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October 11, 2019

Mr. Stanton Foerster, P.E. City Engineer City of Lucas 665 Country Club Road Lucas, Texas 75002

Re: Lemontree Drainage Analysis Final Report and Concept Plan

Dear Mr. Foerster:

As requested, we have completed a drainage analysis of the basin contributing storm water runoff to Reid Branch Tributary 1. Our analysis consisted of the following:

- 1. Review of the record drawings and drainage calculations provided by the City of Lucas for each of the developments within the basin.
- 2. Field survey of selected existing culverts and drainage features within the basin
- 3. Site investigation including walking the accessible drainage courses within the basin and examining the condition of existing culverts and other drainage features.

We have summarized our observations and possible recommendations from the analysis into the sections that follow:

Lemontree Estates Channel & Driveway Culverts Analysis

The northeast portion of the Lovejoy High School site (13.94 ac) drains undetained, to the southwest corner of the Lemontree Estates Addition. The Lovejoy High School record drawings include drainage calculations that indicate the pre-development 100-year flow rate was 34 cfs and the post-development flow rate was 85.3 cfs. However, after careful review of the calculations, we calculated a pre-development 100-year flow rate of approximately 44 cfs and a post-development flow rate of approximately 39 cfs.

Runoff from the Lovejoy High School site flows overland to a roadside ditch along the west side of Citrus Way. The ditch west of Citrus Way flows south to a culvert under Mandarin Cove at the southwest corner of the Lemontree Estates Addition. The culverts under Mandarin Cove are damaged and are undersized for a 100-year flow rate. The runoff then flows east in a roadside ditch along the south side of Citrus Way and through a series of driveway culverts that are also undersized for a 100-year flow rate. Several of the driveway culverts downstream of Mandarin Cove are also sloping the wrong way (against flow).

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Image 1: Downstream Face of Mandarin Cove Culvert

Lemontree Estates Channel & Driveway Culverts Recommendations

- 1. Recalculate the total flow in the roadside ditch west of Citrus Way, including the offsite area from the Lovejoy High School and onsite area within the Lemontree Estates Addition, using current engineering design requirements for runoff coefficients, time of concentration and storm intensities.
- 2. At a minimum, we recommend reconstructing the roadside ditch for about 200 feet on each side of Mandarin Cove and replacing the culverts at Mandarin Cove based on the design criteria selected by the City of Lucas.
- 3. A drainage improvements project could also be considered to reconstruct the roadside ditch along the south side of Citrus Way and the driveway culverts from Mandarin Cove to Orchard Lane based on the design criteria selected by the City of Lucas.

Lovejoy High School Pond Analysis

A large portion of the Lovejoy High School site drains to a detention pond on the east side of the high school property. The record drawings for the pond include design calculations for a 34-inch orifice plate to be installed at the outfall structure for the pond. At the time of design and construction, this exceeded design criteria required for development within the City of Lucas.

During our site investigation it was observed that the pond is discharged via a 36-inch HDPE pipe without any restrictor plate. We also observed an erosion control device at the upstream side of the outfall (shown below).

Field surveys indicate low spots in the middle of the berm for the detention pond has near the outfall culvert as much as a foot lower than the north and south ends of the berm. Rock rip rap has been placed on the east side of the berm in this location indicating that water is going over the berm undetained and creating a potentially erosive situation. The Lovejoy High School record drawings include volumetric calculations for the pond and the pond may not be functioning as it was designed based on our observations.

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Image 2: Lovejoy High School Pond Outfall

Lovejoy High School Pond Recommendations

- 1. Additional surveys and analysis of the pond should be performed to determine if adequate storage is currently provided and if the existing outfall structure should be modified to perform as it was originally designed. Our concept plan exhibit recommends, at a minimum, raising the berm along the east side of the detention pond to be at least 1-foot above the 100-year water surface elevation based on the plans.
- 2. The Lovejoy High School detention pond should be analyzed to determine any improvements necessary to perform in accordance with the design criteria selected by the City of Lucas. This could include performance based on a number of design storms, including more frequently occurring events.
- 3. A detention pond improvements project could be constructed based on the design criteria selected by the City of Lucas.

Rimrock Estates Analysis

The record drawings for Rimrock Estates demonstrate runoff passing through the development via a series of ponds. Pond A is at the downstream limits of the development and is within a drainage easement on two residential lots. The outfall constructed for Pond A does not match the record drawings which may cause the water surface elevation to be higher than anticipated. This condition coupled with a potentially higher release

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rate from the high school detention pond upstream of this development could cause the Pond A water surface to be higher and potentially have adverse impacts on the two residential lots.

The water surface elevation in Pond B is controlled by a broad crested weir constructed at the downstream end of the pond. Design of this pond is based on the maximum design flow rate from the record drawings for the high school detention pond upstream of the development together with additional offsite drainage areas. The proper function of the high school detention pond is therefore critical to the design of Pond B. Additional discharge from the high school detention pond could cause higher water surface elevations in pond B, potentially going over Rimrock Drive. There is also the potential for adverse impacts to adjacent residential lots in this area.

The discharge from Pond B flows eastward in a swale labeled Pond A which turns northward along the east property line of the Rimrock Estates Addition flowing to a point where the drainage swale turns east towards Orchard Road.



Image 3: Rimrock Estates Pond A (Looking North)

<u>Rimrock Estates Recommendations</u>

- 1. The proper function of the Lovejoy High School detention pond is a crucial element for the proper function of the detention ponds constructed in the Rimrock Estates Addition and therefore addressing any detention pond performance issues would be highly recommended.
- 2. Additional surveys and analysis of the drainage swale downstream of Pond B could be performed to determine the anticipated 100-year depth of flow in "Pond A" to determine if improvements would be required to provide necessary free-board to adjacent properties within the Rimrock Estates Addition.

Lemontree Country Estates Addition (Orchard Road) Analysis

Flow discharged from Pond A in Rimrock Estates drains to a swale which drains to the east in the Lemontree Country Estates Addition to Orchard Road. The drainage plans for Rimrock Estates include a total 100-year release rate of 122.65 cfs. Two 18-inch culverts are provided at Orchard Road. These culverts do not have

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capacity to convey runoff from the 100-year event. The road is only slightly higher than the top of the culverts indicating that water will overtop Orchard Road in a 100-year storm event.

The property owners on the north and south side of the channel downstream (east) of the Orchard Road culverts met with us while walking the drainage course and indicated that mowing the channel was difficult due to the steep side slopes. We observed a water depth of 1 to 2 -inches from the west property line of the Lemontree Country Estates Addition to just before the east property line. We observed some channel scour and concrete rubble had been dumped in this location.



Image 4: Channel Downstream of Orchard Road (Looking Upstream / West)

The property owner on the north side of the channel indicated there was frequent standing water on the northeast corner of his property and added that the channel does not drain to the east of his property like it did several years ago. We observed standing water east of Orchard Road along the north side of this property.

Lemontree Country Estates Addition (Orchard Road) Recommendations

- 1. Additional surveys and analysis could be performed on the channel and culverts crossing Orchard Road to determine any improvements necessary to perform in accordance with the design criteria selected by the City of Lucas. Our concept plan recommends at a minimum that the the side slopes of the open channel be flattened to 4:1 or flatter. The channel could also be graded steeper to drain better, if permission to grade on to the adjacent tract downstream (east) could be obtained.
- 2. Debris, trash removal and minimal grading could help alleviate the standing water experienced by the property owner on the north side of the channel (east of Orchard Road).

Kingswood Estates, The Farmstead and Claremont Springs Analysis

Runoff conveyed via the channel downstream (east) of Orchard Road continues flowing to the east and northeast through a series of ponds converging with flow from the southeast corner of Lemontree Estates, runoff from Kingswood Estates, runoff from The Farmstread, and flow released from the retention pond in the Claremont Springs Addition located on the south side of Estates Parkway. The drainage conveyance systems at these locations appear to function as designed. The combined flow channelizes and crosses Lynn Lane via

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eight (8) 48-inch reinforced concrete pipe culverts. We did not observe any significant erosion issues or capacity problems at Lynn Lane.

Stormwater discharged from Claremont Springs flows through The Farmstead crossing Lee Lane via 3 - 6'x3' reinforced concrete box culverts. Drainage calculations from The Farmstead construction plans indicate that the detention ponds provided maintain pre-developed conditions and do not increase runoff within the basin.

Accumulated runoff flowing to the south along Kingswood Drive is conveyed via small undefined roadside swales. Driveways in Kingswood Estates lack culverts and the swales cross each driveway creating a low water crossing at each location. There is very little capacity along these swales, and it appears water ponds in most of the driveways after a storm event, due to grass and silt deposits on the low side of each driveway. Additionally, the swales have a relatively flat slope and water likely stagnates in various flat/low spots along the swales.

Kingswood Estates Recommendations

- 1. At a minimum, we recommend installing a concrete pilot channel in each of the swales from driveway to driveway. This would help to drain most of the water which accumulates in the driveways after a storm event. Without grass impeding flow, a pilot channel should also reduce the likelihood of water stagnating in between driveways. We recommend a concrete pilot channel 2 to 3-ft in width with a 1-inch invert between the driveways, on both sides of the street, for the full length of the north-south portion of Kingswood Drive shown on the exhibit. This approach is unlikely to provide 100-year design storm capacity but should reduce stormwater ponding.
- 2. Alternatively, we recommend a channel be designed along both sides of the road to convey a design storm event as determined by the City. The channel would begin at the downstream end of the drainage channel in the southeast corner of Kingswood Estates. This approach would include installing driveways culverts at each driveway and significant grading efforts to provide ditches along both sides of Kingswood Drive. A portion of each of the driveways would be reconstructed to remove the low water crossing and reconstruct the driveways over the new culverts.

Conclusions

The runoff from the northeast corner of the high school site was slightly reduced, based on our calculations and is not contributing to drainage problems for the existing ditch along Citrus Way, the culverts crossing Mandarin Cove and driveway culverts along the south side of Citrus Way in the Lemontree Estates. At a minimum, we recommend reconstructing the roadside ditch for about 200 feet on each side of Mandarin Cove and replacing the culverts at Mandarin Cove based on the design criteria selected by the City of Lucas. We also recommend consideration of reconstructing the roadside ditch along Citrus Way east of Mandarin Cove and the driveway culverts and designed based on the design criteria selected by the City of Lucas.

A drainage improvements project could also be considered to reconstruct the roadside ditch and the driveway culverts along Citrus Way from west of Mandarin Cove to Orchard Lane based on the design criteria selected by the City of Lucas.

The north end of Lemontree Estates is at the top of the drainage basin and there are no indications that the culvert structure at the southeast corner of the development under Citrus Way lacks capacity to convey the runoff.

Our observations of the Lovejoy High School detention pond indicate less volume may be provided and the outfall structure may not perform as originally designed. This could result in weir flow over the berm, sending

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a higher rate of flow downstream than the original design intended. The design of drainage features downstream of the high school pond in Rimrock Estates are based on the high school pond and outfall structure functioning as originally designed. The water surface elevation through Rimrock Estates could rise causing adverse impacts to the lots and overwhelming other drainage facilities downstream of the high school without some improvements to the detention pond. At a minimum, we recommend the berm for the detention pond be raised to at least 1-foot above the 100-year water surface elevation based on the plans.

The channel crossing the Lemontree Country Estates Addition and the culverts crossing Orchard Lane do not have capacity for a 100-year event. At a minimum, we recommend flattening the side slopes of the channel from Rimrock Estates to the east property line of Lemontree Estates to 4:1 or less for ease of maintenance. A drainage improvements project could also be considered to size the channel and the culverts crossing Orchard Lane in accordance with the design criteria selected by the City of Lucas.

There are no roadside ditches and culverts in the Kingswood Addition and there is some ponding of water in the driveways after a rain event. At a minimum, we recommend installing concrete pilot channels in the swales on both sides of the road from driveway to driveway.

Let us know if there are any questions regarding our observations or recommendations contained in the preliminary report. We are available to discuss this report and our recommendations at your convenience.

Sincerely,

Joseph T. Grajewski, P.E.

Joe R. Carter, P.E., C.F.M.

Enclosures



REVISED: 10/11/19 - CBURGETT

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REVISED: 7/24/19 - CBURGETT H:\Projects\Lucas\2019118 Lemontree Drainage Analysis\Basedwgs\Support\2019118 Drainage Base.dwg



REVISED: 1/29/20 - KANDERSON H:\Projects\Lucas\2019118 Lemontree Drainage Analysis\Basedwgs\Support\2019118 Existing Flows.dwg

PLOT SCALE: 1:2



REVISED: 1/29/20 - KANDERSON H:\Projects\Lucas\2019118 Lemontree Drainage Analysis\Basedwgs\Support\2019118 Suggested Flows.dwg

PLOT SCALE: 1:2

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MEMORANDUM

To: Mr. Stanton Foerster, P.E.

From: Mr. Joseph T. Grajewski, P.E.

Date: May 22, 2020

Subject: Lemontree Estates & Kingswood Estates – Supplemental Drainage Analysis

This memorandum supplements our Lemontree Drainage Analysis dated October 11, 2019. Upon review of the original report, additional information from property owners and site visits to review existing flow patterns, the City requested the following supplemental analysis.

A. Capacity of culvert crossing at Lynn Lane for Reid Branch Tributary 1:

The culvert crossing for Reid Branch Tributary 1 at Lynn Lane is made up of eight (8) 48-inch reinforced concrete pipes. Based on flowline elevations and length obtained for one of the eight concrete pipes, the slope is 1.23%. The pipe has a capacity of 159 cubic feet per second (cfs) flowing full without pressure flow. Assuming each of the pipes are at the same slope, a maximum conveyance rate of 1,272 cfs is provided at this crossing. The water velocity is over 12 feet per second for each pipe at this flowrate and warrants downstream erosion control measures. The 100-year flow rate at this location is 1,555 cfs based on the HEC-HMS Hydrologic Model previously prepared for this basin. This analysis ignores the effects of upstream and downstream channel conditions, and any pressure flow from headwater conditions on the upstream side. A hydraulic model of this culvert crossing could be developed using HEC-RAS to calculate the culvert capacity more accurately at this location.

B. Design an open channel cross section in Kingswood Estates to convey drainage across lots 8, 7, & 6): The attached exhibit (Conceptual Drainage Improvements – Kingswood Estates) illustrates the approximate location for the proposed open channel with a typical section (section A-A). Based on 2foot contours, the proposed channel would have an approximate slope of 0.8% over a length of 715 linear feet. The drainage area contributing to this channel generates a 100-year flow rate of approximately 145 cfs. Given the overall slope and 100-year flow rate, the open channel concept is approximately 30-feet in width and could be constructed within an existing Drainage & Utility Easement; however, a temporary construction easement would be required. This would include the removal of a small diameter culvert observed during a site visit on Lot 7.

- C. Capacity of culvert crossing at Citrus Way near the upper southeast corner of Lemontree Estates: Approximately 30 acres of runoff accumulates at the culvert crossing at the southeast corner of Citrus Way. The existing culvert crossing is two 21-inch corrugated metal pipes. Based on flow line shots obtained from field survey, each pipe has a capacity of approximately 17 cfs flowing full without pressure flow providing a maximum capacity of 34 cfs at this location. This area generates a 100-year flow rate of approximately 95 cfs. If the upstream end of the culvert builds up headwater, additional flow could be conveyed through the culverts from the resultant pressure. If water on the upstream end rises high enough, it could flow over the road in a weir flow condition. This situation is likely since there is not much cover on the culverts at this location.
- D. During a field meeting with property owners and representatives from the City, it was reported that offsite runoff from west of Kingswood Estates flows across lots 8-12 and into the roadside channel on the west side of Kingswood Drive. The original drainage design for Kingswood Estates acknowledged this off-site runoff and provided flow arrows indicating that runoff would flow to the south along the west property lines of lots 8-12. A small berm was observed during the site visit, but it lacked an open channel on the west side to provide positive drainage to the south. A small berm with a minimum height of 2.5-feet could be constructed to redirect this offsite runoff. The attached exhibit (Conceptual Drainage Improvements Kingswood Estates) illustrates the limits of the proposed berm with a typical section (section B-B). If the slope of the drainage channel on the west side of the berm is flatter than 0.5%, a concrete pilot channel shall be required per City requirements.
- E. Most of the runoff within this basin from the Lovejoy High School site flows to the east through Lemontree Estates crossing Orchard Road before continuing to the east and ultimately converging with Reid Branch Tributary 1. The City requested a conceptual analysis to re-direct runoff to the south along Orchard Road and then to the east along the open channel for FM 2170 (Estates Parkway).

There are approximately 75 acres draining to the culvert crossing on Orchard Road generating a 100year flow rate of approximately 250 cfs. This would necessitate an open channel approximately 5 feet deep and 40 feet wide to convey flow to the south along Orchard Road and then east along Estates Parkway. The exhibit attached (Conceptual Drainage Improvements – Orchard-Estates Relief Channel) illustrates the location of this proposed open channel. Additional items to consider with this conceptual plan include:

- i.) The distance from the existing culverts crossing Orchard Road to the culverts crossing Estates Parkway downstream of the pond releasing flow from Claremont Estates is approximately 2,230 linear feet. This area is relatively flat and in some cases the topography flows in the opposite direction. An average slope of 0.3% is anticipated for the proposed drainage channel and will require a concrete pilot channel per City requirements.
- ii.) There are no existing drainage easement along this corridor. The drainage channel will not fit within the right-of-way and will require land rights acquisition.

- iii.) Each of the driveway culverts along Orchard Road and Estates Parkway will need to be re-sized and re-constructed for the re-directed flow. A flowrate of 400 cfs on a 0.33% grade requires 2-5'x5' boxes or 1-10'x5' box.
- iv.) Any structures, water lines or franchise utilities within 40-feet of the right-of-way may conflict with the improvements.
- v.) The re-directed flow will converge with discharge from Claremont Estates at the existing culvert crossing Estates Parkway. Runoff from Claremont Estates is discharged from a detention pond. The 100-year discharge release rate from the pond is 168 cfs. This flow combines with the re-directed 250 cfs and continues in the roadside channel along Estates Parkway.
- vi.) Estates Parkway is owned and maintained by the Texas Department of Transportation (TxDOT) and will require their approval for additional flow to be conveyed in the roadside channels within the right-of-way. It is unlikely the existing roadside channels have capacity for an additional 400 cfs of stormwater and channel improvements will be required (and additional land rights obtained). A minimum of seven (7) driveway culverts will need to be replaced and the culvert structure at the intersection of Estates Parkway and Country Club Road will need to be reconstructed to convey the additional flow.
- F. The offsite area contributing the southwest corner of Kingswood Estates is approximately 46 acres. The rational method can be used to calculate the 100-year flowrate from this area.

C = 0.55

I = 5.75 (30 min Time of concentration)

A = 46 acres

 $Q_{100} = C \times I \times A = 145$ cubic feet per second \rightarrow This flow is conveyed via the open channel described in Part B (above).

G. Runoff from Claremont Estates on the south side of Estates Parkway is collected in a detention pond and discharged to the north into 3-42-inch reinforced concrete pipe culverts. This flow continues on a north-northwest path (through Farmstead) for approximately 1700 linear feet where it converges with flow conveyed to the east along the south side of Kingswood Estates. The City requested a conceptual analysis to re-direct discharge from the pond in Claremont Estates east along the open channel for Estates Parkway.

The 100-year discharge rate from the Claremont Springs detention pond is 168 cfs. This would necessitate an open channel approximately 4 feet deep and 32 feet wide to convey flow east along Estates Parkway. The exhibit attached (Conceptual Drainage Improvements – Estates Relief Channel) illustrates the location of this proposed open channel. Additional items to consider with this conceptual plan include:

i.) The existing roadside channel along Estates Parkway will be re-constructed to provide the required additional capacity. If the drainage channel does not fit within the right-of-way,

additional land rights will be required. Any structures, water lines or franchise utilities near the existing right-of-way may conflict with the drainage improvements.

- Estates Parkway is owned and maintained by the Texas Department of Transportation (TxDOT) and will require their approval for additional flow to be conveyed in the roadside channels within the right-of-way.
- iii.) Each of the six (6) driveway culverts along the south side of Estates Parkway will need to be resized and re-constructed for the re-directed flow. A flowrate of 168 cfs on a 0.40% grade requires a 6'x4' box culvert. Additionally, the culvert structure at the intersection of Estates Parkway and Country Club Road will need to be reconstructed to convey the additional flow.



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