CITY OF GARLAND

EASTERN HILLS GOLF COURSE

SANITARY SEWER ANALYSIS

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MEMORANDUM

City of Garland
Eastern Hills Golf Course
Sanitary Sewer Analysis

B&V Project: Duck Creek Interceptor Project
B&V File: 64993
24 September 2014

To: Rahman Kafray, Engineering Department

From: David Klaus
Reviewed by: Laura Moreno, Layne Parsons

This Technical Memorandum (TM) summarizes the evaluation of the service area, population, flow projections, and hydraulic modeling of the Eastern Hills Golf Course (EHGC) for residential development. This evaluation includes updates to the hydraulic model for abandonment of the Club Creek Lift Station and addition of the 12" gravity relief sewer to the Wind Ridge Lift Station.

1.0 Hydraulic Model Update

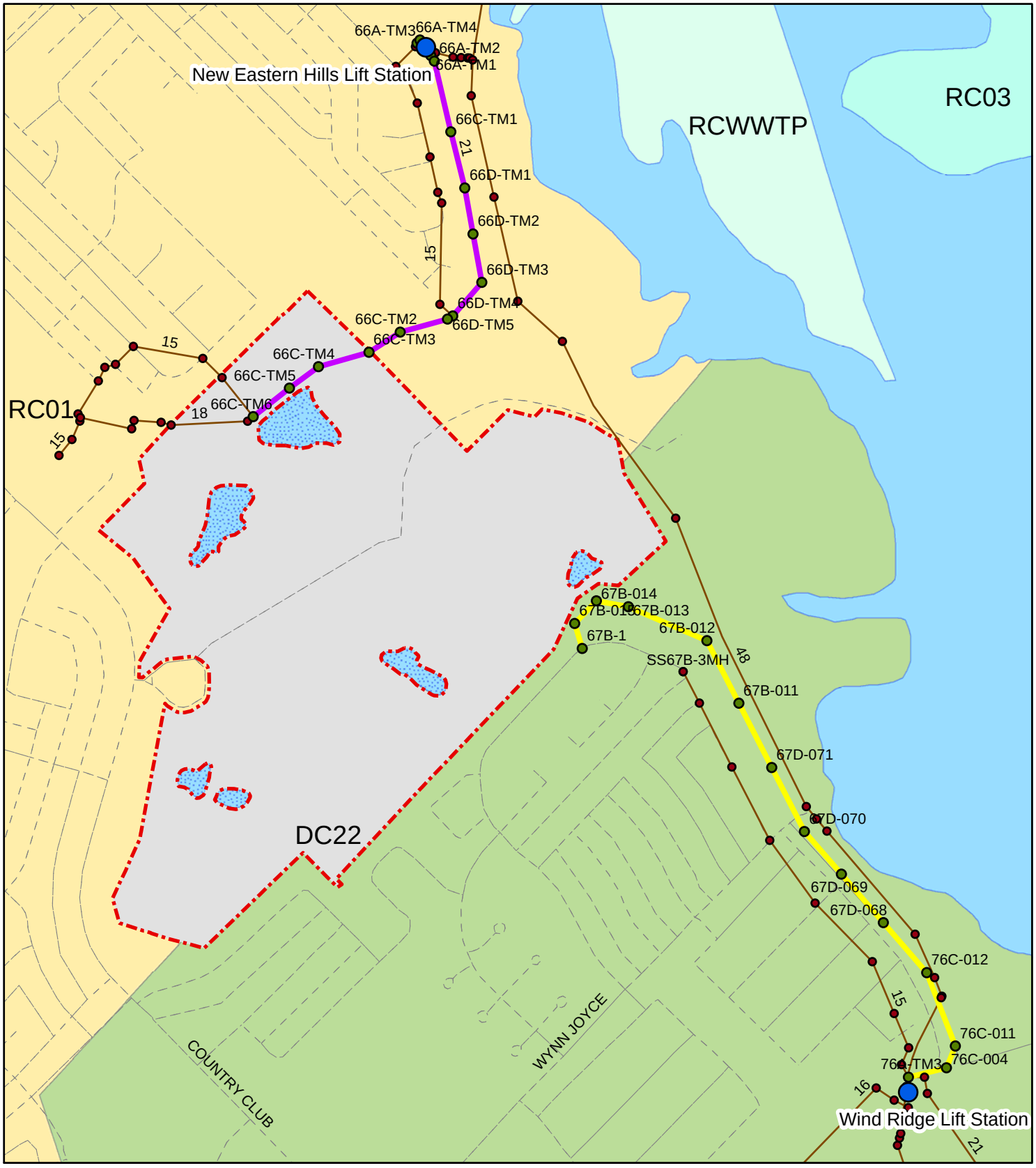
The year 2040 future model from the Wastewater Management Plan Update 2008 was updated to include the abandonment of the Club Creek Lift Station and the addition of the 12-inch relief sewer using plan sets received from the City. Flows from the Club Creek Lift Station were originally assigned to model node SS67B-3MH, the location of 4" force main original discharge, and used the existing 15" gravity sewer to the Wind Ridge Lift Station. The 2040 flows of 0.410 mgd, as shown in the 2008 Wastewater Management Plan Update, Appendix I.2, pg 27, from the Club Creek Lift Station area were reassigned to the upstream node (SS67B-1MH) of the new 12" relief sewer to the Wind Ridge Lift Station. Tables 1 and 2 and Figure 1 identify the relief sanitary sewer inventory added into the model.

Table 1 – 12" Relief Sewer Node Inventory

GIS MH Name	Station Number	x (ft)	y (ft)	Ground Level (ft)	Invert Elevation (ft)
SS76C-004MH	00-00	2555364	7005734	446.00	427.78
SS76C-011MH	01-46	2555419	7005869	443.91	427.96
SS76C-012MH	06-37	2555240	7006327	441.95	428.55
SS67D-068MH	10-50	2554970	7006638	440.23	429.04
SS67D-069MH	14-50	2554708	7006940	438.32	429.52
SS67D-070MH	18-02	2554477	7007206	438.94	429.94
SS67D-071MH	22-50	2554273	7007605	437.52	430.48

Table 1 – 12" Relief Sewer Node Inventory					
GIS MH Name	**Station Number**	**x (ft)**	**y (ft)**	**Ground Level (ft)**	**Invert Elevation (ft)**
SS67B-011MH	27-00	2554068	7008005	440.62	431.02
SS67B-012MH	31-37	2553868	7008395	440.04	431.54
SS67B-013MH	36-71	2553378	7008606	441.09	432.19
SS67B-014MH	38-75	2553178	7008643	439.33	432.43
SS67B-015MH	40-70	2553042	7008502	439.16	432.66
SS67B-1MH	42-33	2553089	7008346	442.00	432.86

Table 2 - 12" Relief Sewer Pipe Inventory						
US GIS MH Name	**DS GIS MH Name**	**Length (ft)**	**Diameter (in)**	**US Invert Elevation (ft)**	**DS Invert Elevation (ft)**	**Slope (%)**
SS76C-004MH	76A-TM3	244.8	12	427.78	425.43	0.960
SS76C-011MH	SS76C-004MH	146.33	12	427.96	427.78	0.123
SS76C-012MH	SS76C-011MH	491.0	12	428.55	427.96	0.120
SS67D-068MH	SS76C-012MH	412.2	12	429.04	428.55	0.119
SS67D-069MH	SS67D-068MH	400.0	12	429.52	429.04	0.120
SS67D-070MH	SS67D-069MH	352.3	12	429.94	429.52	0.119
SS67D-071MH	SS67D-070MH	447.7	12	430.48	429.94	0.121
SS67B-011MH	SS67D-071MH	450.0	12	431.02	430.48	0.120
SS67B-012MH	SS67B-011MH	437.6	12	431.54	431.02	0.119
SS67B-013MH	SS67B-012MH	534.0	12	432.19	431.54	0.122
SS67B-014MH	SS67B-013MH	203.5	12	432.43	432.19	0.118
SS67B-015MH	SS67B-014MH	195.7	12	432.66	432.43	0.118
SS67B-1MH	SS67B-015MH	162.9	12	432.86	432.66	0.123



Legend

- model nodes
- 12in-line-MH
- Lift Stations
- 12in-line
- 21in existing sewer
- NCTCOG_Roads_All
- Eastern Hills Golf Course Area
- EHGC_Ponds
- NCTCOG_Lakes

Eastern Hills Golf Course Developement
Sanitary Sewer Analysis

Figure 1

2.0 Hydraulic Model Parameters

The flows from the EHGC development were estimated using the future flow design criteria and the hydraulic model parameters from the Wastewater Management Plan Update 2008. The parameters for Subsystems DC22 and RC01from the calibrated hydraulic model were applied to generate the development dry and wet weather flows. Model runs were created and reviewed to determine the flows from the area and effects on the modeled sewer pipes.

Dry Weather Flow Parameters

The area for the EHGC development was estimated to be approximately 166 acres using NCTCOG 2005 land use data. Undevelopable land use codes were not included as part of developable land. The EHGC area was determined by subtracting the undevelopable flood plain and water body areas provided by NCTCOG from the 178 acre tract. The population for the developable acres was estimated using a future density of 3.0 units/acre and future equivalent population of 2.6 capita/unit based on the future flow criteria described in the Wastewater Management Plan Update 2008, Figure 5-6, page 5-17. Therefore, approximately 498 single family units can be built within the development area with an estimated population growth of 1,295 residents. The estimated population, a sanitary dry weather future flow criteria of 90 gallons per capita day (gcd), and a diurnal peaking factor of 1.393 were used to determine the average daily dry weather flow (ADDF) and peak ADDF. The diurnal peaking factor is the maximum factor resulting from the average of the DC22 and RC01 subsystems diurnal curves at each 24 hour time step in order to capture the slightly different peak time and diurnal pattern from each of the two basins.

The ADDF was estimated to be 0.116 mgd and the peak ADDF was estimated to be 0.162 mgd for year 2040 based on the projected population of 1,295. Using an average daily flow (ADF) to ADDF ratio of 1.215, the ADF was estimated to be 0.197 mgd. The ADF to ADDF ratio is based on the average of the Duck Creek and Rowlett Creek ADF to ADDF ratios of 1.25 and 1.18 from the Wastewater Management Plan Update 2008.

Wet Weather Flow Parameters

The wet weather flows were estimated using the design criteria for new growth developed as part of the Wastewater Management Plan Update 2008 and the hydraulic model. The percent of contributing area for the new development was set to 2% for Area 1, 3% for Area 2 and 5% for Area 3. The EHGC development area was part of the DC22 and RC01 subsystems delineated as part of the Wastewater Management Plan Update 2008. The wet weather flow parameters

utilized in the future model runs from these two subsystems were averaged and assigned to the new model subcatchment for the EHGC development. Table 3 below shows the average values used for the runoff surfaces, pervious and impervious contributing area, and infiltration contribution for the new EHGC area catchment.

Table 3 – Runoff and Infiltration Parameters

	Runoff Surface Parameters						Infiltration Parameters	
	Runoff Routing Value			Fixed Runoff Coefficient				
	Area 1	Area 2	Area 3	Area 1	Area 2	Area 3	Percolation Coefficient	Percolation Percentage Infiltrating
DC22	30	450	500	0.012	0.1	0.02	0.15	6
RC01	30	400	500	0.1	0.24	0.02	0.3	4
Average Values EHGC Subcatchment	30	425	500	0.056	0.17	0.02	0.225	5

The dry weather and wet weather flow parameters described in the section above were input to the hydraulic model to generate the peak 5-year flow for the EHGC development and review the hydraulic capacity of the existing sanitary sewers to serve the proposed development.

3.0 System Capacity Analysis Scenarios and Model Results

An initial model scenario was run prior to adding the contributing flows from the new EHGC development area to determine existing system flow and confirm available capacity in the 21-inch existing sanitary sewer which runs along the north side of the development area leading to the Eastern Hills Lift Station and the new 12-inch relief sewer running along the east side of the development area leading to the Wind Ridge Lift Station. The model flows from the 12-inch relief sewer ranged from 0.408 mgd to 0.410 mgd with utilization factors ranging from 0.181 to 0.518. Flows ranged from 1.972 mgd to 2.246 mgd and utilization factors from 0.439 to 0.508 for the 21-inch sanitary sewer. Table 4 below shows the results for each of the sewer lines and confirms available capacity in each of the sanitary sewer lines.

Two additional scenarios were run to analyze the capacity utilization of both the 21-inch and 12-inch sewers with the addition of the EHGC development flows.

Scenario 1: All the additional flow from the EHGC development allocated to the 12-inch relief sanitary sewer going to the Wind Ridge Lift Station. The results for Scenario 1 show the 12-inch

sanitary sewer line would be over utilized by the additional flow from the EHGC development and would not be a viable solution to carry all the flow from the new development area. The average utilization observed is about 120 percent.

Scenario 2: All the additional flow from the EHGC development allocated to the existing 21-inch sewer going to the Eastern Hills Lift Station. The model results indicate that the additional flow could be carried by the 21-inch sewer while still leaving some additional capacity, the 21-inch sanitary sewer would have an average utilization of about 60 percent. The Eastern Hills Lift Station has a firm capacity of 3.7 mgd as indicated in the Wastewater Management Plan Update 2008. The updated model results with the EHGC development show peak flows into the lift station at 2.83 mgd. The velocity in the force main from the lift station will increase to 6.6 ft/s which remains under the design criteria of <10 ft/s for force mains.

The following Tables 4 and 5 show the 12-inch and 21-inch sewer data, 2040 5-year peak flow and utilization, as well as peak flows and utilization for the two scenarios.

	Table 4 - Scenario 1											
	Pipe Data								**2040 5yr Flow & Capacity before EHGC Development**		**2040 5yr Flow & Capacity with all new development flow to 12" sewer**	
	US GIS MH Name	DS GIS MH Name	US Station No.	DS Station No.	Length (ft)	Diameter (in)	Slope (ft/ft)	Pipe Capacity (MGD)	Peak Total (MGD)	Utilization Factor Q_total/cap	Peak Total (MGD)	Utilization Factor Q_total/cap
12" to Wind Ridge Lift Station	67B-1	67B-015	42-33	40-70	162.9	12	0.00123	0.809	0.410	0.507	1.032	1.276
	67B-015	67B-014	40-70	38-75	195.7	12	0.00118	0.792	0.410	0.518	1.022	1.290
	67B-014	67B-013	38-75	36-71	203.5	12	0.00118	0.792	0.410	0.518	1.014	1.280
	67B-013	67B-012	36-71	31-37	534	12	0.00122	0.806	0.409	0.507	1.007	1.249
	67B-012	67B-011	31-37	27-00	437.6	12	0.00119	0.796	0.409	0.514	1.003	1.260
	67B-011	67D-071	27-00	22-50	450	12	0.00120	0.799	0.409	0.512	1.001	1.253
	67D-071	67D-070	22-50	18-02	447.7	12	0.00121	0.802	0.409	0.510	1.000	1.247
	67D-070	67D-069	18-02	14-50	352.3	12	0.00119	0.796	0.409	0.514	1.000	1.256
	67D-069	67D-068	14-50	10-50	400	12	0.00120	0.799	0.409	0.512	0.999	1.250
	67D-068	76C-012	10-50	06-37	412.2	12	0.00119	0.796	0.408	0.513	0.999	1.255
	76C-012	76C-011	06-37	01-46	491	12	0.00120	0.799	0.408	0.511	0.999	1.250
	76C-011	76C-004	01-46	00-00	146.3	12	0.00123	0.809	0.408	0.504	0.999	1.235
	76C-004	76A-TM3	00-00	76A-TM3	244.8	12	0.00960	2.260	0.408	0.181	0.999	0.442

	Table 5 - Scenario 2									
	Pipe Data						**2040 5yr Flow & Capacity before EHGC Development[(1)]**		**2040 5yr Flow & Capacity with all new development flow to 21" sewer**	
	US GIS MH Name	DS GIS MH Name	Length (ft)	Diameter (in)	Slope (ft/ft)	Pipe Capacity (MGD)	Peak Total (MGD)	Utilization Factor Q_total/cap	Peak Total (MGD)	Utilization Factor Q_total/cap
21" to Eastern Hills Lift Station	66C-TM6	66C-TM5	289.4	21	0.00190	4.473	2.013	0.450	2.571	0.575
	66C-TM5	66C-TM4	224.5	21	0.00187	4.437	1.998	0.450	2.570	.579
	66C-TM4	66C-TM3	345.7	21	0.00191	4.484	1.989	0.444	2.569	0.573
	66C-TM3	66C-TM2	211.6	21	0.00189	4.461	1.980	0.444	2.569	0.576
	66C-TM2	66D-TM5	307.6	21	0.00192	4.496	1.976	0.439	2.568	0.571
	66D-TM5	66D-TM4	38.6	21	0.00189	4.461	1.972	0.442	2.568	0.576
	66D-TM4	66D-TM3	275.5	21	0.00189	4.461	2.066	0.463	2.660	0.596
	66D-TM3	66D-TM2	305.2	21	0.00190	4.473	2.073	0.463	2.668	0.596
	66D-TM2	66D-TM1	291.7	21	0.00192	4.496	2.070	0.460	2.667	0.593
	66D-TM1	66C-TM1	361	21	0.00188	4.449	2.068	0.465	2.666	0.599
	66C-TM1	66A-TM2	453.5	21	0.00190	4.473	2.066	0.462	2.663	0.595
	66A-TM2	66A-TM1	28.1	21	0.00188	4.449	2.063	0.464	2.663	0.599
	66A-TM1	66A-TM3	115.3	21	0.00191	4.484	2.063	0.460	2.663	0.594
	66A-TM3	66A-TM4	26.8	21	0.00186	4.425	2.246	0.508	2.846	0.643
	66A-TM4	EHLS	39.6	21	0.00202	4.612	2.246	0.487	2.846	0.617

(1) The simulation engine of the dynamic hydraulic model might provide slightly difference results for the same simulation as a series of algorithms are run internally to find the numerical solutions while optimizing run time and ensuring mathematical stability.

A final analysis was performed using the future flow criteria from the Wastewater Management Plan Update 2008 and the model run results to determine the approximate total population which could be served by each of the two lines. The ADDF was estimated to be 0.116 mgd and the peak ADDF was estimated to be 0.162 mgd for year 2040 based on a projected population of 1,295 and a dry weather future flow criteria of 90 gcd. Using an average daily flow (ADF) to ADDF ratio of 1.215, the ADF was estimated to be 0.197 mgd. The ADF to ADDF ratio is based on the average of the Duck Creek and Rowlett Creek ADF to ADDF ratios of 1.25 and 1.18 from the Wastewater Management Plan Update 2008.

The hydraulic model runoff results based on the parameters input indicate that the area will produce a peak infiltration/inflow contribution of 0.501 mgd and the total 5-year peak flow will be 0.663 mgd. Based on the estimated population of 1,295 people, the total peak flow will be 513 gcd. Table 6 below summarizes the flow generation criteria for the new development area.

Table 6 - New Eastern Hills Golf Course Flow Criteria

EHGC Population	1,295
Dry Weather Future Sanitary Flow Rate (gcd)	90
Dry Weather Flow (DWF) (mgd)	0.116
DWF Peaking Factor	1.393
Peak Dry Weather Flow (DWF) (mgd)	0.162
Peak Model Infiltration/Inflow (mgd)	0.501
Peak Model Infiltration/Inflow Rate (gpad)	3,020
5-year Peak Model Flow (mgd)	0.663
Peak Flow per Person (gcd)	513[(1)]

(1) Based on a population of 1,295

Based on the Capital Improvement Project criteria of a d/D of 0.75 for pipes greater than 18-inch and 0.65 for pipes less than 18-inch; the total flow allowable was calculated for each pipe segment. The excess capacity within each pipe segment was used to determine the pipe segment with the limiting capacity for both the 12-inch and 21-inch sanitary sewer pipes. The 12-inch line has a limiting excess capacity of 0.188 mgd resulting in an estimated 368 additional people being able to be served by this line. The 21-inch line has a limiting excess capacity of 1.781 mgd resulting in an estimated 3,474 additional people being able to be served by this line.

Table 7 below shows the limiting pipe segments full capacity, design capacity, excess capacity during 5-year design storm event and the estimated population which could be served by each segment for both the 12-inch and 21-inch line.

Table 7 - Limiting Pipe Segment Information

US Node ID	DS Node ID	Length (ft)	Dia (in)	Slope (ft/ft)	Full Pipe Capacity (MGD)	Pipe Flow @ .75 d/D (mgd)	Pipe Flow @ .65 d/D (mgd)	Existing 5yr Peak Flow	Excess Capacity (mgd)	Max Additional Population
66A-TM3	66A-TM4	26.8	21	0.00186	4.425	4.025		2.246	1.781	3,474[(1)]
67B-015	67B-014	195.7	12	0.00118	0.790		0.598	0.410	0.188	368[(1)]

[(1)] Based on a population density and projected Peak Flow per Person (gcd) as indicated within this report and listed in Table 6.

Land Use Category

- Flood Control
- Institutional
- Hotel Motel
- Retail
- Office
- Under Construction
- Parks and Recreation
- Single Family
- Multi Family
- Utilities
- Industrial
- Vacant
- Water

Eastern Hills LS

Eastern Hills Golf Course

Windridge LS

CENTERVILLE

BELTLINE

OATES

DEXHAM

MILLER

ROWLETT

66

O BANNON

Flow Review Summary

Eastern Hills Golf Course

Development Parameters

Developed Acres: 166
Density: 3.0 units/acre
Population: 2.6 capita/unit
Single Family Units: 498
Population: 1,295
Year 2040

Model Parameters

Sanitary Flow: 90 gallons per capita day
Diurnal Peaking Factor: 1.393
Infiltration/Inflow Rate: 3,020 gpad
ADF to ADDF Ratio: 1.215 (Avg. from DC and RC ratios, 2008 Report Page 4-15)

Eastern Hills Golf Course

Average Daily Flow (ADF): 197,200 gpd (0.197 mgd)
Peak Flow: 663,630 gpd (0.663 mgd)
* Based on a 5-year storm event

LEGEND

- Structures (Existing Model)
- Lift Station
- Structure (12-inch line)
- Eastern Hills Golf Course Development
- Sanitary Sewer Modeled
- Sanitary Sewer Not Modeled
- New 12-inch Sanitary Sewer
- Lakes

CITY OF GARLAND, TEXAS

EASTERN HILLS GOLF COURSE - SANITARY SEWER ANALYSIS

Figure 1

GARLAND

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