Tanner Consulting LLC
LAND PLANNING | LAND SURVEYING | CIVIL ENGINEERING
5323 SOUTH LEWIS AVENUE, TULSA OKLAHOMA 74105-6539

July 13, 2018

Re: Artisan Point – Sanitary Sewer Capacity
Project: 17086

Mr. Jeff Thorn, PE
City of Lee's Summit
Water Utilities
220 SE Green Street
Lee's Summit, MO 64063

Dear Mr. Thorn,

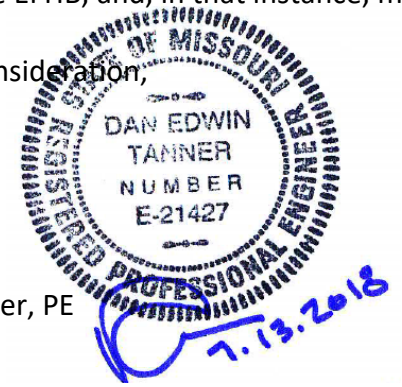
Attached are calculations in conformance with Section 6501 regarding the capacity of existing sanitary sewer mains downstream of the proposed Artisan Point apartment project. The analysis extends 5,400 feet south of the subject property to the East Prairie Lee EFHB. Any previous study by this firm should be discarded.

We have derived a hydraulic profile of the system from GIS data provided by the City. The loads have been derived from Section 6501.C.1. Worksheets are attached.

Please note that future loads that would originate on other than the subject property have been omitted from this model. Preliminary designs for sanitary sewer mains serving the commercial area and extending west along the access road have been previously provided.

The hydraulic grade lines resulting from the fully loaded condition, rely on the pipe to discharge at normal depth at the EFHB, and, in that instance, minor areas of surcharge may be expected. (See profile).

For your consideration,



Dan E. Tanner, PE

Peak Base Flow					
Existing Basin	**Equivalent Development Units (EDU)**	**Area (Acres)**	**Peak Base Flow (GPD/AC)**	**Peak Flow (GPD)**	**Peak Flow (CFS)**
Summit Mill Subdivision to North	1.0	67.23	1,500	100,838	0.1560
Mill Creek of Summit Mill Subdivision	1.0	64.04	1,500	96,060	0.1486
Legacy Wood 1 & 4 Subdivisions	1.0	32.16	1,500	48,240	0.0746
Legacy Wood 2 Subdivisions	1.0	13.55	1,500	20,318	0.0314
Legacy Wood 3 & 5 Subdivisions	1.0	40.72	1,500	61,080	0.0945
Unnamed Subdivsion Under Construction	1.0	34.00	1,500	51,000	0.0789
Elementary School	0.8	500	100	40,000	0.0619
	Peak Existing Base Flow Sum =			**417,535**	**0.6460**
Proposed Basin	**EDU**	**Population**	**Peak Flow/Capita (GPD)**	**Peak Flow (GPD)**	**Peak Flow (CFS)**
Proposed Case Apartments (600 Units)	1.0	1,500	100	150,000	0.2321
	Peak Existing and Proposed Base Flow Sum =			**567,535**	**0.88**

Peak Infiltration				
Existing Basin	**Area (Acres)**	**Peak Infiltration per Acre (GPD/Acre)**	**Peak Flow (GPD)**	**Peak Flow (CFS)**
Summit Mill Subdivision to North	67.23	500	33,613	0.0520
Mill Creek of Summit Mill Subdivision	64.04	500	32,020	0.0495
Legacy Wood 1 & 4 Subdivisions	32.16	500	16,080	0.0249
Legacy Wood 2 Subdivisions	13.55	500	6,773	0.0105
Legacy Wood 3 & 5 Subdivisions	40.72	500	20,360	0.0315
Unnamed Subdivsion Under Construction	34.00	500	17,000	0.0263
Elementary School	22.55	250	5,638	0.0087
		Peak Existing Infiltration Sum =	**131,483**	**0.2034**
Proposed Basin	**Area (Acres)**	**Peak Infiltration per Acre (GPD/Acre)**	**Peak Flow (GPD)**	**Peak Flow (CFS)**
Proposed Case Apartments (600 Units)	35.17	250	8,792	0.0136
		Peak Existing and Proposed Infiltration Sum =	**140,275**	**0.2170**

Peak Inflow					
Existing Basin	**Area (Acres)**	**Inflow Factor (K)**	**Time of Concentration (Minutes)**	**Rainfall Intensity For 50-YR Storm (Inches/Hour)**	**Peak Flow (CFS)**
Summit Mill Subdivision to North	67.23	0.006	53.7	3.4	1.3714
Mill Creek of Summit Mill Subdivision	64.04	0.006	53.0	4.4	1.6907
Legacy Wood 1 & 4 Subdivisions	32.16	0.006	44.6	5.4	1.0420
Legacy Wood 2 Subdivisions	13.55	0.006	35.8	6.4	0.5201
Legacy Wood 3 & 5 Subdivisions	40.72	0.006	47.3	7.4	1.8080
Unnamed Subdivsion Under Construction	34.00	0.006	45.2	6.4	1.3056
Elementary School	22.55	0.003	40.7	4.1	0.2774
				Peak Existing Inflow Sum =	**8.0151**
Proposed Basin	**Area (Acres)**	**Inflow Factor (K)**	**Time of Concentration (Minutes)**	**Rainfall Intensity For 50-YR Storm (Inches/Hour)**	**Peak Flow (CFS)**
Proposed Case Apartments (600 Units)	35.17	0.003	45.6	3.9	0.4115
				Peak Existing and Proposed Inflow Sum =	**8.4266**

Peak Flow = Peak Base Flow + Peak Infiltration + Peak Inflow

Existing Basin	Peak Base Flow (CFS)	Peak Infiltration (CFS)	Peak Inflow (CFS)	
Summit Mill Subdivision	0.1560	0.0520	1.3714	1.5794
Mill Creek of Summit Mill Subdivision	0.1486	0.0495	1.6907	1.8888
Legacy Wood 1 & 4 Subdivisions	0.0746	0.0249	1.0420	1.1415
Legacy Wood 2 Subdivisions	0.0314	0.0105	0.5201	0.5620
Legacy Wood 3 & 5 Subdivisions	0.0945	0.0315	1.8080	1.9340
Unnamed Subdivsion Under Construction	0.0789	0.0263	1.3056	1.4108
Elementary School	0.0619	0.0087	0.2774	0.3480
Proposed Basin				
Proposed Case Apartments (600 Units)	0.2321	0.0136	0.4115	0.6571
SUM =	0.8781	0.2170	8.4266	

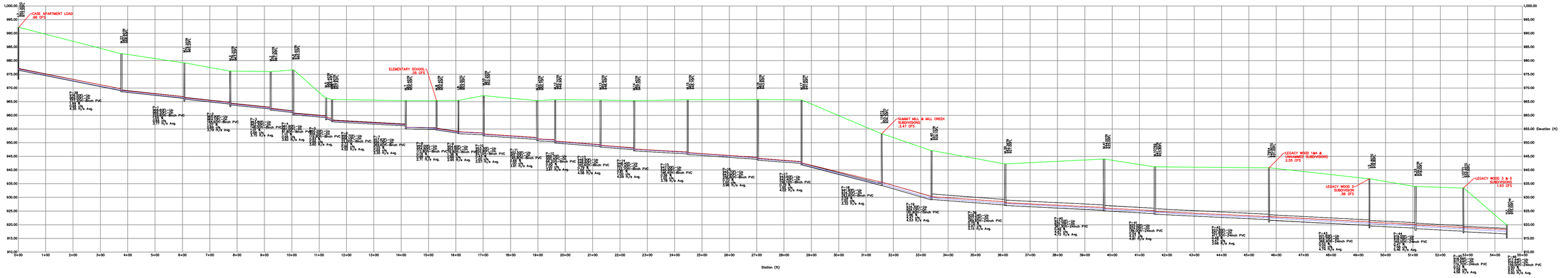
Total Sum (CFS)=	**9.5217**

Peak Flow = Peak Base Flow + Peak Infiltration NO Inflow (Dry Conditions)

Existing Basin	Peak Base Flow (CFS)	Peak Infiltration (CFS)	
Summit Mill Subdivision	0.1560	0.0520	0.2080
Mill Creek of Summit Mill Subdivision	0.1486	0.0495	0.1982
Legacy Wood 1 & 4 Subdivisions	0.0746	0.0249	0.0995
Legacy Wood 2 Subdivisions	0.0314	0.0105	0.0419
Legacy Wood 3 & 5 Subdivisions	0.0945	0.0315	0.1260
Unnamed Subdivsion Under Construction	0.0789	0.0263	0.1052
Elementary School	0.6460	0.2034	0.8495
Proposed Basin			
Proposed Case Apartments (600 Units)	Peak Flow(CFS)	0.4115	0.4115
SUM =	1.2302	0.8096	

Total Sum (CFS)=	**2.0398**

Profile – 1
Scenario: 100Yr



SECTION 6500 - SANITARY SEWERS

CITY OF LEE'S SUMMIT, MISSOURI
DESIGN CRITERIA

6501 DESIGN CRITERIA

A. General

1. The design standards presented in the City of Lee's Summit Design Criteria are the minimum standards to be followed in the design and construction of the Lee's Summit public sewerage system. These standards are not intended to be used as a substitute for actual construction specifications and design computations.

2. For new development (including infill or redevelopment), the existing sanitary sewers shall have adequate capacity to accommodate additional development with no adverse impacts on the existing system or customers.

3. Where sewer lines are extended into the interior of a lot, the sewer line shall not be considered a public sewer main.

4. Pipe Designations

   Force Mains: Force mains are classified as mains transporting wastewater from a pumping station to a sanitary sewer manhole. Force mains are shown in the City's currently-adopted Master Plan. Force mains shall not be tapped.

5. Grid System

   Sanitary Sewers shall be generally located as shown in the City's currently adopted Master Plan.

6. The Missouri Department of Natural Resources (MDNR) must review all sanitary sewer plans after they are reviewed by the City. No construction can take place until MDNR comments are incorporated.

B. Design Factors

1. Sewerage systems shall be sized to provide for the entire watershed in the City's currently adopted Comprehensive Plan and in accordance with the Wastewater Master Plan based upon ultimate growth.

2. The City of Lee's Summit recognizes the impact that extraneous flows (infiltration and inflow) have on sewer capacities.

C. Capacities

1. Peak wastewater flows shall be used to design sanitary sewers for non-residential lands of greater than 100 acres and all residential lands and shall consist of the following three components:

a. Peak Base Flow (PBF): Base flow is defined as the normal wastewater flow generated in the sanitary sewer system exclusive of infiltration and inflow.

   i. The peak base flow or peak dry weather flow (PDWF) used for residential land in Lee's Summit is 1,500 gallons per day per acre (gpd/ac).

   ii. The peak base flow to be used for non-residential land in Lee's Summit is calculated using the equivalent dwelling unit (EDU) methodology described in Paragraph 6501.C.2.

b. Peak Infiltration: Infiltration is defined as groundwater entering the system through defective pipes, pipe joints, and manholes. Peak infiltration is considered the maximum infiltration that occurs during the highest groundwater level period of the year.

   i. The peak infiltration used for residential land in Lee's Summit is 500 gpd/ac.

   ii. The peak infiltration to be used for non-residential land in Lee's Summit is 250 gpd/ac.

c. Peak Inflow: Inflow is defined as rainfall-related water entering the collection system from sources such as private building sewers, down spouts, foundation drains, sump pumps, and cross connections.

   i. Peak inflow is determined by the following equation:

      $$Q = KiA$$

      where

      Q = peak inflow, cubic feet per second (cfs)
      (1.0 cfs = 646,317 gpd)
      K = inflow factor
      i = rainfall intensity that corresponds to a tributary area's time of concentration, inch per hour (iph)
      A = tributary area, acres (ac)

   ii. Lee's Summit shall use a K = 0.006 and K = 0.003 for residential and non-residential land, respectively, and a 50-year storm event. Inflow is directly influenced by the intensity and duration of a storm event and is not a fixed quantity.

   iii. The time of concentration can be calculated by the following equation:

      $$T_c = 18.56\ (A)^{0.2524}$$

      where

      T_c = time of concentration, minutes (min)
      A = tributary area, ac

d. The rainfall intensity can be determined using the table below and the tributary area's T_c as calculated above. Use interpolation to calculate rainfall intensities for T_c not listed in the table.

Year	Time of Concentration (min)									
	5	10	15	30	60	120	180	240	360	600
	Rainfall Intensity (iph)									
1	4.48	3.53	3.05	2.09	1.41	0.86	0.60	0.47	0.35	0.25
3	5.84	4.77	4.13	2.90	1.93	1.18	0.86	0.69	0.51	0.36
5	6.47	5.34	4.63	3.28	2.17	1.32	0.97	0.79	0.58	0.40
10	7.33	6.12	5.32	3.79	2.50	1.52	1.13	0.93	0.68	0.47
25	8.46	7.16	6.22	4.47	2.93	1.78	1.34	1.12	0.80	0.56
50	9.32	7.94	6.91	4.98	3.26	1.98	1.50	1.26	0.90	0.62
75	9.82	8.40	7.31	5.27	3.46	2.10	1.59	1.34	0.96	0.66
100	10.18	8.72	7.59	5.49	3.59	2.18	1.65	1.39	1.00	0.69

e. Peak Flow = Peak Base Flow + Peak Infiltration + Peak Inflow

2. For non-residential lands greater than 8 acres and less than 100 acres in total area, sewer capacity shall be calculated using the EDU methodology described below:

   a. An EDU is a ratio of the flow produced by a particular land use compared to the flow produced by a single residential housing unit. A single residential unit is 1.0 EDU and produces 300 gallons per day (gpd) of peak daily flow. All other land uses are given EDU values that are a ratio to that 1.0 EDU value and are based on the anticipated flow rate.

   b. Table 1 lists common types of non-residential developments. For each type of source, an EDU value is assigned based on the parameters of the building. Each EDU is estimated to produce 300 gpd of peak daily flow, which is based on the assumption of an average of 100 gpd per capita and 3 capita per residence. Calculating the total number of EDUs for a site establishes a value for the peak base flow.

   c. Using the EDU values in Table 6501-1 and the parameters defined for each source, the following formula shall be used to estimate the peak base flow for non-residential development ($PBF_{Non\text{-}res}$):

$$PBF_{Non\text{-}res} = EDU * Building\ Area * Stories * 300\ gpd$$

   where

$PBF_{Non\text{-}res}$ = Peak base flow (gpd)

EDU = Equivalent development units per 1000 ft^2 (see Table 6501-1)

Building Area = Building footprint area in thousands of square feet (1000 ft^2)

Stories = Total building stories (see Table 6501-2)

This formula only applies to the sources listed in Table 6501-1 that have "per 1000 ft^2" indicated as the parameter. To calculate the $PBF_{Non\text{-}res}$ for other sources listed in the table, multiply the EDU for the parameter by the appropriate number, then multiply it by 300 gpd (e.g., an 100-bed hospital would have a $PBF_{Non\text{-}res}$ = [0.8 EDU/bed x 100 beds] * 300 gpd = 24,000 gpd).

d. Peak infiltration and peak inflow can be calculated using the values and equation for non-residential land found in Paragraph 6501.C.1. Alternatively, Figure 6501-3 shows a graph of the combined peak infiltration and inflow values. Figure 6501-3 shall not be used for areas less than 8 acres. Note that Figure 6501-3 **does not** include the peak base flow.

Peak Flow = $PBF_{Non\text{-}res}$ + Peak Infiltration + Peak Inflow

3. For non-residential lands greater than 100 acres or smaller than 8 acres, the residential land method shall be used to calculate sewer capacity, as described in Paragraph 6501.C.4.

4. Sewer capacity for residential land shall be calculated using the equations shown in Paragraph 6501.C.1 or the design curves shown in Figures 6501-1 and 6501-2. For example, in Figure 6501-1, a tributary area of 450 acres corresponds to a design flow of 0.019 cfs/ac, or 5.53 million gallons per day (MGD). This design flow shall be used to size the sewer pipe.

D. Hydraulic Design

1. Minimum Pipe Size: No public sewer shall be less than 8 inches in diameter. The downstream sewer pipe shall have the same or larger nominal diameter as the upstream pipe. Building sewers and building sewer stubs for industrial, commercial, and residential development shall not be less than 4 inches in diameter.

2. Hydraulic Grade

a. Average Velocity: Sewers shall be designed to be free flowing with the hydraulic grade below the top of pipe and above the hydraulic grade line of the existing downstream system into which the sewer discharges, including the Little Blue Valley Sewer District (LBVSD) and Middle Big Creek Sub-District (MBCSD), where applicable, and with hydraulic slopes sufficient to provide an average velocity when running full of not less than 2.25 feet per second (fps). Computations of velocity of flow shall be based on the following Manning's formula.

b. Manning's Formula:

$$V = \left(\frac{1.486}{n}\right) R^{2/3} S^{1/2}$$

$$Q = \left(\frac{1.486}{n}\right) A R^{2/3} S^{1/2}$$

where

V = Velocity (fps)
Q = Pipe flow capacity (cfs)
A = Inside area of pipe (square feet, ft^2)
R = Hydraulic radius (feet, ft)
S = Pipe slope (ft/ft)
n = Pipe roughness coefficient

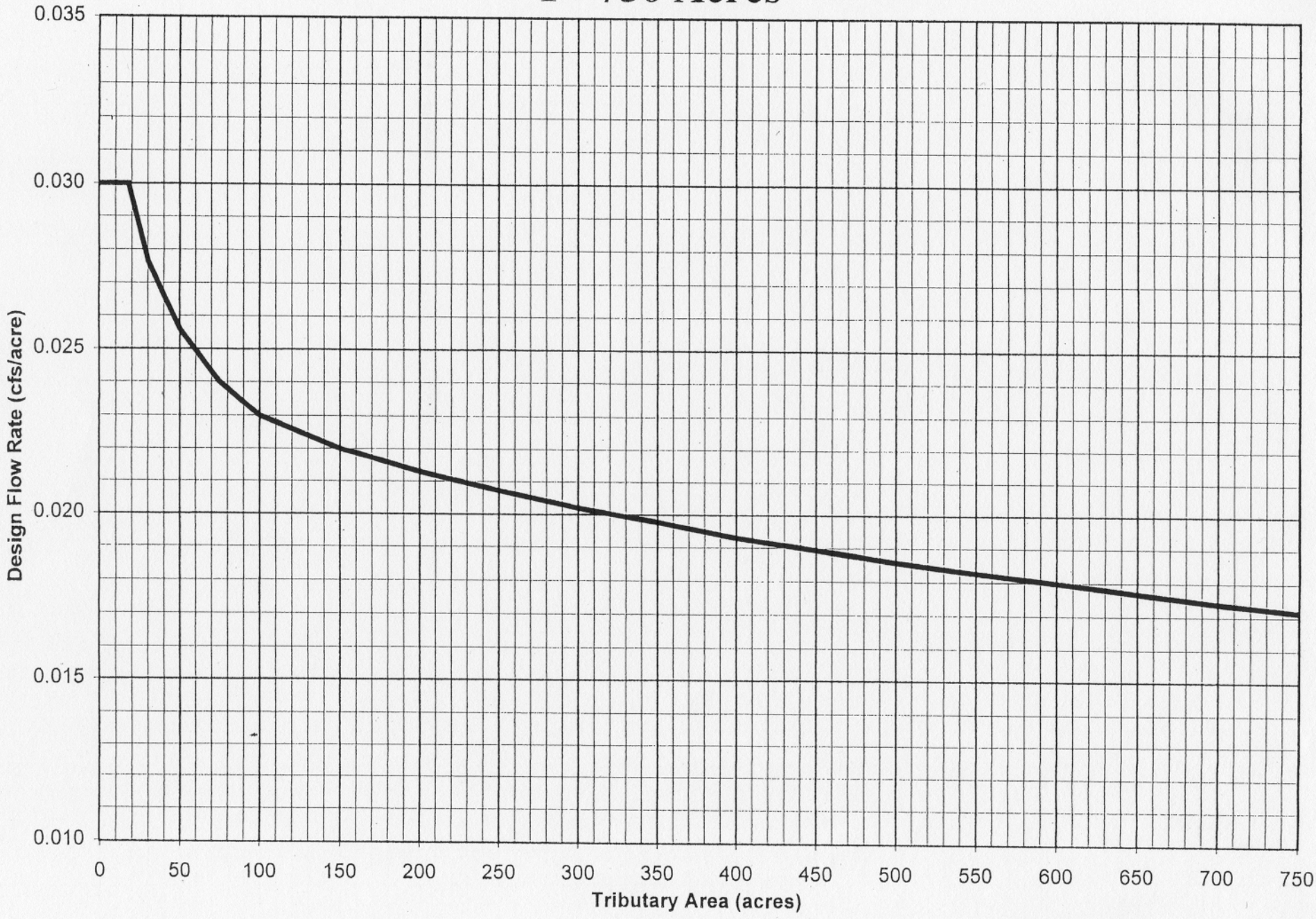
n values: Values for n shall be according to manufacturers' recommendations, or as follows:
Polyvinyl chloride (PVC) – 0.014
Ductile iron pipe (DIP) – 0.015
High-density polyethylene (HDPE) –0.015

c. Maximum Velocity:

i. The maximum permissible velocity at average flow shall be 15 fps. Average flow is defined as peak base flow plus peak infiltration, or 2,000 gpd/ac.

ii. Drop manholes shall be provided to break the steep slopes to limit the velocities to 15 fps in the connecting sewer pipes between manholes (see Paragraph 6501.H.5). Where drop manholes are impracticable for reduction of velocity, the sewer shall be fitted with concrete restraints at 15 foot intervals along the slope to limit movement of the pipe or shall be restrained joint pipe.

Wastewater Design Flow Curve
1 - 750 Acres

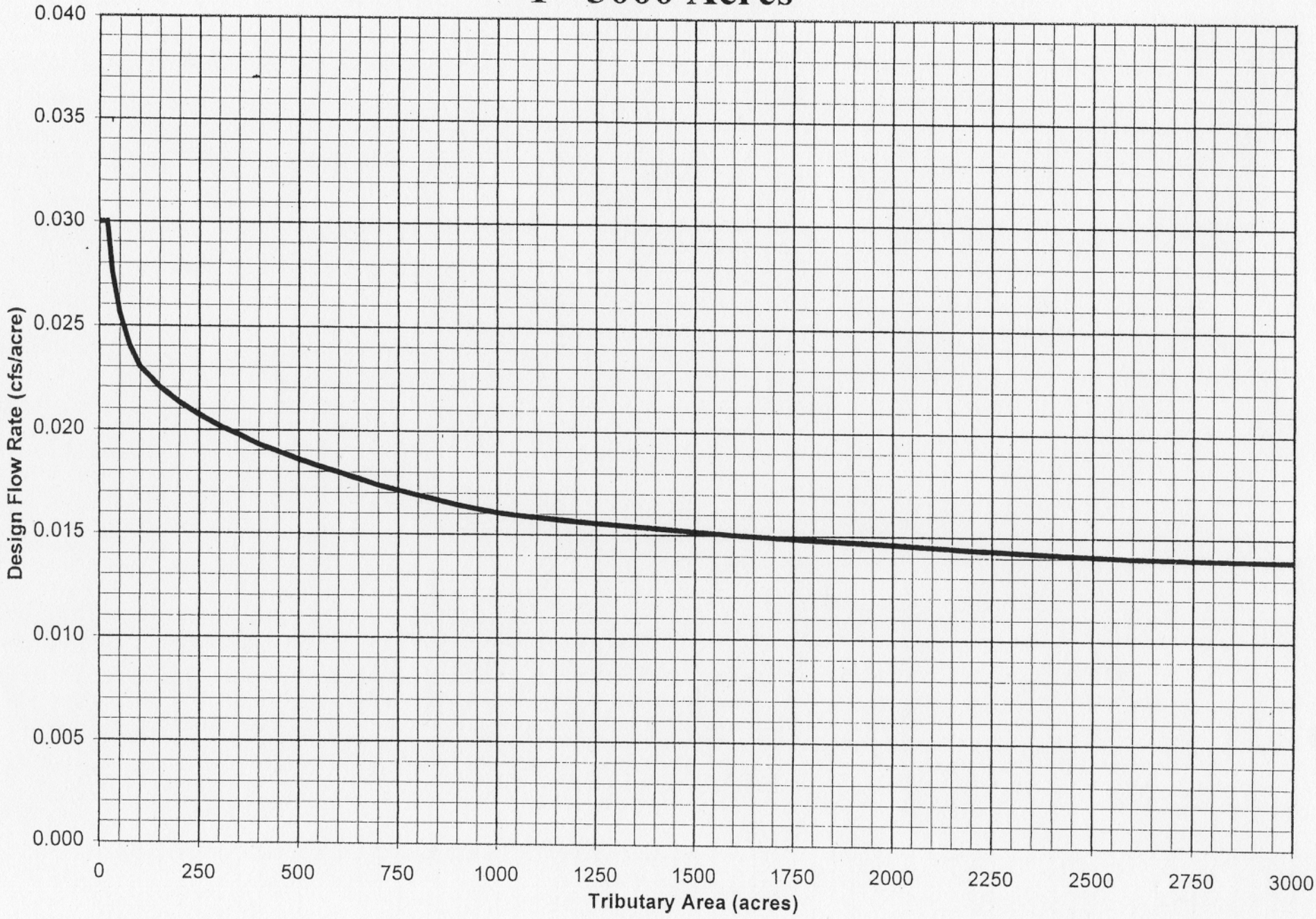


Lee's Summit, Missouri

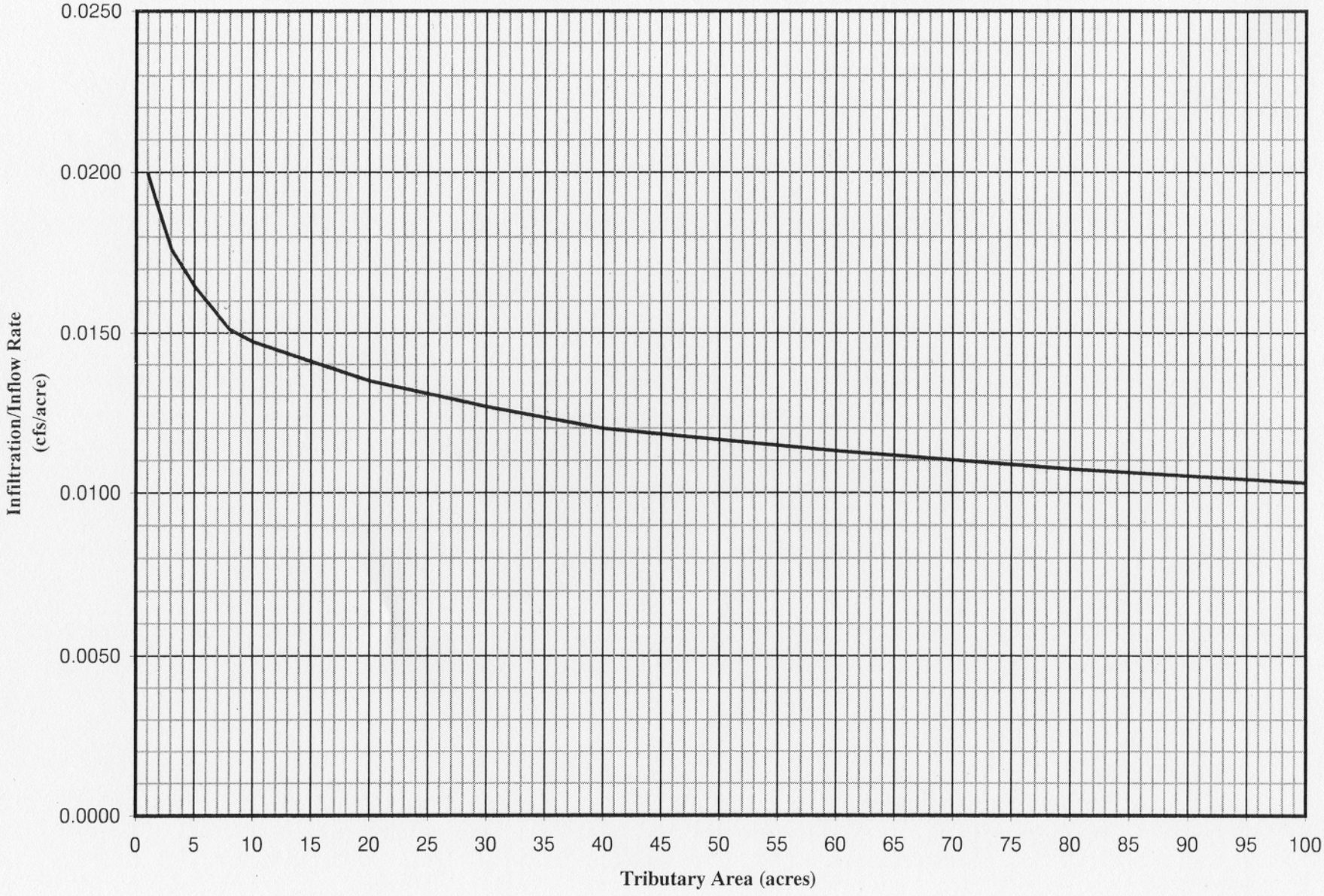
Figure 6501–1

5/4/99

Wastewater Design Flow Curve
1 - 3000 Acres



INFILTRATION / INFLOW
(Commercial Areas less than 100 acres)



Note: The curve shown above does not include peak dry weather flow. Peak dry weather flow must be added to obtain the PWWF.

Figure 6501-3

05/26/04

Table 6501-1. Equivalent Development Units

Source	EDU		Parameter
Institutional			
Hospital (not including ancillary services, i.e., cafeterias)	0.8	per	bed
Nursing Home	0.4	per	unit
Prison/Jail	0.4	per	inmate
Retirement Home	0.4	per	unit
Schools:			
Elementary	0.8	per	1000 ft^2
Middle and High	1.0	per	1000 ft^2
Commercial/Retail			
Office–General	0.3	per	1000 ft^2
Retail Stores	0.2	per	1000 ft^2
Warehouse (minimum 70% warehouse)	0.1	per	1000 ft^2
Shopping Centers and Stores	0.2	per	1000 ft^2
Restaurants:			
Drive-In	0.1	per	parking space
Fast Food (disposable patron wares)	1.6	per	1000 ft^2
Full Service	3.5	per	1000 ft^2
Animal Clinics	1.0	per	1000 ft^2
Auditoriums	0.6	per	1000 ft^2
Automobile Dealerships:			
Office Rate + Service Bays	office rate + 0.1 per service bay		
Automobile Service:			
Fast Service	0.5	per	service bay
Major Service	0.1	per	service bay
Bars and Cocktail Lounges	2.4	per	1000 ft^2
Banquet Rooms–food catered	0.5	per	1000 ft^2
Banquet Rooms–food prepared	1.1	per	1000 ft^2
Beauty Shop/Barber Shop	0.4	per	1000 ft^2
Body Shop	0.1	per	1000 ft^2
Bowling Alleys	0.4	per	lane
Car Wash:			
self-service	3.0	per	stall
automatic at service station	6.0	per	stall
tunnel, car pulled through	requires equipment specs, minimum 33		
Churches	0.5	per	1000 ft^2
Daycare/Nursery Schools	1.0	per	1000 ft^2
Dry Cleaners	0.3	per	1000 ft^2
Clubhouse (apartment)	1.0		
County Club			
private with golf course	3.0 + 2.2/1000 ft^2		
private without golf course	2.2	per	1000 ft^2
Exercise Area			
gym without showers	0.5	per	1000 ft^2
gym with showers	1.4	per	1000 ft^2
Fire Station	by water use		

Table 6501-1. Equivalent Development Units (continued)

Source	EDU		Parameter
Game Room/Arcade	0.8	per	1000 ft^2
Golf Course	3.0		
Greenhouse (area open to public)	0.2	per	1000 ft^2
Group Home	0.4	per	bed
Handball and Racquetball Courts	2.0	per	court
Hotel/Motel	0.3	per	room
Laundromat/Commercial Laundry	0.6/washer or 8.0/1000 ft^2		
Library (excluding book/file storage)	0.4	per	1000 ft^2
Locker Rooms	0.1	per	locker
Medical Offices/Outpatient Clinics	0.4	per	1000 ft^2
Meeting/Conference Rooms	0.6	per	1000 ft^2
Museum	0.4	per	1000 ft^2
Rifle/Handgun Ranges	0.2	per	lane
Roller Rink	1.2	per	1000 ft^2
Schools–Technical Vocational Institute, Junior College	0.9	per	1000 ft^2
Gas Station: with convenience center and without service bays without convenience center and without service bays	 1.0 + 0.3/1000 ft^2 1.0		
Service Station: with 2 service bays with 2 service bays and car wash with 2 service bays and convenience center with 2 service bays, convenience center, and car wash	 2.0 8.0 2.0 + 0.3/1000 ft^2 8.0 + 0.3/1000 ft^2		
Swimming Pools–public (private no charge)	1.1	per	1000 ft^2
Stadium/Arena	1.0/110 seats or 1.0/165 LF of bleachers		
Tanning Rooms/Centers	0.3	per	1000 ft^2
Tennis Courts–with shower facilities	2.0	per	court
Theater	1.2	per	1000 ft^2
Vacant Land	3.0	per	acre
Vehicle Garage	0.2	per	1000 ft^2
Yard Storage Buildings (excluding lumber storage) customer pick-up, no permanent employees	 0.1	 per	 1000 ft^2
Industry	varies–industry specific		

Table 6501-2. Multi-Story Sources

Schools: Elementary Middle and High
Offices
Retail Stores
Warehouse
Shopping Centers and Stores
Restaurants: Fast Food Full Service
Animal Clinics
Bars and Cocktail Lounges
Banquet Rooms
Beauty Shop/Barber Shop
Churches
Daycare/Nursery Schools
County Clubs
Exercise Area/Gym
Fire Station
Game Room
Greenhouse (area open to public)
Library
Medical Offices/Clinics
Meeting/Conference Rooms
Museum
Schools–Technical Vocational Institute, Junior College
Tanning Rooms/Centers
Theaters
Vehicle Garage
Yard Storage Buildings