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SANITARY SEWER ANALYSIS

For

LAKEWOOD BUSINESS PARK

Lee's Summit, Jackson County, Missouri

Prepared for:

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Revision	Date	By	Description
01	10/06/21	JSRT	Per City Comments

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1.0 INTRODUCTION

1.1 General Information

Powell CWM, Inc. prepared this sanitary sewer downstream capacity analysis for the proposed Lakewood Business Park development in Lee's Summit, Missouri. The 30 acre development is located in the Planned Industrial (PI) zoning district and includes three 1+ acre lots along NE Hagan Road, four mid-size 4± acre lots and one large 7.7 acre lot. The planned use for the lots is undetermined and may vary from office space, warehouse, and light industrial. The development will include construction of public improvements and the sanitary sewer will connect to existing manhole 14-068 at the East property line. The downstream receiving sewer for this project is the Maybrook Interceptor Main. The profile for the Maybrook Interceptor is shown in the attachments. This main carries flows from the Maybrook watershed and flows pumped from the Tudor Lift Station in the West Prairie Lee Watershed. Projected 10-year flows include contributions from the Property Reserve Inc. Lift Station #2 and assumed 50% development of presently vacant land. Projected 20-year flows include contributions from the Property Reserve Inc. Lift Station #3 and assume full watershed build-out conditions. The total areas contributing to the Maybrook Interceptor are shown in Figure 1.

1.2 Intent and Scope

The purpose of this analysis is to evaluate the available capacity of the receiving downstream sanitary sewer system and the potential sewage generation of the proposed development. The downstream sewer was evaluated to city manhole 10-074 at the west lake at Lakewood before the 30-inch main, for the existing, 10-year, and 20-year projected flows. The main was divided into 9 sub-areas to examine flow contributions from collector mains. An exhibit showing these subareas and the Maybrook Interceptor are shown in Figure 2. Sanitary sewer GIS data provided by the City of Lee's Summit and Jackson County Property Records is used to estimate peak flows per the Lee's Summit Design and Construction Manual, Section 6500. Manning's Equation for gravity flow is used to determine the full flow capacity of the receiving sewer. Measured flow data from the Tudor Road Lift Station and anticipated flows within 10 and 20-years from PRI lift stations 2 and 3 were provided by the City of Lee's Summit for this analysis. The existing conditions, projected 10-yr flows, and projected 20-yr flows were each evaluated and the results of these analyses are presented herein.

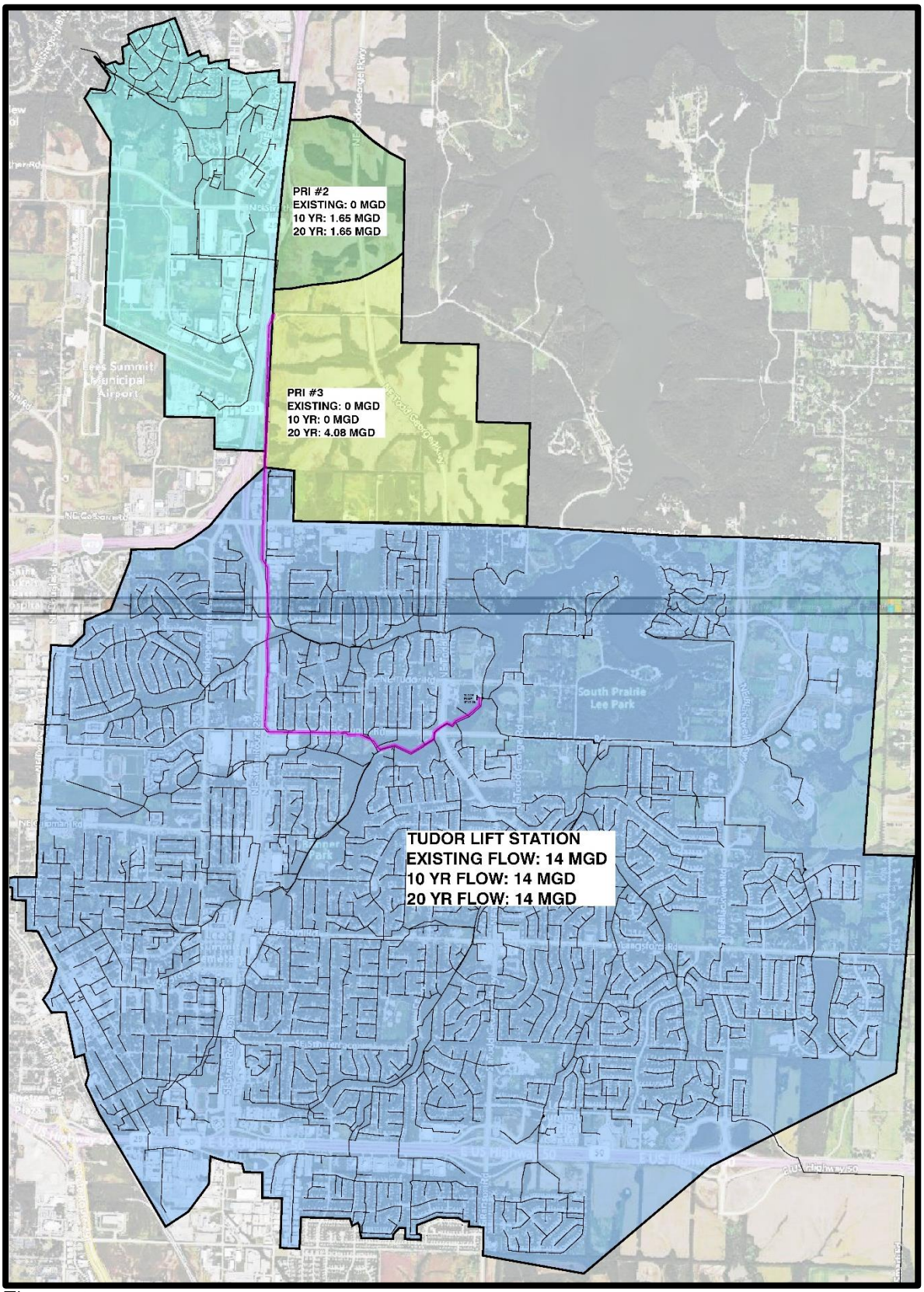

PRI #2
EXISTING: 0 MGD
10 YR: 1.65 MGD
20 YR: 1.65 MGD
PRI #3
EXISTING: 0 MGD
10 YR: 0 MGD
20 YR: 4.08 MGD
TUDOR LIFT STATION
EXISTING FLOW: 14 MGD
10 YR FLOW: 14 MGD
20 YR FLOW: 14 MGD
Lees Summit Municipal Airport
South Prairie Lee Park

Figure 1.

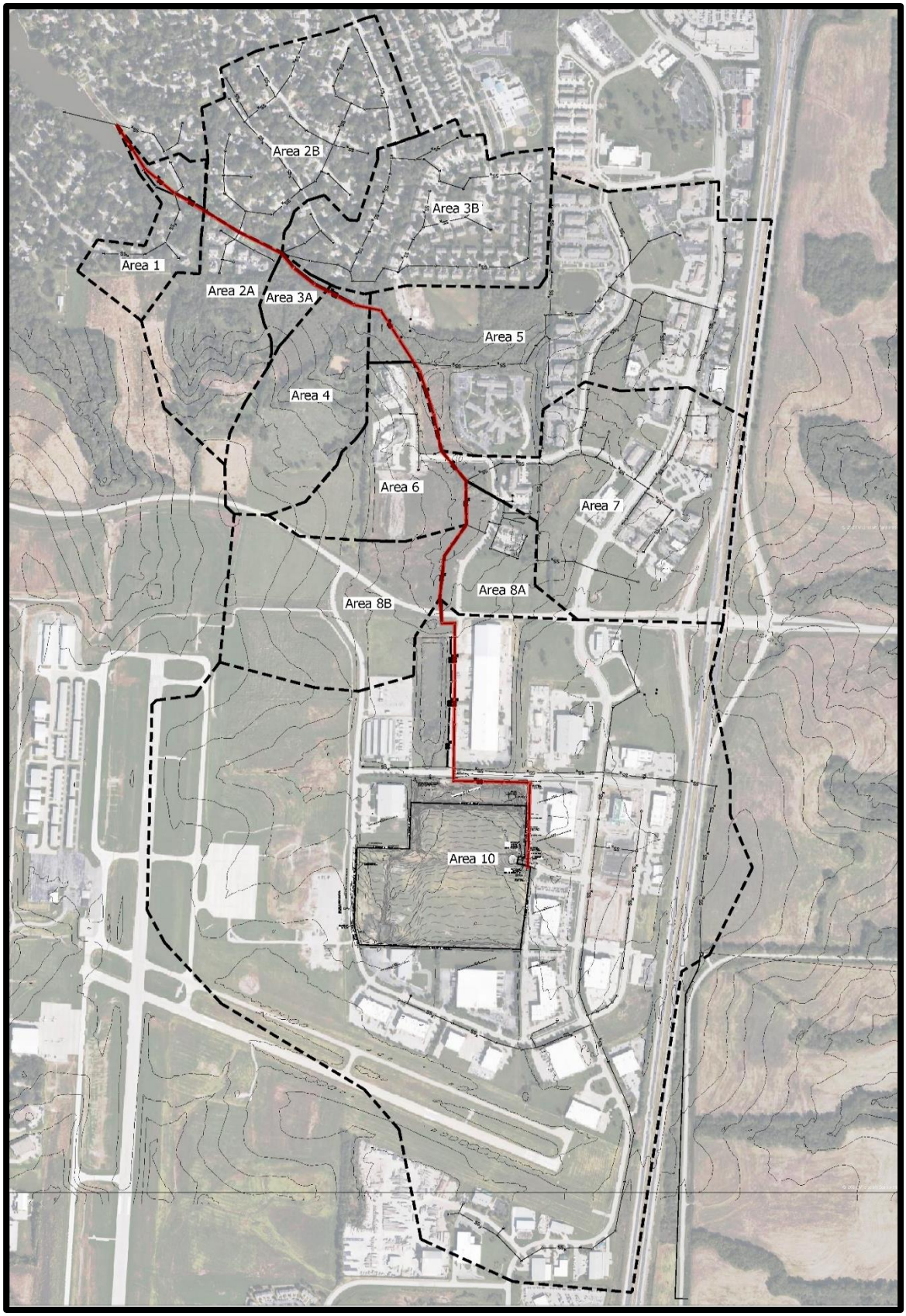

Area 2B
Area 3B
Area 1
Area 2A
Area 3A
Area 5
Area 4
Area 6
Area 7
Area 8A
Area 8B
Area 10

Figure 2.

2.0 WATERSHED ANALYSIS

2.1 Methodology

The Maybrook watershed up to the extents defined by the scope of this project was evaluated for estimated peak flows in the absence of recorded flow data. Watershed peak flow rates determined per Section 6501.C are comprised of the peak dry weather flow (PDWF), peak infiltration, and peak inflow.

The peak dry weather flow is the normal wastewater flows in the sanitary sewer and is estimated at 1,500 gallons per day per acre for proposed residential areas or 300 gallons per day per residential unit for existing residences. The equivalent dwelling unit method is used to estimate the PDWF for the non-residential areas based on the source category per Table 6501-1 of the City of Lee's Summit Design Criteria. Each EDU is equivalent to one residential unit or 300 gallons per day or wastewater production.

Peak infiltration, or the groundwater flow into the sewer system is the maximum infiltration occurring during the period of highest groundwater levels. The peak infiltration used for residential land is 500 gallons per day per acre, and 250 gallons per day per acre for non-residential land.

Peak inflow is the wet weather inflow from sources such as private building sewers, downspouts, sump pumps, and other rainfall related sources. This is determined using the Rational Method. The inflow factor used per Lee's Summit criteria is 0.006 and 0.003 for residential and non-residential lands respectively. The time of concentration is calculated per Lee's Summit Design Criteria equation, $T_c = 18.56(A)^{0.2524}$, and used to interpolate the intensity for a 50-year rainfall event.

The peak flow is the sum of the peak base flow, peak infiltration, and peak inflows as calculated above. The anticipated 10-year peak flow assumes 50% development of presently undeveloped land, using the EDU for vacant land to determine base flow for non-residential land and the standard peak base flow for residential land.

2.2 Watershed Analysis

The full flow capacity of the receiving sewer just prior to entering the 30-inch beneath the lake up to the point of connection is shown in Table 1. The bolded lines are the lines just downstream collector junctions or likely future collector junctions based on topography. These points are used to examine the inflows from the subareas and inflows to the nearest downstream junction are assumed to be negligible.

Table 1. Existing Sewer Capacity

Pipe Section (DS-US)	Diameter, in	Slope, %	Full Flow, cfs	Parallel Interceptor (Y/N)	Diameter, in	Slope %	Full Flow, cfs	Combined Full Flow, cfs	Full Flow (MGD)
56854	27	0.95	30.27	N	-	-	-	30.27	19.57
56855	**27**	**0.62**	**24.45**	**Y**	**15**	**0.58**	**4.93**	**29.38**	**19.00**
54047	27	0.71	26.17	Y	15	0.64	5.18	31.35	20.27
54036	**27**	**1.6**	**39.28**	**N**	**-**	**-**	**-**	**39.28**	**25.40**
54037	**27**	**1**	**31.05**	**N**	**-**	**-**	**-**	**31.05**	**20.08**

54038	27	0.34	18.11	Y	27	0.39	19.39	37.50	24.25
54039	27	0.38	19.14	Y	27	0.39	19.39	38.54	24.92
54049	27	0.29	16.72	Y	27	0.39	19.39	36.12	23.35
54040	27	0.93	29.95	N	-	-	-	29.95	19.36
56860	27	1.96	43.48	N	-	-	-	43.48	28.11
56578	**27**	**1.29**	**35.27**	**N**	**-**	**-**	**-**	**35.27**	**22.80**
54185	27	1.29	35.27	N	-	-	-	35.27	22.80
54041	27	1.16	33.45	N	-	-	-	33.45	21.62
54042	**27**	**1.7**	**40.49**	**N**	**-**	**-**	**-**	**40.49**	**26.18**
54043	**27**	**1.43**	**37.13**	**N**	**-**	**-**	**-**	**37.13**	**24.01**
54044	**27**	**0.8**	**27.78**	**N**	**-**	**-**	**-**	**27.78**	**17.96**
54045	27	0.71	26.17	N	-	-	-	26.17	16.92
54046	27	1.35	36.08	N	-	-	-	36.08	23.33
54050	27	0.6	24.05	Y	15	0.46	4.39	28.45	18.39
54187	27	3	53.79	N	-	-	-	53.79	34.78
54051	27	9.74	96.92	N	-	-	-	96.92	62.66
54052	27	0.31	17.29	Y	21	0.45	10.66	27.95	18.07
54053	27	0.51	22.18	Y	21	0.45	10.66	32.83	21.23
54054	**27**	**0.47**	**21.29**	**Y**	**21**	**0.45**	**10.66**	**31.95**	**20.66**
45080	10	1.4	2.60	N	-	-	-	2.60	1.68
74369	10	1.3	2.50	N	-	-	-	2.50	1.62
74370	10	1.5	2.69	N	-	-	-	2.69	1.74
74371	10	1.1	2.30	N	-	-	-	2.30	1.49
74372	10	2.2	3.26	N	-	-	-	3.26	2.11
74373	10	1.3	2.50	N	-	-	-	2.50	1.62

2.2.1 Existing Condition Analysis

The existing subareas outlined in Figure 2 were analyzed for estimated existing flows using the methods described previously. The results of this analysis are outlined in Table 2. These values include 14 MGD of flow from the Tudor Lift Station. Areas 1-4 are entirely residential or anticipated to be residential. Area 5A contains Howard park which consists of a splash pad and golf course and uses EDU values of 1.1 per 1000 square foot for the splash pad and 3 for the golf course. Area 5A consists of 160 retirement home units, 70,710 square feet of medical office or outpatient clinics, 1,000 sf of animal clinic, 64181 sf of office space, and 20,500 sf of retail space. Area 6 and 8A consists of only retirement home units. Area 7 includes 78,088 sf of medical or outpatient clinics, 80,332 sf of office space, and 10,862 sf of daycare. Area 8B is currently vacant land and not included in the PDWF calculations. Area 9, includes the subject property and mixed usage of industrial, office, retail, medical, and the airport. The office, retail, and medical buildings were calculated per the design criteria and the industrial buildings were assumed to have a conservative EDU of 2 per 1,000 sf of building area, the rationale behind this number is covered in the proposed development calculations.

Table 2. Existing flow data

DS Line	Sub area	Area, acres				PDWF, gpd	Peak Infiltration, gpd	Tc, min	I, iph	Peak Inflow, gpd	Peak Flow, MGD
		Developed		Undeveloped							
		Res	Non-Res	Res	Non-Res						
56855	1	11.61	0	3.24	0	8100	5805	36.7	4.60	207070	0.221
54036	2A	5.71	0	22.53	0	9600	2855	43.1	4.23	93638	0.106
54036	2B	45.32	0	0	0	42600	22660	48.6	3.91	688072	0.753
54037	3A	0	0	5.03	0	0	0	27.9	5.11	0	0.000
54037	3B	45.29	0	0	0	54000	22645	48.6	3.91	687699	0.764
54049	4	0	0	30.33	0	0	0	43.9	4.18	0	0.000
56578	5A	0	20.09	0	0	1560	5022.5	39.6	4.43	172663	0.179
56578	5B	19.45	43.57	0	11.6	64166	20617.5	55.1	3.54	566270	0.651
54042	6	0	8.98	7.51	9.92	19560	2245	42.4	4.27	74354	0.096
54043	7	3.08	41.54	0	23.84	24479	11925	53.9	3.61	333815	0.370
54044	8A	0	4.97	0	9.56	7920	1243	36.5	4.61	44432	0.054
54044	8B	0	0	8.36	33.65	0	0	47.7	3.97	0	0.000
54054	9	0	341.3	0	50.24	159625	85325	83.8	2.75	1133256	1.378
54054	Tudor Lift Station										14.000

Table 3 shows the calculated flows at each reach and the minimum full flow capacity of any pipe or parallel segment in that reach as determined in Table 1. There is a choke point located at the end of the analyzed system, resulting in an available capacity of 0.426-MGD.

Table 3. Existing Flow in Downstream Sewer

Sewer Reach	Minimum Reach Full Flow Capacity, MGD	Peak Flow, MGD	Available Capacity, MGD
56854-56855	19.00	18.57	0.426
56855-54036	20.27	18.35	1.916
54036-54037	20.08	17.49	2.585
54037-54049	23.35	16.73	6.623
54049-56578	19.36	16.73	2.634
56578-54042	21.62	15.90	5.727
54042-54043	24.01	15.80	8.208
54043-54044	17.96	15.43	2.527
54044-54054	16.92	15.38	1.540
54054-74373	1.49	0.15	1.341

2.2.2 10-Year Future Condition Analysis

The anticipated 10-year wastewater flows were calculated based on the existing conditions plus, an assumed 50% development of currently undeveloped or vacant land and flows from anticipated PRI lift station #2. The increased area developed was assigned an EDU of 3 per acre as listed in the Lee's Summit Design Criteria for vacant land. The results of this analysis are shown in Tables 4 and 5. The PRI lift station #2 and additional future development create a surcharge at 3 choke points in the main as shown in red in the Table 5.

Table 4. 10-year flow data

DS Line	Sub area	Area, acres				PDWF, gpd	Peak Infiltration, gpd	Tc, min	I, iph	Peak Inflow, gpd	Peak Flow, MGD
		Developed		Undeveloped							
		Res	Non-Res	Res	Non-Res						
10452	1	13.23	0	1.62	0	10530	6615	36.7	4.60	235964	0.253
54036	2A	16.98	0	11.26	0	26490	8490	43.1	4.23	278454	0.313
54036	2B	45.32	0	0	0	42600	22660	48.6	3.91	688072	0.753
54037	3A	2.52	0	2.52	0	3780	1260	27.9	5.11	49994	0.055
54037	3B	45.29	0	0	0	54000	22645	48.6	3.91	687699	0.764
54049	4	15.17	0	15.17	0	22755	7585	43.9	4.18	246114	0.276
56578	5A	0	20.09	0	0	1560	5022.5	39.6	4.43	172663	0.179
56578	5B	19.45	49.37	0	5.8	69386	22067.5	55.1	3.54	606095	0.698
54042	6	0	13.94	7.51	4.96	24024	3485	42.4	4.27	115422	0.143
54043	7	3.08	53.46	0	11.92	35207	14905	53.9	3.61	417234	0.467
54044	8A	0	9.75	0	4.78	12222	2438	36.5	4.61	87166	0.102
54044	8B	0	16.83	8.36	16.83	15147	4207.5	47.7	3.97	129480	0.149
54054	9	0	366.42	0	25.12	179518	91605	83.8	2.75	1267409	1.539
54054	Tudor Lift Station										14.00
54054	PRI Lift Station #2										1.65

Table 5. Anticipated 10-year flow in downstream sewer

Sewer Reach	Minimum Reach Full Flow Capacity, MGD	Peak Flow, MGD	Available Capacity, MGD
56854-56855	19.00	21.07	-2.067
56855-54036	20.27	20.81	-0.544
54036-54037	20.08	19.75	0.332

54037-54049	23.35	19.20	4.148
54049-56578	19.36	18.93	0.436
56578-54042	21.62	18.05	3.575
54042-54043	24.01	17.91	6.103
54043-54044	17.96	17.44	0.519
54044-54054	16.92	17.19	-0.270
54054-74373	1.49	0.15	1.341

2.2.3 20-Year Future Condition Analysis

The anticipated 20-year wastewater flows were calculated based on the existing conditions plus, an assumed 100% development of currently undeveloped or vacant land and flows from anticipated PRI lift station #2 and #3. The increased area developed was assigned an EDU of 3 per acre as listed in the Lee's Summit Design Criteria for vacant land. The results of this analysis are shown in Tables 6 and 7. The PRI lift station #3 and additional future development create a surcharge condition in much of the downstream line.

Table 6. 20-year flow data

DS Line	Sub area	Area, acres				PDWF, gpd	Peak Infiltration, gpd	Tc, min	I, iph	Peak Inflow, gpd	Peak Flow, MGD
		Developed		Undeveloped							
		Res	Non-Res	Res	Non-Res						
10452	1	14.85	0	0	0	12960	7425	36.7	4.60	264857	0.285
54036	2A	28.24	0	0	0	43395	14120	43.1	4.23	463106	0.521
54036	2B	45.32	0	0	0	42600	22660	48.6	3.91	688072	0.753
54037	3A	5.03	0	0	0	7545	2515	27.9	5.11	99808	0.110
54037	3B	45.29	0	0	0	54000	22645	48.6	3.91	687699	0.764
54049	4	30.33	0	0	0	45495	15165	43.9	4.18	492090	0.553
56578	5A	0	20.09	0	0	1560	5022.5	39.6	4.43	172663	0.179
56578	5B	19.45	55.17	0	0	74606	23517.5	55.1	3.54	645920	0.744
54042	6	7.51	18.9	0	0	39753	8480	42.4	4.27	280854	0.329
54043	7	3.08	65.38	0	0	45935	17885	53.9	3.61	500653	0.564
54044	8A	0	14.53	0	0	16524	3633	36.5	4.61	129900	0.150
54044	8B	8.36	33.65	0	0	42825	12592.5	47.7	3.97	387534	0.443
54054	9	0	391.54	0	0	224734	97885	83.8	2.75	1401563	1.724
54054	Tudor Lift Station										14.000
54054	PRI Lift Station #2										1.65
54054	PRI Lift Station #3										4.08

Table 7. Anticipated 20-year Flow in Downstream Sewer

Sewer Reach	Minimum Reach Full Flow Capacity, MGD	Peak Flow, MGD	Available Capacity, MGD
56854-56855	19.00	26.30	-7.299
56855-54036	20.27	26.01	-5.744
54036-54037	20.08	24.74	-4.660
54037-54049	23.35	24.42	-1.066
54049-56578	19.36	23.86	-4.501
56578-54042	21.62	22.94	-1.316
54042-54043	24.01	22.61	1.398
54043-54044	17.96	22.05	-4.089
54044-54054	16.92	21.45	-4.536
54054-74373	1.49	0.15	1.341

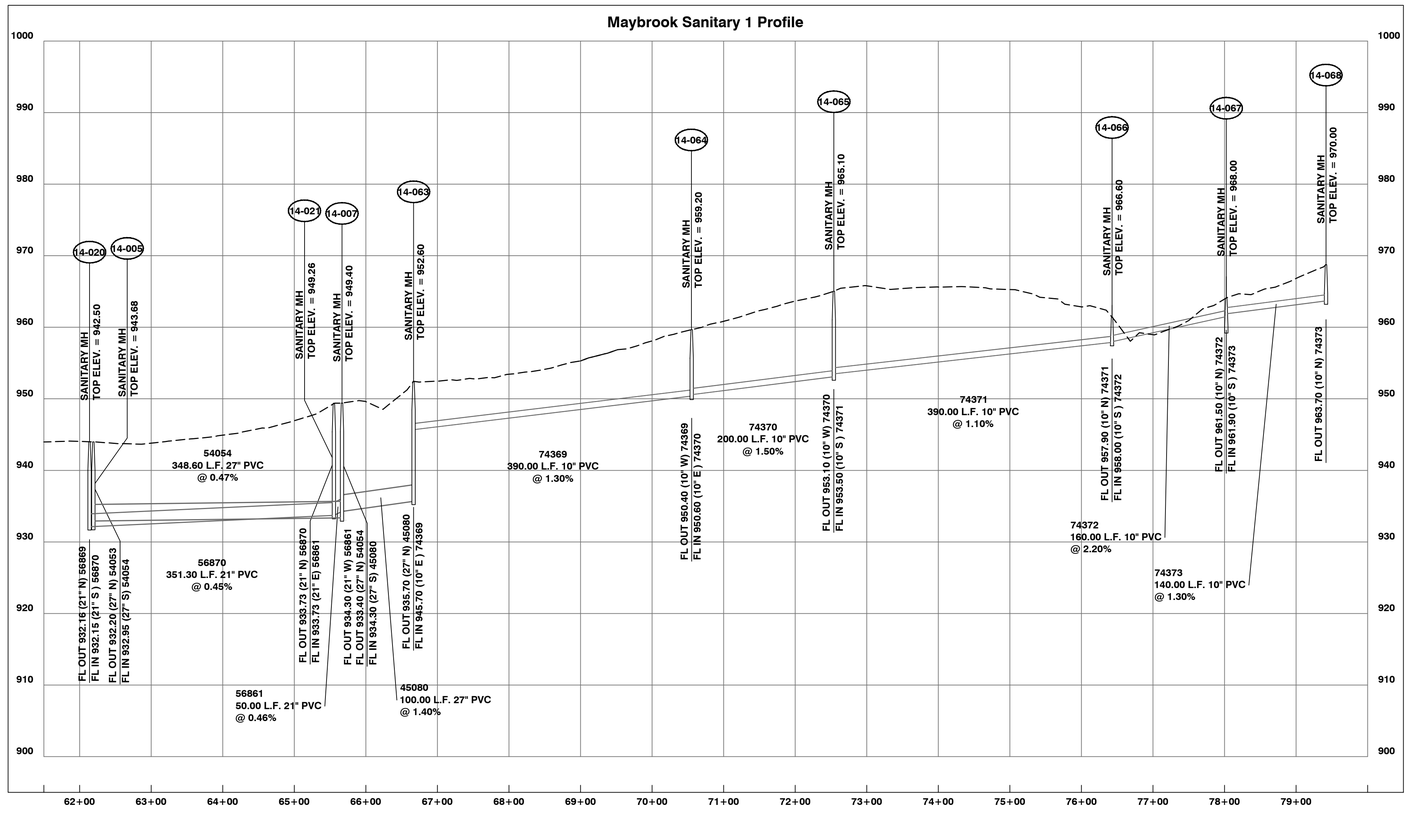
2.2 Proposed Development Analysis

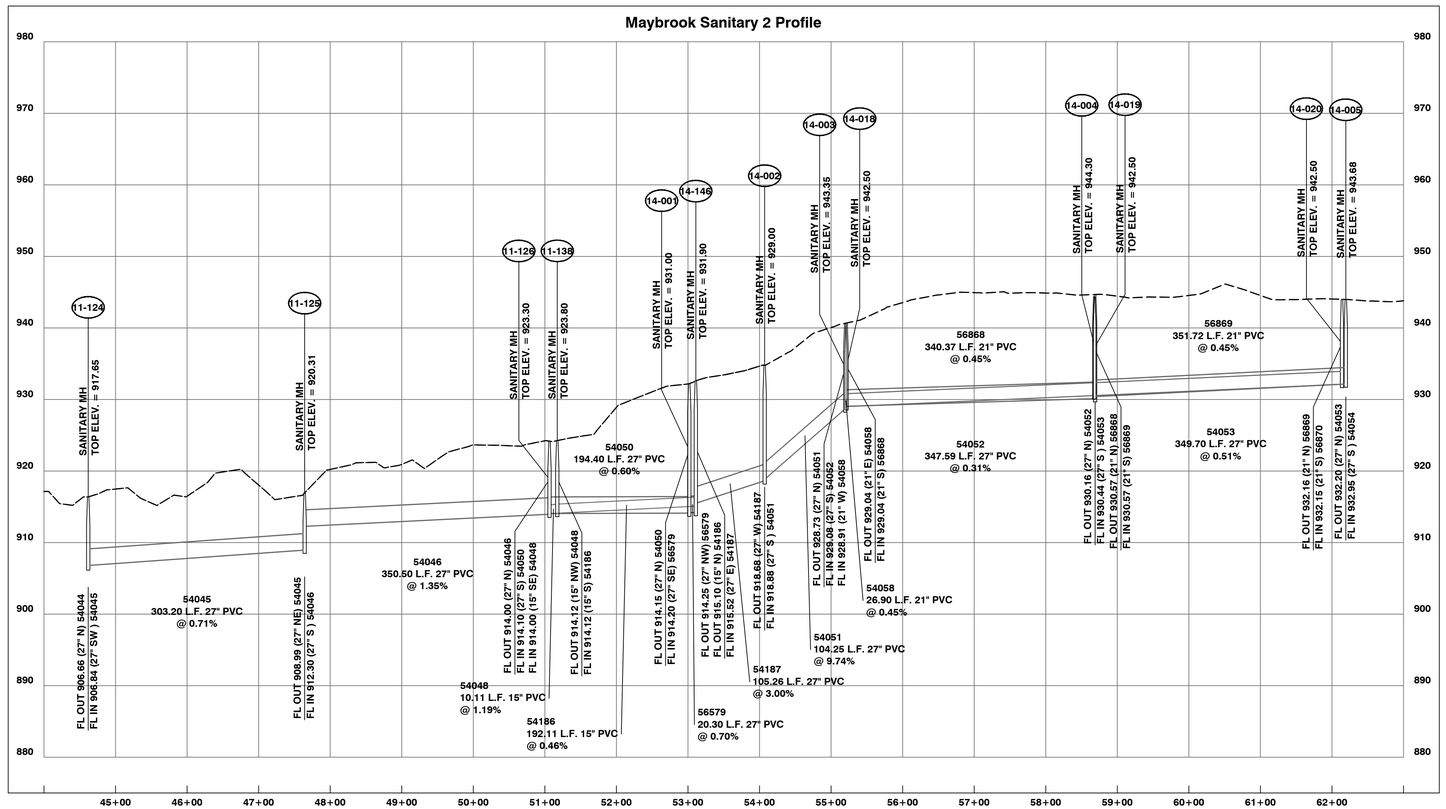
The receiving sewer line for this project is a 10-inch ductile iron pipe on the western property line flowing north to parallel 21-inch and 27-inch polyvinyl chloride (PVC) pipes. The 10-inch DIP receiving sewer has two building service connections, Lot 23A and B of the Lakewood Business Center, and a minimum slope of 1.10% according to Lee's Summit Sewer GIS. The building is approximately 71,000-sq.ft. and is zoned Planned Commercial (CS) with an assumed EDU of 0.3/1000-sq. ft for 2 stories. The total area of these lots is approximately 7.69-acres. Using Figure 6501-1 the flow contribution from these lots is 0.149-MGD.

The proposed development use mix is undetermined so conservatively it is assumed to be 100% light industrial. Using APWA 5500 value of 0.015-cfs/ac for the 30-acre site and adjusting for the included I/I allowance in the APWA value, an EDU value of 2 is assumed for the light industrial use per 1,000 sf. It is assumed that a minimum of 10% of the floor area will be reserved for warehouse and 5% for office space, at 0.1 EDU and 0.3 EDU per 1,000-sf respectively. This results in a peak base flow of 0.196-MGD. Using the method outlined in the Lee's Summit Design Criteria to calculate the I/I, infiltration for the 30-acre site was estimated to be 7,500 gallons per day and inflow to be 202,590 gallons per day for a total I/I of 0.210 MGD. The combined peak flow from the site is 0.399-MGD.

3.0 CONCLUSION

The receiving 10-in DIP sanitary sewer has available capacity for the existing and proposed Lakewood Industrial Park Development sewage. Additionally, the downstream system has available capacity, under current conditions, to the extents of the analysis. The downstream system will adequately serve the project as proposed and the existing tributary sanitary sewer flow from neighboring development, in conformance with the guidelines outlined in the City of Lee's Summit Design and Construction Manual. The total peak design flow from the proposed property was estimated to be 0.399-MGD, with 0.196-MGD peak base flow. **The maximum peak base flow that will not result in system surcharge up to the extent of the analysis is 0.216-MGD**, based on the available 0.426-MGD capacity in line 56855 and the calculated 0.210-MGD of infiltration and inflow. These results are limited to the available GIS information and are not confirmed by any recorded flow data. Approximately 80% of the calculated peak flow is inflow therefore these results are highly dependent on the method of calculation contained in the Lee's Summit Design Criteria.





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Certificates of Authority
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Engineering: MO 0 / KS 241
Land Surveying: MO 123 / KS 34

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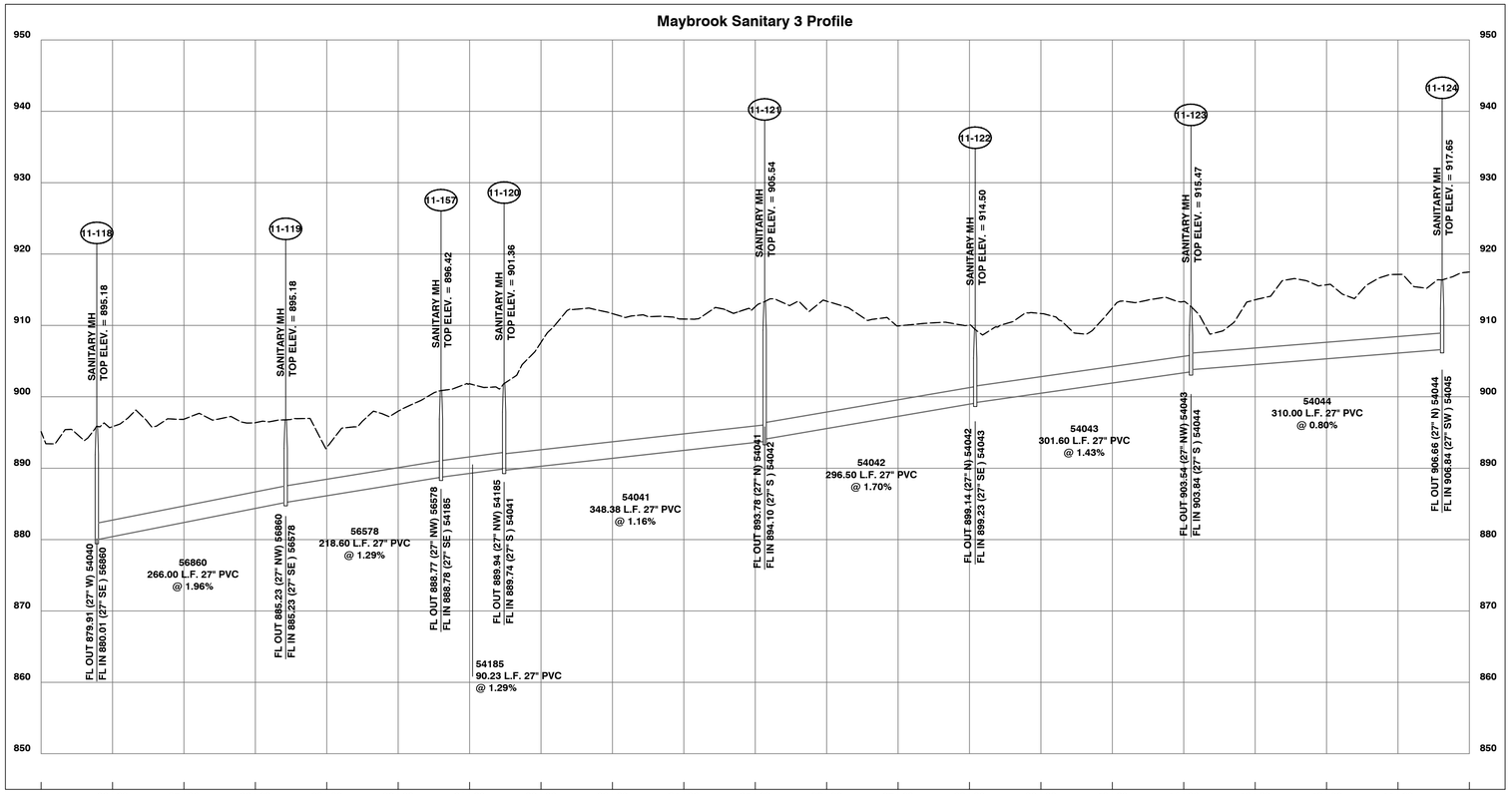

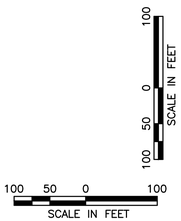

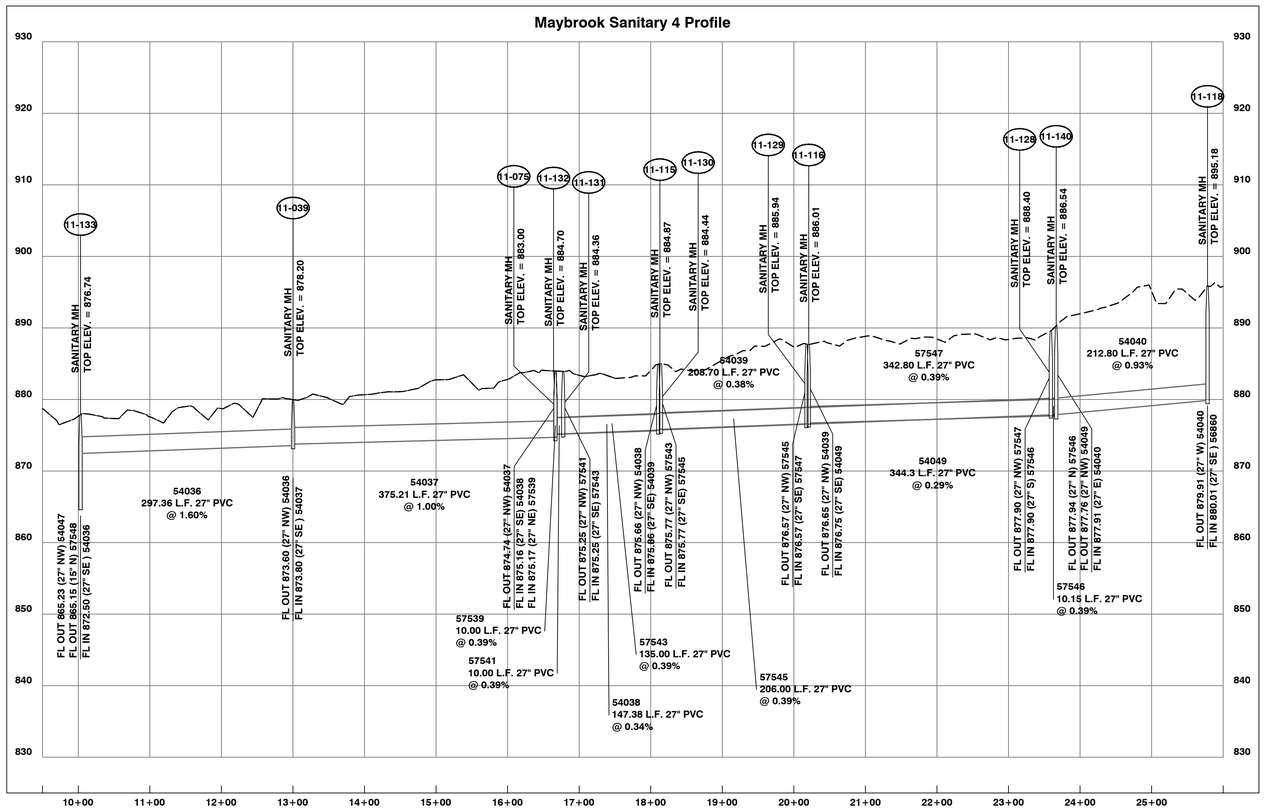

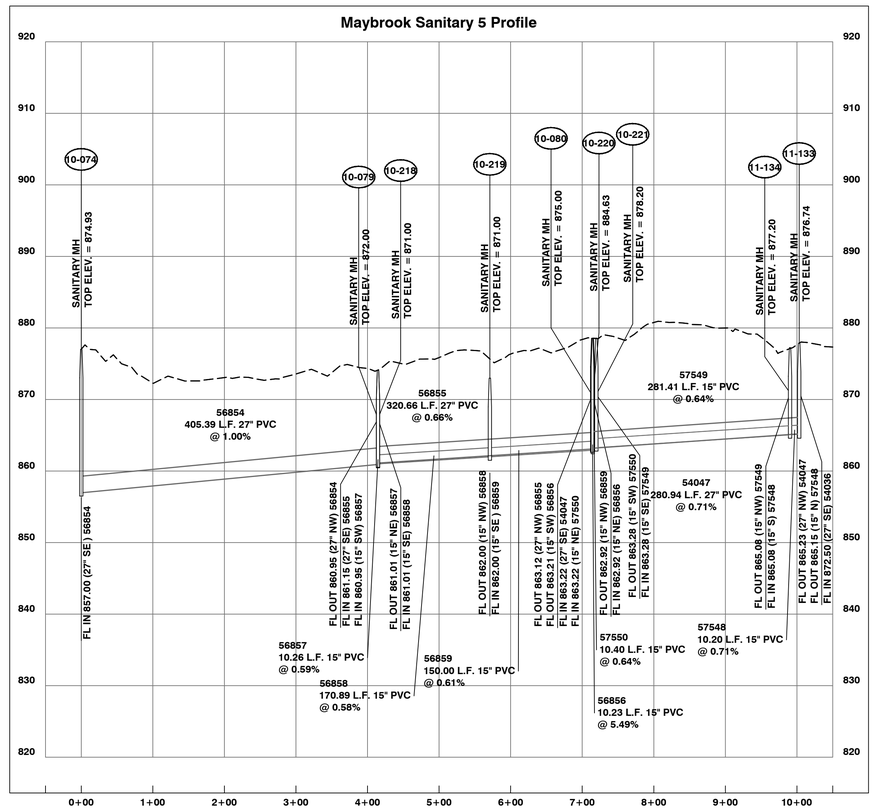

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Engineering: MO 0 / KS 241
Land Surveying: MO 133 / KS 34

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