CHAPTER 5

EXISTING AND PROJECTED WASTEWATER FLOWS AND CHARACTERISTICS

INTRODUCTION

In this chapter, the existing wastewater characteristics for the service area will be analyzed and projections made for future conditions.

Appropriate design of wastewater treatment and conveyance facilities requires the determination of the current and future quantity and quality of wastewater generated from each of the contributing sources. Typically, wastewater is predominantly domestic in origin with lesser amounts contributed by commercial and industrial businesses and by public use facilities such as schools, parks, hospitals, and municipal functions. However, the City of Bingen WWTF has a significant amount of flow from industrial sources also. Additionally, significant infiltration and inflow (I/I) contributions result from groundwater and surface water entering the sewer system during periods of high groundwater levels and rainfall, respectively, as occurs in many other communities in Washington.

DEFINITIONS OF TERMS

The terms and abbreviations used in the analysis are described below, listed in alphabetical order.

AVERAGE ANNUAL FLOW

Average annual flow is the average daily flow over a calendar year. This flow parameter is used to estimate annual operation and maintenance costs for treatment and lift station facilities.

AVERAGE DRY WEATHER FLOW

Average dry weather flow is wastewater flow during periods when the groundwater table is low and precipitation is at its lowest of the year. The dry weather flow period in much of Washington normally occurs during June through September. During this time, the wastewater strength is highest, due to the lack of dilution with the ground and surface water components of infiltration and inflow. The higher strength coupled with higher temperatures and longer detention times in the sewer system create the greatest potential for system odors during this time. The average dry weather flow is the average daily flow during the three lowest consecutive flow months of the year. For this study, average flows for July, August, and September are used.

BASE FLOW

Base flow is wastewater flows during periods when the groundwater table is low and there is no precipitation. This is the sanitary sewer flow without any inflow or infiltration (defined below). Base flow is determined from the influent flow charts during the driest summer months. Base flow values are slightly lower than the average dry weather flow, because the base flow is not an average over the summer months, but the lowest flow during dry summer days. Base flow is adjusted for the peak hour flow to account for peak hour diurnal flows.

BIOCHEMICAL OXYGEN DEMAND (BOD)

Biochemical oxygen demand (BOD) is a measure of the oxygen required by microorganisms in the biochemical oxidation (digestion) of organic matter. BOD is an indicator of the organic strength of the wastewater. If BOD is discharged untreated to the environment, biodegradable organics will deplete natural oxygen resources and result in the development of septic (anaerobic) conditions. BOD data together with other parameters are used in the sizing of the treatment facilities and provide a measurement for determining the effectiveness of the treatment process. BOD is expressed as a concentration in terms of milligrams per liter (mg/L) and as a load in terms of pounds per day (lb/d). The term BOD typically refers to a 5-day BOD, often written BOD_5, since the BOD test protocol requires 5 days for completion. BOD_5 of a wastewater is composed of two components – a carbonaceous oxygen demand ($CBOD_5$) and a nitrogenous oxygen demand ($NBOD_5$). The use of $CBOD_5$ as a parameter for evaluating wastewater strength removes the influence of nitrogenous components, including ammonia and organic nitrogen.

CHLORINE

Chlorine is a chemical element that acts as a strong oxidant when exposed to certain components of organic matter. Chlorine is widely used as a disinfectant in wastewater treatment, and is available both in gaseous (elemental chlorine) and solution forms (hypochlorite). Chlorine is a toxic chemical and is lethal to aquatic biota if present in too high a concentration. Additionally, some organic constituents may react with the chlorine to interfere with chlorination or form toxic compounds, such as chloroform, that can have long-term adverse effect on the beneficial uses of the waters to which they are discharged. To minimize the effects of potentially toxic chlorine residuals on the environment, it has sometimes been found necessary to dechlorinate wastewater treated with chlorine or substitute alternative disinfection systems such as ultraviolet disinfection, as the City of Bingen uses. The City occasionally uses hypochlorite for controlling foam in the oxidation ditch, aerobic digester, and clarifiers as well as to remove biological growth on the clarifier launders.

CONTAMINANTS OF CONCERN

Contaminants of concern in wastewater, in addition to chlorine, BOD, and TSS discussed elsewhere in this section, include nutrients, priority pollutants, heavy metals, and dissolved organics.

Nutrients, such as nitrogen and phosphorus along with carbon, are essential requirements for growth. When discharged to the aquatic environment, these nutrients can lead to the growth of undesirable aquatic life. When discharged in excessive amounts on land, they can also lead to the pollution of groundwater. Additionally, in too high a concentration, nutrients, particularly ammonia, can be toxic to aquatic life.

Priority pollutants are organic and inorganic compounds selected on the basis of their known or suspected carcinogenicity, mutagenicity, teratogenicity, or high acute toxicity. Many of these compounds are found in wastewater. Inorganic constituents, including heavy metals, are often present in wastewater due to commercial and industrial activities and may have to be removed if the presence of the metals will adversely affect the receiving water, or if the wastewater is to be reused. Some heavy metals (most notably copper) can be present in wastewater due to leaching from drinking water pipes.

DOMESTIC WASTEWATER

Domestic wastewater is wastewater generated from single- and multi-family residences, permanent mobile home courts, and group housing facilities such as nursing homes. Domestic wastewater flow is generally expressed as a unit flow based on the average contribution from each person per day. The unit quantity is expressed in terms of gallons per capita per day (gpcd).

EQUIVALENT RESIDENTIAL UNIT (ERU)

An equivalent residential unit (ERU) is a baseline wastewater generator that represents the average single-family residential household. An ERU can also express the average annual flow contributed by a single-family household, in units of gallons per day, or an annual average loading (of 5-day biochemical oxygen demand or total suspended solids) contributed by a single-family household, in units of pounds per day.

INFILTRATION

Infiltration is groundwater entering a sewer system by means of defective pipes, pipe joints, or manhole walls. Infiltration quantities exhibit seasonal variation in response to groundwater levels. Storm events or irrigation trigger a rise in the groundwater levels and increase infiltration. The greatest infiltration is observed following significant storm events or prolonged periods of precipitation. Since infiltration is related to the total amount of piping and appurtenances in the ground and not to any specific water use component, it is generally expressed in terms of the total land area being served. The unit quantity generally used is gallons per acre per day.

INFLOW

Inflow is surface water entering the sewer system from yard, roof and footing drains, from cross connections with storm drains, and through holes in manhole covers. Peak inflow occurs during heavy storm events when storm sewer systems are taxed beyond their capacity, resulting in hydraulic backups and local ponding. Inflow, like infiltration, can be expressed in terms of gallons per capita day or gallons per acre per day.

WWTF flow records are utilized to characterize combined infiltration and inflow (I/I) in the Bingen and White Salmon system in terms of peak hour, peak day, maximum month, and average annual I/I.

MAXIMUM MONTH FLOW (TREATMENT DESIGN FLOW)

Maximum month flow is the highest monthly flow during a calendar year. The maximum month flow normally occurs in the winter due to the presence of more I/I. This wintertime flow is composed of the normal domestic, commercial, and public use flows with significant contributions from inflow and infiltration. The predicted maximum month flow at the end of the design period is used as the design flow for sizing treatment processes and selecting treatment equipment.

NON-RESIDENTIAL WASTEWATER

Non-residential wastewater is wastewater generated from commercial activities, such as restaurants, retail and wholesale stores, service stations, and office buildings, and industrial flow (process wastewater, rinse water, and other industrial activities). Non-residential wastewater quantities for commercial and industrial wastewater are expressed in this Plan in terms of equivalent residential units (ERUs).

PEAK HOUR FLOW

Peak hour flow is the highest hourly flow during a calendar year. The peak hour flow usually occurs in response to a significant storm event preceded by prolonged periods of rainfall which have previously developed a high groundwater table in the service area. Peak hour flows are used in sizing the hydraulic capacity of wastewater collection, treatment, and pumping components. Peak hour flow is typically determined from treatment facility flow records and projected future flows.

SUSPENDED SOLIDS

Suspended solids is the solid matter carried in the waste stream. The total suspended solids (TSS) in a wastewater sample are determined by filtering a known volume of the sample, drying the filter paper, and measuring the increase in weight of the filter paper. TSS is expressed in the same terms as BOD; milligrams per liter for concentration and pounds per day for mass load. The amount of TSS in the wastewater is used in the sizing of treatment facilities and provides another measure of the treatment effectiveness. The concentration of TSS in wastewater affects the treatment facility biosolids production rate, treatment and storage requirements, and ultimate disposal requirements.

WASTEWATER

Wastewater is water-carried waste from residential, business, industry, and public use facilities, together with quantities of groundwater and surface water which enter the sewer system through defective piping and direct surface water inlets. The total wastewater flow is quantitatively expressed in millions of gallons per day (mgd).

EXISTING WASTEWATER FLOWS AND LOADING

WWTF records for the 6-year period from 2007 through 2012 were reviewed and analyzed to determine current wastewater characteristics and influent loadings. Current wastewater flows and loadings were then used in conjunction with projected population data to determine projected future wastewater flows and loadings.

WASTEWATER FLOWS AT CITY OF BINGEN WWTF

Table 5-1 summarizes reported WWTF influent flows for the 6-year period of 2007 to 2012. The monthly average influent WWTF flows ranged from 0.21 mgd to 0.67 mgd.

The 2007 to 2012 dry season average of 0.27 mgd includes 0.04 mgd average dry season infiltration, based on an analysis of WWTF influent flow indicated by flow charts. Hence, base flow (sanitary flow without infiltration and inflow) is estimated to be 0.23 mgd.

The WWTF monitors influent flow entering the WWTF, upstream of the influent screen.

TABLE 5-1

Historical WWTF Influent Flows (2007 to 2012)

Flow Type (mgd)	2007	2008	2009	2010	2011	2012	Average
Average Base Sanitary Flow(1)	0.25	0.24	0.24	0.25	0.25	0.19	0.23
Average Dry Weather Flow(2)	0.27	0.28	0.28	0.28	0.28	0.22	0.27
Annual Average Flow	0.35	0.35	0.36	0.36	0.35	0.32	0.35
Maximum Monthly Flow	0.54	0.58	0.67	0.51	0.49	0.49	0.54
Minimum Day Flow	0.24	0.20	0.24	0.23	0.23	0.18	0.22
Peak Day Flow	1.06	0.92	1.40	0.63	0.90	1.00	0.98
Peak Hour Flow	1.47	1.40	2.16(3)	1.45	1.44	1.94	1.64

(1) Equal to the sanitary flow without inflow and infiltration. These values were determined from dry summer influent flow charts for each year.

(2) Average of July, August, and September.

(3) Peak flow of 2.16 mgd (1,500 gpm) was recorded on January 2, 2009.

Monthly Discharge Monitoring Report (DMR) data for this period are provided in Appendix E and summarized in Table 5-2. Graphical representations of daily and average monthly WWTF flows and influent BOD_5/TSS loadings for the period from 2007 through 2012 are shown in Figures 5-1, 5-2, and 5-3, respectively.

Peak day and peak hour flows occurred during a major storm event on January 2, 2009. Reported peak day influent flow at the WWTP was 1.40 mgd and the reported peak hour flow was 2.16 mgd.

TABLE 5-2

Summary of Discharge Monitoring Reports (DMRs) WWTF Influent Monthly Averages

Year	Average Monthly Flow mgd	Min. Daily Flow mgd	Max. Daily Flow mgd	BOD_5 (mg/L)	BOD_5 (lb/d)	TSS (mg/L)	TSS (lb/d)
Jan-07	0.51	0.35	1.06	122	518	136	579
Feb-07	0.42	0.36	0.53	174	612	174	612
Mar-07	0.41	0.32	0.51	259	890	259	890
Apr-07	0.32	0.29	0.40	216	581	208	559
May-07	0.29	0.26	0.34	171	413	160	387
Jun-07	0.28	0.26	0.31	200	474	197	469
Jul-07	0.28	0.25	0.30	268	620	317	736
Aug-07	0.28	0.25	0.32	243	627	313	806
Sep-07	0.27	0.23	0.34	295	651	538	1,189
Oct-07	0.28	0.25	0.42	272	624	313	718
Nov-07	0.31	0.24	0.73	214	551	286	738
Dec-07	0.54	0.42	0.97	137	611	158	709

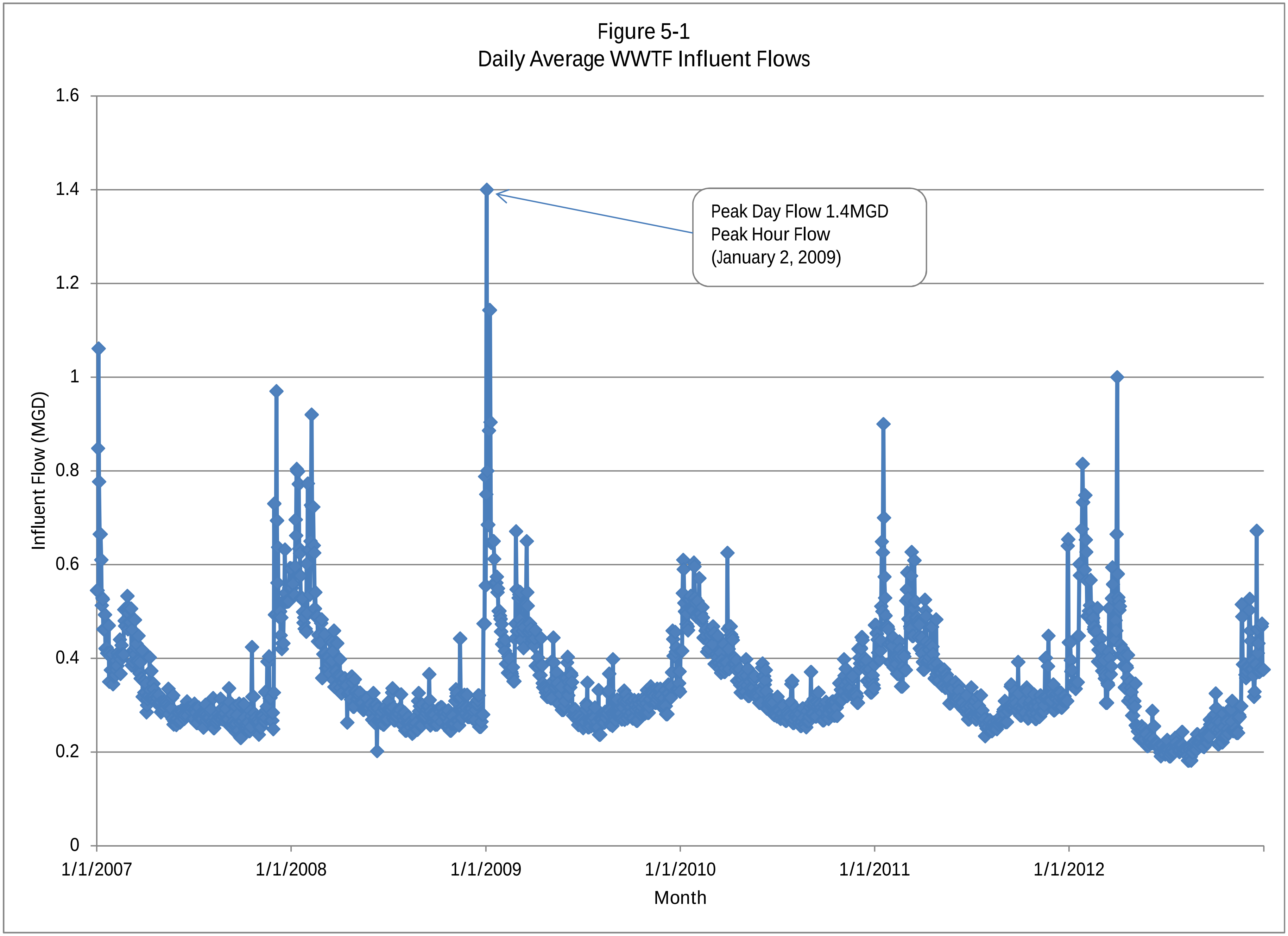
Figure 5-1
Daily Average WWTF Influent Flows
Peak Day Flow 1.4MGD
Peak Hour Flow
(January 2, 2009)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Influent Flow (MGD)
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
Month

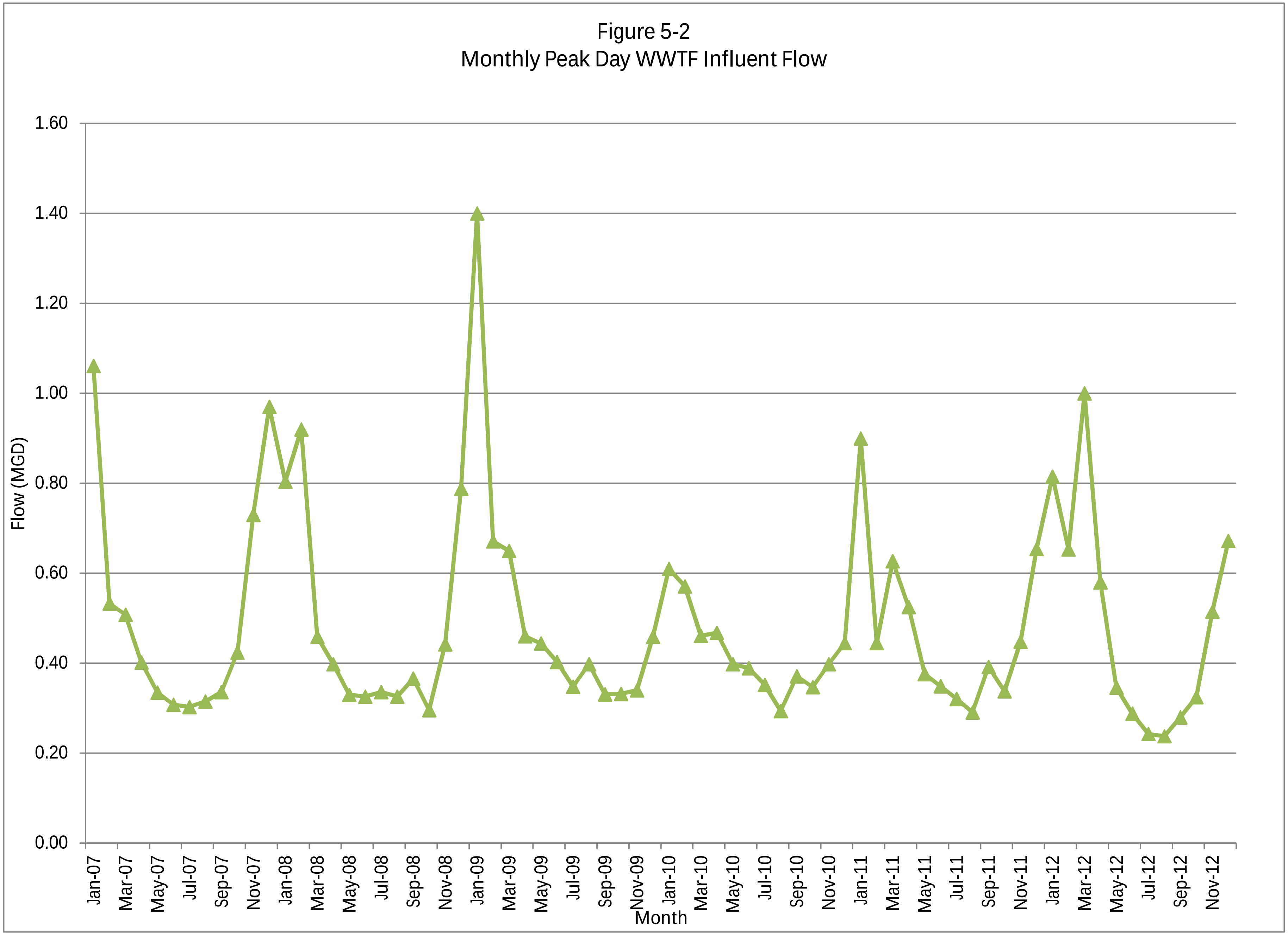

Figure 5-2
Monthly Peak Day WWTF Influent Flow
Flow (MGD)
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Jan-07
Mar-07
May-07
Jul-07
Sep-07
Nov-07
Jan-08
Mar-08
May-08
Jul-08
Sep-08
Nov-08
Jan-09
Mar-09
May-09
Jul-09
Sep-09
Nov-09
Jan-10
Mar-10
May-10
Jul-10
Sep-10
Nov-10
Jan-11
Mar-11
May-11
Jul-11
Sep-11
Nov-11
Jan-12
Mar-12
May-12
Jul-12
Sep-12
Nov-12
Month

Figure 5-3
Monthly Average WWTF Influent Flows

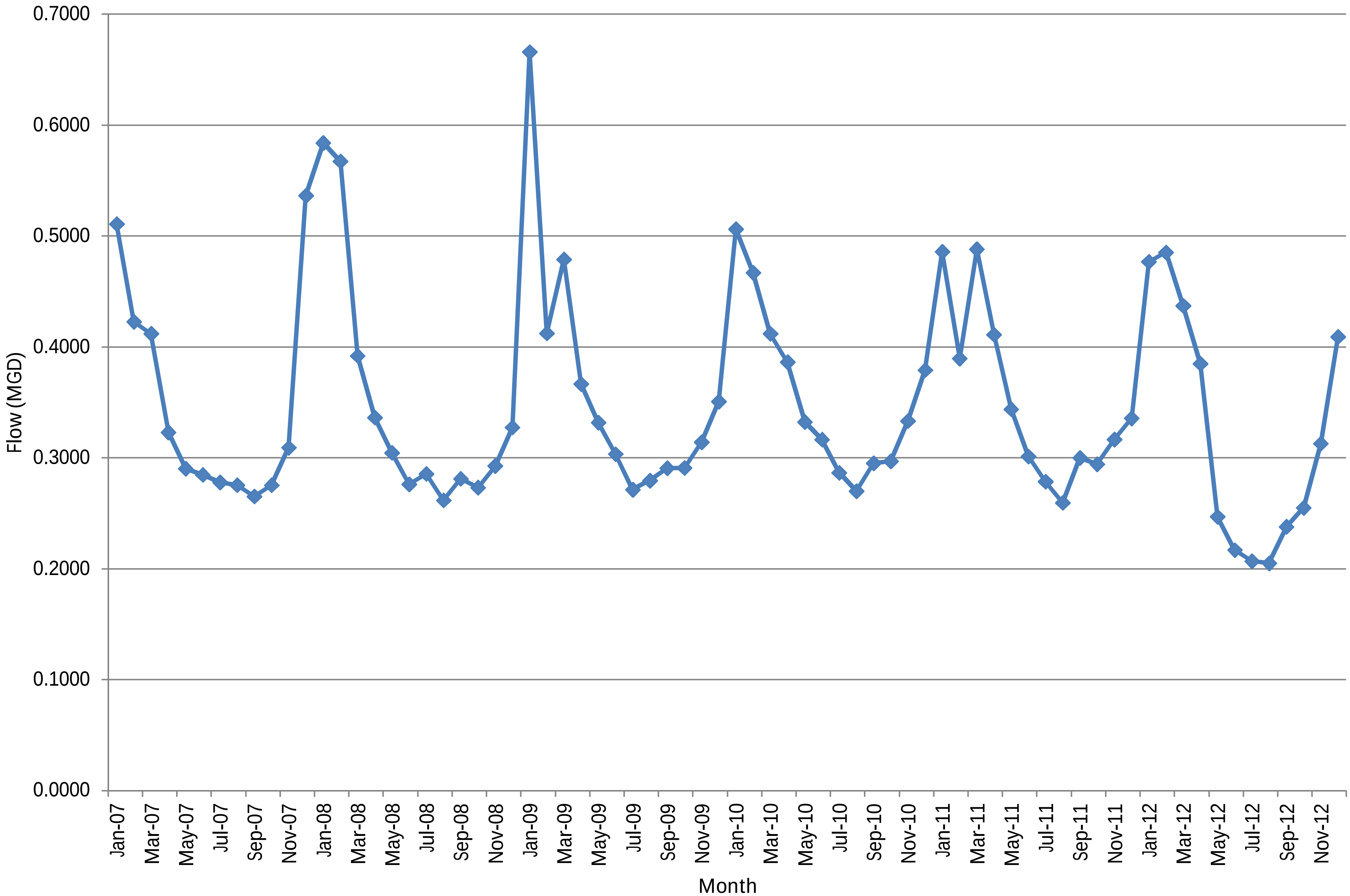

TABLE 5-2 – (continued)

Summary of Discharge Monitoring Reports (DMRs)
WWTF Influent Monthly Averages

Year	Average Monthly Flow mgd	Min. Daily Flow mgd	Max. Daily Flow mgd	BOD_5 (mg/L)	BOD_5 (lb/d)	TSS (mg/L)	TSS (lb/d)
Jan-08	0.58	0.46	0.80	118	573	152	741
Feb-08	0.57	0.36	0.92	147	688	196	918
Mar-08	0.39	0.34	0.46	185	603	202	661
Apr-08	0.34	0.26	0.40	221	618	198	556
May-08	0.30	0.28	0.33	250	590	251	592
Jun-08	0.28	0.20	0.33	233	536	222	511
Jul-08	0.29	0.26	0.34	291	675	287	665
Aug-08	0.26	0.24	0.33	237	609	312	804
Sep-08	0.28	0.26	0.37	286	632	308	681
Oct-08	0.27	0.25	0.30	230	525	274	624
Nov-08	0.29	0.26	0.44	248	604	279	679
Dec-08	0.33	0.25	0.79	222	605	227	620
Jan-09	0.67	0.43	1.40	No Data	No Data	No Data	No Data
Feb-09	0.41	0.35	0.67	274	942	197	676
Mar-09	0.48	0.42	0.65	180	717	147	586
Apr-09	0.37	0.32	0.46	211	646	210	642
May-09	0.33	0.29	0.44	166	458	196	542
Jun-09	0.30	0.26	0.40	263	666	276	699
Jul-09	0.27	0.25	0.35	326	756	363	841
Aug-09	0.28	0.24	0.40	276	712	311	801
Sep-09	0.29	0.27	0.33	279	616	324	716
Oct-09	0.29	0.27	0.33	230	525	331	754
Nov-09	0.31	0.28	0.34	248	604	234	571
Dec-09	0.35	0.28	0.46	199	543	232	633
Jan-10	0.51	0.42	0.61	168	710	167	703
Feb-10	0.47	0.41	0.57	182	708	203	790
Mar-10	0.41	0.37	0.46	233	799	247	849
Apr-10	0.39	0.33	0.47	319	1,029	427	1,375
May-10	0.33	0.31	0.40	282	781	291	807
Jun-10	0.32	0.28	0.39	200	527	289	762
Jul-10	0.29	0.26	0.35	317	758	381	912
Aug-10	0.27	0.25	0.29	242	545	290	652
Sep-10	0.30	0.27	0.37	266	654	347	853
Oct-10	0.30	0.27	0.35	308	764	369	914
Nov-10	0.33	0.31	0.40	No Data	No Data	No Data	987
Dec-10	0.38	0.33	0.45	No Data	No Data	No Data	754

TABLE 5-2 – (continued)

Summary of Discharge Monitoring Reports (DMRs)
WWTF Influent Monthly Averages

Year	Average Monthly Flow mgd	Min. Daily Flow mgd	Max. Daily Flow mgd	BOD_5 (mg/L)	BOD_5 (lb/d)	TSS (mg/L)	TSS (lb/d)
Jan-11	0.49	0.39	0.90	149	603	145	588
Feb-11	0.39	0.34	0.45	185	600	169	550
Mar-11	0.49	0.41	0.63	153	624	137	559
Apr-11	0.41	0.35	0.53	153	525	158	542
May-11	0.34	0.30	0.38	250	717	224	642
Jun-11	0.30	0.27	0.35	270	677	274	687
Jul-11	0.28	0.23	0.32	277	645	317	737
Aug-11	0.26	0.25	0.29	337	731	440	955
Sep-11	0.30	0.26	0.39	249	624	345	862
Oct-11	0.29	0.27	0.34	305	747	348	854
Nov-11	0.32	0.28	0.45	256	675	279	736
Dec-11	0.34	0.29	0.65	226	634	247	692
Jan-12	0.48	0.34	0.82	142	564	157	626
Feb-12	0.49	0.39	0.65	115	461	129	519
Mar-12	0.44	0.31	1.00	140	510	161	588
Apr-12	0.39	0.28	0.58	173	556	194	622
May-12	0.25	0.21	0.35	347	714	468	964
Jun-12	0.22	0.19	0.29	377	682	513	929
Jul-12	0.21	0.19	0.24	391	675	417	721
Aug-12	0.21	0.18	0.24	357	611	397	679
Sep-12	0.24	0.21	0.28	340	674	433	859
Oct-12	0.26	0.22	0.33	316	671	376	798
Nov-12	0.31	0.24	0.52	345	900	437	1,140
Dec-12	0.41	0.32	0.67	150	511	164	559
Average	**0.35**	**0.29**	**0.49**	**228**	**614**	**260**	**718**
Max.	**0.67**	**0.18**	**0.24**	**391**	**1,029**	**538**	**1,375**
Min.	**0.21**	**0.46**	**1.40**	**115**	**413**	**129**	**387**

HISTORICAL INFLUENT LOADING AT WWTF

The annual average and maximum month BOD_5 and TSS mass loading for 2007 through 2012 are listed in Table 5-3.

TABLE 5-3

WWTF Influent Annual Average Flow, BOD_5 and TSS[1]

Year	Annual Average Influent Flow (mgd)	Annual Average BOD (lb/d)	Annual Average TSS (lb/d)	Maximum Month BOD (lb/d)	Maximum Month TSS (lb/d)
2007	0.349	598	699	890	1,189
2008	0.349	605	671	688	918
2009	0.363	599	622	942	841
2010	0.357	606	863	1,029	1,375
2011	0.350	650	700	747	955
2012	0.323	627	750	900	1,140
Average[1]	**0.348**	**614**	**718**	**866**	**1,070**

(1) Average of monthly averages.

The average influent flow rate has remained relatively steady since 2007. BOD influent loadings remained relatively steady from 2007 to 2010, then increased significantly in 2011. TSS influent loadings decreased from 2007 to 2009, then increased significantly in 2010.

As shown on Figures 5-1 through 5-4, the data indicate that the average design flow of 0.80 mgd for the existing facility has not been exceeded. The highest monthly average over the period of 2007 to 2012 was 0.67 mgd. The data also indicate that the peak day design flow of 2.0 mgd has not been exceeded. The peak day flow over the period between 2007 and 2012 was 1.4 mgd.

Appendix F shows the effluent BOD and TSS charts from 2007 to 2012. During the weeks of January 4, 2007, and April 29, 2010, the weekly loading of effluent BOD_5 and TSS exceeded the maximum loading limit in the NPDES permit of 296 lb/d BOD_5 and TSS. The monthly loading was well below the maximum loading of the NPDES permit of 197 lb/d for BOD_5 for both months and was below the limit of 197 lb/d for TSS for the April 2010 occurrence. January 2007 the monthly limit for TSS was 459 lb/d, well above the NPDES limit of 197 lb/d.

EXISTING EQUIVALENT RESIDENTIAL UNITS (ERUS)

To determine the number of residential units with sewer service, water consumption, water billing, and sewer billing records were reviewed.

SEWER CONNECTIONS

Tables 3-7 and 3-8 provided the average number of sewer service connections in 2012 by customer class. The majority of the sewer service connections are in the single-family residential customer class. The total numbers of connections for both cities in 2012 were 1,632.

WINTER WATER CONSUMPTION

The White Salmon and Bingen winter water consumption has remained relatively steady since late 2009. The winter water use is used to estimate wastewater volumes entering the collection system because the amount of winter water consumption typically is equal to wastewater base flow except for a minor amount of water that does not enter the sewer system (such as winter irrigation flows, spills, and evaporation).

Winter water consumption records for the period of 2009 through 2012 were available from each City's computer billing database. Tables 5-4 and 5-6 present the winter water consumption in gallons per day (gpd) by customer class obtained from White Salmon and Bingen. A more detailed summary of winter water consumption records is provided in Appendix G.

TABLE 5-4

White Salmon Winter Water Use by Year and Customer Class

Customer Class	Winter Water Use (gpd)			
	2009-2010	**2010-2011**	**2011-2012**	**Average**
Single-Family Residential[1]	145,600	136,400	127,200	136,400
Multi-Family Residential	900	700	600	700
Commercial[2]	21,600	32,800	20,900	26,200
New Construction	200	100	100	130
Seasonal/Vacant/Empty Lots[3]	900	1,700	900	1,200
Total	**169,200**	**171,700**	**149,700**	**164,700**

(1) Includes code 0, 1, 2, 001 Residential, 011 Rental-Residential, 015 On Well, 016 Empty Residential, 017 Residential Duplex, 050 In city residential

(2) Includes code 10, 31, 002 Commercial, 003 Irrigation, 004 Church, 005 Motel, 006 RV Park, 008 Comb. Comm/Res.

(3) Include 012 Dormant, 013 Vacant Lots, 014 Seasonal

In White Salmon, the water service area is significantly larger than the sewer service area. The City serves approximately 650 more water connections than sewer connections. To determine the winter water use by sewer customers only, water consumption per water service connection was calculated for each customer class (gpd/connection). These values were multiplied by the sewer connections for each customer class to determine the total winter water use by sewer customers shown in Table 5-4.

Everybody's Brewing is a commercial business in White Salmon that brews and sells beer; they also have a restaurant. The winter water use for this business has significantly increased over the past 3 years. A small portion of the water used by the brewery does

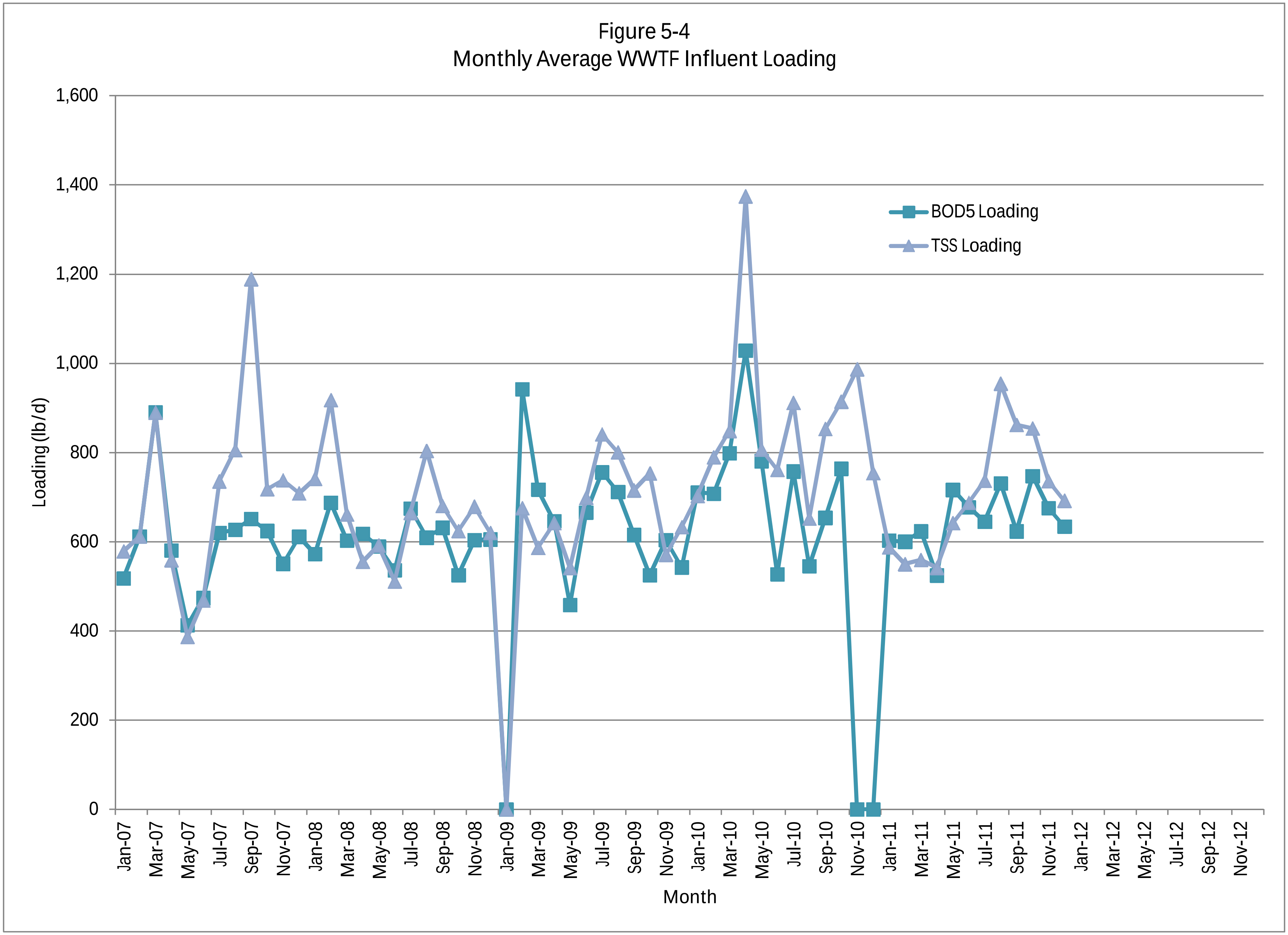

Figure 5-4
Monthly Average WWTF Influent Loading
BOD5 Loading
TSS Loading
Loading (lb/d)
1,600
1,400
1,200
1,000
800
600
400
200
0
Jan-07
Mar-07
May-07
Jul-07
Sep-07
Nov-07
Jan-08
Mar-08
May-08
Jul-08
Sep-08
Nov-08
Jan-09
Mar-09
May-09
Jul-09
Sep-09
Nov-09
Jan-10
Mar-10
May-10
Jul-10
Sep-10
Nov-10
Jan-11
Mar-11
May-11
Jul-11
Sep-11
Nov-11
Jan-12
Mar-12
May-12
Jul-12
Sep-12
Nov-12
Month

not enter the sewer system, but is used for beer production. Table 5-5 shows the winter water use for Everybody's Brewing. The water used in beer production was subtracted from the commercial winter water use in Table 5-4.

TABLE 5-5

Everybody's Brewing Winter Water Use

Water Use (gpd)	2010-2011	2011-2012
Water into Sewer(1)	1,254	1,540
Water for Beer(2)	137	177
Total Winter Water Use(3)	**1,392**	**1,717**

(1) Equals "Total Winter Water Use" minus "Water for Product."
(2) Yearly beer production data obtained from Everybody's Brewing was converted to gpd and averaged over each 2-year period.
(3) November through February data from City of White Salmon billing database.

TABLE 5-6

Bingen Winter Water Use by Year and Customer Class(1)

	Winter Water Use (gpd)			
Customer Class	**2009-2010**	**2010-2011**	**2011-2012**	**Average**
Residential Units	50,500	47,900	44,000	47,500
Commercial	10,900	14,100	23,400	16,100
Industrial	51,300	54,700	47,100	51,000
Total	**112,700**	**116,700**	**114,500**	**114,600**

(1) Winter water consumption is defined as November through February for the purposes of this analysis.

As shown in Table 5-4, the total winter water use in the City of White Salmon ranged from 145,000 gpd to 171,000 gpd. Table 5-6 shows the City of Bingen winter water use ranged from 112,700 gpd to 116,700 gpd.

Table 5-7 shows the combined total winter water use for both cities compared to the influent sewer flows observed at the wastewater treatment facility.

TABLE 5-7

Total Winter Water Use and Winter WWTF Influent Flows

Flow Type (gpd)	2009-2010	2010-2011	2011-2012	Average
Average WWTF Influent Flow(1)	409,500	397,100	403,700	403,400
Base Flow(2)	241,000	245,000	218,000	234,700
Water Consumption(3)	281,900	288,400	259,500	276,600

(1) Average of November to February flows from Table 5-2.
(2) Average of base flows from Table 5-1.
(3) Sum of winter water use from White Salmon (Table 5-4) and Bingen (Table 5-6).

EQUIVALENT RESIDENTIAL UNITS

Use of ERUs is a way to express the amount of water consumption or sewage produced by non-residential customers as an equivalent number of residential customers.

Tables 5-8 and 5-9 summarize the White Salmon and Bingen winter water consumption ERU value for 2009 to 2012.

TABLE 5-8

White Salmon Single-Family Residential (SFR) Equivalent Residential Units (ERUs) and Winter Water Use 2009 to 2012

	2009-2010	2010-2011	2011-2012	Average
SFR Winter Water Use (gpd)	145,600	136,400	127,200	136,400
SF Residential Sewer Service Connections	1,142	1,124	1,148	1,138
ERU value (gpd/ERU)	**127.5**	**121.4**	**110.8**	**119.9**

TABLE 5-9

Bingen Residential Equivalent Residential Units (ERUs) and Winter Water Use 2009 to 2012

	2009-2010	2010-2011	2011-2012	Average
Residential Winter Water Use (gpd)	50,500	47,900	44,000	47,467
Residential Sewer Service Connections	300	323	372	332
ERU value (gpd/ERU)	**168.3**	**148.3**	**118.3**	**145.0**

As shown in Table 5-8 and 5-9, the average daily single-family residential winter water use (which is equivalent to one water use ERU) for both cities from 2009 to 2012 ranged from a high of 168.3 gpd/ERU to a low of 110.8 gpd/ERU. The ERU value for each City has dropped significantly since 2009. This is likely due to water conservation efforts.

The *wastewater* ERU value is calculated based on *winter* water use (in order to exclude water used for irrigation). Based on the average of historical water use records for the years 2009 to 2012, average winter residential water use is 120 gallons per household in White Salmon, and 145 gallons per household in Bingen. However, based on analysis of the data and flows in other communities, it is estimated that only 90 percent of the winter water use makes it into the wastewater system. Thus, the wastewater ERU value is 108 gpd/ERU in White Salmon and 130 gpd/ERU in Bingen.

It should be noted that the ERU calculations above are for the purpose of quantifying and projecting flows and loadings to the two cities' wastewater facilities. Both cities use an ERU billing value of 8,500 gallons per ERU per month. This distinction is important in the financial projections for each sewer utility presented in Chapter 8.

Tables 5-10 and 5-11 summarize current wastewater ERUs based on an analysis of winter water use during the winter of 2011 to 2012.

TABLE 5-10

White Salmon Current Wastewater ERUs

Customer Type	Average Winter Water Use(1) (gpd)	Annual Average Base Flow(2) (gpd)	Sewer ERUs(3)	% of Total ERUs
Single-Family Residential	136,400	122,800	1,137	84.22%
Multi-Family Residential	700	600	6	0.41%
Commercial	23,500	21,200	196	14.54%
New Construction	130	100	1	0.07%
Seasonal/Vacant/Empty Lots	1,200	1,100	10	0.75%
Total	**162,000**	**145,800**	**1,350**	**100.00%**

(1) From Table 5-4.
(2) Equal to 90 percent of Average Winter Water Use.
(3) Equal to Annual Average Base Flow divided by 108 gpd/ERU.

TABLE 5-11

Bingen Current Wastewater ERUs

Customer Type	Average Winter Water Use[(1)] (gpd)	Annual Average Base Flow[(2)] (gpd)	Sewer ERUs[(3)]	% of Total ERUs
Residential	47,500	42,800	329	41.47%
Commercial	16,100	14,500	112	14.05%
Industrial	51,000	45,900	353	44.48%
Total	**114,600**	**103,200**	**794**	**100.00%**

(1) From Table 5-4.
(2) Equal to 90 percent of Average Winter Water Use.
(3) Equal to Annual Average Base Flow divided by 130 gpd/ERU.

INFILTRATION AND INFLOW

The amount of infiltration and inflow (I/I) can be estimated on an annual average, maximum month, and maximum day basis by subtracting the dry weather flow at the WWTF from the annual average, maximum month, and maximum day flows at the WWTF.

For this report, infiltration and inflow is expressed in units of gallons per acre per day (gpad). The *developed* sewer service area within the White Salmon city limits is 484 acres (out of a total of 790 acres) per the White Salmon Comprehensive Plan. The area outside of the White Salmon city limits, but within the sewer service area is approximately 341 acres. Therefore, the total developed sewer service area in White Salmon is estimated at 825 acres. The Bingen sewer service area is 380 acres and the area is not fully developed. Portions of east and north Bingen are available for future development. The exact area available for development in Bingen has not been quantified. Therefore, the total developed sewer service area for both cities combined is approximately 1,205 acres.

Table 5-12 summarizes the infiltration/inflow analysis from 2012. The data contained in this table is useful as a baseline for evaluating changes in infiltration and inflow in the future. This data is also used to estimate future flows.

TABLE 5-12

Estimated 2012 Inflow/Infiltration for Combined Wastewater Flows from Bingen and White Salmon

Flow Type	Influent Flow at WWTF(1) (mgd)	Base Flow(2) (mgd)	I/I(3) (mgd)	Service Area(4) (acre)	I/I(5) (gpad)
Annual Average (2012)	0.32	0.23	0.09	1,205	75
Maximum Month (February 2012)	0.49	0.23	0.26	1,205	216
Peak Day (March 30, 2012)	1.0	0.23	0.77	1,205	639
Peak Hour (March 31, 2012)	1.94	0.79	1.15 (7)	1,205	954

(1) From Table 5-1, WWTF influent flow charts.
(2) From Table 5-1, WWTF summer influent flow charts.
(3) Equals "Influent Flow at WWTF" minus "Base Flow."
(4) Developed areas only in the sewer service area (total acreage of both Cities is 1,248 acres; however, White Salmon provides sewer service outside of their city limits).
(5) Equals "I/I" divided by "Service Area."
(6) Rainfall recorded at the WWTF was 1.75 inches for the previous 24 hours at 7:30 a.m. on March 30 and 1.25 inches for the previous 72 hours at 7:30 a.m. on April 1, 2012; this equates to a 96 hour total of 3.0 inches from 7:30 a.m. on March 29 to 7:30 a.m. on April 1, 2012.
(7) A peaking factor of 3.44 is applied to baseflow to calculate peak hour diurnal flow. This factor is based on Figure C1-1 from the Department of Ecology *Criteria for Sewage Works Design* assuming a 2012 population of 2,985, where $Q_{\text{peak hour}}/Q_{\text{annual average}} = (18 + P^{0.5})/(4 + P^{0.5})$.

Infiltration and Inflow Analysis Using EPA Criteria

Another analysis of infiltration and inflow was performed to compare estimates of per capita I/I to EPA criteria. These infiltration and inflow rates are summarized in Table 5-13.

The U.S. EPA manual entitled *I/I Analysis and Project Certification* provides recommended guidelines for determining if infiltration and/or inflow is excessive.

1. To determine if excessive *infiltration* is occurring, a threshold value of 120 gallons per capita per day (gpcd) is used. This infiltration value is based on an average daily flow over a seven to fourteen day non-rainfall period during seasonal high ground water conditions.

2. To determine if excessive *inflow* is present in a collection system, the U.S. EPA uses a threshold value of 275 gpcd. If the average daily flow (excluding major commercial and industrial flows greater than 50,000 gpd each) during periods of significant rainfall exceeds 275 gpcd, the amount of inflow is considered excessive.

TABLE 5-13

Per Capita Infiltration and Inflow Based on EPA Criteria

Parameter	EPA Criteria for Excessive I/I (gpcd)	Estimated Bingen/White Salmon I/I Value (gpcd)
EPA Excessive Infiltration Criteria	120	144
EPA Excessive Inflow Criteria	275	451

Infiltration

Rainfall records from the National Oceanic and Atmospheric Administration (NOAA) NCDC show a 7-day period, February 2 through 8, 2012, during which no amounts of rainfall were measured. This would also be a period of relatively high groundwater. The average daily flow recorded during this time period is 0.522 mgd. (The highest daily flow was 0.627 mgd.) Since the intent of the EPA criteria was to only include domestic flows, 0.091 mgd of commercial and industrial flow was neglected (23,500 gpd of commercial flow from Table 5-10 and 16,100 gpd of commercial flow and 51,000 gpd of industrial flow from Table 5-11). With a total population of sewer users in 2012 of 2,985, and a residential flow of 0.43 mgd (equal to 0.522 mgd minus 0.091 mgd) for this period, the "EPA I/I Infiltration Value" for Bingen and White Salmon is estimated at 144 gpcd. Because this value is more than the EPA guideline of 120 gpcd, the Bingen/White Salmon collection system is considered to have excessive infiltration by EPA criteria.

The 7-day period between February 2 through February 8, 2012 was immediately before a significant water main leak was discovered on February 21, 2012. The repair of this leak has significantly lowered infiltration and inflow seen during lower flow periods since that time.

Inflow

The maximum day influent flow at the WWTF over the period of 2007 to 2012 was 1.40 mgd (recorded on January 2, 2009), as shown in Table 5-1. Since the intent of the EPA criteria was to only include domestic (residential) flows, the estimated 0.091 mgd of commercial and industrial flow was neglected. With a total population of sewer users in 2009 of 2,902, and a non-commercial flow of 1.31 mgd (equal to 1.40 mgd minus 0.091 mgd) for this day, the "EPA I/I Inflow Value" for Bingen and White Salmon is estimated at 451 gpcd. Because this value is greater than the EPA guideline of 275 gpcd, the sewer collection system is considered to have excessive inflow by EPA criteria. It should be noted that the 1.40 mgd flow significantly exceeded all other flows since 2007, and could thus be considered daily anomalous. If the next-highest peak daily flow is used in this calculation, the I/I does not exceed EPA criteria.

A separate study was completed to identify sources of inflow and infiltration and will be used to develop a plan for managing and/or removing excessive inflow and infiltration. This is discussed further in Chapter 6.

INDUSTRIAL FLOWS

As shown in Table 5-6, winter water use by industries in Bingen ranged from 47,100 gpd to 54,700 mgd since the winter of 2009 to 2010. Industrial flows are significantly different than municipal and commercial flows because the wastewater is typically much higher or lower strength. Industrial flows usually contain constituents that are not present in municipal wastewater or they are present in higher concentrations.

UNDERWOOD FRUIT

As described in Chapter 3, Underwood Fruit is a fruit packaging facility in the City of Bingen that has been issued a separate NPDES permit from Ecology. They discharge wash water that has trace amounts of chemicals: a floating aid (SOPP) and a fungicide (TBZ). Both of these chemicals are regulated under their NPDES discharge permit.

Underwood Fruit's discharge to the sewer system is governed by their NPDES permit and a contract with the City of Bingen, included in Appendix C. The contract with the City states that they cannot discharge more than 30,500 gpd to the City sewer and the strength of the wastewater discharged to the sewer cannot exceed 300 mg/L (76.3 lb/d at 30,500 gpd) BOD_5 and 350 mg/L (89 lb/d at 30,500 gpd) TSS. This fixed capacity at the WWTF is set aside for Underwood Fruit.

TRIBAL FISHCO

As described in Chapter 3, Tribal FishCo is a fish processing facility that is not yet in operation. The discharge evaluation from August 2011 was used to determine the projected characteristics shown in Table 5-14. It is assumed that the facility will come online in 2014 and be a full production by 2017 and remain at this capacity through the 20-year planning periods.

EVERYBODY'S BREWING

As discussed earlier in this chapter, Everybody's Brewing is a brewery and restaurant in White Salmon. Gray & Osborne met with Everybody's Brewing owner Doug Ellenberger and Head Brewer Mike Boler on July 9, 2013 in an effort to characterize the wastewater discharges from the brewing operations. The brewery provided information regarding water usage and beer production that are summarized earlier in this chapter. The brewery produces three different products: IPA, pale ale and lager. When brewing any type of beer, two wastewater discharges result from the brewing operation: kettle wash and mash run. The kettle wash is the higher strength wastewater.

The City of Bingen sampled and tested waste streams from the brewing operation that are summarized in Table 5-14.

TABLE 5-14

Everybody's Brewing Brewery Wastewater Characteristics

Parameter	KW-IPA	KW-IPA	MR-Pale Ale	KW-Pale Ale	MR-Lager	KW-Lager	MR-Lager
Date	7/11/13	7/11/13	7/17/13	7/17/13	7/18/13	7/18/13	7/18/13
Time	11:10 AM	5:00 PM	9:45 AM	12:16 PM	8:16 AM	11:00 AM	2:00 PM
Temp (°F)	160	155	163	145	164	135	140
pH	5.6	6	6.3	6	6.3	6.1	6.2
TS (mg/L)	101,366	113,930	25,660	72,107	23,726	73,424	17,536
TSS (mg/L)	26,693	30,659	2,288	24,348	2,686	19,394	1,030
% VS	94.7	95.3	97	95.8	96.3	95.4	96.1
BOD_5 (mg/L)	68,400	95,000	21,870	45,800	20,070	47,400	15,000
TKN (mg/L)	-	1,740	344	-	337	1,540	-
Estimated gallons/discharge	20 – 30	25	15 – 20	25	15	25 – 30	15 – 20
Estimated TS lb/discharge	17 - 25	24	3 - 4	15	3	15 - 18	2 - 3
Estimated TSS lb/discharge	4 - 7	6	0.3 – 0.4	5	3	4 - 5	0.1 – 0.2
Estimated BOD_5 lb/discharge	11 - 17	20	3 - 4	10	3	10 - 12	2 - 3
Estimated TKN lb/discharge	-	0.4	0.04 – 0.05	-	0.04	0.3 – 0.4	-

KW = Kettle Run; MR = Mash Run
TS = Total Solids, TSS = Total Suspended Solids, VS = Volatile Solids,
BOD_5 = five-day biochemical oxygen demand, TKN = Total Kjeldahl Nitrogen

From discussions with the brewery owner and head brewer, the wastewater discharges average four per week for the kettle wash and four per week for the mash run. The type of beer product varies from week to week. Assuming the IPA kettlewash sample is typical for the highest strength wastewater discharged from the brewery, the BOD discharges could be as high as 17 lb/day and the TSS as high as 7 lb/day. If the mash run pale ale sample is considered representative its mass discharge rate would be 4 lb/day BOD and 0.4 lb/day TSS. Thus rounding up to the nearest whole number an estimated total discharge of 21 lb/day BOD and 8 lb/day TSS is possible based on these initial characterization tests. TKN loadings will be less than 1 lb/day based on these initial tests. We recommend the City of White Salmon develop a sampling and testing program to monitor wastewater from the brewery operation to confirm the current loadings and project future loadings based on any expansion plans for the brewery.

CHARACTERISTICS OF COMBINED INDUSTRIAL WASTEWATER

Table 5-15 provides the known characteristics, including conventional parameters, of the major industrial discharges, based on review of DMRs, permit fact sheets, and operating records.

TABLE 5-15

Characteristics of Major Industrial Discharges

	Unit	Underwood Fruit(1)	Tribal FishCo(2)	Everybody's Brewing
Flow (Year 2012)	gpd	18,180	0	2,000(3)
Flow (Year 2022)	gpd	30,500	28,448	2,000(4)
BOD_5 (max month)	lb/day	76	205	21(4)
TSS (max month)	lb/day	89	94	8(4)
Ammonia-N	lb/day	NA	NA	NA
TKN (max month)	lb/day	NA	23	<1(4)

(1) From NPDES Discharge Monitoring Report.
(2) Projected from August 2011, *East White Salmon Fish Processing Facility Wastewater Discharge Evaluation*.
(3) Estimated, as shown in Table 5-5 and as discussed above.
(4) Assumes no expansion of existing operations.

PROJECTED SEWER SERVICE AREA POPULATION, ERUS AND FLOWS

As discussed in Chapter 3, the combined Bingen/White Salmon estimated 2012 population is 4,491. The City of Bingen population is expected to grow at a rate of 1 percent, and the White Salmon population is expected to grow at a rate of 1.5 percent.

The current and projected 10-year and 20-year ERUs and flows (without consideration of further expansion of the Urban Area Boundary) are summarized in Table 5-16. The 2012 values are based on existing data developed in this chapter and influent flow charts from the WWTF. The projected flows and ERUs are based on use of the growth assumptions applied to all customer classes, with the exception of industrial flows. Industrial flows are projected to remain constant.

I/I is assumed to be constant throughout the period. (In other words, increases in I/I due to the addition of new pipes and deterioration of old pipes are assumed to equal to decreases in I/I due to ongoing I/I reduction efforts.)

Future WWTF flows are projected based on a dry weather flow of 106.9 gpd/ERU. This value is equal to the average base flow of 231,500 gpd divided by the total number of sewer ERUs, 2,166. To estimate future annual average, maximum month, and peak day flows, the I/I flow rates were added to the base level wastewater flows derived from the population projections to obtain the respective future WWTF influent flow rates.

TABLE 5-16

Current and Projected ERUs and Flows

Wastewater ERUs and Flows	Sewer ERUs		
Customer Type	**2012**	**2022**	**2032**
Residential	1,472	1,690	1,941
Commercial	330	377	430
Industrial	353	571	571
Other	11	11	11
Total	**2,166**	**2,649**	**2,953**
Projected Flows (mgd)			
Flow Type	**2012**	**2022**	**2032**
Total Base Flow	0.23	0.30	0.33
Average Annual Flow	0.32	0.39	0.42
Maximum Month	0.49	0.55	0.59
Peak Day	1.00	1.07	1.10
Peak Hour	1.94	2.08	2.14

The average design flow of the plant is 0.80 mgd and the peak design flow is 2.0 mgd, which correspond to the annual average flow and the peak day flow, respectively. As shown in Table 5-16, the projected average annual flow and the projected peak day flow are well within the existing treatment plant capacity in 2032.

EXISTING BOD_5 LOADING

Monthly average influent BOD_5 loadings ranged from 413 lb/d to 1,029 lb/d for the 6-year period of analysis as shown in Table 5-2 and on Figure 5-4. The monthly average influent BOD_5 rated loading of 1,311 lb/d was never exceeded during the 6-year period of analysis. The average influent BOD_5 concentration for the 6-year period is 228 mg/L, which would be considered medium strength domestic wastewater. The average BOD_5 loading for the 6 years, as summarized in Table 5-2, was 614 lb/d.

With a service population of 4,491 for 2012, and an annual average BOD_5 loading of 627 lb/d, the 2012 annual average BOD_5 loading was 0.140 lb/cap/d. This value is lower than the Department of Ecology Criteria for Sewage Works Design of 0.2 lb/cap/d.

To convert the maximum month BOD_5 loading to a per capita and an ERU basis, the 2012 service population of 4,491 and number of ERUs (2,166) and maximum month BOD_5 of 900 lb/d for 2012 was used to calculate a maximum month per capita and ERU BOD_5 loading of 0.200 lb/cap/d and 0.42 lb/ERU/d, respectively. The ratio, for 2012, of the maximum month BOD_5 loading to the annual average BOD_5 loading is 900:627 or

1.44:1. This ratio is used in the development of future flow and loadings to the WWTF later in the chapter.

EXISTING TOTAL SUSPENDED SOLIDS LOADING

A review of Table 5-2 shows that monthly average TSS loadings ranged from 387 lb/d to 1,375 lb/d. The WWTF rated capacity for monthly average influent TSS loading of 1,311 lb/d was exceeded once during the 6-year period of analysis. This exceedance is not considered representative of actual current loadings. The 2012 average loading of 750 lb/d and a 2012 service population and average ERUs of 4,491 and 2,166, respectively, translate to an annual average TSS loading for 2012 of approximately 0.167 lb/cap/d or 0.35 lb/ERU/d.

The 2012 maximum month TSS loading is 1,140 lb/d. Using the same values for the 2012 service population and average ERUs of 4,491 and 2,166, yields a maximum month value of 0.254 lb TSS/cap/d or 0.53 lb/ERU/d. The ratio of the maximum month TSS loading to the annual average TSS loading is 1,140:750 or 1.52:1. This ratio is used in the development of future flow and loadings to the WWTF later in the chapter.

PROJECTED FUTURE WASTEWATER LOADINGS

Future WWTF maximum month BOD_5 and TSS loadings are estimated by multiplying the projected number of ERUs by the respective ERU-based loadings, and adding additional loading for a medium-strength industrial reserve as indicated below. Future ERU-based annual average BOD_5 and TSS loadings are estimated using the ratio of the maximum month to annual average loadings of these parameters. The current maximum month BOD_5 and TSS loadings are 0.42 lb BOD_5/ERU/d and 0.53 lb TSS/ERU/d. The ratio of the maximum month to annual average BOD_5 is 1.44:1. The ratio of the maximum month to annual average TSS is 1.52:1. Table 5-17 provides a summary of projected future WWTF influent BOD_5 and TSS loadings.

TABLE 5-17

Current and Projected WWTF Loadings

ERUs and Loadings	2012	2022	2032
Total ERUs	2,166	2,649	2,953
Annual Average BOD_5, (lb/d)	627	859	947
Maximum Month BOD_5, (lb/d)	900	1,233	1,360
Annual Average TSS, (lb/d)	750	917	1,023
Maximum Month TSS, (lb/d)	1,140	1,394	1,554

As shown in Table 5-17, the projected year 2022 and 2032 maximum month TSS loadings exceeds the rated WWTF capacity of 1,311 lb/d, and the 2032 maximum month BOD_5 loading exceeds the rated WWTP capacity of 1,311 lb/d. The fact that the

TSS/BOD ratio is greater than one may be due to the high industrial component of the wastewater.

Analysis of flows within each basin as well as each major sewer line and at each lift station is provided in Chapter 6, Collection System Evaluation and Recommendations.