Lockwood, Andrews & Newnam, Inc.
A LEO A DALY COMPANY

November 20, 2017

City of Sugar Land
2700 Town Center Boulevard North
Sugar Land, Texas 77479

Attention: Jorge Alba, PE, CFM

Re: Drainage Study for River Bend North, Plantation Bend and Oyster Creek

Dear Mr. Alba,

Per your request, Lockwood, Andrews & Newnam, Inc. has prepared a general scope and fee schedule for Drainage Study for River Bend North, Plantation Bend and Oyster Creek. The effort described in Exhibit A will include the proposed scope of services to complete the drainage report. In general, the tasks include existing conditions analysis, problem identification and conceptual improvement development, proposed conditions analysis, and reporting.

The goal of the Drainage Study for River Bend North, Plantation Bend and Oyster Creek is to support the City in their efforts to identify potential improvements to increase the level-of-service of the area. To accomplish this goal, requires an understanding of the limitations and deficiencies of the drainage systems that serve the region and the objective prioritization of improvement recommendations that are both functionally efficient and financially effective.

We propose to complete the Basic Engineering Services for a total amount of $79,510.00. Exhibit B provides a detailed man hour estimate of the fees associated with the basic services tasks. It is anticipated that the project can be completed within four months of notice-to-proceed.

We are prepared to begin this task immediately and look forward to supporting Sugar Land on this important project. Please feel free to contact me at 713-821-0366 or by email at mjmanges@lan-inc.com if you have any additional questions.

Sincerely,

Matt Manges, P.E., CFM
Team Leader, Regional Stormwater Manager

Attachments:
Exhibit A – Scope of Services
Exhibit B – Fee Schedule
Exhibit C – Study Area

EXHIBIT A

Scope of Services

City of Sugar Land

Drainage Study for River Bend North, Plantation Bend and Oyster Creek (between Dam # 3 and Dulles Av.)

The goal of the Drainage Study for River Bend North, Plantation Bend and Oyster Creek (between Dam # 3 and Dulles Av.) is to support the City in their efforts to understand the root cause of flooding in the area and to recommend improvements to reduce flood risk within the area. To accomplish this goal requires an understanding of the limitations and deficiencies of the drainage systems that serve the region and the objective prioritization of improvement recommendations in the form of Capital Improvement Plan (CIP) projects that are both functionally efficient and financially effective.

SCOPE OF SERVICES FOR:

The scope of work shall consist of Basic Engineering Services and Additional Engineering Services. Basic Engineering Services are those with a defined effort to complete the services. Additional Engineering Services include direct expenses and sub consultants.

I. BASIC ENGINEERING SERVICES

A. General Project Management

1. General Project Management
   General project management will be ongoing through the period of the contract and include items such as participation in the development of a Project Management Plan, developing and updating the project schedule, preparing contract correspondence, transmitting deliverables, documenting the quality control process, and other project oversight activities.

2. Working Meetings with City Staff
   Working meetings with City staff shall be held to discuss study related issues, review the progress of the work effort, or to address issues which may arise. The Engineer shall prepare and deliver meeting minutes to the City within five (5) working days after each meeting. The total anticipated number of meetings is three.

3. Quality Assurance/ Quality Control
   Quality Assurance/Quality Control (QA/QC) Plan: the project, analysis outcome, and reports data will be reviewed by the Engineer for consistency with City requirements and methodologies.

B. Data Collection

1. Document Collection
   The Engineer will collect, review and organize the relevant information related to storm water in the Covington Woods Region. City provided as-builts, available reports, GIS data, and existing models will all be reviewed for inclusion within the

final report. Rainfall information will be gathered for Memorial Day 2015, Tax Day 2016, and Hurricane Harvey.

2. Site Visit
One site visit will be performed to visually inspect specific problem areas and drainage features identified in the initial review and data collection. The Engineer will document site visit with field observation reports and organized photos.

C. Analysis

1. Existing Conditions Model - Hydrologic Analysis

   a. Delineate Drainage Areas
   Drainage areas from any available previous studies will be confirmed and delineated as necessary within the study area based on the LiDAR data, as-built, survey, and site visit information. Drainage areas for inlets within the study area will be delineated to the individual inlet level and offsite contributing drainage areas will be delineated to the manhole level.

   b. Hydrologic parameters
   Hydrologic parameters for drainage areas (such as Rational "C" values) will be confirmed and modified as necessary from previous studies for runoff volume determination and routing. This effort will involve using City standards, soils data, aerial imagery, and field visits.

   c. Time of Concentration Determination
   The time of concentrations from previous studies will be confirmed and determined as necessary for each drainage area. Time of concentration will be calculated according to City design standards.

   d. Rational Method Peak Flow Determination
   Rational method peak flow rates will be determined for each drainage area in accordance with City criteria. These steady state peak flow rates will be utilized as a guide or target for runoff hydrograph development.

   e. Runoff Hydrographs
   Using the drainage areas, runoff hydrographs will be confirmed and developed as necessary. The runoff hydrographs will be developed according to City drainage criteria for 2-, 10-, and 100-year storm events. Hydrographs will also be developed for the Memorial Day 2015, Tax Day 2016, and Hurricane Harvey. Consistent with previous and similar studies, the modified Clark methodology will be implemented. The peak flow for each drainage area will be adjusted to closely match peak flow rate developed with the rational method. This effort will involve modifying the storage coefficient ('R") in the Clark Tc&R formula. Individual runoff hydrographs will be developed for each drainage area for each storm event. Each individual hydrograph will be linked to the associated receiving node (inlet, manhole) in InfoWorks and assigned as an inflow hydrograph.

2. Existing Conditions Model – Hydraulic Analysis

   a. Storm Sewer Network
   A modeling node and conduit network will be developed to represent, cross culverts, storm sewer inlets, and storm sewer conduits found within the

area. The schematic will be based on survey data, City GIS information, field visit data, and previously provided data. Inlets will be included and modeled in detail within the study area. Any offsite contributing storm sewer system will be aggregated and simplified to the manhole level. The conveyance network will be developed and documented using GIS.

b. Oyster Creek and Tributaries
Based on the available City of Sugar Land, Oyster Creek unsteady HEC-RAS model, Oyster Creek from approximately south of Avenue E through Dulles Avenue will be incorporated into the unsteady InfoWorks ICM model.

c. Two-Dimensional Modeling Mesh
LAN will export LiDAR DTM data from point format to a height-aware raster InfoWorks compatible format. Critical topographic features such as curbs or grade breaks will be imported as polygons and breaklines into the dynamic hydraulics model. Simulation areas requiring increased surface resolution will be determined to more accurately model field conditions and create 2D modeling mesh.

d. Overland Flow Roughness Values
Overland flow roughness polygon boundaries will be defined within GIS using land use data, aerial imagery, and data acquired from field visits. Appropriate roughness values as defined by City standards will be assigned for each roughness area and roughness polygons will be imported into the dynamic hydraulics model.

e. Hydraulic Analysis – Run Model
Dynamic hydraulics models will be analyzed for 2-, 10-, and 100-year design storm frequencies as well as Memorial Day 2015, Tax Day 2016, and Hurricane Harvey events. Model errors and warnings will be reviewed and addressed as necessary. Model stability will be evaluated and instabilities reduced in order to provide a highly quality numeric representation of field conditions

3. Develop Improvement Alternatives Model – Hydraulic Analyses

Improvement alternatives will be developed to address drainage deficiencies as defined by City criteria. Improvements such as storm sewer improvements, roadway conveyance improvements, potential topographic adjustments, control structure adjustments and timing modifications will be considered. LAN will also give priority to those improvements that maximize the use of existing infrastructure. Improvement benefits will be evaluated on ability to reduce flood risk and could include marked improvement in conveyance, decrease high tail water conditions within internal drainage channels, decrease or eliminate localized ponding, and decrease or eliminate overland sheetflow deficiencies. Overland sheetflow and open channel interactions will also be evaluated. Up to three (3) recommended alternatives comprised of multiple components that bring the area up to the City's established criteria will be evaluated. The improvements will be evaluated against City criteria as well as extreme event level-of-service.

a. Problem Area Identification and Conceptual Improvement Alternatives
The existing conditions model will be evaluated to identify the core problem areas and the infrastructure deficiencies that cause the problems. Conceptual improvement alternatives will be developed to address the identified deficiencies. Improvement alternatives will be evaluated on

potential benefit, improvement type (roadway, ditch, storm sewer, open channel), construction disruption, and potential cost.

b. Model Proposed Improvements
Identified improvement alternatives will be modeled in the dynamic 2D hydraulic model for the improvements for each study zone. Model development for the proposed alternatives will build upon the existing conditions modeling effort. Impacts to adjacent communities and downstream channel impacts will be evaluated for each improvement alternative. The proposed improvements modeling effort is an iterative process that involves evaluation of benefit and impact for different alternatives and subsequent modification and optimization. Improvements will be evaluated for the 2-, 10-, and 100-year design storm events as well as Memorial Day 2015, Tax Day 2016, and Hurricane Harvey.

c. Document Benefits
LAN will determine and document the benefits for each of the finalized alternatives. The project benefit will be defined as an increased level of protection as compared to the existing condition and the number of structures removed from flooded conditions in accordance with City prioritization criteria.

d. Cost Estimates
Planning level cost estimates will be prepared for each of the alternatives. The Engineer will develop an Estimate of Probable Construction Cost (EPCC) for each alternative. The cost estimates should include all major project items such as inlet counts, storm sewer linear footages, major utility relocations and pavement or concrete replacement with an overall 25% contingency. It is anticipated that unit costs will be provided by the City. If City provided unit costs are not available, available regional unit costs will be used.

D. Reporting

1. Draft Preliminary Drainage Report
   The engineering report will include a discussion of the work performed, general methodology, assumptions applied during the course of study, a discussion of the study goal, the reported drainage problems, possible structural flooding, system capacity issues, a discussion of deviations from general methodology, and a discussion of findings and recommendations. Improvement alternatives will be documented individually and an assessment of project need, benefit, and potential challenges such as ROW or environmental impacts will be addressed. A draft report will be compiled to include text, model output, exhibits, and appendices for the City's review. All Microsoft Word and Excel documents used to generate the draft report are to be included as well as the final models, shapefiles, databases, and worksheets used will be included on a compact disc, DVD or FTP site.

2. Model Output and Exhibits

   Model output and exhibits will be created after all modeling iterations have been completed and report has reached the draft phase.

   a. Tabular Output
      Tables for model input and output information will be created to document the results of the different analysis. Model input information including runoff coefficient calculations, impervious cover calculations, rational peak flow calculations, and subcatchment dynamic peak flow values will be summarized. Model output including ponding depth comparison tables and descriptions of improvement alternatives will be summarized.

   b. Drainage Area Map
      A system level existing conditions drainage area map will be produced for the study area. The drainage area map will be presented in a format that clearly shows the storm system node-link layout, actual drainage area, and subareas delineated by boundary line. The drainage area maps will include the drainage area name, contributing drainage area, time of concentration in minutes, and the 100-yr rainfall runoff rate.

   c. Drainage Area and Hydrologic Information Map
      A system level drainage area map will be produced for the study area. The map will be presented in a format that clearly shows the actual drainage area boundaries with drainage area names, hydrologic information values labeled over an aerial image background.

   d. Inundation Map
      Inundation exhibits will be produced for the drainage systems within the project limits that clearly show the storm system node-link layout and inundation areas for the frequency storms studied. These exhibits will include the inundation extents and inundation depths for existing conditions and the preferred alternative.

   e. Digital Data Submission
      A DVD or CD of all digital items. Items are to include the InfoWorks model, GIS exports, and logs.

3. Final Drainage Report
   One (1) round of comments from the City will be used to revise and update draft report and attached exhibits.

E. Direct Costs and Reimbursable Expenses:

1. Reimbursable expenses will be billed to the Client by invoice. Reimbursements shall be the actual invoice costs. A reimbursable expense budget of $500.00 has been established, as a not-to-exceed amount without prior approval. Reimbursable expenses shall include printing and reproduction, deliveries, and mileage.

2. Survey Data Collection
   Survey data will be collected to capture information necessary to supplement existing asset information. It is anticipated that this task would be to collect additional information to more precisely locate existing utilities and identify potential utility conflicts. Including subconsultant management and markup, this work is estimated for a reimbursable amount of $10,000

Lockwood, Andrews & Newnam, Inc.
A LEO A DALY COMPANY

EXHIBIT B
Fee Schedule
Sugar Land - Drainage Study for River Bend North, Plantation Bend and Oyster Creek

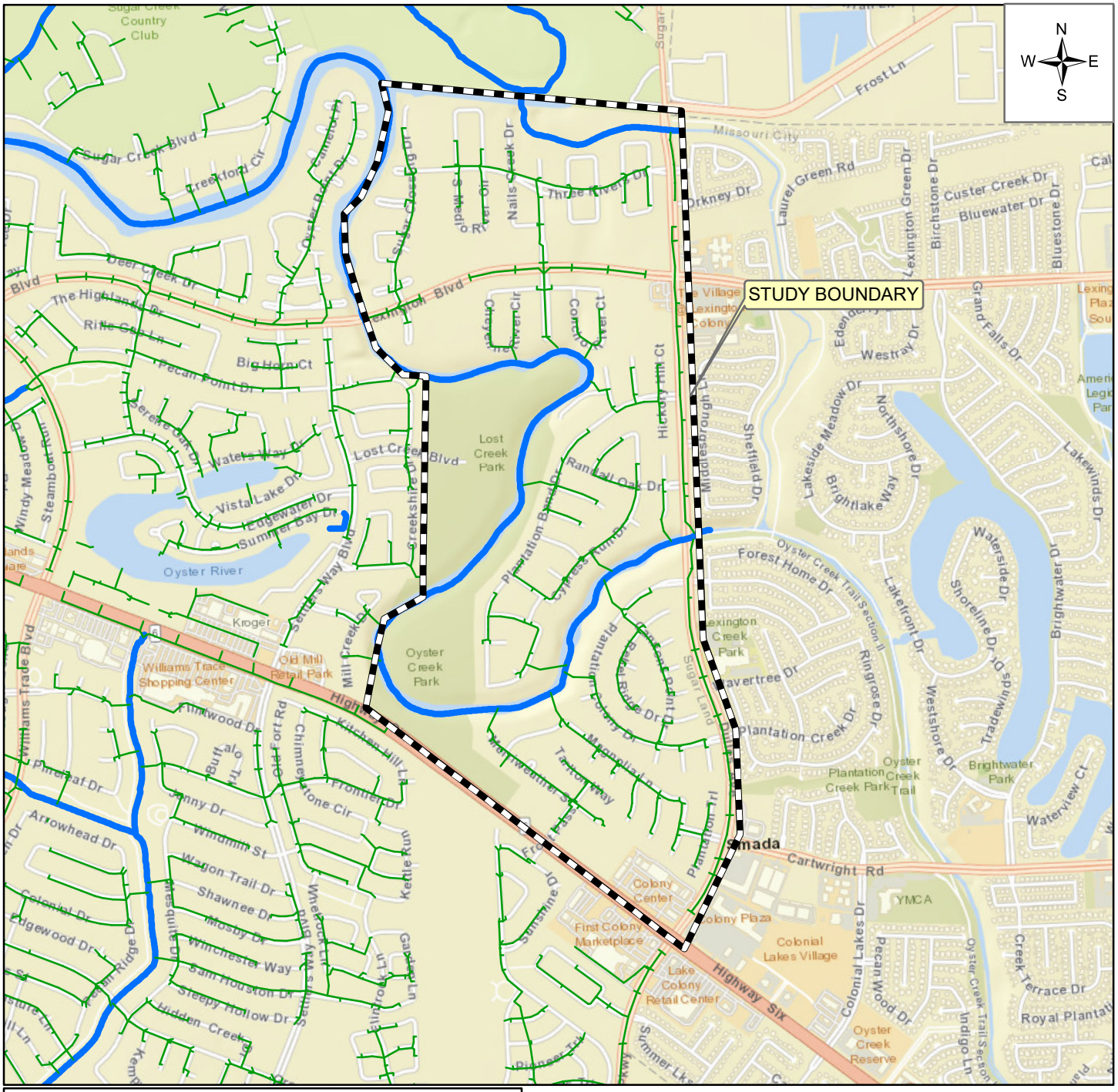
		DESCRIPTION OF WORK TASKS	PRINCIPAL	PROJ MGR / TEAM LDR	SR PROF ENG	GRADUATE ENGINEER	PROJ ADMIN	TOTAL HOURS	TOTAL LABOR COSTS
I.	**BASIC ENGINEERING SERVICES**								
A		**General Project Management**							
	1	General project management and coordination		4			4	8	$ 1,160.00
	2	Working Meetings with City Staff (3 meetings)		6	6		4	16	$ 2,500.00
	3	QA/QC		7	7	2	3	19	$ 3,030.00
		Total	**0**	**17**	**13**	**2**	**11**	**43**	**$ 6,690.00**
B		**Data Collection**							
	1	Document collection			1	4	1	6	$ 680.00
	2	Site visit (1)		2	4	4		10	$ 1,500.00
		Total	**0**	**2**	**5**	**8**	**1**	**16**	**$ 2,180.00**
C		**Analysis**							
C-1		**Existing Conditions Model - Hydrologic Analysis**							
	a	Delineate drainage areas		1	8	28		37	$ 4,640.00
	b	Hydrologic parameters		1	4	22		27	$ 3,350.00
	c	Time of concentration determination		1	4	16		21	$ 2,660.00
	d	Rational Method Peak Flow Determination		1	2	6		9	$ 1,210.00
	e	Runoff hydrographs		1	4	10		15	$ 1,970.00
		Subtotal	**0**	**5**	**22**	**82**	**0**	**109**	**$ 13,830.00**
C-2		**Existing Conditions Model - Hydraulic Analysis**							
	a	Storm sewer network		1	8	22		31	$ 3,950.00
	b	Oyster Creek and Tributary		1	8	34		43	$ 5,330.00
	c	Two-dimensional modeling mesh			2	4		6	$ 760.00
	d	Overland flow roughness values		1	2	8		11	$ 1,440.00
	e	Hydraulic analysis	1	4	20	20		45	$ 6,450.00
		Subtotal	**1**	**7**	**40**	**88**	**0**	**136**	**$ 17,930.00**
C-3		**Develop Improvement Alternatives Model - Hydraulic Analysis**							
	a	Problem area identification and conceptual improvement alternatives		4	8	2		14	$ 2,310.00
	b	Model proposed improvements	1	1	40	40		82	$ 11,090.00
	c	Document benefits		1	6	6		13	$ 1,810.00
	d	Cost estimates		1	6	6		13	$ 1,810.00
		Subtotal	**1**	**7**	**60**	**54**	**0**	**122**	**$ 17,020.00**
		Total	**2**	**19**	**122**	**224**	**0**	**367**	**$ 48,780.00**

Lockwood, Andrews & Newnam, Inc.
A LEO A DALY COMPANY

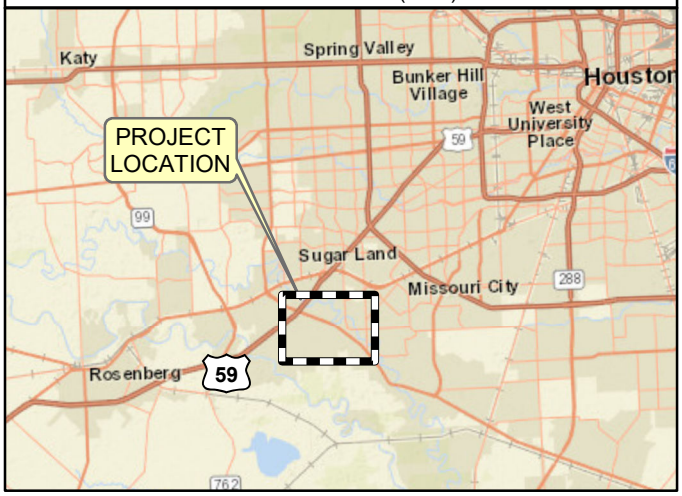
EXHIBIT B
Fee Schedule
Sugar Land - Drainage Study for River Bend North, Plantation Bend and Oyster Creek

	DESCRIPTION OF WORK TASKS	PRINCIPAL	PROJ MGR / TEAM LDR	SR PROF ENG	GRADUATE ENGINEER	PROJ ADMIN	TOTAL HOURS	TOTAL LABOR COSTS
D	**Report**							
1	Draft preliminary drainage report	1	8	12	24	2	47	$ 6,730.00
2	Model Output & Exhibits		2	5	12	4	23	$ 2,850.00
3	Report completion		2	4	4	4	14	$ 1,780.00
	Total	**1**	**12**	**21**	**40**	**10**	**84**	**$ 11,360.00**
E	**Direct Costs and Reimbursable Expenses**							
1	Printing/reproduction, deliveries and mileage							$ 500.00
2	Survey Data Collection							$ 10,000.00
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**$ 10,500.00**
	TOTAL HOURS	**3**	**50**	**161**	**274**	**22**	**510**	
	Contract Labor Rate	$270.00	$220.00	$150.00	$115.00	$70.00		
	TOTAL LABOR COSTS	**$810.00**	**$11,000.00**	**$24,150.00**	**$31,510.00**	**$1,540.00**		**$79,510.00**

Total Contract	**$79,510.00**



VICINITY MAP (NTS)



0 500 1,000
Feet

CITY OF SUGARLAND

Lockwood, Andrews & Newnam, Inc.
A LEO A DALY COMPANY

DRAINAGE STUDY FOR RIVER BEND NORTH, PLANTATION BEND AND OYSTER CREEK

EXHIBIT C - PROJECT LOCATION MAP

Map Document: H:\PotentialProjects\Sugar Land\RiverBend\Exhibit 1 - Project_Location.mxd 11/20/2017 1:07:23 PM mjmanges