expansion joint fillers shall conform to ASTM D994, D1751 or D1752.

- d. Joint Sealing Compound. Joint sealing compounds shall conform to ASTM D1190.

- e. Curing Membrane. All material to be used or employed in curing portland cement concrete must be approved by the engineer prior to its use. It shall be of the liquid membrane type and shall conform to ASTM C309.

1403 CONSTRUCTION DETAILS. The portland cement concrete pavement shall be constructed to the configuration, and to the lines and grades shown on the plans.

- A. Grading and Subgrade Preparation. All excavation or embankment required shall be as defined in Sections 1100 "Grading" and 1200 "Subgrade Preparation" of these technical specifications.

- B. Forms. All forms shall be in good condition, clean, and free from imperfections. Each form shall not vary more than 1/4 inch in horizontal and vertical alignment for each 10 feet in length.

1. Material & Size. Forms shall be made of metal and shall have a height equal to or greater than the prescribed edge thickness of the pavement slab.
2. Strength. Forms shall be of such cross-section and strength, and so secured as to resist the pressure of the concrete when struck off, vibrated, and finished, and the impact and vibration of any equipment, which they may support.
3. Installation. Forms shall be set true to line and grade, supported through their length and, joined neatly in such a manner that the joints are free from movement in any direction.
4. Preparation. Forms shall be cleaned and lubricated prior to each use and shall be so designed to permit their removal without damage to the new concrete.
5. Paving Machine. A slip-form paving machine may be used in lieu of forms. The machine must be equipped with mechanical internal vibrators, and be capable of placing the portland cement concrete pavement to the correct cross-section, thickness, line and grade within the allowable tolerances.

1404 JOINTS. Generally joints shall be formed at right angles to the true alignment of the pavement and to the depths and configuration specified by the standard drawings or as modified by the plans and specifications.

A. Expansion Joints. Expansion joints shall be placed at all locations where shown on the plans and standard details or as directed by the engineer.

1. General. Expansion joints shall extend the entire width of the pavement and from the sub-grade to one inch below the surface of the pavement or the material will have a suitable tear strip provided to allow for the application of the joint sealer.

Under no circumstances shall any concrete be left across the expansion joint at any point.

2. Material. Expansion joints shall be formed by a one piece, one-inch thick preformed joint filler cut to the configuration of the correct pavement section.
3. Stability. Expansion joints shall be secured in such a manner that they will not be disturbed during the placement, consolidation and finishing of the concrete.
4. Dowels. If expansion joints are to be equipped with dowels they shall be of the size and type specified, and shall be firmly supported in place by means of a dowel basket which shall be installed in such a position that the center line of the joint assembly is perpendicular to the center line of the slab and the dowels lie parallel to the slab surface and parallel the center line of the slab. One half of each dowel shall be pointed in accordance with the directions shown on the Plans, and then thoroughly coated with hard grease, or an approved lubricant, to prevent the concrete from bonding to that portion of the dowel. As an option, a dowel sleeve of the dimensions shown on the plans or standard drawings may be used in lieu of grease.

B. Contraction Joints. Contraction joints shall be of the type and dimensions and at the spacing shown on the plans or standard drawings.

1. Templates. The templates shall be removed as soon as the concrete has attained its initial set and finished as outlined for tooling joints.
2. Sawing. Sawed contraction joints shall be cut by means of wet sawing with an approved concrete saw. The joints shall not be sawed until the concrete has hardened to the extent that tearing and raveling is precluded.

All joints shall be sawed during the initial curing period and the sawing shall begin before the pavement starts shrinking and before uncontrolled cracking takes place.

Any procedure which results in premature and uncontrolled cracking shall be revised immediately by adjusting the sequence of cutting the joints or the time interval involved between the placing of the concrete or the removal of the curing media and the cutting of the joints. In no case shall the pavement be left overnight without having the joints sawed.

The standard contraction joint configuration is a 1/8"-3/16" wide joint sawed to a depth of 1/3 the thickness of the slab. Material created by sawing shall be flushed from the pavement before it has had time to dry or set. The spacing shall be as shown on the plans but should generally not exceed 15 feet.

The joint shall be thoroughly cleaned by approved methods prior to the placing of the joint material. This is accomplished by sandblasting the dry joint in two passes, one for each joint face. This sand, as well as dust and dirt deposited by wind and traffic, must be blown out of the joint and away from the area around it using a high-pressure air blast prior to placing the joint material.

3. Pre-molded Strip Joints. Pre-molded strip joints shall be of the proper dimensions as shown on the plans and standard drawings and shall be secured at the proper location so as not to be disturbed by the finishing of the concrete.

C. Longitudinal and Construction Joints. Longitudinal joints or construction joints shall be placed as shown on the plans or where the contractor's construction procedure may require them to be placed.

1. Center Joints. Longitudinal center joints shall be constructed using the methods specified in Section 1404b "Contraction Joints".
2. Longitudinal Construction Joints. Longitudinal construction joints (joints between construction lanes) shall be keyed joints or shall be constructed with tiebars. Joint configuration shall conform to the dimensions shown on the plans or standard drawings.
3. Transverse Construction Joints. Transverse construction joints of the type shown on the plans or standard drawings shall be placed wherever concrete placement is suspended

for more than 30 minutes or for such a time that the concrete has begun to take its initial set. No construction joint shall be placed within ten (10) feet of an expansion, contraction, or other construction joint.

4. Tiebars. Tiebars shall be of deformed steel of the dimensions specified by the plans or standard drawings. Tiebars shall be supported in the proper position and at the specified spacing and be firmly secured so as not to be disturbed by the construction procedure. They shall be free from dirt, oil, paint, grease, loose mill scale, and thick rust, which could impair bond of the steel with the concrete.

1405 PLACING, FINISHING, CURING, AND PROTECTION. Concrete shall be furnished in quantities required for immediate use and shall be placed in accordance with the requirements of Section 2000 “Concrete” of these technical specifications and as specified herein.

- A. Concrete Placement. Prior to placement of the concrete pavement, all debris and foreign material shall be removed from the inner surfaces of the forms and all forms and subgrade properly moistened. All required reinforcement and other special metal parts shall be properly and firmly set into position to preclude movement during placement of the concrete.

The concrete shall be deposited over the entire width of the prepared subgrade between the forms in such a manner to prevent segregation and to require as little rehandling as possible. The pour shall be made 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. Concrete shall be thoroughly vibrated along the forms or sides and along expansion and key type longitudinal joints. Attachments on finishing machines to vibrate the concrete adjacent to forms and longitudinal joints will be permitted provided satisfactory results are attained. Care shall be taken that the vibrator does not penetrate the subgrade or dislodge or move the joints. The vibrating shall be sufficient to produce a smooth pavement edge. Over vibrating will not be permitted, as it will cause segregation. Insufficient vibrating can cause honeycomb. Honeycomb in the edge may be cause for rejection of the pavement.

The concrete shall be well vibrated and tamped against the forms and along all 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.

No concrete shall be placed around manholes or other structures until they have been brought to the required grade, alignment, and cross slope. All utility appurtenances shall be boxed out and isolated using expansion joint material. The minimum size of a boxed out section shall be two feet by two feet.

Concrete shall not be allowed to extrude below the forms.

- B. Concrete Finishing. The pavement shall be struck off and consolidated with a mechanical finishing machine or by hand-finishing methods.

When a mechanical finishing machine is used, the concrete shall be struck off at such a height that after consolidation and final finishing it shall be at the exact elevations as shown on the

plans. A depth of at least 2 inches of concrete shall be carried in front of the strike-off screed for the full width of the slab, whenever the screed is being used to strike off the pavement. The finishing machine shall be provided with a screed, which will consolidate the concrete, by pressure. The concrete shall, through the use of this machine, be brought to a true and even surface, free from rock pockets, with the least possible number of passes of the machine. 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.

When hand finishing is used, the pavement shall be struck off and consolidated by a vibrating screed to the exact elevation as shown on the plans. When the forward motion of the vibrating screed is stopped, the vibrator shall be shut off; it shall not be allowed to idle on the concrete. Internal mechanical vibration shall be used along all formed surfaces.

1. Longitudinal Floating. After the concrete has been struck off and consolidated, it shall be further smoothed by means of a mechanical longitudinal float or float finishers using a longitudinal hand float. If a longitudinal hand float is used, it shall be operated from footbridges spanning the pavement and shall be worked with a wiping motion parallel to the centerline, and passing from one side of the pavement to the other. Movement ahead along the centerline of the pavement shall be in successive advances of not more than 1/2 of the length of the float. The float shall not be less than 12 feet in length and 6 inches in width, and shall be properly stiffened and provided with handles at each end. This operation may be eliminated if specified tolerances can be attained by some other approved method.

In cases where the longitudinal floating operation has been eliminated, the pavement shall be scraped with a straight edge 10 feet long, equipped with a handle to permit it to be operated from the edge of the pavement. The longitudinal float and straightedge shall be operated so that any excess water and laitance are removed from the surface of the pavement. After the scraping operation, the surface of the pavement shall be within the specified tolerances.

2. Straightedging. While the concrete is still plastic, the slab surface shall be tested for smoothness with a 10-foot straightedge swung from handles 3 feet longer than one-half the width of the slab. The straightedge shall be placed on the surface parallel to the centerline of the pavement and at not more than 5-foot intervals transversely. After each test the straightedge shall be moved forward one-half its length and the operation repeated. When irregularities are discovered, they shall be corrected by adding or removing concrete. All disturbed places shall be smoothed with a float not less than 3 feet long and not less than 6 inches wide, and again straightedged. The pavement surface shall have no depression in which water will stand.
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 of the radius shown on the plans or standard details.
4. Final Surface Finish. A burlap drag or a broom finish shall be used as the final finishing method. When a drag is used it shall be at least 3 feet in width and long enough to

cover the entire pavement width. It shall be kept clean and saturated while in use. It shall be laid on the surface of the pavement and dragged in the direction in which the pavement is being laid. When broom finishing, a hard bristle broom shall be used. The broom shall be kept clean and used in such a manner as to provide a uniform textured surface. The curb shall have the same final finish as the pavement.

The final 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 engineer may require changes in the final finishing procedure as required to produce the desired final surface texture.

- C. Curing. Curing shall conform to the requirements set forth in Section 2000 “*Concrete*” with the exception that waterproof paper, or polyethylene sheeting, shall not be acceptable as curing methods for concrete pavement. The use of straw or burlap for curing shall be as approved by the engineer.

As soon as practical after the concrete is finished it shall be cured with one of the acceptable methods. If a liquid curing membrane is used, it shall be according to the manufacturer's directions.

A nozzle producing a uniform mist pattern will be used on all spray equipment when applying the liquid curing membrane. Rate of application to the pavement shall be (1 gallon/175 ft) with a wet thickness of 6 to 10 mils.

If the forms are removed from finished concrete pavement within a period of 72 hours or if a slip-form paving machine has been used, these surfaces shall also be cured.

- D. Protection. The contractor shall, at his own expense, protect the concrete work against damage or defacement of any kind until the City has accepted it. Concrete pavement, which is not acceptable to the engineer because of damage or defacement, shall be removed and replaced, or repaired to the satisfaction of the engineer, at the expense of the contractor.

All vehicular traffic shall be prohibited from using the new concrete pavement until it has attained the proper strength. The concrete pavement shall not be opened for light traffic until the concrete is at least 72 hours old and has attained a minimum compressive strength of 3000 pounds per square inch. The pavement shall not be opened to all types of traffic until the concrete is at least 120 hours old and has attained a minimum compressive strength of 3500 pounds per square inch. If high early strength concrete is used, the pavement may be opened to all types of traffic when the concrete has attained a compressive strength of 3500 pounds per square inch.

- E. Temperature Limitation. Concrete work shall proceed in accordance with the requirements established in Section 2000 “*Concrete*”.

1406 BACKFILL. A minimum of 24 hours shall lapse before forms are removed and 5 days shall lapse before pavement shall be backfilled unless otherwise approved by the engineer.

Backfill shall be accomplished in accordance with Sections 1100 "*Grading*" and 1200 "*Subgrade Preparation*".

The contractor shall be responsible for the repair of any existing street pavement disturbed by the construction to the satisfaction of the engineer.

- 1407 **JOINT SEALING AND CLEANUP.** All joints shall be sealed with an approved joint sealer applied in accordance with the manufacturer's directions and City specifications, standards and design criteria. The joints shall be sealed within 7 days of the placement of the concrete and prior to the opening of the pavement to traffic.

The contractor shall be responsible for the removal of excess dirt, rock, broken concrete, concrete splatters and over spray from the area of the construction.

- 1408 **CONCRETE CURB.** Concrete curb will be constructed as shown on the plans unless otherwise approved by the City Engineer. The three options available for concrete curb are as listed below and detailed in Standard Details 14-1, 14-2, 14-3, and 14-4.

- A. **Integral Curb** Integral curb shall be constructed immediately following the finishing operation unless otherwise shown on the plans. Special care shall be taken so that the curb construction does not lag the pavement construction and form a "cold joint."

Steel curb forms shall be required to form the backs of all curbs except where impractical because of small radii street returns or other special sections.

In placing curb concrete, sufficient spading shall be done to secure adequate bond with the paving slab and eliminate all voids in the curb.

Curbs shall be formed to the cross section as shown on the drawings with a mule or templates supported on the side forms and with a float not less than 4 feet in length.

The finished surface of the curb and gutter shall be checked by the use of a 10-foot straightedge and corrected if necessary. Where grades are flat and while the concrete is still plastic, the drainage of the gutter should be checked with a 4-foot level.

- B. **Separate Curb and Gutter with Tiebars.** Separate curb and gutter may be poured prior to pouring the remaining pavement. Tiebars 5/8 inches (5/8") in diameter and 24 inches (24") long shall be cast in the curb and gutter at 30-inch centers as shown on the standard details.
- C. **Separate Curb and Gutter with Keyway** Separate curb and gutter may be poured prior to pouring the remaining pavement. A keyway of the configuration and dimensions shown on the standard details shall be cast in the curb and gutter section.

- 1409 **SURFACE TOLERANCES.** Concrete pavement shall have a surface tolerance in all directions of 1/4 inch in 10 feet when checked with a 10-foot straightedge.

- 1410 **THICKNESS TOLERANCES.** It is the intent of these specifications that pavement shall be constructed strictly in accordance with the thickness shown on the plans. The thickness of the

pavement may be measured by coring, and where any pavement is found deficient in thickness, it may be compensated for at an adjusted unit price or shall be removed and replaced.

In removing pavement, it shall be removed from the outside edge of the curb and gutter (curb and gutter with tiebars or keyway may remain if in good condition) to a longitudinal joint, or between longitudinal joints, and on each side of the deficient measurement until no portion of the exposed cross sections are more than 2/10-inch (2/10") deficient, except that there shall not be less than 5 linear feet (5') of pavement removed. If there remains less than 10 feet (10') of acceptable pavement between the section that has been removed and a transverse contraction, expansion, or construction joint, the contractor shall remove pavement to the joint.

SECTION 1500 - PAVEMENT MARKING

1501 GENERAL. The Contractor shall furnish and apply painted reflectorized pavement marking materials at the locations and in conformance with the details shown on the plans. Three types of materials are allowed unless otherwise required in the Special Provisions or contract drawings.

- A. Scope. The Contractor shall furnish and apply white and yellow plastic or painted reflectorized pavement marking materials at the locations and in conformance with the details shown on the plans. Three types of materials are required, as follows:
1. Hot applied type shall be used for all longitudinal line markings unless otherwise indicated and shall be applied to the pavement surface in a molten state by mechanical means with surface application of glass spheres, and which upon cooling to normal pavement temperature, produces an adherent reflectorized stripe of specified thickness and width and is capable of resisting deformation.
 2. Cold applied type shall be used for all transverse and symbol markings unless otherwise indicated and shall consist of a homogeneous, extruded, prefabricated material of specified thickness and width, which shall contain reflective glass spheres uniformly distributed throughout the cross-section, and shall be applied to the pavement surface by means of a precoated adhesive and pressure.
 3. Paint applied type shall only be used for those markings as indicated on the plans and shall be of good commercial quality, adhere to the asphaltic concrete, and shall be approved by the Engineer.

1502 HOT APPLIED TYPE.

A. General.

This specification describes the materials and application procedures for heated white and yellow thermoplastic pavement markings extruded or sprayed to the roadway surface in a molten state. After cooling to normal temperature, the materials shall produce an adherent reflectorized stripe of specified thickness and width. The sprayed or extruded materials shall be used for edge lines, lane lines, centerlines, medians, no passing zones and gore areas.

The compound shall not deteriorate upon contact with sodium chloride, calcium chloride, or other chemicals used to prevent formation of ice on roadways or streets or because of the content of pavement materials or from petroleum falling from vehicular traffic. In the plastic state, the material shall not give off fumes, which are toxic or otherwise injurious to persons or property. The material shall not break down or deteriorate if held at the plastic temperature for a period of four (4) hours or by reason of three (3) reheating to the plastic temperature (400 degrees F. to 450 degrees F.) The temperature versus viscosity characteristics and the color of the plastic material shall remain constant through reheating, and shall be the same from batch to batch.

B. Material.

The material shall be a mixture of resins and other materials providing an essentially nonvolatile thermoplastic compound specifically developed for traffic marking.

1. Binder. The binder shall be composed entirely of alkyd type resins, 70 percent minimum of which shall be a maleic modified glycerol ester of rosin. The total binder content of the thermoplastic compound shall be no less than 18 percent by weight.
2. Pigment. The pigment used for the white thermoplastic compound shall be titanium dioxide, meeting the requirements of ASTM D 476-73, Type II. The titanium dioxide pigment content shall be no less than 10 percent by weight of the white thermoplastic compound and be uniformly distributed throughout the thermoplastic compound. The yellow thermoplastic compound shall be no less than 2.5 percent by weight of yellow pigment provided that yellow thermoplastic material shall be "Federal Yellow" in color (Federal Test Method Standard 141 Method 4252). The material shall not change its color or brightness character even after prolonged exposure to sunlight.
3. Filler. The filler to be incorporated with the resins as binder shall be a white calcium carbonate or equivalent filler.
4. Glass Beads. During manufacture, Type II B (Missouri State Highway Department Specifications for reflectorizing glass spheres) spheres shall be mixed into the material at the rate of not less than 30 percent nor more than 40 percent by weight of thermoplastic compound immediately after the thermoplastic material is applied. Glass beads shall meet the following requirements:

- a. General Properties. Glass beads shall be manufactured from high quality material of a composition design to be highly resistant to traffic wear and to effects of weathers and shall be clean, clear, colorless and free from foreign matter.
- b. Sieve Analysis. The glass beads shall meet the following gradation requirements:

	Type IIA		Type IIB	
<u>US Standard</u>	Percent Passing			
<u>Sieve Numbers</u>	<u>Min.</u>	<u>Max.</u>	<u>Min.</u>	<u>Max.</u>
16	100	---	---	---
18	98	100	---	---
30	60	90	100	---
40	---	---	80	100
50	15	50	---	---
80	---	---	0	10
100	0	10	---	---
200	0	5	---	---

- c. Index of Refraction. The index of refraction of Type IIA and IIB glass beads shall be at least 1.50 when tested by the immersion method at 77 degrees F.

- d. Irregular Shapes. Glass beads shall be spherical in shape containing not more than 30 percent irregular shapes, when tested in accordance with ASTM Method D 1155-53 (1975).
- e. Tests. Glass beads, when subjected to the following tests shall show no readily discernable darkening and/or dulling.
 - 1. Ten grams + 0.5 grams of glass beads placed in Whitman single thickness cellulose extraction thimble, 33 by 80 millimeters, are refluxed for one (1) hour in a Soxhlet extractor having an 80 millimeter siphon capacity using 150 millimeters of distilled water. All connections shall be ground glass. At the end of the refluxing period, allow the filtrate to cool to room temperature and titrate with 0.1 normal hydrochloric acid (not to exceed 4.5 milliliters) using phenolphthalein indicator. The beads shall be dried to 110 degrees C and examined for dulling under 60-power magnification.
 - 2. Method of Determining Calcium Chloride Resistance. Immerse approximately 10 grams of glass beads in a 1.0 normal calcium chloride solution for 3 hours. Rinse well, by decantation, with distilled water. Spread beads on clean filter paper and allow drying. Examine the beads for darkening under 60-power magnification.
 - 3. Method of Determining Sodium Sulfide Resistance. Immerse approximately 10 grams of glass beads in a 50 percent solution of Sodium Sulfide for one hour. Rinse well by decantation, with distilled water. Spread beads on a clean filter paper and allow drying. Examine the beads for darkening under 60-power magnification.
- f. Binder-Sealer. Binder-Sealer shall be a butadiene styrene, neoprene, epoxy or other material recommended by the manufacturer of the thermoplastic material.
- g. Packaging and Marking. The granulated thermoplastic material shall be packaged in suitable bags to which it will not adhere during shipment and storage. Each bag shall weigh approximately 50 pounds (23kg). Each container label shall designate the color, manufacturer's name, batch number, and date of manufacture. Each batch manufactured shall have its own separate number. The label shall warn the user that the material shall be heated to 211 degrees + 7 degrees C. (412.5 degrees +/- 12.5 degrees F.) during application. The Contractor shall assume all costs resulting from the use of patented materials, equipment, devices, or processes used on, or incorporated in, the work, and shall agree to indemnify and save harmless the purchaser and his duly authorized representatives from all suites at law, or action of every nature for, or on account of, the use of any patented materials, equipment, devices, or processes.

C. Characteristic Requirements.

1. The material shall be capable of being applied at a temperature range of 400 degrees to 450 degrees F and to a thickness of 0.09 or 0.125 inch. It shall set to withstand vehicular traffic in not more than 2 minutes when the air temperature is 50 degrees F. and not more than 10 minutes when the air temperature is 90 degrees F. After application and setting, the material shall show no appreciable deformation or discoloration, shall remain free from track, and shall not leave from the pavement under normal traffic conditions within a pavement temperature range of -20 degrees F to 150 degrees F. The stripe shall maintain its original dimensions and placement.
 - a. Color. White thermoplastic material shall, after setting, be pure white and free from dirt or tint. Yellow thermoplastic shall match Federal Test Standards Number 595A-Color 13538. The material shall not change its color and brightness characteristics after prolonged exposure to sunlight.
2. Manufacturer's Certification. The contractor shall furnish a manufacturer's certification in triplicate, to the engineer, attesting that all materials supplied conform to the requirements of these specifications. The certification shall include or have attached, a certified test report from an approved independent testing laboratory, showing specific test results conforming to all test requirements of these specifications. The following tests shall be made on at least 10 pounds of thermoplastic material from each batch manufactured.
 - a. White material shall not show deviations from a magnesium oxide standard greater than the following data, using a standard color difference meter:

<u>Scale Definition</u>	<u>Magnesium Oxide Std.</u>	<u>Sample Minimum</u>
RE Reflection	100	75
A-Redness-Greenness	0	-5 to +5
B-Yellowness – Blueness	0	-10 to +10

- b. Materials shall be tested in accordance with ASTM D 1501-71, Procedure A, "Standard Recommended Practice for Exposure of Plastic to Fluorescent Sunlamps." There shall be no darkening of color after 100 hours of exposure.
 - c. Material shall have not more than 0.5 percent by weight of retained water when tested by ASTM D 570-63 (1972), "Water Absorption of Plastics." The procedure for 24-hour immersion, Paragraph 6.1, shall be used for this test.
 - d. The softening point of the thermoplastic compound (as measured by the ball and ring method ASTM E 28-67 (1972) shall not occur at a temperature less than 200 degrees F.
 - e. There shall be no cracking, checking, flaking or separation of the sample material from the sample base prepared as follows:

A clean standard concrete block having uniform temperature of 75 degrees F to 80 degrees F shall have the surface primed with a binder-sealer proposed for use by the manufacturer. A 4-inch wide 1/8-inch thick stripe of the thermoplastic material shall be applied and the sample conditioned for 24 hours at 12 degrees F to 18 degrees F.

- f. Specific gravity of the compound at 77 degrees F shall be 2.15.
- g. Bond strength of the compound applied to Portland Cement concrete shall exceed 180 psi.
- h. Freeze/Thaw bond strength of the compound subjected to 5 cycles of 16 hours at 15 degrees C, then 8 hours submerged in water, the bond strength to primed Portland Cement concrete shall exceed 120 psi.
- i. The material shall meet the requirements of this specification for a period of one year. The thermoplastic must also melt uniformly with no evidence of skins or unmelted particles for this one-year period. The manufacturer shall replace any material not meeting the above requirements.

The City of Raytown reserves the right to sample test and reject any and all materials provided and installed under this project.

3. Application.

Marking on this project shall be applied only on clean, dry pavement and at pavement surface and air temperatures above 50 degrees F. The contractor shall remove loose debris (such as dust, dirt, sand and gravel) from the pavement surface, where the marking is to be located, immediately prior to application of the binder-sealer or marking material.

- a. When required, binder-sealer shall be applied to the pavement surface in sufficient quantities to completely cover the area occupied by the thermoplastic material.

- 1. Sprayed Thermoplastic.

A binder-sealer shall be applied to the pavement surface prior to application of sprayed marking material if recommended by the manufacturer of the marking material.

- 2. Extruded Thermoplastic.

A binder-sealer shall be applied to Portland Concrete pavement surfaces prior to application of thermoplastic markings.

On bituminous pavement mixtures and seal coats, a binder-sealer shall be applied prior to marking application if recommended by the manufacturer of the marking material.

b. Application Temperature.

Thermoplastic material shall be applied at a temperature between 400 degrees and 450 degrees F.

c. Marking Dimensions.

Longitudinal and transverse dimensions shall be as shown on the plans. Application of the marking material shall be performed in a manner, which will provide continuous uniformity in the dimensions of the stripe. The cutoff ends of each stripe shall be square. The sides of each stripe shall be uniform and straight (excluding final bead application and binder-sealer). Width and thickness dimensions shall be as follows:

1. White Markings
 - (1) Lane Line 4" by 0.09"
 - (2) Edge Line 4" by 0.09"
 - (3) Stop Line 18" by 0.125"
 - (4) Crosswalk Line 6" by 0.125"
 - (5) Block Style Crosswalk 24" by 0.125" by 6'
 - (6) Symbols and Legends M.U.T.C.D. Standard
2. Yellow Markings
 - (1) Center Line 4" by 0.09"
 - (2) Cross-hatch Line 12" by 0.09"

d. Immediate Reflectance.

Type II-A glass beads shall be applied by an automatic dispenser to the top surface of the hot applied thermoplastic stripe immediately after the stripe is formed on the pavement. The glass shall be embedded into the top surface of the stripe to at least one-half of the bead diameter and at an application rate of 3.0 pounds of beads per 100 lineal feet.

4. Equipment.

All sprayed or extruded marking shall be applied using a vehicle (or vehicles) of sufficient size and stability to provide smooth, straight, uniform markings. The equipment used to install hot thermoplastic materials under this specification shall be constructed to provide mixing and agitation of the material. Conveying parts of the equipment between the main material reservoir and the shaping die or sprayer head shall be so constructed as to prevent accumulation and clogging. All parts of the equipment, which come in contact with the material, shall be so constructed as to be easily accessible and exposable for cleaning and maintenance.

The equipment shall be constructed so that all mixing and conveying parts up to and including the shaping die or sprayer head will maintain the material at a temperature not less than 375 degrees F. (191 degrees C.).

To assure that the thermoplastic does not fall below the minimum temperature, the shaping die or sprayed head shall be heated by means of a gas-fired infrared heater or a heated, oil-jacketed system.

The equipment shall be so constructed as to insure continuous uniformity in the dimensions of the stripe. The applicator shall provide a means for cleanly cutting off square stripe ends and shall provide a method of applying "skip" lines. The use of pans, aprons or similar appliances, which the die overruns, will not be permitted under this specification. The equipment shall be so constructed as to provide for varying die widths and to produce varying widths of traffic marking.

A special kettle shall be provided for melting and heating the thermoplastic material. The kettle must be equipped with a thermostat so that the heating can be done by controlled heat transfer liquid rather than by direct flame, so as they provide positive temperature control and prevent overheating of the material. The heating kettle and applicator shall be so equipped and arranged as to meet the requirements of the National Board of Fire Underwriters, of the National Fire Protection Association, of the State, and of the Local Authorities.

Glass spheres applied to the surface of the completed stripe shall be applied by an automatic bead dispenser attached to the striping machine in such a manner that the beads are dispensed almost instantaneously upon the installed line. The glass sphere dispenser shall be equipped with an automatic cut-off control synchronized with the cut-off of the thermoplastic material.

The equipment shall be so arranged as to permit preheating of the pavement immediately prior to application of the thermoplastic material if the thermoplastic manufacturer recommends pre-heating. The applicator shall be mobile and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc.

The applicator shall be capable of containing a minimum of 125 pounds of molten material.

Application Techniques. The surface shall be dry and all dust, debris and other foreign matter shall be removed from the road surface prior to the application of the binder-sealer and the thermoplastic material. A rough-textured surface shall be cleaned by air blast. A smooth-textured surface may be cleaned by brooming but if there is any doubt about the resulting cleanliness the Engineer can require use of air blast.

Those sections of pavement where extra dust and grime collects, such as gore areas and adjacent to raised islands, may require a water wash and scrubbing in addition to brushing and air blast.

To insure proper adhesion, the Contractor shall apply the binder-sealer over the application area prior to the actual thermoplastic installation. The binder-sealer shall be applied by spraying, shall form a continuous wet film of approximately 2 -3 mils

thickness and shall be at least 2 inches wider than the applied thermoplastic so as to assure adhesion at the edges. The binder-sealer shall be allowed to set long enough for the solvent to evaporate and become tacky. This can be as much as one hour or longer but not less than 30 minutes. If there is doubt, the longer time shall be used even though some tackiness might be lost.

For bituminous surfaces less than two months old and having less than 20% bare, exposed aggregate, the application of binder-sealer may be waived.

Bubbles forming in the applied thermoplastic is evidence that solvent remains in the binder-sealer. Rather than reduce the rate of application of the binder-sealer more time should be allowed for evaporation of the solvent before continuing.

1503 COLD APPLIED TYPE.

A. Materials.

1. The preformed markings shall consist of a yellow or white conformable ribbon or other flat shape as specified and shall be fabricated of resins, plasticizers, fillers, suitable pigments, reflective glass beads, and a pressure sensitive adhesive.
2. The reflective glass beads shall be distributed evenly throughout and applied into the top surface to produce immediate and continuous retro reflection. The marking material shall be so formulated and the top dressing of glass beads so distributed over the surface that the applied lines and shapes will show a high initial visibility that will remain during the effective life of the material. The material which permits or promotes adherence of excessive amounts of road film so as to decrease markedly visual impact shall not be acceptable regardless of compliance with other provisions of this specification. The glass bead adhesion shall be such that beads are not easily removed when the material surface is scratched with a thumbnail.
3. The daylight reflectance of white marking material shall not be less than 50% when tested according to ASTM E97. The color of yellow marking material shall be within the red and green tolerance limits of the highway Yellow Color Tolerance Chart issued by the U.S. Department of Transportation.
4. Preformed words and symbols shall conform to the applicable shapes and sizes as prescribed in the latest revision of the Manual on Uniform Traffic Control Devices for Streets and Highways.
5. The preformed markings shall be capable of being adhered to asphalt concrete or portland cement concrete pavement with a precoated, factory applied, pressure sensitive adhesive. A primer may be used to precondition the pavement surface, when recommended by the manufacturer, due to climate or pavement conditions. When a solvent or other type of adhesive supplements the adhesive backing, the material used and the application

procedure shall be in accordance with the manufacturer's recommendation.

6. The thermoplastic pavement marking material shall mold itself to pavement contours, breaks and faults by action of traffic at normal pavement temperatures, and shall be formulated with resealing characteristics enabling the material to fuse with itself and with previously applied marking materials of the same composition without externally applied tackifiers or adhesives.
7. Materials will be considered only from manufacturers of reflectorized plastic pavement markers and legends, which can submit evidence of successful product use over the past 5 years, under climatic conditions similar to that of the work location.
8. The marking material shall be a minimum of .06 inches in thickness when measured without the precoated adhesive.
9. Retro Reflectance: The material, when tested under actual conditions, shall conform to those requirements set forth in Texas Test method 828-B, entitled "Method for Determining Retro reflectance of Pavement Markings".
10. Skid Resistance: The surface of the retro reflective pavement marking film shall provide a minimum skid resistance value of 35 BPN when tested according to ASTM E 303.
11. Glass Sphere Retention: The plastic shall have glass sphere retention qualities. A 2" x 6" specimen of plastic shall be cut at a right angle to the beveled edge and bent parallel to the beveled edge of a 1/2" mandrel. While the specimen is bent, a strip of 1/2" wide masking tape (such as Utilitape, manufactured by Permacel) shall be applied firmly along the length of the area of maximum bend and then removed. Should any glass spheres remain on the masking tape when the strip is removed, the sample shall be rejected.
12. Reflectivity Retention: To have a good effective performance life, the glass beads must be strongly bonded and not be easily removed by traffic wear.

One of the following tests shall be employed to measure reflectivity retention:

a. Taber Abraser Simulation Test

Using a Taber Abraser with an H-18 wheel and a 125-gram load to sample shall be inspected at 200 cycles, under a microscope to observe the extent and type of bead failure.

No more than 15% of the beads shall be lost due to popout and the predominant mode of failure shall be "wear down" of the beads.

or

b. Federal Test Method Standard No. 141a

Using H-18 calibrate wheels with a 1000 gram load on each wheel, the sample shall be inspected at 500 cycles to determine the extent and type of bead failure.

The maximum loss in weight shall be 0.25 grams due to bead abrasion.

13. Tensile Strength: The film shall have a minimum tensile strength of 150 pounds per square inch of cross-section when tested according to ASTM D 638-76.
14. Effective Performance Life: The film, when applied according to the recommendations of the manufacturer, shall provide a neat durable marking that will not flow or distort due to temperature if the pavement surface remains stable. Although reflectivity is reduced by wear, the pliant polymer shall provide a cushioned, resilient substrate that reduces bead crushing and loss. The film shall be weather resistant and, through normal traffic wear, shall show no fading, lifting or shrinkage which will significantly impair the intended usage of the marking throughout its useful life and shall show no significant tearing, roll back or other signs of poor adhesion.

B. Installation.

1. Cold applied thermoplastic materials shall be applied to clean, dry pavement surfaces, free of dirt and foreign matter, by removing the release paper and placing the plastic on the surface with continuous pressure for a period of about 30 seconds, then permitting traffic to pass over it.
2. All markings shall be applied in accordance with the manufacturers recommendations. Marking configurations shall be in accordance with the "Manual on Uniform Traffic Control Devices".
3. New Pavement: In all areas where pavement markings are to be placed on new asphalt pavement, installation shall be performed by rolling the material into the surface course with the final pass of the roller.
4. Existing Pavement: In areas where pavement markings are specified to be used on existing pavement, a pavement primer should be used as recommended by the manufacturer in addition to the precoated adhesive.
5. The plastic and its adhesive shall be sufficiently free to tack so that it can be easily handled without the protective backing, and be repositioned on the surface to which it is to be applied, before permanently fixing it in this position with a downward pressure.

C. Submittals.

1. The Contractor shall furnish a manufacturer's certification attesting that all

materials supplied conform to the requirements of these Specifications. The certification shall include, or have attached, specific results of laboratory tests for the specified physical and chemical properties as determined from samples representative of the lot or lots of thermoplastic compound, glass spheres and reflectorized plastic marker material supplied. These submittals shall be the basis of acceptance of these materials.

2. The manufacturer shall supply instructions describing the application of this material and identify all activators and additional adhesives that are to be used at the time of application, if any.
3. Each work and symbol marking shall be supplied with a diagram with each section numbered to correspond with the completed layout.
4. The Contractor shall identify proper solvents and/or primers (where necessary) to be applied at the time of application, all equipment necessary for proper application, and recommendations for application that will assure the materials shall be suitable for use for one year after the date of receipt.

1504 PAINT APPLIED TYPE.

A. Materials.

The paint shall be of good commercial quality that conforms to Federal Specifications TT-P-85D. The traffic paint shall provide optimum adhesion for glass spheres when both binder and glass spheres are applied in recommended quantities. The Contractor shall have the manufacturer submit material specifications to the Engineer prior to approval.

B. Construction Requirements.

1. The Contractor shall be responsible for laying out the lines accordance with the plans.
2. The pavement shall be clean and dry prior to applying the paint.
3. The traffic paint should be applied at a wet film thickness of 15 mils (0.38 mm) and glass spheres should be applied at the rate of 6 pounds per gallon (0.7 kg per liter) of paint.
4. The glass beads shall be sprayed into the wet traffic paint through a pressurized glass gun set 1" to 4" (2.5 to 10.2 cm) behind the paint spray gun.

1505 MEASURING AND PREMARKINGS. The Contractor shall do all measuring and premarking required for application of the pavement markings.

1506 REMOVAL OF EXISTING PAVEMENT MARKINGS. The Contractor shall remove the necessary existing pavement markings by grinding, burning, or obliterating them by some other approved means. Painting them will not be acceptable. The Engineer will direct the Contractor to

which markings need to be removed and the extent of the removal shall meet the approval of the Engineer.

1507 PLOWABLE REFLECTORS. Plowable reflector pavement markers shall be low profile, two-way, blue or yellow colored reflector pavement markers and shall have cast iron housing with acrylic prismatic reflectors measuring 9.25" x 5.86" x 1.69" with a .025" maximum projection above the roadway. Each reflector shall be visible from both directions and shall have a 1.87 square inch reflective face. Plowable reflectors shall be Model 96L as manufactured by Stimsonite Corporation of Niles, Illinois or approved equal. Installation shall be as per manufacturer's recommendations. All excess epoxy used in the installation process shall be removed from the face and surrounding area of the marker.

Blue markers are to be installed adjacent to each fire hydrant. The marker shall be located 2 1/2 feet from the centerline of all roadways on the side nearest to the fire hydrant.

Yellow markers are to be installed between all centerline pavement marking lines at 40' intervals for all designated collector and arterial roadways or wherever necessary as determined by the City Engineer.

SECTION 1600 - TRAFFIC CONTROL SIGNING

1601 SCOPE. The work of this Section shall consist of all labor, materials, equipment and services necessary to complete the supplementary traffic control signing as shown on the Plans and herein specified.

1602 GENERAL. The signs shall meet the requirements of the latest edition of the Manual of Uniform Traffic Control Devices, unless otherwise required in the Special Provisions or contract drawings.

The Contractor shall locate the signs in the field in accordance with the Plans, the Manual on Uniform Traffic Control Devices, and subject to the approval of the Engineer. Dimensions on the detailed drawings on the Plans shall take precedence. The contractor will be responsible for orientation, elevation, offset and level of all signs erected.

The Contractor shall verify, prior to erecting any sign, that underground utilities will not be damaged as a result of placing the signpost.

1603 MATERIALS.

A. Steel Sign Posts:

1. Steel: ASTM A 446, commercial quality.
2. Shape and Holes: Steel "U" Channel Section Sign Posts. The posts furnished under this specification shall be formed from hot rolled high carbon rail steel. After all fabrication including punching, is completed, the posts shall be hot dipped galvanized to comply with the requirements of ASTM A123. Posts shall be painted green after galvanizing.
 - a. All posts shall have a uniform "U" cross section and shall be the lengths designated on the plans.
 - b. The posts shall weigh, before punching, not less than three (3) pounds per linear foot of post length.
 - c. Posts shall be punched on the centerline of the web while hot. The holes shall be three-eighths (3/8) inch in diameter and shall be punched one (1) inch apart on centers starting one (1) inch from the top of the post and extending down for six (6) feet.

B. Square Steel Sign Posts:

1. Steel: ASTM A570, Grade 50. Yield strength after cold forming is 60,000-psi minimum.
2. Shape and Holes: Steel Square Sign Posts. The posts furnished under this specification shall be formed of 14 gauge (.083 U.S.S. gauge) steel, carefully rolled to size and shall be welded directly in the corner by high frequency resistance welding and externally

scarified to agree with corner radii. After all fabrication is completed, the posts shall be hot-dipped galvanized conforming to ASTM A653, G90, Structural Quality, and Grade 50 Class 1. The corner weld is zinc coated after scarifying operation. Both interior and exterior of the post shall be galvanized.

Perforated signposts shall be one or more of the following sizes:

Size	U.S.S. Gauge	Weight/ft
1 : A x 1 :"	14	1.71
2" x 2"	14	1.99

Holes shall be 7/16" +/- 1/64" in diameter on one (1) inch centers on all four sides down the entire length of the post. On square tubing, holes shall be on centerline on each side in true alignment and opposite each other directly and diagonally. The finished posts shall be straight and have a smooth, uniform finish. It shall be possible to telescope all consecutive sizes of square tubes freely and for not less than ten (10) feet of their length without the necessity of matching any particular face to any other face. All holes and ends shall be free from burrs and ends shall be cut square. Permissible variation in straightness is 1/16 of an inch in 3 feet.

C. Round Steel Street Name Posts:

1. Steel: ASTM A446.
2. Shape: Round steel posts shall be 2 3/8" in diameter and .065" U.S.S. gauge. Posts shall be hot-dipped galvanized conforming to ASTM A653, G90.

D. Bolts and Nuts. ASTM Design A307 galvanized in accordance with ASTM Design A153. Bolts shall be round-headed as shown on plans and shall have screwdriver slots.

E. Aluminum Flat Sheets. ASTM B209, Alloy 6061-T6.

F. Reflective Sheeting:

1. Description. This material shall be reflective sheeting capable of being used to reflectorize any properly prepared, smooth, flat, wood or metal surface. It shall be furnished in two classes, as follows:

Flat Surface (Enclosed Lens)
Class 1 - Heat Activated Adhesive
Class 2 - Pressure Sensitive Adhesive

All sheeting that is used on R1-1 and R2-1 signs shall be high intensity (3M or approved equal) or super engineering grade (Nikkalite or approved equal).

2. Construction and Materials:

- a. A uniform monolithic layer of spherical glass lens elements shall be embedded

in a binder over light reflecting material resulting in an optical reflective system. The light reflecting material shall have a pre-coated adhesive backing protected by a removable liner.

- (1) Type 1 Sheeting (Flat Surface-Enclosed Lens) shall have a transparent flexible covering, applied as a sheet or a sprayed-on coating, to produce a flat, smooth, moisture-resisting film over the lens elements.
 - b. Adhesive Backing. The adhesive backing shall produce a bond to support a one and three-quarters (1 - 3/4) pound weight for five (5) minutes without the bond peeling more than a distance of two (2) inches when tested according to (4.4.4) Federal Specification L-S-300A. The adhesive for Class 1 shall be as specified in (b) (2.1) and for Class 2 shall be as specified in (b) (2.2).
 - (1) Class 1 Adhesive. The backing for Class 2 Sheeting shall have a tack-free adhesive which shall be activated by applying heat to the material in a temperature range of 175 F. to 250 F. The adhesive must be such that the sheeting can be positioned at temperatures up to 100 R. without damage to the sheeting.
 - (2) Class 2 Adhesives. The backing for Class 2 Sheeting shall have a pressure sensitive adhesive, which requires no heat, solvent, or other preparation for adhesion to smooth, dry, clean surfaces.
 - c. Liner. The adhesive backing of the sheeting shall be completely covered by a protective liner, which shall be easily removable without soaking in water or other solvents. During removal, the liner shall not break or tear, and shall not remove the adhesive from the backing when tested according to (4.4.4) Federal Specification L-S-300A. Removal of the liner shall cause no dimension change or other defect in the sheeting.
3. Color. The colors, by visual inspection, shall conform to the colors shown and specified in the latest edition of the "Manual on Uniform Traffic Control Devices for Streets and Highways".
4. Uniformity. The surface appearance of the sheeting shall be uniform. There shall be no streaks, discoloration or other condition that will cause the sheeting to show a non-uniform appearance when examined at a distance of fifty (50) feet in daylight or at night in the light from an automobile headlamp. In a single sign, variation in color or reflectivity of the sheeting noticeable at a distance of not less than 50 feet under day or night conditions shall be cause for rejection of the sign.
5. Performance:
 - a. Specular Glass. When measured with an 85 Gloss Meter, Type I sheeting shall have a specular gloss reading of not less than 40. Gloss shall be measured according to Federal Standard Test Method 141/6103.

- b. Reflective Intensity. The reflective intensity values of the sheeting shall not be less than the values specified in Table I. The reflective values shall be determined according to (4.4.7) of Federal Specification L-S-300A.
- c. Shrinkage. When tested as in (4.4.11) of Federal Specification L-S-300A, the sheeting shall not shrink more than one thirty-second (1/32) of an inch in ten (10) minutes or more than one-eighth (1/8) of an inch in twenty-four (24) hours.
- d. Accelerated Weathering.
 - 1. When subjected to twelve-hundred (1200) hours of accelerated weathering, the sheeting shall be substantially equal in appearance to the unweathered sheeting. There shall be no more than a slight loss of gloss and no evidence of cracking, scaling, pitting, delamination, edge lifting or curling or more than one thirty-second (1/32) of an inch of shrinkage or expansion. The lens elements shall show no cracking or other deterioration except that slight etching or crazing of the elements will be permitted.
 - 2. Accelerated weathering will be conducted in a twin arc ATLAS WEATHEROMETER operated according to ASTM E42, Apparatus D, with the following additions and exceptions.
 - a. At the end of each twenty (20) hour cycle the panels will be placed in a cold cabinet at approximately 0-degrees F for one (1) hour. After removal from the cold cabinet the panels will be returned to the weatherometer to await the start of the next cycle.
 - b. Water used in the weatherometer will be City water softened to a total hardness content of less than five (5) parts per million expressed as calcium carbonate.

G. SUBMITTALS:

- 1. The Contractor shall show manufacturers certifications attaching typical test results representative of the materials and certifying that all materials supplied conform to all of the requirements specified.
- 2. The Contractor shall furnish a written statement from the sheeting manufacturer guaranteeing satisfactory performance of the sheeting materials.

H. FABRICATION OF FLAT SHEET SIGN PANELS:

Flat sheet signs shall be cut to the size and shape shown on the plans. They shall be free from buckles, warps, dents, cockles, burrs and other defects caused by fabrication. Signs shall be attached to posts as shown on the plans.

I. APPLICATION OF REFLECTIVE SHEETING:

1. Preparation of metal and application of reflective sheeting shall be strictly in accordance with the sheeting manufacturer's instructions.
2. The applicator shall use equipment recommended by the sheeting manufacture and shall be experienced in the application of the particular sheeting specified.

1604 INSTALLATION. Installation shall be in accordance with the details on the plans and as specified herein. The posts shall be erected by driving, either by hand or with mechanical devices. The method of driving shall not substantially alter the cross-sectional dimensions of the posts or materially damage the spelter coating. All areas where the galvanizing has been removed or damaged shall be cleaned and painted with zinc rich paint. Battered tops will not be permitted. Posts, which are bent or otherwise damaged during or after erection, shall be removed from the site and replaced at the contractor's expense. After driving, the portion of the posts above ground shall be oriented as required above and the posts shall be firm in the ground.

1605 EXISTING SIGNS. The Contractor shall preserve all existing traffic signs in useful condition so as to provide traffic control during construction. All existing traffic signs except those signs to be removed shall be reused and relocated, as shown on the plans, after construction. All existing signs that are to be removed after construction shall be carefully protected and shall be removed and returned to a place designated by the City Engineering Department.

SECTION 1700 – BIKE PATHS & SHARED LANES

1701 SCOPE. The work of this Section shall consist of retrofitting and constructing Bike Paths and Shared Lanes for bicycles.

1702 SIGNS. The bicycle signs shall meet the requirements of the latest edition of the Manual of Uniform Traffic Control Devices, unless otherwise required in the Special Provisions or contract drawings.

The Contractor shall locate the signs in the field in accordance with the Plans, the Manual on Uniform Traffic Control Devices, and subject to the approval of the Engineer. Dimensions on the detailed drawings on the Plans shall take precedence. The contractor will be responsible for orientation, elevation, offset and level of all signs erected.

The Contractor shall verify, prior to erecting any sign, that underground utilities will not be damaged as a result of placing the signpost.

1703 GUIDELINES FOR RETROFITTING BIKE LANES.

Bike lane shall be a minimum of 4 feet wide excluding curb and gutter that are signed, striped, and marked for bicycle use.

Appropriate where significant bicycle demand is desired or expected on arterial streets, generally defined as having average daily traffic flows that exceed 10,000 or average vehicle speeds that exceed 30 mph.

Appropriate on streets where lane designation is not complicated by frequent roadway intersections and commercial driveways.

Traffic Speed & Lane Widths:

35 mph or less – maintain 11-foot travel lanes (if 2 or more lanes in each direction) or 12-foot center turn lanes.

40 mph or more – maintain 12-foot travel lanes (if 2 or more lanes in each direction) or 12-foot center turn lanes.

Number of Lanes & Lane Widths:

In situations of 4 lanes of traffic (2 in each direction), and a significant number of left-turn movements, consider restriping for a continuous left-turn lane, 2 travel lanes, and 2 bike lanes.

1704 GUIDELINES FOR RETROFITTING SHARED LANES.

Shared Lane shall be a minimum of 13 feet wide excluding curb and gutter that are marked for bicycle use.

Appropriate where significant bicycle demand is desired or expected on arterial streets and there is not enough width for a separate 4-foot Bike Lane.

Traffic Speed & Lane Widths:

35 mph or more – maintain 10.5-foot inside lanes and a minimum 13.5-foot outside lanes (if 2 or more lanes in each direction) or 10-foot center turn lane and 13-foot driving lanes.

1705 MATRIX.

Minimum Width Criteria

		<u>4-foot Bike Lanes</u>	<u>Shared Lanes</u>
25 mph - 2 Lanes	width	28' of Asphalt	24' of Asphalt
	lanes	4' - 10' - 10' - 4'	12' - 12'
	curb to curb	32' b-b	28' b-b
30 mph - 2 Lanes	width	28' of Asphalt	24' of Asphalt
	lanes	4' - 10' - 10' - 4'	12' - 12'
	curb to curb	32' b-b	28' b-b
35 mph - 2 Lanes	width	30' of Asphalt	24' of Asphalt
	lanes	4' - 11' - 11' - 4'	12' - 12'
	curb to curb	34' b-b	28' b-b
35 mph - 3 Lanes	width	42' of Asphalt	36' of Asphalt
	lanes	4' - 11' - 12' - 11' - 4'	13' - 10' - 13'
	curb to curb	46' b-b	40' b-b
35 mph - 4 Lanes	width	52' of Asphalt	48' of Asphalt
	lanes	4' - 11' - 11' - 11' - 11' - 4'	13.5' - 10.5' - 10.5' - 13.5'
	curb to curb	56' b-b	52' b-b
40+ mph - 3 Lanes	width	44' of Asphalt	36' of Asphalt
	lanes	4' - 12' - 12' - 12' - 4'	13' - 10' - 13'
	curb to curb	48' b-b	40' b-b
40+ mph - 4 Lanes	width	56' of Asphalt	48' of Asphalt
	lanes	4' - 12' - 12' - 12' - 12' - 4'	13.5' - 10.5' - 10.5' - 13.5'
	curb to curb	60' b-b	52' b-b

SECTION 2000 – CONCRETE (kcmmmb)

2012 KCMMB Concrete Material Specification

1. The 28 day compressive strength for concrete shall be 5,000 psi and designated as "KCMMB 5K", or shall be 4,000 psi and designated as "KCMMB 4K". Mixes for High Early Strength Concrete shall meet the same requirements as stated below for standard 4K and 5K mixes (designated as "KCMMB HE"), and any additional requirements noted below specific to High Early Strength Concrete. Compressive strength shall be determined in accordance with ACI 318. All mix designs submitted to the Kansas City Metro Materials Board shall have a unique number designated by the concrete supplier. This unique name must match the name on the concrete delivery ticket or the concrete will be rejected. Mix designs for Flowable Fill shall be submitted to individual cities for approval.
2. The KCMMB shall approve each coarse aggregate source. Coarse aggregate shall be entirely granite, calcite cemented sandstone, quartzite, basalt, diabase, rhyolite, or trap rock. All coarse aggregate shall come from a large, accessible, uniform geological formation and be easily field identifiable in concrete. All coarse aggregate test results shall not exceed the following percentages by weight:

AASHTO T103 Soundness by Freeze/Thaw 50 cycles	<u>Max. Allowable %</u>
3/4 - 3/8	1.0%
3/8 - #4	2.0%
ASTM C127	
Absorption %	0.5%
ASTM C123 Lightweight Pieces	
% Light Weight Pieces	0.5%
ASTM C142 Clay Lumps and Friable	
% Deleterious	0.3%
Coal and Lignite	
% Coal and Lignite	0.05%
ATM C117 Material Finer than #200 by washing	
% Passing	0.5%
Sum of all deleterious	
% Total deleterious	1.0%
ASTM C88 Sulfate Soundness (MgSO4) Weighted % loss	
3/4 - 3/8	0.5%
3/8 - #4	4.0%
ASTM C131 LA Abrasion	
% Loss	28.0%

3. Coarse aggregates shall meet the gradation requirements of the current ASTM C33. The acceptable gradation sizes shall be number 1 through 7, 56, 57, 67, 357 or 467. Mix designs shall specify the gradation designation.

4. Limestone found in concrete mixes, delivered from centrally batched concrete plants shall not exceed 3% by weight of the coarse aggregate fraction. Limestone found in all other concrete mixes shall not exceed 2% by weight.
5. Fine aggregate shall meet the requirements set forth in the current ASTM C33. The percentage by weight of clay lumps and friable particles shall not exceed 0.25%. The percentage by weight of material passing the no. 200 sieve shall not exceed 2%. The percentage by weight of coal and lignite shall not exceed 0.25%. Soundness shall be determined using magnesium sulfate.
6. Aggregates in mixes must be proportioned to have a minimum of 55% coarse aggregate by weight. An optimized gradation will also be acceptable if it meets KDOT or MoDOT specifications.
7. Cementitious Materials: The total mass of cementitious materials shall be a minimum of 600 pounds per cubic yard of concrete and consist of one of the following options:
 - A. A minimum of 450 pounds per cubic yard of ASTM C 150 Type I, II, I/II, or III portland cement combined with one of the following:
 1. ASTM C 989 Grade 100 or 120 Ground Granulated Blast Furnace Slag (GGBFS) at a maximum of 25% of the combined total cementitious weight.
 2. ASTM C 618 Class F fly ash at a maximum of 25% of the combined total cementitious weight. In addition Loss on Ignition is limited to a maximum of 3.0%.
 - B. Manufactured ASTM C 595 Blended Hydraulic Cement Type IS or IP with the following limitations:
 1. Type IS – The slag constituent shall not exceed 25% of the mass of the combined portland cement and slag.
 2. Type IP – The pozzolan constituent shall not exceed 25% of the mass of the combined portland cement and pozzolan.
 - C. The total alkali content of the concrete shall be limited to the sum of the acid soluble alkali content of portland cement plus either one-sixth the alkali content of fly ash or one-half of the alkali content of slag, to a maximum of 5 lb/yd³.

Note: Mortar Bar Expansion tests are required if the cementitious combination contains less than 25% GGBFS or Class F fly ash. If a mix design with less than 25% GGBFS or Class F fly ash is submitted, the mortar bar expansion shall be a maximum of 0.10% at 16 days when tested according to ASTM C 1567. The C 1567 test shall be performed on cementitious combinations submitted as noted above and include aggregate combinations from one of the three following options:

1. Test each coarse aggregate and percentage submitted with Missouri River sand obtained from the Holliday Sand Riverside Dredge. (For each cementitious combination tested, this option only allows this specific coarse aggregate source and percentage to meet the Mortar Bar Expansion test.)
2. Test with 55% Pink Quartzite from the Dell Rapids Pit, Dell Rapids, South Dakota and 45% Missouri River sand obtained from the Holliday Sand Riverside Dredge. (For each cementitious combination tested, this option allows any approved coarse aggregate at 55% to meet the Mortar Bar Expansion test.)
3. Test using 100% Missouri River sand obtained from the Holliday Sand Riverside Dredge. (For each cementitious combination tested, this option allows any aggregate combination to meet the Mortar Bar Expansion test.)

Regardless of which option above is used, all aggregate combinations must meet the rest of the KCMMB Specification. The Mortar Bar Expansion shall be a maximum of 0.10% at 16 days.

8. Water cement ratio shall not exceed 0.44. Only potable water shall be used. The minimum water cement ratio shall be 0.25.
9. Air Entrainment shall meet the requirements set forth in the current ASTM C260. The percentage of air content by volume shall be 6.5% plus/minus 1.5%. Mixes shall be designed for 6.5% air content. For precast manufacturing facilities that utilize dry cast concrete, air contents will be determined by taking three separate cores at random intervals throughout the KCMMB year. If submitting for the first time, drycast suppliers can receive conditional approval by submitting a mix design that meets all the KCMMB specifications except for air content. They will be conditionally approved until receiving results from the first air content test. The core locations will be specified by the participating KCMMB member after the project has been constructed. The cores shall be 4" diameter partial depth through walls of finished concrete products. Provide a Linear-Traversal Test (ASTM C457), Procedure A, on each core using the proposed mix design. Provided, for each mix design submitted, the average of the three tests is above 5% total air content, with no single sample being less than 4%, the facility will be approved to dry cast concrete structures using that mix until April 1st of the following year. Test results for each ASTM C457 test should include the total air content and the corresponding specific surface in square inches per cubic inch, the spacing factor in inches, and a recalculation of the air content, specific surface and spacing factor using bubbles with a size of 0.04" and less. If submitting the same mix design for the following year, the last three air test can be submitted for conditional air content approval.
10. All concrete delivery tickets shall include the plant name, design w/c ratio, batch weights per cubic yard, total batched weight of all materials for quantity delivered, time batched, design slump, water withheld (2 gal/yd maximum, no water shall be withheld from HE concrete), allowable slump range, moisture correction for aggregates, and dosages of all approved admixtures. Pre-cast concrete manufactures shall keep concrete delivery tickets on file for one year. Certifications for the pre-cast concrete shall be provided when the product is delivered to the job site.
11. For High Early mix designs, test results for the ASTM C 1074 shall be submitted. Compression tests may be performed at times other than those in ASTM C 1074 provided the tests occur within the time limits of ASTM C 1074 and give the majority of data points early in the time frame. Control of Slump, time of set, and workability shall be controlled by use of admixtures only, NO water shall be withheld from a high early mix.

Revised Date: 10-28-2011

SECTION 2100 - CONCRETE CURB, CURB & GUTTER, SIDEWALK, AND DRIVEWAY ENTRANCES

- 2101 SCOPE. This section covers concrete curb, curb and gutter, concrete sidewalk and concrete driveway entrances, including reinforcing steel, forms, joints, finishing, curing, and other appurtenant work.
- 2102 MATERIALS. All items of material included in this work shall conform to the requirements of Section 2000 "Concrete".
- 2103 GENERAL. All construction covered in this section shall conform to the requirements of Section 2000 "Concrete". All curb or curb and gutter construction shall be performed prior to placement of pavement or sidewalk, except when otherwise approved by the engineer. All forms shall be in good condition with not more than one-fourth (1/4) inch variation in horizontal and vertical alignment for each ten (10) feet in length.
- 2104 GRADING AND SUBGRADE PREPARATION. All excavation required in the grading and subgrading preparation shall be considered as "Unclassified Excavation" as defined in Section 1100 "Grading". All grading shall be done in conformance with Sections 1100 "Grading", and 1200 "Subgrade Preparation".
- 2105 EXPANSION AND CONTRACTION OR CONSTRUCTION JOINTS. Expansion and contraction or construction joints shall be as herein specified on the standard detail sheets or as otherwise specified by the City Engineer.
- 2106 FINISHING. Finishing shall be performed as follows:
- a. Curb and Curb and Gutter. The curb shall be tooled to the required radii as soon as possible after the concrete takes its initial set. After the forms and templates are removed the joints shall be tooled and the curb surface finished with a wood or cork float to remove all imperfections without additional mortar. In all cases the resulting surface shall be smooth and of uniform color with all rough spots, projections, and form stakes removed. No plastering of the concrete will be allowed. The finished curb shall have a true surface, free from sags, twists, or warps, and shall have a uniform appearance, and shall be true to the specified lines, grades, and configurations shown on the drawings.
 - b. Sidewalk and Driveway Entrances. After the concrete has been thoroughly consolidated and leveled, and the initial set has taken place, the surface shall be finished with a soft wood or cork float and either burlap or broom finished with no other mortar than that contained in the concrete. The resulting surface shall be uniform in color and contain no imperfections. The edges shall be rounded with a tooling edge. Special care shall be taken to ensure a straight, neat appearance along the edges of the sidewalk or driveway entrance and at the joints.
- 2107 REINFORCEMENT (Curb and Gutter). Reinforcement for concrete curb and gutter shall be as designated on Standard Details 21-1 and 21-2. The exception to this shall be when the curb and gutter is to be constructed on an asphaltic concrete base with a minimum depth of three inches (3"). In this case, no reinforcement shall be required unless otherwise determined by the City Engineer.
- 2108 REINFORCEMENT (Other). Reinforcement for all other work shall be as shown on the contract drawings or as depicted on details contained in this specification.

SECTION 2200 - STEEL BEAM GUARDRAIL

2201 SCOPE. This section governs the furnishing of all labor, equipment, tools, and materials and the performance of all work necessary for the installation of steel beam guardrail as shown on the construction plans or standard drawings.

2202 MATERIALS.

- A. Steel Posts. All posts, terminal posts connectors, and steel blocks for guardrail shall be formed from a structural steel meeting the requirements of ASTM M-180 Class A, Type I.
- B. Guardrail and Hardware. All guardrail and hardware shall conform to the requirements of AASHTO M-180 Class A, Type I.

2203 ERECTION.

- A. Setting Posts. Posts shall be set to the depth and spaced at the intervals shown on the construction plans or standard drawings. They shall be set vertical and true to line and grade. Steel posts may be driven by a power hammer or may be set in dug or bored holes of a size sufficient to permit thorough compacting of the backfill around the post. The backfill material shall be dry sand, placed in layers not exceeding 12 inches in thickness to a height 12 inches below the finished grade. After erecting and adjusting the rail to true line and grade, the sand backfill shall be compacted by flooding. The final 12 inches of backfill consisting of suitable earth material shall then be compacted in six (6) inch lifts. Any "mushrooming" of the top of the post shall be removed and damaged spelter coating on posts shall be repaired by the Zinc alloy stick method while the surface is heated to approximately 600 deg. F. Other methods of repairing the spelter coating shall receive prior approval of the Engineer.
- B. Placing the Guardrail. Boltholes shall be shop punched. Field punching, reaming and drilling will not be permitted. Guardrail beams shall be spliced, only at posts by lapping in the direction of traffic, using the required number of splice bolts. Beams for twisted turned down terminal section may be either field or shop twisted. Sufficient twist shall be introduced such that the beam shall retain the required shape in a relaxed condition. Beams to be erected on a radius of 150 feet or less shall be shop-curved as shown on the plans.

Each end of every installation of guardrail shall have an end, bridge anchor, or terminal section of the design and type shown on the construction plans or standard drawings. They shall be of the same material and shall be galvanized in accordance with the requirements for the guardrail beam.

Galvanized rail shall be handled in a manner to avoid damage to the galvanized coating. Any section of rail, end sections or terminal sections on which the spelter coating has been bruised or broken shall be rejected, or may, with the prior approval of the Engineer, be repaired by the method described for repairing damaged spelter coating of steel posts.

SECTION 2300 – TRAFFIC CONTROL

2301 GENERAL. The Contractor shall be responsible for maintenance, control, and the safeguarding of traffic within and immediately abutting the project as further outlined herein, and as may otherwise be provided for in the Special Provisions. The City will be responsible for maintenance, control, and safeguarding of traffic on all detours, which do not lie within the project limits, unless otherwise required in the Special Provisions or contract drawings.

The Contractor must provide a detour plan to the Engineer and notify the Engineer at least 48 hours prior to implementing a detour plan or closing a street.

The Contractor shall notify the central dispatcher of the Fire Department and the Police Department prior to the closing or cutting of any public thoroughfare.

Failure to notify the Engineer and police dispatcher will result in an immediate suspension of work.

2302 STREET CLOSURES. Streets may not be closed to through traffic unless otherwise provided for in the Special Provisions. Streets shall not be closed to traffic until the Engineer has approved such closure. Street closures shall be made in such a manner as to provide for maximum public safety and public convenience, and if closed, shall be opened to through traffic at such time as the work has been completed, or as the Engineer may direct.

2303 EXISTING TRAFFIC SIGNS AND FACILITIES. The City, unless otherwise indicated, will make all necessary adjustments to traffic signals and traffic signal activators at no cost to the Contractor. Existing traffic and street name signs, which will interfere with construction, shall be removed by the Contractor and stored in a safe place. These signs shall not be removed until the Engineer has so directed and until the necessary measures have been taken to safeguard traffic after the signs have been removed. Preservation and maintenance of the signs shall be the sole responsibility of the Contractor. Upon completion of the project, the Contractor shall reset all such signs.

2304 DETOURS. Detours outside the limits of the project shall be the sole responsibility of the Contractor unless otherwise provided in the Special Provisions. Detours within the limits of the project such as side street crossings, temporary bridges over freshly placed concrete, utilization of one or more lanes of the construction are for maintenance of traffic, and such related facilities for the maintenance of traffic shall be the responsibility of the Contractor, the costs which shall be included in the unit contract prices unless otherwise provided for in the Special Provisions. All detour signage shall conform to the standards set forth in MUTCD.

2305 LOCAL AND EMERGENCY TRAFFIC. Local traffic shall be provided access to private properties at all time, except during some urgent states of construction when it is impracticable to carry on the construction and maintain traffic simultaneously, such as for the placing of asphalt concrete pavement, placing and curing of portland cement concrete pavement, and deep sewer excavations which prohibit safe travel of vehicular traffic.

No private driveway may be closed without the approval of the Engineer, unless written permission has been given the Contractor by the owner of the property affected.

Emergency traffic such as Police, Fire and disaster units shall be provided reasonable access at all times. The Contractor shall be liable for any damages, which may result from his failure to provide such reasonable access.

2306 PROTECTION OF PEDESTRIAN AND VEHICULAR TRAFFIC. The Contractor shall take every precaution to protect pedestrian and vehicular traffic. Whenever, in the opinion of the Engineer, the Contractor has not provided sufficient or proper safety precautions and safeguards, he shall do so immediately and to whatever extent the Engineer deems advisable.

2307 RESTRICTION OF PARKING. Where parking is a hazard to through traffic or to the construction work, it shall be restricted either entirely or during the time when it creates a hazard. Signs for this purpose will be initially furnished and placed by the City unless indicated otherwise. The Contractor shall be responsible for and shall maintain the signs if they are used on any street which is directly involved in the construction work. If the parking signs are to be used beyond the confines of the work area, such as another street being used as a detour, the signs will be the responsibility of the Contractor.

2308 FLAGMEN. The Contractor shall furnish at his own expense all flagmen who may be needed unless otherwise provided for in the Special Provisions. Flagmen will be required when equipment is crossing a road that is open to vehicular traffic. Hand signaling devices, flagman attire, flagging procedures, and flagman stations shall be in accordance with the M.U.T.C.D.. On projects requiring handling of two-way traffic over a single lane, each flagman involved in controlling traffic through and along the work area shall be equipped with a portable transceiver radio and a Stop - Slow hand signaling device.

2309 TRAFFIC CONTROL WITHIN AND ABUTTING THE PROJECT. The contractor shall place and maintain all signs, barricades and warning lights within the limits of the project on all streets, alleys, and driveways entering the project so that approaching traffic will turn right or left on existing and undisturbed streets before reaching the warning signs and barriers immediately abutting the project. Unless otherwise provided for in the Special Provisions, all required signs will be furnished by the Contractor.

Barricades shall be furnished by the Contractor. The barricades shall be of a conventional design normally used in street construction work, and painted a current traffic yellow with black stripes as shown in Part VI of the Manual on Uniform Traffic Control Devices, latest edition.

2310 FLASHERS. Flashers used shall be a type approved by the Engineer with a 7-inch lens, amber in color, and reflectorized rim. The rate of flashes shall be regular and shall be between 50 and 60 flashes per minute + or - 5 percent; the "on" time shall be at least 25 percent of the cycle + or - 5 percent. Batteries shall be replaced in flasher units when the voltage is less than 4.6 volts for a 6-volt unit and 9.2 volts for a 12-volt unit.

2311 TEMPORARY SURFACING. Whenever the Engineer determines the construction operation requires surfacing to permit vehicular or pedestrian traffic, the contractor shall provide temporary surfacing of crushed stone. Whenever temporary surfacing will be required for a sustained period or on high volume roadways, the top 1 1/2" or temporary surface shall be of Bituminous cold mix "Possipatch" or approved equal. Such temporary surfacing shall be maintained by the Contractor in a safe, reasonably smooth condition as long as it is in use. Crushed stone for temporary surfacing shall meet the requirements of Paragraph 1007.2 Missouri Highway Specifications for Type 2 Aggregate, Gradation A.

SECTION 2400 - PLANING

2401 SCOPE. This section governs the furnishing of all labor, equipment, tools, and materials and the performance of all work required for planing pavement surfaces.

2402 EQUIPMENT. Planing the surface of pavements shall be completed by the used of a planer conforming to one of the two (2) following types:

A. Heater Planing.

1. Machine. The heater planing machine shall be designed and built for planing work, be self propelled and shall have the means of heating, planing and cutting the old surface and blading the cuttings into a single windrow.
2. Heater. The machine shall be equipped with an adequate pavement surface heater to heat the surface to the optimum temperature for planing.
3. Operating Width. The heating and cutting width of the machine shall be the same and shall not be less than eight (8) feet.
4. Drive Wheels. The rear driving wheels shall be tandem to protect the softened surface of the pavement.
5. Speed. The machine shall be capable of operating at a speed compatible with the heating capacity of the burner.
6. Power. The planer shall have adequate power to force the cutting edge to the proper depth below the surface of the heated pavement without chattering or causing irregularities in the surface of the planed pavement. This machine shall have enough power to operate all auxiliary equipment without interfering with the performance of the machine as a planer.
7. Air Pollution. The machine shall comply with current air pollution standards.
8. Warning Lights. The planing machine shall be equipped with a flashing warning light visible from 360 degrees. The light shall be mounted near the rear of the machine, at least 2 feet above the highest part of the planing machine, and shall be used whenever the machine is being used or moved upon the City streets.

B. Cold Planing.

1. Machine. The cold planing machine shall be self-propelled and shall have in combination the means of planing and cutting, without softening, the old surface and blading the cuttings into A single windrow.
2. Air Pollution. The machine shall be equipped with a dust suppression system including water storage tanks and high-pressure spray bars.

3. Operating Width. It is desirable that the cutting width be greater than five (5) feet. In the event the cutting width is less than 5 feet a system of electronic grade control for consecutive passes will be required.
4. Cutting Drum. The cutting drum shall be totally enclosed to prevent discharge of any loosened material on adjacent work areas.
5. Warning Lights. The planing machine shall be equipped with a flashing warning light visible from 360 degrees. The light shall be mounted near the rear of the machine, at least two (2) feet above the highest part of the planing machine, and shall be used whenever the machine is being used or moved upon the City streets.

2403 CONSTRUCTION DETAILS.

A. Methods for operations for Planing:

1. Operator. An experienced and capable operator shall operate the planing machine.
2. Utilities. Street surfaces adjacent to manholes, water valves and other utility extensions, shall be completely removed to the full depth of cut specified for the street unless otherwise specified by the Engineer.
3. Material Disposal. The material left windrowed by the machine, or removed by hand labor methods, shall be removed immediately from the surface of the pavement and disposed by the Contractor at a disposal area designated or as directed by the Engineer.
4. Surface Conditions
 - A. Heater Planing. The temperatures at which the work is performed, the nature and condition of the equipment and the manner of performance of the work shall be such that the pavement is not torn, gouged, broken or otherwise damaged by the planing operation.
 - B. Cold Planing. The drum lacing patterns shall produce a smooth surface finish after planing, with groove depths not to exceed 3 inches unless otherwise approved by the Engineer.

B. Types of Cuts to be made by Planing:

1. Leveling. Sufficient passes, shall be made such that all irregularities or high spots are eliminated, and that 100 percent of the surface is planed.
2. Average Depth. Sufficient passes, or cuts, shall be made in order to remove a specified depth over the entire street section. These depths will be designated in the Special Provisions or as directed by the Engineer.
3. Bridge Deck Planing. Sufficient passes, or cuts, shall be made in order to remove the material as specified on the plans or in the Special Provisions.

Clean-up. All loose asphalt and debris shall be removed from the street surface and curb and gutter. Any material and debris that adheres to the curb and gutter shall be removed.

SECTION 2500 - ASPHALT CRACK SEALING, IMPROVED STREET CHIP SEAL, SLURRY SEAL, AND UNIMPROVED STREET SEAL

2501 SCOPE. This section governs the furnishing of all labor, equipment, tools and material, and the performance of all work necessary for minor pavement patching and crack cleaning and sealing, construction of asphalt seal-coat and slurry seal, complete, in place, at the locations specified in the Special Provisions and as directed by the City Engineer.

2502 CRACK SEALING.

- A. Crack Sealing Material. Asphalt Material used for crack sealing shall be RC-250, 800 or 3000 with 1 per cent anti-stripping agent added as specified in the contract or as directed by the City Engineer. The temperature range for these RC's shall be 240-290 deg F when applied.

When the ambient temperature exceeds 60 deg F the material used for crack sealing may be emulsified asphalt Designation CRS-1 or CRS-2.

- B. Weather Limitations. Crack sealing shall be performed only on days when the ambient temperature is greater than 25 deg F and rising at the time work is to begin. Crack sealing shall not be done on days when ice or other conditions prevent proper cleaning of the cracks.
- C. Distributor. A distributor as listed in Section 1305 is required for handling the liquid asphalt for crack sealing.
- D. Aggregate for Blotting. "Buckshot Aggregate" shall be clean and dry and conform to the following gradation:

<u>Sieve Size</u>	<u>Percent Passing</u>
No. 4	90-100
No. 10	0-15

- E. Cleaning. All cracks shall be thoroughly cleaned of undesirable material by the use of an 85 to 90 C.F.M. compressor with air hoses and attachments.
- F. Filling Procedure. After all cracks have been thoroughly cleaned, the operator of the hand hose shall apply hot liquid asphalt to the cleaned cracks. Application of the liquid asphalt shall be done in such a manner to avoid an accumulation of excess material on areas adjacent to the cracks. Excess material on the cracked areas shall be redistributed by means of a U-shaped squeegee.

2503 IMPROVED STREET CHIP SEAL.

- A. Description. This work shall consist of the application of asphaltic cements and cover aggregate to an existing improved street surface.

B. Requirements for Materials to be used for Improved Street Sealing.

1. Asphalt Cement.

- a. The asphalt cement for sealing shall be 85-100 penetration grade, complying with ASTM D-946.

The material shall be sampled and tested as set forth by Section 4 of ASTM D-946.

- b. A sample of the liquid bituminous materials may be taken from each distributor or relay on the job site. If the liquid bituminous materials do not meet the specifications as set out in the contract after applying, the Contractor shall correct, at his own expense, all unsatisfactory areas. No additional areas shall be sealed until corrections have been accomplished.

2. Cover Aggregates.

a. Precoated Limestone.

- (1) Aggregate. This material shall be precoated limestone chips of the Bethany Falls Ledge, or other materials approved by the City Engineer. Stone chips for seal coating shall be precoated with 3/4 to 1 percent by weight of MC-70, as specified in Paragraph 4. All material shall be free of moisture, dust and lumps and shall be approved by the City Engineer prior to use.

The chips shall be uniformly heated in a dryer until surface dry. The asphaltic material and hot aggregate shall be measured separately and accurately immediately before introduction into the mixer. Mixing shall be at a suitable temperature and sufficient to produce a thoroughly and uniformly coated aggregate. Precoated seal coat chips shall be stockpiled at least 3 days before using.

- (2) Gradation. Limestone chips to be used for sealing shall, when graded through sieves with square openings, conform to the following percentages:

<u>Sieve Size</u>	<u>Percent Passing</u>
2"	100
3/8"	95-100
No. 4	18 Max.
No. 10	0-2

- (3) Physical Properties. The chips, when tested by Los Angeles Abrasion test shall have a percentage of wear not to exceed 35 percent after 500 revolutions as determined by ASTM C-131. The shale content of the material shall not exceed 0.5 percent by weight. The materials shall be free of acid or other deleterious substances.

- (4) Asphalt Coating. Asphalt for the coating of limestone cover aggregate shall be MC-70 conforming to ASTM D-2027, Liquid Asphalt, Medium Cure.

b. Lightweight Cover Aggregate.

- (1) Aggregate. Lightweight cover aggregate consists of expanded shale produced by the rotary kiln method and shall comply with the quality and gradation requirements as set forth in these specifications.

- (2) Unit Weight. The dry loose weight of Lightweight Cover Aggregate shall not be less than 39 nor more than 48 lbs per cubic foot.

- (3) Quality Requirements.

- (a) Soundness. The loss ration for Lightweight Cover Aggregate shall not be less than 0.90 when subjected to 25 cycles of the freezing and thawing test as set forth in Section 4, MCIB Specification.

- (b) Wear. The percent loss shall not exceed 25 percent when tested by the Los Angeles Abrasion Test Method (ASTM C-131).

- (c) Deleterious Substances. The deleterious substances in each individual aggregate shall not exceed the following percentages by weight:

Sticks (wet weight)	0.5
Coal	0.5
Soft Friable Materials	2.5
Unburned or Underburned Shale	0.5

The above percentages are when taken separately. In addition, any combination of the above shall not exceed 3.0 percent.

- (d) Absorption. The water absorption of the expanded shale aggregate shall not exceed 18 percent when soaked for 24 hours.

- (4) Gradation. Lightweight cover aggregate shall conform to the grading requirements as follows:

<u>Sieve Size</u>	<u>Percent Passing</u>
3/8	100
No. 4	0-15
No. 8	0-2
No. 100	0-0.5

c. Weighing of Cover Aggregate.

The Contractor shall furnish scales for weighing cover aggregate as required in Section 1407 entitled "Scales and Weighing of Vehicles." All loads of cover aggregate will be

weighed and evidenced by approved delivery tickets showing the net weight in pounds for each load. Two copies of each ticket shall accompany the load to the work site. Upon the load being incorporated in the work, the inspector will sign both copies and one of these copies will be returned to the Contractor.

C. Spot Patching.

Holes, where the surface is broken out, shall be cleaned of any loose material. Holes shall be tacked with a light coating of emulsified asphalt. The tack coat shall extend beyond the limits of the patch.

The emulsified asphalt used for the tack coat shall be CRS-1, RS-1, MS-1 or SS-1h conforming to ASTM D-977. Patches shall be made in holes or depressions where the surface is in good condition. The City Engineer will indicate the extent to which patches shall be made.

The prepared hole shall be patched with hot-mix asphaltic patching material by placing in layers not to exceed 2 inches; each layer being thoroughly compacted before the next layer is placed. After the patching material is placed and raked to a uniform surface, it shall be thoroughly compacted by rolling with a tandem or three-wheeled roller with a minimum weight of 180 pounds per lineal inch or a vibrating shoe compactor. An appropriate number of passes shall be made to insure that the patch is firmly consolidated. The edges shall be will bonded with the old surface. The completed patch shall be in the same plane as the existing pavement.

The asphaltic concrete used for patching at the different locations shall be as directed by the City Engineer and shall conform to one of the mixes as set out in Section 1404, for Types 3 and 4 Asphaltic Concrete Surface. Generally the Type 4 mix shall be used for patching.

D. Sealing.

1. Cleaning. After all holes and cracks have been repaired to the satisfaction of the City Engineer, and immediately before sealing the Contractor shall thoroughly clean the area to be sealed. The street shall be dry before applying the seal coat.
2. Sealing. After the street has been prepared as set forth above the Contractor shall apply the liquid asphalt by means of an approved distributor meeting the requirements of Section 1305. Provisions shall be made by the Contractor to properly protect the curbs and gutters from the asphaltic spray. Liquid bituminous material shall be applied at a rate between 0.16 and 0.22 gallons per square yard. The City Engineer in the field will determine the specific rate for each job.

To insure uniform application of the bituminous material to the street surface at the beginning of each distributor load or portion thereof, the Contractor will be required to cover a portion of the street surface with building paper. The area covered by the building paper shall be used as the starting point for each distributor load or each part of a distributor load after a temporary delay, and the spray bars shall be discharged on

this paper until all nozzles are working properly. After use, the building paper shall be removed and disposed of by the Contractor.

Immediately after the application of the asphalt, the Contractor shall by means of a self-propelled mechanical spreader, apply a uniform layer of cover aggregate. This material shall be spread at the rate specified by the City Engineer. This rate shall be between 10 and 20 pounds per square yard for precoated limestone chips and between 8 and 10 pounds per square yard for lightweight aggregate. If material is spread on any area in excess of the amount specified by the City Engineer, the surplus shall be immediately removed and placed elsewhere as directed. No payments will be made to the Contractor for the picking up and redistribution of the excess. Hand spreading will be permitted only in those areas not accessible to the mechanical spreader.

Immediately after spreading the cover aggregate, the entire surface shall be rolled with multiple wheels, pneumatic-type rollers. Rolling shall be continued until a thoroughly compacted surface with a uniform aggregate coverage has been obtained. The City Engineer may require additional rollers if one roller cannot keep up with the operations. The first pass of the rollers over the cover aggregate shall not exceed 5 miles per hour. The rollers shall not exceed 10 miles per hour during any rolling operation.

Where double sealing is specified or directed by the City Engineer, the area shall be treated with two coats. The top seal coat shall be applied the same day as the first seal coat. Double sealing will be performed as set out for sealing.

The Contractor shall seal all roadway areas within the street right-of-way, except private driveways, including sealing of intersections, alleys, etc, to the property line.

During the sealing operation as described above, the Contractor shall cooperate with the City Engineer in arranging a program and schedule of work so traffic may be handled or routed around or thorough the section being sealed. Whenever possible, the street will be closed; but when this is not possible, the sealing will be done in strips while traffic is diverted to the balance of the street. No traffic will be permitted on the sealed portion of the roadway until rolling is completed.

When bleeding occurs or more material is required, additional cover aggregate shall be spread as directed. As soon as the cover material has adhered to the surface, all excess cover aggregate shall be immediately removed.

2504 SLURRY SEAL.

- A. Description. This work shall consist of the application of Slurry Seal Material to an existing surface. The Slurry Seal shall consist of a mixture of emulsified asphalt, mineral aggregate and water, properly proportioned, mixed and spread on the surface in accordance with this specification and as directed by the City Engineer.

B. Materials.

1. Emulsified Asphalt. The Emulsified Asphalt to be used for this work shall be CRS-1h unless otherwise specified.
2. Aggregate for Slurry Seal. The mineral aggregate used for this work shall be chat aggregate which is a by-product of the milling of lead and zinc ores and shall conform to the following grading requirements:

<u>Sieve Size</u>	<u>Percent Passing</u>
3/8"	100
No. 4	82-94
No. 8	45-65
No. 16	25-46
No. 30	15-35
No. 50	10-25
No. 200 *	5-15

* The percent passing the No. 200 Sieve shall be determined by ASTM C-117.

3. Mineral Filler. Mineral Filler shall be any recognized brand of Portland Cement that is free from lumps.
4. Water. Water shall be potable and shall be free of harmful soluble salts.

C. Equipment.

1. Slurry Mixing Equipment. The slurry-mixing machine shall be self-propelled. Sufficient storage capacity for aggregate, emulsified asphalt, cement and water shall be provided to properly mix and apply a minimum of 8 tons of aggregate without the use of auxiliary tracks and tanks. The mixed unit shall be capable of delivering to the spreader unit properly proportioned and thoroughly mixed slurry on a continuous flow basis.

The mixing machine shall be equipped with an approved fines feeder that shall provide a uniform, positive, accurately metered, predetermined amount of the specified mineral filler at the same time and location that the aggregate is fed.

2. Slurry Spreading Equipment. Attached to the slurry-mixing machine shall be a squeegee distributor equipped with flexible material in contact with the surface to prevent loss of slurry from the distributor box. The rear flexible seal shall act as a strike off and be adjustable in width. It shall be maintained to prevent loss of slurry on varying grades and crown by adjustments to assure uniform spread. A burlap drag will be required to obtain the desired texture. The box shall be equipped with a steering device and shall be kept clean and free of any build up of asphalt and aggregate.

- D. Proportioning. The City Engineer shall approve all Slurry Seal Materials and methods prior to mixing and application. The proportions of the mixture to be used shall be as follows unless the City Engineer approves variations:

Aggregate for Slurry Seal	13.5 to 16.5 lbs per sq. yd. (dry basis)
Emulsified Asphalt	9.5 to 10.5 percent by weight of dry aggregate.
Mineral Filler (added)	1.5 to 3.0 percent by weight of dry aggregate.
Water	Quantity to produce proper consistency.

Once the proper consistency is obtained changes in proportioning of the various components of the mixture shall be held to a minimum.

- E. Construction Requirements.

1. Surface Preparation. Immediately prior to applying the Slurry Seal the surface shall be thoroughly cleaned of all objectionable materials and pre-wetted, leaving no standing water.
2. Application. The mixture shall be spread to leave a uniform non-skid film of fine aggregate and asphalt on the surface. Squeegees shall be used to spread the Slurry Seal mixture in areas inaccessible to the spreader box and other areas where hand spreading may be required. A hand drag shall be used at these locations to give the same texture as the machine-layed surface.

A sufficient amount of slurry shall be carried in all parts of the spreader box at all time so that complete coverage is obtained. No lumping, balling, or unmixed aggregate shall be permitted. Any oversized aggregates or foreign materials shall be removed from the aggregate prior to delivery to the mixing machine. No streaks or slick spots shall be left in the unfinished surface.

3. Weather Limitations. Slurry Seal shall be placed only when the surface temperature is 60 deg. F or above, the relative humidity is below 80 percent and no precipitation.

- F. Property Owner Notification. The City will supply the Contractor door tags, which the Contractor shall place on the doors of all involved property owners. The door tag shall comply with the included sample or an approved equal.

2505 UNIMPROVED STREET SEALING.

- A. Description. This work shall consist of applying a single liquid asphaltic coat with limestone cover aggregate to unimproved streets.

B. Requirements for Liquid Asphalt Materials.

The particular grade of liquid asphalt required on different streets will be an R-C or M-C liquid asphalt, as determined by the City Engineer, conforming to the requirements of ASTM D-2027 entitled "Specifications for Liquid Asphalt Type M-C or R-C".

C. Cover Aggregate.

This material shall be limestone chips of the Bethany Falls Ledge or an approved equal, and the shale content shall not be greater than 0.5 percent maximum by weight.

The chips when tested by Los Angeles Abrasion Test shall have a percentage of wear not to exceed 35 percent after 500 revolutions as determined by ASTM C-131.

All chips shall have less than 1 percent moisture, adhere immediately to the liquid asphalt, and not strip from the surface.

Gradation for limestone chips to be used for sealing shall conform to the following:

<u>Square Sieve Size</u>	<u>Percent Passing</u>
1/2"	100
3/8"	80-100
No.	0-26
No.10	0-2

The Contractor shall furnish scales for weighing cover aggregate as required in Section 1407 entitled "Scales and Weighing of Vehicles." All loads of cover aggregate will be weighed as required, and evidenced by approved delivery tickets showing the net weight in pounds for each load. Two copies of each ticket shall accompany the load to the work site. Upon the load being incorporated in the work, the inspector will sign both copies and one of these copies will be returned to the Contractor.

D. Sealing.

The rate of application shall be 0.15 to 0.25 gallons per square yard and shall contain 1 per cent of an anti-stripping agent (single strength), thoroughly mixed with the cutback asphalt. The specific rate of application will be determined for each street by the City Engineer. The distributor used shall meet the requirements of Section 1305.

Immediately after the application of the liquid asphalt the Contractor shall, by means of a mechanical spreader, apply a uniform layer of cover aggregate. This material shall be spread at the rate specified by the City Engineer within the range of 16 and 24 pounds per square yard.

If material is spread on any area in excess of the amount specified by the City Engineer, the surplus shall be immediately removed and placed elsewhere as directed. No payment will be made to the Contractor for the picking up and redistribution of such excess. The same applies for spillage. Hand spreading will be permitted only in those areas not accessible to the

mechanical spreader.

Immediately after spreading the seal coat aggregate, the entire surface shall be rolled with multiple wheels, pneumatic-type rollers. Rolling shall be continued until a thoroughly compacted surface with uniform aggregate coverage has been obtained. These rollers shall weigh between 8 and 10 tons.

Where double sealing is called for, or required by the City Engineer, the area shall be treated with two seal coats, the topcoat to be applied in the same manner as set out for sealing.

During the sealing operation as described above, the Contractor shall cooperate with the City Engineer in arranging a program and schedule of work so traffic may be routed around or through the section being sealed. Whenever possible, the street will be closed; but when this is not possible, the sealing shall be done in strips while traffic is diverted to the balance of the street. No traffic will be permitted on the sealed portion of the roadway until the rolling is completed.

The Contractor will be required to maintain a uniform aggregate coverage over the entire surface until such time as no more aggregate will be needed on any part of the surface to make a completed and finished job. When bleeding occurs or more material is required, additional cover aggregate shall be spread as directed.

2506 PROVISIONS FOR PUBLIC CONVENIENCE DURING SEALING OPERATION. The Contractor shall provide and maintain sufficient signs, barricades, warning lights, flag persons and watch persons to protect the work and public in a manner satisfactory to the City Engineer. Any areas damaged prior to acceptance by the City shall be repaired at the Contractor's expense.

The Contractor will furnish signs for "No Parking" to be used. These signs shall comply with the standards established by the MUTCD with regard to size, color, wording, height and placement. When "No Parking" signs are posted on the streets with parking meters, the Contractor shall cover the parking meter heads with cloth or paper bags.

The Contractor shall take all necessary precautions to protect the public (pedestrian and vehicular) from flying debris. The Contractor shall use warning signs and devices to warn motorists of work ahead and shall use traffic cones where necessary to guide traffic.

SECTION 3000 - SANITARY SEWERS

- 3001 SCOPE. This section applies to sanitary sewer construction and shall consist of furnishing all labor, materials, and equipment for the complete installation of sewers and appurtenances.
- 3002 GENERAL. It is understood that throughout this section these specifications may be modified or deleted by appropriate items in the contract documents.

When reference is made to a standard specification (ASTM, AWWA, etc.), the specification referred to shall be understood to mean the latest revision of said specification except as otherwise noted in the contract documents.

Vitrified Clay Pipe is not permitted for use in the City of Raytown.

3003 MATERIALS.

A. Reinforced Concrete Pipe

Pipe	ASTM C76, C497, C506, & C507, except as modified herein.
Fine Aggregate	Clean natural sand, ASTM C33. Artificial or manufactured sand will not be permitted.
Cement	ASTM C150, containing not more than five percent (5%) tricalcium aluminate.
Gaskets	ASTM 361 polymer shall be neoprene or other synthetic rubber. Natural rubber will not be acceptable.

1. Materials. Cement shall not contain tricalcium aluminate in excess of 5.0 percent. Fine aggregate shall be natural sand conforming to the requirements of MCIB Bulletin No. 1.

2. General. Furnish maximum lengths manufactured by supplier, except for fittings, closures and specials. Moisture absorption by boiling test shall not exceed 5.0 percent. Concrete pipe sections shall be cut while still green, reinforcing shall be exposed and welded together at junctions and miters. Splice shall be built up to nominal wall thickness with mortar or concrete.

3. Circular Pipe. Furnish ASTM C 76, Class III minimum, with either Wall B or Wall C. Reinforcement shall be circular or elliptical. Elliptically reinforced pipe shall be marked in accordance with Section 15.2, ASTM C 76, for correct installation.

4. Arch Pipe. Furnish ASTM C 506, Class A-III minimum. Reinforcement shall be single line or double line.

5. Elliptical Pipe. Furnish ASTM C 507, Class HE-III or Class VE-III minimum. Reinforcement shall be double cage.

6. Low-Head Pressure Pipe. Furnish ASTM C 361. Reinforcement shall be circular or elliptical. Elliptically reinforced pipe shall be marked in accordance with Section 15.1.4, ASTM C 361, for correct installation.

7. Joints. Flexible gasketed joints in concrete pipe shall be made with continuous ring, compression type rubber gaskets. Design of joints and physical requirements of rubber type gaskets shall conform to ASTM C 361 and C 443. Natural rubber will not be acceptable.

B. Ductile Iron Pipe

Pipe	ANSI A21.51; ASTM A536, Grade 60-42-10, Thickness Class 50 unless otherwise required by the City Engineer.
Mechanical and Push-On Joint	ANSI A21.11, except gaskets shall be neoprene or synthetic rubber. Natural rubber will not be acceptable.
Flanged Joints	ANSI A21.10.
Fittings	ANSI A21.10, pressure rating of not less than that specified for pipe. Fittings used with ductile-iron pipe shall be ductile-iron or cast iron. Fittings for pipe with mechanical joints shall have mechanical joints. Fittings for pipe with push-on joints shall be either mechanical joint or push-on joint.
Lining & Coating	Lining application shall be performed by pipe manufacturer only. Jobbing of lining will not be allowed. All lining shall be done at point of pipe manufacture. All ductile-iron pipe, fittings and specials shall be cement mortar lined in accordance with ANSI A21.4. Coat all pipe, fittings and specials with manufacturers standard coal tar coating.

C. Polyvinyl Chloride (PVC) Pipe: Conform to ASTM D3034, except as otherwise specified herein

A. General. Furnish maximum pipe lengths manufactured by the supplier, except for fitting, closures and specials.

B. Design. The minimum wall thickness for PVC Pipe shall conform to SDR-35 (SDR-26 for stub lines). PVC Material shall conform to ASTM D1784 and shall have a cell classification of 12454-B, 12454-C, 12364-C, or 13364-B. AA2000" or corrugated pipe shall not be used.

C: Joints. Flexible gasketed joints shall be compression type with a gasket confined in a machined groove in the spigot end of the pipe. Oil resistant rubber gasket rings shall conform to the requirements of ASTM D 1869. Gaskets shall be neoprene or other synthetic material. Natural rubber gaskets will not be acceptable.

D. Fittings. Fittings defined as wye connections suitable for assembly to 4-inch or 6-inch house or building sewers shall be saddle-type fittings molded of PVC plastic.

- 3004 ALIGNMENT. Piping shall be laid to the lines and grades indicated on the drawings using laser beam equipment, surveying instruments or batter boards to maintain alignment and grade. If batter boards are used, they shall be erected at intervals not exceeding 25 feet. Not less than three batter boards shall be maintained in proper position at all times during the trench grading operation.
- 3005 HANDLING. Handle pipe materials and fittings in a manner to insure installation in sound and undamaged condition. Do not drop or bump. Use slings, lifting lugs, hooks and other devices designed to protect pipe, joint elements and coatings. In handling plastic pipe of ten (10) feet in length or greater, a double sling will be required unless otherwise approved by the Engineer.

Materials shall be shipped, moved and stored with provisions to prevent movement or shock contact with adjacent units.

- 3006 CLEANING. The interior of all pipe and fittings shall be thoroughly cleaned before installation and shall be kept clean until the work has been accepted. All joint contact surfaces shall be kept clean until the joint is completed.

Whenever pipe laying is stopped, using a pipe plug to prevent trench water, sand, and earth from entering the pipe must close the open end of the pipe. In no case shall said plug be removed and water allowed to enter the sewer until the Engineer is satisfied that the sewer will not be injured by water coming in contact with the pipe, pipe backfill or subgrade. The Engineer may require the contractor to pump the water from the trench before continuing trenching or pipe laying operations.

Every precaution shall be taken to prevent foreign material from entering the pipe during installation. No debris, tools, clothing, or other materials shall be placed in the pipe.

- 3007 LAYING PIPE. Lateral displacement of the pipe shall be prevented during embedment operations. Pipe shall not be laid in water, or under unsuitable weather or trench conditions.

Pipe laying shall begin at the lowest elevation with bell ends facing the direction of laying except when reverse laying is permitted by the Engineer.

- 3008 JOINTING. All joint preparation and jointing operations shall comply with the instructions and recommendations of the pipe manufacturer. Immediately before joints are pushed together, all joint surfaces shall be coated with the lubricant furnished with the pipe. The position and condition of each rubber gasket (unbonded gaskets) shall be checked with a feeler gauge after the joint is completed.

Joints for reinforced concrete pipe shall conform to Section 7 of ASTM C361 except that gaskets shall have a circular cross section and shall be confined in a groove in the pipe spigot. Pipe with collars in lieu of integral bells will not be acceptable.

Joints for PVC pipe shall comply with all recommendations and instructions of the pipe manufacturer.

- 3009 TEMPORARY PLUGS. Provide and install plugs as manufactured by pipe supplier or as fabricated by contractor of approved construction. Plugs shall be watertight against heads up to 20 feet of water. Secure plugs in place in a manner to facilitate removal when required to connect pipe.

Mechanical plugs, braced with a 4x4 timber wedged against the opposite wall of the manhole, shall be installed at the downstream end (connection with existing line) on all sanitary sewer extension projects under construction and shall be verified by the contractor at the completion of each working day. Also, the open end of the sewer shall be plugged at the end of the workday with a suitable mechanical plug to prevent entry of foreign material until work is resumed.

3010 CONNECTIONS TO EXISTING PIPELINES AND STRUCTURES

- A. Connect pipe to existing structures and pipelines where indicated. Observe pertinent articles of specifications pertaining to joint locations.
- B. Openings in manhole sections for sewer connections shall be core-drilled and shall be done to produce a smooth, uniform, cylindrical hole of proper size to accommodate a resilient connector meeting requirements of ASTM C 923. The resilient connectors shall be a solid sleeve, Romac bolt on coupling or approved equal.

Any additional holes cut in the field shall be drilled with a core-drill or in a manner approved by the Engineer.

- C. Manholes to be built on an existing sewer shall be constructed in such a manner as will not disrupt service of the existing sewer. The manhole base, walls and invert shall be completed before the top half of the sewer pipe is cut or broken away. Rough edges of the pipe thus exposed shall be covered with expansive grout, in such a manner as to produce a smooth and acceptable finish. Any portion of the existing sewer damaged by the Contractor shall be repaired or replaced at no expense to the City.
- D. Connections between different pipe materials shall be made using proprietary transition coupling, unless otherwise specified on the Plans.

- 3011 WYE BRANCHES AND SADDLES. Wye branches and saddles shall be pitched at 45° and installed at locations designated on the plans. The contractor shall verify that wye branch or saddle locations have been marked in advance of the construction of sewers serving any property which will require sewer service and, if the locations have not been designated, shall stop the sewer construction until the necessary wye branch or saddle locations have been obtained.

Wye branches and saddles shall be installed with the lower lip not more than two inches (2") below the outside top of the pipe. Wye branches or saddles shall not be covered until each location has been recorded.

Each wye branch or saddle shall be marked with a wooden strip extending from the wye vertically to within one foot (1') of the ground surface. **All service line branches shall be extended to within 3 feet of the minimum sewerable floor elevation at the time of the main construction.**

Markers shall be securely anchored and maintained vertical until backfilling has been completed. Wye branches or saddles shall be closed with a suitable plug held in place by an approved joint sealing compound.

3012 SERVICE CONNECTIONS. Service connections made to the sewer prior to backfilling shall not be installed as vertical risers but shall be laid on a slope not to exceed one foot vertical to one foot horizontal. A 45° bend shall be used to join the wye branch to the service connection or stub line. The service pipe shall make such a horizontal angle with the sewer line that a proper connection to the 45° bend or stub line is obtained without trimming the pipe and with no danger of jute or jointing material being forced into the sewer. Each service connection pipe shall have a solid bearing on rock backfill. Each service connection shall be a minimum 5-feet away from manholes.

3013 CONCRETE ENCASEMENT. Concrete encasement shall be installed where and as shown on the drawings and where, in the opinion of the Engineer, such pipe encasement is necessary because of unforeseen conditions encountered in the work. All pipe which is to be encased shall be suitably supported and blocked in proper position and shall be anchored against flotation. The minimum 28-day compressive strength of concrete used for encasement of sewer lines shall be 3000 psi.

3014 WATER LINE CLEARANCES

GRAVITY SANITARY SEWERS - When potable water pipes and gravity sanitary sewers are laid parallel to each other, the horizontal distance between them shall be not less than 10 feet. The distance shall be measured from edge to edge. The laying of water pipes and sanitary sewers shall be in separate trenches with undisturbed earth between them. In cases where it is not practical to maintain a 10 ft separation, The City of Raytown will consider proposals providing equivalent protection by other methods on a case-by-case basis, if supported by data from the design engineer. Equivalent protection may require sanitary sewer construction with one of the following additional protective features: concrete encasement, vacuum sewers, or jointless pipe such as polyethylene or cured-in-place.

When a water pipe and a sanitary sewer cross and the sewer is 2 feet or more (clear space) below the water pipe, no special requirements or limitations are provided herein. At all other crossings, the sanitary sewer is to be constructed of one of the following materials (or approved equal) and pressure tested to assure water tightness.

- Ductile iron pipe conforming to ASTM A536 or ANSI/AWWA C151/A21.51 with minimum thickness class 50, and gasketed, push-on or mechanical joints in conformance with ANSI/AWWA C110/A21.10 or ANSI/AWWA c111/A21.11.
- PVC pipe conforming to ASTM D3034 with minimum wall thickness of SDR41, ASTM F679, ASTM F789, or ASTM F794, with gasketed push-on joints in conformance with ASTM D3212.
- Reinforced concrete pipe conforming to ASTM C76 with gasketed joints in conformance with ASTM C361 or ASTM C443.

Joints in the sewer pipe shall be located as far as practical from the intersected water main.

Where a water main is laid across or through an area where there is an existing sanitary sewer, which is not constructed of one of the above specified materials and is 2 feet (2'/0.6 m) or less below the water pipe, the existing sewer shall be encased in concrete with a minimum of six inches (6") thickness for a ten foot (10') distance on each side of the crossing or the crossed section of sewer replaced to meet the above specified construction requirements. The City of Raytown will consider proposals providing equivalent protection by other means on a case-by-case basis, if supported by data from the design engineer.

Where sanitary sewer lines are to be installed under and across water lines and a two foot (2') clearance cannot be obtained because of limiting grades or grades of existing structures, then the sewer line shall be constructed of ductile iron pipe for a distance of at least ten feet (10') in each direction from the crossing.

SEWER CONNECTIONS. There are to be no physical connections between any parts of the potable water system with building sewers, sanitary sewers, or wastewater treatment facilities by means of which it would be possible for sewage, even under exceptional circumstances, to reach the wells, storage reservoirs, or distribution systems.

PRESSURE SEWER LINES. When force mains run parallel to water lines, the separation distance shall be as far as practical, but at least a 10 ft horizontal separation shall be maintained. There shall be at least a 2 ft vertical separation at crossings with the water main crossing above the sewer force main. In cases where it is not practical to maintain the required vertical or horizontal separation distance between a water line and a sanitary sewer force main, The City of Raytown will consider proposals providing equivalent protection by other methods on a case-by-case basis, if supported by data from the design engineer.

SEWER MANHOLES. No water pipe shall pass through or come in contact with any part of a sewer manhole.

STORM SEWERS. The separation distance between a storm sewer (which is not a combined storm/sanitary sewer) and a water main should be based on geotechnical considerations. Required separation distances between water mains and combined storm/sanitary sewers are equivalent to those for water mains and gravity sanitary sewers.

DRAINS. Underground drains from fire hydrants or valve pits should not be directly connected to sanitary or storm drains.

All of the above recommended protective measures shall apply to water and sewer service lines.

All special protective measures outlined by The City of Raytown shall be required in the final design and implemented during the construction phase when it is impractical for geotechnical reasons, to cross water lines over sewer lines.

3015 **SEWER MANHOLES.** Manhole construction shall comply with all of the applicable requirements of Section 3100 "*Sanitary Sewer Manholes*".

3016 ACCEPTANCE TESTS FOR GRAVITY SEWERS.

General. The Public Works Inspector shall be permitted access to the construction work at any time for inspection of the work and construction methods. Each reach of sewer shall meet the requirements of the following acceptance tests. All defects shall be repaired to the satisfaction of the Engineer by and at the expense of the contractor.

A. Visual Inspection.

1. Contractor shall clean pipe of excess mortar, joint sealant and other dirt and debris prior to inspection.
2. Sewer shall be inspected by running a T.V. camera the full length of the line and recording on tape (tape to be retained by the City) and/or by physical passage where space permits. Determine from T.V. and/or physical inspection the presence of any misaligned, displaced, or broken pipe and the presence of visible infiltration or other defects. The pipe between successive manholes shall not be more than one-fourth (1/4) of the pipe diameter out of alignment. Sewer lateral locations shall be identified on the videotape and recorded by distance from a manhole.
3. Correct defects as required prior to conducting leakage tests.

B. Leakage Tests. A leakage test shall be performed on the full length of all sewer lines prior to acceptance.

1. Exfiltration Leakage Test.

- a. Contractor may perform leakage testing by exfiltration on **sewer pipe larger than eighteen (18) inches I.D.**
- b. Furnish all labor, equipment, tools and materials required including bulkheads, water and all miscellaneous items required to perform the tests.
- c. Test all sewer pipe over eighteen (18) inches I.D. after either the completed backfill or partial backfill sufficient to stabilize the position of the pipe in both alignment and grade is accomplished. Contractor may select section of the project for testing at any time by notifying the Engineer 24 hours in advance.
- d. Perform at depths of water as measured above center line of pipe of not less than two (2) feet nor more than ten (10) feet (consideration shall be given for water table above said centerline).
- e. Maintain test as necessary to locate all leaks but not less than two hours.
- f. Repeat as necessary after repair of leaks and defects until leakage, as measured, does not exceed 0.15 gallons per inch of internal diameter per hour per 1000 feet of pipe length (200 gal/inch of I.D./day/mile).

- g. Protect manholes and other structures by means of bulkheads to prevent bursting pressures from being applied inside the structure.
- h. De-water pipe upon completion of testing.

2. Air Leakage Test.

- a. Contractor shall perform air tests for all pipe sizes.
- b. Furnish all facilities required including necessary piping connections, test pumping equipment, pressure gauges, bulkheads, regulator to avoid over pressurization, and all miscellaneous items required.

(1) The pipe plug for introducing air to the sewer line shall be equipped with two taps. One tap will be used to introduce air into the line being tested, through suitable valves and fittings, so that the input air may be regulated. The second tap will be fitted with valve and fittings to accept a pressure test gauge indicating internal pressure in the sewer pipe. An additional valve and fitting will be incorporated on the tap used to check internal pressure so that a second test gauge may be attached to the internal pressure tap. The pressure test gauge will also be used to indicate loss of air pressure due to leaks in the sewer line.

(2) The pressure test gauge shall meet the following minimum specifications:

Size (diameter)	4-1/2 inches
Pressure Range	0-15 P.S.I.
Figure Intervals	1 P.S.I. Increments
Minor Subdivisions	0.05 P.S.I.
Pressure Tube	Bourdon Tube or Diaphragm
Accuracy	+/- 0.25% of maximum scale reading
Dial	White coated aluminum with black lettering, 270 deg. Arc and mirror edge.
Pipe Connection	Low Male 1.2" N.P.T.

Calibration data will be supplied with all pressure test gauges. Certification of pressure test gauge will be required from the gauge manufacturer. This certification data shall be up to date (within 1 year from test) will be available when tests are performed.

- c. Test each reach of sewer pipe between manholes after completion of the installation of pipe and appurtenances and the backfill of sewer trench.
- d. Plug ends of line and cap or plug all connections to withstand internal pressure. One of the plugs provided must have two taps for connecting equipment. After connecting air control equipment to the air hose, monitor

air pressure so that internal pressure does not exceed 5.0 psig. After reaching 4.0 psig throttle the air supply to maintain between 4.0 and 3.5 psig for at least two (2) minutes in order to allow equilibrium between air temperature and pipe walls. During this time, check all plugs to detect any leakage. If plugs are found to leak, bleed off air, tighten plugs, and again begin supplying air. After temperature has stabilized, the pressured is allowed to decrease to 3.5 psig. At 3.5 psig, begin timing to determine the time required for pressure to drop from 3.5 psig to 2.5 psig. If the time, in seconds, for the air pressure to decrease from 3.5 psig to 2.5 psig is greater than that shown in the table below, the pipe shall be presumed free of defects.

<u>Pipe Size</u>	<u>Required Time per 100 LF</u>	<u>Maximum Required Time</u>
8"	70 sec.	227 sec.
10"	110 sec.	283 sec.
12"	158 sec.	340 sec.
15"	248 sec.	425 sec.
18"	356 sec.	510 sec.
21"	485 sec.	595 sec.
24"	634 sec.	680 sec.
27"	765 sec.	765 sec.
30"	851 sec.	851 sec.
33"	935 sec.	935 sec.

If air test fails to meet above requirements, repeat test as necessary after all leaks and defects have been repaired. Prior to acceptance all constructed sewer lines shall satisfactorily pass the low-pressure air test.

- e. In areas where ground water is known to exist, install a one-half inch diameter capped pipe nipple, approximately 10" long, through manhole wall on top of one of the sewer lines entering the manhole. This shall be done at the time the sewer line is installed. Immediately prior to the performance of the line acceptance test, ground water level shall be determined by removing pipe cap, blowing air through pipe nipple into the ground so as to clear it, and then connecting a clear plastic tube to pipe nipple. The hose shall be held vertically and a measurement of height in feet of water shall be taken after the water stops rising in this plastic tube. The height in feet shall be divided by 2.3 to establish the pounds of pressure that will be added to all readings.

- C. Deflection Test. A deflection test shall be required on all installations involving flexible or semi-rigid pipe after said pipe has been laid and backfilled. The maximum allowable deflection shall not exceed 5.0 percent (5%) of the pipe's actual internal diameter as measured in the field. The deflection test shall consist of guiding a device of the appropriate size for the pipe involved to accurately measure any deflection in the pipe. The device to be used shall be approved by the Public Works Inspector prior to its use. Attention is directed to the fact that

the pipe's nominal diameter is greater than the actual internal diameter of the pipe. Lamping will not be approved as a substitution for deflection testing.

Upon completion of the testing, all piping showing a deflection greater than 5.0 percent (5%) shall be excavated, replaced, backfilled, and retested to the satisfaction of the Engineer.

3017 ACCEPTANCE TEST FOR MANHOLES.

A. Visual Inspection.

All precast concrete manholes shall be visually inspected to determine the presence of misaligned, displaced, broken manhole sections or other physical defects. All defects shall be satisfactorily corrected prior to conducting vacuum leakage tests.

B. Vacuum leakage tests:

Each manhole shall be tested immediately after assembly and prior to backfilling. All lifting holes shall be plugged with non-shrink grout. No standing water shall be allowed in the excavation during testing.

C. Vacuum testing procedure:

All vacuum tests on concrete sewer manholes shall be performed according to ASTM C1244 procedures as modified herein.

All Manholes shall be vacuum tested in the presence of a Public Works Inspector. The vacuum test shall consist of properly sealing the manhole openings, applying a vacuum equivalent to ten inches (10") of mercury, and measuring the time the manhole will hold an acceptable level of vacuum. The vacuum test shall be performed in accordance with the following procedures:

- a. Each manhole shall be tested after backfilling to, at least, the level of the bottom adjustment ring.
- b. The vacuum test shall include testing of the seal between the cast iron frame and the concrete cone or slab.
- c. All pipes entering the manhole shall be plugged at least eight inches (8") into the sewer pipe. The plug shall be inflated at a location beyond the manhole/pipe gasket.
- d. All plugs shall be adequately braced to prevent the plug or pipe from being dislodged and drawn into the manhole.
- e. A vacuum of at least ten and one half inches (10.5") of mercury shall be drawn on the manhole. The valve shall be shut on the vacuum line to the manhole and the vacuum line shall be disconnected. The vacuum line valve shall be opened and the vacuum shall be adjusted to ten inches (10") of mercury.

- f. The pressure gage shall be liquid filled having a 3.5-inch diameter face with a reading from 0 to 30 inches of mercury. The pressure gage shall be calibrated a minimum of one time per year.
- g. The time for the vacuum reading to drop from ten inches (10") of mercury to nine inches (9") of mercury shall be equal to or less than the following values for the manhole to be considered as passing the vacuum test:

<u>Manhole Depth</u>	<u>Time (minutes)</u>
10 feet or less	2.0
10.1 to 15 feet	2.5
15.1 to 25 feet	3.0
25.1 or greater	3.5

- h. If a manhole fails a vacuum test, the manhole shall be uncovered and the leak repaired. The manhole shall then be backfilled and retested.

3018 ACCEPTANCE TESTS FOR PRESSURE SEWAGE FORCE MAINS.

- A. Perform hydrostatic pressure and leakage tests. Conform to AWWA C 600 procedures as modified herein. Test shall apply to all pressure sewers. Perform after backfilling.
- B. Test separately in segments between sectionalizing valves, between a sectionalizing valve and a test plug, or between test plugs. Select test segments such that adjustable seated valves are isolated for individual checking. Contractor shall furnish and install test plugs at no additional cost to the Owner, including all anchors, braces, and other devices to withstand hydrostatic pressure on plugs. Contractor shall be responsible for any damage to public or private property caused by failure of plugs. Limit fill rate of line to available venting capacity.
- C. Pressure Test. Conduct at 1.5 time maximum operating pressure determine by following formula:

$$P_{pt} = 0.650 (OP-GE), \text{ in which}$$

P_{pt} = test pressure in psi at gauge elevation

OP = operating pressure in feet as indicated for highest elevation of the hydraulic gradient of each section of the line

GE = elevation in feet at centerline of gauge.

Perform satisfactorily prior to determining leakage.

- D. Leakage Test. Conduct at maximum operating pressure determined by the following formula:

$$P_{lt} = 0.433 (OP-GE), \text{ in which}$$

P_{lt} = test pressure in psi at gauge elevation

OP and GE - as in previous article

SECTION 3100--SANITARY SEWER MANHOLES

3101 SCOPE. This section covers standard, drop, and special sewer manholes. Manholes shall be constructed complete with covers, steps, fittings, and other appurtenances, in accordance with the details indicated on the drawings.

At the option of the contractor, standard and drop manholes shall be constructed of precast concrete sections or cast-in-place concrete.

Only manholes, which are required to have outside pipe and fittings for dropping sewage into the lower line, will be designated as drop manholes. Inside drop manholes where the incoming line discharges directly into the manhole and which do not require special fittings will be considered standard manholes.

3102 MATERIALS.

Concrete	Materials, handling, forms, finishing, curing, and other work as specified in Section <u>2000 Concrete</u> .
Precast Sections	Circular precast concrete; ASTM C478, except as modified. Joints shall be of a bitumastic material or preformed flexible joint sealant applied in accordance with manufacturer's recommendation. A-Lok pipe to manhole connectors or approved equal are required for all manhole connections up to a pipe diameter of 36".
Minimum Thickness	As indicated on the drawings.
Reinforcement	As indicated on the drawings.
Openings	Circular or horseshoe-shaped box-out for each connecting pipe, with surfaces grooved or roughened to improve mortar bond where manholes are constructed over existing lines, water stop gaskets shall be required.
Portland Cement	ASTM C150
Sand	Concrete sand (fine aggregate) sieved through 8 mesh screen
Shrinkage-Correcting Aggregate	Master Builders "Embeco", Sika "Kemox", or Sonneborn "Ferrolith G-DS".
Mortar	One part portland cement Type II, 3 parts sand, 1/4 part hydrated lime, ASTM C-207.
Non-Shrinking Mortar	Premixed or job mixed; job mixed shall be one part shrinkage-correcting aggregate, one part portland cement, one part sand.
Gaskets	
Mastic	Hamilton-Kent "Kent-Seal No. 2" (minimum two-1" or one-2" beads per joint), or approved equal. Enough material shall be applied to fill the joint so that a minimum of 1/4-inch bead is visible, to be smoothed off after completion.
Flexible Joint	Preformed "O" ring; butylrubber or bituminous polymer are acceptable. Natural rubber is not acceptable
Coal Tar Paint	Koppers "Bitumastic Super-Service Black," Porter "Tarmastic 103," Tnemec "450 Heavy Tnemecol," or approved equal
Castings	ASTM A48, with asphalt varnish coating applied at the foundry

- 3103 STANDARD MANHOLES. All manholes shall be constructed, complete with covers and ladder steps, in accordance with the details shown on the drawings and found herein. Standard manholes above the foundations, unless otherwise required by the plans, shall be constructed of poured-in-place concrete or solid, precast, curved segmental concrete masonry units of circular sections specially cast for use in manhole construction. Manholes shall be constructed with eccentric cones unless otherwise approved by the City Engineer.

Foundations for all standard manholes shall have a minimum 28-day compressive strength of 3000 psi.

Precast concrete sections shall be inspected when delivered and all cracked or otherwise visibly defective units rejected.

- 3104 CONSTRUCTION. All mortar shall be used within 40 minutes after mixing. Mortar, which has begun to take on initial set, shall be discarded and shall not be mixed with additional cement or new mortar.

Manhole inverts shall be constructed of concrete conforming to the requirements of Section 2000 "Concrete", with the exception that the concrete shall have a minimum 28-day compressive strength of 3000 psi.

In no case shall the invert section through a manhole be greater than that of the outgoing pipe. The shape of the invert shall conform exactly to the lower half of the pipe it connects. Side branches shall be connected with as large of a radius of curve as practicable. All inverts shall be troweled to a smooth clean surface.

Circular precast sections shall be provided with a mastic gasket or preformed flexible joint to seal joints between sections. The space between connecting pipes and the wall of precast sections shall be completely filled with non-shrinking mortar.

All manholes under construction shall be covered in an appropriate manner to prevent the entry of any stormwater runoff, trench water, sand, earth or any other foreign substances at any time during construction or while the manhole is unattended.

- 3105 DAMPPROOFING. Surfaces to receive paint shall be dry. Before backfilling is started, the exterior surfaces of precast and poured-in-place manholes shall be painted with two (2) heavy coats of coal tar paint. Application shall be in accordance with the manufacturer's specifications and instructions.

- 3106 CASTINGS. Manhole rings and covers shall be Clay and Bailey No. 2008MR, Deeter No. 1315MR, Neenah No. R-1536MR, or approved equal (MR = Full Mud Ring). Manhole lids shall be stamped with "CITY OF RAYTOWN" across the top and "SEWER" across the middle.

When bolt-down type manhole rings and covers are required and specified, Clay and Bailey No. 2014MR, Deeter No. 1121MR, or approved equal, with rubber gaskets and stainless steel cover bolts 5/8-inch diameter with hexagonal-head bolts shall be furnished. Bolt-down type manhole rings shall be anchored to the manhole with not less than four 3/4-inch diameter anchor

bolts having a minimum of 14 inches (14”) of embedment, except in concrete manholes in which the ring is embedded in concrete.

If castings arrive on the job without a foundry coating, one coat of coal tar paint shall be applied. Before painting, all castings shall be thoroughly cleaned and properly supported. All loose rust shall be removed by wire brushing. Castings shall not be handled until the paint is dry and hard. All castings shall be interchangeable with the Clay and Bailey model numbers.

- 3107 STUBLINES. A minimum of a 4-foot long stublines for future connections shall be provided in manholes at the locations indicated on the drawings and shall terminate in a bell and plug.
- 3108 CONNECTIONS TO EXISTING MANHOLES. All sewers constructed of rigid pipe extending from manholes shall be encased with concrete to the first pipe joint from the manhole. An A-Lock, PSX Gasket, or approved equal shall be required for all rigid and flexible pipe connections.
- 3109 PLASTIC MANHOLE STEPS. Polypropylene coated steel reinforced steps "plastic steps" shall be M.A. Industries, Inc., model PS-2-PF, American Step Company, Inc., model ML-13 or approved equal manhole step for precast concrete manholes.
- 3110 GRADE RINGS. All manholes shall be fitted with an adjusting ring or rings providing a minimum adjustment of four inch (4”) and a maximum adjustment of twelve inches (12”) and one adaptor ring between the cone section and the casting in conformance with Detail 31-6.
- 3111 ACCEPTANCE TESTING. Vacuum tests shall be conducted on all newly constructed manholes and existing manholes that have been repaired or restored or manholes constructed over existing sewers. Refer to *Section 3017 – Acceptance Test For Manholes*.

SECTION 4000 - STORM SEWERS

4001 SCOPE. This section covers the furnishings of all labor, materials, and equipment for the complete installation of storm sewers and appurtenances in accordance with the contract documents. The work shall consist of the construction of storm sewers for the removal of water from collection points, in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the contract drawings or established by the engineer. Unless otherwise indicated in these specifications, the phrase "Storm Sewer" shall refer to pipe sewers, box culvert sewers, or paved or rock lined channels.

4002 REINFORCED CONCRETE PIPE. All reinforced concrete pipe shall conform to ASTM C76, Class III. This specification covers reinforced concrete pipe of 12 to 108-inches in diameter and is intended for use in conveyance of storm water and for the construction of culverts.

Installation shall conform to the requirements of Section 6000 "*Excavation, Trenching, and Backfilling*". No pipe culverts shall be placed until the engineer has approved the embedment below the proposed reinforced concrete pipe.

Round Pipe: ASTM C-76, Class III, Wall B.

Elliptical Pipe: ASTM C-507, Class HE-III.

Arch Culvert Pipe: ASTM C-506, Class A-III.

Joints:

1. Flexible Gasket: Flexible gaskets may be either flat gaskets cemented to the pipe tongue or spigot, O-ring gaskets, or roll-on gaskets. All gaskets shall conform to ASTM C-433.
2. Cement Mortar: Cement mortar shall consist of one part Type I portland cement by volume to three parts sand conforming to ASTM C-144 by volume mixed with sufficient water to form a workable stiff mortar paste.
3. Plastic Compound: This compound shall be a homogeneous blend of bituminous material, inert filler and suitable solvents or plasticizing compounds thoroughly mixed at the factory to a uniform consistency suitable for sealing joints of concrete pipe. The compound shall conform to the following requirements:

Bitumen, soluble in CS, percent by weight, minimum	.45%
Ash, percent by weight	15-50%
Penetration, standard cone	150g, 5 seconds, 25 C
Trowel grade, bulk type	110-250mm
Extruded rope or flat tape type	50-120mm

4003 CORRUGATED METAL PIPE. Corrugated metal storm sewer pipe shall be furnished with connecting bands, elbows, and fittings. Corrugated metal storm sewer pipe shall have annular ends. The same type of pipe base metal (steel or aluminum) shall be used throughout any

individual run or installation of pipe or for pipe extensions. Materials shall conform to the requirements of AASHTO M-36. Bituminous and/or other coatings shall be provided when required by the special Provisions. Bituminous coating shall conform to AASHTO M-190. All Ultra-Flo pipe shall be aluminized type 2.

Corrugated metal culvert pipe gauge requirements shall conform to Design Aid 4-9 of the Design Criteria. In no case shall any pipe be lighter than 16 gauge.

Corrugated metal storm sewer pipe shall be handled in such a manner that it is not chipped, dented, or bent. If in handling the culvert the base metal is exposed in any way, it shall be rejected or repaired to the satisfaction of the engineer.

The excavation, trenching, and backfilling of corrugated metal pipe storm sewers shall be performed in accordance with the requirements of *Section 6000 "Excavation, Trenching, & Backfill"* of these specifications. No pipe culverts shall be placed until the engineer has approved the embedment below the pipe.

- A. Corrugated Metal Pipe; Aluminized Type 2: Sheet steel for aluminized CMP shall conform to ASTM A-929 or AASHTO M-274. Pipe manufacture shall conform to ASTM A-760 or AASHTO M-36. Fitting shall be fabricated from the same material as the pipe.
- B. Minimum thickness of the metal after galvanizing shall be as follows:

Circular Culvert Pipe
(2 2/3" x 1/2" corrugations)

Under Roadways or In <u>Street Right-of-Way</u>		<u>Under Railroads</u>		<u>Not under Roadways</u>	
Minimum Diameter	Thickness	Minimum Diameter	Thickness	Minimum Diameter	Thickness
15-21"	.064"	12-18"	.079"	12-30"	.064"
24-30"	.079"	21-24"	.109"	36-54"	.079"
36-54"	.109"	30-36"	.138"	60-84"	.109"
60-72"	.138"	42-84"	.168"		
84"	.168"				

Circular Culvert Pipe
(3" x 1" corrugations)

<u>Under Roadways or In Street Right-of-Way</u>		<u>Not under Roadways</u>	
Minimum		Minimum	
Diameter	Thickness	Diameter	Thickness
36-54"	.079"	36-54"	.064"
60-84"	.109"	60-84"	.079"

Circular Culvert Pipe
(5" x 1" corrugations)

Under Roadways or In
Street Right-of-Way

	Minimum
Diameter	Thickness
36-54"	.079"
60-84"	.109"

Not under Roadways

	Minimum
Diameter	Thickness
36-54"	.064"
60-84"	.079"

Arch Culvert Pipe
(2 2/3" x 1/2" corrugations)

<u>Equivalent</u> <u>Diameter</u>	<u>Minimum</u> <u>Thickness</u>	<u>Span*</u>	<u>Rise*</u>
15"	.064	17"	13"
18"	.064	21"	15"
21"	.064	24"	18"
24"	.079	28"	20"
30"	.079	35"	24"
36"	.109	42"	29"
42"	.109	49"	33"
48"	.109	57"	38"
54"	.109	64"	43"
60"	.138	71"	47"

*Subject to manufacturing tolerances.

Arch Culvert Pipe
(2 2/3" x 1/2" corrugations)

<u>Equivalent</u> <u>Diameter</u>	<u>Minimum</u> <u>Thickness</u>	<u>Span*</u>	<u>Rise*</u>
36"	.046	40"	31"
42"	.064	46"	36"
48"	.064	53"	41"
54"	.079	60"	46"
60"	.079	66"	51"
66"	.079	73"	55"
72"	.079	81"	59"
78"	.109	87"	63"
84"	.109	95"	67"
90"	.109	103"	71"

*Subject to manufacturing tolerances.

Minimum Thickness

.064
.079
.109
.138

Equivalent Nominal Gage

16
14
12
10

- C. Structural Plate Pipe and Pipe Arches. Structural plate shall conform to the requirements of AASHTO M-167. Corrugations shall have a depth of two (2) inches and a pitch of six (6) inches, and be galvanized with a zinc coating of 2.0 ounces per square foot for plates 0.168 inch and less thickness, and 3.0 ounces per square foot for plates greater than 0.168 inches in thickness. Bolts, nuts, and washers for connecting plates shall be galvanized in accordance with AASHTO M-232. Bolts shall be not less than 3/4 inch diameter and conform to ASTM A-449. Nuts shall conform to ASTM A-563, Grade C.

- 4004 SMOOTH INTERIOR CORRUGATED POLYETHYLENE PIPE. This specification applies to high-density polyethylene corrugated pipe with an integrally formed smooth interior. This specification is applicable to nominal sizes 12 to 60-inch diameter. Requirements for test methods, dimensions, and markings are those found in AASHTO Designation M-294, Type S. Pipe and fittings shall be made of polyethylene compounds which meet or exceed the requirements of Type III, Category 4 or 5, Grade P33 or P34, Class C per ASTM D-1248 with the applicable requirements defined in ASTM D-1248. Clean rework material may be used.

The pipe and fittings shall be free of foreign inclusion and holes, and visible defects. The ends of the pipe shall be cut squarely and cleanly so as not to adversely effect joining.

The nominal size for the pipe and fittings is based on the nominal inside diameter of the pipe. Corrugated fittings may be either molded or fabricated by the manufacturer. Fittings produced by manufacturers other than the supplier of the pipe shall not be permitted without the approval of the City Engineer. Joints shall be made with integral bell or split couplings, corrugated to match the pipe corrugations, and engage a minimum of 4 corrugations. A neoprene gasket shall be utilized with the coupling to provide a soil-tight joint. Installation shall be in accordance with Section 6000 of these specifications. A manufacturer's certifications that the project was manufactured, tested, and supplied in accordance with this specification shall be furnished.

- 4005 CATCH BASINS, INLETS, AND JUNCTION BOXES. The methods of excavation and backfilling for catch basins, inlets, and junction boxes shall conform to the requirements of Section 6000 "*Excavation, Trenching, and Backfilling*" and Standard Details of these specifications.

Reinforced concrete catch basins and inlets shall conform to the standard concrete inlet drawings and shall be constructed of concrete having a minimum 28-day compressive strength of 4000 psi. Concrete cover over steel reinforcement shall be not less than 1-1/2 inches for covers and 1-1/2 inches for walls and floors. All exposed concrete shall have smooth steel trowel or brushed finish. Interiors of structures shall have the forms removed and surface voids filled.

Foundations for all standard catch basins and inlets shall have a minimum 28-day compressive strength of 3000 psi.

The floors of all catch basins, inlets, and junction boxes shall have inverts. Inverts shall be constructed of concrete conforming to the requirements of Section 2000 "*Concrete*", with the exception that the concrete shall have a minimum 28-day compressive strength of Class I 3000 psi.

Erosion and sediment control devices shall be in place during construction per plans and specifications. All catch basins, inlets, pipes, and junction boxes shall be thoroughly cleaned of

any accumulation of silt, debris or foreign matter of any kind, and shall be free from such accumulations at the time of final inspection.

- 4006 CASTINGS. Manhole rings and covers shall be Clay and Bailey No. 2008, Deeter No. 1315, Neenah R-1536 or approved equal. Manhole lids shall be stamped with "CITY OF RAYTOWN" across the top and "STORM" across the middle.

Curb Inlet rings and covers shall be Clay and Bailey No. 2020, Deeter No. 2016, Neenah R-1537 or approved equal. Manhole lids shall be stamped with "CITY OF RAYTOWN" across the top and "STORM" across the middle.

When bolt-down type manhole rings and covers are required and specified, Clay and Bailey No. 2014, Deeter No. 1121, or approved equal, with rubber gaskets and stainless steel cover bolts 5/8-inch diameter with hexagonal-head bolts shall be furnished. Bolt-down type manhole rings shall be anchored to the manhole with not less than four 3/4-inch diameter anchor bolts having a minimum of 14 inches (14") of embedment, except in concrete manholes in which the ring is embedded in concrete.

If castings arrive on the job without a foundry coating, one coat of coal tar paint shall be applied. Before painting, all castings shall be thoroughly cleaned and properly supported. All loose rust shall be removed by wire brushing. Castings shall not be handled until the paint is dry and hard. All castings shall be interchangeable with the Clay and Bailey model numbers.

- 4007 REINFORCED CONCRETE BOX CULVERTS. The work performed herein covers the installation of concrete work in strict accordance with the applicable provisions of Section 2000 "Concrete", Section 6000 "Excavation, Trenching, and Backfilling", Standard Details.

- 4008 PAVED DITCHES AND RIP-RAP. Paving concrete for paved ditches shall conform to the applicable provisions of Section 2000 "Concrete" of these specifications and shall conform to the standard drawings or approved equal.

The concrete shall be placed beginning at the lower end of the portion of the ditch to be lined and progressing toward the upper end. If required on the contract drawings, the concrete shall be reinforced with the type of reinforcement and in the manner indicated. Contraction or construction joints shall be spaced and formed as indicated on the contract drawings.

The surface shall be finished with a wooden float. A light brooming may be required for a more acceptable finish. Immediately after the finishing operations are completed, the concrete shall be protected and cured in conformance with the requirements specified in Section 2000 "Concrete".

Riprap shall be placed at the locations and to the dimensions shown on the contract drawings in accordance with the specified requirements.

Riprap shall be graded as necessary to form a dense blanket. The finished surface shall present an even surface conforming to the lines, grades, and sections given. Riprap shall be placed to a minimum depth of eighteen inches (18").

Riprap shall be placed in such a manner that voids created by larger pieces are filled in by smaller pieces and no voids extend directly through the riprap to the surface below. The riprap shall be placed in rows transversely to the centerline of the ditch and in the manner indicated on the drawings. The riprap shall be placed with ends and sides abutting and the joints between rows breaking with the joints in the preceding row.

Riprap shall consist of durable field or quarry stones. Riprap pieces shall range in weight from five (5) pounds to two hundred (200) pounds. Not less than 75 percent (75%) shall be within the range of one hundred (100) pounds to two hundred (200) pounds.

Stone for riprap shall be free from earth, soapstone, shale, shale-like or other easily disintegrated material that will tend to decrease the durability of the material after placement.

When grouted stone riprap is indicated the spaces between stones of grouted riprap shall be filled with grout consisting of one (1) part Portland Cement and three (3) parts of fine aggregate with sufficient water to form a plastic mix. The grout shall be poured and broomed into the spaces until they are completely filled.

- 4009 HEADWALLS, WINGWALLS, ENDWALLS, AND END SECTIONS. Construction will be according to details in the approved plans. Precast concrete or fabricated metal end sections may be used in place of cast-in-place concrete structures with the engineer's approval. Shop drawings will be submitted for precast box culvert pieces.

Materials will be in accordance with Section 2000 "*Concrete*" and Section 4000 "*Storm Sewers*" and Standard Details of this Specification. The same type of pipe base metal (steel or aluminum) shall be used throughout any individual run or installation of pipe or for pipe extension, including end sections.

The end sections for pipe culverts shall be installed in accordance with the requirements specified in Section 6000 "*Excavation, Trenching, and Backfilling*" of these specifications.

The area excavated for the pipe and headwalls shall be backfilled with suitable material and the material shall be compacted in accordance with the provisions of Section 6000 "*Excavation, Trenching, and Backfilling*" of these specifications.

- 4010 RESTORATION OF SURFACE CONSTRUCTION. The restoration of concrete and asphalt pavement, gravel surfacing, walks, drives, curbs, and other surface construction removed or damaged during the progress of the work covered by this section shall conform to the applicable provisions of these specifications.

- 4011 CONSTRUCTION DETAILS.

- A. Trench Excavation: Trenches shall be excavated to the width and depth as necessary to lay the sewer pipe to the grade line as indicated on the plans. Deviation from plan line and grade will not be permitted except under special circumstances subject to approval of the Engineer. The materials to be excavated are to be deposited on the sides of trenches and excavations, and beyond the reach of slides, or transported to the spoil banks, or used for backfilling. The length of the trench excavation opened at one time shall be limited depending on the nature of the soil or other

safety considerations.

Trenches shall be excavated to a width, which will provide adequate working space and pipe clearances for proper pipe installation, jointing and embedment. However, the limiting trench widths must comply with bedding class requirements as shown on the plans. Over excavation shall be replaced with granular bedding material.

1. Unclassified Excavation. Unclassified excavation is defined as the removal of all material encountered regardless of its nature. All material excavated will be considered as Unclassified Excavation unless the Special Provisions specify Classified Materials.
2. Rock Excavation: Rock excavation is defined as the removal of all rock ledges six (6) inches or more in thickness, and detached rock or boulders having a volume of more than one & one half (1 1/2) cubic yards and shale occurring in its natural state, hard and unweathered.

A rock ledge is defined as a continuous body of rock, which may include interbedded seams of shale or other soft materials. Such interbedded soft material seams less than twelve (12) inches in thickness will be included in the measurement of rock excavation. Such seams twelve (12) inches or greater in thickness will be included only in the measurement of earth excavation. No soft or disintegrated rock which can be removed with a pick or digging machine, no loose, Shaken or previously blasted rock, no broken stones, and no rock which may fall into the trench from outside the limits of excavation will be included. When solid rock is encountered in the trench, it shall be stripped of earth, and the Engineer notified. When the Engineer permits blasting, the Contractor shall use the utmost care to protect life and property. **A City of Raytown Blasting Permit will need to be obtained.** The Contractor shall comply with all laws, ordinances, and applicable safety code requirements and regulations relative to the handling, storage and use of explosives and protection of life and property, and they shall be responsible for all damage thereto caused by their subcontractor's operations.

When blasting is required for rock excavation, all such operations shall conform to the requirements set forth in *Section 6100 "Blasting"*.

3. Earth Excavation. Earth excavation is defined as the removal of all material not defined as rock.
4. De-watering. The Contractor shall remove any water, which may accumulate, or be found in the trenches and other excavations made under the Contract.

The Contractor shall form all dams, flumes or other works necessary to keep them clear of water while the sewers and their foundation, and other foundations works, are being constructed. All water shall be removed from such excavation in a manner to not damage property.

5. Cribbing and Sheeting. The Contractor shall furnish, install, and maintain such sheeting, bracing, etc., as may be required to support any excavation and to prevent any movement which could in any way injure or delay the work or endanger adjacent pavement, building

or other structures. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed they shall be immediately filled and consolidated.

For the purpose of preventing injury or property damage, the Contractor may leave in place all sheeting or bracing, etc., To be embedded in the backfill of the trench. No sheeting or bracing, however, shall be left in place within five (5) feet of the surface without the written permission of the Engineer.

Whenever timber or other sheeting is driven to a depth below the elevation of the top of the pipe, or whenever any sheeting is driven for protection of trench walls in water bearing soil, the Engineer shall determine whether or not this section of the sheeting may be removed. Should he determine that any portion of this sheeting must be left in place, it shall be considered, as Extra Work and will be compensated for on such a basis.

6. Unstable Foundation. Where materials are encountered in the bottom of the trench which are deemed as unsuitable by the Engineer to afford a sufficiently stable pipe foundation, the materials shall be removed to a depth and limits as ordered by the Engineer. Areas undergraded shall be backfilled with approved granular material or materials meeting the approval of the Engineer.
7. Protection of Property. The contractor shall satisfactorily shore, support, and protect any and all structures and all pipes, sewers, drains, conduits, and other facilities, and shall be responsible for any damage resulting thereto. The Contractor shall not be entitled to any damages or extra pay on account of any postponement, interference, or delay caused by any such structures and facilities being on the line of work, whether they are shown on the plans or not; specifically, but not limited to damage due to delay in utility relocation.

B. Laying and Jointing:

1. Handling and Protection: All pipe shall be protected during installation against shock and free fall, and be installed without cracking, chipping, breaking, bending, or damage to coating materials. Damaged pipe materials shall be replaced with new materials except as the Engineer may permit repair.
2. Grade Control. Maximum deviation from plan line or grade of any pipe after installation and backfilling shall not be greater than 0.1 foot. All pipe shall have a continuous slope free from depressions that will not drain. The Contractor shall establish such grade control devices as are necessary to maintain the above tolerances.
3. Laying. The laying of pipe in finished trenches shall be commenced at the lowest point and installed with the bell end forward or upgrade. All pipe shall be laid with ends abutting and true to line and grade. They shall be carefully centered so that when laid they will form a sewer with a uniform invert.
4. Bedding. The class of bedding required shall be as indicated on the plans or standard details. Bedding shall be rodded, spaded, and compacted as necessary to provide firm uniform support for the pipe; and not subject it to settlement or displacement.

5. Jointing. Preparatory to making pipe joints, all surfaces of the portions of the pipe to be jointed shall be clean and dry. Lubricants, primers, adhesives, etc. that are used shall be compatible with the jointing material recommended or specified. All bell and spigot ends of concrete pipe shall be primed prior to application of trowelable, bitumastic plastic compound.

Trenches shall be kept water-free and as dry as possible during bedding, laying and jointing, and for as long a period as required to protect the pipe joints and concrete structures.

As soon as possible after the joint is made, sufficient material shall be placed alongside each side of the pipe to offset conditions that might tend to move the pipe off line and grade.

a. Concrete Pipe:

- (1) Plastic joint sealant shall be applied to the tongue or spigot prior to the insertion into the bell or groove. A Sufficient amount of sealant shall be used to fill the annular joint space with some squeeze out. Wipe the outside surface of the joint with additional material to assure a complete seal.
- (2) Mortar. When cement mortar is used the joint surface shall be clean and soaked with water immediately before the joint is made. A layer of mortar shall be placed in the loser portion of the bell or groove of the installed pipe and on the upper portion of the tongue or spigot of the pipe section to be installed. The tongue or spigot shall then be inserted into the bell or groove of the installed pipe until the mortar is squeezed out on both the interior and exterior surfaces. The annular joint space shall be completely filled and abutting joint sections flush and even, with excess mortar struck off.
- (3) Flexible Gaskets. Flat gaskets may be cemented to the pipe tongue or spigot. O-ring gaskets shall be recessed in the groove of the pipe tongue or spigot and confined by the bell or groove after the joint is completed. Roll-on gaskets shall be placed around the tongue or spigot and rolled into position as the joint is assembled. Flat gaskets and o-ring gaskets shall be lubricated as recommended by the manufacturer.

- b. Corrugated Steel Pipe. Corrugated steel pipes shall be joined with a band type of coupling. The band shall be drawn and secured on the pipe by connecting devices as furnished by the manufacturer. Pipe ends for annular corrugations shall be identical to the rest of the pipe barrel (plain ends), or in the case of helical pipe, the pipe ends at the joint shall be reformed to an annular corrugation or flange (reformed end). Gaskets, if required, shall be furnished in accordance with the plans and Special Provisions.

C. Trench Backfill.

1. Compacted backfill shall be required for the full depth of the trench above the embedment

where beneath structures, street, road, or highway right-of-way, driveways, walks, parking areas, and at all locations shown on the plans or as directed by the Engineer during the progress of the work.

2. The top portion of the backfill beneath established sodded areas shall be finished with at least twelve (12) inches of topsoil corresponding to, or better than, those underlying adjoining sodded areas. The Engineer prior to placement shall approve topsoil, and unless otherwise directed, shall be material previously excavated and stockpiled for the purpose during excavating and grading operations. Grades on areas to receive topsoil shall be established and maintained as a part of the grading operations. Immediately prior to dumping and spreading topsoil, the surface shall be loosened by discing or scarifying to a depth of two (2) inches to permit bonding of the topsoil to the underlying surface.
3. At the option of the Contractor, compacted backfill may be job-excavated material or material obtained off site, except that all street crossings shall be backfilled with MoDot Type I rock, four (4) feet back of curb to four (4) feet back of curb. Job-excavated material may be used for compacted backfill (outside of Street Right of Ways) when the job-excavated material is finely divided and free from debris, organic material, cinders, or other corrosive material, and stones larger than three (3) inches in greatest dimension. Large masses of moist, stiff clay shall not be used. Job-excavated material shall be compacted to ninety-five (95) percent of maximum density at optimum moisture content as determined by ASTM D698 when the test is appropriate, or to seventy (70) percent relative density as determined by ASTM D2049 when that test is appropriate.
4. The method of compaction and the equipment used shall be appropriate for the material to be compacted and shall not transmit damaging shocks to the pipe.

The combination of the thickness of the layer, the method of compaction and the type of compaction equipment used shall be at the discretion of the Contractor subject to obtaining the densities as specified above.

5. Backfill shall not be placed when material contains frost, is frozen, or a blanket or snow prevents proper compaction. Backfill shall not contain waste material, organic material, or debris of any kind.
6. Trench backfill above pipe embedment in locations other than those specified shall be compacted to ninety (90) percent of maximum density at optimum moisture content as determined by ASTM D698, unless otherwise permitted by the Engineer.
7. Uncompacted earth backfill material to be placed above embedments shall be free of brush, roots, more than two (2) inches in diameter, debris, cinders, or other corrosive material, and junk, but may contain rubble and detritus from rock excavation, stones, and boulders in certain portions of the trench depth. Uncompacted backfill material above embedments may be placed by any method acceptable to the Engineer which will not impose excessive concentrated or unbalanced loads, shock, or impact on and which will not result in displacement of installed pipe. Uncompacted backfill shall be placed to the extent necessary to prevent excessive future settlement.

8. Compact masses of stiff clay or other consolidated material more than one (1) cubic foot in volume shall not be permitted to fall more than five (5) feet into the trench unless cushioned by at least two (2) feet of loose backfill above pipe embedment.
9. No uncompacted trench backfill material containing rocks, or rock excavation detritus, shall be placed in the upper eighteen (18) inches of the trench except with specific permission of the Engineer, nor shall any stone larger than eight (8) inches in its greatest dimension be placed within three (3) feet of the top of pipe. Large stones may be placed in the remainder of the trench backfill only if well separated and so arranged that no interference with backfill settlement will result.

D. Structural Plate Erection. Structural plate pipe, fabricated from hot-dip galvanized steel plates, shall be assembled by bolting individual plates together to erect the pipes or structures as shown on the plans. The plate manufacturer shall furnish bolts, fittings, and other appurtenances. All materials shall be handled in such a manner that they are not chipped, dented, or bent. If the base material is exposed in any way it shall be rejected, or repaired to the satisfaction of the Engineer.

4012 DRAINAGE MAINTENANCE. Trenches across roadways, driveways, walks, or other trafficways adjacent to drainage ditches or water courses shall not be backfilled prior to completion of backfilling the trench on the upstream side of the traffic way, to prevent impounding water after the pipe has been laid. Bridges and other temporary structures required to maintain traffic across such unfilled trenches shall be constructed and maintained by the Contractor. Backfilling shall be done so that water will not accumulate in unfilled or partially filled trenches. All material deposited in roadway ditches or other watercourses crossed by the line of trench shall be removed immediately after backfilling is completed and the original section, grades, and contours of ditches or watercourses shall be restored. Surface drainage shall not be obstructed longer than necessary.

4013 DISPOSAL OF EXCESS EXCAVATED MATERIALS. Except as otherwise permitted, all excess excavated materials shall be disposed of away from the site of work.

Broken concrete and other debris resulting from pavement or sidewalk removal, excavated rock in excess of the amount permitted to be and actually installed in trench backfill, junk, and debris encountered in excavation work and other similar waste materials shall be disposed of away from the site of the work.

Excess earth from excavations located in unimproved property shall be distributed directly over the pipe trench and within the pipeline right-of-way to a maximum depth of six (6) inches above the original ground surface elevation at and across the trench and sloping uniformly. Drag with blade machine, or other suitable tool to a smooth, uniform surface without obstructing drainage at any point. Wasting of excess excavated material in the above manner will not be permitted where the line of trench crosses or is within a railroad, public road, or highway right-of-way. The disposal of waste and excess excavated materials, including hauling, handling, grading, and surfacing shall be a subsidiary obligation of the contractor and no separate payment will be made therefore.

4014 SETTLEMENT. The Engineer may perform periodic inspections to insure that no settlement has occurred. The Contractor shall be responsible for all settlement of backfill, fills and

embankments, which may occur within two (2) years of time after final acceptance of the contract under which the work was performed.

A suitable maintenance bond in an amount approved by the City Engineer shall be furnished to the City of Raytown by the Contractor guaranteeing the maintenance of the construction under which the contract was performed. Said bond shall remain in effect for the period mentioned above from the date of completion and acceptance of the work by the City.

The Contractor shall make, or cause to be made, all repairs or replacements made necessary by settlement within thirty (30) days after notice from the Engineer. Should the Contractor fail to make such repairs the City Engineer may cause repairs to be made and the cost of these repairs shall be the responsibility of the Contractor.

4200 STORM SEWER OPEN CHANNELS

4201 SCOPE. This section includes all work for construction of open channel lining at the location, and to the lines, grades and dimension indicated on the drawings. Grading shall have been previously completed in accordance with *Sections 1000 - "Site Preparation" and 1100 - "Grading"*.

4202 MATERIALS.

- A. Concrete. Concrete and materials shall conform to the requirements set forth in *Section 2000 - "Concrete"*.
- B. Stone. Stone for riprap, grouted riprap, and gabion linings shall consist of quarried rock and be sound, durable, and angular in shape. No more than 10 percent shall have an elongation greater than 3:1, and no stone shall have an elongation greater than 4:1. Material shall be free from cracks, seams, or other defects. Shale and stone with shale seams are not acceptable.
1. The minimum weight of the stone shall be 155 pounds per cubic foot as computed by multiplying the specific gravity times 62.4 pounds per cubic foot.
 2. Not more than 10 percent of the stone shall exhibit splitting, crumbling, or spalling when subject to 5 cycles of the sodium sulfate soundness test in accordance with AASHTO T104.
 3. Stone shall be of the following gradations:

Riprap (15" Minimum Thickness)

<u>Weight of Stone in lbs.</u>	<u>Percent Lighter by Weight</u>
180	100 (minimum)
120	80 (maximum)
60	50 (maximum)
6	10 (maximum)

Grouted Stone Lining (12" Minimum Thickness)

<u>Weight of Stone in lbs.</u>	<u>Percent Lighter by Weight</u>
90	100 (minimum)
60	80 (maximum)
30	50 (maximum)
3	10 (maximum)

Gabion Fill Stone

<u>Stone Size Inches</u>	<u>Percent Smaller by Weight</u>
*	100
2	0

* one-half of least dimension of gabion basket.

Stone shall be graded within the above limits as required to provide a unit weight in-place of 100 pounds per cubic foot or greater.

C. Filter Blanket. Filter blanket may be either of the following types at the Contractor's option:

1. Granular Filter. Granular filter material shall consist of sound, durable rock particles conforming to the following gradation.

<u>Sieve Size</u>	<u>Cumulative Percent Passing By Weight</u>
1	100
2"	70-100
No. 4	50-85
No.10	35-70
No.40	20-50
No.100	15-40

2. Filter Fabric. Filter fabric shall consist of woven or non-woven fabric. The synthetic fiber of either the woven or non-woven fabric shall consist of polypropylene, nylon, or polyester filaments. The percent open area shall be not less than 4 percent nor more than 10 percent. The cloth shall provide an Equivalent Opening Size (EOS) no finer than the U.S. Standard Sieve No. 70. In addition, filter fabric shall meet the following physical requirements:

- a. Tensile Strength. Minimum grab tensile strength, both warpwise and fillingwise, shall be 200 pounds when tested in accordance with ASTM D 1682, using a 4 inch by 6 inch specimen and a jaw speed of 12 inches per minute.
- b. Elongation. Grab elongation shall be not less than 15 percent nor more than 60 percent, both warpwise and fillingwise, when tested in accordance with ASTM D 1682.
- c. Tear Strength. Minimum trapezoid tear strength shall be 100 pounds, both warpwise and fillingwise. Method of test for woven fabrics shall be in accordance with ASTM D 1117.
- d. Bursting Strength. Minimum bursting strength shall be 200 psi when tested in accordance with ASTM D 3887.
- e. Seam Strength. Woven fabric shall have a minimum seam-breaking strength of 180 pounds when tested in accordance with ASTM D 1683, using a jaw speed of 12 inches per minute.
- f. Width. Filter fabrics shall be furnished in widths of not less than 6 feet.

D. Gabion Baskets. Baskets shall be of the dimensions indicated on the drawings and be fabricated using hexagonal triple-twist wire mesh.

1. Wire.

1. Wire shall be galvanized-steel having a minimum tensile strength of 60,000 psi, and be zinc coated with a minimum coating weight of 0.80 oz. psf.
2. Wire shall be plastic coated with a minimum tensile strength of 60,000 psi, and with a coating with a nominal thickness of .02165". It shall be capable of resisting deleterious effects of natural weather exposure or immersion in salt water.

2. Wire Mesh. Maximum dimension of the mesh opening shall be 4 1/2 inches or less, and the maximum area of the mesh opening shall not exceed 12 square inches. Wire shall be 0.115-inch (minimum) diameter.

3. Selvedge Wire. Selvedge wire shall be 0.150-inch (minimum) diameter. All perimeter edges of the mesh forming the gabion selvedges have strength equal to or greater than the body of the basket.

4. Lacing and Stay Wire. Wire shall be 0.091 inch diameter or larger.

5. Diaphragms. Gabions shall be divided into cells not greater than 4 feet in width by wire mesh diaphragms. Diaphragms shall be factory secured to the base of the basket by continuous spiral wire.

E. Grout. Grout shall consist of one part portland cement and five parts aggregate by volume. The aggregate shall be a mixture of crushed stone and clean sand. Uniformly graded from coarse to fine, and meet the following gradation:

<u>Sieve Size</u>	<u>Cumulative % Passing</u>
2"	100
No.4	40-60

Water shall be proportioned to provide a grout having a consistency to permit thorough penetration of the grout into the joints and voids between the stones, but shall not exceed 5.0 gallons per sack of cement. The Contractor may use concrete conforming to MCIB Mix Number A 384- 1/2-2 or A 420 1/2-4 in lieu of the grout here-in-before specified.

4203 CONSTRUCTION DETAILS.

A. Foundation Preparation. After completion of grading in accordance with *Section 1100 – "Grading"*, the area to receive channel lining shall be trimmed and dressed to conform to the cross sections indicated on the drawings within a tolerance of plus or minus 2 inches from the theoretical slope lines and grades. All deleterious materials shall be removed from the foundation area.

B. Concrete Lining.

1. Preparation. Earth foundation subgrade shall be moistened by sprinkling. Forms shall be securely staked, braced, and set to line and grade. Reinforcement and tie bars shall be held in position by bar chairs, concrete brick, or other approved devices.
2. Placing and Finishing. Place, consolidate, and strike off concrete to the thickness indicated on the drawings. Concrete shall be tamped or vibrated to eliminate all voids and bring sufficient mortar to the top for finishing. Surface finish shall be a wood-float finish. Round all edges and joints with a 1/4 inch radius edging tool, except contraction joints may be sawed to a depth of 30 percent of the thickness of the concrete lining after concrete has hardened but before uncontrolled cracking occurs. Apply curing membrane as specified in Section 2000 "Concrete".

C. Filter Blanket.

1. Granular Filter. Place granular filter to its full thickness in a single operation. Construction methods shall be such that the material is placed without segregation. Compaction of granular filter material is not required.
2. Filter Fabric. Place filter fabric with its long dimension horizontal and lay free of tension, stress, folds, wrinkles, or creases.
 - a. Place to provide 18 inches minimum overlap at each joint and anchor to prevent dislocation during construction of overlaying material.
 - b. Fabric shall not be left exposed more than two weeks prior to placement of overlaying material. Tracked or wheeled equipment or vehicles shall not be operated on the fabric.

D. Riprap Placement. Riprap shall be placed on the prepared foundation in a manner that will provide 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 thicknesses indicated. Riprap shall be placed to full-course thickness in one operation and in such a manner as to avoid displacing the underlying material. If the underlying layer consists of filter fabric, the Contractor shall place the riprap in such a way as to not tear, puncture, or shift the fabric. Riprap shall not be dropped more than 3 feet when being placed directly on the fabric. Tears or rips in the fabric shall be repaired with fabric lapped a minimum of 12 inches in all directions.

1. Placing. Placing of riprap in layers, or by dumping into chutes, or by similar methods likely to cause segregation will not be permitted.
2. Distributing. The larger stones shall be well distributed and the entire mass of stone shall conform to the specified gradation. All material shall be so placed and distributed that there will be no objectionable accumulations of either the larger or smaller sizes of stone.

3. Hand Placing. It is the intent of these specifications to produce a fairly compact riprap protection in which all sizes of material are placed in their proper proportions. Hand placing or rearranging of individual stones by mechanical equipment may be required to the extent necessary to secure the specified results.

Damage to baskets by mechanical equipment will not be allowed. Any damaged baskets shall be repaired or replaced at the direction of the Engineer.

- E. Grouted Stone Lining. Place stone and grout in a manner to produce a securely bound solid mass with the stone interstices completely filled. Sweep the surface clean of all surplus grout with a stiff broom. Apply curing membrane as specified in Section 2000 "Concrete".
- F. Gabion Lining.
 1. Assembly. Assemble each gabion unit by binding all vertical edges together with a continuous piece of connecting wire stitched around the vertical edge with coils spaced at 3 inches or less. Set empty units to line and grade and join units by stitching with connecting wire along adjoining edges. Stainless steel hog rings spaced no more than 6" apart and shall conform to ASTM A313-92. Installation shall be by mechanical means. Install and securely fasten internal tie wires in each cell if necessary to retain the shape of the cell during filling operations.
 2. Filling. Fill gabion cells with stone carefully by hand or machine to provide a minimum of voids and avoid bulges and distortions of the gabion. After filling, secure the lid to the sides, ends, and diaphragm by stitching with connecting wire.

SECTION 6000 - EXCAVATION, TRENCHING AND BACKFILLING (Pipeline Construction)

- 6001 **SCOPE.** This section covers excavation and trenching work and shall include the necessary clearing, grubbing, and preparation of the site; removal and disposal of all debris; excavation and trenching as required; the handling, storage, transportation, and disposal of all excavated material; all necessary sheeting, shoring, and protection work; preparation of subgrades; pumping and dewatering as necessary or required; protection of adjacent property, backfilling, pipe embedment, surfacing and grading, and other appurtenant work.

Attention is directed to the additional requirements set forth in the General Conditions, Supplemental General Conditions or Special Conditions.

- 6002 **GENERAL REQUIREMENTS.** Excavation work shall be performed in a safe and proper manner with appropriate precautions being taken against all hazards. Excavations shall provide adequate working space and clearances for the work to be performed therein. In no case shall excavation faces be undercut for extended footings.

Subgrade surfaces shall be clean and free of loose material of any kind when concrete is placed thereon.

Excavations for manholes and similar structures constructed of masonry units shall have such horizontal dimension that not less than six inches (6") clearance is provided for outside plastering.

Backfilling and construction of fills and embankments during freezing weather shall not be done except by permission of the engineer. No backfill, fill, or embankment materials shall be installed on frozen surfaces, nor shall frozen materials, snow, or ice be placed in any backfill, fill, or embankment.

- 6003 **CLASSIFICATION OF EXCAVATED MATERIALS.** When specifically indicated in the proposal and contract, classification of excavated materials will be made as follows:

- a. **Rock.** Rock excavation will be so classified when sandstone, limestone, blue shale or other similar material is encountered and, in the opinion of the engineer, requires drilling or blasting to remove the material.
- b. **Earth and Sand.** All material not classified as rock.

- 6004 **CLEARING.** The contractor shall do all clearing necessary for access, stringing of pipeline materials, and construction of the pipeline and appurtenant structures.

At the option of the contractor, all trees, underbrush, stumps, roots, and other combustible materials may be stacked and burned on the site at such locations as permitted by the Missouri Department of Natural Resources, City Fire Marshall, and City Engineer or removed entirely from the site and disposed of at such locations as determined by the contractor. All materials to be burned shall be piled neatly and, when in suitable condition, shall be burned completely. Piling for burning shall be done in such a manner and in such locations as to cause the least fire risk. All burning shall be so thorough that the materials are completely reduced to ashes. Great care shall

be taken to prevent the spread of fire beyond the permanent site limits. Fireguards of adequate width shall be provided wherever there is surface vegetation around any brush pile. No burning of trimmings or brush shall be done when the direction or velocity of the wind is such that there would be any danger of fire being carried into adjacent areas. All governmental requirements relative to burning, fire prevention, and air pollution shall be complied with. See Specification Paragraph 1005a.

- 6005 DEWATERING. The contractor shall provide and maintain adequate dewatering equipment to remove and dispose of all surface and ground water entering excavations, trenches, or other parts of the work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the pipe to be installed therein is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

All excavations for trenches which extend down to or below ground water shall be dewatered by lowering and keeping the ground water level beneath such excavations twelve inches (12") or more below the bottom of the excavation.

Surface water shall be diverted or otherwise prevented from entering excavated areas or trenches to the greatest extent practicable without causing damage to adjacent property.

The contractor will be held responsible for the condition of any pipe or conduit which he may use for drainage purposes, and all such pipes or conduits shall be left clean and free of sediment.

- 6006 SHEETING AND SHORING. Except where banks are cut back on a stable slope, excavation for structures and trenches shall be properly and substantially sheeted, braced, and shored, as necessary, to prevent caving or sliding, to provide protection for workers and the work, and to provide protection for existing structures and facilities. Sheet piling, bracing, and shoring shall be designed and built to withstand all loads that might be caused by earth movement or pressure and shall be rigid, maintaining shape and position under all circumstances.

Trench sheet piling shall not be pulled before backfilling unless the pipe strength is sufficient, in the opinion of the engineer, to carry trench loads based on trench width to the back of sheet piling; nor shall sheet piling be pulled after backfilling. When ordered by the engineer, sheet piling shall be left permanently in the trench. Payment for such sheet piling will be made in accordance with the contract provisions for extra work.

When trench sheet piling is left in place, such sheet piling shall not be braced against the pipe, but shall be supported in a manner that will preclude concentrated loads or horizontal thrusts on the pipe. Cross braces installed above the pipe to support sheet piling may be removed after pipe embedment has been completed.

- 6007 ALIGNMENT AND GRADE. The alignment and grade or elevation of each pipeline shall be maintained as shown on the contract drawings by overhead grade lines parallel to the pipe invert, unless the contractor uses lasers to control the grade.

- 6008 MINIMUM COVER (Water Mains and Service Lines). Where pipe grades or elevations are not definitely fixed by the contract drawings, trenches shall be excavated to a depth sufficient to provide a minimum depth of backfill covering the top of the pipe of forty-two inches (42").

Greater pipe cover depths may be necessary on vertical curves or to provide necessary clearance beneath existing pipes, conduits, drains, drainage structures, or other obstructions encountered at normal pipe grades. Measurement of pipe cover depth shall be made vertically from the outside top of pipe to finished ground or pavement surface elevation. Water mains and service lines are not the responsibility of the City of Raytown and should meet the requirements of the Raytown Water Company or Public Water District #2.

6009 STABILIZATION. Trench bottoms which become soft, mucky, or otherwise unstable during construction operations shall be stabilized, by and at the expense of the contractor, with one or more layers of crushed rock or other suitable material, where and as necessary to provide a firm and stable base for granular fill pipe foundation material to be placed thereon. Not more than one-half inch (1/2") depth of mud or muck shall be allowed to remain on the stabilized trench bottom when the granular fill pipe foundation material is installed.

6010 TRENCH EXCAVATION. The contractor shall not open more of the trench in advance of pipe laying than is necessary to expedite the work. One block or 400 feet (whichever is the shorter) shall be the maximum length of open trench on any line under construction. The contractor shall backfill all open trench by the end of the day's work, except that which is necessary for inspection or immediate continuation of the following day's work.

Except where tunneling is shown on the drawings, is specified, or is permitted by the engineer, all trench excavations shall be open cut from the surface.

The alignment, depth, and grade of all trenches shall be maintained as shown on the drawings by overhead grade lines parallel to the pipe invert.

All open trenches shall be provided with adequate protective devices as approved by the City Engineer.

6011 LIMITING TRENCH WIDTHS. Trenches shall be excavated to a width that will provide adequate working space and pipe clearances for proper pipe installation, jointing, and embedment. Ledge rock, boulders, and large stones shall be removed to provide a clearance of six inches (6") below and on each side of all pipes. These distances are minimum clear distances that will be permitted between any part of the pipe and appurtenances being laid on any part, projection, or point of such rock, boulder, or stone.

Cutting trench banks on slopes to reduce earth load to prevent sliding and caving will be permitted only in areas where the increased trench width will not interfere with surface features or encroach on right-of-way limits. Slopes shall not extend lower than one foot (1') above the top of the pipe.

Limiting trench widths below an elevation of one foot (1') above the exterior top of the installed pipe shall be not less than fifteen inches (15") nor more than twenty-four inches (24") greater than the nominal outside diameter of the pipe.

6012 UNAUTHORIZED TRENCH WIDTHS. Where, for any reason, the width of the lower portion of the trench as excavated at any point exceeds the maximum permitted in Section 6011 of these specifications either special pipe embedment, or arch concrete encasement, as required by loading

conditions and as determined by the engineer, shall be furnished and installed by and at the expense of the contractor.

- 6013 MECHANICAL EXCAVATION. The use of mechanical equipment will not be permitted in locations where its operation would cause damage to trees, buildings, culverts, or other existing property, utilities, or structures above or below ground.

Mechanical equipment used for trench excavation shall be of a type, design, and construction, and shall be so operated, that the rough trench excavation bottom elevation can be controlled, that uniform trench widths and vertical sidewalls are obtained at least from an elevation one foot (1') above the top of the installed pipe to the bottom of the trench, and that trench alignment is such that pipe when accurately laid to specified alignment will be centered in the trench with adequate clearance between the pipe and sidewalls of the trench. Undercutting the trench sidewall to obtain clearance will not be permitted.

If the contractor prefers to undercut the bottom of the trench and bring to grade with 1/2-inch (1/2") crushed rock, he may do so, provided the depth of undercut and backfill with crushed rock shall not exceed four inches (4"). Where crushed rock is used, it shall be placed in the trench, spread uniformly, and graded prior to placing the pipe in the trench.

- 6014 ARTIFICIAL FOUNDATIONS IN TRENCHES. Whenever so ordered by the engineer, the contractor shall excavate to such depth below grade as the engineer may direct and the trench bottom shall be brought to grade with such material as the engineer may order installed. All concrete or other foundations made necessary by unstable soil shall be installed as directed by the engineer. Compensation for extra excavation, concrete, or other foundations, except where provided by contract unit prices, shall be made in accordance with the contract provisions for extra work.

- 6015 PIPE BEDDING. The pipe shall be laid in a flat-bottom trench that has been carefully graded and shaped so that the barrel of the pipe will have bearing for its full length. Blocking of the pipe will not be permitted.

Granular embedment material shall be spread and the surface graded to provide a uniform and continuous support beneath the pipe at all points between bell holes or pipe joints. It will be permissible to slightly disturb the finished subgrade surface by withdrawal of pipe slings or other lifting tackle.

After each pipe has been graded, aligned, and placed in final position on the bedding material and shoved home, sufficient pipe embedment material shall be deposited and compacted under and around each side of the pipe and back of the bell or end thereof to hold the pipe in proper position and alignment during subsequent pipe jointing and embedment operations.

Embedment material shall be deposited and compacted uniformly and simultaneously on each side of the pipe to prevent lateral displacement.

- A. Water Mains: Shall be coordinated with the appropriate Water Utility.

B. Sanitary Sewers: Granular material shall be used for pipe bedding and haunching. Granular material is also required for the initial backfill on PVC pipe installations. Compacted soil or granular material may be used for initial backfill of DIP and RCP installations. Continuity of embedment material shall be interrupted by compacted soil around each manhole to impede passage of water through the embedment.

Bell holes shall provide adequate clearance for tools and methods used in installing pipe. No part of any bell or coupling shall be in contact with the trench bottom; trench walls or granular embedment at the time the pipe is jointed.

Bedding, haunching and initial backfill materials shall be free of cinders and corrosive materials.

- C. Storm Sewers: Granular material is required for the haunching and initial backfill of all storm sewer installations.

If the pipe is located within four feet of the curb and gutter, granular material shall be used for haunching, initial backfill and final backfill for all storm sewer installations.

6016 PIPE INSTALLATION. All work shall be in accordance with the following standards or as specified herein.

- A. Flexible Thermoplastic Pipe; ASTM D2321
- B. Ductile Iron Water Mains; AWWA C600
- C. Reinforced Concrete Pipe

Joints for reinforced concrete pipe shall conform to Section 7 of ASTM C361, except that gaskets shall have a circular cross section and shall be confined in a groove in the pipe spigot. Pipe with collars in lieu of integral bells will not be acceptable.

Core holes and handling holes in concrete pipe shall be repaired by cementing a properly shaped concrete plug in place with epoxy cement or by other methods acceptable to the engineer.

- D. Corrugated Metal Pipe

Corrugated metal storm sewer pipe shall be laid with the separate sections joined firmly together, with the outside laps of the circumferential joints pointed upstream, and with the longitudinal laps on the side.

Lateral displacement of the pipe shall be prevented during embedment operations. Pipe shall not be laid in water, nor under unsuitable weather or trench conditions.

All joint preparation and jointing operations shall comply with the instructions and recommendations of the pipe manufacturer.

Hooks shall not be permitted to contact joint surfaces. Care shall be exercised in handling all pipes to prevent damage to pipe ends. Damaged pipe or pipe damaged in laying shall be replaced by and at the expense of the contractor.

6017 TRENCH BACKFILL. All trench backfill above pipe initial backfill shall conform to the following requirements.

Compacted backfill shall be required for the full depth of the trench above the embedment where beneath structures, street, road, or highway right-of-way, driveways, walks, parking areas, and at all locations shown on the plans or as directed by the engineer during the progress of the work.

The top portion of the backfill beneath established sodded areas shall be finished with at least twelve inches (12") of topsoil corresponding to, or better than, those underlying adjoining sodded areas. The engineer prior to placement shall approve topsoil, and unless otherwise directed, shall be material previously excavated and stockpiled for the purpose during excavating and grading operations. Grades on areas to receive topsoil shall be established and maintained as a part of the grading operations. Immediately prior to dumping and spreading topsoil, the surface shall be loosened by discing or scarifying to a depth of two inches (2") to permit bonding of the topsoil to the underlying surface.

At the option of the contractor, compacted backfill may be job-excavated material or graded gravel. Embedment shall be graded gravel Type CA-5, 3/4" or 1" washed aggregate. All street crossings (existing or proposed) shall have total aggregate (CA-5) or flowable fill (mix design to be approved by engineer) backfill from 4' back of the curb to 4' back of curb. Above the initial backfill, job-excavated material may be used for compacted final backfill when the job-excavated material is finely divided and free from debris, organic material, cinders, or other corrosive material, and stones larger than three inches (3") in the greatest dimension.

Gravel for compacted backfill, other than for street crossings, shall conform to the following gradation:

Sieve Size	Percent Passing by Weight
1 inch	100
3/4 inch	85 - 100
3/8 inch	50 - 80
No. 4	35 - 60
No. 40	15 - 30
No. 200	5 - 10

The gravel mixture shall contain no clay lumps or organic matter. The fraction passing the No. 4 sieve shall have a liquid limit not greater than 25 and a plasticity index not greater than 5. The backfill shall be compacted by a suitable vibratory roller or platform vibrator to not less than 70 percent (70%) relative density as determined by ASTM D2049.

The method of compaction and the equipment used shall be appropriate for the material to be compacted and shall not transmit damaging shocks to the pipe.

The combination of the thickness of the layer, the method of compaction and the type of compaction equipment used shall be at the discretion of the contractor subject to obtaining the densities as specified above.

Backfill shall not be placed when material contains frost, is frozen, or a blanket of snow prevents proper compaction. Backfill shall not contain waste material, organic material, or debris of any kind.

Trench backfill above pipe embedment in locations other than those specified shall be compacted to 90 percent (90%) of maximum density at optimum moisture content as determined by ASTM D698, unless otherwise permitted by the City Engineer.

Uncompacted earth backfill material to be placed above embedments shall be free of brush, roots more than two inches (2") in diameter, debris, cinders, or other corrosive material, and junk, but may contain rubble and detritus from rock excavation, stones, and boulders in certain portions of the trench depth. Uncompacted backfill material above embedments may be placed by any method acceptable to the engineer which will not impose excessive concentrated or unbalanced loads, shock, or impact on and which will not result in displacement of installed pipe. Uncompacted backfill shall be placed to the extent necessary to prevent excessive future settlement.

Compact masses of stiff clay or other consolidated material more than one (1) cubic foot in volume shall not be permitted to fall more than five feet (5') into the trench unless cushioned by at least two feet (2') of loose backfill above pipe embedment.

No uncompacted trench backfill material containing rocks, or rock excavation detritus, shall be placed in the upper eighteen inches (18") of the trench except with specific permission of the engineer, nor shall any stone larger than eight inches (8") in its greatest dimension be placed within three feet (3') of the top of pipe. Large stones may be placed in the remainder of the trench backfill only if well separated and so arranged that no interference with backfill settlement will result.

- 6018 STRUCTURE BACKFILL. Backfill around structures shall be compacted to the extent necessary to prevent future settlement by tamping or other means acceptable to the engineer.

Material for backfill shall be composed of earth only and shall contain no wood, grass, roots, broken concrete, stones, trash, or debris of any kind. No tamped or otherwise mechanically compacted backfill shall be deposited or compacted in water.

- 6019 DENSITY TESTING. At the option of the engineer, in-place field density testing to determine compliance with specified compaction requirements may be performed using a nuclear moisture-density measuring device. If, as a result of this field-testing, the engineer determines that further compaction is required, the contractor shall revise their compaction procedures to obtain the results specified.

- 6020 TUNNEL AND CASING PIPE INSTALLATION. Pipelines shall be constructed in tunnels of the type designated on the drawings, in conformity with the requirements that follow. Casing pipe will have the strength and integrity equal to or greater than the carrier pipe. Installation will comply with all applicable federal, state, or regulations. Before starting work on any tunnel,

complete details of the method of operation and liner to be used shall be submitted to the engineer for review.

Smooth wall casing pipe shall be welded-steel construction and shall be new material with a minimum yield point of 35,000 psi. Minimum casing wall thickness shall be as indicated in the following table.

Nominal Wall Thickness (Inches)

Diameter of Casing (Inches)	Under Railroads (AREA-Part 5)	All Other Uses
Less than 14	0.188	0.188
14	0.219	0.188
16	0.219	0.250
18	0.250	0.250
20	0.281	0.250
22	0.312	0.250
24	0.344	0.281
26	0.375	0.281
28	0.406	0.312
30	0.406	0.312
32	0.438	0.312
34	0.469	0.312
36	0.469	0.344
38	0.500	0.344
40	0.500	0.344
42	0.500	0.344
44	0.560	0.375
46	0.560	0.375
48	0.560	0.375
50	0.625	0.406
52	0.625	0.406

The conduit shall be installed by jacking into place. Earth displaced by the conduit shall be removed through the interior of the conduit by hand, by auger, or by other acceptable means. Sections of the casing pipe shall be welded together to form a continuous conduit capable of resisting all stresses, including jacking stresses. The casing pipe conduit in its final position shall be straight and true in alignment and grade, as required by the drawings. There shall be no space between the earth and the outside of the casing. Pressure grouting shall fill any voids that do occur.

Wood skids shall be provided as shown on the drawings. The wood shall be pressure treated with creosote, pentachlorophenol, or salt-type preservative in accordance with AWWA C2. Cut surfaces shall be given two (2) heavy brush coats of the same preservative. The wood skids shall be securely strapped to the pipe with steel straps.

In sanitary sewer construction, after installation of the pipe in the tunnel, the entire annular space between the pipe and the tunnel walls shall be filled with stabilized sand. Stabilized sand shall be

mixed in the proportions of at least 282 pounds of portland cement to each cubic yard of sand. Cement and sand (fine aggregate) shall be as specified for cast-in-place concrete. Stabilized sand shall be thoroughly mixed in a mechanical mixer. Stabilized sand shall be blown into casing so that all space is filled.

Both ends of casing conduit shall be closed with common brick and mortar.

No interruption of traffic will be permitted at any location where tunnels are required.

6021 DRAINAGE MAINTENANCE. Trenches across roadways, driveways, walks, or other trafficways adjacent to drainage ditches or water courses shall not be backfilled prior to completion of backfilling the trench on the upstream side of the trafficway, to prevent impounding water after the pipe has been laid. Bridges and other temporary structures required to maintain traffic across such unfilled trenches shall be constructed and maintained by the contractor. Backfilling shall be done so that water will not accumulate in unfilled or partially filled trenches. All material deposited in roadway ditches or other watercourses crossed by the line of trench shall be removed immediately after backfilling is completed and the original section, grades, and contours of ditches or watercourses shall be restored. Surface drainage shall not be obstructed longer than necessary.

6022 PROTECTION OF TRENCH BACKFILL IN DRAINAGE COURSES. Where trenches are constructed in ditches or other watercourses, backfill shall be protected from surface erosion. When the grade of the ditch exceeds 1 percent (1%), ditch checks shall be installed. Unless otherwise shown on the drawings or directed by the engineer, ditch checks shall be concrete. Ditch checks shall extend not less than two feet (2') below the original ditch or watercourse bottom for the full bottom width and at least eighteen inches (18") into the side slopes and shall be at least twelve inches (12") thick.

6023 DISPOSAL OF EXCESS EXCAVATED MATERIALS. Except as otherwise permitted, all excess excavated materials, shall be disposed of away from the site of work.

Broken concrete and other debris resulting from pavement or sidewalk removal, excavated rock in excess of the amount permitted to be and actually installed in trench backfill, junk, and debris encountered in excavation work and other similar waste materials shall be disposed of away from the site of the work.

Excess earth from excavations located in unimproved property shall be distributed directly over the pipe trench and within the pipeline right-of-way to a maximum depth of six inches (6") above the original ground surface elevation at and across the trench and sloping uniformly. Drag with blade machine, or other suitable tool to a smooth, uniform surface without obstructing drainage at any point. Wasting of excess excavated material in the above manner will not be permitted where the line of trench crosses or is within a railroad, public road, or highway right-of-way. The disposal of waste and excess excavated materials, including hauling, handling, grading, and surfacing shall be a subsidiary obligation of the contractor and no separate payment will be made therefore.

6024 SETTLEMENT. The contractor shall be responsible for all settlement of backfill, fills and embankments that may occur within two (2) years of time after final acceptance of the contract under which the work was performed.

The contractor guaranteeing the maintenance of the construction under which the contract was performed shall furnish a suitable maintenance bond in an amount approved by the City Engineer to the City of Raytown. Said bond shall remain in effect for the period mentioned above from the date of completion and acceptance of the work by the City.

The contractor shall make, or cause to be made, all repairs or replacements made necessary by settlement within thirty (30) days after notice from the engineer.

SECTION 6100 - BLASTING

6101 GENERAL.

- A. Blasting will be permitted. Blasting shall be done only by people experienced in the handling of explosives, and in accordance with the recommendations of the AGC Manual of Accident Prevention in Construction and OSHA regulations. In locations where flying rock may be present, additional overburden shall be ready for use and/or in place before denotation. All trenching operations utilizing explosives shall be suitably backfilled to prevent any fly rock endangerment to persons or property. The use of these procedures does not relieve the contractor of responsibility for damage to life and property but acts only as an added assurance to the owner that damage will not occur.
- B. The office of the Raytown Fire Marshall will be known as the "authority having jurisdiction" regarding the storage, handling, use and control of explosives used in construction projects. All permits for this use will be issued by the Fire Marshall's office. Control of the right-of-way remains with the Engineering Division.

Requirements of the Uniform Fire Code, Article 77 regarding explosives and blasting agents shall be considered part of these specifications. All explosives and related material shall be in conformity with the requirements of the Raytown Fire Marshall's office, or the specifications contained herewith, whichever is more stringent. Blasting will not be permitted within eighty feet (80') of any building structure.

All blasting operations shall be conducted under the direction of a Missouri certified blaster. Certificates of blaster certification shall be carried by blasters or shall be on file at the Fire Department during blasting operations. A blaster and at least one other person shall be present at the firing of a blast. Persons responsible for blasting operations at a blasting site shall, as a minimum, conform to the criteria as outlined.

The Contractor shall comply with all laws, ordinances, applicable safety code requirements, and regulations relative to the handling, storage, and use of explosives and the protection of life and property. The contractor shall be responsible for all damage caused by their blasting operations and shall be responsible for responding to all complaints. Suitable methods shall be employed to confine all materials lifted by blasting within the limits of the excavation or trench. All rock which cannot be handled and compacted as earth shall be kept separate from other excavated materials and shall not be mixed with backfill or embankment materials except as specified or directed

All blasting by the contractor and their subcontractors shall be in conformity with the requirements having jurisdiction over the right-of-way, or the specifications contained herewith, under the Uniform Fire Code and Fire Marshall's office, whichever is more stringent.

The blast design shall be submitted to the Fire Marshall and Public Works Department for review prior to any blasting operations. The blast design shall contain sketches of the drill patterns, delay periods, and decking and shall indicate the type and amount of explosives to

be used, critical dimensions, and the location and general description of structures to be protected, as well as a discussion of design factors to be used, which protect the public and meet the applicable air blast and ground vibration standards. The blast design shall be prepared and signed by a certified blaster. The Fire Marshall and City Engineer may request changes to the design submitted.

C. **BLASTING DEFINITIONS:**

1. Air blast – the airborne shockwave or acoustic transient generated by an explosion.
2. Blaster – the qualified person in charge of, and responsible for the loading and firing of a blast.
3. Chief – Means the Fire Department Chief or designee as per the Uniform Fire Code as adopted.
4. City Engineer – Means the City Engineer or designee.
5. Decibel – A unit of air over pressure commonly used to measure air blast.
6. Explosive – Means any chemical compound, mixture, or device, the primary or common purpose of which is to function by explosion.
7. Licensing Officer – Means the City Engineer or designee.
8. Particle Velocity – A measure of the intensity of ground vibration, specifically the time rate of change of the displacement amplitude of ground vibration; commonly expressed in inches per second.
9. Pre-Blast Survey – A documentation, consisting of 35mm photographs as a minimum, of the existing condition of structures near an area where blasting is to be conducted.
10. Permit Area – Means the land owned or leased by the permittee upon which blasting is to be done. It includes the boundaries of all land in which the permittee has rights under low to occupy and use.
11. Permittee – Any person, as hereinafter defined, who shall apply for and obtain a permit under the terms of this Article and in accordance therewith.

6102 PREBLAST SURVEY. Unless otherwise directed by the Engineer, the Contractor shall provide a preblast survey of all structures located within a minimum 600 feet radius of their blast sites. The survey shall be of such nature as to accurately establish the structural condition of all houses and buildings (exterior and interior), bridges, overpasses, etc., within the specified area by means of photographic or videotape methods. Structures such as pipelines, cables, transmission lines, cisterns, wells, and other water systems warrant special attention; however, the assessment of these structures may be limited to surface conditions and other readily available data. The interior of the existing sanitary sewer shall be surveyed by means of a permanently recorded closed circuit video camera prior to blasting operations and after blasting has been concluded in the area of the existing sewer.

No blasting shall be allowed until the preblast survey has been completed and has been reviewed and accepted by the City Engineer and Fire Marshall. The contractor must submit, or make available, to the City Engineer and Fire Marshall preblast survey reports for all structures within the specified area. Qualified personnel regularly engaged in blasting operations shall perform the preblast survey.

The person who conducted the survey shall sign the written report of the survey. Copies of the report shall be promptly provided to the City Engineer and Fire Marshall. The surveyor before the

initiation of blasting shall complete all surveys. A disinterested third party, regularly engaged in performing preblast surveys, shall conduct all surveys.

The contractor shall submit with the bid, a detailed preblast survey method to be reviewed by the City Engineer and Fire Marshall. The preblast survey shall not commence until the City Engineer and Fire Marshall for completeness have reviewed the survey method.

- 6103 PUBLIC NOTIFICATION. Before blasting is started, the contractor shall inform all residents within a radius of 1500 feet of the blasting location by means of printed information sheets.
- 6104 WARNING SYSTEM. The contractor shall provide suitable warning by siren or whistle prior to all blasts.
- 6105 OVER-BLASTING. The requirements presented herein shall not relieve the contractor from responsibility to avoid disturbing earth or rock beyond indicated and specified lines and levels.
- 6106 UTILITY NOTIFICATION. The contractor shall notify the owner of all gas, water, and petroleum pipelines in any area where blasting will be utilized. A representative of the pipeline owner shall be allowed to be present to observe preparations and blasting.
- 6107 BLASTING SCHEDULE. The contractor shall conduct blasting operations at times approved by the Fire Marshall and City Engineer, and announced in the blasting schedule.

All blasting shall be conducted between 8:30 a.m. and 4:30 p.m. The Fire Marshall or City Engineer may specify more restrictive time periods for blasting.

- 6108 BLASTING SIGNS, WARNINGS, AND ACCESS CONTROL. Blasting signs shall meet the specifications of this section. The contractor shall:
- A. Conspicuously place signs reading *Blasting Area* along the edge of any blasting area that comes within 100 feet of any public road right-of-way, and at the point where any other road provides access to the blasting area; also, conspicuously place signs reading “*Blasting Area - Turn Off Two-Way Radios*” along the edge of any blasting area that comes within 500 feet of any public road right-of-way and 1000 feet on either end of the blasting area; and
 - B. At all entrances to the permit area from public roads or highways, place conspicuous signs that state “*Warning! Explosives In Use*”, which clearly list and describe the meaning of the audible blast warning and all-clear signals that are in use, and which explain the marking of blasting areas and charged holes awaiting firing within the permit area.

Warnings and all clear signals of different character or pattern that are audible within a range of 1000 feet from the point of the blast shall be given. Each person within the permit area and each person who resides or regularly works within 1000 feet of the permit area shall be notified of the meaning of the signals.

Access within the blasting area shall be controlled to prevent presence of livestock or unauthorized persons during blasting and until an authorized representative of the contractor

has reasonably determined that no unusual hazards, such as imminent slides or un-detonated charges, exist; and access to and travel within the blasting area can be safely resumed.

6109 CONTROL OF ADVERSE EFFECTS. Blasting shall be conducted to prevent injury to persons; damage to public or private property outside the permit area, adverse impacts on any underground mine, and change in the course, channel, or availability of surface or ground water outside the permit area.

A. Air blast. Air blast shall not exceed the maximum limits listed on the next page at the location of any dwelling, public building, school, church, or community or institutional building outside the permit area, except as provided in this section.

Lower frequency limit of measuring system, in Hz (+3 dB)	Maximum level, in dB
0.1 Hz or lower--flat response ¹	134 peak.
2 Hz or lower--flat response	133 peak.
6 Hz or lower--flat response ¹	129 peak.
C-weighted--slow response	105 peak dBC.

¹ Only when approved by the Fire Marshall.

If necessary to prevent damage, the Fire Marshall or City Engineer can specify lower maximum allowable air blast levels than those of listed in this section for use in the vicinity of a specific blasting operation.

The contractor shall conduct periodic monitoring to ensure compliance with the air blast standards. The measuring systems shall have an upper-end flat frequency response of at least 200 Hz.

- B. Ground Vibration. The maximum ground vibration for protected structures listed in this section shall be established in accordance with either the maximum peak-particle-velocity limits, the scaled-distance equation, the blasting level chart, or by the Fire Marshall or City Engineer. All structures in the vicinity of the blasting area, such as water towers, pipelines and other utilities, tunnels, dams, impoundments, and underground mines, shall be protected from damage by establishment of a maximum allowable limit on the ground vibration, 1.0 inches per second, the Fire Marshall or City Engineer may specify a more restrictive limit in the interest of the public safety, or the Fire Marshall or City Engineer may approve a higher limit if justified by the contractor.

The maximum ground vibration shall not exceed the following limits at the location of any dwelling, public building, school, church, or community or institutional building outside the permit area.

	MAXIMUM ALLOWABLE	SCALED PEAK
Distance (D) from the blasting site in feet.	Particle velocity (Vmax) for ground vibration in inches/second ¹	Factor to be applied without seismic monitoring ²
0 to 300	1.00	50
301 to 5,000	1.00	55
5,001 and beyond	0.75	6

¹ Ground vibration shall be measured as the particle velocity. Particle velocity shall be recorded in three mutually perpendicular directions. The maximum allowable peak particle velocity shall apply to each of the three measurements.

² Applicable to the scaled-distance equation.

A seismographic record shall be provided for each blast.

A contractor may use the scaled-distance equation, $W=(D/D_s)$, to determine the allowable charge weight of explosives to be detonated in any 8-millisecond period, without seismic monitoring; where W=the maximum weight of explosives, in pounds; D=the distance, in feet, from the blasting site to the nearest protected structure; and D_s=the scaled-distance factor, which may initially be approved by the City Engineer using the values for scaled-distance factor listed.

The contractor may use the ground-vibration limits in [Figure 1](#) this section to determine the maximum allowable ground vibration.

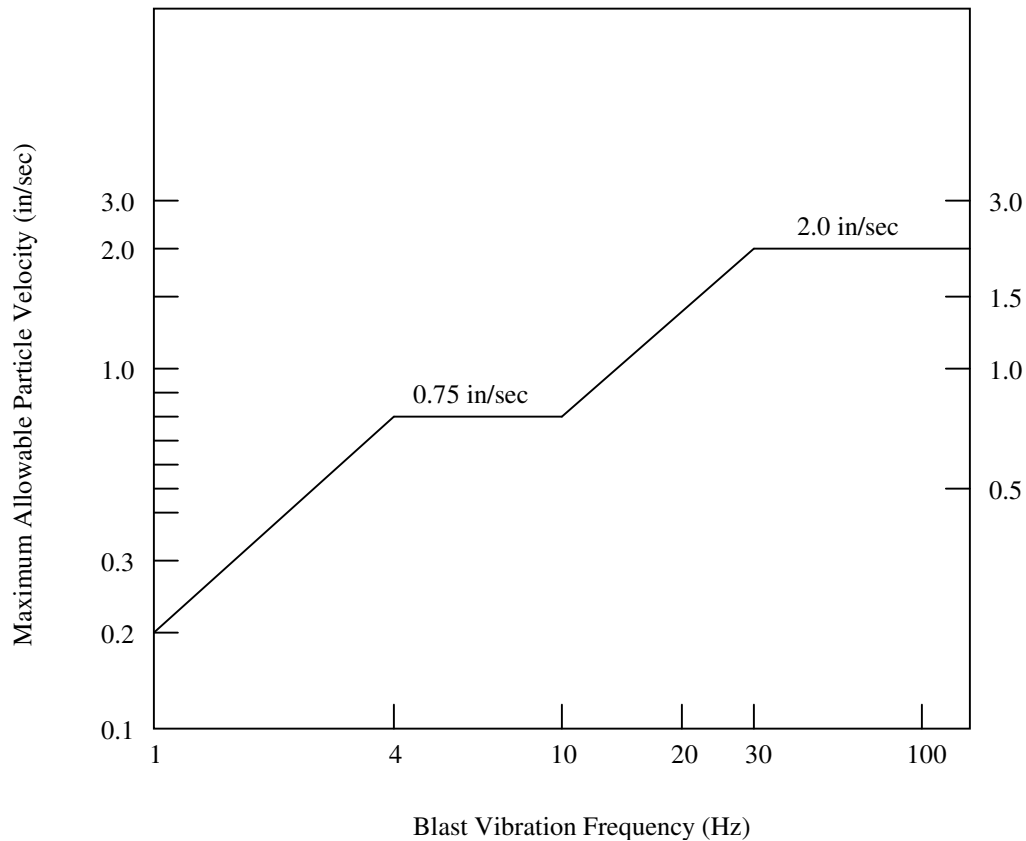


Figure1

Figure 1 – Alternate blasting level criteria
(Source – Modified from figure B-1. Bureau of Mines R18507)

If the Figure 1 limits are used, a seismographic record including both particle velocity and vibration-frequency levels shall be provided for each blast. The Fire Marshall and City Engineer shall approve the method for the analysis of the predominant frequency contained in the blasting records before application of this alternative-blasting criterion.

The Fire Marshall and City Engineer can reduce the maximum allowable ground vibration beyond the limits otherwise provided by this section, if determined necessary to provide damage protection.

The contractor shall conduct seismic monitoring of all blasts.

6110 RECORDS OF BLASTING OPERATIONS. The contractor shall retain a record of all blasts for at least three (3) years. Upon request, copies of these records shall be made available to the Engineer and to the public for inspection. Such records shall contain the following data:

- A. Name of the contractor conducting the blast.
- B. Location, date, and time of the blast.
- C. Name, signature, and certification number of the blaster conducting the blast.
- D. Identification, direction, and distance, in feet, from the nearest blast hole to the nearest dwelling, public building, school, church, community or institutional building outside the permit area, except those described herein.
- E. Whether conditions, including those which may cause possible adverse blasting effects.
- F. Type of material blasted.
- G. Sketches of the blast pattern including number of holes, burden, spacing, decks, and delay pattern.
- H. Diameter and depth of holes.
- I. Types of explosives used.
- J. Total weight of explosives used per hole.
- K. The maximum weight of explosives detonated in an 8-millisecond period.
- L. Initiation system.
- M. Type and length of stemming.
- N. Mats or other protections used.
- O. Seismographic and airblast records, shall include:
 - 1. Type of instrument, sensitivity, and calibration signal or certification of annual calibration;
 - 2. Exact location of instrument and the date, time and distance from the blast;
 - 3. Name of the person and firm taking the reading;
 - 4. Name of the person and firm analyzing the seismographic record; and
 - 5. The vibration and/or airblast level recorded.

6111 BLASTER. The blaster shall be trained and be knowledgeable in the applications of all section.

The blaster shall be responsible for:

- A. Explosives, including
 - 1. Selection of the type of explosive to be used;
 - 2. Determination of the properties of explosives which will produce desired results at an acceptable level of risk; and
 - 3. Handling, transportation, and storage;
- B. Blast designs, including
 - 1. Geologic and topographic considerations;
 - 2. Design of a blast hole, with critical dimensions;
 - 3. Pattern design, field layout, and timing of blast holes; and

- 4. Field applications;
- C. Loading blast holes, including priming and boosting;
- D. Initiation systems and blasting machines;
- E. Blasting vibrations, air blast, and flyrock, including
 - 1. Monitoring techniques, and
 - 2. Methods to control adverse effects;
- F. Secondary blasting applications;
- G. Current federal and state rules applicable to the use of explosives;
- H. Blast records;
- I. Schedules;
- J. Preblasting surveys, including
 - 1. Availability
 - 2. Coverage, and
 - 3. Use of in blast design;
- K. Blast-plan requirements
- L. Certification and training;
- M. Signs, warning signals, and site control
- N. Unpredictable hazards, including
 - 1. Lightning,
 - 2. Stray currents,
 - 3. Radio waves, and
 - 4. Misfires

The appropriate licensing authority shall license the blaster. The blaster shall be responsible for obtaining all necessary permits required for blasting operations.

SECTION 6200 - TUNNELING, BORING AND JACKING (PIPELINES)

6201 SCOPE. This section governs construction of steel casings, complete with bulkheads and sand fill, by boring and/or jacking at the locations and to the lines and grades indicated on the drawings directed by the City Engineer, or where constructed at the contractor's option, when approved, to bypass obstructions without open cutting.

6202 MATERIALS.

- A. Steel Liner Plate. Steel tunnel liner plates shall be Armco "Standard", Commercial Shearing and Stamping Company "Commercial", Republic "Truscon Paneled Out", or equal and shall be galvanized in accordance with ASTM A 123. The design and shape of the liner plates shall be such that assembly can take place entirely from within the tunnel liner. Sufficient sections shall be provided with one and one-half (1 1/2) inch or larger grouting holes, located near the centers, so that when the plates are installed there will be one line of holes on either side of the tunnel and one at the crown. The holes in each line shall not be more than nine (9) feet apart and, unless otherwise approved, shall be staggered. Bolts and nuts shall conform to ASTM A 153, A 307, A 325 and A 449 as applicable.
- B. Steel Casing.
1. Steel casing for bored or jacked construction shall conform to ASTM A-139.
 2. Steel shall be grade B under railroads and grade A for all other uses.
 3. Minimum wall thickness for steel casing shall be in accordance with the following table:
- | <u>Diameter of Casing</u> | <u>Under Railroads</u> | <u>All Other Uses</u> |
|---------------------------|------------------------|-----------------------|
| 24" | 0.406" | 0.281" |
| 26" | 0.438" | 0.281" |
| 28" | 0.469" | 0.312" |
| 30" | 0.469" | 0.312" |
| 32" | 0.500" | 0.312" |
| 34" | 0.500" | 0.312" |
| 36" | 0.500" | 0.312" |
4. Casing joints shall be welded by a certified welder in accordance with AWWA C-206.
- C. End Seals. End seals shall be concrete conforming to Section 3102 of these specifications. Mortar shall comply with Section 3102 of these specifications.
- D. Sand Fill. Sand fill shall comply with ASTM C-33 or MCIB Section 4, Fine Aggregate. Moisture content of the sand shall not exceed. 0.5%.

6203 CONSTRUCTION DETAILS.

A. General.

1. Prior to starting work, complete details of the method of operation and liner materials to be used shall be submitted to the City Engineer. The pipeline, in the area to be tunneled, bored or jacked, shall be completed before the construction of adjacent portions of the same pipeline. The purpose of this requirement is to allow for slight discrepancies in alignment and grade, which may occur, in the tunneled, bored or jacked installation, so minor adjustments in the adjacent pipe can be made.
2. The maximum allowable deviation from plan alignment and grade shall be as follows except when altered by the Plans or Special Provisions:
 - a. Alignment 1.0%
 - b. Grade 1.0%

B. Casing Installation.

1. The steel casing shall be advanced in a continuous operation without interruption. Sections of the casing pipe shall be welded together to form a continuous conduit capable of resisting all stresses, including jacking stresses. The casing in its final position shall be within alignment and grade tolerances specified in Section 6203 (A2). There shall be no space between the earth and the outside of the casing. Pressure grouting shall fill any voids, which do occur.
2. Boring operations shall be performed by experienced crews using a rotary type boring machine designed especially for this purpose. Boring shall be performed in a manner to prevent disturbing the overlying and adjacent materials.
3. Jacking.
 - a. Jacking frame, guides, blocking, head and reaction devices shall be arranged to apply uniform pressure about the casing circumference without damage to the casing material, and to maintain alignment within specified tolerances.
 - b. Jacking reaction device shall provide adequate resistance to withstand 200 percent of the maximum jacking pressure.
 - c. Provide jacks of adequate number and size for the required jacking pressure; but not less than two jacks.
 - d. Maintain jacking pit and pipe installation in such condition that drainage does not accumulate. Control and disposition of surface and subsurface water at the site of jacking operations shall be the Contractor's responsibility subject to the approval of the City Engineer.
 - e. Excavation of the heading shall not be extended more than 1 inch outside the top and sides (upper 300-degree sector) of the casing and shall be true to grade at the invert (lower 60-degree sector).

- f. Once jacking begins, it shall proceed without interruption until installation of the entire length of the jacked line is complete.
4. Excavation in Jacked Casings. Perform excavation within jacked casings by hand or machine methods as necessary to remove the materials encountered without disturbing the overlying material. The jacked casing shall be advanced a sufficient distance ahead of the excavation face and/or shield used as necessary to protect the workman and the work, and to prevent the uncontrolled entry of unstable materials into the casing.
5. Unstable Materials. If materials are encountered during casing installation that cannot be excavated safely or without creating voids around the exterior of the casing, the Contractor shall discontinue casing installation and stabilize such materials by dewatering, chemical soil stabilization, grouting, or other methods, and/or modify equipment and procedures as necessary to complete the casing installation.

C. Lining Installation.

1. Excavation. Excavate by approved methods applicable to materials encountered. Experienced crews using a rotary type boring machine designed especially for this purpose shall perform the boring operations. Include dewatering and chemical soil stabilization or grouting when necessary due to existing field conditions. Conduct excavation in a manner to prevent disturbing the overlaying and adjacent material.
2. Lining. Assemble liner plates immediately following the excavation. Advance casing continuously with excavation. When liner plates are being installed, care shall be taken to maintain alignment, grade and circular shape of the tunnel. All voids between liner and surrounding earth shall be filled with grout forced in under pressure. The grout shall consist of two parts of sand to one part of Portland Cement, mixed with sufficient water to maintain a freely pouring consistency. As the pumping through any hole is stopped, it shall be plugged to prevent the backflow of grout. After lining installation is complete it shall be cleaned of all debris and all leaks which allow flowing or seeping water into tunnel, shall be stopped.

D. Pipe Installation.

1. Pipe shall be placed inside the casing to the plan line and grade by the use of projection type spacers. Projection type spacers shall be RACI Type F60 or approved equal. The casing spacers shall be installed according to the manufacturers guidelines and recommendations. Wooden skids are not acceptable.
2. End seals shall be constructed after the pipe is installed and approved.
3. In sanitary sewer construction, the annular space between the casing and pipe shall be filled with stabilized sand blown in so that all space is filled without disturbing the alignment and grade of the pipe.
4. No interruption of traffic will be permitted at any location where a tunnel or casing is required.

SECTION 7100 - CHAIN LINK FENCING

- 7101 SCOPE. This specification covers chain link fencing and gates.
- 7102 FENCE TYPE. Fencing shall conform to the alignment and details shown on the drawings and shall consist of galvanized or aluminum-coated steel fabric, steel posts, top rail, and bottom rail or tension wire. Posts shall be set in concrete.
- 7103 MATERIALS. All steel or malleable iron parts and accessories shall be hot-dip galvanized or aluminum coated after fabrication.

Fabric	9 gauge, 2-inch mesh; galvanized ASTM A392, Class II or aluminum-coated ASTM A491, Class II.
Posts	Steel H-Section, 0.35 percent carbon; steel pipe, ASTM A120, standard weight (Schedule 40); or steel hollow structural tubing, ASTM A500 or A501.
Line Posts	
For 6-foot Fencing	H-Section 4.10 pounds per foot; 2 3/8 inch OD pipe, 3.65 pounds per foot; or 2 inch square, 3.85 pounds per foot.
For 42-inch Fencing	H-Section, 2.70 pounds per foot; or 1 7/8 inch OD pipe, 2.72 pounds per foot.
Terminal Posts	End, corner, and pull posts.
For 6-foot Fencing	2 7/8 inch OD pipe, 5.79 pounds per foot; or 2 1/2 inch square, 5.59 pounds per foot.
For 42-inch Fencing	2 3/8 inch OD pipe, 3.65 pounds per foot; or 2 inch square, 3.85 pounds per foot.
Gate Posts	Gate or leaf 6 foot or less, 2 7/8 inch OD pipe, 5.79 pounds per foot; or 2 1/2 inch square, 5.59 pounds per foot; gate or leaf over 6 foot, 4 inch OD pipe, 9.10 pounds per foot; or 3 inch square, 9.10 pounds per foot.
Top Rail	1 5/8 inch OD steel tubing, 1.40 pounds per foot.
Rail Couplings	Sleeve type, 6 inches long.
Post Tops (when barbed wires are required at the top of the fence)	Pressed steel, malleable iron, with pressed steel extension arm, or hole for top rail, designed to prevent entry of moisture into tubular posts.
Posts Tops	Pressed steel, malleable iron, or cast aluminum; designed to prevent entry of moisture into tubular posts.
Barbed Wire	NOT ALLOWED
Stretcher Bars	Steel, 3/16 inch by 3/4 inch, or equivalent area.
Fabric Ties	Aluminum bands or wires.
Gate Frames	Steel tubing, 1 7/8 inch OD, 2.09 pounds per foot; or 2 inch square, 2.10 pounds per foot.
Tension Wire	Galvanized or aluminum coated coil spring wire, 7 gauge.
Handrail-Setting Cement	Hallemite "Por-Rok Cement".

- 7104 GATES. Gates shall be swing type, hinged to swing 90° from closed to open, complete with frames, latches, stops, keepers, hinges, and fabric. Gate leaves shall have intermediate members and diagonal truss rods as required for rigid construction. Joints between frame members shall be made by welding or by means of heavy fittings, and shall be rigid and water tight. Gate fabric

shall be same as fence fabric and shall be attached to frame ends by stretcher bars, bolt hooks, or other mechanical means.

Hinges shall be heavy pattern with large bearing surfaces and shall not twist or turn under the action of the gate. Latches shall be plunger bar type, full gate height, and arranged to engage the gate stop, except single gates less than ten feet (10') wide may be provided with a forked latch. Latches shall be arranged for padlocking with the padlock accessible from both sides of the gate. Stops shall consist of a roadway plate with anchor set in concrete and arranged to engage the plunger. Keepers shall consist of mechanical devices for securing and supporting the free end of gates when in the full-open position.

Gates shall be installed so that they cannot be removed without disassembly of the hardware. Hardware attachment bolts shall be peened so that removal will be difficult.

7105 FENCE CONSTRUCTION. The installed fence shall conform to the alignment and finish grade indicated. All posts shall be plumb and unless otherwise shown or required shall be spaced ten feet (10') apart for 6-foot fencing and six feet (6') apart for 42-inch fencing. Where necessary, the fence grade shall be adjusted to fit the ground contour by slipping the fence fabric links. Ground surface irregularities shall be graded as required to maintain not more than a two-inch (2") clearance below the bottom of the fence fabric.

Where posts are set in earth, concrete foundations thirty-six inches (36") deep shall be provided. If bedrock is encountered, post excavation shall be continued to the thirty-six inch (36") depth or eighteen inches (18") into the rock, whichever is less. Concrete foundations shall be circular in horizontal section, not less than ten inches (10") in diameter for line posts, and with a diameter not less than the post OD plus nine inches (9") for terminal and gate posts, except that foundations in bedrock shall be a minimum of six inches (6") larger than the outside dimension of the post. Foundations shall extend above the ground surface and shall be crowned approximately one inch (1"). Concrete for foundations shall conform to the requirements of Section 2000 "*Concrete*". Each foundation shall be cured for at least seventy-two (72) hours before further work is done on the post.

Top rails and bottom tension wires shall be installed before the fabric. Top rails shall be furnished in at least eighteen-foot (18') lengths and shall be securely connected to gate and terminal posts. Tension wires shall be installed approximately six inches (6") above grade and shall be attached to each post and securely anchored at terminal and gateposts. Straight runs between braced posts shall not exceed 1500 feet. A terminal post shall be provided at each change in slope.

Fabric shall be attached to the top rail, bottom rail, and bottom tension wire at twenty-four inch (24") centers and to the line posts at fifteen-inch (15") centers. Barbed wire shall be fastened to each extension arm by internal clips or external fabric ties. Each stretcher bar shall be threaded through the fabric and anchored to the post at fifteen-inch (15") center by positive mechanical means.

Horizontal pipe brace and an adjustable truss extending to an adjacent line post shall brace each gate and terminal post. Corner posts shall be braced in both directions.

Fabrics shall be stretched taut and anchored so that a pull of 150 pounds at the middle of a panel will not lift the bottom of the fabric more than six inches (6").

SECTION 7200 - SEEDING AND SODDING

- 7201 SCOPE. This section covers the furnishings of all labor, equipment, tools and materials, and the performance of all work for seeding or sodding as designated on the contract drawings.

Sodding unless otherwise approved by the City Engineer shall restore all areas of established yards.

- 7202 GENERAL. The seeding work shall consist of furnishing and drilling in or sowing seed by an experienced seeding contractor having approved equipment manufactured expressly for the purpose, such as a seed drill with fertilizer attachment, mulch chopper and blower for the application of hay or straw mulch, mulch puncher or straight serrated disc for punching mulch into soil and a cultipacker that may be used for final compaction.

For public improvement projects seeding shall be required at all locations shown on the plans and for all grass covered areas that are disturbed by construction operations, either by grading, parking of equipment, temporary roads, or any other operation that has destroyed the existing grasses of the original site, and that is not designated on the drawings to be replaced with sod.

For all other types of construction, including that work done under a work within right-of-way permit, seed shall be required where areas are disturbed by construction within the right-of-way in established yards or as directed by the City Engineer.

An experienced sod-laying contractor shall perform sod work.

- 7203 MATERIAL. The sod shall be densely-rooted Kentucky Bluegrass. The sod shall contain a growth of not more than 10 percent (10%) of other grasses and clovers, shall be free from all prohibited and noxious weeds, and shall be three-fourths (3/4") to one and one-fourth inch (1-1/4"); each strip containing at least one (1) square yard. Sod shall be cut in strips not less than twelve inches (12") wide.

Commercial fertilizer for seeded or sodded areas shall contain 12 percent (12% by weight) nitrogen, 12 percent (12% by weight) phosphoric acid, and 12 percent (12% by weight) potash. It shall be uniform in composition, free flowing, and delivered to the site in standard size bags, showing weight, analysis, and name of manufacturer. It shall be stored until use in a weatherproof storage place in such a manner that it will be kept dry and its effectiveness will not be impaired.

Seeds for cover crops shall be the kind and mixture of seeds specified herein. Seeds shall be free of prohibited weed seeds and shall not have more than 1 percent (1%) of noxious weed seeds. Seeds shall be delivered to the site in convenient containers, each fully labeled, bearing the name, or trademark and a warranty of the producer and a certificate of the percentage of the purity and germination of each kind of seed specified. The tags shall be made available to the Engineer for filing.

The following formula shall be used to determine the amount of commercial seed required to provide for each kind of seed the specified quantities of pure live seeds.

$$\text{Pounds of Commercial Seed Required} = \frac{10,000 \times \text{Rate of Pure Live Seeds (lbs/acre)}}{\text{Purity \%} \times \text{Germination \%}}$$

Where seeding is required in areas of established yards, shoulders and slopes in street right-of-way, and any other areas where a high-quality seeding is deemed necessary, the seed mixture will be as follows:

KIND OF SEED	MINIMUM PURE LIVE SEED (%)	RATE OF PURE LIVE SEED POUNDS/ACRE
Perennial Rye (Derby or equivalent)	80%	65
Turf-type Tall Fescue (Rebel II or equivalent)	80%	175
Annual Rye	85%	10
		Total 250 lbs/Acre

Where seeding is required in vegetation-covered medians, the seed mixture will be as follows:

KIND OF SEED	MINIMUM PURE LIVE SEED (%)	RATE OF PURE LIVE SEED POUNDS/ACRE
Buffalograss	85%	90
Annual Rye	85%	110
		Total 200 lbs/Acre

Where seeding is required in areas off street right-of-way that are not maintained periodically, the seed mixture will be as follows:

KIND OF SEED	MINIMUM PURE LIVE SEED (%)	RATE OF PURE LIVE SEED POUNDS/ACRE
Alta Fescue or Kentucky 31 Fescue (Festuca Elatior) Var. Arundinaces)	75%	90 lbs.
Rye Grass (Lolium Perenne or L. Multiflorum)	80	50
		Total 140 lbs./Acre

Mulch for application to seedbed areas shall include wheat straw, oat straw, smooth brome grass hay, Sudan grass hay or prairie hay. Prairie hay shall consist chiefly of bluestem grasses, switchgrass, Indian grass and other desirable native perennial grasses. Mulch shall be free of prohibited and noxious weed seeds.

7204 TIME OF SEEDING OR SODDING. Seeding and fertilizing shall be performed between February 1 and April 30 for spring planting and between August 15 and October 15 for fall planting, unless otherwise acceptable to the Engineer. Seeding and fertilizing shall not be done during periods of such severe drought, high winds, or excessive moisture, as determined by the Engineer, that satisfactory results are not likely to be obtained.

Sod shall not be placed during a drought, during the period June 1 to September 1, on frozen ground, nor during the period October 15 to March 15, unless authorized by the Engineer.

Any seeding or sodding to be performed during periods other than those previously designated will require a written request to extend the permissible period for performing such work. Said request shall explain the reason for the variance and shall include a guarantee (by the general contractor) of satisfactory results by the end of the first four (4) weeks of the following growing season as previously defined, or the necessary re-seeding or re-sodding work performed at that time. The request shall be initiated by the general contractor and directed to the City Engineer for consideration for approval.

7205 APPLICATION OF FERTILIZER. Before tilling of the soil for seeded areas, the commercial fertilizer of the type specified shall be uniformly distributed over the entire site at the rate of six hundred (600) pounds per acre, and incorporated into the soil to a depth of at least two inches (2") by discing or harrowing methods or with a fertilizer drill. The fertilizer may be applied with the seeding operation only if a seed drill with a fertilizer attachment is used. (The above fertilizer rate is equivalent to seven [7] pounds to five hundred [500] square feet).

7206 PREPARATION OF SOD BED. The sod bed shall have a uniform surface free from washes and depressions and shall conform to the finished grade profile or cross section shown on the plans. The soil, except where fresh topsoil has just been applied and compacted, shall be thoroughly tilled to a depth of two inches (2"). Freshly graded areas, which have set long enough to become dry and crusted over, shall be tilled as specified above, preparatory to placing the sod. The contractor must have the prepared sod-bed inspected and approved by the City prior to any sod being placed. Any sod placed prior to the sod-bed being inspected and approved by the City is subject to being removed, the deficiencies corrected, and the sod replaced at the contractors expense.

Sod placed next to existing grassy areas, curbs, sidewalks or like boundaries shall be cut-in to match like grades.

7207 PLACEMENT OF SOD. Sod shall be transplanted within twenty-four (24) hours from the time it is harvested. All sod in stacks shall be kept moist and protected from exposure to the sun and from freezing.

The fertilized sod beds shall be in a firm but not too compacted condition with relatively fine texture at the time of sodding. Sod shall be moist when it is placed. The use of dry sod will not be permitted. Sod strips shall be laid along contour lines by hand, commencing at the lowest point of the area and working upward. The transverse joints of sod strips shall be staggered and the sod carefully placed to reduce tight joints. The sod shall be firmed, watered, and re-firmed immediately after it is placed. The "firming" shall be accomplished by application of a roller weighing not less than sixty (60) nor more than ninety (90) pounds per linear foot of roller. On steep slopes, compacting with hand shovels may firm the sod. The firming process shall pack the sod roots firmly into the prepared soil.

The contractor shall water installed sod within twenty-four hours and shall water all sod twice daily for a minimum of thirty (30) days from initial laying, except on those days where a minimum of 1/4 inch (1/4") of rain falls in a twenty-four hour period.

7208 PREPARATION OF THE SEEDBED. The area to be seeded shall be thoroughly tilled to a depth of at least three inches (3") by disking, harrowing or other approved methods until the soil is well pulverized. After completion of the tilling operation, the surface shall be cleared of all stones, stumps, or other objects larger than one and a half inches (1-1/2") in thickness or diameter, and of roots, wire, grade stakes, and other objects that might be a hindrance to maintenance operations. Areas tilled shall then be brought to the desired line and grade and maintained until seeding and mulching is complete to ensure a smooth area with no gullies or depressions.

Any objectionable undulations or irregularities in the surface resulting from tillage or other operations shall be removed before planting operations are begun. Seedbed preparation shall be performed only during periods when satisfactory results are likely to be obtained. When results are not satisfactory because of drought, excessive moisture or other causes, the work shall be stopped until such conditions have been corrected to the satisfaction of the Engineer.

7209 PLACEMENT OF SEED. Seeding may be accomplished by means of approved mechanical power-drawn drills followed by packer wheels, or by broadcast-type seeders or hydraulic type seeders in small areas not accessible to machine methods, or as approved by the City Engineer. Mechanical power-drawn drills shall have depth bands set to maintain a planting depth of at least one-quarter inch (1/4") but not to exceed one-half inch (1/2"). All seed sown by broadcast-type seeders shall be "raked in" or otherwise covered with soil to a depth of at least one-quarter inch and rolled to obtain a firm seed bed. Water shall be applied when necessary.

Hydraulic seeding equipment shall include a pump capable of being operated at 100 gallons per minute and at 100 pounds per square inch pressure, unless otherwise directed. The equipment shall have an acceptable gauge and a nozzle adaptable to hydraulic seeding requirements. Storage tanks shall have a means of agitation and a means of estimation of the volume used, or remaining in the tank.

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 4 inches (4") apart.

7210 MULCHING. Straw or hay mulch shall be applied uniformly to seeded areas at the rate of not less than two (2) tons per acre. Baled straw or hay shall be broken up and loosened sufficiently before being fed into the blower hopper to avoid the placing of matted or unbroken clumps. The use of wet straw or hay is prohibited.

Mulching shall be performed within twenty-four (24) hours after seeding, but not be done during windy or rainy weather or when such weather is imminent. Mulching shall be started at the windward side of relatively flat areas, or at the upper part of steep slopes and shall continue uniformly until each area is covered.

The mulching material shall be disced or punched into the soil so that it is partially covered. Several passes may be required, if a straight disc is used, in order to mix the mulching material with the topsoil sufficiently to ensure protection from erosion by either wind or water. The mulch tilling operation shall be performed parallel to the ground contours.

- 7211 MAINTENANCE. All seeded areas shall be protected against damage by vehicle and pedestrian traffic by the use of barriers and appropriate warning signs. If at any time before completion and acceptance of the seeding work any portion of the seeded area becomes gullied or otherwise damaged, filling shall repair such damaged areas with soil to original grade, re-seeding and re-mulching. All costs of repair work shall be borne by the contractor.

Contractor shall be responsible for watering areas seeded for a period of five (5) weeks after the time of seeding, except when thoroughly wetted by rain. Sprinkling of the seeded areas shall be carefully done in such manner as to avoid standing water, surface wash, or scour.

All sodded areas shall be thoroughly watered twice daily for a period of thirty days (30) after placing, except when thoroughly wetted by rain of 1/4-inch (1/4") or more in a 24-hour period.

- 7212 GUARANTEE. The contractor will be required to guarantee all sod installed on this project for thirty (30) days from the date of installation. After the thirty-day period, the City will inspect all sod. Any sod that is dead at the end of the thirty-day period shall be replaced by the contractor at their expense and is subject to an additional thirty-day warranty period. All healthy sod at the end of the thirty-day period will be accepted by the City and turned over to the property owner for maintenance. The contractor is not required to guarantee any healthy sod accepted by the City after the thirty-day period.

SECTION 7300 - EROSION CONTROL

7301 SCOPE. This section covers all labor and materials for the construction of erosion control measures. It includes the installation of erosion control devices that result in the reduction of soils leaving the construction site. Measures shall address but are not limited to inlet protection, stream protection, adjacent property protection, and public right-of-way protection.

7302 GENERAL. Erosion control measures will be required on all construction plans submitted to the City of Raytown Public Works Department. All projects which disturb an accumulative area of more than one acre will be temporarily seeded and mulched to the requirements of section “7200 Seeding and Sodding” immediately after street construction is complete. No other work will be allowed to begin until the seeding and mulching is complete unless approved by the City Engineer.

Erosion control measures will be required to be installed prior to any grading or construction activities. Erosion control methods include, but are not limited to, the following techniques: settling basins, sediment traps, rock entrance construction and perimeter controls.

During construction, the City Engineer or their representative may require or the applicant may request, that the construction of the erosion control facilities and associated designs be modified. Modifications to the erosion control plan shall be submitted to City Engineer prior to any construction activities if physical conditions are discovered on the site inconsistent with the assumptions upon which the approval was based, including, but not limited to, unexpected soil conditions, runoff patterns, general weather generated problems, or changes in the design of the improved areas.

7303 MATERIALS. Materials shall consist of silt fence as shown in detail 73-1, Straw bales as shown in detail 73-2, Inlet protection as shown in detail 73-3, Rock construction entrance as shown on detail 73-4, OR any combination of methods as approved by the city engineer or his representative.

Temporary seeding will be a combination of annual and perennial Rye. Total seeding rate will be 200 lbs/Acre and shall consist of 130 lbs/Acre of annual Rye and 70 lbs/Acre of perennial Rye. All seeding shall meet the requirements set forth in section 7200 “SEEDING AND SODDING”.

7304 MAINTENANCE. On any property where grading or other work has been permitted, it shall be up to the permittee or owner to maintain and repair erosion control facilities. Whenever the City Engineer or his representative find that any existing grading, drainage, or ground condition is defective or deficient under the requirements of this division, all work shall cease until measures have been taken to meet the conditions of this division.

SECTION 8000 - MATERIALS TESTING

- 8001 SCOPE. This section shall apply to all required testing services for soils, asphalt and concrete.
- 8002 GENERAL. A testing laboratory qualified and approved by the City to perform the required sampling, analysis, testing and report writing services shall conduct all materials testing. Reports shall be prepared by or under the supervision of and bear the seal and signature of a professional engineer. Improperly completed or certified reports will not be accepted.
- 8003 RESPONSIBILITIES OF THE CONTRACTOR OR DEVELOPER. The contractor or developer shall provide all the required tests as herein specified at his expense. The contractor shall allow the testing agency access to the job site as may be required and shall furnish any labor as may be required by the testing agency to obtain and handle samples at the source of the material and at the site of the work. Adequate facilities shall be provided at the project site for the safe storage and proper curing of specimens requiring such facilities. The use of a testing agency's service does not relieve the contractor of the responsibility to furnish the required materials and to perform the required construction in full compliance with the City of Raytown technical specifications. The successful passing of a test does not constitute acceptance of the work or materials represented by the test or any portion of the work or materials. Final acceptance of the project shall be granted only through the issuance of a Project Completion Certificate by the City of Raytown and the expiration of the two (2) year maintenance period as established in these specifications.
- 8004 RESPONSIBILITIES OF THE TESTING AGENCY. All testing agencies shall meet the requirements of ASTM E329. A representative shall inspect, sample and test the materials and work as required by the City Engineer. Any material furnished or work performed by the contractor failing to conform to the specification requirements shall be immediately brought to the attention of the City Engineer and the contractor. Preliminary written field reports of all tests and inspection results shall be given to the contractor immediately after they are performed. A copy of all reports shall be forwarded to the City Engineer, as they are made available. Results of all tests taken, including failing tests, shall be reported. The testing agency and its representative are not authorized to revoke, alter, relax, enlarge or release any requirement of the specifications, nor to approve or accept any portion of the work.
- 8005 ASPHALT TESTING. Sampling and testing of the asphalt mix shall be required on all asphalt paving projects constructed in the City of Raytown.
- A qualified testing laboratory technician at either the construction site or the batching plant per ASTM Standards D979 and D3665 shall acquire samples of the actual asphalt mix being used on a paving project. These samples shall be used to perform an aggregate gradation test (ASTM C136), asphalt extraction test (ASTM D2172), stability and flow test (ASTM D1559) and bulk specific gravity test (ASTM D2726). One complete group of tests shall be conducted on both the base material and the surface material for each paving project.
- In-place density tests shall be conducted with a nuclear testing device during the course of the work supplied by a qualified testing laboratory. Density tests shall be performed by a qualified laboratory technician to verify that the performance specifications in Section 1309 "*Density and Surface Requirements*" of this specifications manual have been achieved. The inspector based upon his observation of the paving process shall determine the number of tests to be taken and the locations thereof. A minimum of two (2) tests per 1500 feet of street improvement shall be taken unless otherwise directed by the City Engineer. Tests performed with a nuclear device shall be conducted as per the requirements of ASTM D2950.
- 8006 CONCRETE TESTING. Sampling and testing, by a qualified testing laboratory, shall be required on all concrete work including curb and gutter, sidewalk, slope paving, retaining walls, inlets, manholes or any other structures.

During the progress of the work, compression tests of the concrete used shall be made as directed by the engineer in accordance with the requirements of ASTM C31, C143, and C172. At least one sample, consisting of four (4) cylinders minimum, shall be taken from each 100 cubic yards of concrete placed or fraction thereof. In the case of a reinforced concrete box, a minimum of one sample shall be taken for each day's pour. The cylinders shall be cast in the field and transported to the laboratory 24 hours after the concrete was placed. Each set of compression test cylinders shall be marked or tagged with the date and time of day the cylinders were made, the location in the work where the concrete represented by the cylinders taken was placed, the delivery truck or batch number, the air content, and the slump. From each sample consisting of four cylinders, one (1) shall be broken at seven (7) days, one (1) at fourteen (14) days and two (2) at twenty-eight (28) days noting the compressive strength of each break.

Slump tests (ASTM C143) and air tests (ASTM C231) shall be made for each 25 cubic yards of concrete placed or fraction thereof. A minimum of two (2) slump and air tests shall be taken per day. Slump and air tests shall be taken with each cylinder series.

If samples of fresh concrete have not been obtained and tested, a minimum of three (3) cores shall be taken per ASTM C42 and broken as directed by the engineer. Air content (ASTM D457) and cement content (ASTM C85) 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 95% of the specified strength (f'_c) and if the strength of any single core is not less than 80% of f'_c . All core holes shall be completely filled with a low-slump, high strength concrete at the expense of the contractor.

All reports by testing laboratories shall include the type of structure and information on obtaining, transporting, storing, curing, time between obtaining and casting cylinders (when applicable), supplier, finisher and batch as well as the specific test data.

- 8007 SOIL TESTING. Sampling and testing, by a qualified testing laboratory, shall be required on all subgrade preparation for street construction and all trench backfilling operations within the City of Raytown.

Prior to the contractor commencing subgrade compaction for any street improvement project, the City Engineer shall designate the locations and depths at which a qualified technician shall acquire samples of soil for performing a moisture density test (ASTM D698 for cohesive soils and ASTM D2049 for non-cohesive soils). A minimum of two (2) density tests shall be performed for every 1000 feet of street construction.

Reports for moisture-density tests shall include the date, the location of the tests, the elevation or depth at which the test was taken, the maximum dry density, and the optimum moisture content as well as properly constructed moisture-density curves for each sample. Also included shall be a determination of the soils plastic index (PI) and liquid limit and classification in accordance with ASTM D2487.

During the progress of the subgrade preparation, in-place density tests shall be performed with a nuclear density tester by a qualified technician approved by the City of Raytown. The inspector based upon his observation of the subgrade preparation shall determine the number of tests to be taken and the location thereof. A minimum of two (2) tests per lift per 1500 feet of street improvement shall be taken unless otherwise directed by the City Engineer. Results of these tests shall indicate whether or not the performance specifications stated in Section 1205 "*Compaction Requirements*" of this specification manual have been achieved. If the tests indicate the compaction is not sufficient, the contractor shall increase the compactive effort on all such inadequately compacted areas. Tests performed with a nuclear device shall be conducted as per the requirements of ASTM D2922.

During the progress of the work of trench backfilling, in-place density tests shall be performed with a nuclear density tester by a qualified laboratory technician. The inspector based upon his

observation of the backfilling process shall determine the number of tests to be taken and the locations thereof. A minimum of two (2) tests per 1000 feet of trench shall be taken unless otherwise directed by the City Engineer. Results of these tests shall indicate whether or not the performance specifications stated in Section 6017 "*Trench Backfill*" of this specification manual have been achieved. If the tests indicate the compaction is not sufficient, the contractor shall increase the compactive effort on all such inadequately compacted areas.