APPENDIX D - DRAINAGE CHARACTERISTICS AND PROPOSED IMPROVEMENTS

CITY OF AUSTIN STREET STORM DRAIN SYSTEM CRITERIA

The City of Austin Drainage Criteria Manual (DCM) contains the hydrologic and hydraulic criteria for the assessment and design of street storm drainage systems. The DCM's primary criteria with respect to the hydrologic and hydraulic assessments of the adequacy of existing storm drain systems are as follows:

- The street drainage system must be able to convey the flows from greater than the 25-year frequency storm through the 100-year frequency storm within the defined public rights-of-ways and/or drainage easements (DCM 1.2.2.C).
- Conveyance provisions for the 100-year frequency storm must be made within defined rights-of-ways and easements (DCM 3.1.0).
- North Lamar Boulevard and Burnet Road have an arterial street classification; therefore, the minimum clear pavement width (i.e. clear pavement between the flooded gutters) must be 24 feet (DCM 3.2.0).

In addition to the DCM, the City of Austin Urban Design Criteria Manual and the adopted North Burnet/Gateway Master Plan, require the replacement of open drainage shoulder ditches with underground storm drainage conduits and the placement of all storm drainage collector conduits under the roadway pavement section.

Due to the conceptual nature of the drainage study for the North Lamar and Burnet corridors, the capacities of the existing street storm drainage system ditches (within the rights-of-ways) were assessed against peak 25-year and 100-year flows at full ditch flow depths. Detailed hydrologic and hydraulic analyses should be performed for the existing street storm drainage systems in the subsequent preliminary and final design phases to take into account allowable street flooding through the 100-year flood event (i.e. allow street flooding as long as there is at least 24 feet of clear pavement width).

HYDROLOGIC AND HYDRAULIC ANALYTICAL PROCEDURES

For this corridor study, drainage areas contributing runoff to the roadway rights-of-ways and contributing runoff directly onto the pavements along the roadways were delineated. Drainage area delineations were based upon the City of Austin's effective HEC-HMS model basin delineations, the City's GIS topographic mapping, and drainage boundary area investigations. Peak 25-year and 100-year (Q25, Q100) flows from each drainage area were calculated by using the peak Q25 and Q100 flow rates per acre of drainage area from the City of Austin's effective HEC-HMS models of the watersheds. The North Lamar Boulevard Watersheds are Little Walnut Creek and Walnut Creek. The Burnet Road Watersheds are Shoal Creek, Little Walnut Creek, and Walnut Creek. **Table D-1** and **Table D-2** summarizes the peak Q25 and Q100 flows at identified locations along Burnet Road and North Lamar Boulevard respectively.

Table D-1: Existing Hydrologic Conditions - Burnet Road

Roadway Segments	Q25*	Q100*
Romeria to Koenig	5	7
Romeria to Oaks	20	26
Addison to Oaks	25	35
Addison to Pegram	27	36
Pasadena to Pegram	62	86
Pasadena to Northcross	23	32
Anderson to Northcross	122	199
Teakwood to Anderson	614	854
Research to Teakwood	320	449
Research to Helen Milton Smith	11	15
Braker to Helen Milton Smith	77	103
Braker to Brockton	56	83
Kramer to Brockton	7	10
Kramer to Duval	75	102

**Q25: Peak 25-year flow; Q100: Peak 100-year flow*

Table D-2: Existing Hydrologic Conditions - North Lamar Boulevard

Roadway Segments	Q25*	Q100*
Research to Little Walnut Creek	86	116
Rundberg to Little Walnut Creek	49	67
Rundberg to Rutland	18	24
Braker to Rutland	122	164
Braker to Walnut Creek	68	93
Parmer to Walnut Creek	264	367
Villages at Sage Creek to Parmer	188	259
Villages at Sage Creek	119	166
Connally High School	76	106

**Q25: Peak 25-year flow; Q100: Peak 100-year flow*

The hydraulic capacities of the existing storm drainage pipes were not assessed, because there are few roadway segments with continuous storm drainage pipe systems. The hydraulic capacities of the existing street storm drainage ditches at each surveyed section were performed using the Manning's equation routine of the Flow Master hydraulic program. Ditch configurations were based on twelve cross-section surveys, six along Burnet Road and six along North Lamar Boulevard, performed as part of this corridor study. All ditches were assumed to be grass-lined with a Manning's "n" of 0.035, and ditch flow line slopes were assumed to be at the same slopes as the roadway centerline grades at the cross-section survey locations.

BURNET ROAD EXISTING DRAINAGE CHARACTERISTICS AND ISSUES

Approximately 180 acres of drainage area contribute runoff directly to the pavement and another 720 acres of drainage area contribute runoff to existing storm drain systems within the roadway right-of-way. The street storm drain systems along Burnet Road consist of various combinations of open shoulder ditches ("bar ditches"), curb-and-gutter, and storm drain conduits with scattered curb inlets

that discharge into the storm drain conduits. The shoulder ditches range in configuration and size of broad swales, trapezoidal ditches, and "V-bottom" ditches. Most ditches are grass lined. No ditch was surveyed to be over 3-feet deep. The existing street storm drain conduits range in size from 8-inch to 72-inch RCP, though some storm drain pipe sizes are not given in the City's GIS storm drain system mapping. The conceptual hydrologic assessments of peak Q25 and Q100 flows along Burnet Road are summarized on **Table D-1**. The conceptual hydrologic and hydraulic assessments of the existing storm drain systems along Burnet Road identified the following drainage issues:

1. Approximately 7,185 feet of Burnet Road (26% of its corridor length) have an open ditch along at least one shoulder. The sections of Burnet Road with shoulder ditches are located north of Research Boulevard. According to City of Austin corridor urban design criteria, these shoulder ditches are to be replaced with buried storm drain conduits.

2. The approximate flow capacities of the shoulder ditches (excluding potential capacity reductions caused by driveway culverts) were calculated as follows:

- Survey Section 3 ditch capacity-630cfs
- Survey Section 4 ditch capacity-180cfs
- Survey Section 5 ditch capacity-110cfs
- Survey Sections 1, 2 and 6 were not located at shoulder ditches (i.e. located south of Research Boulevard).

3. In general, the existing shoulder ditches appear to have adequate capacity up to the Q100 runoff event at each survey section north of Research Boulevard. The capacities of the ditches could be reduced by the driveway culverts. Hydraulic analyses of driveway culverts were beyond the scope of this corridor study.

4. Storm drain conduits paralleling the roadway are not continuous along most sections of Burnet Road. Storm drain conduits are concentrated south of Research Boulevard to Koenig Lane and immediately north of Research Boulevard to McNeil Road. It appears that most storm drain conduits within the Burnet Road right-of-way are continuations of off-site drainage systems that are routed to and along Burnet Road to drainage discharge points. The curbed sections of Burnet Road convey roadway drainage along its curb-and-gutters to scattered storm drain curb inlets. Total replacement of existing storm drain conduits will be necessary to connect storm drain collector conduits that will replace the existing open shoulder ditches and isolated storm drain conduits and to convey off-site storm drain flows that will combine with roadway drainage flows.

5. City GIS information of the existing storm drain systems is limited. Detailed surveys and hydrologic/hydraulic assessments of the existing systems are needed to better define existing drainage conditions. However, surveys and assessments of the existing storm drainage systems within the right-of-way are not a high priority if the existing systems are replaced by new buried storm drain conduits, curb-and-gutters, and curb inlets.

6. There are no stormwater detention structures or stormwater quality treatment structures within the Burnet Road right-of-way. The City owns scattered regional stormwater detention and stormwater quality structures within the watersheds to which some of the Burnet Road storm drain systems discharge. The detention and water quality treatment capacities of the existing regional structures to treat Burnet Road runoff are currently unknown. The conveyance capacities of the existing storm drain conveyance systems and drainage easements from the Burnet Road right-of-way to the regional structures are currently unknown.

NORTH LAMAR BOULEVARD EXISTING DRAINAGE CHARACTERISTICS AND ISSUES

Approximately 215 acres of drainage area contribute runoff directly to the pavement along the corridor study area. The street storm drain systems along North Lamar Boulevard consist of various combinations of open shoulder ditches ("bar ditches"), curb-and-gutter, and storm drain conduits with scattered curb inlets that discharge into the storm drain conduits. The shoulder ditches range in configuration and size of broad swales, trapezoidal ditches, and "V-bottom" ditches. Most ditches are grass lined. No ditch was surveyed to be over 3-feet deep. The existing street storm drain conduits range in size from 18-inch to 36-inch reinforced concrete pipe (RCP), though some storm drain pipe sizes are not given on the City's GIS storm drain system mapping. The conceptual hydrologic assessments of peak Q25 and Q100 flows along North Lamar Boulevard are summarized in **Table D-2.** The conceptual hydrologic and hydraulic assessments of the existing storm drain systems along North Lamar Boulevard identified the following drainage issues:

1. Approximately 16,100 feet of North Lamar Boulevard (52% of its corridor length) have an open ditch along at least one shoulder. According to City of Austin corridor urban design criteria, these shoulder ditches are to be replaced with buried storm drain conduits.

2. The flow capacity of the shoulder ditch at Survey Section 1 was calculated to be approximately 220cfs, and the flow capacity of the shoulder ditch at Survey Section 6 was calculated to be approximately 60cfs (excluding potential capacity reductions caused by driveway culverts). The remaining four section surveys along North Lamar Boulevard were not located at shoulder ditches.

3. In general, the existing shoulder ditches have adequate capacity up to the Q100 runoff event from Research to Thurmond. There is insufficient survey information to assess the ditch capacities from Rutland to Caddo. The ditches appear to have insufficient Q100 capacity from the Walnut Creek Bridge to Connally High School. The capacities of the ditches could be reduced by the driveway culverts. Hydraulic analyses of driveway culverts were beyond the scope of this corridor study.

4. Storm drain conduits paralleling the roadway are not continuous along most sections of North Lamar Boulevard. The only continuous storm drain pipe system along North Lamar Boulevard, mapped on the City GIS database, is from Cooper Drive to Little Walnut Creek. All other curbed sections of North Lamar Boulevard convey drainage along its curb-and-gutters to scattered storm drain curb inlets. Total replacement of existing storm drain conduits will be necessary in order to connect storm drain collector segments that will replace the existing open shoulder ditches and storm drain conduits.

5. City GIS information of the existing storm drain systems is limited. Detailed surveys and hydrologic/hydraulic assessments of the existing systems are needed to better define existing drainage conditions. However, surveys and assessments of the existing storm drainage systems within the right-of-way are not a high priority if the existing systems are replaced by new buried storm drain conduits, curb-and-gutters, and curb inlets.

6. During the 100-year storm event, Walnut Creek has a flood elevation high enough that it crosses a portion of the North Lamar Bridge at Walnut Creek. During the 25-year and 100-year storm events, Little Walnut Creek overflows the North Lamar Bridge at Little Walnut Creek.

7. There are no stormwater detention structures or stormwater quality treatment structures within

the North Lamar Boulevard right-of-way. The City owns scattered regional stormwater detention and stormwater quality structures within the watersheds to which some of the North Lamar Boulevard storm drain systems discharge. The detention and water quality treatment capacities of the existing regional structures to treat North Lamar Boulevard runoff are currently unknown. The conveyance capacities of the existing storm drain conveyance systems and drainage easements from the North Lamar Boulevard right-of-way to the regional structures are currently unknown.

PROPOSED DRAINAGE IMPROVEMENTS

Storm drainage improvements were assessed for the North Lamar Boulevard and Burnet Road corridors to include buried storm drain conduits, curb-and-gutters with curb inlets, stormwater detention, and stormwater quality treatment. Engineer's conceptual opinions of probable construction costs for the drainage improvements were prepared for the full lengths of the two corridors (i.e. long-term drainage improvements), for short-term drainage improvements along North Lamar Boulevard (Rundberg Lane to Braker Lane), and for short-term drainage improvements along Burnet Road (Koenig Lane to Anderson Lane). The following sections discuss the conceptual design assessments and opinions of probable construction costs.

STREET STORM DRAINAGE SYSTEM IMPROVEMENTS

The Flow Master hydraulic program was used to determine storm drain conduit sizes, based upon the following input parameters:

- Peak flow equal to the 100-year peak flow for on-site and off-site drainage.
- Full pipe flow at Q100 flow conditions.
- Manning's "n" value of 0.012 for concrete pipe.
- Conduit flow line slope equal to centerline of roadway slope.
- Minimum conduit size equal to 18 inches; maximum pipe size of 60" diameter before using a box culvert section.

Exhibits D-1 and D-**2** show the conceptual sizing and layouts of the proposed storm drain conduits for North Lamar Boulevard and Burnet Road respectively. The existing off-site drainage systems discharging to the corridors and the proposed on-site curb inlets are assumed to discharge to a single new storm drain collector conduit aligned parallel to each roadway's centerline; however, proposed roadway and bicycle track sections and water quality treatment structures might require the use of dual storm drain collector conduits along sections of the roadways.

The proposed storm drain collector conduits discharge at existing outlet locations along the corridor rights-of-ways. There were no conceptual assessments of off-site storm drainage conveyance systems. The number of storm drain curb inlets along each segment of the storm drain systems is calculated to be equal to the total on-site storm Q100 drainage flow at each discharge point divided by an assumed inlet capacity of 8cfs per inlet. Storm drain manholes are on approximately 250-feet spacing and are sized for the proposed storm drain conduit sizes. New curb & gutters are constructed for the full length of each corridor, including curb & gutters along a center median.

Creek stabilization measures are incorporated at the proposed North Lamar Boulevard storm drain outlets at Little Walnut Creek and at Walnut Creek. Storm drainage system improvements require right-of-way preparation, erosion/sedimentation controls, tree protection measures, traffic controls, and mobilization.

The street storm drainage system improvements for the short-term corridor improvements are assumed to be the same configuration as for the long-term corridor improvements.

STORMWATER DETENTION IMPROVEMENTS

The City of Austin Drainage Criteria Manual (DCM 1.2.2.D) does not allow peak flow rates to be increased at any point of discharge from a site for the 2-year through 100-year storm frequency events. The proposed corridor improvements, including pavement and streetscape improvements, will likely increase the impervious cover within the corridor rights-of-ways, and the storm drainage system improvements will likely decrease storm runoff lag times, thereby, peak storm runoff flow rates will likely be increased from the corridor rights-of-ways. The DCM presents several options for mitigating increases in flow rates:

- Provide on-site detention such that post-construction discharges are reduced to acceptable levels (DCM 8.1.0).
- Participate in the City's Regional Stormwater Management Program (RSMP) by paying the RSMP fee as long as there are no adverse impacts where the increases in flow rates occur and the appropriate regional detention facility has available excess capacity to provide detention storage for the corridor improvements (DCM 8.2.0).
- Fund the costs to increase the capacities of the appropriate regional detention facilities (DCM 8.2.0) and the costs of improvements to conveyance systems and easements from the corridor rights-of-ways to the regional detention facilities.

Developing conceptual assessments of the three stormwater detention options presented above are beyond the scope of this study. However, the RSMP fee calculator (DCM Appendix D) was used to calculate a stormwater detention allowance cost based upon total proposed impervious cover within the corridors.

STORMWATER QUALITY TREATMENT IMPROVEMENTS

The City of Austin Environmental Criteria Manual requires water quality controls if the impervious cover of the net site area exceeds 20% (ECM 1.3.4.2.G), and 100% of the surface area of new or re-developed area with impervious cover is to have water quality treatment (ECM 1.9.2.A). The runoff from the increase in surface area of pavement must be treated; however, the surface areas of the new sidewalks proposed as part of the corridor streetscape improvements are excluded from impervious cover calculations for water quality treatment purposes (ECM 1.8.1). Based upon these criteria, pavement sections of both corridors will likely increase impervious cover and will require water quality treatment. The Environmental Criteria Manual presents several options for mitigating water quality impacts:

- Provide on-site water quality treatment (ECM 1.6.0).
- Participate in the City's Urban Watersheds Structural Control Fund in lieu of constructing on-site controls as long as the appropriate regional water quality treatment facilities have available excess capacity to provide water quality treatment for the corridor stormwater runoff and the receiving watersheds are classified as "Urban Watersheds", including Little Walnut Creek and Shoal Creek Watersheds, but excluding the Walnut Creek Watershed (ECM 1.6.4.B).
- Fund the costs to increase the capacities of the appropriate regional water quality treatment facilities (ECM 1.6.4.B).

Developing conceptual assessments of the three stormwater quality treatment options presented above are beyond the scope of this study. However, recent City bid costs for installation of bio-retention street stormwater quality treatment facilities were used to calculate water quality treatment costs based upon the increase in proposed pavement impervious cover within the corridors. It appears that there will be no increase in impervious pavement cover within the short-term corridor sections of either North Lamar Boulevard or Burnet Road; therefore, stormwater quality treatment will likely not be required for the short-term corridor improvements. The Engineer's conceptual opinions of probable construction costs for short-term and long-term street storm drain system improvements, stormwater retention, and water quality treatment improvements are presented in next section.

CONCEPTUAL OPINIONS OF PROBABLE DRAINAGE IMPROVEMENT CONSTRUCTION COSTS

The Engineer's conceptual level opinions of probable construction costs for the proposed North Lamar Boulevard and Burnet Road corridor drainage improvements are summarized below in **Table D-3** and **D-4**. The cost summarized are based on the assumption that all proposed drainage improvements are constructed within existing corridor rights-of-ways and drainage easements and that no new permanent right-of-way or drainage easement acquisitions are required for the drainage improvements.

Table D-3: Burnet Road Drainage Improvements

Improvement Component	Cost
Short-Term Drainage Improvements	
Street Storm Drain Improvements	$3,883,014
Water Quality Improvements	$0
Stormwater Detention Allowance	$796,000
Contingency	$935,803
Engineering Cost	$449,185
Total Drainage Construction Cost	$6,064,002*
Long-Term Drainage Improvements	
Street Storm Drain Improvements	$11,184,537
Water Quality Improvements	$33,350
Stormwater Detention Allowance	$1,676,000
Contingency	$2,578,777
Engineering Cost	$1,237,813
Total Drainage Construction Cost	$16,710,478*

** Cost does not include public art or contingency/engineering cost associated with public art.*

Table D-3: North Lamar Boulevard Drainage Improvements

Improvement Component	Cost
Short-Term Drainage Improvements	
Street Storm Drain Improvements	$3,312,072
Water Quality Improvements	$0
Stormwater Detention Allowance	$492,000
Contingency	$760,814
Engineering Cost	$365,191
Total Drainage Construction Cost	$4,930,077*
Long-Term Drainage Improvements	
Street Storm Drain Improvements	$16,707,632
Water Quality Improvements	$106,720
Stormwater Detention Allowance	$965,000
Contingency	$3,555,870
Engineering Cost	$1,706,818
Total Drainage Construction Cost	$23,042,040*

** Cost does not include public art or contingency/engineering cost associated with public art.*

EXHIBIT 1 : BURNET ROAD

EXHIBIT 1 : NORTH LAMAR BOULEVARD