BLACK & VEATCH CORPORATION

TECHNICAL MEMORANDUM **B & V Project: 136772.201**
Lawrence Wastewater Master Plan **Date February 14, 2004**

To: Roger Coffey

From: Robert Schweiger, Matt Schultze

RE: Southeast Lawrence Sanitary Sewer Expansion

1. PROJECTED LAND-USE AND WASTEWATER FLOWS

Peridian Group Development Area South of K-10

The area to be developed by Peridian Group is within the City sub-basin boundary of EL-2. All of this area is tributary to the 2003 Wastewater Master Plan planned pump station EL2PS1 located in sub-basin EL-2. All the flow that is pumped through EL2PS1 is pumped into the gravity sewers that flow to pump station PS-25 at the East Hills Business Park. The area proposed for development south of K-10 is shown in Figure 1.

The following analyses performed were based on the Peridian Group's e-mail from Aaron Gaspers dated January 14, 2004 which included updated population, land-use, and flow data for the development area. In the Peridian Group's estimated flows they had divided the development up into Phase 1 and Phase 2 categories. Peridian Group assumed that Phase 1 would be developed in the first 10 years, with Phase 2 being developed after 10 years. The Master Plan provided flows for year 2010 and year 2025, therefore, for comparison purposes, it was assumed that Phase 1 would be developed by year 2010.

Three analyses were performed:

1. The first analysis was a review of the parameters used by the Peridian Group to determine the Average Day Flows (ADF), which is equivalent to wastewater production, and the Peak Wastewater Flows (PF), which is equivalent to peak wet-weather design flows.

2. The second analysis was performed using the 1998 and 2003 Master Plan future flow design curve information with the Peridian Group population and land-use information to calculate the projected peak flows. The second figure, Figure 5, shows the 1998 Master Plan future flow criteria and design curve used for this analysis. The future flow criteria, shown in Figure 5, used for the flow calculations include the following:

Wastewater Production = 100 gpcd
Wastewater Production to Average Day Flow factor = 1.2
Wastewater Production to peak wastewater production peaking factor from design curve based on population being calculated
Infiltration rate for residential areas = 500 gpad
Infiltration rate for office/commercial areas = 200 gpad
Infiltration rate for park areas = 0 gpad

Inflow coefficient "K" for residential areas = 0.005
Inflow coefficient "K" for office/commercial areas = 0.003
Inflow coefficient "K" for park areas = 0.0005
Estimated Time of Concentration from design curve based on area being calculated
Design storm return interval = 10-year

The above parameters are the same values in the 2003 Master Plan future flow design curve. The ADF rate of 4,330 gpad that the Peridian Group assigned to the commercial developments was the same rate used for this second analysis for commercial development.

3. The third analysis was a review of the 2003 Master Plan to summarize the parameters used to calculate the projected peak flows for the area south of K-10.

A comparison of the analysis results is listed in the following table:

	Analysis 1 Peridian Group 3.0 Peaking Factor	Analysis 2 Black & Veatch Projected Peak Flow	Analysis 3 2003 Wastewater Master Plan
Year 2010			
Developed Area	501.55 acres	501.55 acres	163 acres
Population	3,517	3,517	1,200
ADF	1.469 mgd	1.493 mgd	0.159 mgd
PF	4.407 mgd	4.521 mgd	1.190 mgd
PF/ADF factor	3.0	3.0	7.5
Year 2025			
Developed Area	957.82 acres	957.82 acres	446 acres
Population	6,467	6,467	2,900
ADF	2.579 mgd	2.671 mgd	0.560 mgd
PF	7.737 mgd	7.756 mgd	4.2 mgd
PF/ADF factor	3.0	2.9	7.5
Minimum PF/ADF factor allowed		3.0	
Adjusted PF		8.023 mgd	

The calculated PF to ADF peaking factor for analysis 2 resulted in a value lower then the minimum recommended number to use; therefore the PF for analysis 2 was increased to change the resulting peaking factor to 3.0, the minimum KDHE value. The primary differences between the projected peak flows and peaking factors from the first two analyses and the third analysis is due to the larger population and higher industrial/commercial flow rates compared to the amount of area for development. In year 2010, the ADF values for the first two analyses are over 9 times the third analysis value while the amount of area only increased 3 times as much. For the year 2025, the ADF only increased 4.5 times while the acreage only increased 2.1 times as much. Since the majority of the PF is related to the acreage being served, through infiltration and

inflow, the smaller the acreage being served compared to the ADF flows leads to a smaller PF to ADF peaking factor.

Farmland Development North of K-10

In evaluating the Farmland development north of K-10, flow calculations were based on assuming 100% Light/Medium industrial development, and then using the 1998 Master Plan flow criteria for the Lawrence design curve shown in Figure 2. Light/medium industrial development was used based on planning information provided in the memo from Jim Roberts to Linda Finger dated 10/20/03. Calculations were based on 347 developed acres, as mentioned in the same memo. The list below shows the data used to calculate the light/medium industrial peak flows from this area.

Developable Area = 347 acres
Equivalent Population = 3,470
WWP (Wastewater Production) = 0.347 mgd
WWP peaking factor = 1.76
ADF = 0.416 mgd
Infiltration = 0.069 mgd
10-year inflow = 1.68 mgd
PF = 2.36 mgd (10-year storm level of protection)
PF/ADF factor = 5.7

It was assumed that all the Farmland area flow will be conveyed to PS-25 by gravity, which is located at the edge of East Hills Business Park. It was assumed that wastewater flows from this area will commence after Year 2010.

2. WASTEWATER FACILITY IMPACTS

Pump Station PS-25 and EL2PS1 Analysis

An analysis was performed on the proposed pump station EL2PS1 for the area south of K-10 and the existing pump station PS-25 at the East Hills Business Park. The results of the analysis show that the size of both the pump stations would need to be increased to handle the additional flow generated by the new development areas shown in the Peridian Group development plans. The following table shows the flows that would be handled by the pump stations for the Year 2010 and Year 2025 conditions.

	Analysis 1 Peridian Group 3.0 Peaking Factor	Analysis 2 Black & Veatch Projected Peak Flow
EL2PS1 Total Flow		
Year 2010		
Peridian Group	4.4 mgd	4.5 mgd
Year 2025		
Peridian Group	7.7 mgd	8.0 mgd
PS-25 – Existing Capacity = 1.95 mgd		
Year 2010		
Peridian Group	4.4 mgd	4.5 mgd
Farmland	0.0 mgd	0.0 mgd
East Hills B.P. *	1.6 mgd	1.6 mgd
Total	6.0 mgd	6.1 mgd
Year 2025		
Peridian Group	7.7 mgd	8.0 mgd
Farmland	2.4 mgd	2.4 mgd
East Hills B.P. *	2.2 mgd	2.2 mgd
Total	12.3 mgd	12.6 mgd

* - East Hills Business Park flows are based on 2003 Wastewater Master Plan data.

By year 2025, pump station EL2PS1 would need to handle a peak flow of 8.0 mgd and pump station PS-25 would need to handle a peak flow of 12.6 mgd.

Pump Station PS-19 Analysis

An analysis was performed on pump station PS-19 and is shown in detail in the **Technical Memorandum - Pump Station PS-19 Capacity Analysis** dated February 13, 2004. The table below summarizes the results of the analysis.

Farmland NW Development Flows

	Analysis 1 Initial Development	Analysis 2 Western Portion Build-out	Analysis 3 Total Development
Area (+/- acres)	33.02	21.56	55
Estimated Population	442	345	1,093
Estimated ADF (mgd)	0.071	0.041	0.149
Projected PF from Area (mgd)	0.347	0.228	0.591
Projected PF routed to PS-19 (mgd)	0.320	0.209	0.549

Note: PF = Peak 10-year wet weather flow, ADF = Average Day Flow

PS-19
Existing capacity = 1.94 mgd
Available capacity for 55 acre tract = 0.36 mgd (if remaining undeveloped land is fully developed)
Available capacity for 55 acre tract = 0.46 mgd (if remaining undeveloped land stays undeveloped)

Our recommendation is to not allow the flows generated by the entire development (Analysis 3) to be conveyed to PS-19. Flows generated from the initial development in the tract (Analysis 1) may be conveyed to PS-19. Once EL2PS1 becomes operational, the flows generated from the entire western portion of the tract (Analysis 2) may be conveyed to PS-19 with the flows from the entire eastern portion of the development being conveyed to EL2PS1. A more detailed look should be taken to determine exactly how the flows will be conveyed and routed to PS-19 from this partial development because there is a history of sewer overloading problems in the area.

Wastewater Treatment Plant Impacts

The City Planning Department has indicated that the year 2025 population for the City of Lawrence will remain at approximately 150,000 people even though there has been a significant increase in the population projected for the southeast area by the Peridian Group. City Planning stated that the projected increase in population for the southeast area would cause a reduction in population increase in other areas of the City for year 2025. The locations or areas of this reduction in population increase are not known and cannot be predicted by Planning at this time.

Projected average annual day wastewater flows for the southeast Lawrence area were evaluated to determine the impacts to the Kansas River Wastewater Treatment Plant (WWTP) and the Wakarusa River WWTP. The proposed increase in the projected average annual day wastewater flow for the southeast area is follows:

	Annual Average Day Flow, Year 2025*		
	New Revision	Master Plan	Net Increase
Peridian Area	2.67 mgd	0.56 mgd	2.11 mgd
Farmland Area	0.42 mgd	0.00 mgd	0.42 mgd
Total	3.09 mgd	0.56 mgd	2.53 mgd

*Note: The above values do not include flow from the East Hills Business Park which is unchanged from the Master Plan to the new revision.

As indicated by Planning, there will not be an overall change in 2025 average day flow for the City of Lawrence, however, the allocation of average day flow to either of the WWTP's may change depending on how much of the southeast area flow is conveyed to

the Kansas River WWTP vs. the Wakarusa River WWTP. It is not known how much of the net increase in flow would be directed to the Kansas River WWTP, however, based on the projected growth areas identified in the Master Plan, it is likely that the majority of the net increase in flow would have been routed to the new Wakarusa River WWTP. The Master Plan indicated that flow from growth areas in West Lawrence and south of the Wakarusa River should be conveyed to the Wakarusa River WWTP.

Based on the above assumption of a shift in growth from the Wakarusa River WWTP service area to the Kansas River WWTP service area, a significant impact would be realized to the Kansas River WWTP if all the southeast area flow is routed to the Kansas River WWTP as recommended in the Master Plan. The Master Plan indicated the 2025 average day flow to the Kansas River WWTP would be 11.9 mgd. The current design capacity of the WWTP is 12.5 mgd. The net increase of 2.53 mgd for added developments described above would increase the average day flow to the Kansas River WWTP to 14.4 mgd.

Two options are available to account for the shift in growth and flow from other parts of the study area to the southeast area. These options are described below:

Option A – Increase the Capacity of the Kansas River WWTP

Option A would involve conveying all southeast area flow to the Kansas River WWTP and would require an increase in treatment capacity for the Kansas River WWTP from 12.5 mgd to 14.4 mgd, an increase of 1.9 mgd. As indicated in the Master Plan, any future increase in capacity of the Kansas River WWTP, while feasible, would be difficult due to space limitations at the site. In addition, a capacity expansion of 1.9 mgd is not practical, because providing similar process trains would dictate a minimum capacity expansion of 4.0 mgd.

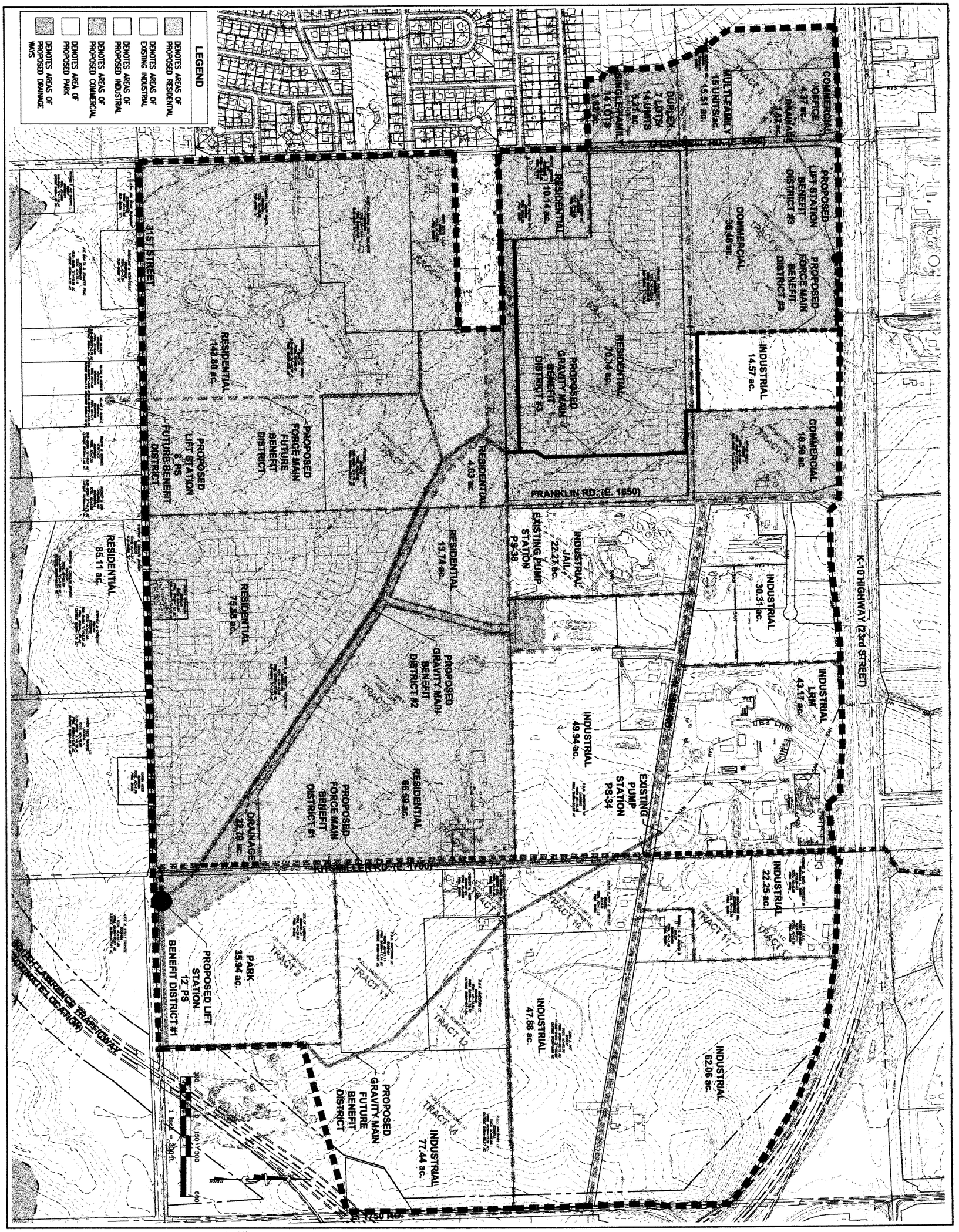
Option B – Convey Long-Term Flows South of K-10 to Wakarusa River WWTP

Option B would involve conveying all short-term flows for the southeast area to the Kansas River WWTP. However, after the Wakarusa River WWTP is placed in service in year 2011, all flows originating south of K-10 would be conveyed from PS EL2PS1 to the Wakarusa River WWTP through a new force main. Approximately 2.67 mgd in average day flow would be conveyed to the Wakarusa River WWTP, including 0.56 mgd originally projected in the Master Plan to be conveyed to the Kansas River WWTP. This reduction of 0.56 mgd from the Kansas River WWTP would allow the additional 0.42 mgd average day flow projected for the Farmland development to be conveyed to the Kansas River WWTP without the need for a capacity expansion at this WWTP.

Recommendation

It is recommended that additional study be conducted to implement Option B and convey long-term flows south of K-10 to the Wakarusa River WWTP. It appears prudent to develop a short-term plan to convey southeast area flow to the Kansas River WWTP, a

long-term plan to convey a portion of the southeast area flow to the Wakarusa River WWTP, and a phased wastewater system plan to accommodate the transition between the short-term and long-term plans.



REV.	DATE	CO

PROJECT RECORD:

DIGITAL I.D.: F-SAN_EXH.DWG

PROJECT NO.: 03056

DATE: OCTOBER 8, 2003

SHEET NO. 1 OF 1 SHEETS

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Lawrence Wastewater Master Plan

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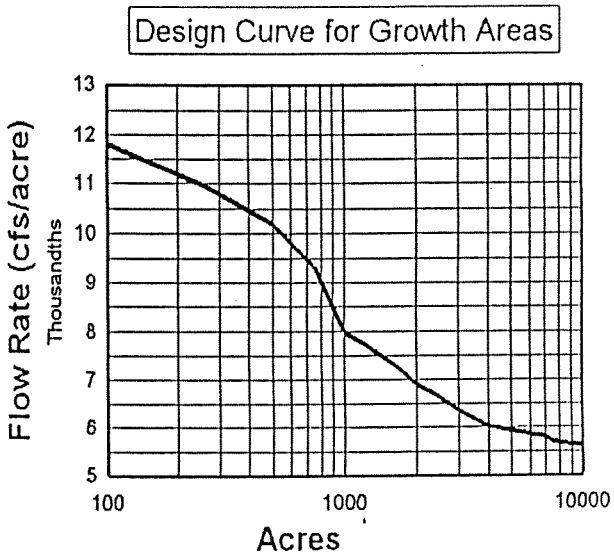
Figure 1 – Peridian Group Proposed East Lawrence Expansion in Sub-basin EL-2

Future Flow Criteria

Percent Zone	Zone Type	Description	Density (Units/ Acre)	Equivalent Capita/ Unit	Equivalent Capita/ Acre	Capita Usage (gpcd)	Average WWP (gapd)	Infil- tration (gpad)	Inflow Coeff. "K"
35%	1	Low Density Residential	4	2.3	9	100	920	500	0.0035
0%	2	Medium Density Residential	4	3	12	100	1200	500	0.0050
9%	3	High Density Residential	10	2.3	23	100	2300	500	0.0050
6%	4	Office & Commercial	2	2.9	6	100	580	200	0.0030
47%	5	Light/Med Industry	1	10	10	100	1000	200	0.0030
0%	6	Heavy Industry	1	25	25	100	2500	200	0.0030
0%	7	Public	1	7	7	100	700	0	0.0005
3%	8	Agricultural/ Park	1	1	1	100	100	0	0.0005
100%		Average(weighted)	3	5.9	10.3	100	1030	324	0.0033

Design Curve Data

Acres	Tc (min.)	10-Year I (in/hr)	WWP Peaking F	Design Flow cfs/acre	Design Flow cfs	Design Flow mgd	ADF mgd	Ratio Design Flow/ADF	Ratio Design Flow/WWP	Equivalent Population	ADF Unit Rate gcd
1	60	2.60	2.00	0.01211	0.012	0.008	0.001	6.57	7.79	10	118.6
10	60	2.60	2.00	0.01211	0.121	0.078	0.012	6.57	7.79	101	118.6
25	60	2.60	1.95	0.01204	0.301	0.195	0.030	6.53	7.74	251	118.6
50	60	2.60	1.91	0.01197	0.598	0.387	0.060	6.49	7.69	503	118.6
75	60	2.60	1.86	0.01190	0.892	0.577	0.089	6.45	7.65	754	118.6
100	60	2.60	1.82	0.01182	1.182	0.764	0.119	6.41	7.60	1005	118.6
250	65	2.37	1.77	0.01100	2.750	1.778	0.296	6.02	7.07	2513	117.6
500	75	2.14	1.73	0.01019	5.094	3.292	0.592	5.56	6.55	5026	117.7
750	95	1.90	1.69	0.00934	7.005	4.528	0.902	5.02	6.01	7539	119.6
1000	125	1.50	1.65	0.00797	7.971	5.152	1.192	4.32	5.13	10052	118.6
1250	130	1.43	1.64	0.00772	9.651	6.237	1.483	4.21	4.96	12565	118.0
1500	145	1.35	1.62	0.00744	11.157	7.211	1.791	4.03	4.78	15078	118.8
1750	155	1.28	1.61	0.00719	12.579	8.130	2.087	3.89	4.62	17592	118.7
2000	165	1.20	1.60	0.00691	13.810	8.926	2.375	3.76	4.44	20105	118.1
2500	180	1.13	1.58	0.00666	16.638	10.754	2.972	3.62	4.28	25131	118.3
3000	192	1.05	1.57	0.00637	19.118	12.356	3.545	3.49	4.10	30157	117.5
4000	215	0.96	1.55	0.00606	24.229	15.660	4.721	3.32	3.89	40209	117.4
5000	220	0.93	1.54	0.00594	29.690	19.190	5.882	3.26	3.82	50262	117.0
7000	240	0.90	1.53	0.00582	40.732	26.326	8.297	3.17	3.74	70366	117.9
7500	250	0.87	1.51	0.00570	42.747	27.629	8.882	3.11	3.66	75392	117.8
10000	270	0.86	1.50	0.00565	56.458	36.490	11.990	3.04	3.63	100523	119.3



LAWRENCE, KANSAS
SOUTHEAST STUDY AREA - 1998

LAND USE DESIGN CURVE
SECTION 09, YEAR 2020

FIGURE 5

BLACK & VEATCH LLP