SPECIFICATION
FOR
STREET PROJECTS

ITEM 601
GENERAL

Standards established by the City of League City for the design and construction of its streets shall provide for pavements with long service life and low maintenance. Excess maintenance of inadequate pavements is an unnecessary drain on tax dollars. An investment in adequately designed and constructed streets needing little maintenance over a long service life frees more dollars for capital improvements necessary to serve the community.

Pavements are designed for both economy and long service. The EOR shall take into consideration the street classification and traffic which will include the axle weights and volumes, thickness design, surface material quality, base material quality, sub-grade material quality, geometric design, and jointing.

Standards of this publication shall be considered minimum for any specific location and the EOR should base his design upon the actual conditions which exist within the development under consideration for design.

Provisions must be made for the un-interrupted extension of main thoroughfares as shown on the major street plan for the City. Streets must provide for free circulation within developments and interconnectivity to adjacent developments.

ITEM 602
GEOMETRIC DESIGN

A street is a public way for purposes of vehicular travel including public transit and refers to and includes the entire area within the right-of-way. The street also serves pedestrian and bicycle traffic and usually accommodates public utility facilities within the right-of-way. The improvement or development of streets shall be based on the street classification that is part of a comprehensive community development plan for League City. The design values shall be those for the ultimate planned development.

All streets shall be designed with a thorough understanding of the capabilities of the vehicle-driver system and a sound knowledge of traffic engineering principles.

For balance in street design, all geometric elements shall, as far as economically feasible, be determined to provide safe, continuous operation at a speed likely under the general conditions for that streets classification.

602.1 Residential Street. (SEE STREET AND ROAD MATRIX)

Residential streets primarily are land service streets in residential subdivisions. Traffic generally consists of vehicles serving the homes plus an occasional heavy truck. Traffic volumes range from less than 200 to 700 vehicles per day with 1% to 2% heavy commercial traffic. Trucks using these streets have a maximum tandem-axle load of 36 kips and 20 kips maximum single axle load.

602.1.1 Pavement Type.

Urban residential streets shall be provided with a standard curb, gutter and storm sewer design. These streets shall consist of a pavement composed of Portland Cement concrete constructed on a prepared sub-grade. The concrete pavement shall have a minimum thickness of six inches (6”) and constructed in accordance with ITEM 606 "Concrete Pavement". The prepared sub-grade shall have a minimum thickness of six inches (6") and constructed in accordance with ITEM 604, Sub-grade, Sub-base and Base courses".

602.1.2 Pavement Width.

On residential streets in areas where the primary function is to provide land service and foster a safe and pleasant environment, at least one unobstructed moving lane must be ensured even where parking occurs on both sides. The level of user inconvenience occasioned by the lack of two moving lanes is remarkably low in areas where single-family units prevail. Residential streets shall have a minimum pavement width of twenty-eight feet (28’). This back-of-curb to back-of-curb width provides for 8 feet parking lanes. Opposing conflicting traffic will yield until there is sufficient width to pass.

602.1.3 Right-of-Way Width.

The Right-of-way width shall be sufficient to accommodate the ultimate planned roadway including median (if used), sidewalks, utility strips in the border areas, and necessary drainage facilities. The minimum right-of-way width for residential streets shall be sixty feet (60'). Additional easements adjacent to the right-of-way may be required for multiple utility installations.

602.1.4 Cul-de-Sacs and Turnarounds.

A residential street that is designed to leave one end permanently closed shall not exceed 880 feet in length and shall be provided at the closed end with a turnaround. Length shall be measured from the centerline of the adjoining street to the center of the cul-de-sac bulb. The surface portion of the turnaround shall have a minimum diameter of eighty feet (80'). The minimum right-of-way shall exceed the turnaround diameter by twenty feet (20') to provide at least a ten-foot (10') border area adjacent to the street.

602.1.5 Design Speed.

Design speed is not a major factor for residential streets. For consistency in design elements, a design speed of 25 MPH shall be used.

602.1.6 Sight Distance.

Minimum stopping distance should be 155 feet. Passing sight distance is not applicable. Corner intersection sight distance should comply with ITEM 805 – Intersection Sight Distance of this manual.

602.1.7 Intersection Design.

Intersections, including median openings, shall be designed with adequate corner sight distance, and the intersection area shall be kept free of obstacles. Any landscaping in the sight distance triangle shall be low-growing, and shall not be higher than three feet (3') above the level of the intersecting street pavements.

The intersecting streets should meet at approximately a 90-degree angle, but in no case less than a 75-degree angle. The maximum lengths between intersections shall be 1200 feet, except cul-de-sac street shall be 880 feet. At street intersections, the minimum radius of curb returns shall be twenty-five feet (25').

602.1.8 Horizontal Alignment.

~~There is an advantage in~~In residential areas, the alignment should be arranged to discourage through traffic. ~~in purposely arranging the alignment to discourage through traffic.~~ The alignment design shall be such that the safety of the facility is not reduced. Street curves should be designed with as large a radius curve as feasible; the minimum center line radius on simple or compound curves being 160 feet, the minimum centerline radius on reverse curves being 300 feet with a minimum tangent length of 100 feet. Streets designed with less than the minimum curve radius shall include a bubble type intersection with a minimum surface radius of forty feet (40').

602.1.9 Grades.

Grades for residential streets should be as flat as is consistent with the surrounding terrain. The gradient should be less than 15 percent. Where grades of 4 percent or steeper are necessary, the drainage and erosion control designs shall become critical. Vertical curves shall be installed when algebraic differences in grade exceeds 1 percent.

To provide for proper drainage, the minimum grade that shall be used for streets with outer curbs is 0.25 percent, with a minimum 1 percent fall around curb return radius at intersections with a twenty-five-foot (25') radius. Grades for larger radius shall be

determined on an individual basis. The minimum grade for a cul-de-sac street with a forty-foot (40') curb radius shall be 0.60 percent along the gutter. A minimum gradient of 0.40 percent around the longest radius is required on an L-type street intersection. Drainage across street intersections by means of "valley" Gutters shall be prohibited.

602.1.10 Pavement Crown.

Pavement cross slope shall provide proper drainage. The amount of cross slope over the pavement section shall be a minimum of one-half inch (1/2") per foot from the curb line to quarter point, and three-eight inch (3/8") from quarter point to centerline.

602.1.11 Drainage.

Surface sheet flows are usually intercepted by the street section of curb and gutter and conveyed to appropriate outlets. ~~, for~~For urban streets, the flow is transferred at frequent intervals from the street cross section by curb-opening inlets to basins and from there by storm sewer conduit to major outfalls. To avoid undesirable flow line conditions, the minimum gutter grade shall be as specified in ITEM 602.1.8 “Grades.”

Inlets shall be located in such a manner that the more restrictive of the following criteria will govern:

a) Maximum storm water ponding depth as measured at the gutter low point shall be no more than nine (9) inches, and
b) Storm water is not carried more than 300 feet along the curb line from the high point of a gutter to an inlet opening.

Inlets should be placed away from collector streets or arterial streets and on the side streets at street intersections. An attempt should be made to place the proposed inlets away from the esplanade openings and out of major intersections. No inlets or grates shall be placed within residential driveways. Storm sewers and inlets shall be provided in accordance to ITEM 703.1.11 "Closed Conduit Systems".

602.1.12 Border Area.

The border between the roadway and the right-of-way line shall be wide enough to serve several purposes; including provisions of a buffer space between pedestrians and vehicular traffic, sidewalk space, and an area for placement of utilities. The roadway shall be centered within the designated right-of-way and the border area sloped from the property line to the top of the curb at a minimum grade of three-eight’s inch (3/8") per foot.

602.1.13 Sidewalks.

In residential areas, sidewalks shall be constructed on both sides of the street. The sidewalks shall be located as far as practical from the traffic lanes and usually close to the right-of-way lines. Clear sidewalk width shall be four-foot (4’) minimum. Curb-cut ramps shall be

provided at cross walks to accommodate physically handicapped persons. Sidewalks and curb-cut ramps shall be provided in accordance with ITEM 806 – Pedestrian Facilities (Sidewalks and Wheel Chair Ramps).

602.1.14 Driveways.

A driveway is an access constructed within the public way, connecting the public roadway with adjacent property and intended to be used in such a way that access into the adjacent property will be complete and will not cause the blocking of any sidewalk border area or street roadway. Driveways shall be constructed in accordance with ITEM 801 – Access Management Standards and League City "Standard Details".

602.1.15 Street and Roadway Lighting.

~~Good visibility under day or night conditions is one of the fundamental requirements enabling motorists to move on roadways in a safe and coordinated manner.~~ Properly designed street lighting shall produce comfortable and accurate visibility at night, which will facilitate and encourage both vehicular and pedestrian traffic. Street lights shall be provided at a maximum spacing of five-hundred feet along residential streets. Street lights shall be located at street intersections. Installation shall be per AASHTO's "Roadway Lighting Design Guidelines" (latest edition).

602.1.16 Traffic Control Devices.

~~Consistent and uniform application of traffic control devices is important.~~ Details of the standard devices and warrants for many conditions are found in the Texas Manual on Uniform Traffic Control Devices. Geometric design of streets shall include full consideration of the types of traffic control to be used. Multi-way stops will require a multi-way stop warrant study. Design per AASHTO's "Guidelines for Geometric Design of Very Low Volume Local Roads".

602.2 Local Streets. (SEE STREET AND ROAD MATRIX)

Local streets primarily serve as access to farms, residences or other abutting property not planned as urban style development. Because of the relatively low traffic volumes, design standards are of a comparatively low order as a matter of practicality. However, to provide the requisite traffic mobility and safety, together with the essential economy in construction, maintenance, and operation, they must be planned, located and designed to be suitable for predictable traffic operations and must be consistent with the development abutting the right-of-way.

602.2.1 Pavement Type.

Local streets shall be provided with a curb, gutter and storm sewer design, or an open drainage ditch design with appropriate right-of-way dedication. These streets shall consist of a pavement composed of Portland cement concrete constructed on a prepared sub-grade, or a hot mix asphaltic concrete constructed on a prepared sub-base and sub-grade.
The concrete pavement shall have a minimum thickness of six-inches (6") and constructed in accordance with ITEM 605 "Concrete Pavement".

The hot mix asphaltic concrete pavement shall have a minimum thickness of two-inches (2") and constructed in accordance with ITEM 606 "Hot Mix Asphaltic Concrete Pavement". The prepared sub-base shall have a minimum thickness of eight-inches (8") and constructed in accordance with ITEM 604 "Sub-grade, Sub-base and Base Courses". The prepared sub-grade shall have a minimum thickness of six-inches (6") and constructed in accordance with ITEM 604 "Sub-grade, Sub-base and Base courses".

602.2.2 Pavement Width.

Two travel lanes usually can accommodate the normal traffic volumes on local roads. Streets that are planned with a curb, gutter and storm sewer design shall be provided in accordance with ITEM 602.1 "Residential Streets". Streets that are planned with an open ditch design shall be provided with a minimum pavement width of twenty-four feet (24'). Two-foot (2') roadway shoulders shall be constructed adjacent to all pavement edges that are not curbed.

602.2.3 Right-of-Way Width.

The right-of-way width shall be sufficient to accommodate the ultimate planned roadway including median (if used), sidewalks (if required), utility strips in the border areas, roadway shoulders, necessary drainage facilities and outer slopes.

The minimum right-of-way width for rural local streets with a curb, gutter and storm sewer design shall be sixty feet (60'). The minimum right-of-way width for streets with an open ditch drainage design shall be determined by the open ditch drainage requirement, but in no case, less than seventy feet (70'). Additional easements adjacent to the right-of-way may be required for multiple utility installations.

602.2.4 Cul-de-Sacs and Turnarounds.

Cul-de-sacs and turnarounds for rural local streets shall be provided in accordance with ITEM 602.1.4 "Cul-de-sacs and Turnarounds".

602.2.5 Design Speed.

Geometric design features should be consistent with a design speed selected as appropriate for environmental and terrain conditions. A design speed of 25 mph is generally applicable

to roads in level terrain and where expected traffic volumes warrant rural local road classification.

602.2.6 Sight Distance.

Sight distance for rural local roads shall be provided in accordance with ITEM 805 – Intersection Sight Distance of this manual.

602.2.7 Intersection Design.

Intersection design for rural local roads shall be provided in accordance with ITEM 602.1.7 "Intersection Design".

602.2.8 Horizontal Alignment.

Horizontal alignment shall be provided in accordance with ITEM 602.1.8 "Horizontal Alignment".

602.2.9 Roadside Shoulders.

A shoulder is the portion of the roadway contiguous with the traveled way for accommodation of stopped vehicles, for emergency use and for lateral support of sub-base and surface pavement. Roadway shoulders shall be constructed adjacent to all pavement edges that are not curbed.

Shoulders shall be surfaced to provide a better all-weather load support than that afforded by the native soil. Materials used to surface shoulders include gravel, shell, crushed rock, mineral or chemical additives, bituminous surface treatments, and various forms of asphaltic or concrete pavements.

Shoulders are important links in the lateral drainage systems. Shoulders shall be flush with the roadway surface and abut the edge of the travel lane. Shoulders shall provide an adequate cross slope for drainage of the roadway.

602.2.10 Pavement Crown.

Surface cross slope must be provided to ensure drainage. Roads of this type shall be out slope graded toward the curb or open ditch. The amount of cross slope shall be one-half inch (1/2") per foot from edge of pavement to centerline. The cross slope on roadside shoulders shall be three-quarter inch (3/4") per foot.

602.2.11 Roadside Slopes.

Back-slopes, fore-slopes and roadside ditches shall have gentle well-rounded transition. Roadside ditches shall provide for a fore-slope of 3:1 or flatter. Flat Fore-slopes increase safety by providing maneuvering area in emergencies, are more stable than steep slopes, aid in establishment of plant growth, and simplify maintenance work. Back-slopes of roadside ditches shall be 3:1 or flatter to make it easier for motorized equipment to be used in maintenance.

602.2.12 Grades.

Grades for rural local roads should be as flat as is consistent with the surrounding terrain. The maximum gradient for roadways without curbs shall be less than 7 percent. Where grades of 4 percent or steeper are necessary, the drainage and erosion control design shall become critical. Vertical curves shall be installed when algebraic differences in grade exceeds 1 percent. Grades for curb, gutter, and storm sewer designs shall be provided in accordance with ITEM 602.1.9 "Grades".

602.2.13 Drainage.

Roadside drainage channels perform the vital function of collecting and conveying surface sheet flows from the roadway and adjacent property. Roadside drainage channels, therefore, shall have capacity for the ~~design run off~~base flood, developed for pavement and pre-developed for adjacent property, shall provide for unusual storm water without saturation of the pavement subgrade, and shall be located and shaped to avoid hazard to traffic. The channel grade does not have to follow that of the road bed. The minimum grade shall be 0.10 percent.

Drainage for roadways with outer curbs shall be provided in accordance with ITEM 602.1.11 "Drainage".

602.2.14 Border Area.

The border between the roadway and the right-of-way line shall be wide enough to serve several purposes; including drainage maintenance and an area for placement of underground utilities and possible overhead utilities.

The roadway shall be centered within the designated right-of-way and the border area constructed in a stable and easily maintained state.

602.2.15 Driveways.

Driveways shall be provided in accordance with ITEM 602.1.14 "Driveways".

602.2.16 Traffic Control Devices.

Traffic control devices shall be provided in accordance with ITEM 602.1.16 "Traffic Control Devices".

602.3 Collector Streets. (SEE STREET AND ROAD MATRIX)

The collector street is intended to serve the collection function for a group of access roads and ideally not the immediate access needs of individual residences. However, the collector street does serve the access function for higher density residential development and for some neighborhood facilities.

602.3.1 Pavement Type.

Collector streets shall be provided with a standard curb, gutter and storm sewer design. These streets shall consist of a pavement composed of portland cement concrete constructed on a prepared sub-grade. The concrete pavement shall have a minimum thickness of seven - inches (7") and constructed in accordance with ITEM 605 "Concrete Pavements". The prepared sub-grade shall have a minimum thickness of six-inches (6") and constructed in accordance with ITEM 604 "Sub-grades, Sub-based, and Base courses".

602.3.2 Pavement Width.

~~Two moving traffic lanes plus additional width for parking are sufficient for most collector streets.~~ Collector streets ~~may~~ shall be designed with two divided one-way roadways or a single two-way roadway. ~~A median separating the two opposing traffic lanes is a highly desirable element in planned high density areas.~~

Divided one-way roadways ~~design shall~~shall be designed to provide for two 25-foot width roadways. This back-of-curb to back-of-curb width shall provide for two 12-foot ~~width~~ wide traffic lanes and two 12 foot parking lanes, allowing parking on the outer two lanes until development necessitates use of all four lanes for moving traffic. Collector streets with two divided one-way roadway designs may be constructed in stages with development when approved by the ~~Public Works~~Engineering Department.

A single two-way roadway shall include two 12-foot width traffic lanes. Parallel parking lanes from 9 to 10-foot width shall be provided on both sides of traffic lanes. This back-of-curb to back-of-curb width will vary from 42 to 44 feet as the conditions and intensity of development may require.

602.3.3 Median.

A median is defined as the portion of a divided street separating the traveled way for traffic in opposing directions. The median width is expressed as the dimension between the through-lane edges. For maximum efficiency, a median ~~should~~ shall be highly visible both night and day and in definite contrast to the through-traffic lanes. Medians should be as wide as feasible but of a dimension in balance with other components of the cross section. Medians with grass shall be of raised curb and gutter design while turning lane medians shall be flush with the pavement surface. For collector streets median treatment shall comply with ITEM 807 – Median Design of this manual. A continuous left-turn lane, flush with the adjoining traffic lanes with appropriate traffic markings~~and painted~~, may be an acceptable approach, with approval from the ~~Public Works~~Engineering Department.

On collector streets with raised median, openings shall be designed in accordance with ITEM 807 of this manual. Median openings shall be designed to include left turn lanes as needed and designed per ITEM 801 of this manual.

Openings must have adequate sight distance and the design shall comply with ITEM 807 of this manual.

602.3.4 Right-of-Way Width.

The right-of-way width shall be sufficient to accommodate the ultimate planned roadway, including median (if used) sidewalks, utility strips in the border areas, and necessary drainage facilities. The minimum right-of-way width for collector streets with two divided one-way roadway designs shall be ninety feet (90'). The minimum right-of-way width for collector streets with one single two-way roadway designs shall be eighty feet (80'). Any collector street designed with open ditches shall require at a minimum an additional ten feet (10') of right-of-way dedication. Additional easements adjacent to the right-of-way may be required for multiple utility installations.

602.3.5 Cul-de-Sacs and Turnarounds.

A collector street shall terminate at a residential street and/or a minor/major arterial.

602.3.6 Design Speed.

~~Design speed is a factor in the design of collector streets.~~ For consistency in design elements a minimum design speed of 35 MPH shall be used for collector streets. In the typical street grid, the closely spaced intersections usually limit vehicular speeds and thus make the effect of design speed of lesser significance. The longer sight distance and curve radius commensurate with design speeds higher than the value indicated result in safer streets and shall be used.

602.3.7 Sight Distance.

Stopping sight distance for collector streets shall be 250 feet. Design for passing sight distance seldom is applicable on collector streets. Intersection corner sight distance shall comply with ITEM 805 of this manual.

602.3.8 Intersection Design.

Intersections, including median opening, shall be designed with proper corner sight distance, and the intersection area shall be kept free of obstacles. Where predicted turning volumes may be significant, speed-change lanes and channelization shall be incorporated into the intersection design. The intersection streets should meet at approximately a 90-degree angle, but in no case less than a 75-degree angle. The maximum lengths between street intersections shall be 1200 feet with a minimum spacing of 300 feet. Intersections should be designed with a corner radius for pavement adequate for larger vehicles anticipated; a minimum radius of curb returns shall be thirty feet (30').

602.3.9 Horizontal Alignment.

The designer shall strive for as high a standard as practical for collector alignments. Horizontal and vertical alignments must complement each other and be considered in combination. Caution that the safety of the facility is not reduced should be taken in the design. Street curves should be designed with as large a radius curve as feasible; the minimum centerline radius being 500 feet and a minimum tangent length in reverse curves of 100 feet.

602.3.10 Grades.

Grades for collector streets should be as level as consistent with the surrounding terrain. A 0.30 percent grade is acceptable to facilitate drainage, however, it is recommended to use 0.50 percent grade or more, when possible, for drainage purposes. Street grades are depressed below the surrounding terrain to accommodate adjacent property sheet drainage to the curb area and accumulation in the storm drainage system. Vertical curves shall be installed when algebraic differences in grades exceed 1 percent. Vertical curves shall meet the sight distance criteria for the design speed.

602.3.11 Pavement Crown.

Pavement cross slope shall provide proper drainage. Each pavement of a divided street shall be sloped to drain to the outer curb. Normally, parabolic sections are used for single two-way streets, and plane sections are used for divided streets. The amount of cross slope over a single two-way street shall be three percent (3%) from the curb line to quarter point, and two percent (2%) from quarter point to center line. Pavements on divided collectors shall have a normal cross slope of two percent (2%). On an auxiliary lane, normally the cross slope should not exceed 2 percent on outer lanes and 1 percent on inner left turn lanes.

602.3.12 Drainage.

Drainage for collector streets shall be provided in accordance with ITEM 602.1.11 "Drainage" with the following exception: The gutter grade shall be as specified in ITEM 602.3.10 "Grades".

602.3.13 Border Area.

The border areas between the roadway and the right-of-way line shall be wide enough to serve several purposed including provisions of a buffer space between pedestrians and vehicular traffic, sidewalk space, and an area for both underground and above ground utilities, such as traffic signals and fire hydrants. The roadway shall be centered within the designated right-of-way and the border areas sloped from the property line to the top of the curb at a minimum grade of three-eight inch (3/8") per foot. Traffic signals, utility poles, fire hydrants, and other utilities shall be placed as far back of the curb as practical for safety reasons. Breakaway features should be built into structures when feasible and as an aid for safety considerations.

602.3.14 Sidewalks.

On Collector Streets, sidewalks are to be constructed on both sides of the street. The sidewalks shall be located as far as practical from the traffic lanes and usually close to the right-of-way lines. Clear sidewalk width shall be five-foot (5') minimum. Curb-cut ramps shall be provided at cross walks to accommodate physically handicapped persons. Sidewalks and curb-cut ramps shall be provided in accordance with ITEM 806 – Pedestrian Facilities (Sidewalks and Wheel Chair Ramps).

602.3.15 Driveways.

Driveways for collector streets shall be provided in accordance with ITEM 602.1.14, "Driveways".

602.3.16 Street and Roadway Lighting.

Street lights shall be provided at all intersections with other roadways and at appropriate spaced intervals as determined by the Public Works Department. Design shall be per AASHTO's "Roadway Lighting Design Guide" (latest edition).

602.3.17 Traffic Control Devices.

Traffic control devices shall be applied consistently and uniformly. Details of the standard devices and warrants for many conditions are found in the TMUTCD. Geometric design of streets shall include full consideration of the types of traffic control to be used, especially at intersections where multiple phases of actuated traffic signals are likely to be needed.

Traffic signals are a major element in the design of major collector street intersections. Successful operations of a collector street depend largely on proper pavement markings. Pavement markings shall be provided in accordance to the TMUTCD.

602.4 Omitted

602.5 Minor Arterial Streets. (SEE STREET AND ROAD MATRIX)

The design of minor arterials covers from two-lane to multi-lane roads. Minor arterial streets bring traffic to and from major arterial streets and expressways, and serve major movements of traffic within and through and urban area. Traffic volumes vary from 3000 to 7000 vehicles per day with 5% to 7% heavy commercial traffic. Trucks using these streets have a maximum tandem axle load of 46 kips and a 35-dip maximum single-axle load. The principle characteristic of the arterial should be mobility with limited or restricted service to local development.

602.5.1 Pavement Type.

Urban arterial streets shall be provided with a standard curb, gutter and storm sewer design. These streets shall consist of a pavement composed of Portland Cement concrete constructed on a prepared sub-grade. The concrete pavement shall have a minimum thickness of eight-inches (8") and constructed in accordance with ITEM 605, "Concrete Pavements". The prepared sub-grade shall have a minimum thickness of six-inches (6") and constructed in accordance with ITEM 604, "Sub-grades".

602.5.2 Pavement Width.

A minimum of four moving traffic lanes is required to handle the capacity of urban minor arterials. Pavements shall be widened through intersections by the addition of one or two lanes to accommodate turning vehicles. Parking on an arterial street should only be considered when provision is required because of existing conditions. Medians shall be provided for all minor arterial streets. The divided one-way roadways design shall provide for two twenty-five feet (25') width roadways. This back-of-curb to back-of-curb width shall provide for two twelve-foot (12') travel lanes in each direction.

602.5.3 Medians.

Medians for urban minor arterial streets shall be provided in accordance with ITEM 602.3.3 "Medians".

602.5.4 Right-of-Way Width.

The width of right-of-way for the complete development of an arterial street is influenced by traffic requirements, intersection design, and extent of ultimate expansion. The required

width of right-of-way is the summation of the various cross-sectional elements - through pavements, median, auxiliary lanes, and borders. Every opportunity shall be taken to provide the required width along all of the facility. The minimum right-of-way width for minor arterials shall be one-hundred feet (100'). Additional easements adjacent to the right-of-way shall be required for utility installations.

602.5.5 Design Speed.

A design speed for minor urban arterial streets generally range from 40 to 50 mph. The lower (40 mph and below) speeds apply in built-up areas or under particularly restricted conditions in suburban areas. A high speed (50 mph or above) is appropriate in outlying sections approaching rural conditions.

602.5.6 Sight Distance.

The provision of adequate sight distance is important in urban minor arterial design. Stopping sight distance shall be in the range from 305 to 425 feet. Stopping sight distance is based upon posted speed and AASHTO guidelines. Design for passing sight distance seldom is applicable on urban minor arterials with two divided one-way roadways. Intersection corner sight distance shall comply with ITEM 805 of this manual.

602.5.7 Intersection Design.

Each individual intersection shall be carefully evaluated by a traffic engineer to determine the best design to handle the expected traffic volumes and adjacent developments. Intersections shall be designed with a minimum edge corner radius of 50 feet. Where expected turning volumes are significant, speed change lanes and channelization shall be considered. Turn lane design shall comply with ITEM 801 of this manual. Intersection legs that will operate under stop sign or signal control shall be at right angles. Where necessary, cut slopes should be flattened, and horizontal or vertical curves shall be lengthened to provide additional sight distance.

602.5.8 Horizontal Alignment.

Alignment of the minor arterial is ideally developed strictly with the design speed selected. It is desirable to use the highest alignment design possible with a minimum centerline radius being 800 feet and a minimum tangent length in reverse curves of 100 feet.

602.5.9 Grades.

Grades for minor arterial streets shall be provided in accordance with ITEM 602.3.10, "Grades".

602.5.10 Pavement Crown.

Each pavement of a divided arterial shall be sloped to drain to the outer edge. Pavement should have a normal cross slope of 2 percent. On auxiliary lanes, the cross slope should not exceed 2 percent on outer lanes and 1 percent on inner left turn lanes.

602.5.11 Drainage.

A drainage system to accommodate design run-off shall be included in the design of every arterial street. Street flows from adjacent property that is intercepted by the street section of curb and gutter shall be limited to a property depth of 150' along and adjacent to the right-of-way. For urban streets, the flow is transferred at frequent intervals from the street cross section by curb-opening inlets to basins and from there by storm sewer conduit to major outfalls. To avoid undesirable flow-line conditions, the minimum gutter grade shall be 0.30 percent, it is recommended to use 0.50 percent grade or more, when possible, for better drainage purposes. Inlets shall be located in such a manner that the more restrictive of the following criteria will govern:

a) Maximum storm water ponding depth as measured at the gutter low point shall be no more than nine (9) inches, and
b) Storm water is not carried more than 300 feet along the curb line from the high point of a gutter to an inlet opening.

~~. Inlets shall be located in such a manner that storm water is not carried more than 300 feet along the curb line from the high point of a gutter to an inlet opening.~~ Inlets shall be recessed (horizontally displaced) away from the curb gutter line so that any depression at the mouth of the inlet occurs wholly within the limits of the gutter, with no irregularity of elevation extending into the travel lane. Inlets should be placed away from arterial streets, on side streets, at intersections. Storm sewers and inlets shall be provided in accordance to ITEM 703, "Closed Conduit System".

602.5.12 Border Area.

Border areas for minor arterials shall be provided in accordance with ITEM 602.3.13, "Border Area".

602.5.13 Sidewalks.

Sidewalks for urban minor arterials shall be provided in accordance with ITEM 602.3.14, "Sidewalks".

602.5.14 Access Control.

Control of access is highly desirable on an arterial facility. This provision will not only enhance its initial service capability but will also preserve the original level of service. While service may be required to abutting property, it shall be carefully regulated to limit the number of points and their locations. Access control is especially needed in areas

approaching intersections where auxiliary and storage lanes may be required. Access to arterial streets shall be permitted only where minimum spacing standards are met. The spacing standards are the minimum distance between access points on the same side of the road. To ensure a safe balance between access and traffic mobility, these standards vary depending on the nature of the access point. Residential driveways shall not be designed for access to arterial streets. Commercial driveways shall be allowed access to arterial and shall comply with ITEM 801 of this manual.

602.5.15 Lighting.

Lighting is very important to safe operation of an urban arterial. The higher volumes and speeds require the driver to make correct decisions with adequate time to make the proper maneuvers without creating undue conflict in the traffic lanes. A safely designed lighting system is more important to optimum operation of an urban arterial than any other city street. The lighting shall be continuous and an energy-saving type. Design shall be per AASHTO's "Roadway Lighting Design Guide".

602.5.16 Traffic Control Devices.

Traffic control devices such as signs, markings, signals, and islands are placed on or adjacent to a street to regulate, warn, or guide traffic. Each device is designed to fulfill a specific need with regard to traffic operation, control, or safety. The need for traffic control devices shall be determined by an engineering study made in conjunction with the geometric design of the street. The TMUTCD shall be used to ensure standard design and uniform application of the various traffic control devices.

Traffic signal design shall comply with ITEM 803 of this manual.

Successful operation of an arterial street depends largely on proper pavement marking. Recent development in products for pavement markings shows considerable promise in providing adequate long-life marking. Pavement markings shall be provided in accordance to the TMUTCD and the "Standard Details".

602.6 Omitted.

602.7 Major Arterials.

The major arterial system serves the major centers of activity, the highest traffic volume corridors, and longest trip desires and carries a high proportion of the total city area travel on a minimum of mileage. The system should be integrated both internally and between major rural connections. The major arterial system carries most of the trips entering and leaving the city, as well as most of the through movements by passing the central city. In addition, significant intra-area travels, such as between central business districts and

outlying residential areas, between major inner-city communities and between major suburban centers, is served by this class of facility.

The design of major arterials covers a broad range of roadways, from four-lane to six-lane, and is the most difficult class of roadway design because of the need to provide a high standard of operation. The designer must be thoroughly familiar with the standards established by the American Association of State Highway and Transportation Officials in order to skillfully blend the various geometric aspects into a functional network. All major arterials shall be provided in accordance with the requirements of the Texas State Department of Highways and Public Transportation.

602.7.1 Pavement Type.

Urban arterial streets shall be provided with a standard curb, gutter and storm sewer design. These streets shall consist of a pavement composed of Portland Cement concrete constructed on a prepared sub-grade. The concrete pavement shall have a minimum thickness of eight-inches (8") and constructed in accordance with ITEM 605, "Concrete Pavements". The prepared sub-grade shall have a minimum thickness of six-inches (6") and constructed in accordance with ITEM 604, "Sub-grades".

602.7.2 Pavement Width.

A minimum of four moving traffic lanes is required to handle the capacity of urban major arterials. Pavements shall be widened through intersections by the addition of one or two lanes to accommodate turning vehicles. Medians shall be provided for all major arterial streets. The divided one-way roadways design shall provide for two twenty-five-foot (25') width roadways. This back-of-curb to back-of-curb width shall provide for two twelve-foot (12') travel lanes in each direction.

602.7.3 Medians.

Medians for major arterial streets shall be provided in accordance with ITEM 602.3.3 "Medians".

602.7.4 Right-of-Way Width.

The width of right-of-way for the complete development of an arterial street is influenced by traffic requirements, intersection design, and extent of ultimate expansion. The required width of right-of-way is the summation of the various cross-sectional elements - through pavements, median, auxiliary lanes, and borders. Every opportunity shall be taken to provide the required width along all of the facility. The minimum right-of-way width for major arterials shall be one-hundred feet and twenty (120'). Additional easements adjacent to the right-of-way shall be required for utility installations.

602.7.5 Design Speed.

A design speed for major arterial streets generally range from 40 to 50 mph. The lower (40 mph and below) speeds apply in built-up areas or under particularly restricted conditions in suburban areas. A high speed (50 mph or above) is appropriate in outlying sections approaching rural conditions.

602.7.6 Sight Distance.

The provision of adequate sight distance is important in urban minor arterial design. Stopping sight distance shall be in the range from 305 to 425 feet. Stopping sight distance is based upon posted speed and AASHTO guidelines. Design for passing sight distance seldom is applicable on urban minor arterials with two divided one-way roadways. Intersection corner sight distance shall comply with ITEM 805 of this manual.

602.7.7 Intersection Design.

Each individual intersection shall be carefully evaluated by a traffic engineer to determine the best design to handle the expected traffic volumes and adjacent developments. Intersections shall be designed with a minimum edge corner radius of 50 feet. Where expected turning volumes are significant, speed change lanes and channelization shall be considered. Turn lane design shall comply with ITEM 801 of this manual. Intersection legs that will operate under stop sign or signal control shall be at right angles. Where necessary, cut slopes should be flattened, and horizontal or vertical curves shall be lengthened to provide additional sight distance.

602.7.8 Horizontal Alignment.

Alignment of the major arterial is ideally developed strictly with the design speed selected. It is desirable to use the highest alignment design possible with a minimum centerline radius being 800 feet and a minimum tangent length in reverse curves of 100 feet.

602.7.9 Grades.

Grades for minor arterial streets shall be provided in accordance with ITEM 602.3.10, "Grades".

602.7.10 Pavement Crown.

Each pavement of a divided arterial shall be sloped to drain to the outer edge. Pavement should have a normal cross slope of 2 percent. On auxiliary lanes, the cross slope should not exceed 2 percent on outer lanes and 1 percent on inner left turn lanes.

602.7.11 Drainage.

A drainage system to accommodate design run-off shall be included in the design of every arterial street. Street flows from adjacent property that is intercepted by the street section of curb and gutter shall be limited to a property depth of 150' along and adjacent to the right-of-way. For urban streets, the flow is transferred at frequent intervals from the street cross section by curb-opening inlets to basins and from there by storm sewer conduit to major outfalls. To avoid undesirable flow-line conditions, the minimum gutter grade shall be 0.30 percent, it is recommended to use 0.50 percent grade or more, when possible, for better drainage purposes. Inlets shall be located in such a manner that the more restrictive of the following criteria will govern:

a) Maximum storm water ponding depth as measured at the gutter low point shall be no more than nine (9) inches, and
b) Storm water is not carried more than 300 feet along the curb line from the high point of a gutter to an inlet opening.

~~Inlets shall be located in such a manner that storm water is not carried more than 300 feet along the curb line from the high point of a gutter to an inlet opening.~~ Inlets shall be recessed (horizontally displaced) away from the curb gutter line so that any depression at the mouth of the inlet occurs wholly within the limits of the gutter, with no irregularity of elevation extending into the travel lane. Inlets should be placed away from arterial streets, on side streets, at intersections. Storm sewers and inlets shall be provided in accordance to ITEM 703, "Closed Conduit System".

602.7.12 Border Area.

Border areas for minor arterials shall be provided in accordance with ITEM 602.3.13, "Border Area".

602.7.13 Sidewalks.

Sidewalks for urban minor arterials shall be provided in accordance with ITEM 602.3.14, "Sidewalks".

602.7.14 Access Control.

Control of access is highly desirable on an arterial facility. This provision will not only enhance its initial service capability but will also preserve the original level of service. While service may be required to abutting property, it shall be carefully regulated to limit the number of points and their locations. Access control is especially needed in areas approaching intersections where auxiliary and storage lanes may be required. Access to arterial streets shall be permitted only where minimum spacing standards are met. The spacing standards are the minimum distance between access points on the same side of the road. To ensure a safe balance between access and traffic mobility, these standards vary depending on the nature of the access point. Residential driveways shall not be designed

for access to arterial streets. Commercial driveways shall be allowed access to arterial and shall comply with ITEM 801 of this manual.

602.7.15 Lighting.

Lighting is very important to safe operation of an urban arterial. The higher volumes and speeds require the driver to make correct decisions with adequate time to make the proper maneuvers without creating undue conflict in the traffic lanes. A safely designed lighting system is more important to optimum operation of an urban arterial than any other city street. The lighting shall be continuous and an energy-saving type. Design shall be per AASHTO's "Roadway Lighting Design Guide".

602.7.16 Traffic Control Devices.

Traffic control devices such as signs, markings, signals, and islands are placed on or adjacent to a street to regulate, warn, or guide traffic. Each device is designed to fulfill a specific need with regard to traffic operation, control, or safety. The need for traffic control devices shall be determined by an engineering study made in conjunction with the geometric design of the street. The TMUTCD shall be used to ensure standard design and uniform application of the various traffic control devices.

Traffic signal design shall comply with ITEM 803 of this manual.

Successful operation of an arterial street depends largely on proper pavement marking. Recent development in products for pavement markings shows considerable promise in providing adequate long-life marking. Pavement markings shall be provided in accordance to the TMUTCD and the "Standard Details".

ITEM 603
PREPARATION OF RIGHT-OF-WAY

This ITEM shall consist of preparing the right-of-way for construction operations by the removal and disposal of all obstructions from the right-of-way and from designated easements, except such trees, shrubs and structures and certain areas designated by the Public Works Department for preservation.

603.1 Clearing and Grubbing.

The right-of-way shall be cleared of stumps, brush, logs, rubbish, trees and shrubs, and all obstructions and objectionable materials whether above or below ground except live utility facilities or other facilities designated for preservation by the Public Works Department or EOR.

Areas required for embankment construction; for roadway, channel and structural excavation; and for borrow sites and material sources shall be cleared and grubbed. On areas required for roadway, channel, or structural excavation, all stumps, roots, etc., shall be removed to a depth of at least two (2) feet below the lower elevation of the excavation.

Holes remaining after removal of all obstructions, objectionable material, trees, stumps, etc., shall be backfilled with suitable material and tamped as directed by the Public Works Department or EOR. The operation of preparing the right-of-way shall be completed by balding, bull dozing, or by other approved methods, so that the prepared right-of-way shall be free of holes, ditches and other abrupt changes in elevations and irregularities of contour to prevent pounding of water and to provide proper drainage. All cleared and grubbed material shall be disposed of in a proper manner.

603.2 Roadway Excavation.

Substances encountered within the limits of the roadway shall be excavated to the lines, grades and typical cross sections and in accordance with specifications and as indicated in the plans. All excavation shall be accomplished in such a manner as to allow proper drainage. All suitable material removed from the excavation should be used for embankments and other such purposes as directed by the Public Works Department or EOR. If material encountered within the limits of the work is considered unsuitable, it shall be excavated and replaced with suitable material.

All utility trenches and structure excavation shall be backfilled in accordance with ITEM 410, "Backfill and Settlement".

603.3 Embankment.

Embankments shall be constructed by placing and compacting materials of acceptable quality following the lines, grades, and cross sections as indicated on the approved construction plans. Before any embankment is placed, all clearing and grubbing operations shall have been completed. Each layer of embankment material shall not exceed six inches (6”) in compacted depth. It shall be disked sufficiently to break down oversize clods and thoroughly mixed so that a uniform material is secured. Each layer shall be uniformly compacted to at least 95% maximum density at optimum moisture by roller or vibratory equipment suitable for the type of material encountered. Testing for density will be in accordance with ASTM D2922 and ASTM D698.

ITEM 604
SUBGRADE, SUBBASE AND BASE COURSES

All sub-grade, sub-base and base course construction shall provide for a stabilized material with uniform support and with no abrupt changes in degree of support. Stabilization, as applied to roadway construction, can be defined as a means of permanently consolidating

soils and base materials by markedly increasing their strength and bearing capacity and decreasing their water sensitivity and volume change during wet/dry cycles. Soils with a PI (plasticity index) value greater than ten (10) shall be stabilized with hydrated lime, Portland cement, or lime-fly ash as long as the material has been found chemically reactive with stated material. Soils with a PI (plasticity index) value less than ten (10) or soils that are not suitable for chemically treating with lime shall be stabilized with Portland Cement or fly ash or lime-fly ash. A geo-technical investigation shall be performed on all projects to assist in the design phases in determining the type and amount of additive that will be required to produce the optimum results. Sub-grade, sub-base and base courses shall be constructed with a width of two feet (2'), on each side thereof, greater than the width of the subsequent course. All sub-grade, sub-base and base courses shall be constructed as herein specified and in conformity with the typical cross sections of the approved plans.

604.1 Stabilization. (Lime, Lime-Fly Ash, Portland Cement)

This ITEM shall consist of treating the sub-grade, sub-base or base course by pulverizing, addition of stabilization material, mixing and compacting the mixed material to the required density. This ITEM applies to natural ground, borrow fill, existing pavement structure or base material and shall be constructed as specified herein and in conformity with the typical sections, lines and grades as shown on the plans or as established by the Public Works Department.

604.1.1 Lime.

Only sub-grade, sub-base, or base material, in-place or borrow, that has been found to be effectively treated with lime, containing no weeds, roots, or other vegetation; pulverized so 100% passes two-inch (2") sieve shall be considered acceptable material. Hydrated lime shall be Type "B", commercial lime slurry in conformance with TxDOT, ITEM 264. The amount of lime required shall be determined by a qualified materials testing laboratory to be the optimum content of the soil in no case less than 5% by weight.

604.1.2 Construction Method.

It is the primary requirement of this specification to secure a complete course of stabilized treated material containing a uniform mixture, free from loose or segregated areas, of uniform density and moisture content, well bound for its full depth and with a smooth surface suitable for placing subsequent courses.

604.1.2.a Scarification and Pulverization.

After the soil has been shaped to conform to the typical sections, lines and grades as shown on the plans and all soft areas (revealed by proof rolling) have been removed and corrected, the material should be scarified to the specified depth and width of stabilization and then

partially pulverized. All delirious materials like roots, turf, etc., and aggregates larger than three inches (3") shall be removed.

604.1.2.b Application.

Hydrated lime shall be uniformly spread by successive passes over a measured section of roadway until the proper moisture and lime content has been secured. Provisions shall be made for agitation in the distributor truck to prevent settling of lime solids.

604.1.2.c Preliminary Mixing.

The material and lime shall be thoroughly mixed by approved rotary speed road mixers and the mixing continued until a homogeneous, friable mixture of material and lime is obtained, free from clods or lumps. Materials containing plastic clays or other material which will not readily mix with lime shall be mixed as thoroughly a possible at the time of lime application. During this step, water should be added to raise the moisture of the soil-lime mixture to at least 5% above optimum moisture content. After the initial mixing, the lime-treated layer shall be shaped to the approximate section and compacted lightly with a pneumatic roller prior to curing in order to minimize evaporation loss, lime carbonation, and to prevent excessive wetting from possible heavy rains.

604.1.2.d Preliminary Curing.

The lime material mixture shall cure a minimum of 48 hours to permit the lime and water to break down (or mellow) the soil material. Duration of this curing period should be based on engineering judgment; for extremely heavy clays, the curing period may be extended to 7 days or more, if necessary.

604.1.2.e Final Mixing.

After the required curing time, the lime material mixture shall be uniformly mixed. Mixing and pulverization shall continue until all clods are broken down and a homogeneous friable mixture or material and lime is obtained, such that when all non-slaking aggregates retained on the no.4 sieve are removed, the remainder of the material shall meet the following requirements when tested from the roadway in the roadway conditions by laboratory sieves:

Minimum Passing	1-inch sieve	100%
Minimum Passing	No.4 Sieve	60%

Additional water may be required after final mixing to raise the mixture to optimum moisture content prior to compaction. Rotary mixing is mandatory for this operation.

604.1.2.f Compaction.

Compaction of the mixture shall begin immediately after final mixing. The lime material mixture shall be compacted to at least 95% of the maximum density within 3% of optimum moisture as determined by ASTM D 698 (Standard Proctor Density). The density value shall be based on a representative field sample of the lime material mixture.

604.1.2.g Finishing, Curing and Preparation for Surfacing.

After the final layer of lime-soil material has been compacted, it shall be shaped to the required lines and grades in accordance with typical sections. The completed section shall then be finished by rolling with a pneumatic tire roller sufficiently light to prevent hair cracking. The completed section shall be moist-cured, which consists of maintaining the surface in a moist condition by light sprinkling and rolling, as necessary, moist rolling. Curing shall continue until covering with a subsequent course. Such course shall be applied within 14 days after final mixing is completed.

604.1.3 Quality Control.

The design and construction of all lime stabilized sub-grade and sub-bases shall be monitored and tested in accordance to specified ASTM and TxDOT Standards by a recognized Independent Testing Laboratory, experienced and well qualified for providing geo-technical engineering and material testing / inspection services within the local area. All specified field tests shall be performed in the presence of a city inspector at locations and frequencies determined by city inspector. The laboratory shall furnish reports to the Public Works Department, the Developer and the Contractor on all of its design determinations, all of its services and all of its quality control testing.

604.1.3.a Design.

A representative sample of the raw-soil or soil / aggregate for use in sub-grade, sub-base or base course shall be obtained to determine the optimum lime content of the material. A minimum of four (4) Atterberg limits (ASTM D 4318) will be required; starting with 5% lime and increasing lime content. A PI-Value vs. lime curve will show the percentage of hydrated lime required to produce optimum results the lime content required shall not be less than 5% of the dry weight of lime material mixture.

604.1.3.b Sieve Analysis.

Field tests at a frequency of one test for every 2000 square yards with a minimum of one test for each street, shall be required during the final mixing. The material shall be properly cured, uniformly mixed and pulverized to meet the specifications.

604.1.3.c Plasticity Indexes of Lime Material Mixture.

A representative field sample of the final mixed lime-material shall be obtained to determine the Atterberg limits (ASTM D 4318). The PI valve of the lime soil material shall conform to the previous lime determination and in all cases less than 20. If the lime material mixture is not uniform in composition, additional samples will be required.

604.1.3.d Standard Proctor.

A representative field sample of the final mixed lime material mixture shall be obtained to prepare the moisture / density relationship (ASTM D 698). If the lime material mixture is not uniform in composition, additional samples will be required.

604.1.3.e Lime Material Depth Check.

Representative areas of the lime material mixture, at a frequency of one test for every 2000 sq. yds., a minimum of one test for each street, shall be checked after final grade has been achieved to determine if the specified depth of sub-grade or sub-base material has been obtained.

604.1.3.f Compaction Tests.

Representative areas of the lime material mixture, at a frequency of one test for every 500 sq. yds., a minimum of one test for each street, shall be tested at each six-inch (6") layer of required lime material mixture depth. Compaction tests (ASTM D 2922) shall be performed on areas that will receive subsequent courses within five (5) days or if lime material mixture loses stability due to drying, wetting or construction damage; retests will be required. The lime material mixture shall be compacted to at least 95% maximum density within 3% of optimum moisture as determined by ASTM D 698 (Standard Proctor Density).

604.1.4 Lime-Fly Ash.

Only sub-grade, sub-base, or base material, in-place or borrow, that has been found to be effectively treated with lime-fly ash, containing no weeds, roots, or other vegetation; pulverized so 100% passes two-inch (2") sieve shall be considered acceptable material. Hydrated lime shall be Type "B", commercial lime slurry in conformance with TxDOT, ITEM 264. Fly ash shall be residue or ash remaining after burning finely pulverized coal at high temperatures conforming to requirements of ASTM C 618, Type

C" or "F" with a minimum CaO content of 20 %, loss on ignition not to exceed 3% and contain no lignite ash. The amounts of lime-fly ash required shall be determined by a qualified materials testing laboratory to be the optimum line content of the soil in no case less than 5% by weight.

604.1.5 Construction Method.

It is the primary requirement of this specification to secure a complete course of stabilized treated material containing a uniform mixture, free from loose or segregated areas, of uniform density and moisture content, well bound for its full depth and with a smooth surface suitable for placing subsequent courses.

604.1.5.a Scarification and Pulverization.

After the soil has been shaped to conform to the typical sections, lines and grades as shown on the plans and all soft areas (revealed by proof rolling) have been removed and corrected, the material should be scarified to the specified depth and width of stabilization and then partially pulverized. All delirious materials like roots, turf, etc., and aggregates larger than three inches (3") shall be removed.

604.1.5.b Application.

Hydrated lime-fly ash shall be uniformly spread as a single mix, single pass over a measured section of roadway. Provisions shall be made for agitation in the distributor truck to prevent settling of lime-fly ash solids. Include fly ash in percentage amounts in lime or lime slurry as established from geotechnical evaluation for application, mixing, and compaction.

604.1.5.c Preliminary Mixing.

The material and lime-fly ash shall be thoroughly mixed by approved rotary speed road mixers and the mixing continued until a homogeneous, friable mixture of material and lime-fly ash is obtained, free from clods or lumps. Materials containing plastic clays or other material which will not readily mix with lime-fly ash shall be mixed as thoroughly a possible at the time of application. During this step, water should be added to raise the moisture of the soil-lime mixture to at least 5% above optimum moisture content. After the initial mixing, the lime-fly ash treated layer shall be shaped to the approximate section and compacted lightly with a pneumatic roller prior to curing in order to minimize evaporation loss, lime carbonation, and to prevent excessive wetting from possible heavy rains. Operations shall be conducted to minimize elapsed time between mixing and compacting lime-fly ash subgrade in order to take advantage of rapid initial set characteristics. Complete compaction within 2 hours of commencing compaction and not more than 6 hours after adding and mixing last stabilizing agent.

604.1.5.d Preliminary Curing.

The lime-fly ash material mixture shall cure a minimum of 48 hours to permit the lime and water to break down (or mellow) the soil material. Duration of this curing period should be based on engineering judgment; for extremely heavy clays, the curing period may be extended to 7 days or more, if necessary.

604.1.5.e Final Mixing.

After the required curing time, the lime-fly ash material mixture shall be uniformly mixed. Mixing and pulverization shall continue until all clods are broken down and a homogeneous friable mixture or material and lime-fly ash is obtained, such that when all non-slaking aggregates retained on the no.4 sieve are removed, the remainder of the material shall meet the following requirements when tested from the roadway in the roadway conditions by laboratory sieves:

Minimum Passing	1-inch sieve	100%
Minimum Passing	No.4 Sieve	60%

Additional water may be required after final mixing to raise the mixture to optimum moisture content prior to compaction. Rotary mixing is mandatory for this operation.

604.1.5.f Compaction.

Compaction of the mixture shall begin immediately after final mixing. The lime-fly ash material mixture shall be compacted to at least 95% of the maximum density within 3% of optimum moisture as determined by ASTM D 698 (Standard Proctor Density). The density value shall be based on a representative field sample of the lime material mixture.

604.1.5.g Finishing, Curing and Preparation for Surfacing.

After the final layer of lime-fly ash-soil material has been compacted, it shall be shaped to the required lines and grades in accordance with typical sections. The completed section shall then be finished by rolling with a pneumatic tire roller sufficiently light to prevent hair cracking. The completed section shall be moist-cured, which consists of maintaining the surface in a moist condition by light sprinkling and rolling, as necessary, moist rolling. Curing shall continue until covering with a subsequent course. Such course shall be applied within 14 days after final mixing is completed.

604.1.6 Quality Control.

The design and construction of all lime-fly ash stabilized sub-grade and sub-bases shall be monitored and tested in accordance to specified ASTM and TxDOT Standards by a

recognized Independent Testing Laboratory, experienced and well qualified for providing geo-technical engineering and material testing / inspection services within the local area. All specified field tests shall be performed in the presence of a city inspector at locations and frequencies determined by city inspector. The laboratory shall furnish reports to the Public Works Department, the Developer and the Contractor on all of its design determinations, all of its services and all of its quality control testing.

604.1.6.a Design.

A representative sample of the raw-soil or soil / aggregate for use in sub-grade, sub-base or base course shall be obtained to determine the optimum lime-fly ash content of the material. A minimum of four (4) Atterberg limits (ASTM D 4318) will be required; starting with 5% lime-fly ash and increasing lime-fly ash content. A PI-Value vs. lime-fly ash curve will show the percentage of hydrated lime-fly ash required to produce optimum results the lime content required shall not be less than 5% of the dry weight of lime-fly ash material mixture.

604.1.6.b Sieve Analysis.

Field tests at a frequency of one test for every 2000 square yards with a minimum of one test for each street, shall be required during the final mixing. The material shall be properly cured, uniformly mixed and pulverized to meet the specifications.

604.1.6.c Plasticity Indexes of Lime-Fly Ash Material Mixture.

A representative field sample of the final mixed lime-fly ash material shall be obtained to determine the Atterberg limits (ASTM D 4318). The PI valve of the lime-fly ash soil material shall conform to the previous lime determination and in all cases less than 20. If the lime-fly ash material mixture is not uniform in composition, additional samples will be required.

604.1.6.d Standard Proctor.

A representative field sample of the final mixed lime-fly ash material mixture shall be obtained to prepare the moisture / density relationship (ASTM D 698). If the lime-fly ash material mixture is not uniform in composition, additional samples will be required.

604.1.6.e Lime Material Depth Check.

Representative areas of the lime-fly ash material mixture, at a frequency of one test for every 2000 sq. yds., a minimum of one test for each street, shall be checked after final grade has been achieved to determine if the specified depth of sub-grade or sub-base material has been obtained.

604.1.6.f Compaction Tests.

Representative areas of the lime-fly ash material mixture, at a frequency of one test for every 500 sq. yds., a minimum of one test for each street, shall be tested at each six-inch (6") layer of required lime material mixture depth. Compaction tests (ASTM D 2922) shall be performed on areas that will receive subsequent courses within five (5) days or if lime-fly ash material mixture loses stability due to drying, wetting or construction damage; retests will be required. The lime-fly ash material mixture shall be compacted to at least 95% maximum density within 3% of optimum moisture as determined by ASTM D 698 (Standard Proctor Density).

604.1.7 Portland Cement.

This ~~ITEM~~ Item shall consist of treating the sub-grade, sub-base or base by pulverizing, addition of Portland cement, mixing, wetting and compacting the mixed material to the required density. This ~~ITEM~~ Item applies to natural ground, embankment, existing pavement structure, or flexible base material, and shall be constructed as specified herein and in conformity with the typical sections, lines and grades as shown on the plans or established by the Engineer. Only sub-grade soil, sub-base or base material (TxDOT ITEM 275 or 276), that has been found to be effectively treated with Portland Cement; containing no weeds, roots or other vegetation; pulverized so that 100% passes two-inch (2") sieve, 20% maximum passes No. 200 sieve; and PI valve maximum of 10 shall be considered acceptable.

Portland cement shall conform to ASTM C150 Type I. The amount of Portland cement required for treatment of sub-grade shall produce a cement-soil material with a minimum 200 PSI compressive strength at seven (7) days (TEX-120-E). The amount of Portland cement required for treatment of sub-base or base courses shall produce a cement-soil aggregate material with a minimum 650 PSI compressive strength at 7 days (TEX-120-E). Portland cement treatment of material in place shall be constructed in accordance with TxDOT ITEM 275.

Portland cement treatment of base material shall be constructed in accordance with TxDOT ITEM 276.

604.1.8 Construction Method.

It is the primary requirement of this specification to secure a complete course of stabilized treated material containing a uniform mixture, free from loose or segregated areas, of uniform density and moisture content, well bound for its full depth and with a smooth surface suitable for placing subsequent courses.

604.1.8.a Scarification and Pulverization.

After the soil has been shaped to conform to the typical sections, lines and grades as shown on the plans and all soft areas (revealed by proof rolling) have been removed and corrected, the material should be scarified to the specified depth and width of stabilization and then partially pulverized. All delirious materials like roots, turf, etc., and aggregates larger than two inches (2") shall be removed.

604.1.8.b Application.

Portland cement shall be uniformly spread by successive passes over a measured section of roadway until the proper moisture and Portland cement content has been secured. Provisions shall be made for agitation in the distributor truck to prevent settling of solids.

604.1.8.c Mixing.

Do not place and mix cement when temperature is below 40 degrees F and falling. Place base when temperature taken in shade and away from artificial heat is above 35 degrees F and rising. Spread cement uniformly on soil at rate specified by laboratory. When bulk cement spreader is used, position it by string lines or other approved method to ensure uniform distribution of cement. Apply cement only to area where operations can be continuous and completed in daylight, within one hour of application. Amount of moisture in soil at time of cement placement shall not exceed quantity that will permit uniform mixture of soil and cement during dry mixing operations. Do not exceed specified optimum moisture content for solid cement mixture. Do not allow equipment other than that used in spreading and mixing to pass over freshly spread cement until it is mixed with soil. Dry mix cement with soil after cement application. Continue mixing until cement has been sufficiently blended with soil to prevent formation of cement balls when water is applied. Mixture of soil and cement that has not been compacted and finished shall not remain undisturbed for more than 30 minutes. Immediately after dry mixing is complete, uniformly apply water as necessary and incorporate it into mixture. Pressurized equipment must provide adequate supply to ensure continuous application of required amount of water to sections being processed within 3 hours of cement application. Ensure proper moisture distribution at all times. After last increment of water has been added, continue mixing until thorough and uniform mix has been obtained. Ensure percentage of moisture in mixture, based on dry weights, is within 2 percentage points of specified optimum moisture content prior to compaction. When uncompacted soil cement mixture is wetted by rain indicating that average moisture content exceeds tolerance given at time of final compaction, reconstruct entire section in accordance with this Section at no additional cost to City.

604.1.8.d Compaction

Prior to beginning compaction, ensure mixture is in loose condition for its full depth. Uniformly compact the loose mixture to specified density, lines and grades. After soil and cement mixture is compacted, apply water uniformly as needed and mix thoroughly. Then

reshape surface to required lines, grades, and cross section and lightly scarify to loosen imprints left by compacting or shaping equipment. Roll resulting surface with pneumatic-tire roller and "skin" surface with power grader. Thoroughly compact mixture with pneumatic roller, adding small increments of moisture, as needed. When aggregate larger than No. 4 sieve is present in mixture, make one complete coverage of section with flat-wheel roller immediately after skinning operation. When approved by Public Works Department, surface finishing methods may be varied from this procedure, provided dense uniform surface, free of surface compaction planes is produced. Maintain moisture content of surface material at its specified optimum during finishing operations. Compact and finish surface within period not to exceed 2 hours to produce smooth, closely knit surface, free of cracks, ridges or loose material, conforming to crown, grade, and line shown on Drawing within period not to exceed 2 hours.

604.1.8.e Construction Joints

At the end of each day's construction, form straight transverse construction joint by cutting back into total width of completed work to form true 2-inch depth vertical face free of loose and shattered material. Construct cement treatment for large wide areas in series of parallel lanes of convenient length and width approved in advance by the Public Works Department.

604.1.8.f Finishing, Curing and Preparation for Surfacing.

Moist cure for a minimum of 3 days before placing base or surface course, or opening to traffic. When open, restrict traffic to light pneumatic rollers or vehicles weighing less than 10 tons. Keep subgrade surface damp by sprinkling. Roll with light pneumatic roller to keep surface knit together. Place base and surface within 14 days after final mixing and compaction, unless prior approval is obtained from the Public Works Department.

604.1.9 Quality Control.

The design and construction of all Portland Cement stabilized sub-grade, sub-bases and base courses shall be monitored and tested in accordance with specified ASTM and THD standards by a recognized independent testing laboratory, experienced and well qualified for providing geo-technical engineering and material testing / inspection services within the local area. All specified field tests shall be performed in the presence of a City Inspector at locations and frequencies determined by the City Inspector. The laboratory shall furnish reports to the Public Works Department, the Developer and the Contractor on all of its design determinations, all of its services and all of its quality control testing.

604.1.9.a Design.

The mix will be designed with the intention of producing a minimum average compressive strength as specified. Cement stabilized material specimens shall be prepared, cured and

tested as outlined in test method TEX-120-E. The cement content shall not be less than 4.5% of the dry weight of the cement material mixture.

The base material, when tested in accordance to test method TEX-110-E, shall meet the requirements of TxDOT ITEM 275.4. The soil binder material, when tested in accordance to test method TEX-106-E, shall meet the requirements of TxDOT ITEM 275.4.

604.1.9.b Sieve Analysis.

Field test at a frequency of one test for every 2000 sq. yds., with a minimum of one test for each street shall be required during mixing and pulverization of Portland Cement treatment for material in place. The material shall be so pulverized that, at the completion of moist-mixing, when all non-slaking aggregate retained on the No.4 sieve are removed, the remaining material shall meet the following requirements when tested from the roadway in the roadway condition by laboratory sieves:

Minimum Passing 1-inch Sieve 100%

Minimum Passing No. 4 Sieve 60%

604.1.9.c Standard Proctor.

A representative field sample of the mixed cement material mixture shall be obtained to prepare the moisture / density relationship (ASTM 698).

604.1.9.d Compaction Tests.

Representative areas of the cement material mixture, at a frequency of one test for every 500 sq. yds., a minimum of one test for each street, shall be tested at each six-inch (6") layer of required cement material mixture depth. Compaction tests (ASTM 2922) shall be performed within 4 hours after Portland cement is added to the sub-grade, sub-base or base course material. If the cement material mixture loses stability due to drying, wetting or construction damage; additional cement shall be added and retests will be required, the cement material mixture shall be compacted to at least 95% maximum density within 3% of optimum moisture as determined by ASTM 698 (Standard Proctor Density).

ITEM 605
CONCRETE PAVEMENT

This ITEM shall consist of a pavement composed on Portland Cement concrete, with reinforcement, with or without curbs, constructed as herein specified on a prepared stabilized sub-grade in conformity with thickness, lines and grades, and typical cross sections as indicated in the specifications and plans.

605.1 Materials.

The source of supply of each material shall be approved by the Public Works Department or EOR, before being incorporated in the work, and shall be sampled and tested for determining compliance, before and during the course of the work. Only materials conforming to these specifications and approved by the Public Works Department or EOR shall be used in the work.

605.1.1 Portland Cement.

Portland cement shall conform to ASTM C-150, Type I or Type IA. The cement shall conform to applicable ASTM specifications for weight variations and length of storage. Cement which has become caked or lumped shall not be used.

605.1.1.a Mineral Filler for Portland Cement.

Type "F" fly ash of acceptable quality and meeting requirements of ASTM C 618 may be used as mineral admixture in concrete mixture. When fly ash mineral filler is used, store and inspect in accordance with ASTM C 618. Do not use fly ash in amounts to exceed 25 percent by weight of cementitious material in mix design. Cement content may be reduced when strength requirements can be met. Note: When fly ash is used, term "cement" is defined as cement plus fly ash.

605.1.2 Coarse Aggregate.

Coarse aggregate shall consist of durable particles of gravel, crushed gravel, or crushed stone of reasonably uniform quality throughout, free from injurious amounts of salt, alkali, vegetable matter or objectionable material and shall conform to ASTM C-33. Grading of Course Aggregate for roadway paving shall conform to the requirements prescribed in ASTM C-33 for size Number 467. Grading of course aggregate for curb installation shall conform to the requirements prescribed in ASTM C-33 for size Number 7.

605.1.3 Fine Aggregates.

Fine aggregates shall consist of sand or a combination of sand, and shall be composed of clean, hard, durable, uncoated grains and shall conform to ASTM C-33.

605.1.4 Water.

Water used in mixing or curing shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable matter, or other substance injurious to the finished product. Water shall be tested in accordance with AASHTO T26. Water known to be potable may be used without test.

605.1.5 Admixtures.

Admixtures shall have proven compatibility with all local concrete materials, including cement and other proposed admixtures, and shall can provide the concrete with the desired properties without subsequent loss of strength of durability. Admixtures shall not be used to replace cement. Admixtures shall comply with all the requirements of TxDOT ITEM 437. When using admixtures in concrete, the compatibility of intermixing admixtures and the amounts required to produce the desired result shall be assured by the admixture manufacturer. The water contained in admixtures shall be considered part of the mixing water.

605.1.6 Reinforcing Steel.

All bar reinforcement for concrete streets shall be deformed, conforming to ASTM A615, Grade 40, open hearth, basic oxygen, or electric furnace new billet steel, minimum bar size No. 4. Steel for reinforcement may be shop or field bent or cut. All bending and cutting shall be performed in accordance with TxDOT ITEM 440.3.

All steel for reinforcement shall be secured in place by use of approved metal or plastic supports and spacers and ties. Supports shall be of sufficient strength to maintain the reinforcement in place throughout the concreting operation. All splices in reinforcement shall have a minimum lay of 30 bar diameters. Lapped ends of bars shall be placed in contract and securely wired. All tie-wire shall be 16 gauge or heavier, black annealed wire.

605.1.7 Load Transmission Device for Expansion Joints.

Expansion joints shall be of the dowel type, load transmission device consisting of smooth, steel dowel bars of size and type indicated in the standard details, secured in position by a transverse joint filler board. Steel dowel bars shall be open-hearth, basic oxygen, or electric-furnace steel conforming to the properties specified for grade 60 in ASTM A 615. One end of dowel bar shall be encased in an approved cap having an inside diameter of 1/16 inch greater than the diameter of the dowel bar. The cap shall be such strength, durability and design as to provide free movement of the dowel bar. Dowel bars shall be installed through approve fittings at 22-inch centers.

Joint filler materials shall be timber boards, rebounded neoprene filler, or rebonded recycled tire rubber. In all cases the joint filler material shall be ¾ inch and furnished in a single piece for the full depth and width required for the joint unless otherwise authorized by the Public Works Department or EOR.

Joint filler timber boards shall be obtained from Redwood or Cypress. They shall be sound heartwood and shall be free from sapwood, knots, clustered bird's eye, checks and splits.

Rebounded neoprene filler consists of ground closed-cell neoprene particles, rebonded and molded into sheets of the required dimensions. These sheets must meet the requirements of ASTM D 1752, Type I.

Rebonded recycled tire rubber consists of granular particles of rubber, made by grinding automobile and truck tires, securely bound together by a synthetic resin or plastic binder. The filler must be molded into sheets of the required dimensions and which meet the testing requirements of both ASTM D 1751 and ASTM D 1752, except that the requirements for asphalt content and expansion are waived. The density of the material must be at least 30 lb./ft.

605.1.8 Joint Sealing Material.

Poured sealer for joints shall conform to the requirements of ASTM D 1190, alternatively, low-modules Silicone Rubber Highway Joint Sealant conforming to TxDOT ITEM 433.2 (f) may be used.

605.1.9 Curing Material.

Membrane curing compounds for concrete shall be the white pigmented type conforming to the requirements of ASTM C-309.

605.2 Equipment.

All equipment necessary for the proper handling, mixing, hauling, placing, finishing and curing of the concrete shall be maintained in good working condition, throughout the construction of the project, to assure the proper prosecution of the work.

605.2.1 Aggregate Weighing Equipment.

Aggregate bins and scales shall conform to ASTM C 94.

605.2.2 Cement Weighing Equipment.

Where bulk cement is used, it shall be batched by weight and the scales shall conform to the requirements ASTM C94.

605.2.3 Mixers.

Mixers shall be of an approved stationary or truck-type capable of combining the ingredients into a thoroughly mixed and uniform mass and shall conform to the requirements of ASTM C-94.

605.2.4 Hauling Equipment.

Hauling equipment shall be provided in accordance with ASTM C-94.

605.2.5 Forms.

Forms shall be of such cross section and strength and so secured as to resist the pressure of the concrete when placed and the impact and vibration of any equipment they support, without springing or settlement. the method of connection between sections shall be such that the joints shall not move in any direction. The maximum deviation of the top surface shall not exceed 1/8 inch in 10 feet or the inside face not more than 1/4 inch in 10 feet from a straight line.

605.2.6 Mechanical Vibratory Equipment.

All concrete placed for pavement shall be consolidated by approved mechanical vibrators. A vibratory form-type paving screed shall be so designed and operated as to strike off, consolidate, and finish the pavement to the required cross section. Paving screeds shall be maintained in a tight and good operating condition, accurately adjusted to the required crown or profile, and free from deflection, wobble, or vibration tending to affect the precision of finish.

605.2.7 Joint Sealing Equipment.

Sealing equipment shall be capable of installing the sealant in joints in accordance with manufacture's recommendation.

605.2.8 Membrane Sprayer.

A pressure sprayer capable of applying a continuous uniform film will be required.

605.2.9 Other Equipment.

The contractor shall also furnish all other equipment, small tools, and supplies which are necessary to the proper prosecuting of the work.

605.3 Proportioning and Design of Concrete.

Concrete shall be composed of Portland cement, fine aggregate, coarse aggregate, water, and admixtures. The actual proportions of materials to be used for various mixes shall be determined by an approved independent testing laboratory in accordance with ACI Standard 211 so as to produce a quality concrete that will meet or exceed the requirements as herein specified.

605.3.1 Concrete Strength.

The concrete mix will be designed to produce a minimum flexural strength of 550 PSI at the age of 7 days and a minimum compressive strength of 3500 PSI at the age of 28 days. Unless otherwise specified, the concrete shall contain not less than 5.5 sacks of Portland cement per cubic yard of concrete. The water-cement ratio (net gallons of water per sack of cement) shall not exceed 6.25 gallons/sack. Concrete specimens shall be prepared, cured and tested in accordance with ASTM C-39 and ASTM C-239.

605.3.2 Workability of Concrete.

Concrete shall be uniformly plastic, cohesive and workable. Workable concrete is defined as concrete which can be placed without honeycomb and without voids in the surface of the pavement after the specified finishing operation has been completed. Workability shall be obtained without producing a condition such that free water appears on the surface of the slab when being finished.

The mix will be designed to produce concrete which will have a slump of 4(+-1) inches when tested in accordance with ASTM C-143. The maximum allowed slump for field placement shall be 5 inches (5").

605.3.3 Entrained Air.

Entrained air shall be used in all concrete. Air entrainment shall be provided with air-entrained Portland Cement or by adding an air-entraining agent. The amount of admixture shall be adjusted to meet variations in concrete ingredients and job conditions to provide a total air content (percent by volume) of 5 (+- 1) inches when tested in accordance with ASTM C-173.

605.3.4 Water Reducing Retarding Admixtures.

A water reducing retarding admixture shall be used in the concrete batch when the air temperature is expected to exceed 78 degrees during the concrete placement.

605.3.5 Mix Design.

It shall be the responsibility of the Contractor to furnish the mix design. The mix shall be designed to conform with the requirements contained herein and in accordance with ACI 214. An Independent Material Testing Laboratory employed by the Developer shall perform the work required to substantiate the design. Complete concrete design data shall be submitted to the Public Works Department for approval.

605.4 Subgrade and Forms.

The sub-grade for pavement sections shall be properly constructed in accordance to ITEM 604 "Sub-grade, Sub-base and Base Courses" before forms, steel or concrete can be placed. All forms shall be accurately set to the required grade and alignment and, during the entire operation of placing, compacting and finishing of the concrete, shall not deviate from this grade and alignment more than 1/8 inch in 10 feet of length. The forms shall not be removed for at least 12 hours after the completion of finishing operations. They shall be carefully removed in such a manner that no damage will be done to the edge of the pavement. Any damage resulting from this operation shall be immediately repaired by saw cut and full-depth replacement. Adjacent slabs may be used instead of forms provided that the concrete is well protected from possible damage by finishing or placing equipment.

605.5 Reinforcing Steel Placing.

All reinforcing steel, including tie bars, dowel bars, and load transmission devices used in accordance with plan provisions shall be accurately placed and secured in position in accordance with details shown on the "Standard Details". The reinforcement shall be accurately located in the forms, and firmly held in place, before and during concrete placement, by means of bar supports, adequate in strength and number to prevent displacement, to keep the steel at the proper distance from the forms and to carry the reinforcing bars they support. Bars shall be supported by standard galvanized bar supports, bar supports with plastic tips, stainless steel bar supports, or approved plastic bar supports. Reinforcing bars shall be securely wired together at alternate intersections, following a pattern approved by the Engineer, and at all splices, and shall be securely wired to each dowel intersection. Before any concrete is placed, all mortar, mud, dirt, etc., shall be cleaned from the reinforcement. No concrete shall be deposited until the Engineer has inspected the placement of the reinforcing steel and given permission to proceed.

605.6 Joint Assemblies.

All transverse and longitudinal joints when required in the pavement shall be of the type or alternate type shown on the approved plans and shall be constructed at the required location, on required alignment, in required relationship to tie bars and joint assemblies. Such stakes, braces, brackets or other devices shall be used as necessary to keep the entire joint assembly in true vertical and horizontal position. Careful workmanship shall be exercised in the construction of all joints to ensure that the concrete sections are separated by an open joint or by the joint materials and to ensure that the joints will be true to the outline indicated.

605.6.1 Construction Joints.

Intentional stoppage of the placing of concrete shall be at either an expansion joint or at a weakened plane joint. When the placing of concrete is stopped at an expansion joint, the

complete load transmission device shall be installed and rigidly secured in required position and cross section. When placing of concrete is stopped at a weakened plane joint, the complete joint assembly, including 24" tie bars, shall be installed and rigidly supported in required position. Weakened plane joints shall be either keyed, tongue and grooved, or butt-type with tie bars to hold adjacent slabs in vertical alignment. Construction joints shall be tooled to a sufficient width and depth in order to receive joint sealant material.

605.6.2 Expansion Joints.

Traverse expansion joints shall be formed perpendicular to the centerline and surface of the pavement and shall be constructed at radius points of curb returns for cross street intersections and at regular intervals, a maximum spacing of 80 feet. Expansion joints shall be of the dowel type, load transmission in accordance with ITEM 605.1.7 "Load Transmission Devices for Expansion Joints". On completion of curing of the pavement, the joint seal space form shall be removed and the joint seal space above the joint filler board shall be thoroughly cleaned to remove all projecting concrete, laitance, dirt or foreign matter. The concrete faces of the joint seal space shall be left true to line and section throughout the entire length of the joint. The faces of the joint seal space shall be clean and surface dry at the time joint sealing filler is placed.

605.6.3 Weakened-Plane-Joint

Weakened plane joints shall consist of longitudinal joints and block-out-type construction joints and shall be formed or sawed. When the joints are sawed, the saw shall be power driven, shall be manufactured especially for the purpose of sawing concrete, and shall be capable of performing the work. Longitudinal joints shall be constructed accurately to required lines, shall be perpendicular to the pavement surface at the joint, and the pavement surface over and adjacent to the joint shall be finished as specified. If the deformed metal strip is used, it shall be secured in position with metal stakes, adequate to prevent any lateral movement while the concrete is being place. Longitudinal joint spacing shall not exceed 15 feet.

605.7 Mixing and Delivery of Concrete.

The Concrete shall be mixed and delivered to the work site in accordance with ASTM C-94.

605.8 Placing Concrete.

The method of concrete placement shall avoid segregation of the aggregate or displacement of the reinforcing steel and joint assemblies. Concrete shall be deposited on a moist grade as near as possible in its final position in the forms. Workers will not be permitted to walk in concrete with any earth or foreign material on their boots or shoes. The placing of concrete shall be rapid and continuous between planned transverse joints. Concrete shall

be thoroughly consolidated against and along the faces of all forms and along the full length and width of the slab by an approved mechanical vibratory unit. Concrete shall be distributed to such a depth that when consolidated and finished, the slab thickness required will be obtained at all points and the surface shall not at any point, be below the established grade. Special care shall be exercised in placing and spading concrete against forms and at all joints to prevent the forming of honey combs and voids. The consistency of the concrete as placed should allow the completion of all finishing operations without the addition of water to the surface. When conditions are such that additional moisture is needed for finish, the water shall be applied to the surface by fog spray only, and shall be held to a minimum amount.

The maximum time interval between the addition of cement to the batch, and placing of concrete in the forms shall not exceed 60 minutes for agitated concrete and 15 minutes for non-agitated concrete. The use of an approved water reducer retarding agent will permit the extension of time maximum by 30 minutes. The use of a water reducer retarding agent will be required when the air temperature is expected to exceed 78 degrees during the concrete placement.

605.8.1 Placing Concrete in Hot Weather.

When concrete is to be placed during hot weather, air temperatures above 78 degrees F, it shall be placed without the addition of more water to the concrete than required by the design - slump and consistency. Control of the initial set of the concrete and lengthening the time for finishing operations, under adverse wind, humidity and hot weather conditions shall be accomplished with the use of an approved water reducer retarding agent. Because of the detrimental effects of high concrete temperatures, operations in hot weather shall be directed towards keeping the concrete as cool as is practicable and protecting the surface of the concrete from rapid evaporation of moisture. Slab sections with numerous plastic shrinkage cracks shall be considered unacceptable and shall be removed and replaced.

605.8.2 Placing Concrete in Cold Weather.

Concrete shall not be placed when the air temperature is 40 degrees F. and falling, but may be placed when the air temperature is above 40 degrees F. and rising. When concrete is placed in cold weather conditions, the contractor shall have available a sufficient supply of approved covering material to maintain the temperature of the air surrounding the concrete at not less than 50 degrees F. for not less than 5 days.

605.8.3 Placing Concrete in Inclement Weather.

Concrete placement will not be permitted when impending weather conditions will impair the quality of the finish work. If rainfall should occur after placing operations are started, the contractor shall provide ample covering to protect the work. Areas of the pavement surface where the texture has been damaged by the protective cover shall be textured and cured unless the concrete has hardened. Areas that have suffered surface erosion and have

coarse aggregate exposed shall be considered unacceptable and shall be removed and replaced.

605.9 Finishing Concrete.

All concrete pavements shall be struck off and consolidated with an approved vibrating screed, except as herein provided. Hand-finishing will be permitted on that portion of pavement outside the normal pavement width or configuration. As soon as the concrete has been spread between the forms, the approved vibrating screens shall be operated to consolidate the concrete and remove all voids. Hand-manipulated vibrators shall be used for areas not covered by the mechanical vibratory unit. The vibrating screed shall first be operated to compact and finish the pavement to the required section and grade, without surface voids.

After the pavement has been struck off and consolidated, it shall be scraped with a metal straightedge 10 ft. long equipped with a handle to permit operation from the edge of the pavement. Any excess water and laitance shall be removed from the surface of the pavement. The straightedge shall be operated parallel to the centerline of the pavement and shall be moved forward one-half its length after each pass. Irregularities shall be corrected by adding or removing concrete. A burlap drag or canvas-rubber belt shall be used for final finish texture. Burlap bag or belt shall be long enough to cover the entire pavement width. They shall be kept clean and saturated while in use. The burlap drag shall be laid on the pavement surface and dragged in the direction which the pavement is being placed. The canvas-rubber belt shall be laid on the pavement surface and moved forward with a combined transverse and longitudinal motion in the direction which the pavement is being placed. These textures shall provide a gritty, skid resistant surface.

After completion of texturing, and before the concrete has taken its initial set, the edges of the slab, and expansion joints shall be tooled. A stiff bristled broom shall be drawn along these edges.

605.10 Curbs.

Curbs shall be installed along the edges of all streets where shown in the plans and shall be constructed to the cross section in accordance with the approved plans. Curbs, and curbs and gutters may be constructed using forms or Slip form or extrusion equipment. The edge of each gutter of the curb and gutter section built first may be used as a slab form in lieu of setting forms. The curb, or curb and gutter, shall be given a textured finish to match the pavement.

605.11 Curing.

All concrete pavement shall be cured by protecting it against loss of moisture for a period of not less than 3 days from the beginning of curing operations. Unless otherwise specified

on the plans, white liquid membrane curing shall be used for concrete pavement and curbs. The membrane method of curing shall be applied behind the final finishing operation after all free water has disappeared from the surface. Complete and uniform coverage at the required rate of 150 sq. ft. per gallon shall be required. The compound shall be kept agitated to prevent the pigment from settling, and it shall be applied to the pavement edges immediately after the forms have been removed. Should the film of compound be damaged from any cause before the expiration or 3 days after original application, the damaged portions shall be repaired immediately with additional compound.

605.12 Opening Pavement to Traffic.

The pavement shall be closed to all traffic, including vehicles of the Contractor, until the concrete is at least 3 days old. At the end of the 3-day period, if so desired by the Contractor, the pavement may be opened for use by light vehicles of the Contractor. The pavement shall remain closed to all other traffic, including public access, construction equipment and heavy trucks until the concrete has reached a minimum compressive strength of 3000 psi. Sections of pavement not required to be open for public traffic should remain barricaded and closed to public traffic until the approval of the City.

605.13 Sealing Joints.

Joints to be sealed shall be filled with joint-sealing material before the pavement is opened to traffic and as soon after completion of the curing period as is feasible. Just before sealing, each joint shall be thoroughly cleaned of all foreign material, including membrane curing compound, and joint faces shall be clean and surface-dry when seal is applied. The sealing material shall be applied to each joint opening in accordance with the approved plans. The joint filling shall be done without spilling material on the exposed surfaces of the concrete.

605.14 Laboratory Services.

The design and construction of all concrete pavement shall be monitored and tested in accordance to specified ASTM, ACI and/or TxDOT Standards by a recognized independent testing laboratory, experienced and well qualified for providing concrete engineering and material testing / inspection services within the local area. The testing laboratory shall be responsible for the prompt notification to the Public Works Department or EOR and the Contractor of any observed irregularities of deficiencies of work or materials.

605.14.1 Mix Design Verification.

A representative sample of the proposed materials shall be obtained from the supplier's plant to determine if the materials and the design are within the specifications: Analysis of Strength Data - ACI 214, Standard Specification for Concrete Aggregates - ASTM C33,

Concrete Admixtures - THD 437.Mix design verifications will be required for pavement projects over 2000 square yards.

605.14.2 Batch Plant Inspections.

Laboratory technicians shall inspect batch plant prior to each placement to verify compliance with mix design, weights, procedures, and handling.

605.14.3 Monitor Placement.

Laboratory technicians shall monitor field placement of concrete to verify compliance with mix design, slump range, time and temperature control, procedures and handling. Continuous monitoring will be required for the placement of all roadway pavement and curb and gutter pavement. Continuous monitoring will not be required for curb installation. No roadway pavement may be placed without the presents of the laboratory technician.

605.14.4 Strength.

Strength tests as well as slump, air content, and temperature tests shall be made with a frequency of not less than one set of samples for each 150 cubic yards of concrete. Each test shall be made from a separate batch on each day concrete is placed, at least one set of samples shall be made for each class of concrete and at least one set of samples shall be made for each street. A set of samples shall include 4-cylinder specimens 2 at 7-day and 2 at 28-day strengths. Cylinder specimens shall be tested in accordance with ASTM C39. Slump tests shall be made in accordance with ASTM C143, Air content test shall be made in accordance with ASTM C 173, and temperature tests shall be made in accordance with ASTM C 1064. Strength tests shall be required for all concrete placements.

605.14.5 Core Samples.

The testing laboratory shall core drill the pavement to determine pavement thickness. Length of drilled cores shall be determined in accordance with ASTM C174. Core samples shall be required for all roadway pavements prior to approval at a frequency of not less than one test for each 1000 sq. yds. with a minimum of one core for each street.

605.15 Deficient Pavement Thickness.

The thickness of the pavement will be determined in accordance with ITEM 605.14.5 Core samples. Locations of core tests may be selected by the engineer. When the measurement of the initial core from any unit is not deficient more than 0.20 inches from the plan thickness, the pavement thickness will be considered satisfactory. When the measurement of the initial core from any unit is deficient more than 0.20 inches but not less than 0.25 inches from the plan thickness one additional core will be taken from the unit and the average of the two cores will be determined. If the average measurement of these two cores is not deficient more than 0.25 inches from the plan thickness, the pavement

thickness will be considered satisfactory. If the average measurement of these two cores is deficient more than 0.25 from plan thickness, the pavement thickness will be considered unsatisfactory. This pavement unit with unsatisfactory thickness may be isolated by existing control joints and additional core samples shall be required in the pavement units along the width and length in each direction from the identified unit of deficient thickness. These pavement units shall be tested in the same method as described above. All pavement units of unsatisfactory thickness will be considered unacceptable by the city and shall be removed and replaced with pavement of required thickness.

ITEM 606
HOT MIX ASPHALTIC CONCRETE PAVEMENT

This ~~ITEM~~ Item shall consist of a base course, a leveling up course, a surface course or any combination of these courses as shown on the plans. Each to be composed of a compacted mixture of mineral aggregate and asphaltic material. The pavement shall be constructed on the previously completed and approved sub-grade, and base course. Materials and construction requirements for asphaltic, concrete, pavement shall be provided in accordance with TxDOT 340, Type "D".

ITEM 607
TRAFFIC SIGNS

All traffic signs shall conform to the requirements of "Part II-Signs" of the TMUTCD. All blank signs shall be Reflectorized sheet aluminum, in accordance with TxDOT 636, mounted on 2" galvanized steel posts with vandal-proof bolt-thru brackets. Street name signs shall be 6" extruded aluminum blades with a green reflective background and white reflective letters mounted on 2" galvanized steel posts with approved caps and vandal-proof fasteners. Roadside traffic sign supports for collector streets and arterial streets shall be provided in accordance with TxDOT ITEM 646.

ITEM 608
PAVEMENT AND CURB MARKINGS
(Reflectorized Paint)

Reflectorized paint markings shall be provided for all rural streets. Reflectorized paint markings may be used on urban streets for special applications when approved by the Public Works Department. Pavement and curb markings shall conform to the requirements of "Part III-Markings" of the TMUTCD and League City standards unless on a TxDOT facility where TxDOT standards shall apply. All materials used for Reflectorized paint shall conform to the requirements of the State Department of Highways and Public Transportation, Material and Test division. The contractor shall obtain a certification from the paint manufacturer attesting that the paint provided conforms to the state requirement.

Construction method for Reflectorized pavement marking shall be provided in accordance with TxDOT ITEM 666.

ITEM 609
TRAFFIC BUTTONS

Traffic buttons shall be provided for all Urban Collector Streets and Urban Arterial Streets and shall conform to the requirements of "Part III-Markings" of the TMUTCD.

All materials and construction methods shall be provided in accordance with TxDOT ITEM 672.

DESIGN FEATURE	MAJOR ARTERIAL	MINOR ARTERIAL	COLLECTOR	RESIDENTIAL	RURAL/LOCAL
Number of Lanes	4 to 6	2 to 4	2	2	2
Right-of-Way (min)	120'	100'	80' (90' if ditch) 90' (100 if ditch)	60'	60'
Lane Width *a) Divided one-way; lane* *b) Single two-way* *c) Shoulders*	TXDOT	a) 2-25' roadways, 12' lanes b) N/A c) N/A	a) 2-25' roadways, 2-12' traffic & 2-12' parking lanes b) 12' lanes - 10' parking lanes c) N/A	a) N/A b) 24' travel path c) 4' for ditch drainage	a) N/A b) 24' travel path c) 4' for ditch drainage
Median Width	TXDOT	14' to 40'	14' to 40'	N/A	N/A
Design Speed (mph)	50 mph	50 mph	Min 35 mph	25 mph	30 mph
Sight Distance *a) Stopping sight dist.* *b) Passing sight dist.* *c) Intersection corner sight dist.*	TXDOT	a) 475' to 550' b) 1,800 to 1,950' c) N/A	a) 275' to 325' b) 1,300' c) N/A	a) 120 ' to 200' b) N/A c) 210' to 310'	a) 120' to 200' b) N/A c) 210' to 310'
Intersection Design *a) Length between intersection* *b) Intersection street angle* *c) Radius of curb return*	Traffic engineer to determine the best design to handle the expected traffic volumes	Traffic engineer to determine the best design to handle the expected traffic volumes	a) 300' min 1200' m'ax. b) no less than 75" c) 30'	a) 1200' max. b) no less than 75" c) 25'	a) 1200 max. b) no less than 75" c) 25'
Horizontal Curve *a) centerline radius simple/ compound curve* *b) centerline radius reverse curve* *c) tangent length reverse curve*	a) 2,000 b) c)	a) 800' b) N/A c) 100'	a) 500' b) N/A c) 100'	1) 160' b) 300' c) 100'	a) 160' b) 300' c) 100'
Grades *a) Slope* *b) Vertical curves*	TxDOT	a) 0.5% or more b) diff. in grades exceed 1%	a) 0.5% or more b) diff. in grades exceed 1%	a) less than 15% b) diff. in grade exceed 1%	a) less than 7% b) diff. in grades exceed 1%
Pavement Crown *a) Driving lanes* *b) Left turn lanes* *c) Shoulders*	TXDOT	a) 2% b) 1% c) N/A	a) 2% b) 1% c) N/A	a) 2% b) 1% c) N/A	a) 2% b) 1% c) 4%
Pavement Type	TXDOT	8' thick concrete Curb and gutter or open ditch	7" thick concrete Curb and gutter or open ditch	6" thick concrete or 2" thick hot mix asphalt, curb and gutter or open ditch	6" thick concerete or 2" thick hot mix asphalt; curb and gutter or open ditch
Storm Inlets Spacing	TXDOT	300" max or 8-inch above gutter	300' max or 8-inch above gutter	300' max or 8-inch above gutter	300' max or 8-inch above gutter
Driveway Access *a) Residential* *b) Commerical*	TXDOT	a) No Access b) 500'-1,000' desirable	a) See standard details b) See standard details	a) See standard details b) See standard details	a) See standard details b) See standard details
Street Lighting	Continuous and energy saving type	Continuous and energy saving type	Continuous and energy saving type	Continuous and energy saving type	
Traffic Control Devices	MUTCD shall be used	MUTCD shall be used	MUTCD shall be used	MUTCD shall be used	MUTCD shall be used
Sidewalks	2 - 4 ' sidewalks or 1 - 8' sidewalk	2 - 4 ' sidewalks or 1 - 8' sidewalk	2 - 4 ' sidewalks or 1 - 8' sidewalk	2 - 4 ' sidewalks or 1 - 8' sidewalk	2 - 4 ' sidewalks or 1 - 8' sidewalk
Cul-de-Sacs & Turnarounds *a) Lenth (max.)* *b) Diameter (min.)* *c) Right-of-way width*	N/A	N/A	a) 880' b) 100' c) exceed diameter by 20'	a) 880' b) 80' c) exceed diameter by 20"	a) 880' b) 80' c) exceed diameter by 20'

SPECIFICATION
FOR
DRAINAGE PROJECTS

ITEM 701
GENERAL

The intent of this section is to present minimum standards for storm water quality and the design and construction of hydraulic structures for the secondary system of storm sewers and roadside ditches. Hydraulic structures for these secondary systems should convey storm water safely, control erosion, be cost effective, require minimal maintenance, and add safety and esthetics to the drainage system.

Specific design criteria; including the appropriate rainfall frequency and discharge methodology selected for use in the area, as well as specific hydrologic and hydraulic criteria used for the planning of storm sewers, channel improvements and detention facilities, is defined in The Master Drainage Plan. Structural designs for primary channels, lateral outfall channels and detention facilities, as well as drop structured, culverts, bridges, storm sewer outfalls, and detention reservoir control structures; the City has as of Resolution No. 2011-07 adopted The Harris County Flood Control Districts (HCFCD) Criteria Manual for the design of flood control and drainage facilities, except where superseded by The Master Drainage Plan and with the following modifications and additions:

a) Maximum storm water ponding depth as measured at the gutter low point shall be no more than nine (9) inches,
b) Detention facilities shall have
    i. two (2) feet of freeboard above the 1% annual exceedance probability (100-year) storm water surface elevation, or at the 0.2% annual exceedance probability (500-year) storm water surface elevation, whichever is higher,
    ii. a maximum basin side slope ration of 4:1
    iii. a minimum slope of 0.5% slope for flume/pilot channel directing flow to the outflow structure,
    iv. Overflow path and pipes shall be sized to convey the 0.2% annual exceedance probability (500-year) peak inflow.
c) Discharge must be limited and directed in a manner that will not damage adjacent properties or public infrastructure, and does not cause hazardous conditions, and
d) ~~Detention ponds, including amenity ponds, shall have a maximum basin side slope ratio of 4:1.~~Dry Detention facilities may be utilized as an amenity park if approved by the Director of Engineering. All proposed improvements in the detention facility that is being utilized as an amenity park will need to meet Chapter 50 (Floods) of the City's Local Code of Ordinances while also providing sufficient emergency egress and warning signage.

Storm water management for construction activities shall follow the "Storm Water Management Handbook for Construction Activities".

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ITEM 702
CULVERTS

Culverts allow for roadway, railroad, driveway and other utility crossings of open ditches. Materials used for culvert construction shall include pre-cast reinforced concrete pipe, monolithic reinforced concrete boxes and pre-cast reinforced concrete boxes.

The size and flow line of a culvert will depend on the hydraulic requirements, with the minimum pipe diameter of ~~18~~ 24 inches (or equivalent to a 24-inch circular pipe) and the minimum box size of 24 inches x 24 inches.

All culverts for public roadway crossings of drainage channels with a depth greater than 4 feet shall include headwalls to protect the embankment from erosion. Protective traffic rated guardrails shall also be included along culvert headwalls for the protection of the general public.

ITEM 703
CLOSED CONDUIT SYSTEMS

Closed conduit systems for storm sewers shall be constructed of HDPE, reinforced concrete pipe, monolithic reinforced concrete boxes or pre-cast reinforced concrete box structures.

The size and flow-line of a pipe or box structure will depend on the hydraulic requirements. Inlet leads servicing curb opening inlets shall have a minimum pipe diameter of 24 inches.

703.1 Alignment.

All closed conduit systems shall be typically designed in a straight line with inlet lead perpendicular to the storm sewer system.

~~Storm sewers shall be located in public street right-of-way's or in a storm sewer easement adjoining and parallel to a street right-of-way. If reinforced concrete pipe is to be used for the storm sewer, the location of the storm sewer may be installed in the roadway with a five-foot (5') offset from the centerline of the roadway. The location of a storm sewer shall not be within side lot easements that prohibit future maintenance access, unless approved by the Public Works Department. Closed conduit systems may be installed within adequately sized drainage easements or drainage fee strips.~~ Storm sewers shall be located with a five-foot (5') offset from the centerline of the roadway or within a divided median, or in a storm sewer easement adjoining and parallel to a street right-of-way. For storm seers located under pavement, reinforced concrete pipe is to be used. The location of a storm sewer shall not be within side lot easements that prohibit future maintenance access, unless approved by the Engineering Department. Closed conduit systems may be installed within adequately sized drainage right-of-way, easements or drainage fee strips.

703.2 Manholes.

A manhole is used for access to closed conduit systems for maintenance and inspection. Manholes shall be placed at changes in conduit size, material, grade, alignment, junction of two or more conduits, and at intervals no greater than 600 feet on continuous runs.

703.3 Inlets.

Inlets to closed conduit drainage systems shall be designed to convey the design storm discharge. Inlets shall be designed so debris will not reduce the entry capacity below the design storm discharge.

Curb Inlets shall be located in such a manner that the more restrictive of the following criteria will govern:

e) Maximum storm water ponding depth as measured at the gutter low point shall be no more than nine (9) inches, and
f) Storm water is not carried more than 300 feet along the curb line from the high point of a gutter to an inlet opening.

~~Curb inlets for roadways shall be spaced so that the maximum travel distance of water in the gutter will not exceed 300 feet.~~ Inlets should be placed away from collector streets or arterial streets and on the side streets at street intersections. An attempt should be made to place inlets away from esplanade openings and out of major intersections. Inlets should be located along the street at the extension of a lot line in order to avoid conflicts with future or existing driveways. Curb inlets should be located at the point of curve of the intersection curb radius along urban residential streets. Curb inlets should be located out from under the pavement surface. Curb Inlets along Collector and Arterial classified streets shall be recessed (horizontally displaced) away from the curb gutter line so that any depression at the mouth of the inlet occurs wholly within the limits of the gutter, with no irregularity of elevation extending into the travel lane. Curb inlets shall have a minimum capacity of 5 c.f.s. Grate top inlets will not be permitted in unlined open ditch areas.

703.4 Storm Sewer Outfalls.

All storm sewer outfall pipe sewers for unlined channels shall be constructed of RCP or HDPE. ~~In accordance with the ITEMs in this manual and shall include a timber bent structure, regardless of pipe size.~~ A standard manhole must be placed just outside of the ultimate channel right-of-way or drainage easement. The grade of the pipe shall be that required to produce at a minimum a three feet per second velocity when flowing full. Erosion protection will be required for all storm sewer outfalls.

ITEM 704
MATERIALS

Materials shall be stored, handled and used as described under ITEM 105 "Control of Materials".

The use of manufactures names and catalog numbers as may be used to describe various products is not intended to be proprietary, but merely to indicate clearly the respective type of material that can be accepted. Submittals for product acceptance, other than those named, must be directed to the Public Works Department by the EOR representing the developer. Contractor submittals will not be accepted.

The City of League City reserves the right to engage, at any time during the progress of the work, a material testing laboratory to test and inspect all pipe, boxes, or accessory structures.

704.1 Reinforced Concrete Pipe.

Unless specifically called for, Reinforced Concrete Pipe (RCP) shall include both Fiber Reinforced Concrete Pipe (FRCP) meeting ASTM C-1450 and Steel Reinforced Concrete Pipe (SRCP) meeting ASTM C-76, both types having a bell and spigot ends. The spigot end shall have a grove made into it to accept the manufactures rubber gasket. RCP& FRCP shall be installed in accordance to ASTM C1479.

704.1.1 Joints.

Joint material shall be tubular rubber gasket conforming to ASTM C 443 manufactured from extruded closed cellular rubber, the base polymer being a blend of nitrile and vinyl meeting the physical requirements of ASTM D 1056, Class 2 CL and meeting the chemical resistance requirements of AASHTO M 198. Joint lubricants shall consist of flax soap or equal, mineral lubricants are not permitted. Install per pipe manufacturers recommendations or as specified by the notes on plans or as directed by COLC.

Special care shall be taken in joining the bell and spigot ends as not to cause damage to the gasket. Damaged gaskets shall be cause for rejection of acceptance to the City's system.

704.2 Precast Reinforced Concrete Boxes.

Pre-cast reinforced concrete box sections for storm sewers or culverts shall conform to the requirements of ASTM C-850 for H20 loading.

704.2.1 Joints.

Joint material shall be rubber gasket meeting the requirements of ASTM C1677. Filter fabric to be used at all joints per City of League City Box Culvert Bedding and Backfill Details.

704.3 Monolithic Reinforced Concrete Boxes.

Monolithic reinforced concrete boxes for storm sewers and culverts shall be provided in accordance with The Standard Structural Designs of The Texas State Department of Highways and Public Transportation and in accordance with TxDOT ITEM 462.

704.4 High Density Polyethylene (HDPE).

HDPE pipe to meet AASHTO M 294 and shall be installed in accordance to ASTM D 2321.

704.4.1 Joints.

Coupling devices shall provide a positive union of adjacent pipe sections while effectively preventing displacement of the pipe along its axis and lateral displacement at the joint and shall provide leak resistant connections. Couplings shall be provided and supplied by the same manufacturer of the pipe.

704.5 Manholes.

Manholes shall be constructed of pre-cast concrete sections or concrete cast-in-place. Detailed drawings of various types and sizes of manholes are included in the engineered plans and each manhole shall be constructed in strict accordance with these drawings. Manholes shall be installed vertical and symmetrically above storm sewer main.

Manholes shall have inverts in them in which flow channels to the spring line of the pipes are constructed, inverts equal in depth to one-half the diameter of the pipes connected to the manholes.

Inlet and outlet pipes shall extend through the walls of the manhole for a sufficient distance beyond the outside surface to allow for connections but shall be cut off flush with the wall on the inside surface. Non-shrink grout shall be placed around these pipes so as to form a tight, neat and smooth connection.

Manhole bases shall be cast or installed on a firm 6 inch minimum of cement stabilized sand. Backfilling of manholes shall be provided in accordance with ITEM 410 "Backfill and Settlement" and Manhole Backfill Detail.

704.5.1 Precast Concrete Manholes.

Pre-cast concrete manholes shall be provided in accordance with TxDOT ITEM 465, (excluding ITEM 465.2 C, D and E), Park Equipment Storm Manhole Detail PCMHST-1 or approved equal.

704.5.2 Cast-in-Place Monolithic Concrete Manholes.

Cast-in-Place Manholes shall be constructed in accordance with the details on monolithic poured professionally engineered sealed design plans.

The minimum wall thickness shall be 6 inches. Maximum wall thickness shall be determined by the design engineer as dictated design by supporting design load and geotechnical reports. Concrete shall be placed complete in one casting. No joints will be allowed. Concrete shall be handled as described under concrete ITEM 407.15, "Concrete." Engineer of record shall supply engineered detail drawings for cast-in-place manholes.

704.5.3 Rings and Covers.

Ferrous castings shall be of uniform quality, free from blow holes, shrinkage, distortions, and other strength defects. They shall be smooth and cleaned by shot blasting. Gray Iron used in the manufacture of castings shall conform to ASTM A 48 Class 35B; Ductile Iron casting shall conform to ASTM A 536.

All castings shall be manufactured true to pattern, component parts shall fit together in a satisfactory manner. Round frames and covers shall have machine bearing surfaces to prevent rocking and rattling. Frame and cover castings must meet all the requirements of AASHTO
M 306. Castings shall be customized for the City of League City and shall be manufactured and installed in accordance with the City of League City "Standard Details."

The mill test reports or manufacturer's certification to the Engineer for each lot or shipment of steel and iron materials shall be provided to the office of the Engineering Department. For castings, also furnish a manufacturer's certification stating that the casting meets the proof-load testing requirements of AASHTO M 306.

704.6 Inlets.

Inlet structures for open ditch interceptor structures shall be constructed of pre-cast concrete or cast-in-place concrete. Curb inlets for roadways shall be constructed of pre-cast concrete sections. Curb Inlets along Collector and Arterial classified streets shall be recessed (horizontally displaced) away from the curb gutter line so that any depression at the mouth of the inlet occurs wholly within the limits of the gutter, with no irregularity of elevation extending into the travel lane. Detail drawings of various types and sizes of inlets shall be included in the approved plans.

Inlet and outlet pipes shall extend through the walls of the structure for a sufficient distance beyond the outside surface to allow for connections but shall be cut off flush with the wall on the inside surface. Mortar shall be placed around these pipes so as to form a tight, neat, smooth connection.

Inlet inverts shall be constructed and shaped accurately with concrete so as to be smooth, uniform and cause minimum resistance to flowing water. The inlet bottom shall be sufficiently sloped downward toward the outlet to prevent pounding.

Inlet bases shall be cast or installed on a firm bedding of 6 inches of cement stabilized sand. Backfill around curb inlets shall be cement stabilized sand.

704.6.1 Precast Concrete Inlets.

Pre-cast inlets shall be provided in accordance with TxDOT ITEM 465, (excluding ITEM 465.2 C, D and E), Park Equipment Storm Inlet Details or approved equal.

704.6.2 Cast-in-Place Concrete Inlets.

Cast-in-Place Inlets shall be constructed in accordance with the details on monolithic poured professionally engineered sealed design plans.

The minimum wall thickness shall be 6 inches. Maximum wall thickness shall be determined by the design engineer as dictated by supporting design loads and geotechnical reports. Concrete shall be placed complete in one casting. No joints will be allowed. Concrete shall be handled as described under concrete ITEM 407.15, "Concrete." Engineer of record shall supply engineered detail drawings for cast-in-place inlets.

704.6.3 Frame, Grates, Rings and Covers.

Ferrous castings shall be of uniform quality, free from blow holes, shrinkage, distortions, and other strength defects. They shall be smooth and cleaned by shot blasting. Gray Iron used in the manufacture of castings shall conform to ASTM A 48 Class 35B; Ductile Iron casting shall conform to ASTM A 536.

All castings shall be manufactured true to pattern, component parts shall fit together in a satisfactory manner. Round frames and covers shall have machine bearing surfaces to prevent rocking and rattling. Frame and cover castings must meet the proof-load testing requirement of AASHTO M 306. Castings shall be customized for the City of League City and shall be manufactured and installed in accordance with the City of League City "Standard Details."

The mill test reports or manufacturer's certification to the Engineer for each lot or shipment of steel and iron materials shall be provided to the office of the Engineering Department. For castings, also furnish a manufacturer's certification stating that the casting meets the proof-load testing requirements of AASHTO M 306.

704.7 Headwalls and Wingwalls.

Headwalls and wing-walls shall be provided in accordance with the standard structural designs of the Texas State Department of Highways and Public Transportation and in accordance with TxDOT ITEM 466. Concrete shall be provided in accordance with ITEM 407.15 "Concrete".

704.8 Pipe Bedding Material.

Where not otherwise specified or noted, all bedding material shall be provided in accordance with ITEM 407.14.2 "Cement-Stabilized Sand".

704.9 Concrete.

Concrete shall be provided in accordance with ITEM 407.15 "Concrete".

ITEM 705
EXCAVATION

Excavation shall be provided in accordance with ITEM 408 "Excavation".

ITEM 706
CONDUIT LAYING

All conduits shall be laid and maintained in the required lines and grades; with all appurtenances at the required locations.

All recommendations of the manufacturer shall be carefully observed during handling and installation of each material. During handling and placement, materials shall be carefully observed and inspected, and any damage, defective, or unsound materials shall be rejected and removed from the job site.

706.1 Trench Condition.

Trench condition shall be provided in accordance with ITEM 409.1 "Trench Condition".

706.2 Conduit Bedding and Embedment.

Except where otherwise approved by the Engineering Department, all pipe, boxes and appurtenances shall be installed in a continuous envelope of specified bedding material. Specified bedding material for drainage structures shall be cement stabilized sand (see ITEM 407.14.,"Materials"), extending from 6" below to 6" above the outer part of the conduit, extending for the full width between the undisturbed trench walls. The bedding material required beneath the conduit shall be placed, graded and tamped to the conduit sub-grade

profile over the entire width between undisturbed trench walls and cut-outs made for the projection of the pipe bells.

The conduit shall be placed and adjusted to proper grade on this prepared bedding, then jointed, braced and blocked, as required. After conduit is graded into place, bedding material shall be placed simultaneously on both sides of the conduit and worked carefully into place without disturbing the conduit alignment, to an elevation of 6" over the conduit.

706.3 Assembling Conduit.

Assembly shall meet the manufactures recommendations for conduit and accessories being used. Unless otherwise directed, conduits shall be laid with bell ends facing up-grade.

All connections shall be watertight and made so that a smooth uniform flow-line will be obtained throughout the drainage system.

ITEM 707
BACKFILL AND SETTLEMENT

Backfill and settlement shall be provided in accordance with ITEM 410 "Backfill and Settlement".

ITEM 708
VISUAL TEST

All drainage facilities shall be inspected visually to verify accuracy of alignment and freedom from debris and obstruction. Storm Sewers 48 inches and smaller will be inspected with television equipment.

The developer is responsible for the TV inspection of newly constructed storm sewer lines. The TV inspection shall take place before the final walk-through inspection is performed.

Personnel from the City's Storm Water Department or the City's Engineering Department shall witness the TV inspection, which shall be performed during the City's normal working hours.

The method for the inspection shall include:

1. Cleaning the lines, (if not already cleaned);
2. Removing downstream plugs, if any;
3. Videotaping the system.

The developer shall provide the City with one copy of the TV videotape and one copy of the TV inspection report. For each segment the video tape and corresponding written report shall clearly identify.

1. Each line segment being inspected;
2. The size and type of pipe being inspected;
3. Accurate footage of the line segment inspected;
4. Deficiencies in materials, alignment, pipe shape, grade, or any other apparent deficiencies; and

Any drainage structure which causes excess pounding of water, any miss aligned joints, settled conduits or other defects; shall be cause for rejection.

Any system designed as a submerged system shall be inspected in the dry, prior to flooding. All other drainage systems shall be dry and clean prior to visual test.

ITEM 709
STORM SEWER CONNECTIONS TO THE EXISTING SYSTEM

Unless otherwise approved by the Engineering Department, all connections of a storm sewer system to existing storm sewer systems shall be made at manholes with the crown of the inlet pipe installed at the same elevation as the crown of the existing pipe as the taps are being made.

ITEM 710
CLEAN UP AND RESTORATION

Clean up and restoration shall be provided in accordance with ITEM 414 “Clean-up and Restoration”.

ITEM 711
APPROVAL AND ACCEPTANCE

Approval and acceptance shall be provided in accordance with ITEM 415 "Approval and Acceptance".

ITEM 712
WARRANTY OF WORK

Warranty of work shall be provided in accordance with ITEM 416, "Warranty of Work".

ITEM 807
Median Design

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A median separating the two opposing traffic lanes is a highly desirable element in planned high-density areas. A flush median is required for 2-lane streets when the Average Daily Traffic (ADT) is expected to reach or exceed 3,000 vehicles per day. A flush median is required for 4-lane streets when the ADT is expected to reach or exceed 6,000 vehicles per day. A raised median is required for streets when the ADT is expected to reach or exceed 20,000 vehicles per day.

Minimum Median Width:

(1) For local streets, refer to **Divided Street Typical Cross Section**.
(2) For street classifications depicted on the Master Mobility Plan, refer to **Divided Street Typical Cross Section**.

Minimum Median Length:

(1) Median lengths are based on functional street classification of the main roadway and intersecting street.
(2) Refer to Section 801 of this manual. ~~**Median Design – Median Length and Opening** for minimum median length requirements.~~
~~(3) Median Geometry – Refer to **Median Design – Median Nose and Left Turn Bay**.~~
~~(4) Street Taper Geometry – Refer to **Median Design – Roadway Tapers for Median Designs (Local Streets)** for subdivision street taper geometrics.~~