Existing Data Review
For the
Development of a Stormwater Retrofit Plan for Water Resource Inventory Area (WRIA) 9: Historical Flow, Total Suspended Solids, and Turbidity Data

A Project Funded by the Puget Sound Watershed Management Assistance Program FY 2009

December 2011

King County

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1.0 Introduction

King County was awarded a Puget Sound Watershed Management Assistance Program Fiscal Year 2009 grant by Region 10 of the U.S. Environmental Protection Agency (EPA) to develop a stormwater retrofit plan for Water Resources Inventory Area (WRIA) 9 and estimate of costs for retrofitting all developed lands of Puget Sound. The goal of this grant was to prioritize a plan to implement stormwater BMPs (best management practices) in developed areas of WRIA 9 primarily built without stormwater controls. Another goal of the grant was to create a cost estimate for achieving flow and water quality goals in WRIA 9 that could be extrapolated to all of Puget Sound. In Task 4 of the project work plan (King County 2010) has the following milestone: deliver existing data review report by May, 2011.

This data report completes Task 4 and describes the results of the existing data review conducted as part of this grant-funded project. Included in this report are reviews of available data on historical flow, total suspended solids (TSS) and turbidity for the study area. Additional information on water quality and quantity can be found in the extensive assessments and plans that have been conducted in the recent past. Those reports include the: Green Duwamish Water Quality Assessment (King County 2002), the WRIA 9 Salmon Recovery Plan (WRIA 9 2005), the Miller Walker Basin Plan (City of Burien 2006), the Newaukum Creek Basin Characterization Project Report (King County 2007) and the Des Moines Basin Plan (Des Moines Creek Basin Committee 1997). This report summarizes data accessible in the study region back to 2001/2002. This is intended to be a characterization of the region not an extensive list of all data gathered at all sites in the area.

1.1 Description of Project Area

The project area for the WRIA 9 Stormwater Retrofit Grant consists of the Green/Duwamish watershed and sections of the Central Puget Sound watershed (Figure 1). The study basin excludes the area above the Howard Hanson Dam and the city of Seattle. Lands within the city of Seattle are not included in the study area because the vast majority of Seattle's lands within WRIA 9 are served by a combined sewer and stormwater system and CSO control programs are already underway in this area. The area of WRIA 9 upstream of the Howard Hanson Dam is not included in the study area because it is primarily forested and maintained for the City of Tacoma's water supply.

The total area being evaluated is estimated to be approximately 282 sq miles (King County 2010). The region is highly diverse in land cover and land use. It has over 65 sq miles of commercial forest, nearly 8 sq miles of agricultural production, 149 sq miles of highly urbanized developments, defined as inside the Urban Growth Area (UGA), as well as rural lands outside of the UGA.

Along with unincorporated King County, there are 15 cities within the study area, (including the cities of Algona, Auburn, Black Diamond, Burien, Covington, Des Moines, Enumclaw, Federal Way, Kent, Maple Valley, Normandy Park, Renton, Seatac, and Tukwila) and the Muckleshoot Indian Reservation.

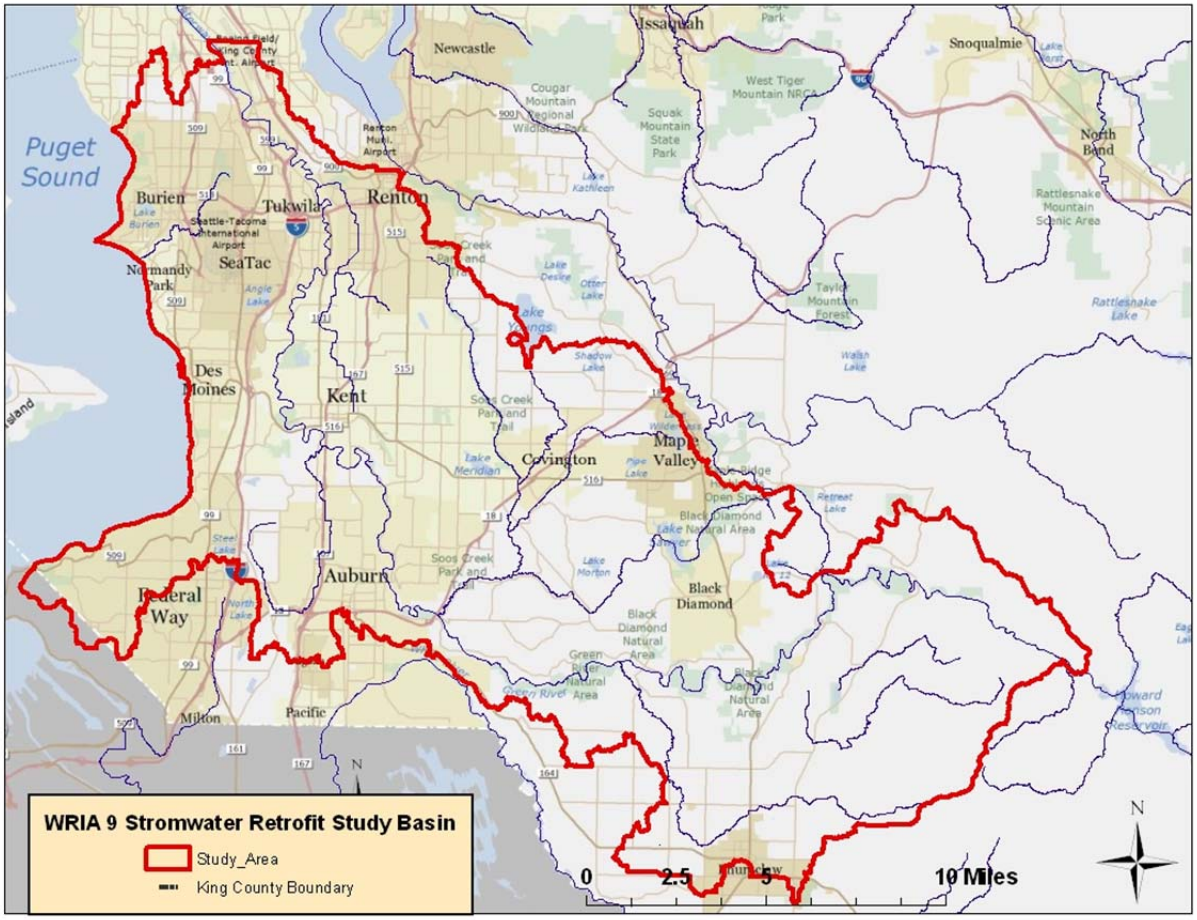

Figure 1. Map of Study Basin

1.2 Data Timeframe and Ownership

Due to the cost of installing and maintaining water quality/quantity gauging equipment and the inevitable failure of equipment the timeframes of active logging at each station vary. The following graph shows the active logging timeframe for flow gauges in the study region (Figure 2). Turbidity loggers have not historically been installed in the basin (although they have been installed as a result of this project). Records for Total Suspended Solids (TSS) consist primarily of grab samples gathered by King County staff at the sites listed.

Several governmental organizations maintain data logging equipment in the study area. These entities include: King County, USGS, and the city of Federal Way. For the purposes of this report most of the data used was collected by either the USGS or King County. Flow gauges, TSS and turbidity data have been gathered for over 10 years in some locations while other locations have intermittent data collection periods

Figure 2. Illustration of years when active gagging occurred at locations within the study area

Gauge ID#	Stream	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
		Active gauge indicated by green highlight									
44i	Big Spring Creek										
11h	Bow Lake										
09a	Covington Creek										
40d	Crisp Creek										
11c	Des Moines Creek										
11d	Des Moines Creek										
11f	Des Moines Creek										
11g	Des Moines Creek										
26a	Jenkins Creek										
54i	Little Soos Creek										
1211347	Mill Creek										
1211349	Mill Creek										
42a	Miller Creek										
42b	Miller Creek										
42j	Miller Creek										
54h	Soosette Creek										
03g	Springbrook Creek										
12113346	Springbrook Creek										
42k	Walker Creek										
12112600	Big Soos Creek										
12108500	Newaukum Creek										

This report is not intended to be a complete review of all data (Flow, TSS, and Turbidity) gathered in the study area. It is intended to be a review of parameters described and considered to be characteristic of the region (sites identified in the QAPP). The data selected can be readily accessed through online databases. Other organizations do collect data in waterways of the study basin but the data are not easily accessible and typically represent locations where sampling has not been active for a long enough timeframe to be used for a historical conditions analysis.

1.3 Order of Data Presentation

The data presented in this report will be grouped by parameters. Flow, TSS and turbidity will each be individually presented by stream and ordered by input into the Green/Duwamish River. Streams that do not flow into the Green/Duwamish (Miller, Des Moines, Walker, etc.) but discharge into Puget Sound will be presented by creek from south to north beginning with the gauge most upstream.

1.4 Metrics Presented

In this report standard summary statistics are provided. These include: instantaneous maximum values (15-minute intervals), instantaneous minimum values (15-minute intervals), yearly means for the sampling period as well as the range of each. Additionally several hydrologic flow metrics are included. High Pulse Count is defined as the number of days each water year that discrete high flow pulses occur. Pulses are described as the occurrence of daily average flows that are greater than or equal to twice the long term daily average flow. High Pulse Range is the number of days between the first high pulse of the water year (WY) and the last high pulse of the water year. Two-Year peak: Winter Base Flow is the ratio of the two-year frequency peak flow rate to the winter (October 1–April 30) base flow. Years with incomplete records were not graphed or charted due to lack of data and confidence of accuracy.

1.5 Deviations from Project Work Plan

This report presents existing stream flow and water quality data used to calibrate hydrologic models in the project area. This report does not present existing data for precipitation, land use and land cover, stormwater facility maps, and other atmospheric conditions used to estimate evaporation and vegetative transpiration. These other existing data sets will be described in the watershed modeling report as part of Task 7 of the project.

2.0 Data

All graphs and tables are listed in the appendix in the order presented.

2.1 Flow

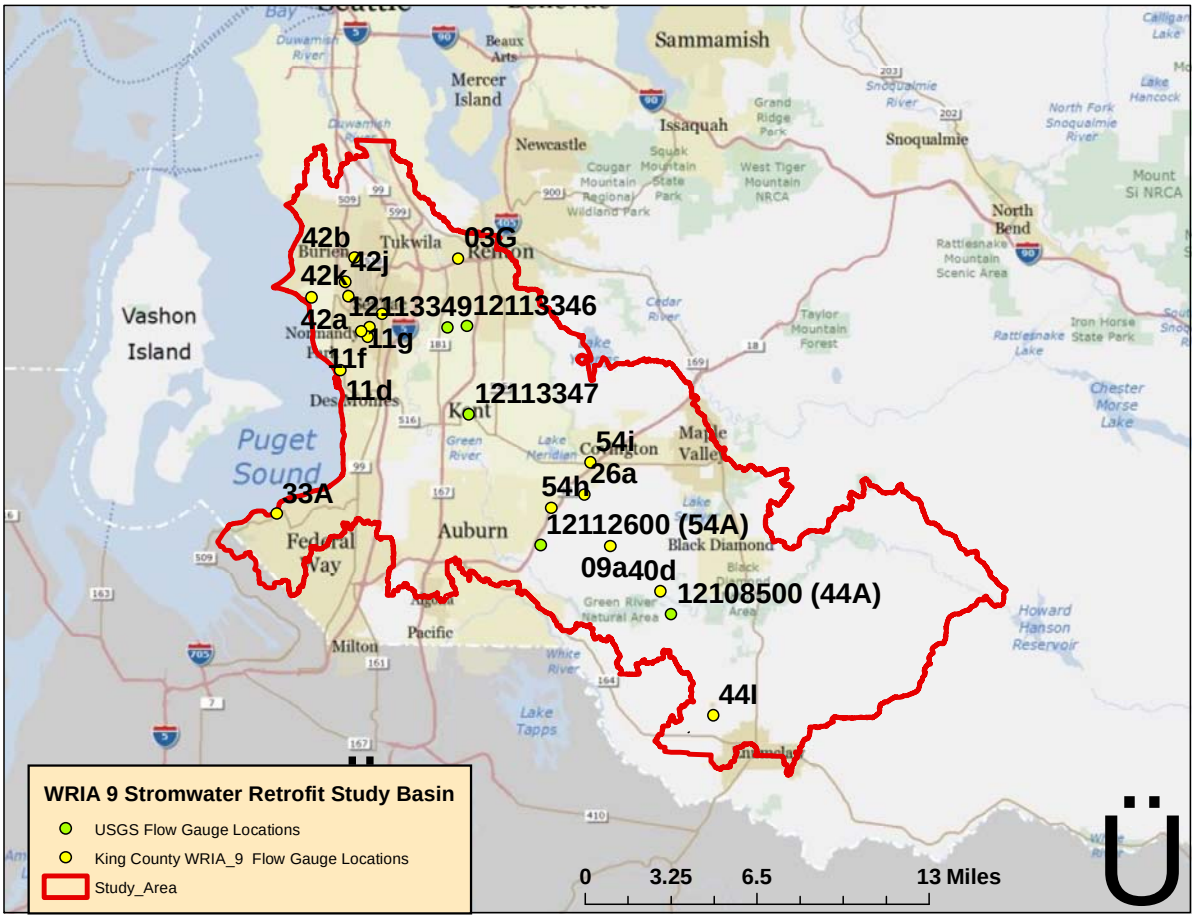

Figure 3. Map showing the locations of the flow gauges referred to in this report

Big Spring Creek

Big Spring Creek is a small (1.3 miles in length) spring fed creek located on the Newaukum plateau. It is an important cold water source for the middle Newaukum. Big Spring Creek drains into Newaukum creek at river mile 6.5 (approximate). Gauge 44I is located on Big Spring Creek at river mile 0.4 immediately downstream of 424th Ave (Figure 3).

Gauge 44I (Big Spring Creek) has data records beginning in April of 2007. Yearly instantaneous maximum flows range between 14.2 (2010) and 23.2 (2008) cfs (not including truncated data from water year 2007). Yearly mean discharges have ranged between 5.2 (2009) and 6.3 (2010) cfs. The yearly minimum flow varies between 2.1(2011) and 2.7(2008) cfs.

Newaukum Creek

Newaukum Creek drains into the Middle Green River above Big Soos Creek. The creek drains a basin of approximately 17,279 acres. The basin consists of primarily agricultural and light density residential land

use and a portion of the city of Enumclaw is within the basin. Shared King County and USGS gauge 12108500 (44A) is located about .9 miles upstream from Newaukum's confluence with the Green River.

Gauge 12108500 has maintained a mean yearly flow between 42.2 (2005) and 65.6 (2006) cfs since 2001. The maximum daily flow has been between 860 (2009) and 207 cfs (2003). The minimum flow has ranged from 8.7 (2009) to 15 cfs (2010).

Crisp Creek

Crisp Creek is a small creek that originates from several small groundwater fed streams and drains into the Green River at river mile 40.1. The creek basin drains an area of approximately 2,665 acres and is nearly 3 miles in length. The upper portion of the watershed consists of mainly commercial forest while the lower portion contains a few farms and residential homes. Flow gauge 40d is located at approximately river mile 0.9

Gauge 40d has data from 1994 through August 2001.The yearly instantaneous maximum varied between 18.5 (2008) and 58.9 (2009) cfs. The yearly mean flow for gauge 40d has averaged between 6.2 (2003) and 9.0 (2007) cfs while the instantaneous yearly minimum ranged between 1.4 (2006) and 3.6 (2010) cfs.

Covington Creek

Covington Creek is a waterway located in the Middle Green watershed. It is one of the four major tributaries to Soos Creek which drains to the Green River at RM 33.7. Covington Creek flows out of several headwater lakes (Lake Morton, Lake Sawyer, and Ravensdale Lake) and gauge 09a (downstream of 323rd St.) is located approximately 1.4 miles from its confluence with Soos Creek.

Gauge 09a has data available from 1998 – August 31, 2011 (inactive in 2007). The gauge has a yearly instantaneous maximum between 594 (2009) and 102(2010) cfs. The yearly mean discharge has varied between 0.9 (2003) and 1.6 (2008) cfs. The minimum yearly discharge has been between 17.7 (2003) and 35.5(2006) cfs.

Little Soos Creek

Little Soos Creek is another of the 4 primary tributaries to Soos Creek. Its headwaters are located at Lake Young's and gauge 54i is sited roughly 0.3 of a mile upstream of its drainage to Soos Creek. The drainage area of Little Soos Creek is estimated to be 2097 acres.

Gauge 54i (Little Soos Creek) has had a yearly mean discharge between 4.0 (2003) and 6.1 (2002) cfs for the years of 2002-2011. The minimum flow has ranged between zero (dry in 2002) and 1.8 (2008) cfs while the instantaneous maximums have varied between 20.0 (2010) and 233 (2006) cfs.

Jenkins Creek

Jenkins Creek a main tributary to Soos Creek and originates at Lake Wilderness. It runs approximately 7.0 miles before draining to Soos Creek and the main stem drains and estimated area of 5,483 acres.

Gauge 26a is located 0.4 miles upstream from its confluence with Soos Creek just upstream of Kent Black Diamond Rd SE.

Between 2002 and 2010 gauge 26a had a yearly mean between 29.5 (2003) and 45.3 (2010) cfs. Instantaneous peak maximums have ranged between 427 (2009) and 121 (2003) cfs. Instantaneous minimums vary between 8.2 (2005) and 10.8 (2008) cfs.

Soosette Creek

Soosette Creek is another primary contributor to the Soos Creek watershed. The creek is 5.8 miles in length and drains an area of approximately 3,538 acres. Gauge 54h is located just upstream of Hwy 18 and is 1.4 river miles upstream of its discharge to Soos Creek.

Between 2002 and 2011 gauge 54h had a mean yearly discharge between 4.0 (2003) and 6.1 (2002) cfs while the instantaneous minimum has varied from 0.06 (2004) and 0.27 (2006) cfs. Maximum discharges at gauge 54h ranged from 60.5(2010) to 329(2009) cfs.

Big Soos Creek

Big Soos Creek drains into the middle Green River east of Covington. The basin is approximately 17,500 acres and station 12112600 (54A) is located 1.2 miles upstream from the Green River. The creek drains a variety of land uses including medium density residential, agricultural land and forest. Big Soos Creek also has tributaries including Ravensdale and Jenkins Creeks.

Station 12112600 has a yearly mean flow ranging between 95.1 (2004) and 171 cfs (2006). The maximum daily flow is between 399 (2008) and 1610 cfs (2009). Minimum flows range from 19 (2003) to 34 cfs (2010).

Mill Creek

The South Fork of Mill Creek originates in the city of Kent. The creek is approximately 4.2 miles in length and enters Springbrook Creek before becoming the Black River and emptying into the Green River. The watershed is estimated to drain an area 7,020 acres. The watershed is very developed containing portions of the city of Kent. USGS gauge 1211334C7 is located in Earthworks Park 0.6 miles upstream of Titus St. while gauge 12113349 is located 100 ft upstream of the footbridge on Interurban Trail in Orillia.

Between 2001 and 2009 gauge 1211347 has had a yearly mean discharge between 2.3 (2001) and 4.3 (2002) cfs. The minimum flow has ranged from zero (dry in 2003 and 2004) to 0.65 (2008) cfs and the maximum flows vary from 50 (2005) to 233 (2002) cfs.

Gauge 12113349 has maintained a yearly mean discharge between 10.3 (2005) and 16.4 (2002) since 2001. The minimum flows have ranged from 0.15 (2008) to 0.98 (2002) cfs and the maximum discharge varies between 140 (2001) and 342 (2002) cfs.

Springbrook Creek

Springbrook Creek is a 12-mile-long tributary of the Green River. Springbrook Creek becomes the Black River 0.7 miles from its confluence with the Green at RM 11.0. The Creek drains an area of 15,763 acres and has a variety of land covers from urbanized to lightly developed. USGS gauge 12113346 is located 1.2 miles upstream from Springbrook's confluence with Mill Creek just upstream from 84th Ave. King County gauge 03g is located on lower Springbrook Creek 1.3 miles from the drainage to the Green River and just downstream of Grady Way.

USGS gauge 12113346 had a yearly mean flow between 8.0 (2009) and 11.2 (2007) cfs between 2001 and 2009 and the minimum flows ranged from 0.52 (2003) to 1.7 (2002) cfs. The maximum flows have ranged between 130 (2003) and 397 (2007) cfs.

King County Gauge 03g was active from 2002–2005 and then again in 2011. All of the years that were active still have data gaps (other than 2003) that have considerable effects on the summary statistics.

Joe's Creek

Joes Creek is a stream located in the southern portion of WRIA 9 near the King/Pierce county line. The drainage area is estimated at 1,541 acres and the creek receives flows from both Lakes Lorene and Jeane. The stream is 3.1 miles in length and drains into Dumas Bay (Puget Sound).

Des Moines Creek

Des Moines Creek is originates in the city of SeaTac and flows through Des Moines on its way to Puget Sound. The main stem of Des Moines creek is approximately 3.8 miles long with a western fork of 1.3 miles and an eastern fork of 0.9 miles for a combined length of 6 miles. The basin drains an area of 3,590 acres and flows through a very urbanized landscape. Gauge 11h is located on the outlet from Bow Lake and King County gauge 11c is located 0.9 mile downstream. Gauge 11g is sited on the western fork 0.2 miles upstream from its confluence with the main stem of Des Moines Creek. Gauge 11f is located approximately 500ft downstream of the confluence of the western fork and the main stem. Gauge 11d is situated 0.2 miles upstream from the mouth of the creek in Des Moines Beach Park.

Gauge 11h has maintained a yearly mean flow between 0.82 (2008) and 1.3 (2006) cfs since 2002. The minimum flow has run dry every year since 2002. The maximum discharge has run from 13.7 (2010) to 37.8 (2008) cfs.

King County gauge 11c has seen a range of mean flows from 1.5 (2005) to 2.6 (2004) cfs while the minimum discharge has stayed between 0.08 (2005) and 0.16 (2010) cfs and the instantaneous maximum varies from 77.2 (2010) to 155 (2004) cfs.

Gauge 11g began logging in 2002 then went offline until 2005 between 2005 and 2011 this station has logged a mean discharge between 1.6 (2008) and 2.7 (2007)cfs. The creek has run dry every complete year of record. The maximum flows have ranged from 20.1 (2010) to 116 (2008) cfs.

Since 2002 gauge 11f has maintained a mean yearly flow between 2.9 (2005) and 5.5 (2007) cfs. The minimum flow has ranged between dry (2004–2007) and 0.07 (08-10) cfs. The maximum flow ranges from 50.6(2010) and 316 (2004) cfs.

Gauge 11d is the located near the mouth of Des Moines Creek and has run every year since 2002. The mean flows have maintained an average between 5.2 (2005) and 8.2 (2002) cfs. The minimum discharge have ranged from 0.4 (2005, 2007) to 0.73 (2002) cfs while the maximum flows have stayed between 98.5 (2010) and 477(2004) cfs

Walker Creek

Walker Creek basin is located just west of Sea-Tac airport. The basin drains an area of 918 acres and is 2.4 miles in length. The creek merges with Miller Creek approximately 400 ft from Puget Sound and drains into the bay. King County gauge 42k is located near the headwaters of Walker Creek below Hwy 509.

Gauge 42k has maintained a mean yearly flow between 0.20(2008) and 0.31(2010) every year since 2007. The minimum flow has averaged between 0.01(2007, 2009-11) and 0.02(08) cfs and the maximum instantaneous yearly flow ranged from 2.3(2010) to 10.1(2008) cfs.

Miller Creek

Miller Creek is located immediately north of the Walker Creek basin. It drains portions of Sea-Tac airport as well as areas located in Burien. The creek is 5.4 miles long and drains an area of approximately 4,756 acres. It is located in a highly urbanized environment and converges with Walker Creek before flowing in to Puget Sound. King County gauge 42b is located just south of state route 518 at the Miller Creek detention facility. This gauge is sited approximately 3.8 miles for the mouth of the Creek. Gauge 42j is located on the east side of Hwy 509 and is 2.5 miles from the mouth. Gauge 42a is the lowest on the creek just 0.4 miles from its discharge to the Sound.

Gauge 42b has maintained a mean yearly flow between 1.3 (2005) and 3.3 (2002) since 2002. The instantaneous minimum has been between 0 (dry in 2003–2006) and 0.22 (2007) cfs while the instantaneous maximum ranged from 21.6 (2005) to 107 (2004) cfs.

King County gauge 42j has been active since 2007. Since that time it has maintained an average yearly mean flow between 3.1 (2008) and 5.2 (2007) cfs. The instantaneous minimum discharge has ranged from 0.25 (2008, 2009) and 0.36(2010) cfs while the maximum instantaneous flow have stayed between 40.7 (2010) and 125 (2008) cfs.

Gauge 42a is located closest to the mouth of Miller Creek and has maintained a mean yearly discharge of 5.1 (2005) to 9.9 (2007) cfs. The instantaneous minimum discharge remained between 0.82 (2007–2008) and 1.5 (2010).The instantaneous maximum flow ranged from 164 (2005) to 296 (2004) cfs.

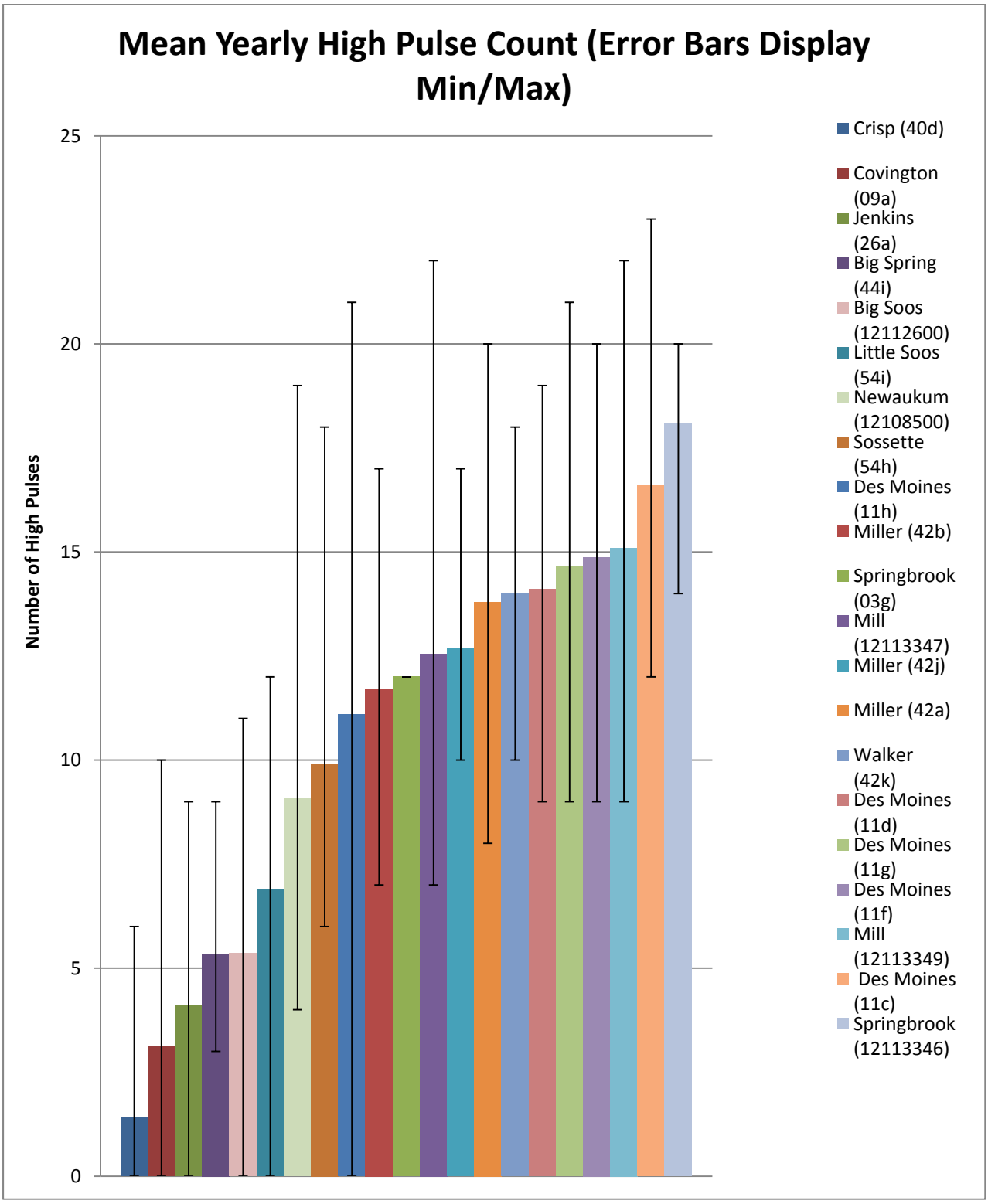

Figure 4. Bar chart showing the mean yearly high pulse count and the maximum and minimum values for each stream summarized in this report.

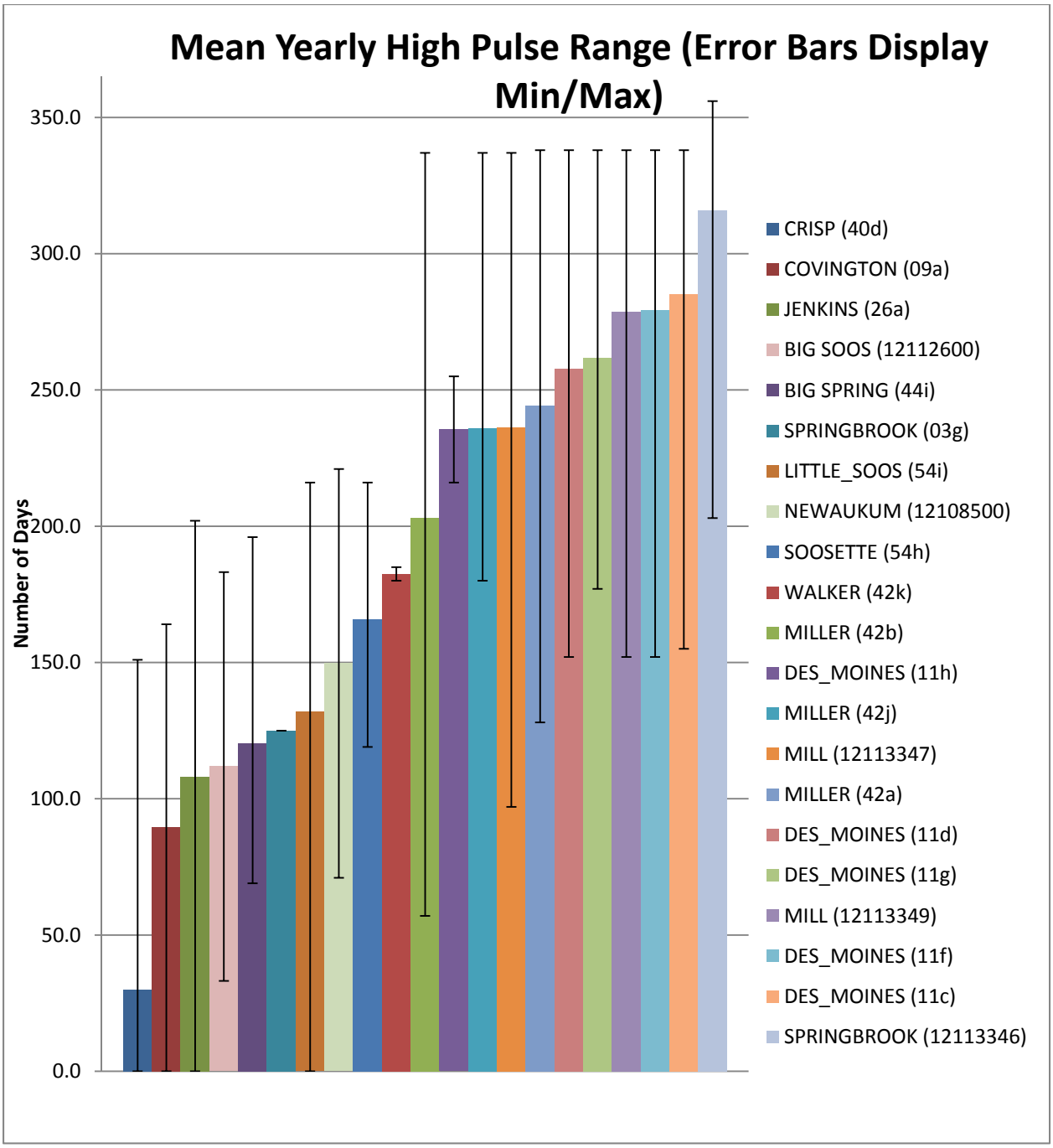

Figure 5. Bar chart showing the mean yearly high pulse range and the maximum and minimum values for each stream.

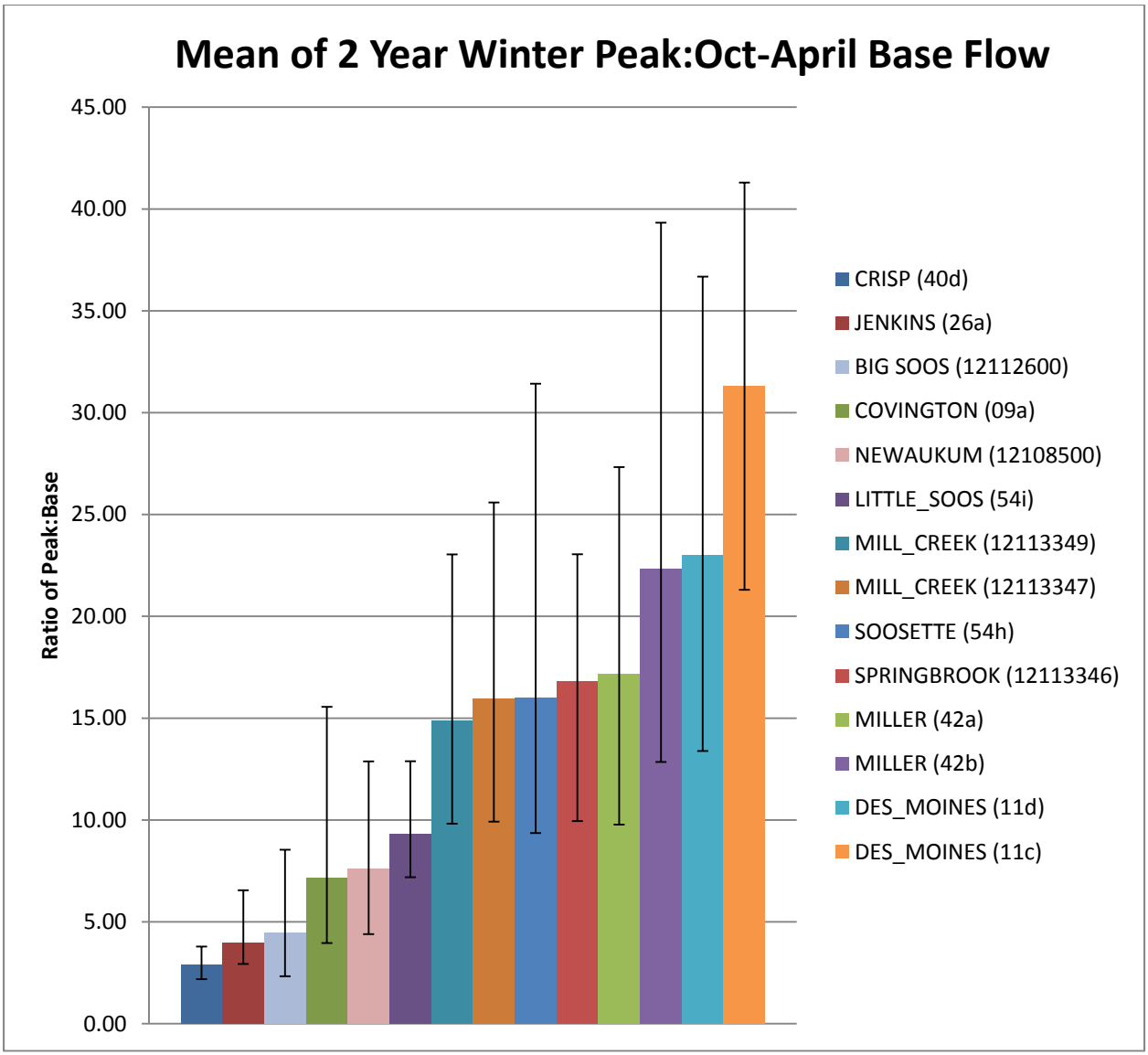

Figure 6. Bar chart showing the mean ratio of winter peak flow to Oct-Apr base flow.

***Not all streams are shown in this graph due to the lack of continuous data needed to create statistic.**

2.2 Turbidity

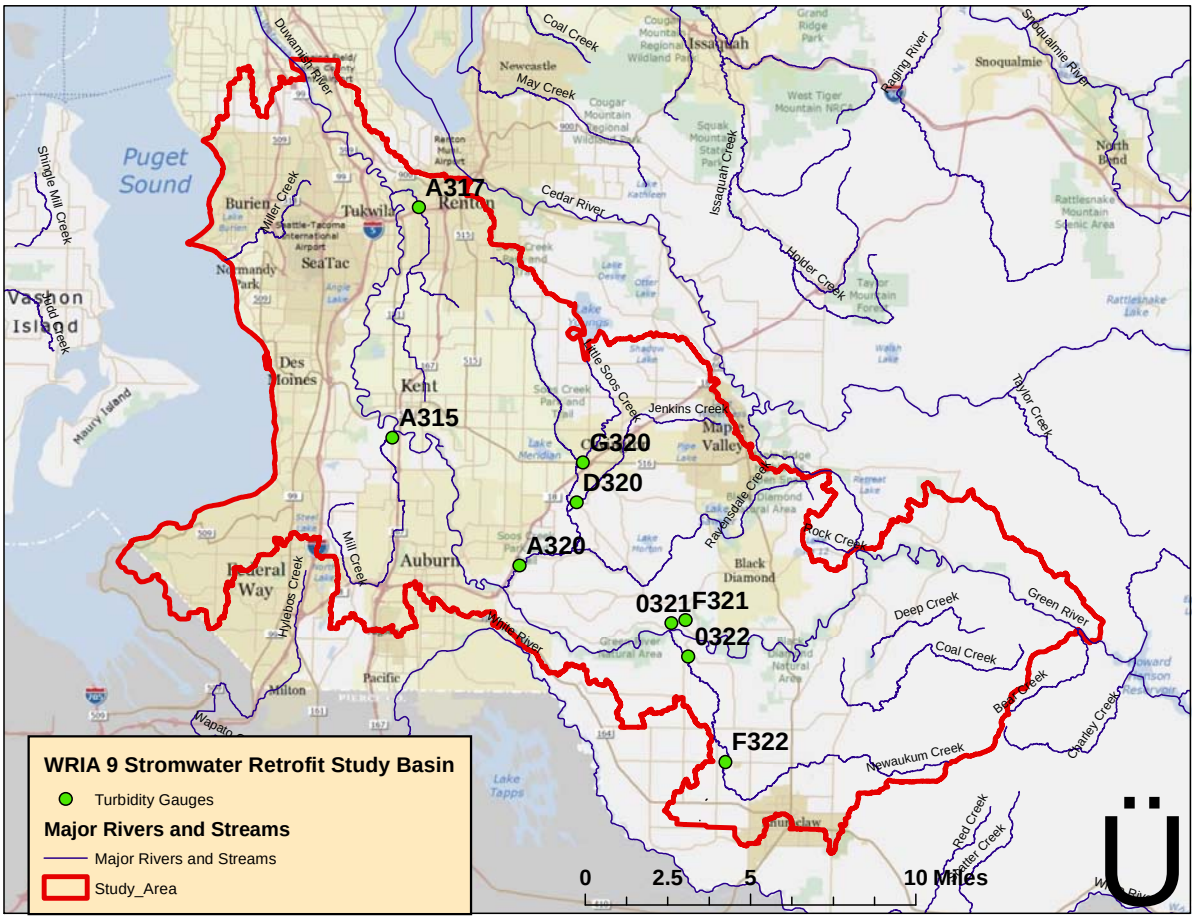

Figure 7. Map showing the locations of turbidity sensors in the WRIA 9 Stormwater Retrofit study

Newaukum Creek

Newaukum Creek has two historical water quality sampling locations. Site F322 is located approximately 5 miles upstream from Newaukum creeks discharge into the Green River. The site is located near 416th st in Enumclaw (Figure 7). From 3/18/2001 until 8/6/2012 there have been 192 turbidity samples taken at this location. Mean NTU was 9.3 with a max of 213 NTU and a min of 0.66 NTU (Figure 8).

Site O322 is located at approximate river mile 1.0 on Newaukum Creek. Between 1/9/2001 and 12/10/2003, 35 turbidity samples were taken with a mean of 3.4 NTU, a maximum NTU of 12.3 and a minimum of 0.75 NTU.

Crisp Creek

Crisp Creek (described in the previous section) has two King County water quality sampling locations. Site F321 is located 1.4 miles up Crisp Creek west of 212th Ave SE. Between 10/14/2002 and 12/3/2008 there have been 99 measurements made at this location. The mean turbidity was 1.1 NTU with a minimum sample of 0.21 NTU and a maximum of 5.1 NTU

Sample location O321 is sited 0.9 miles from Crisp Creek's drainage to the Green River. Between 10/14/2002 and 12/3/2008, 90 samples were collected at this location. The mean turbidity sample was 2.8 NTU while the minimum value was 0.52 NTU and the maximum 24.9 NTU.

Little Soos Creek

Water quality sampling site G320 is located on Little Soos Creek 0.3 miles upstream from its confluence with Soos Creek. Between 10/14/2002 and 12/13/2008 79 samples were collected at this location. The mean sample value was 2.1 NTU while the minimum value was 0.76 NTU and the maximum reading was 5.2 NTU.

Jenkins Creek

Jenkins Creek is a tributary to Big Soos Creek. Station D320 is located just upstream from Jenkins confluence with Big Soos Creek near Kent-Black Diamond Road. Between 1/9/2001 and 8/6/2012 104 samples have been taken at this location with a mean value of 1.4 NTU, a maximum value of 3.6 NTU and a minimum of 0.52 NTU.

Soos Creek

Soos Creek has water quality station A320 located 1.2 miles upstream of the drainage to the Green River. Between 10/14/2002 and 12/3/2008, 108 samples were taken at this location with a mean value of 4.4 NTU, a minimum value of 0.51 NTU, and a maximum value of 85.3 NTU.

Mill Creek

Station A315 is located on Mill Creek approximately 0.25 miles upstream from its discharge to the Green River. This station has taken 129 turbidity samples between 1/9/2001 and 12/3/2008. The mean value of these samples is 10.0 NTU with a maximum of 38.2 NTU and a minimum value of 1.3 NTU.

Springbrook Creek

Sampling site A317 is located at RM 1.26 of Springbrook Creek. 35 sampling events occurred between 10/22/2002 and 11/19/2003. The mean value of these samples is 20.4 NTU while the minimum value is 5.7 NTU and the maximum is 61.1 NTU.

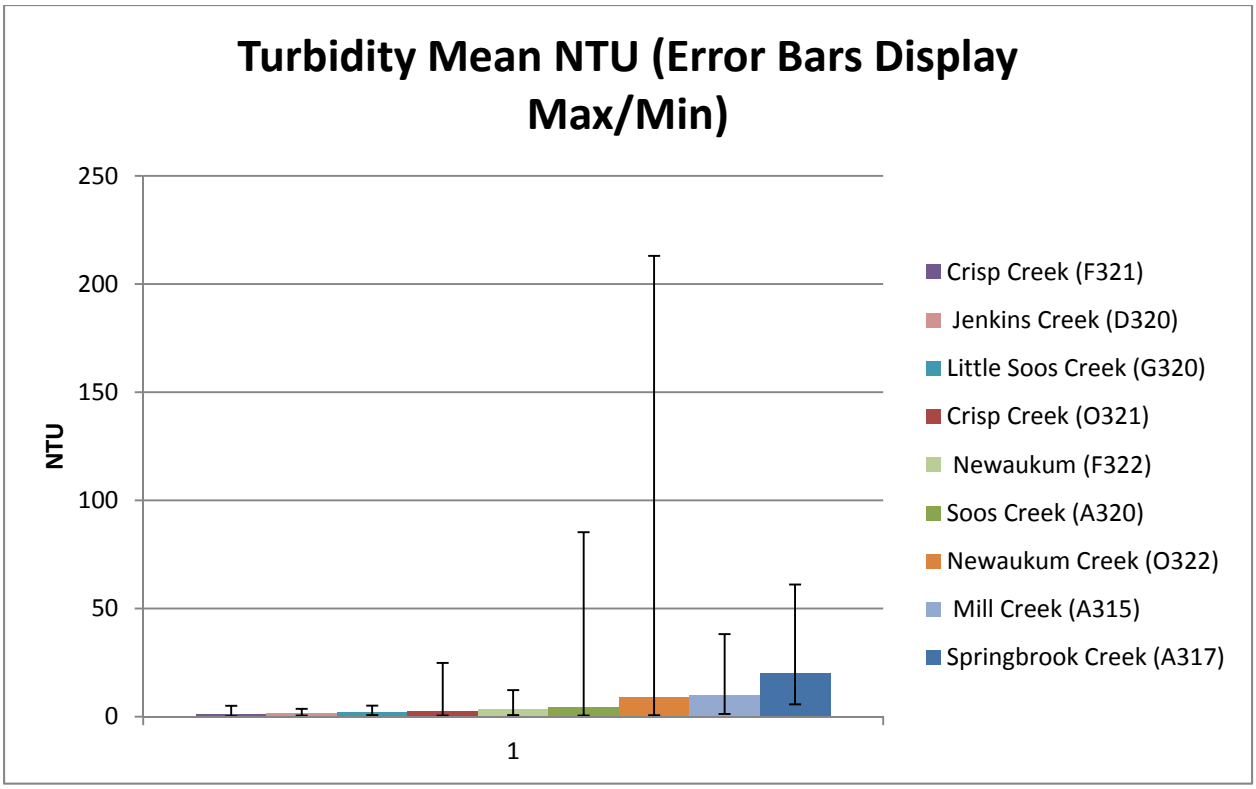

Figure 8. Bar chart showing the mean, maximum and minimum turbidity at the nine stations historically monitored in the WRIA 9 study area.

2.3 TSS

Historically TSS data have been collected at 12 locations which have been described in previous sections (figure 9)

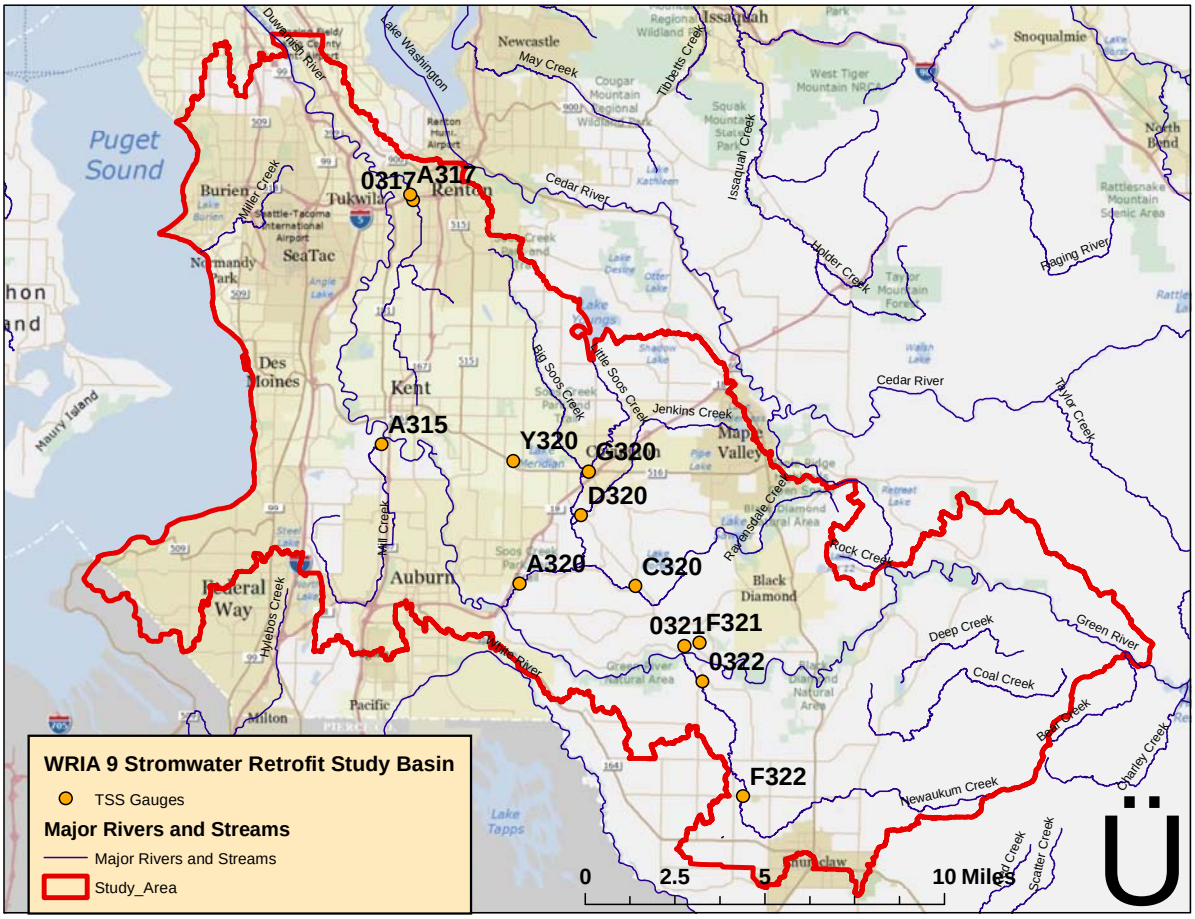

Figure 9. Map of locations collecting TSS data in the WRIA 9 study area.

Newaukum Creek

Newaukum Creek has 2 water quality stations (figure 9) that have historically collected data (both described in prior sections) Site F322 collected 35 TSS samples between 1/9/2001 and 12/10/2003. These samples had a mean value of 3.8 mg/L, a maximum value of 10.5 mg/L and a minimum of 1.1 mg/L (figure 10).

O322 collected 245 TSS samples between 1/9/2001 and 8/6/2012. Of those samples the mean value was 12.6 mg/L while the maximum value was 504 mg/L and the minimum was 0.7 mg/L.

Crisp Creek

Crisp Creek has two water quality stations that gather TSS data. Both of these sites are described in the flow section.

Station F321 has collected TSS samples 95 times between 10/14/2002 and 4/25/2011. Of these samples, the mean was 1.6 mg/L while the minimum value was 0.5 mg/L and the maximum was 8.2 mg/L.

90 samples have been taken at King County station O321 between 10/14/2002 and 12/3/2008. These samples have a mean value of 7.5 mg/L. The minimum sample value is 1.0 mg/L while the maximum value is 84.8 mg/L

Covington Creek

Covington Creek site C320 is located 2.2 miles upstream from Covington Creek's confluence with Big Soos Creek.

Station C320 has collected 88 TSS samples from 10/14/2002 through 12/3/2008. The mean value for these samples is 1.8 mg/L while the minimum is 0.5 mg/L and the maximum is 4.3 mg/L.

Jenkins Creek

Water quality location D320 also collects TSS data (described in prior sections). Between 10/14/2002 and 8/1/2011 there were 117 TSS samples collected at this site. The mean of these samples was 2.7mg/L while the maximum was 8.7mg/L and the minimum was 0.6mg/L.

Little Soos Creek

Site G320 is located on Little Soos Creek (described in previous section) and has collected 78 samples between 10/14/2002 and 12/3/2008. The mean sample value for that time was 3.2 mg/L while the minimum value was 0.73 mg/L, and the maximum sample value was 7.4mg/L.

Soos Creek

Site A320 (previously described) collected 199 TSS samples between 1/9/2001 and 8/6/2012. The mean value of these samples was 10.3 mg/L. the maximum value was 347 mg/L and the minimum was 1.0 mg/L.

Soosette Creek

Station Y320 is located on Soosette Creek west of Lake Meridian 4.3 miles upstream from Soosette's discharge into Big Soos Creek. Between 12/3/2002 and 11/18/2003, 15 samples were taken at this location (Y320). The mean of these samples is 4.3 mg/L while the minimum value is 1.4 mg/L and a maximum value of 8.0 mg/L.

Mill Creek

Site A315 (previously described) collected 138 TSS samples between 1/9/2001 and 3/29/2012. The mean of these samples was 10.6 mg/L while the maximum was 67 mg/L and the minimum was 1.1 mg/L.

Springbrook Creek

Springbrook Creek has two water quality sampling locations on it. Site O317 is located 1.4 miles upstream from the discharge into the Green River while site A317 is located 1.3 miles upstream from the confluence. Sampling site O317 was sampled 132 times between 10/14/2002 and 8/1/2011. The mean value for the samples is 8.9 mg/L while the minimum is 2.1 mg/L and the maximum is 79.8 mg/L. Location A317 was sampled 35 times from 10/22/2002 to 11/19/2003. These samples resulted in a mean value of 27.5 mg/L, a minimum value of 2.8 mg/L and a maximum value of 118 mg/L.

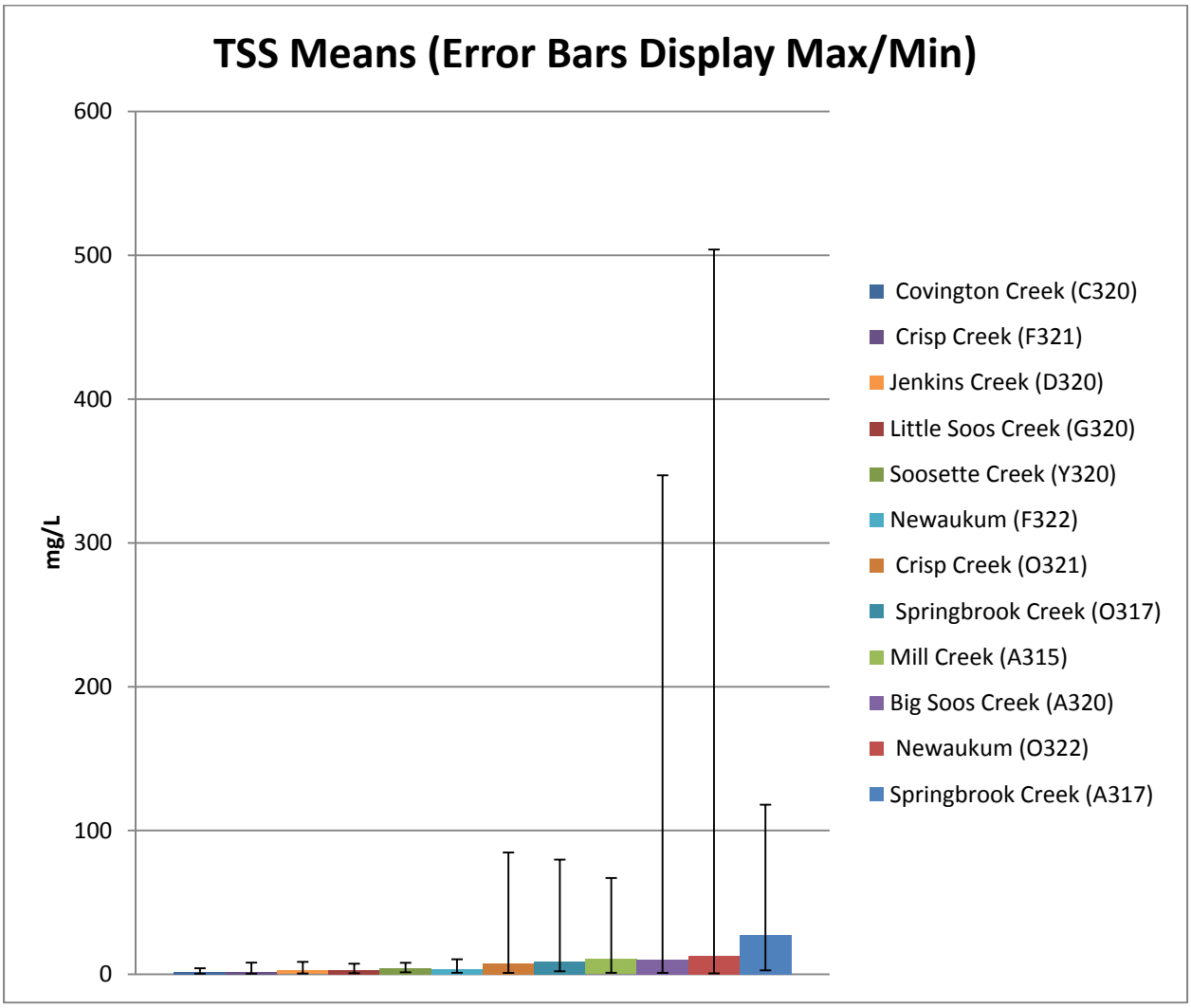

Figure 10. Bar chart of TSS means, maximums and minimums at the 7 locations monitored in the WRIA 9 study area.

3.0 Summary

The stream data summarized in this report present a wide variety of land cover and uses across WRIA 9. Big Spring and Crisp creeks represent basins with low levels of urbanization (single family homes and agricultural production) while basins like Des Moines and Miller Creeks have a much more developed land cover. The graphs and descriptions included in the report suggest what many others have already reported. Basins representing minimal impervious development respond with fewer High Pulse Counts (Figure 4), lower High Pulse Range (Figure 5) and a lower 2-YR Peak: Oct–Apr Base Flow ratio (Figure 6) (Crisp Creek, Big Spring Creek). While more developed basins (Des Moines, Miller and Springbrook) tend to have a greater number of high pulses, high pulse range and 2-YR Peak:Oct-Apr Base Flow ratios.

TSS and turbidity are also generally higher in more developed basins and lower in less developed basins. Streams located in basins with the lowest amounts of impervious surface tend toward a lower mean TSS value (Figure 10) (Crisp Creek's mean TSS 1.64 mg/L and a max of 8.2 mg/L) while more densely urbanized streams have much higher TSS values (Springbrook station A317 has a mean TSS value of 27.5mg/L and a maximum value of 118 mg/L). Turbidity values follow the same pattern (Figure 8) with Springbrook Creek, having a mean turbidity reading of 20.3 NTU and a maximum of 61.1 NTU while Crisp Creek has a mean value of 1.1 NTU and a maximum of 5.5 NTU.

4.0 References

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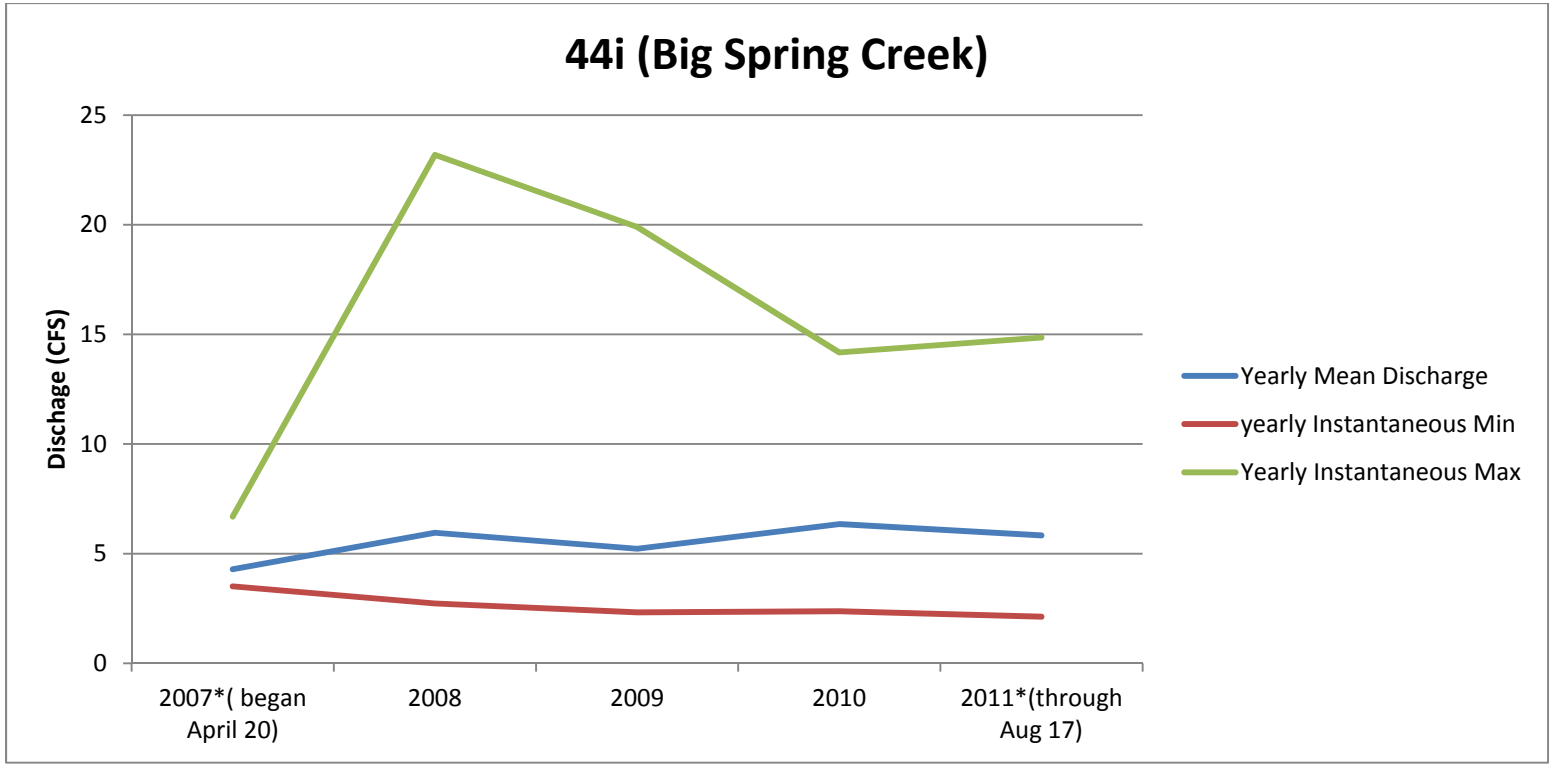
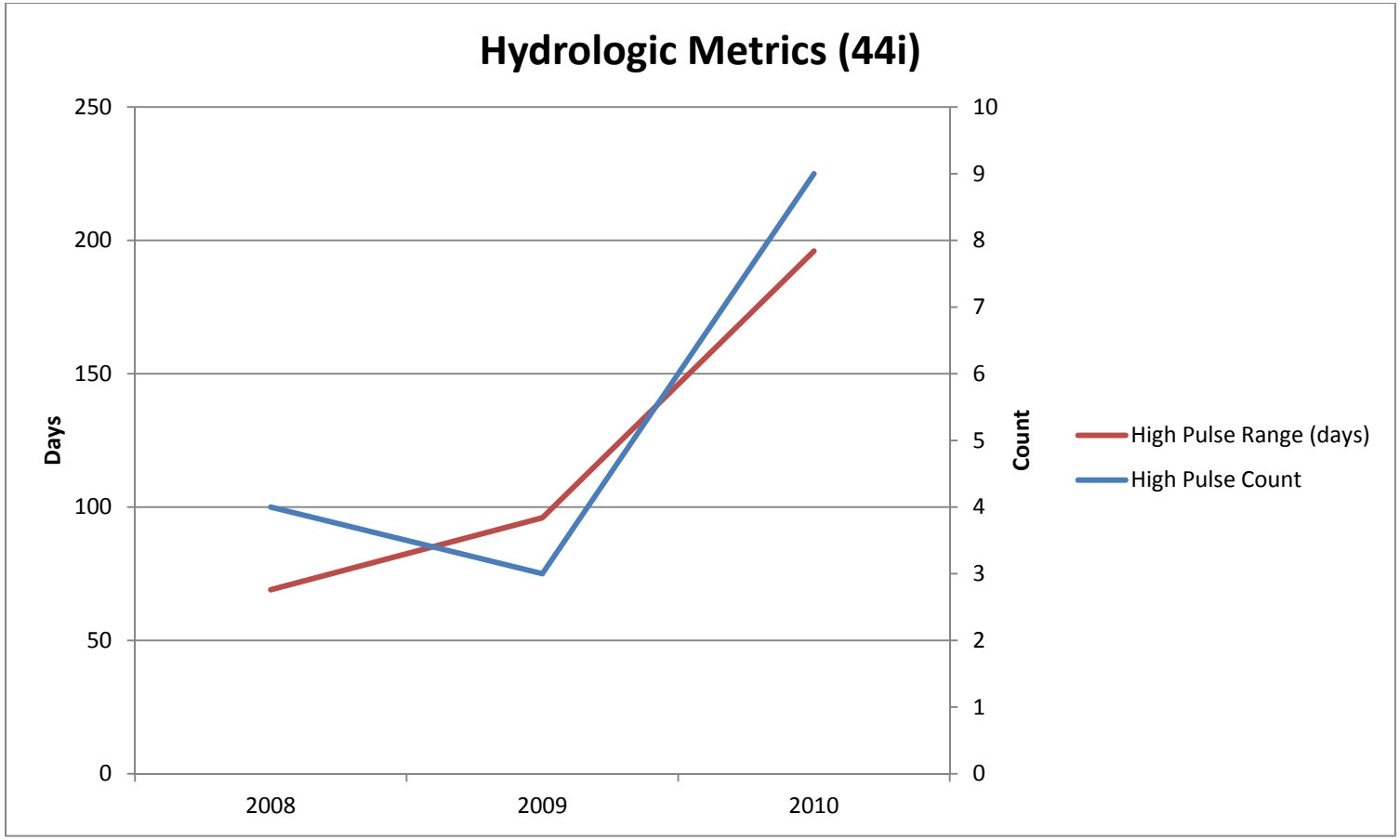
by Jim Simmonds, King County Department of Natural Resources and Parks, Water and Land Resources Division, Seattle, Washington.

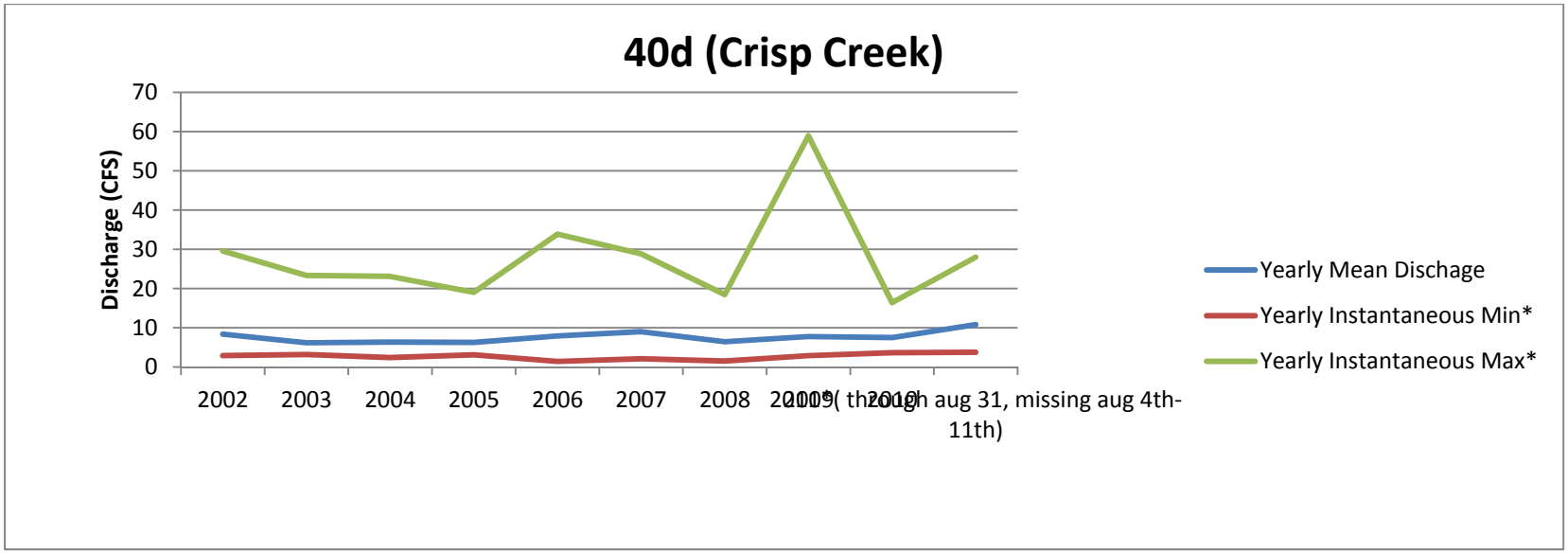
Appendix

Flow tables and graphs

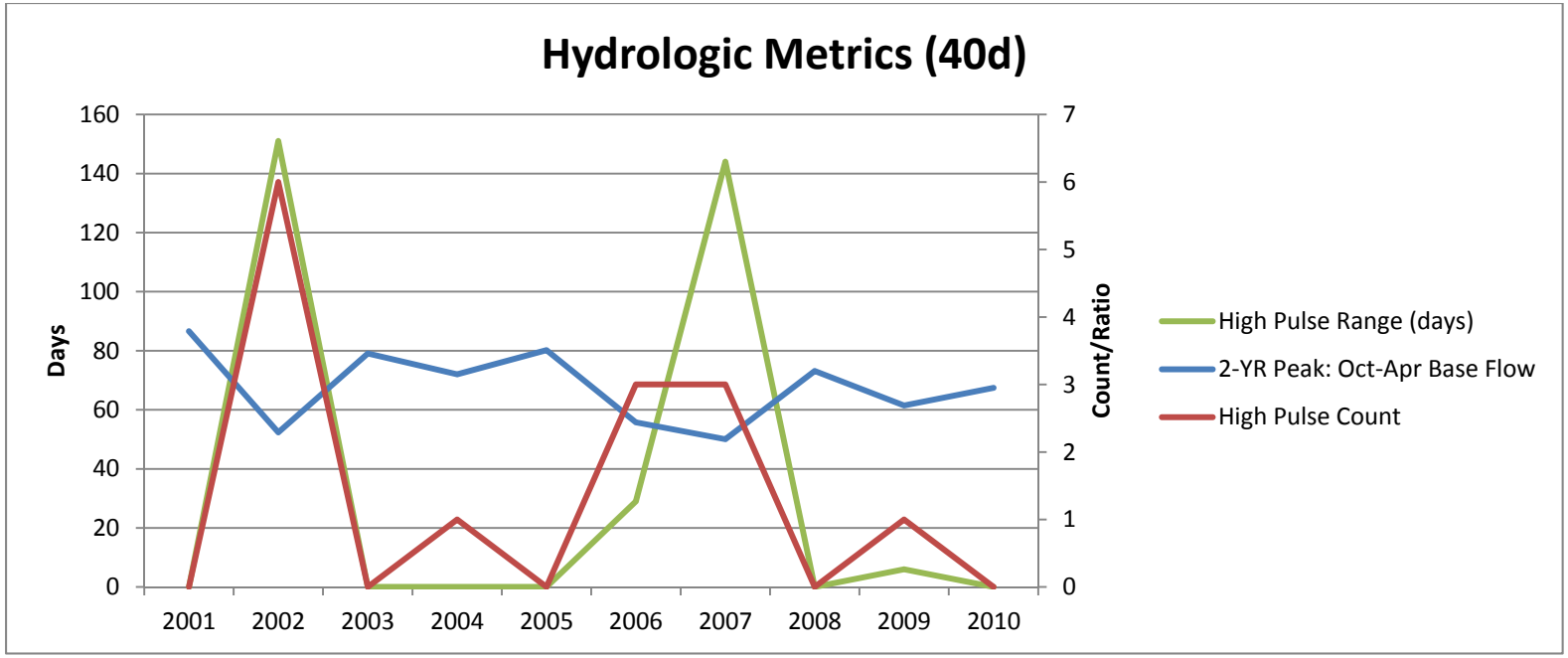


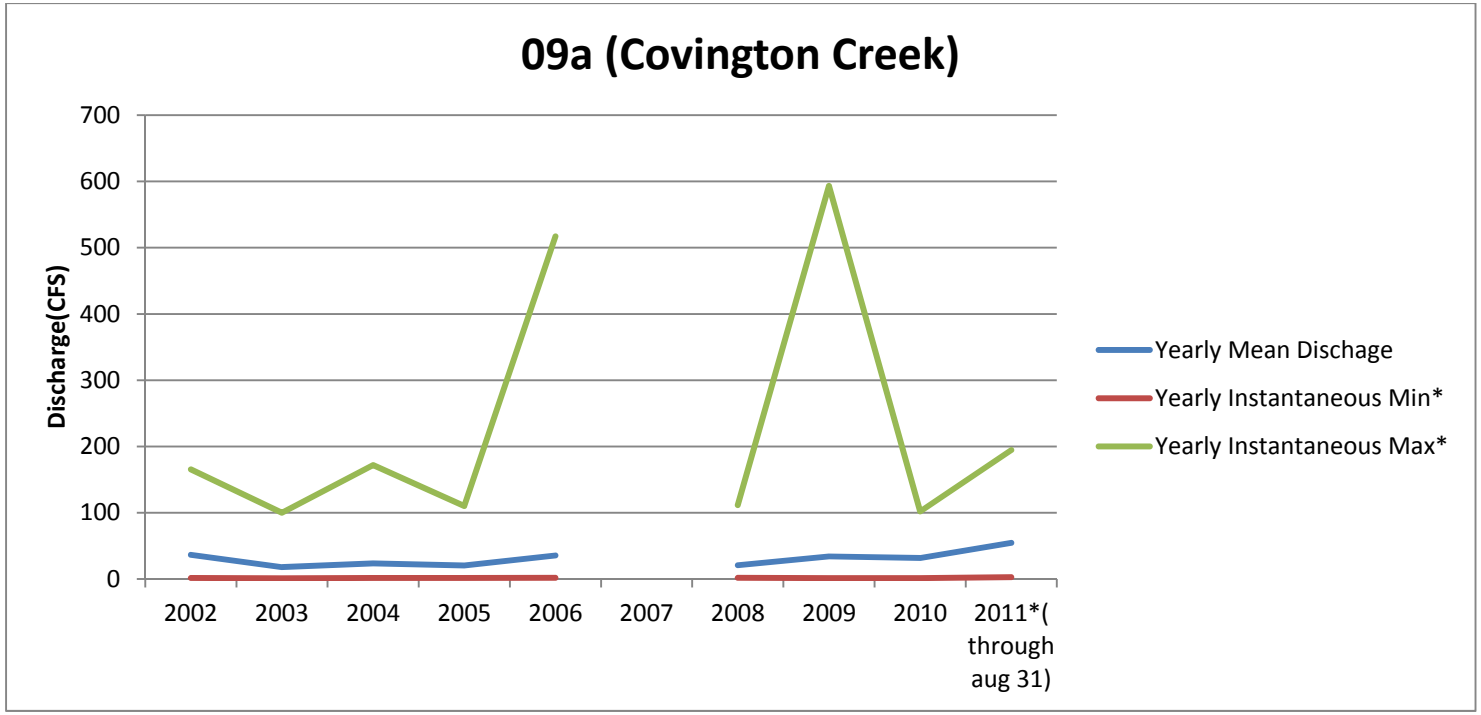
44i Big Spring Creek	2002	2003	2004	2005	2006	2007*(began April 20)	2008	2009	2010	2011*(through Aug 17)
Yearly Mean Discharge						4.2	5.9	5.2	6.3	5.8
Yearly Instantaneous Min*						3.5	2.7	2.3	2.3	2.1
Yearly Instantaneous Max*						6.6	23.1	19.9	14.1	14.8


Hydrologic Metrics (44i)
Days
Count
250
200
150
100
50
0
10
9
8
7
6
5
4
3
2
1
0
2008
2009
2010
High Pulse Range (days)
High Pulse Count

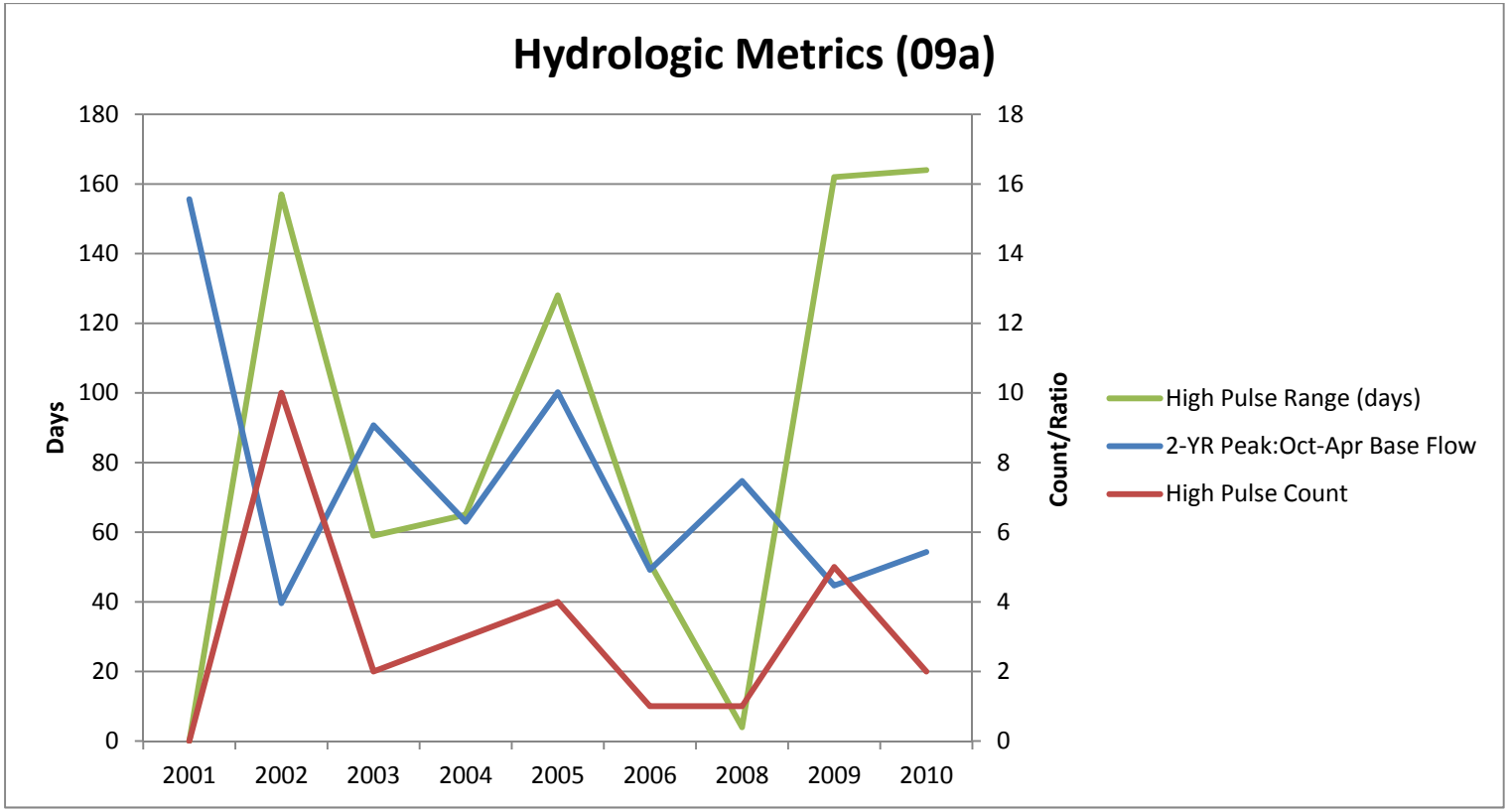


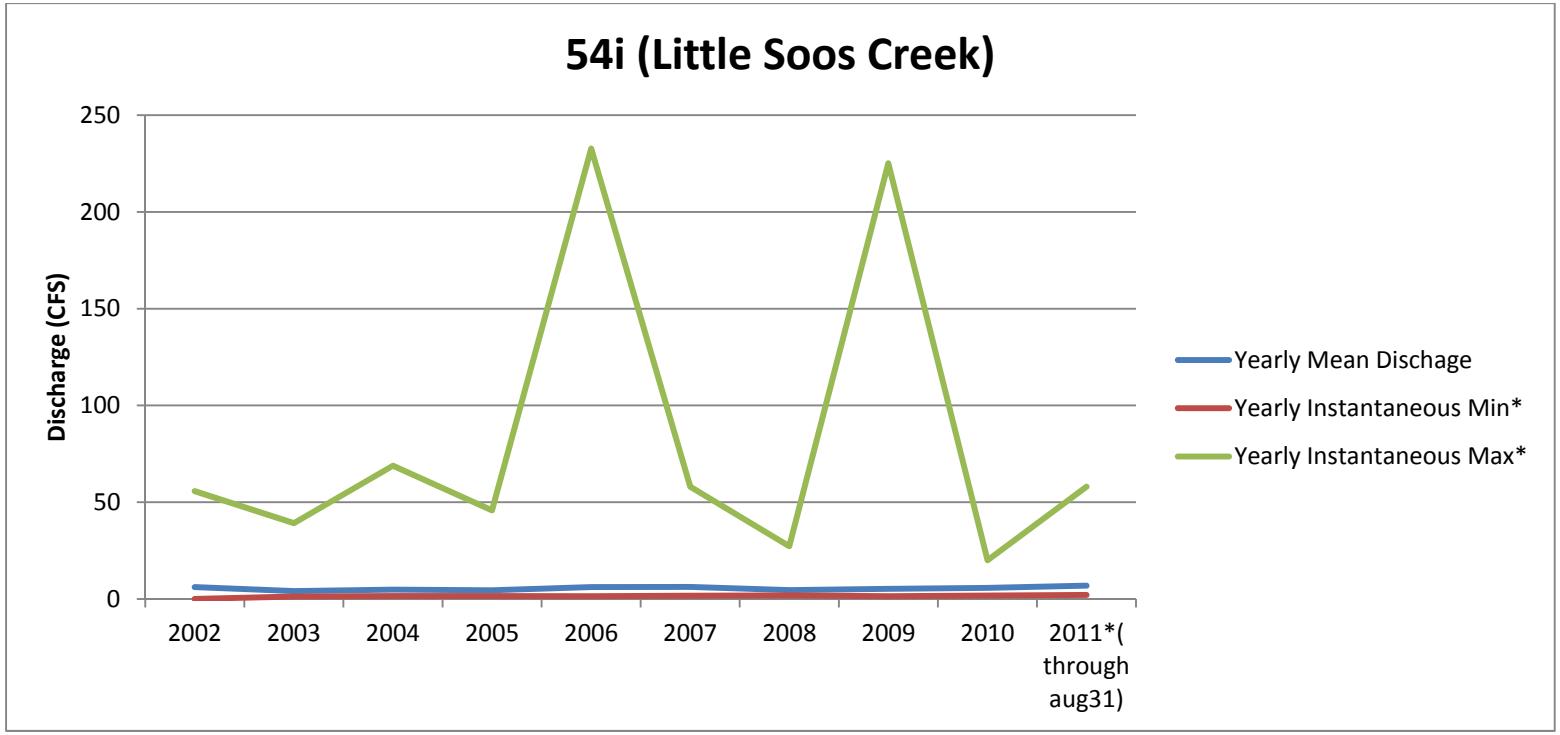
40d Crisp Creek	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011*(through Aug 31, missing Aug 4-11)
Yearly Mean Discharge	8.3	6.1	6.3	6.2	7.9	8.9	6.4	7.7	7.4	10.8
Yearly Instantaneous Min*	2.9	3.1	2.3	3.1	1.4	2.1	1.5	2.9	3.6	3.7
Yearly Instantaneous Max*	29.5	23.3	23.0	19.0	33.8	28.8	18.4	58.9	16.4	28.0


Hydrologic Metrics (40d)
Days
Count/Ratio
160
140
120
100
80
60
40
20
0
7
6
5
4
3
2
1
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
High Pulse Range (days)
2-YR Peak: Oct-Apr Base Flow
High Pulse Count

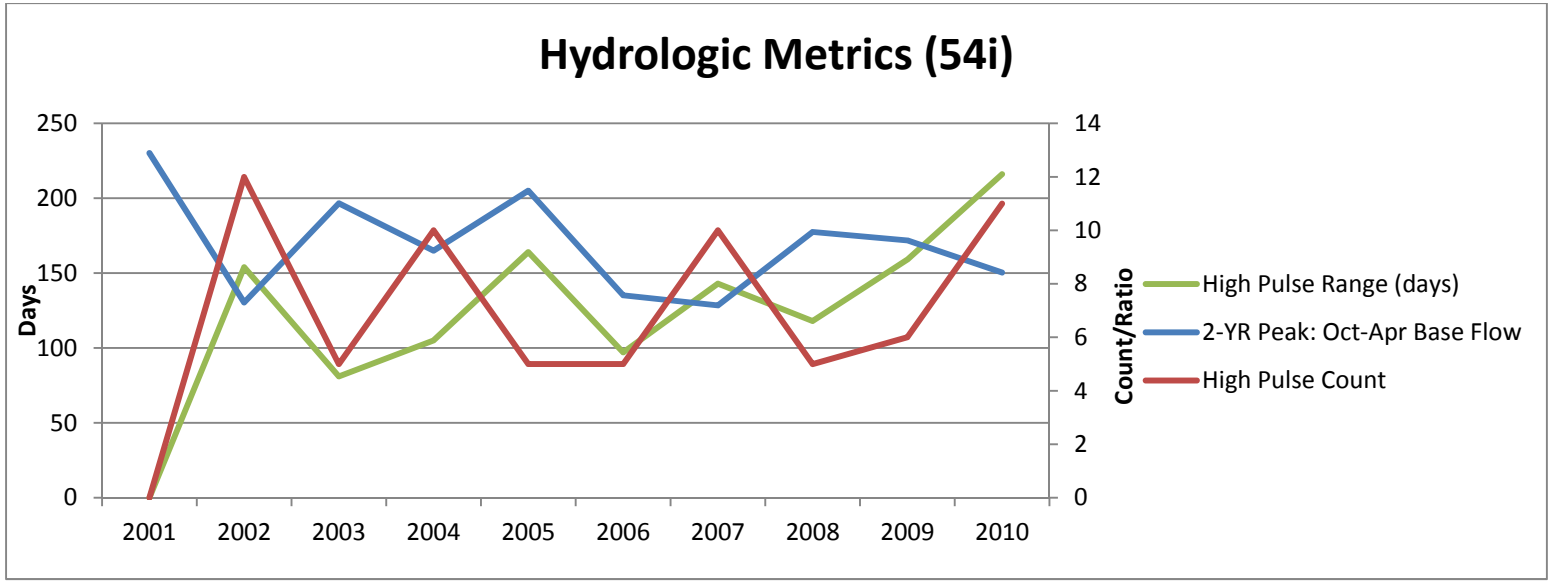


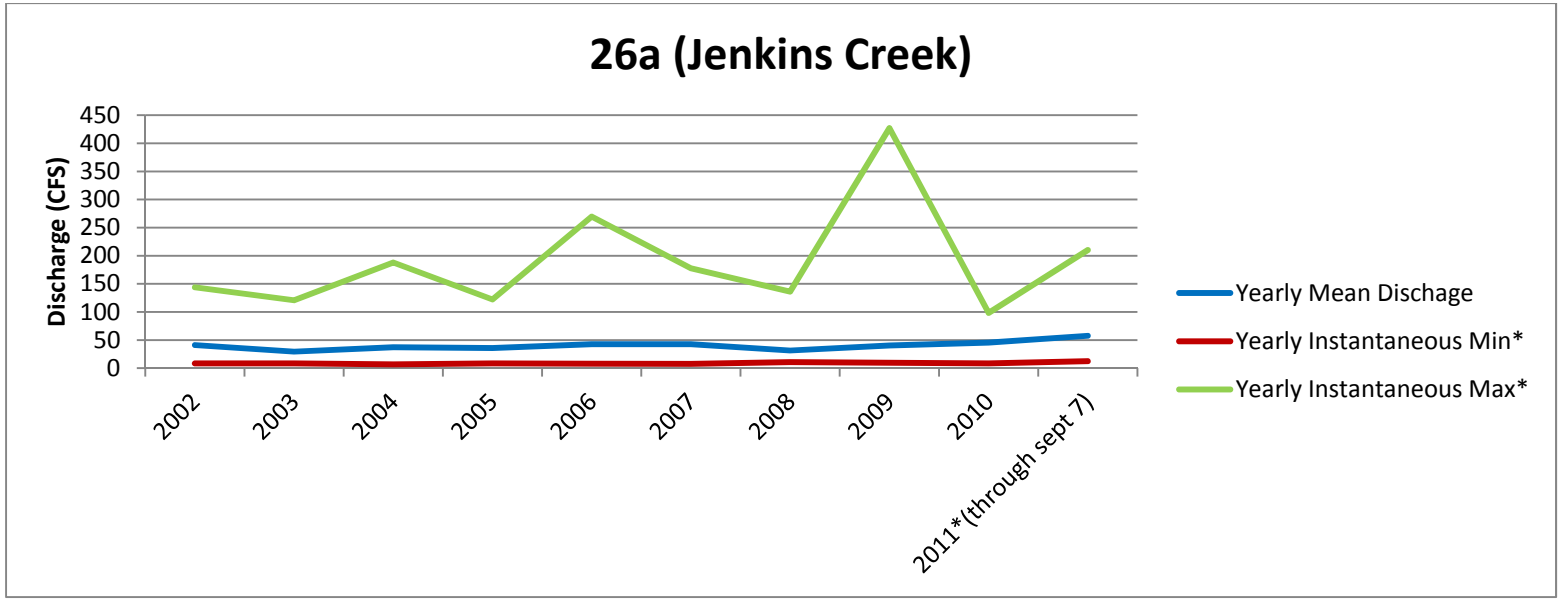
09a Covington Creek	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011*(through aug 31)
Yearly Mean Discharge	36.4	17.7	23.3	20.3	35.5		20.7	34.0	31.6	54.5
Yearly Instantaneous Min*	1.5	0.92	1.4	1.5	1.5		1.6	1.1	1.1	2.6
Yearly Instantaneous Max*	165	100	172	110	517		111	593	101	194


Hydrologic Metrics (09a)
Days
Count/Ratio
180
160
140
120
100
80
60
40
20
0
18
16
14
12
10
8
6
4
2
0
2001
2002
2003
2004
2005
2006
2008
2009
2010
High Pulse Range (days)
2-YR Peak:Oct-Apr Base Flow
High Pulse Count

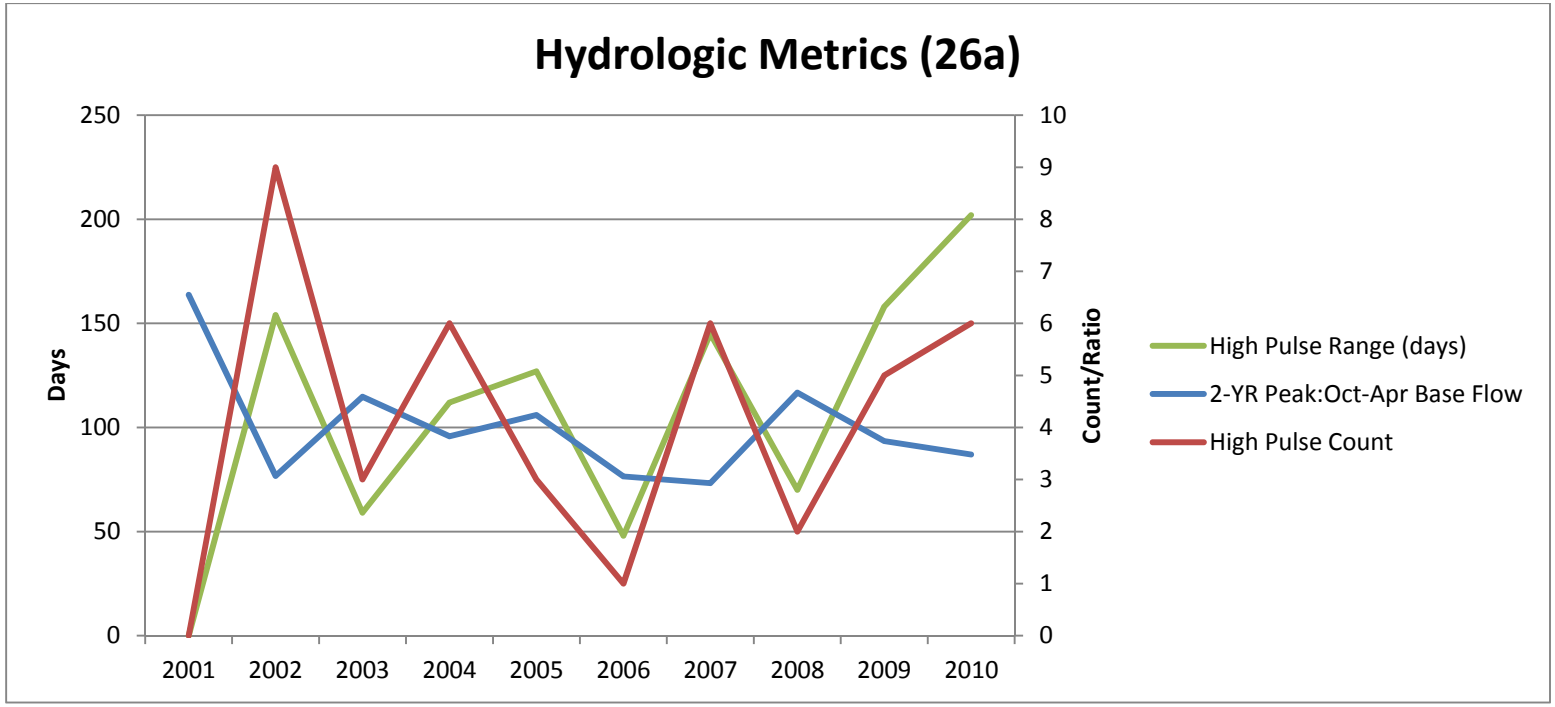


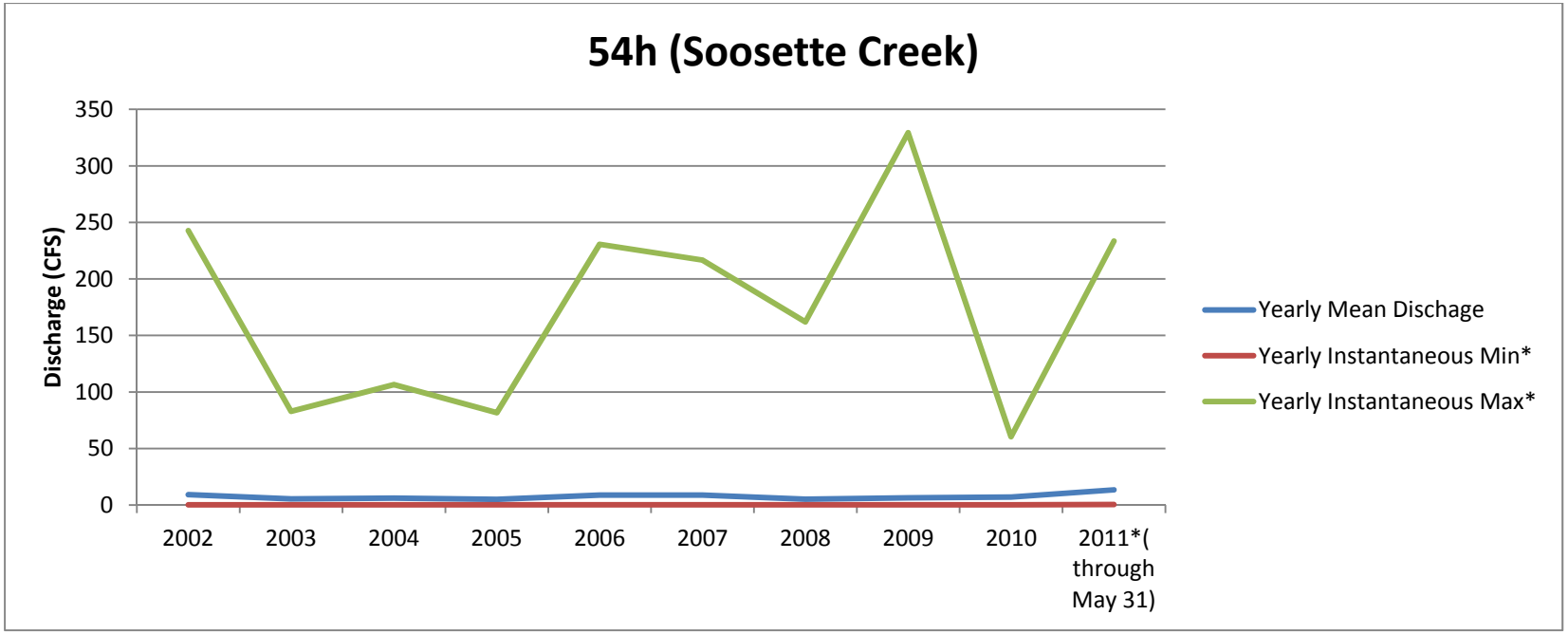
54i(Little Soos Creek)	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011*(through Aug31)
Yearly Mean Discharge	6.1	4.0	4.7	4.4	6.0	6.1	4.5	5.2	5.7	6.8
Yearly Instantaneous Min*	0	1.1	1.5	1.5	1.4	1.6	1.8	1.4	1.7	2.0
Yearly Instantaneous Max*	55.7	39.1	68.8	45.7	232	58.0	27.2	225	20.0	58.0


Hydrologic Metrics (54i)
Days
Count/Ratio
250
200
150
100
50
0
14
12
10
8
6
4
2
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
High Pulse Range (days)
2-YR Peak: Oct-Apr Base Flow
High Pulse Count

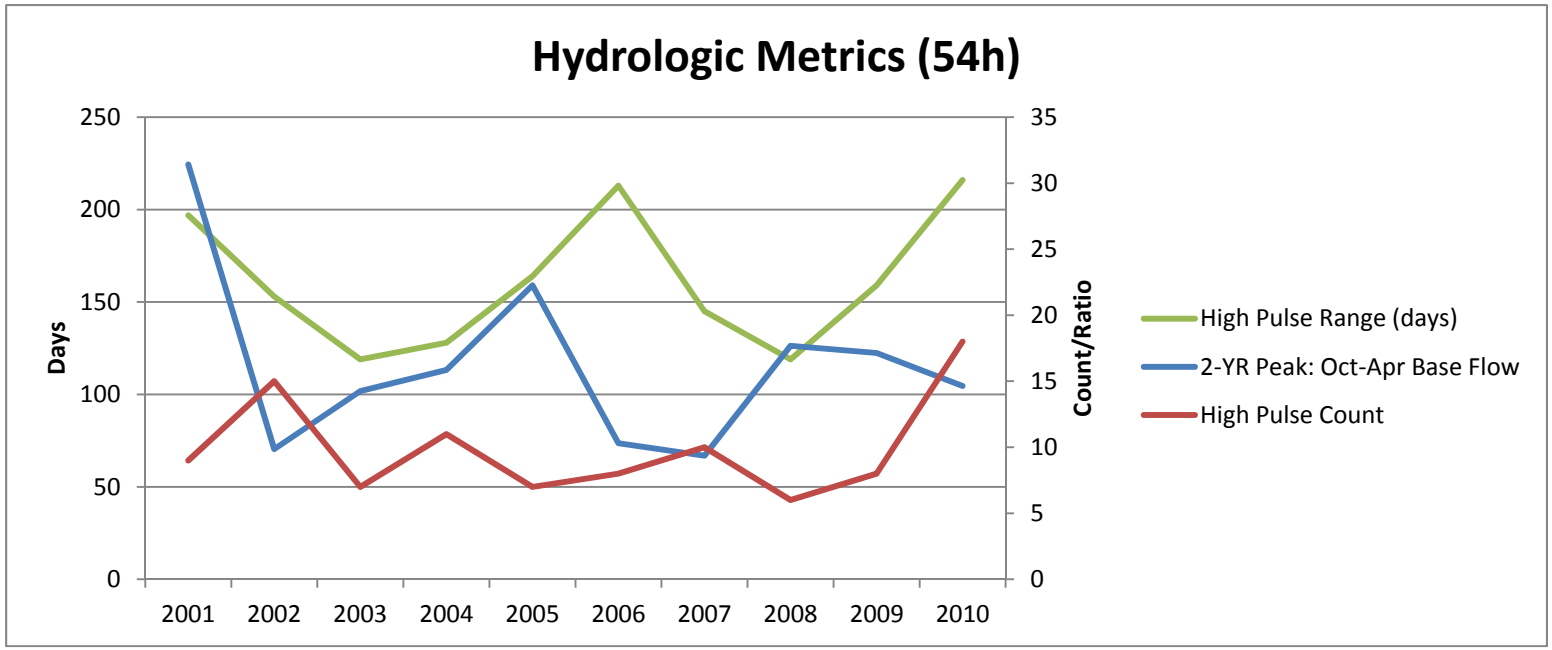


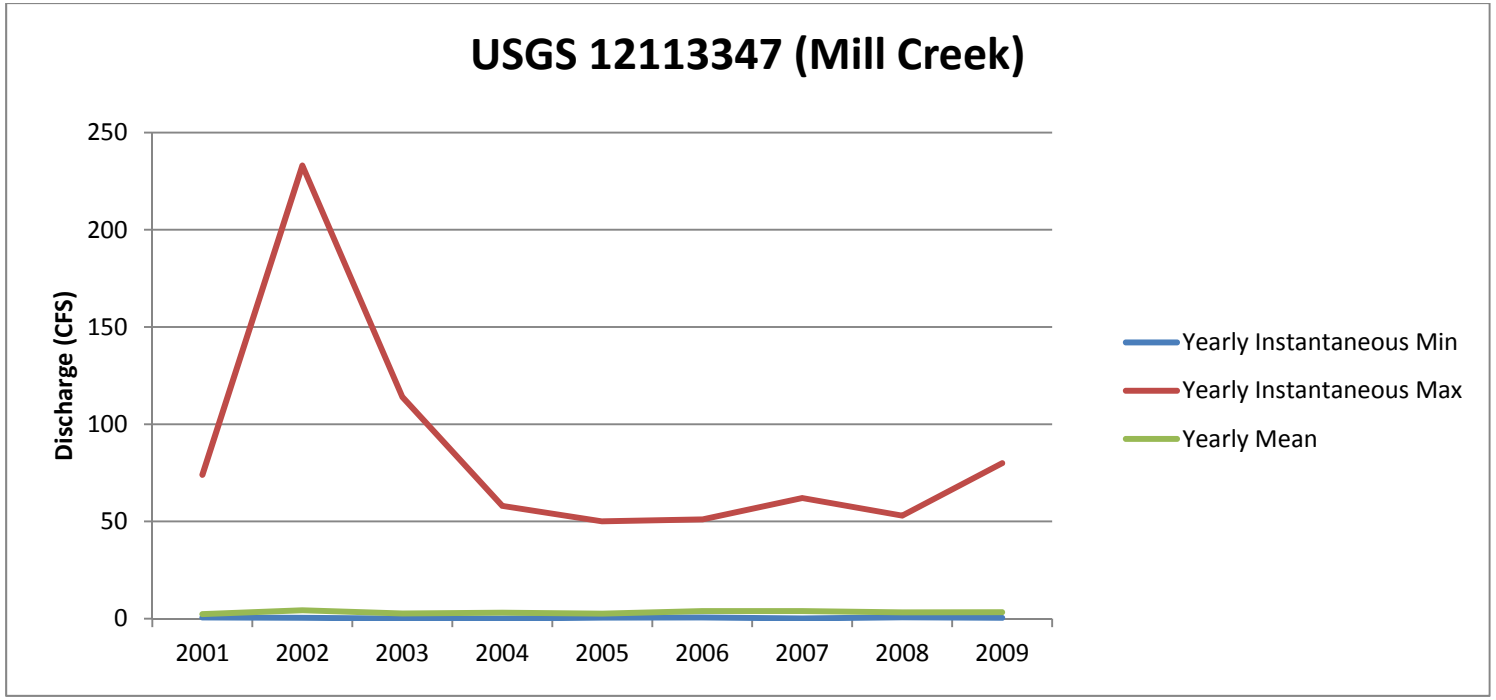
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011*(through Sept 7)
Yearly Mean Discharge	41.1	29.4	37.0	35.7	42.5	42.6	31.3	40.2	45.3	57.6
Yearly Instantaneous Min*	8.2	8.2	6.5	8.2	7.8	7.4	10.7	9.3	8.4	12.4
Yearly Instantaneous Max*	144	121	188	122	270	178	136	427	98.4	210


Hydrologic Metrics (26a)
Days
Count/Ratio
250
200
150
100
50
0
10
9
8
7
6
5
4
3
2
1
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
High Pulse Range (days)
2-YR Peak:Oct-Apr Base Flow
High Pulse Count

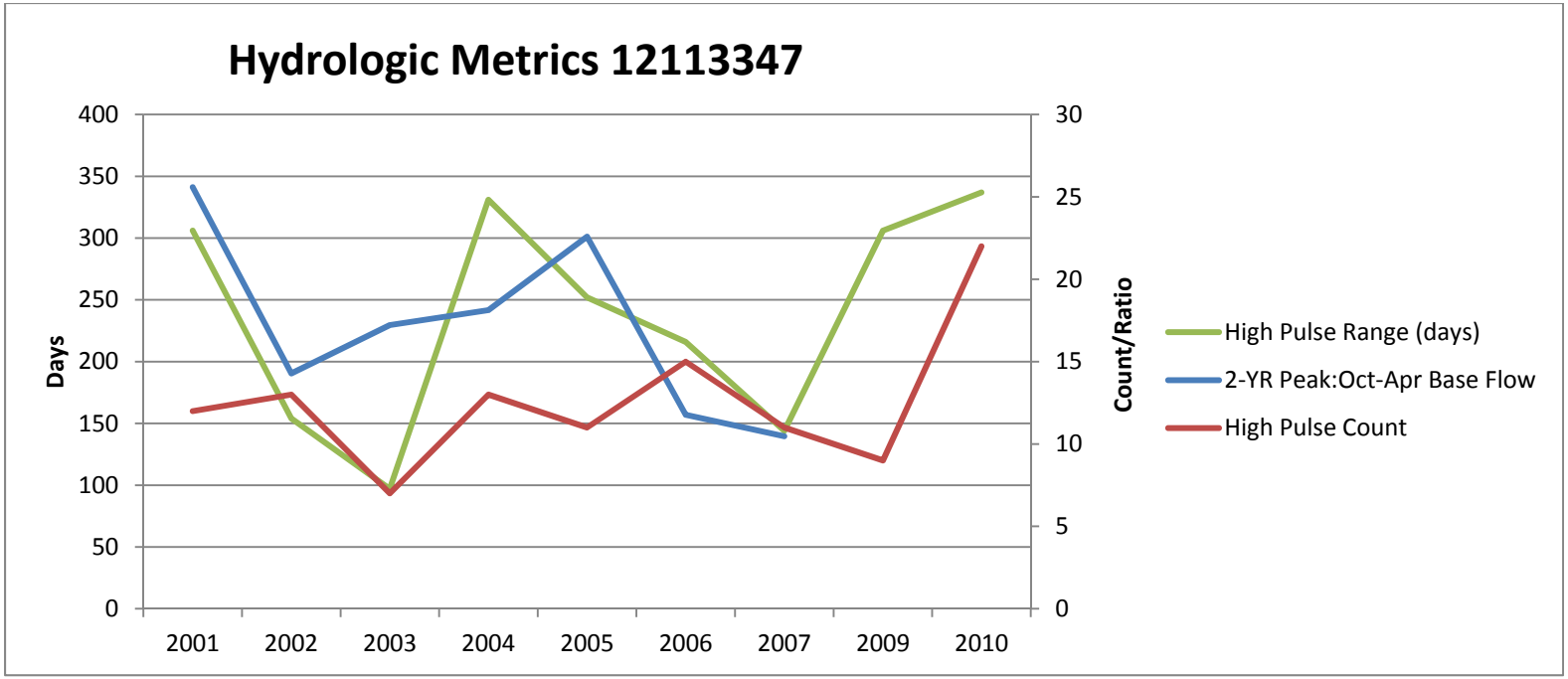


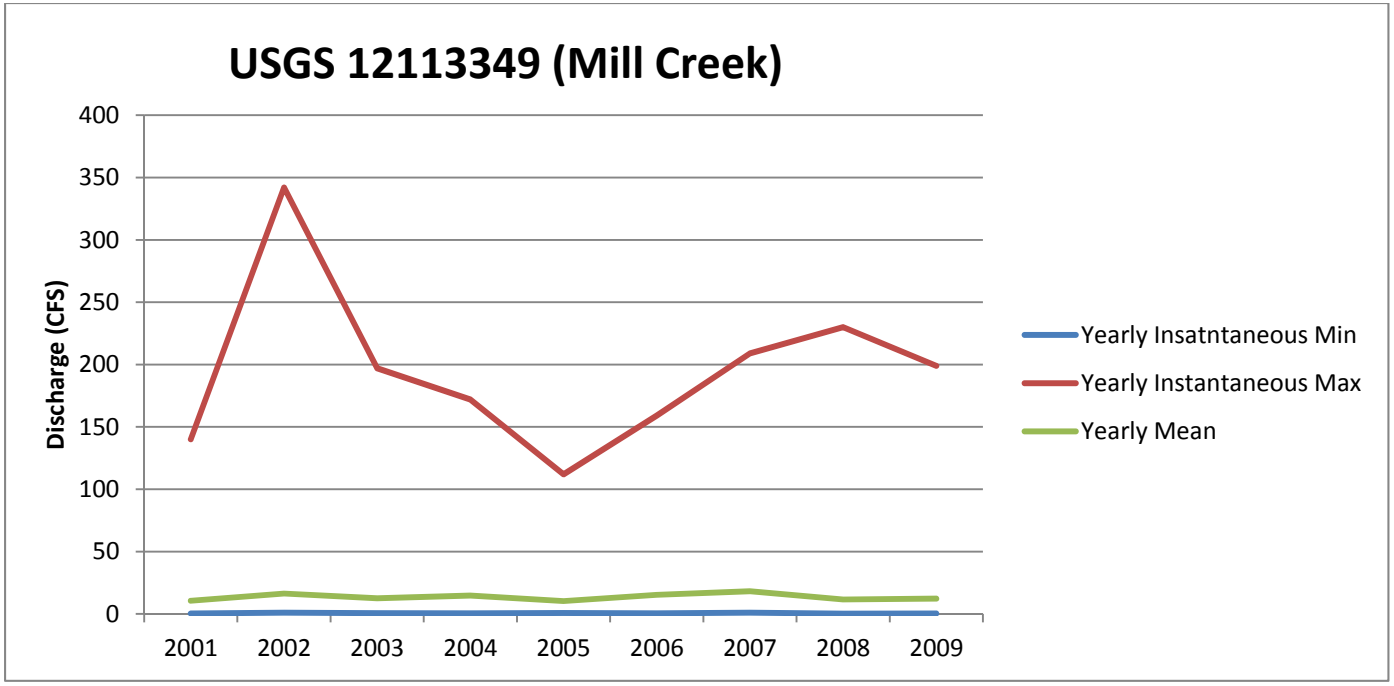
54h (Soosette Creek)	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011*(through May 31)
Yearly Mean Discharge	9.1	5.3	6.1	5.0	8.7	8.8	5.1	6.3	6.9	13.4
Yearly Instantaneous Min*	0.15	0.15	0.06	0.12	0.27	0.20	0.12	0.13	0.17	0.42
Yearly Instantaneous Max*	243	82.9	107	81.7	231	216	162	329	60.4	233


Hydrologic Metrics (54h)
Days
Count/Ratio
250
200
150
100
50
0
35
30
25
20
15
10
5
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
High Pulse Range (days)
2-YR Peak: Oct-Apr Base Flow
High Pulse Count

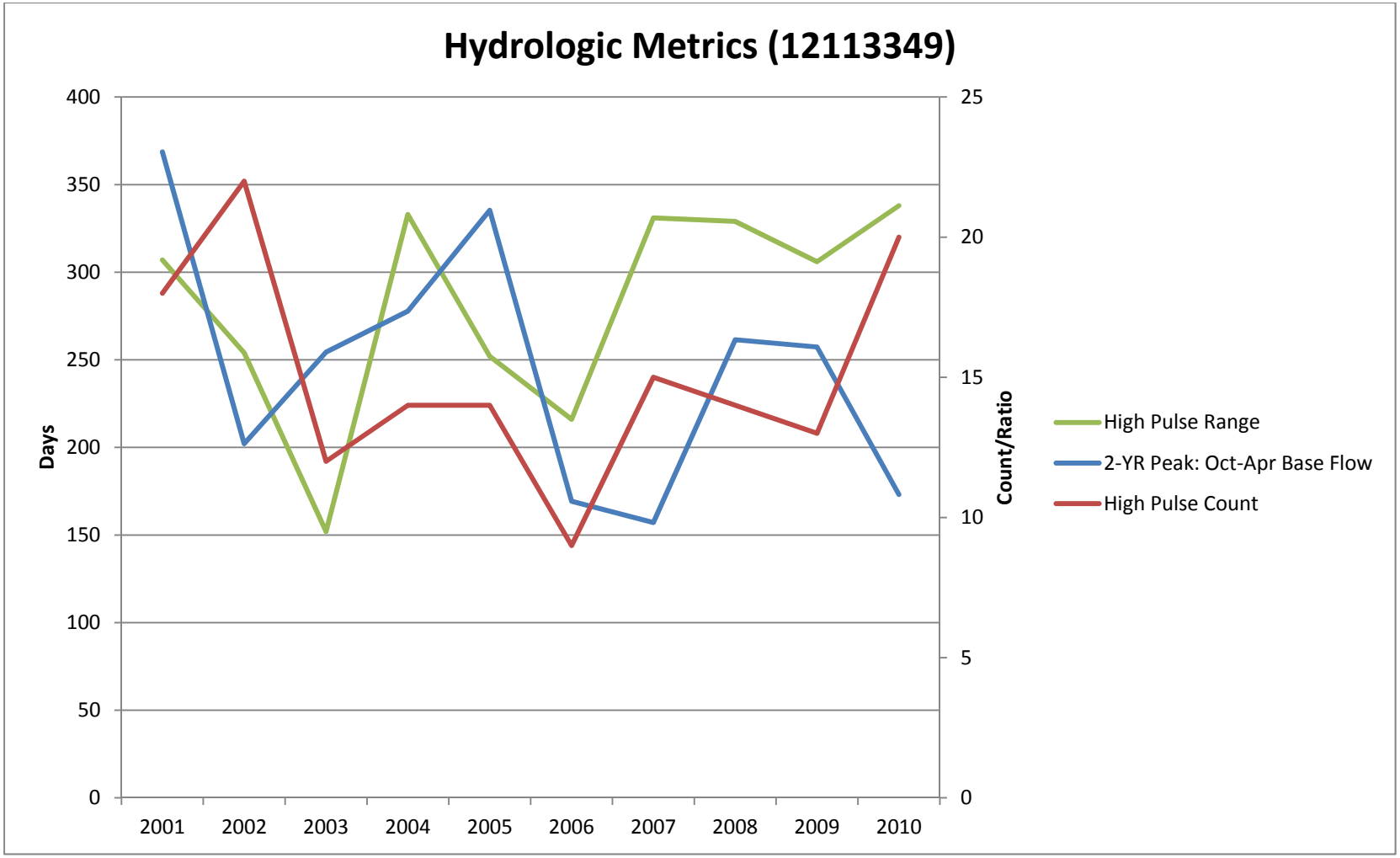


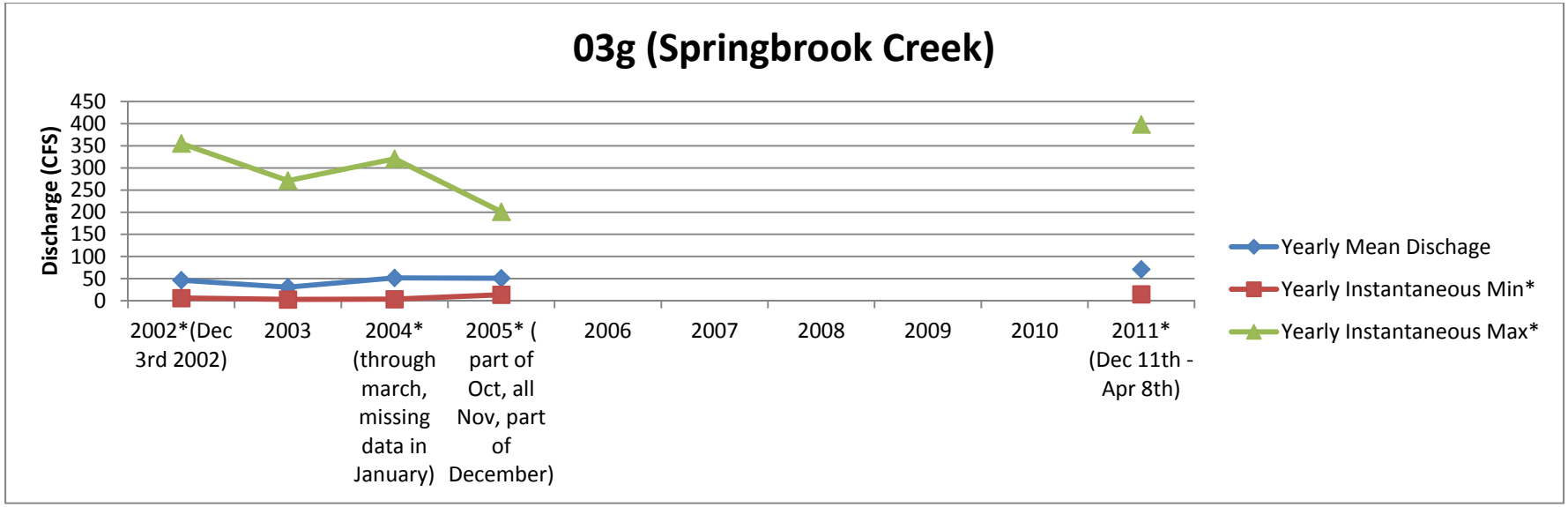
12113347 (Mill Creek)	2001	2002	2003	2004	2005	2006	2007	2008	2009
Yearly Mean Discharge	2.3	4.2	2.6	2.9	2.5	3.8	3.8	3.2	3.2
Yearly Instantaneous Min*	0.56	0.44	0	0	0.52	0.56	0.09	0.60	0.41
Yearly Instantaneous Max*	74	233	114	58	50	51	62	53	80


Hydrologic Metrics 12113347
Days
400
350
300
250
200
150
100
50
0
30
25
20
15
10
5
0
Count/Ratio
2001
2002
2003
2004
2005
2006
2007
2009
2010
High Pulse Range (days)
2-YR Peak:Oct-Apr Base Flow
High Pulse Count

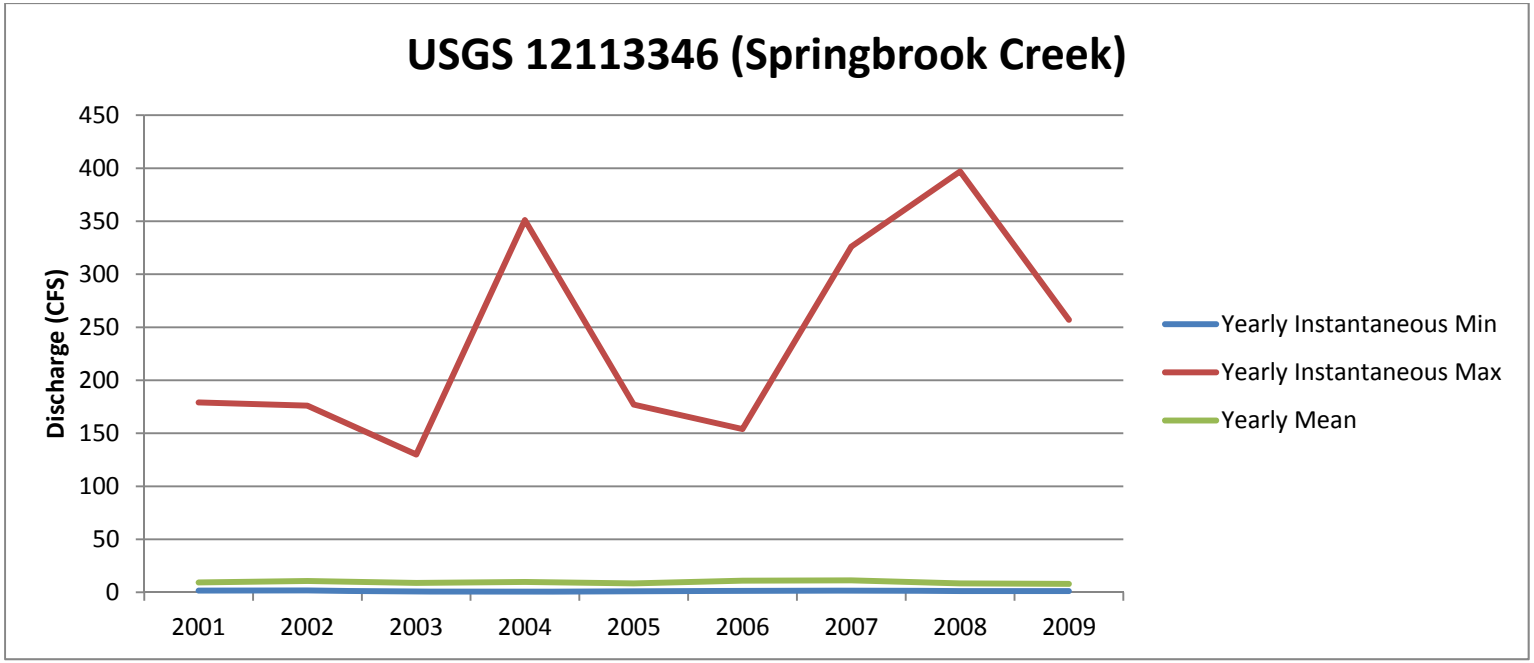


12113349 (Mill Creek)	2001	2002	2003	2004	2005	2006	2007	2008	2009
Yearly Mean Discharge	10.5	16.3	12.4	14.6	10.2	15.3	18.1	11.6	12.2
Yearly Instantaneous Min*	0.35	0.98	0.61	0.43	0.65	0.36	0.96	0.15	0.26
Yearly Instantaneous Max*	140	342	197	172	112	159	209	230	199

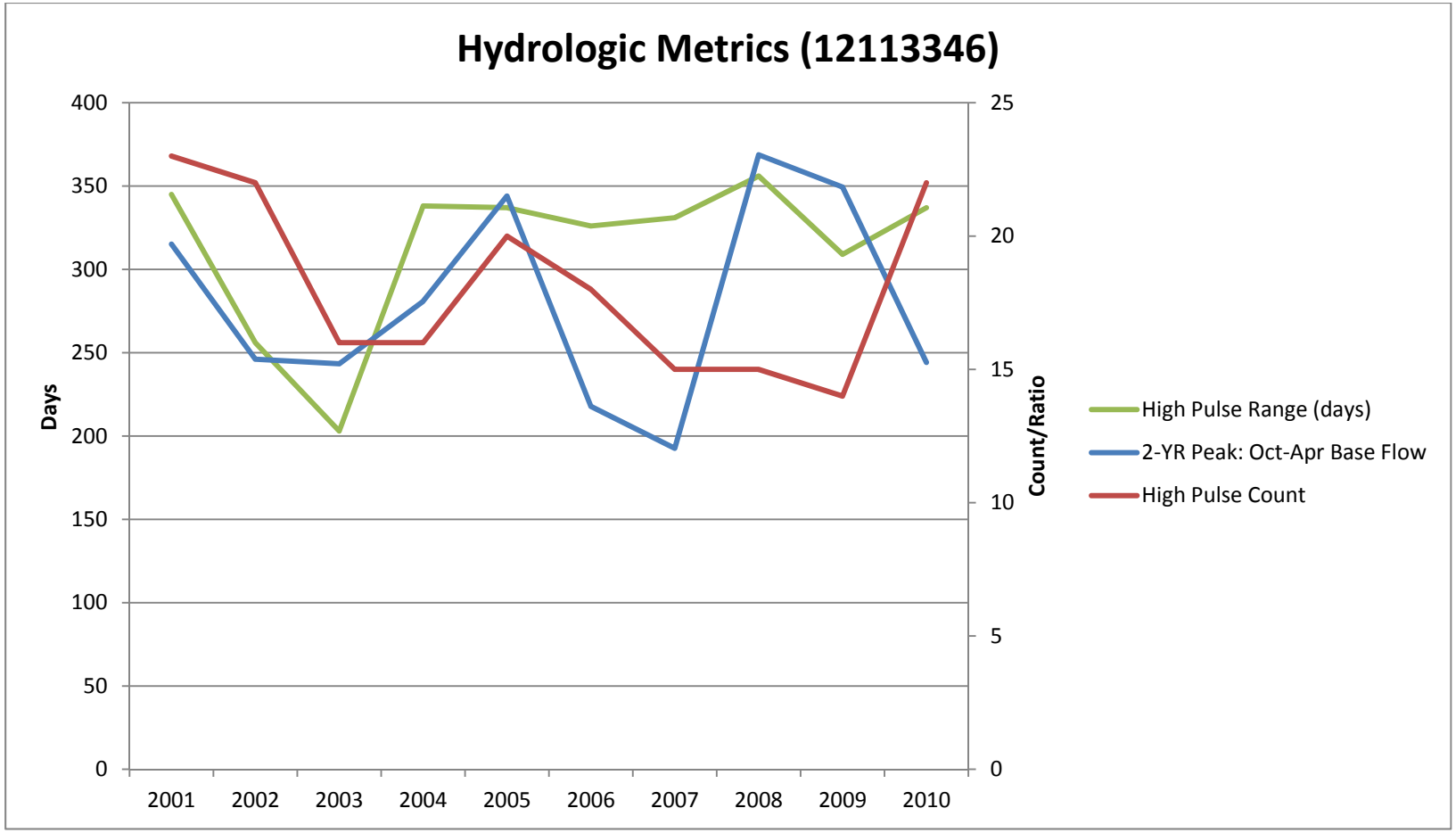

Hydrologic Metrics (12113349)
Days
Count/Ratio
400
350
300
250
200
150
100
50
0
25
20
15
10
5
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
High Pulse Range
2-YR Peak: Oct-Apr Base Flow
High Pulse Count

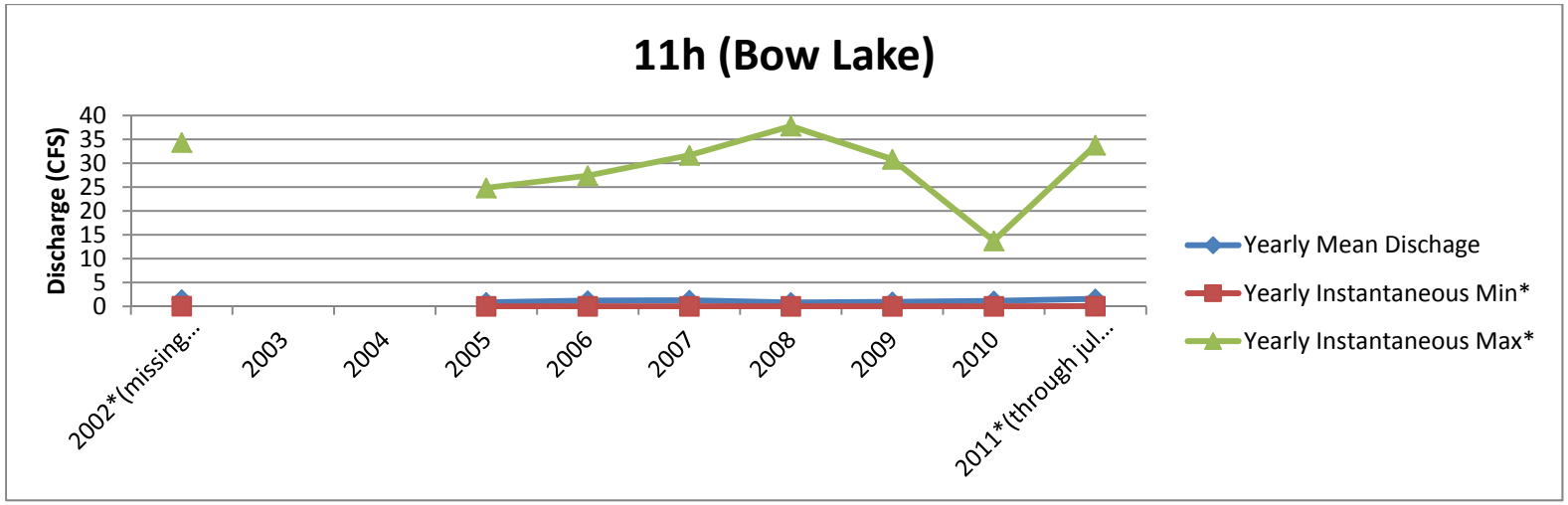


03g Springbrook Creek	2002*(Dec 3rd 2002)	2003	2004* (through March, missing data in January)	2005* (part of Oct, all Nov, part of December)	2006	2007	2008	2009	2010	2011* (Dec 11 -Apr 8)
Yearly Mean Discharge	46.2	30.4	51.6	50.7						70.9
Yearly Instantaneous Min*	6	2.7	3.4	13.4						14.3
Yearly Instantaneous Max*	355	271	321	201						398

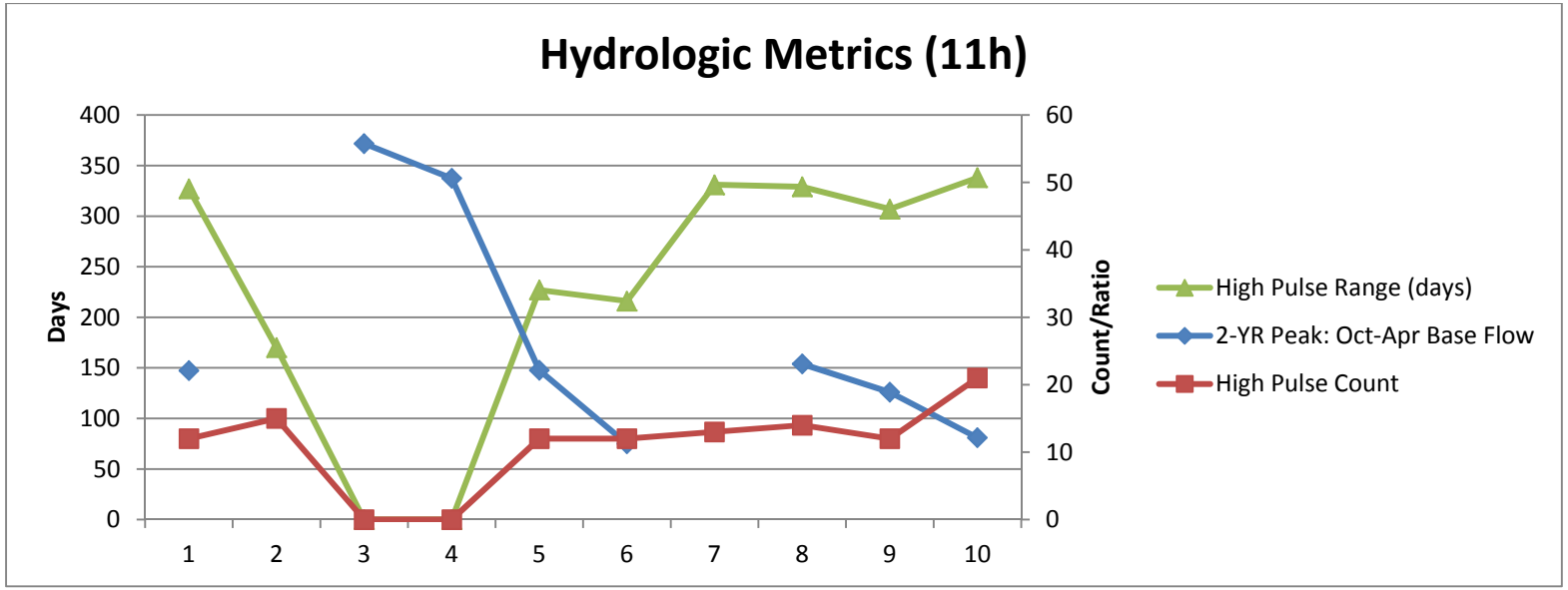


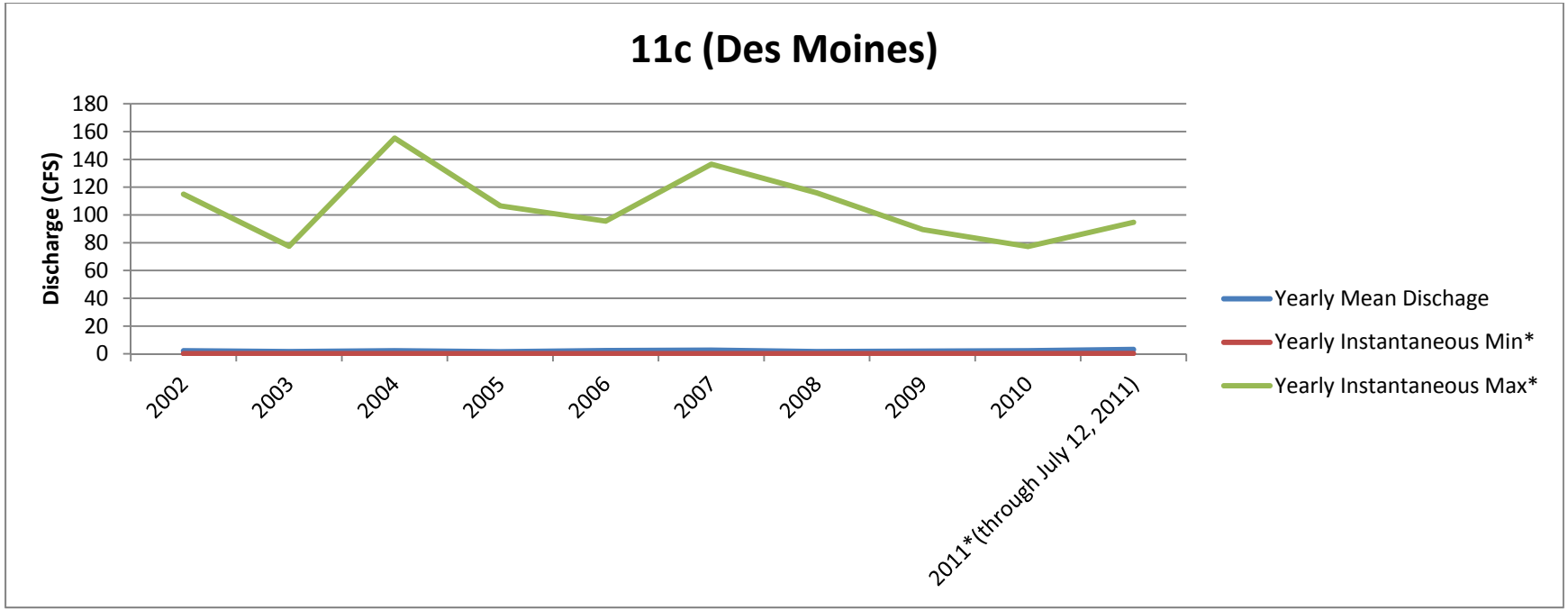
12113346 (Springbrook Creek)	2001	2002	2003	2004	2005	2006	2007	2008	2009
Yearly Mean Discharge	9.2	10.5	8.8	9.7	8.3	10.9	11.1	8.3	7.9
Yearly Instantaneous Min*	1.6	1.7	0.52	0.60	1	1.4	1.3	1.1	1.1
Yearly Instantaneous Max*	179	176	130	351	177	154	326	397	257


Hydrologic Metrics (12113346)
Days
Count/Ratio
400
350
300
250
200
150
100
50
0
25
20
15
10
5
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
High Pulse Range (days)
2-YR Peak: Oct-Apr Base Flow
High Pulse Count

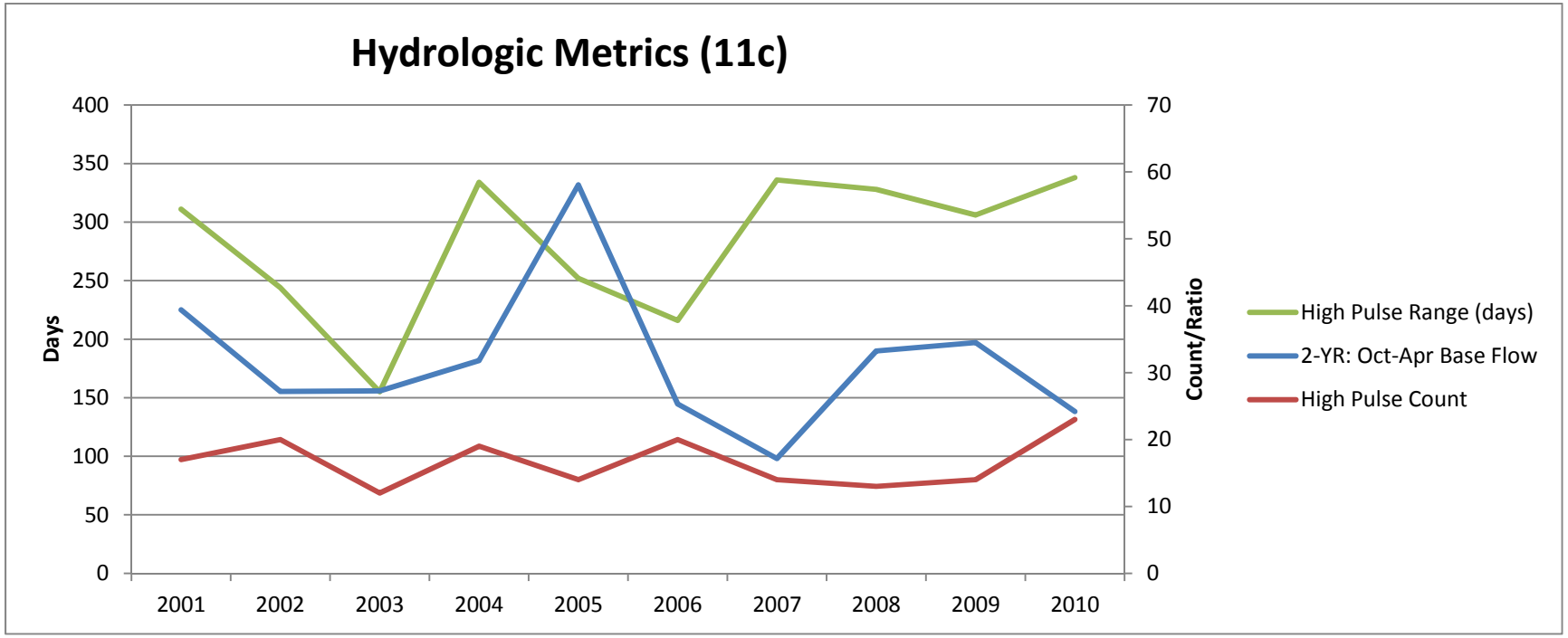


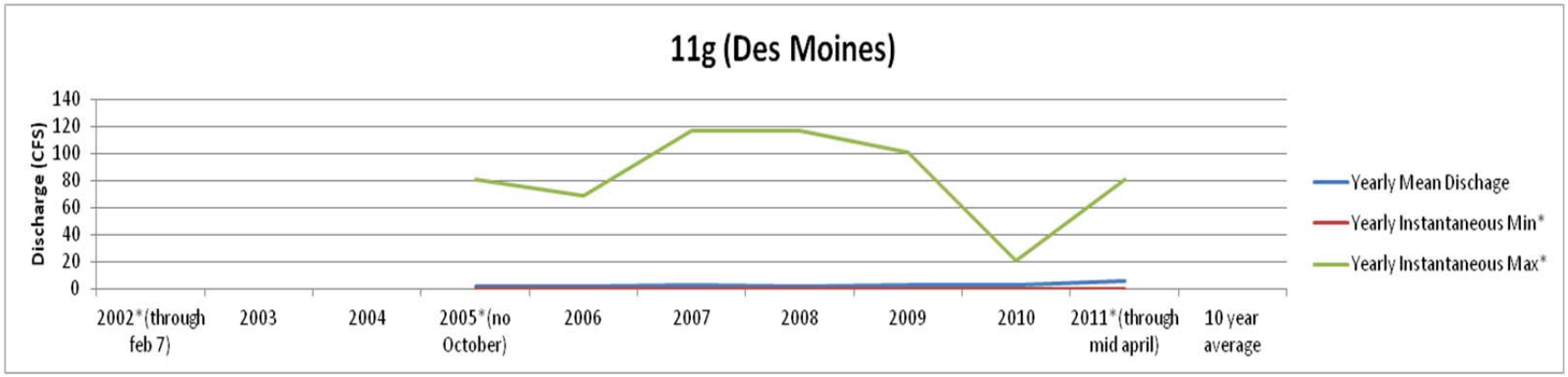
11h (Bow Lake)	2002*(missing part of Feb, Mar, June, all of Jul, Aug, Sept)	2003	2004	2005	2006	2007	2008	2009	2010	2011*(through Jul 12)
Yearly Mean Discharge	1.3			0.82	1.1	1.2	0.81	0.92	1.1	1.5
Yearly Instantaneous Min*	0.03			0	0	0	0	0	0	0.04
Yearly Instantaneous Max*	34.3			24.8	27.4	31.6	37.7	30.8	13.7	34.0


Hydrologic Metrics (11h)
Days
Count/Ratio
400
350
300
250
200
150
100
50
0
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
High Pulse Range (days)
2-YR Peak: Oct-Apr Base Flow
High Pulse Count

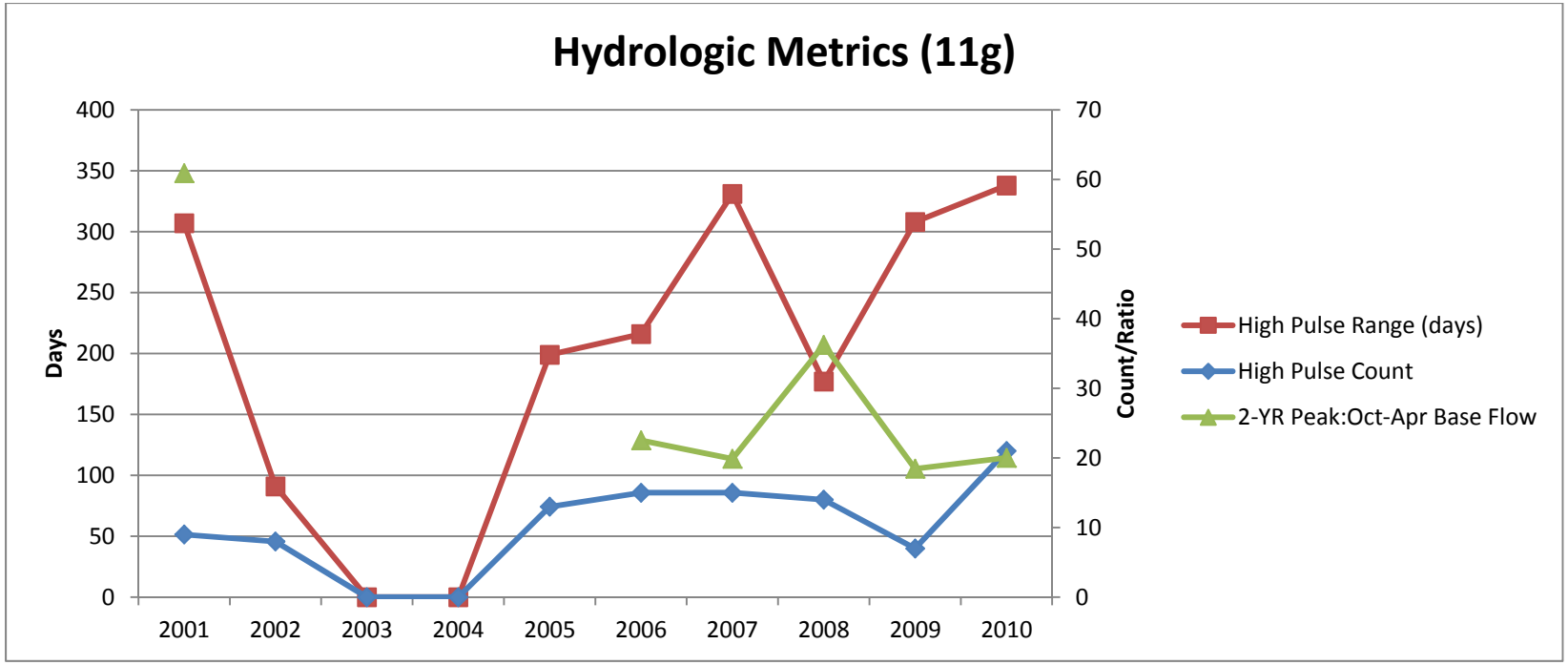


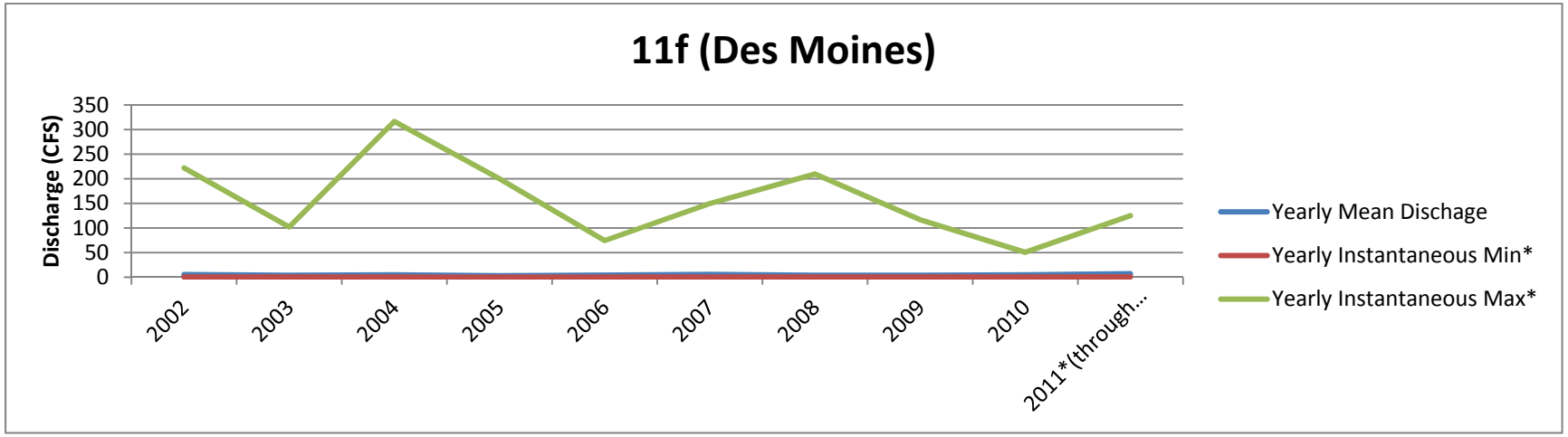
11c (Des Moines)	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011*(through July 12, 2011)
Yearly Mean Discharge	2.2	1.5	2.2	1.4	2.3	2.6	1.6	1.9	2.2	3.1
Yearly Instantaneous Min*	0.15	0.12	0.12	0.08	0.11	0.14	0.12	0.12	0.16	0.29
Yearly Instantaneous Max*	115	77.4	155	107	95.5	137	116	89.4	77.2	94.7


Hydrologic Metrics (11c)
Days
Count/Ratio
400
350
300
250
200
150
100
50
0
70
60
50
40
30
20
10
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
High Pulse Range (days)
2-YR: Oct-Apr Base Flow
High Pulse Count

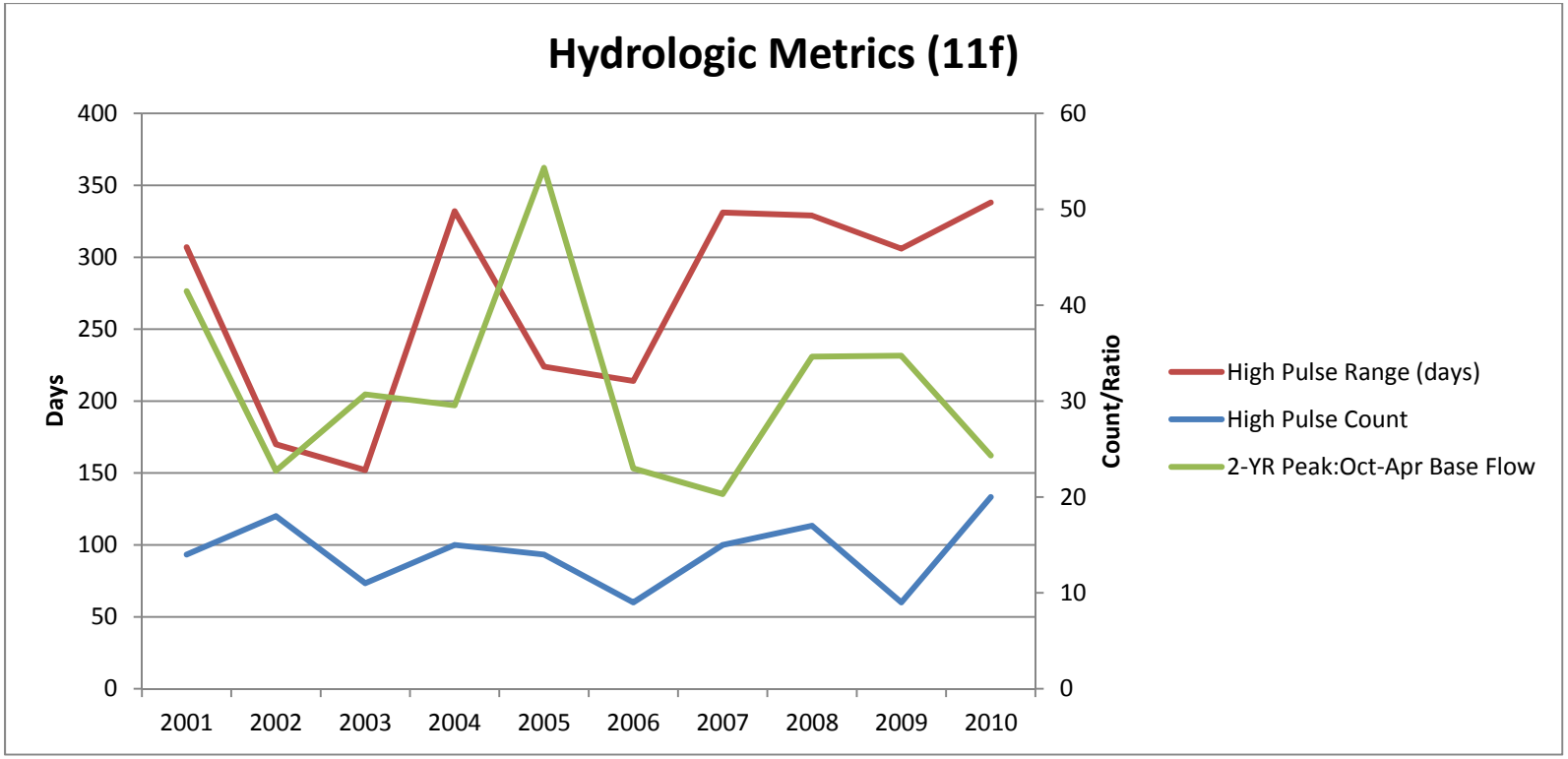


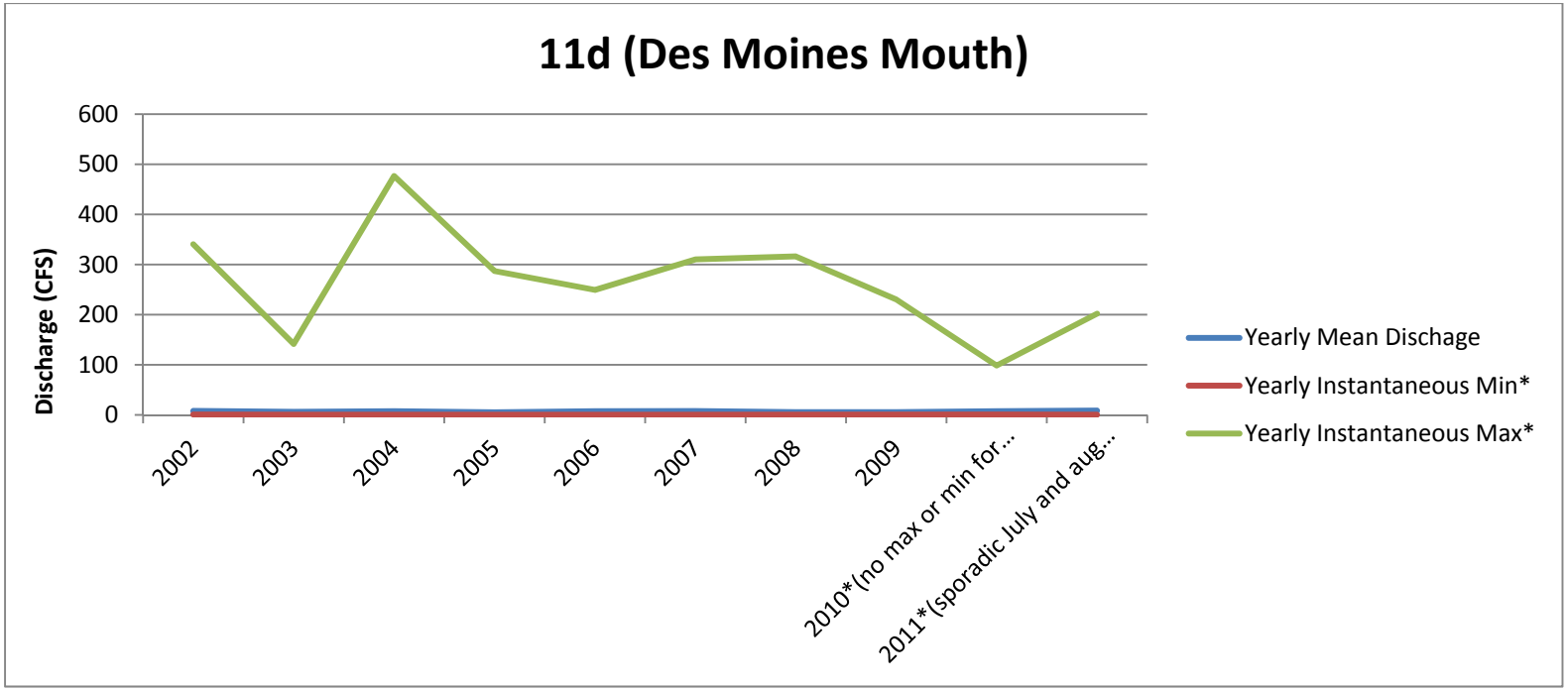
11g (Des Moines)	2002* (through Feb 7)	2003	2004	2005*(no October)	2006	2007	2008	2009	2010	2011* (through mid-April)
Yearly Mean Discharge	2.8			1.3	1.9	2.7	1.6	2.4	2.3	5.3
Yearly Instantaneous Min*	0.06			0	0	0	0	0	0	0.06
Yearly Instantaneous Max*	62.0			80.2	68.1	116	117	101	20.1	80.5


Hydrologic Metrics (11g)
Days
Count/Ratio
400
350
300
250
200
150
100
50
0
70
60
50
40
30
20
10
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
High Pulse Range (days)
High Pulse Count
2-YR Peak:Oct-Apr Base Flow

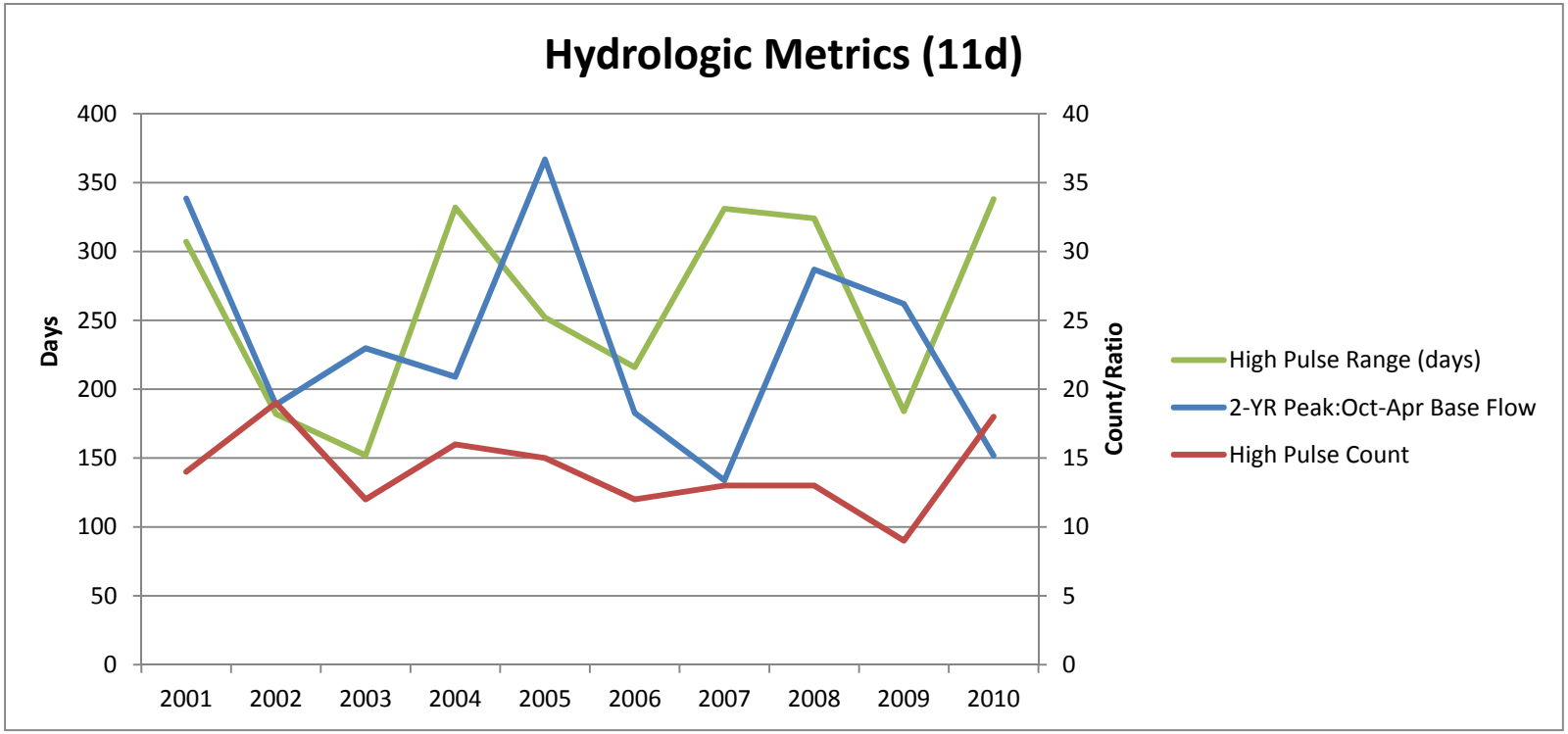


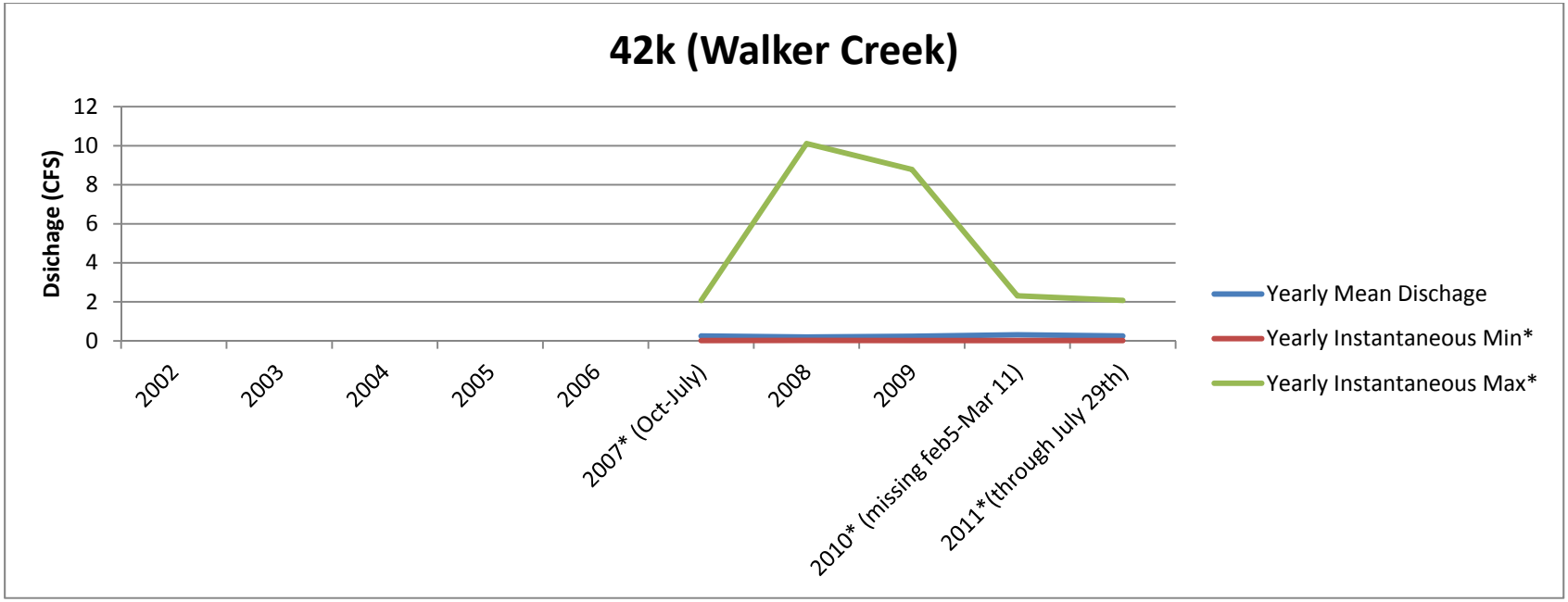
11f (Des Moines)	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011* (through July 11, 2011)
Yearly Mean Discharge	5.2	3.6	4.6	2.9	3.8	5.4	3.5	3.5	4.6	7.0
Yearly Instantaneous Min*	0.24	0.18	0	0	0	0	0.07	0.07	0.07	0.32
Yearly Instantaneous Max*	222	102	317	200	74.4	150	210	117	50.5	125


Hydrologic Metrics (11f)
Days
Count/Ratio
400
350
300
250
200
150
100
50
0
60
50
40
30
20
10
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
High Pulse Range (days)
High Pulse Count
2-YR Peak:Oct-Apr Base Flow

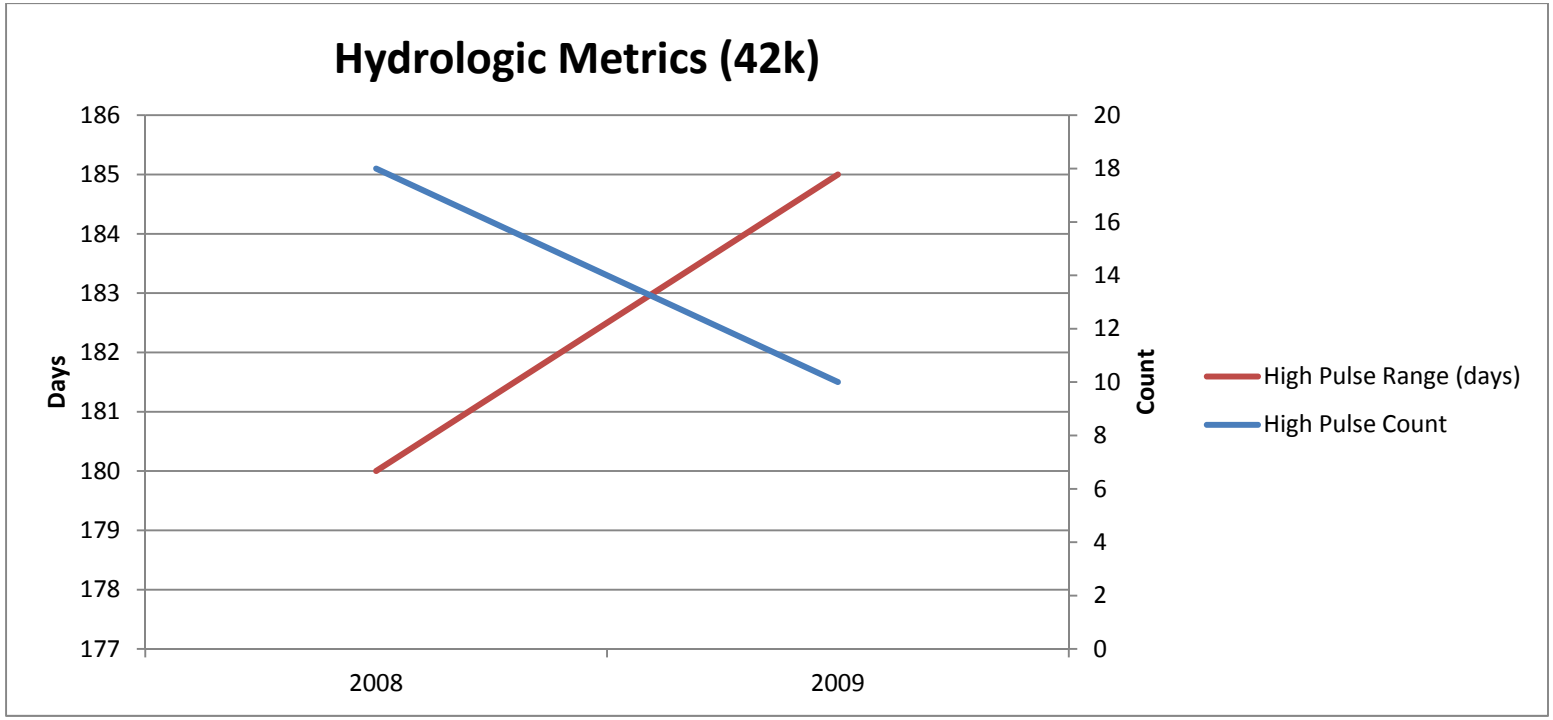


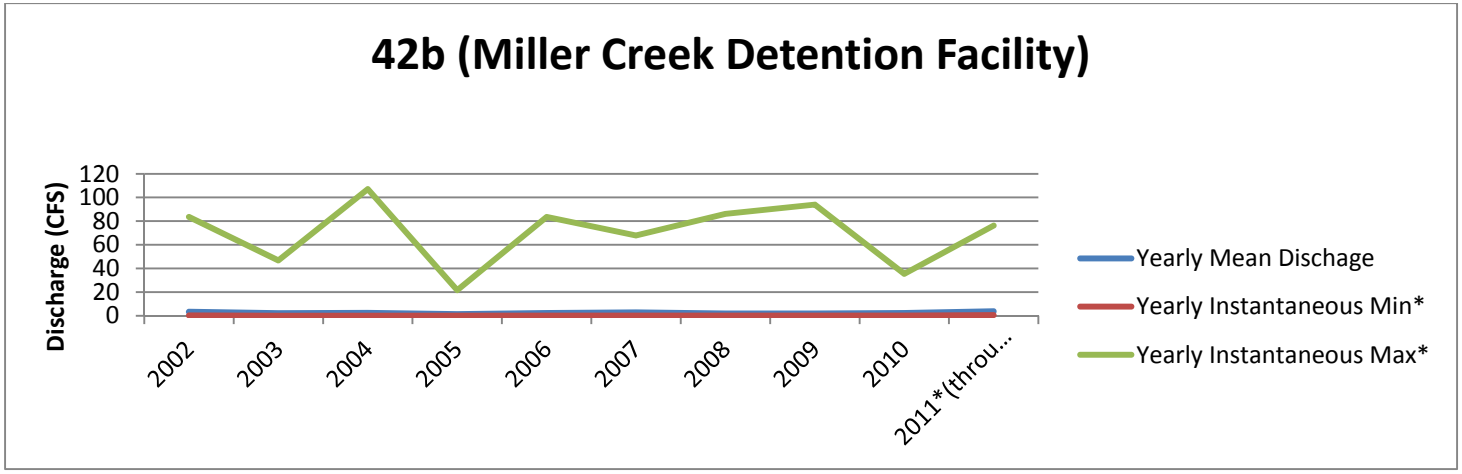
11d (Des Moines)	2002	2003	2004	2005	2006	2007	2008	2009	2010*(no max or min for Sept/Oct)	2011*(sporadic July and Aug readings, no max/min for Sept/Oct)
Yearly Mean Discharge	8.1	6.1	7.4	5.2	7.4	7.7	5.4	5.5	7.4	8.7
Yearly Instantaneous Min*	0.73	0.51	0.57	0.4	0.56	0.4	0.51	0.51	0.8	0.48
Yearly Instantaneous Max*	341	141	477	287	249	310	316	231	98.4	202


Hydrologic Metrics (11d)
Days
Count/Ratio
400
350
300
250
200
150
100
50
0
40
35
30
25
20
15
10
5
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
High Pulse Range (days)
2-YR Peak:Oct-Apr Base Flow
High Pulse Count

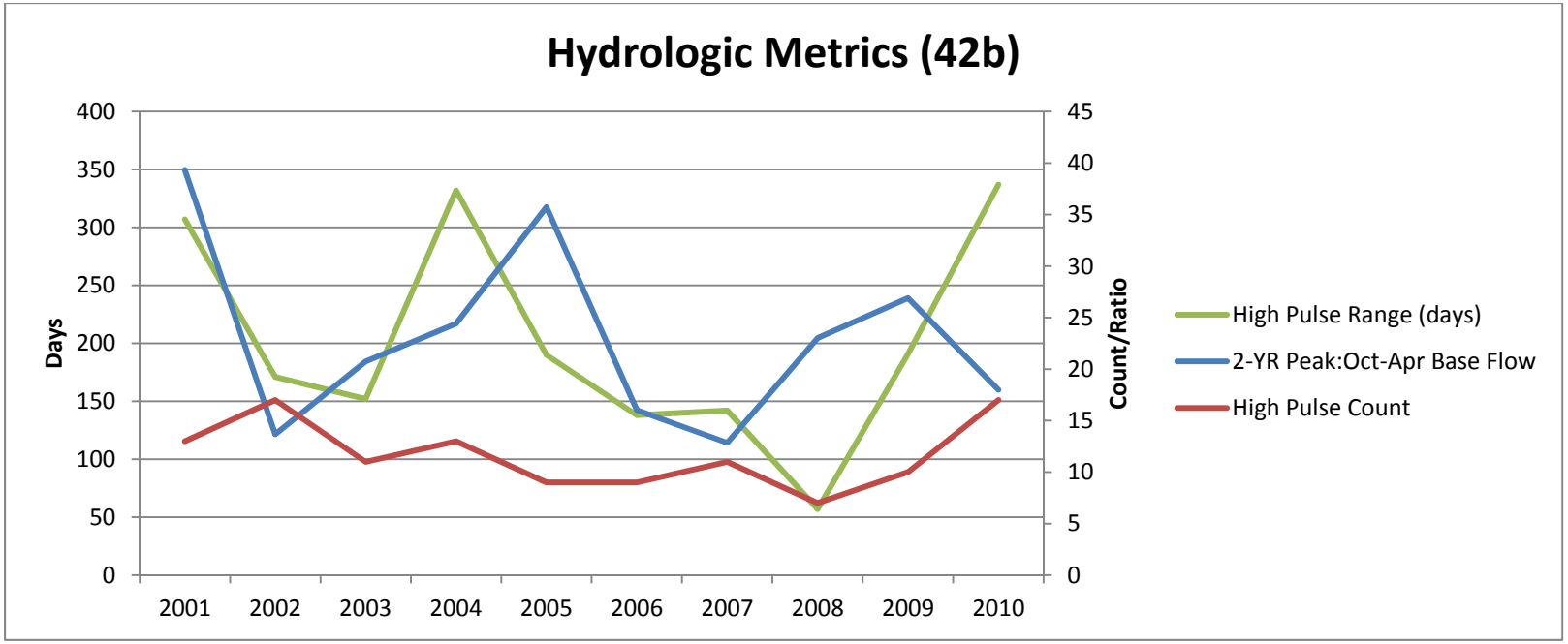


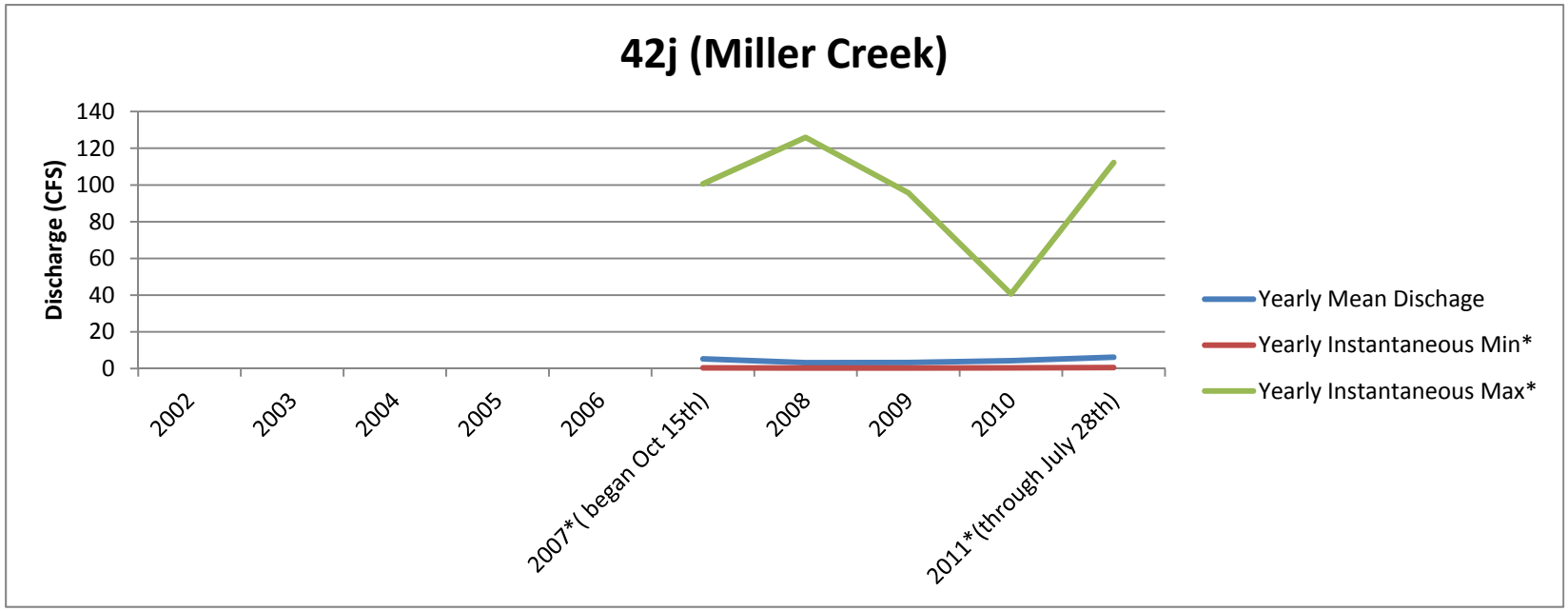
42k Walker Creek	2002	2003	2004	2005	2006	2007* (Oct-July)	2008	2009	2010* (missing Feb 5-Mar 11)	2011*(through July 29th)
Yearly Mean Discharge						0.24	0.19	0.23	0.31	0.24
Yearly Instantaneous Min*						0.01	0.02	0.01	0.01	0.01
Yearly Instantaneous Max*						2.0	10.1	8.7	2.3	2.0


Hydrologic Metrics (42k)
Days
186
185
184
183
182
181
180
179
178
177
Count
20
18
16
14
12
10
8
6
4
2
0
2008
2009
High Pulse Range (days)
High Pulse Count

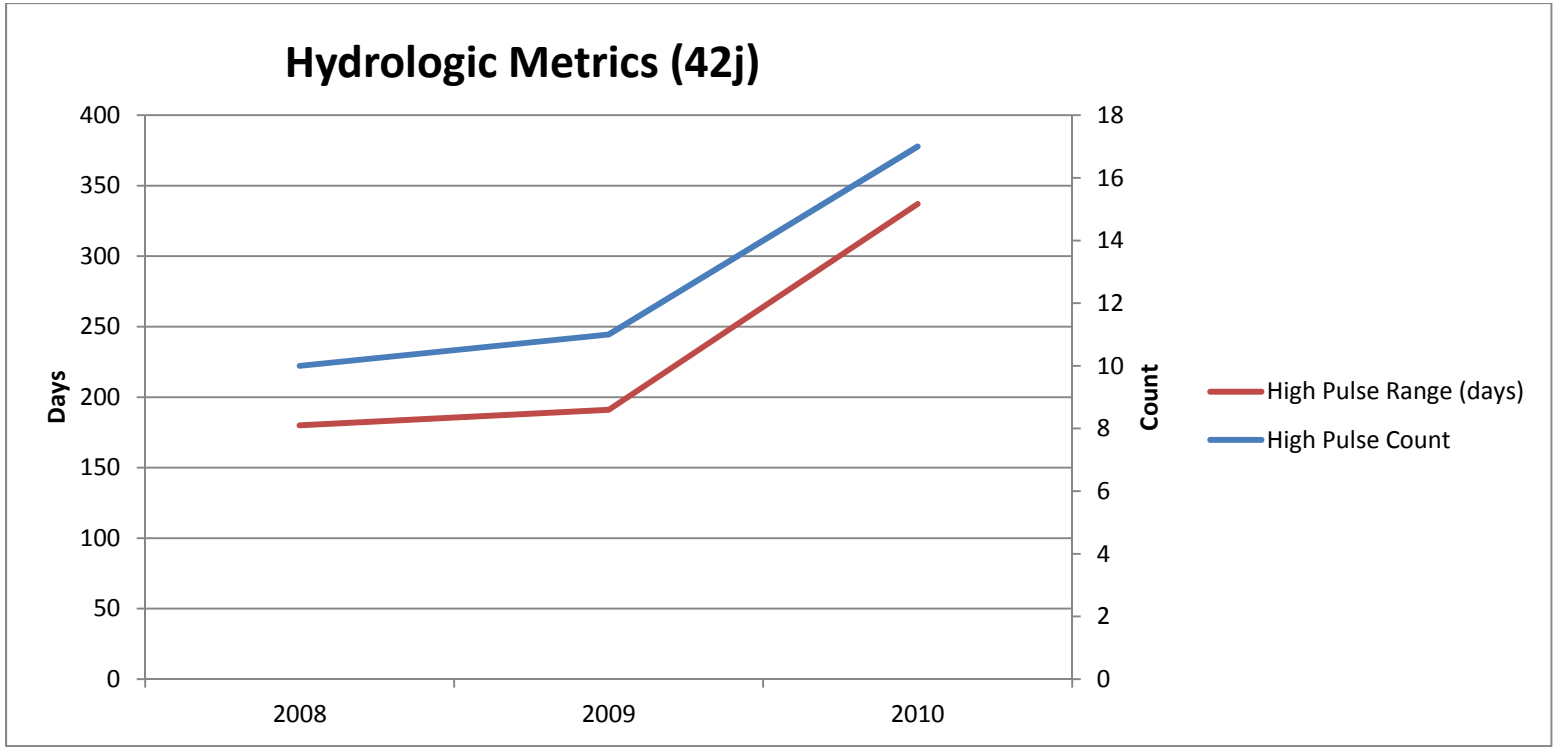


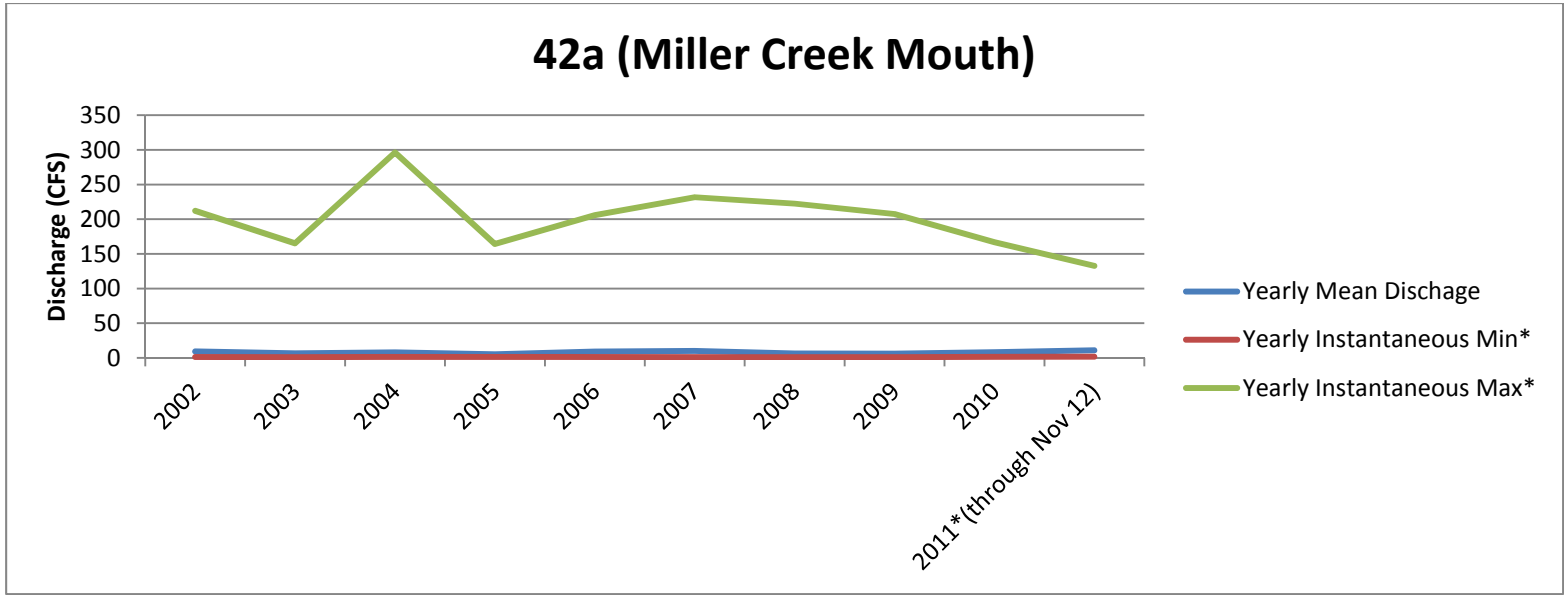
42b (Miller Creek)	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011*(through June 17, 2011)
Yearly Mean Discharge	3.2	2.1	2.3	1.3	2.2	2.8	1.8	1.8	2.2	3.7
Yearly Instantaneous Min*	0.17	0	0	0	0	0.22	0.1	0.14	0.14	0.44
Yearly Instantaneous Max*	83.5	46.7	107	21.6	83.5	67.8	86.1	94.0	35.3	76.2


Hydrologic Metrics (42b)
Days
Count/Ratio
400
350
300
250
200
150
100
50
0
45
40
35
30
25
20
15
10
5
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
High Pulse Range (days)
2-YR Peak:Oct-Apr Base Flow
High Pulse Count

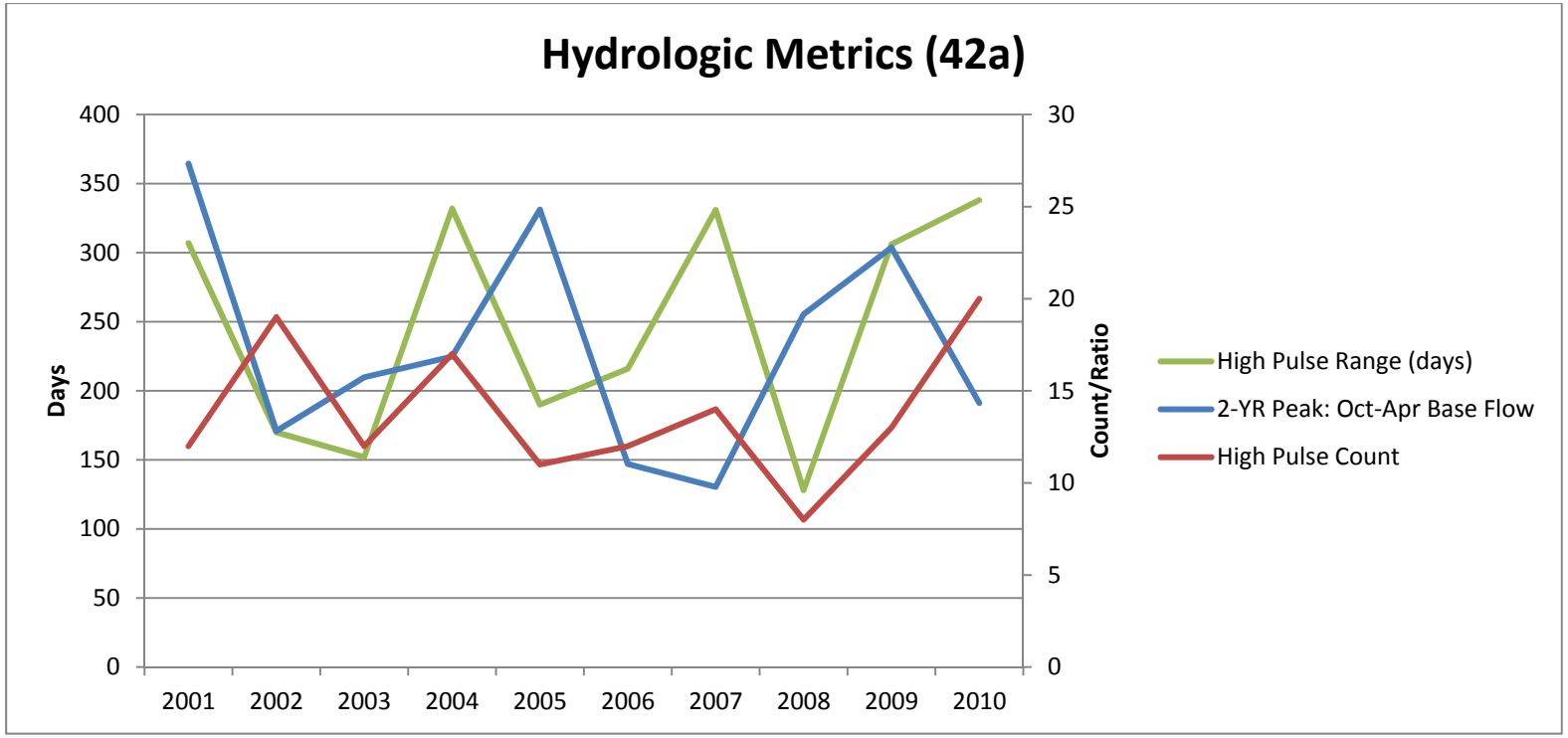


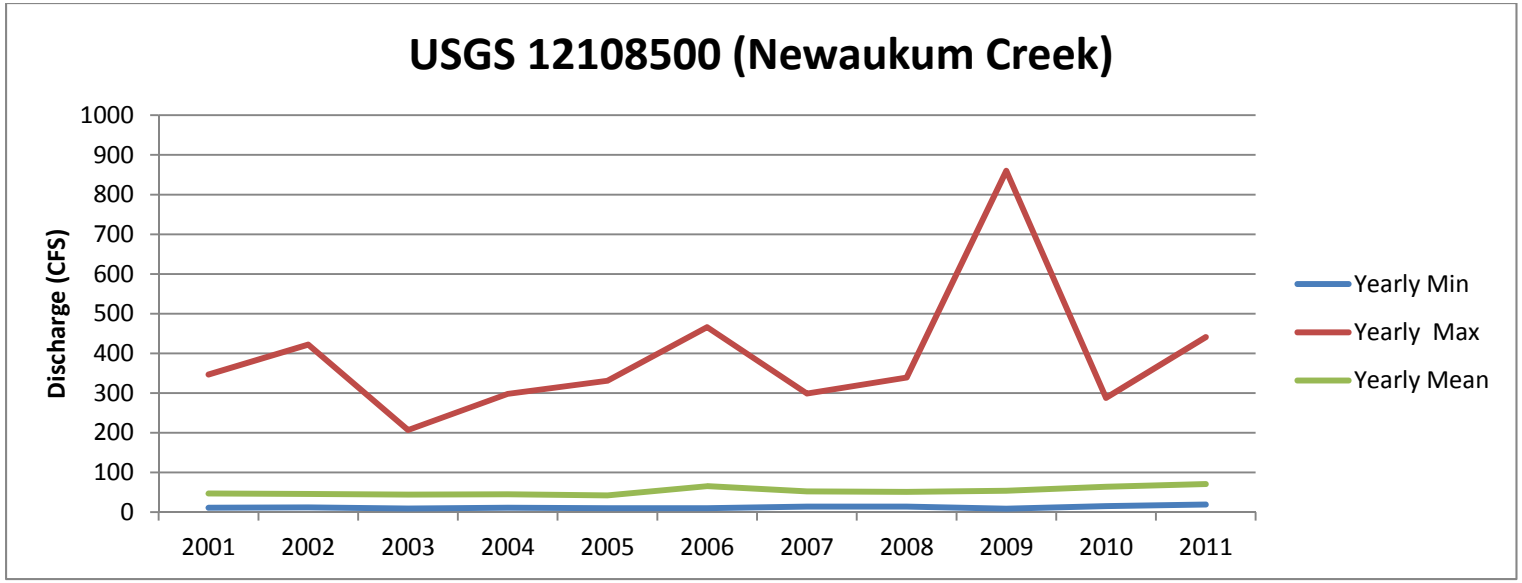
42j (Miller Creek)	2002	2003	2004	2005	2006	2007* (began Oct 15)	2008	2009	2010	2011*(through July 28)
Yearly Mean Discharge						5.1	3.1	3.2	4.2	6.1
Yearly Instantaneous Min*						0.31	0.25	0.25	0.36	0.51
Yearly Instantaneous Max*						101	126	95.6	40.6	112


Hydrologic Metrics (42j)
Days
Count
400
350
300
250
200
150
100
50
0
18
16
14
12
10
8
6
4
2
0
2008
2009
2010
High Pulse Range (days)
High Pulse Count

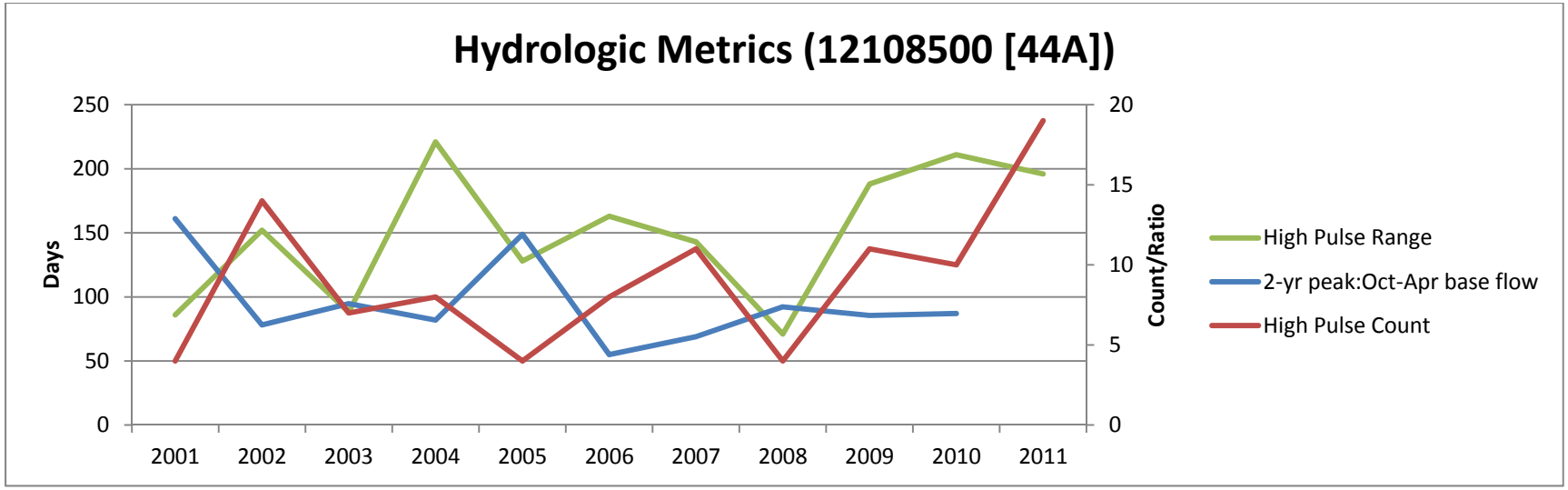


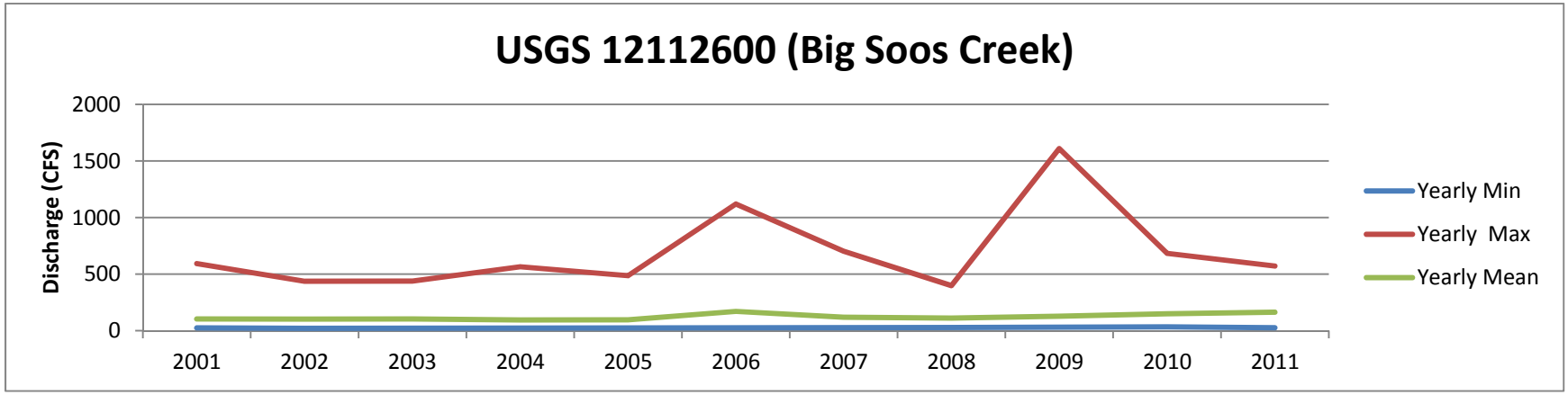
42a (Miller Creek)	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011*(through Nov 12)
Yearly Mean Discharge	9.1	6.4	7.7	5.1	8.9	9.8	6.2	5.9	8.2	10.7
Yearly Instantaneous Min*	1.2	1.0	1.3	1.1	1.4	0.82	0.82	1.3	1.4	1.6
Yearly Instantaneous Max*	212	165	296	164	206	232	222	208	166	13.0


Hydrologic Metrics (42a)
Days
Count/Ratio
400
350
300
250
200
150
100
50
0
30
25
20
15
10
5
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
High Pulse Range (days)
2-YR Peak: Oct-Apr Base Flow
High Pulse Count



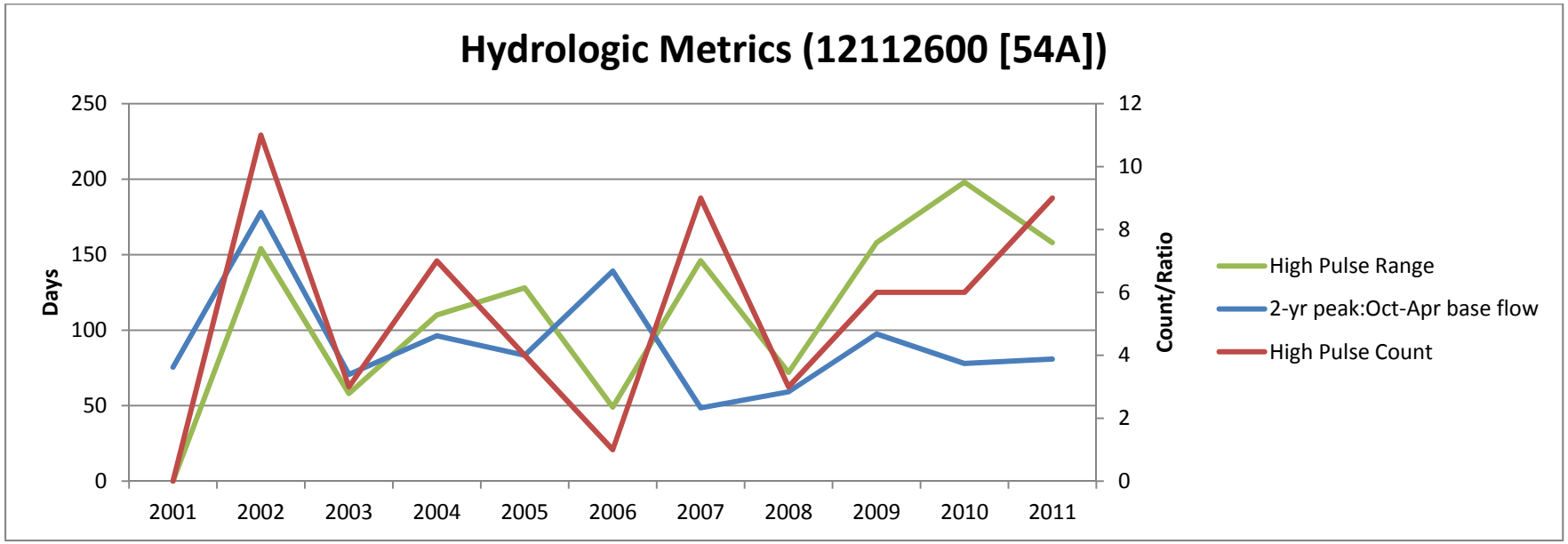
12108500 [44A] (Newaukum Creek)	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011* (Incomplete year)
Yearly Mean Discharge	46.9	45.6	44.0	44.8	42.2	65.7	52.1	51.2	53.7	63.9	70.5
Yearly Instantaneous Min*	11	12	9	11	10	9.8	14	14	8.7	15	19
Yearly Instantaneous Max*	347	422	207	298	331	466	299	339	860	288	441



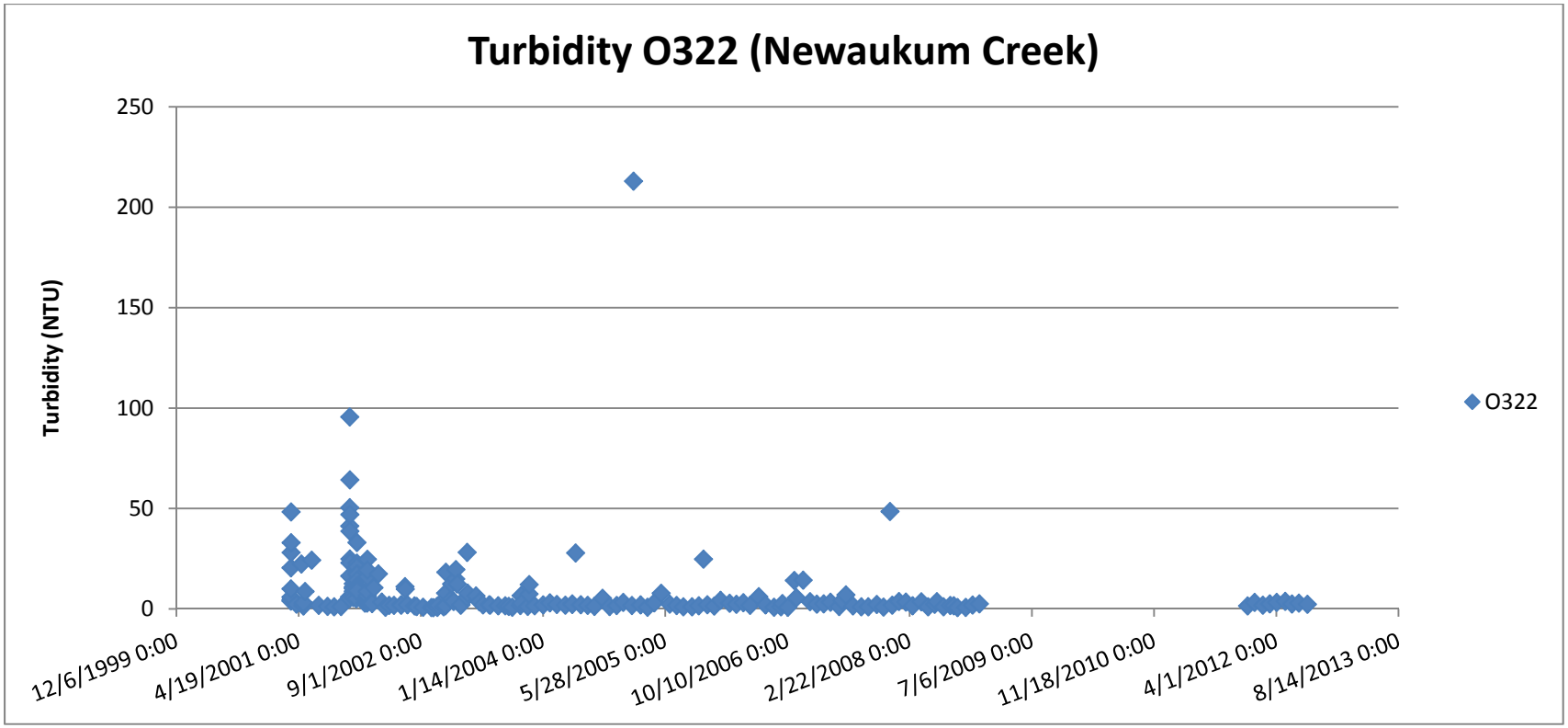


12112600 [54A] (Big Soos Creek)	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Yearly Mean Discharge	103.8	101.9	102.9	95.1	96.0	171.4	119.2	111.2	127.7	149.2	163.3

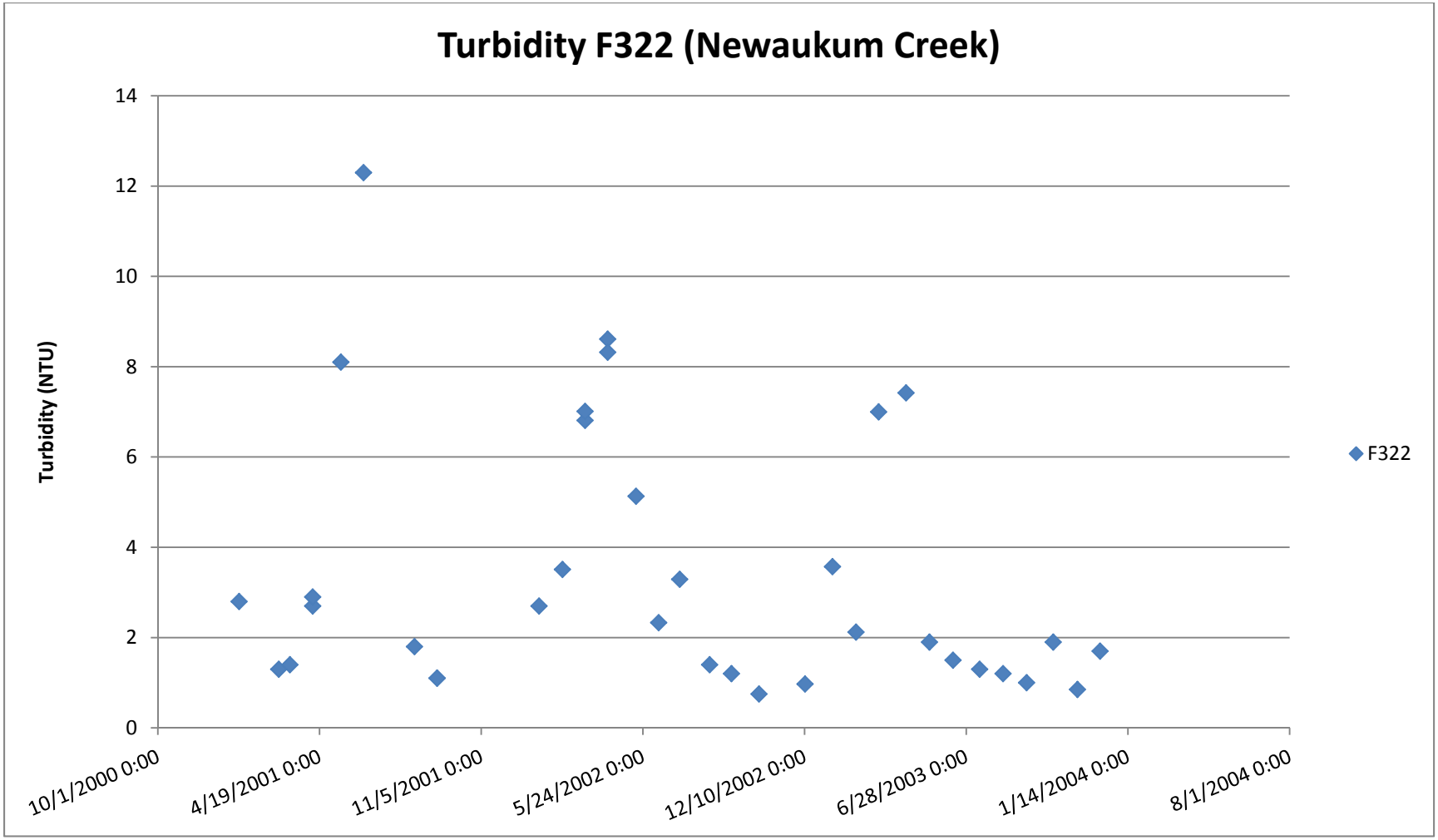
Yearly Instantaneous Min	24	21	19	23	24	25	27	28	28	34	26
Yearly Instantaneous Max	593	437	438	565	486	1120	703	399	1610	684	572



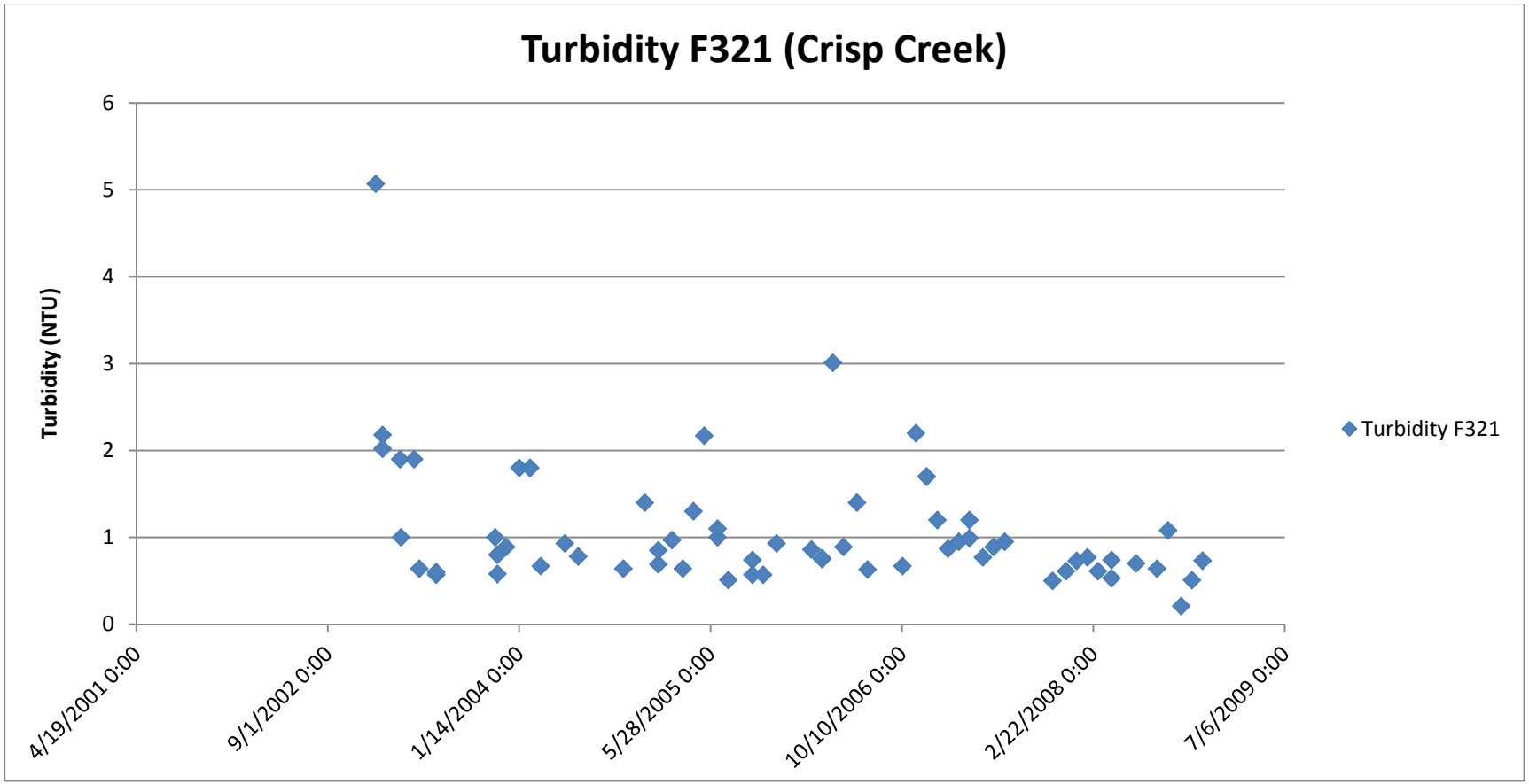
Turbidity graphs and tables



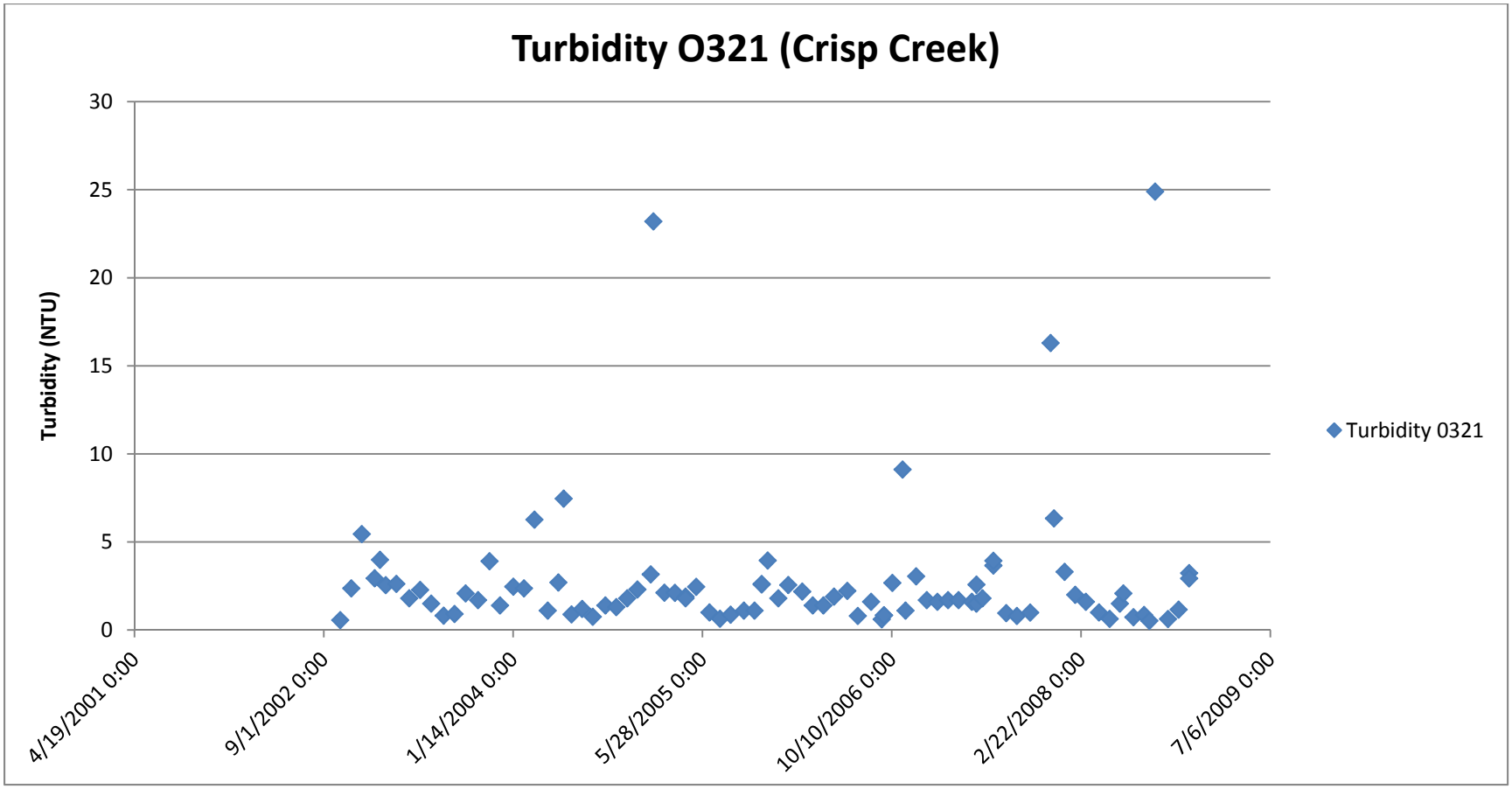
O322	Max	Min	Mean
	213	0.66	9.3



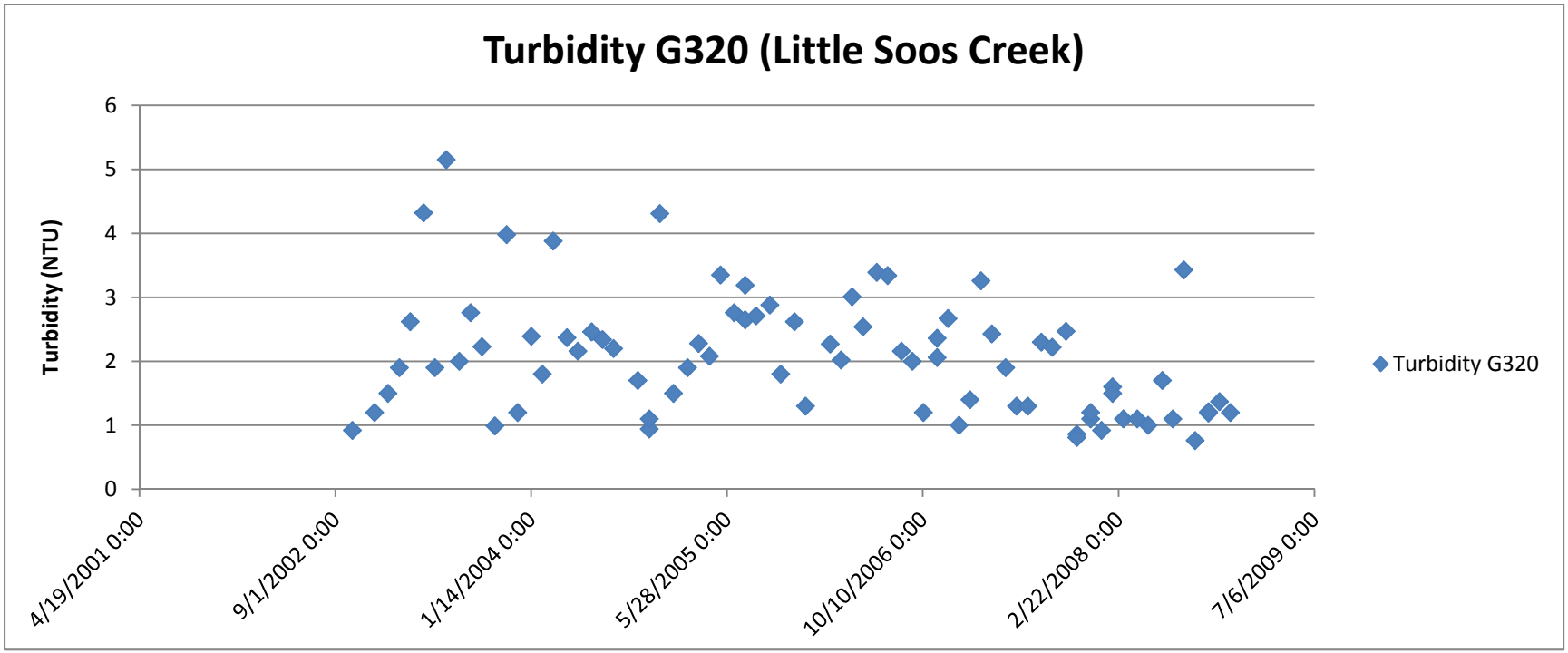
F322	Max	Min	Mean
	12.3	0.75	3.4



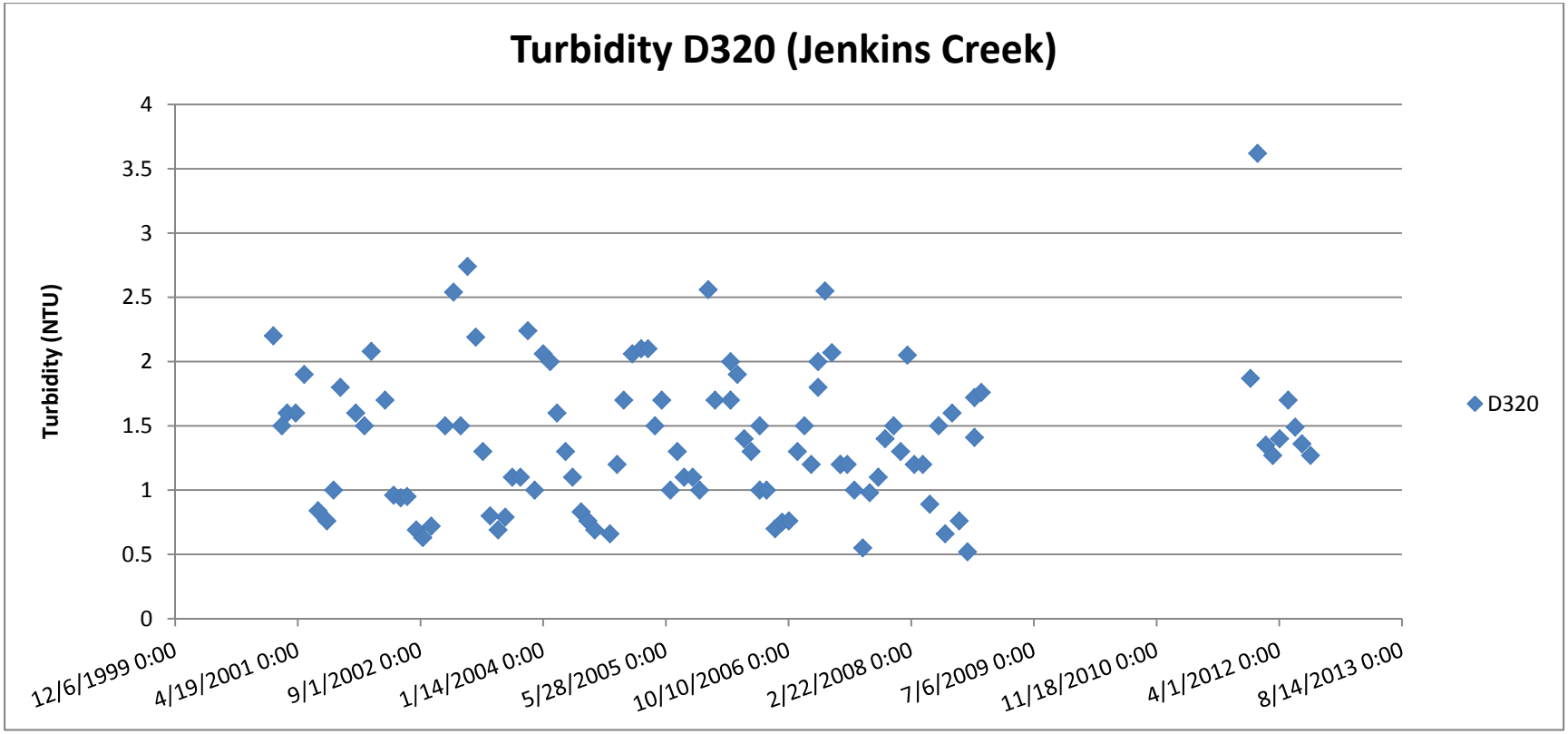
G320	max	min	mean
	5.1	0.76	2.1



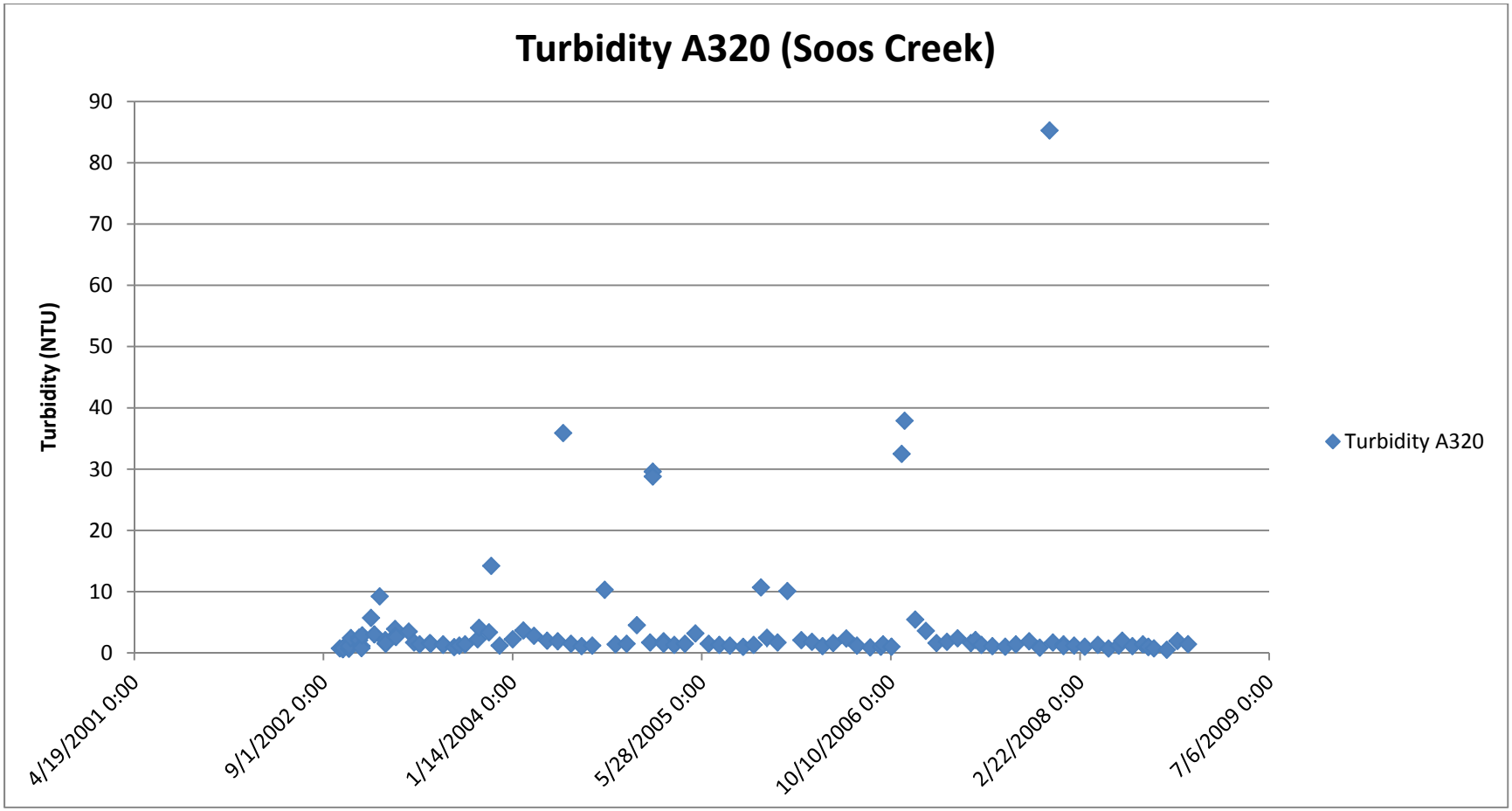
O321	max	min	mean
	24.9	0.5	2.8



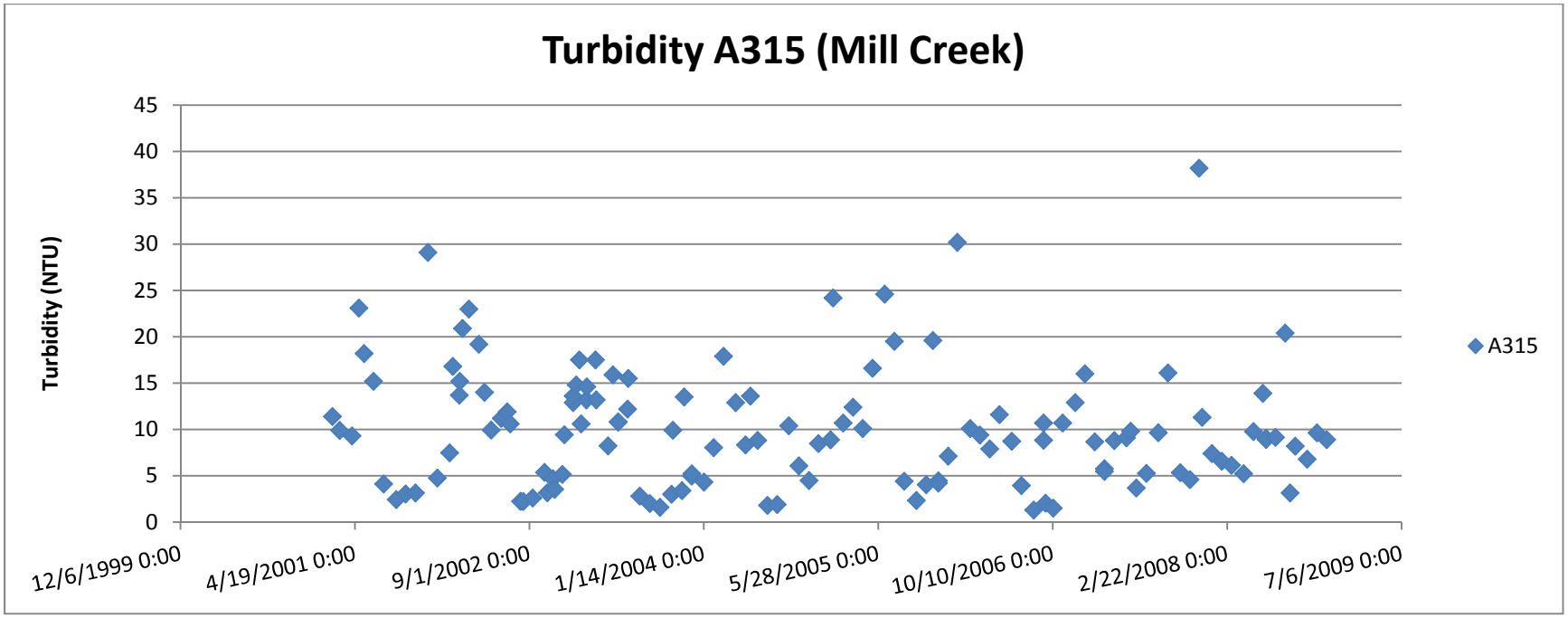
G320	max	min	mean
	5.2	0.76	2.1



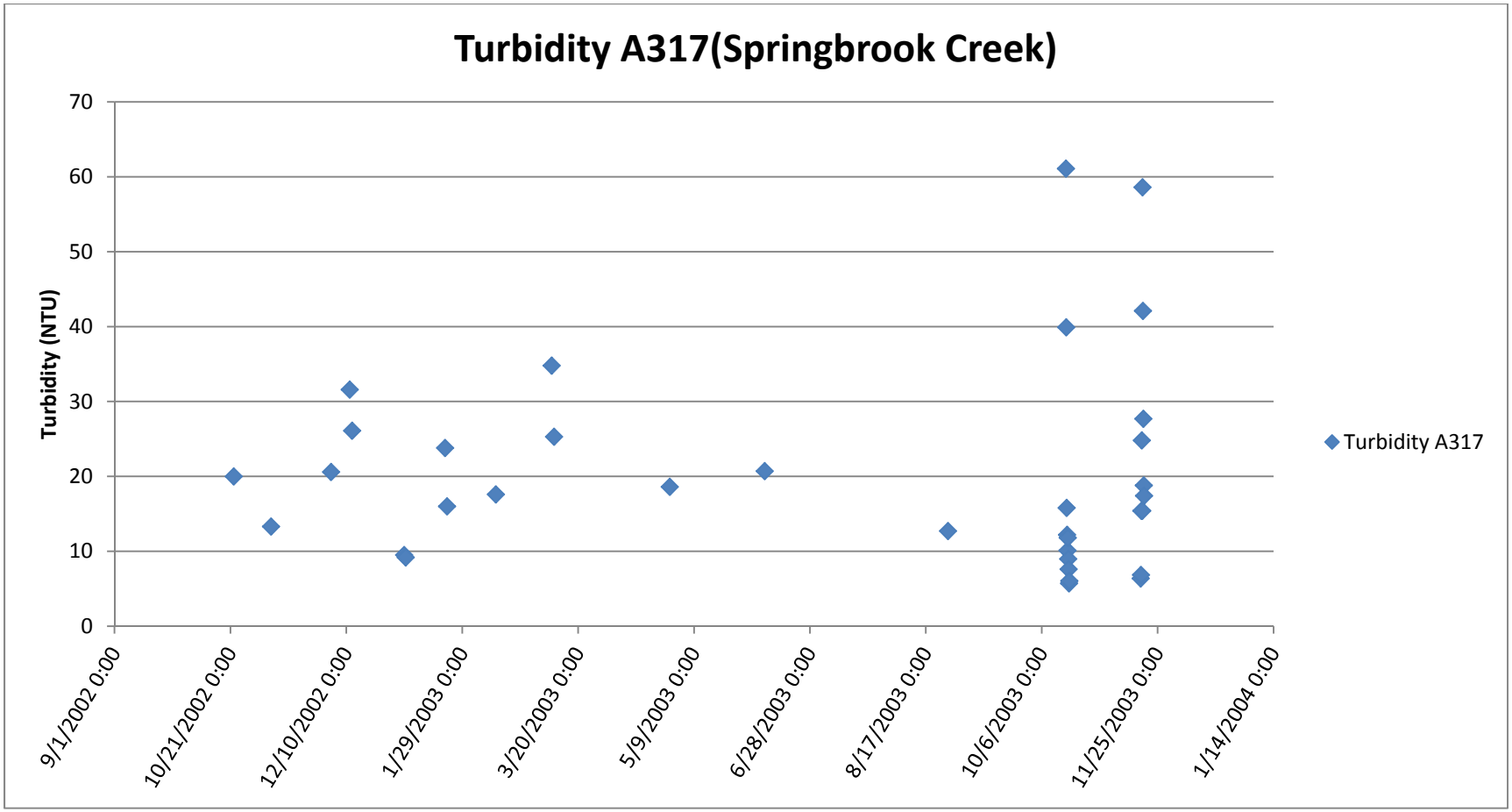
D320	Max	Min	Mean
	3.6	0.52	1.4



A320	max	min	mean
	85.3	0.51	4.4

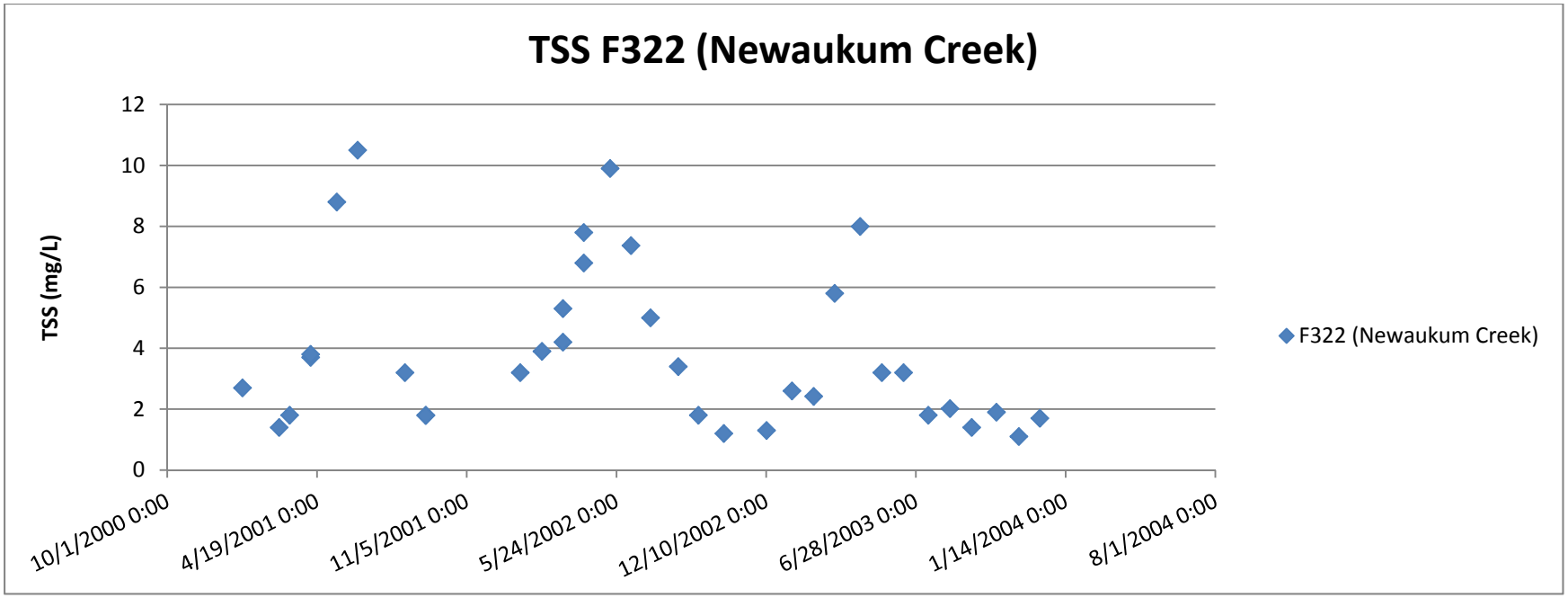


A315	Max	Min	Mean
	38.2	1.3	10

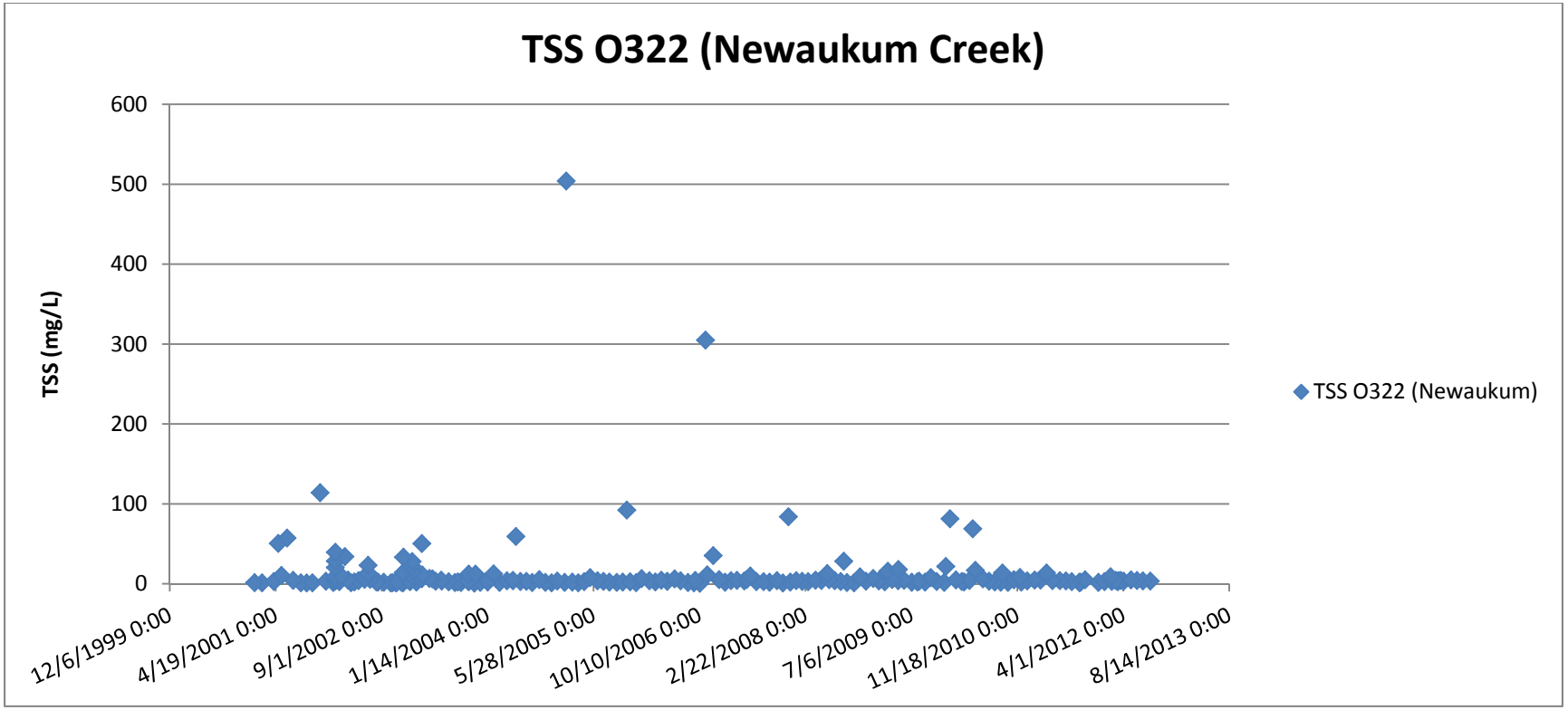


A317	Max	Min	Mean
	61.1	5.7	20.4

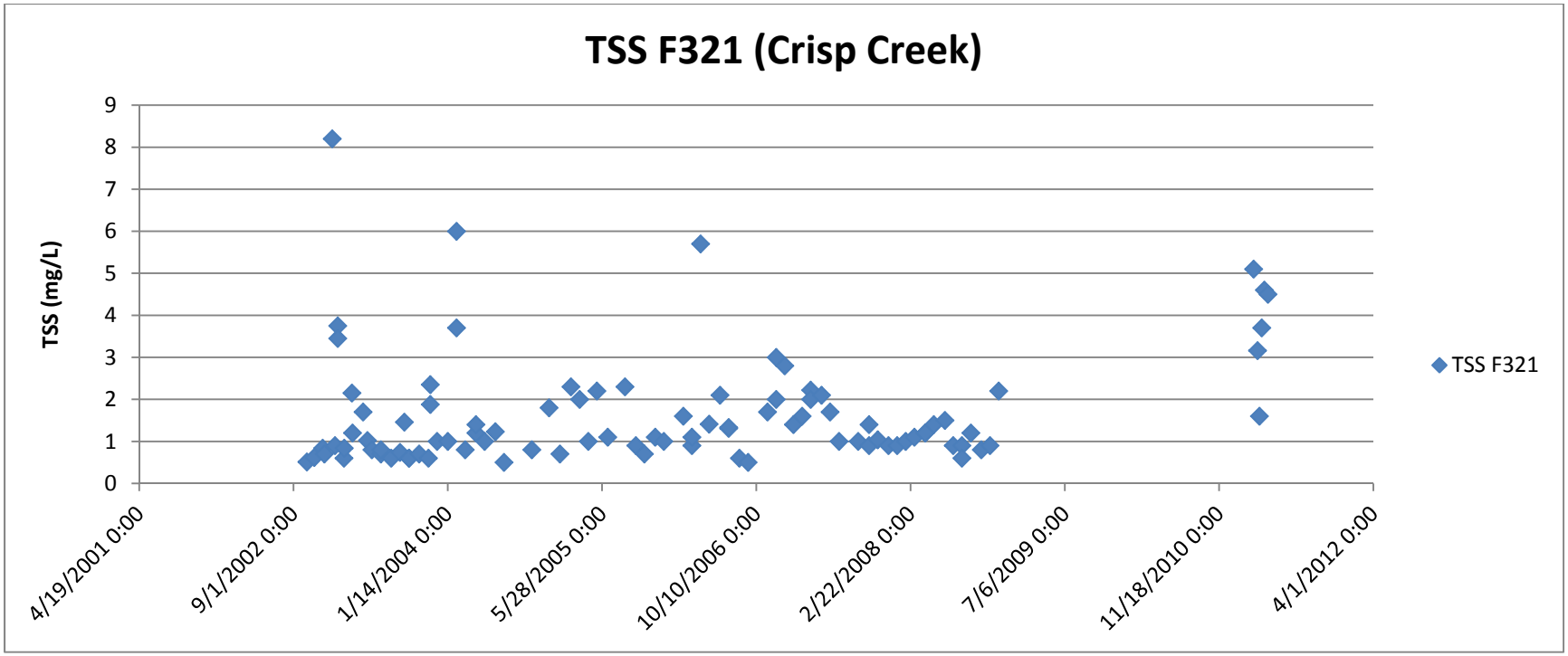
TSS graph and tables



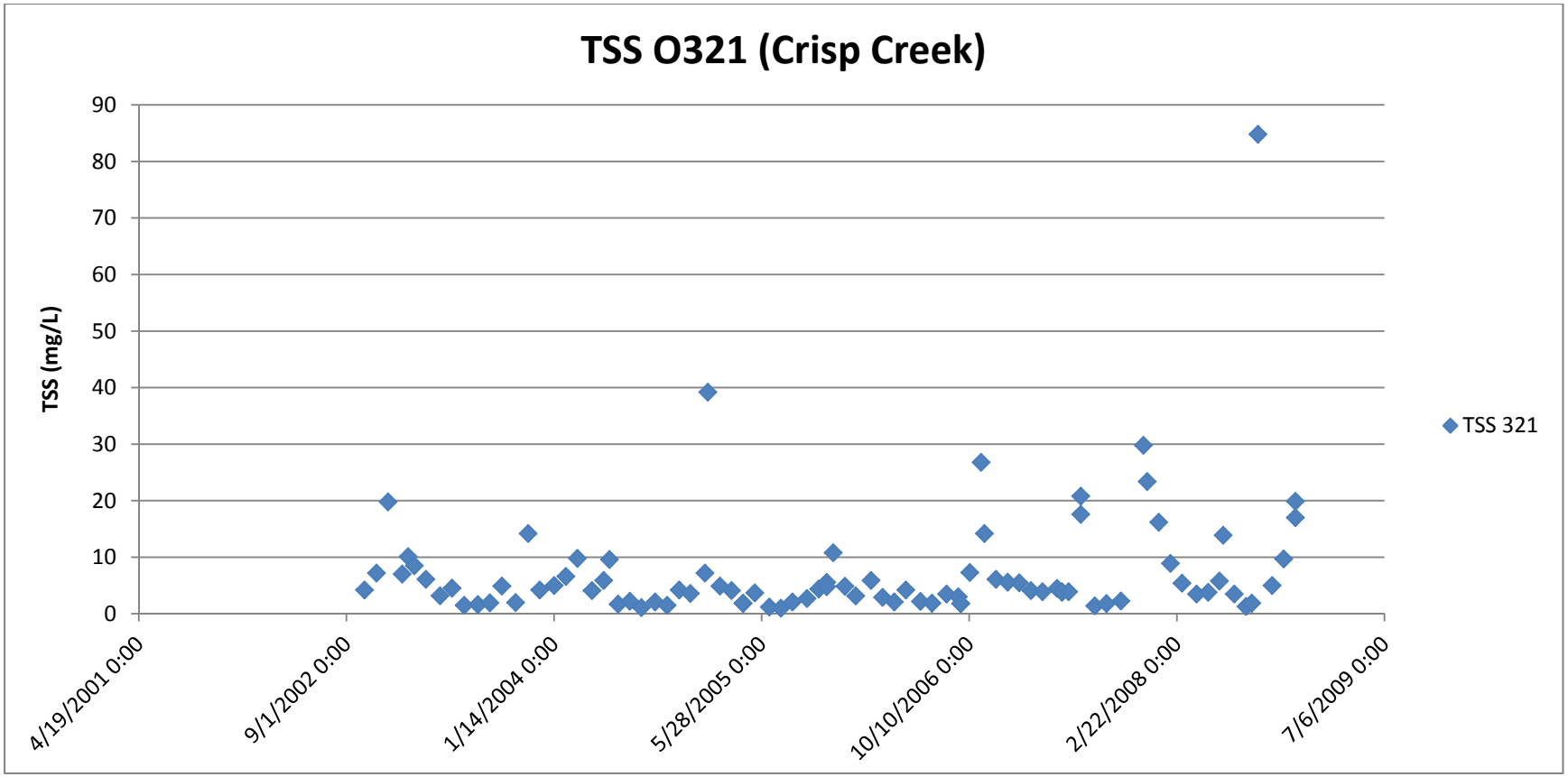
F322	Max	Min	Mean
	10.5	1.1	3.9



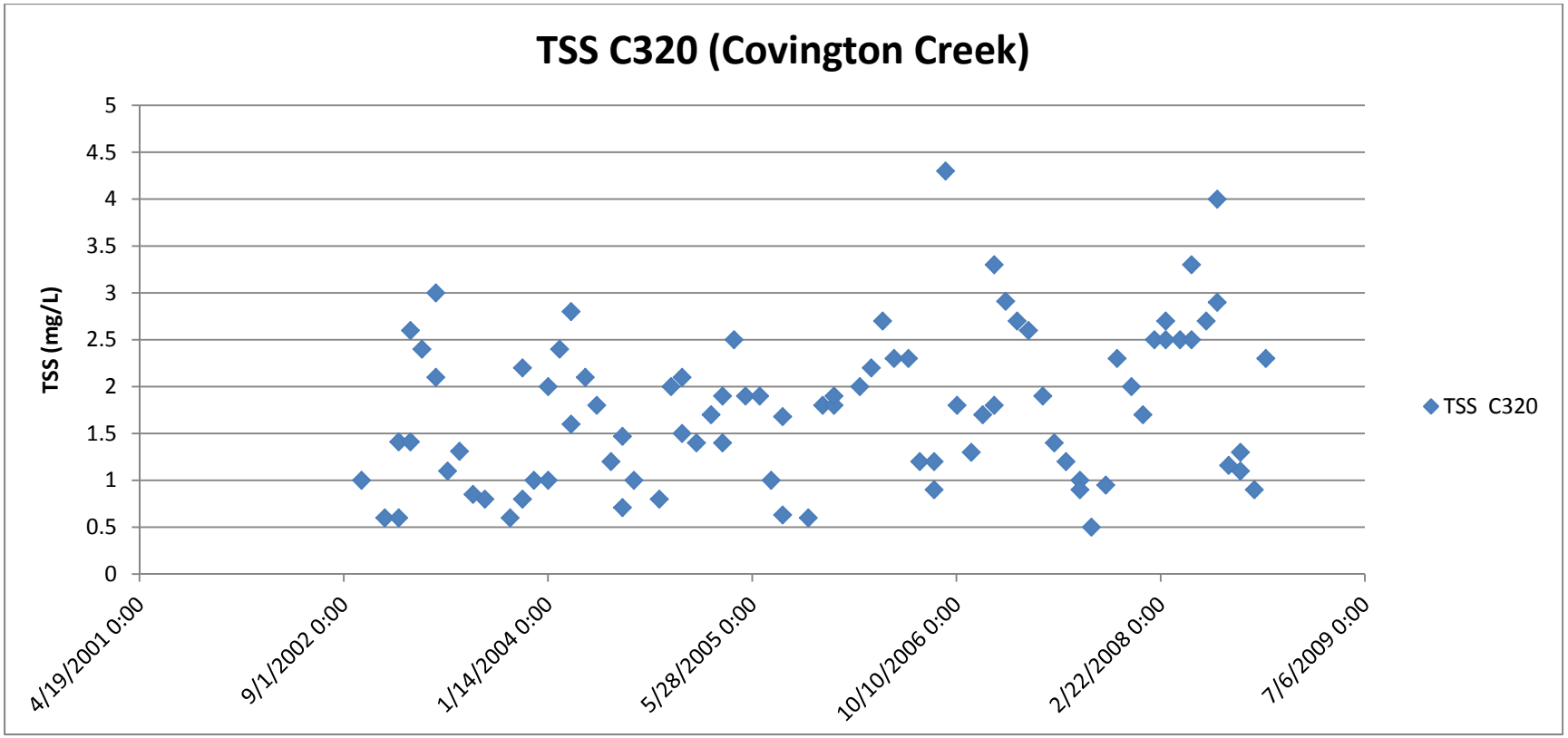
O322	max	min	mean
	504	0.7	12.6



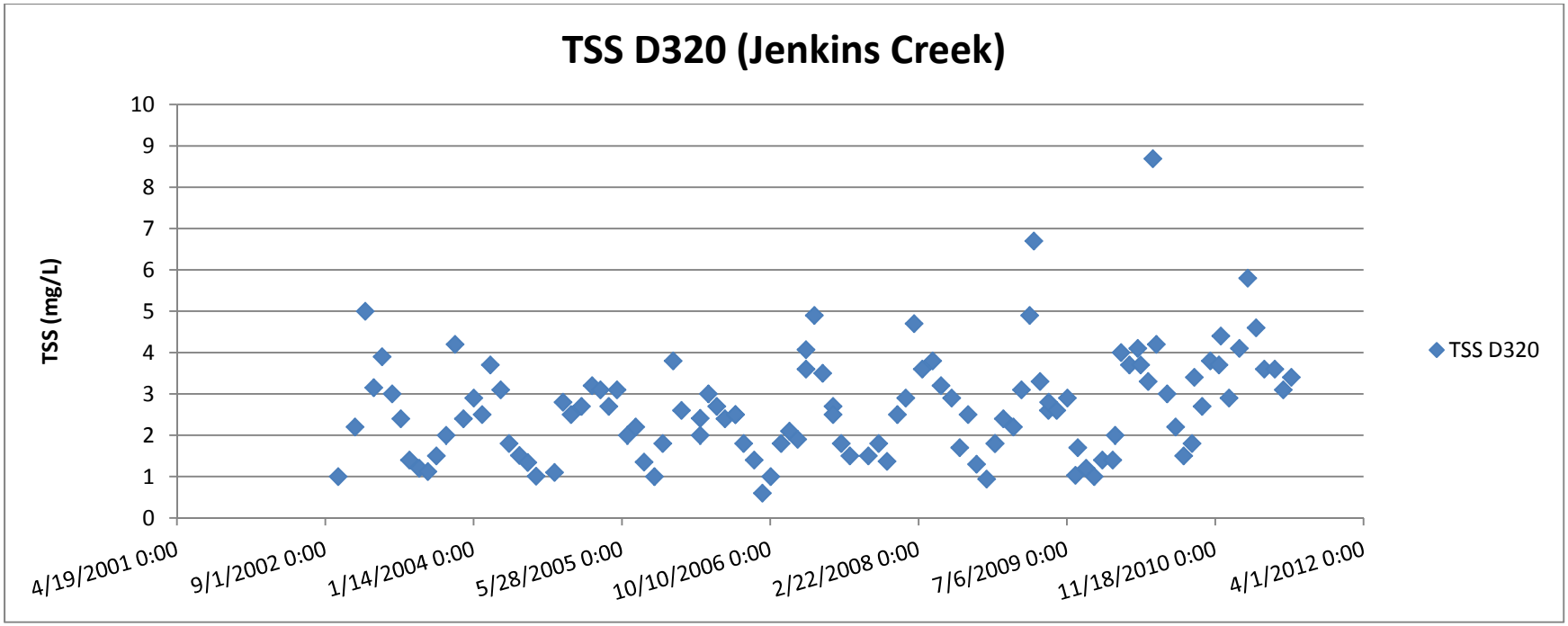
F321	max	min	mean
	8.2	0.50	1.6



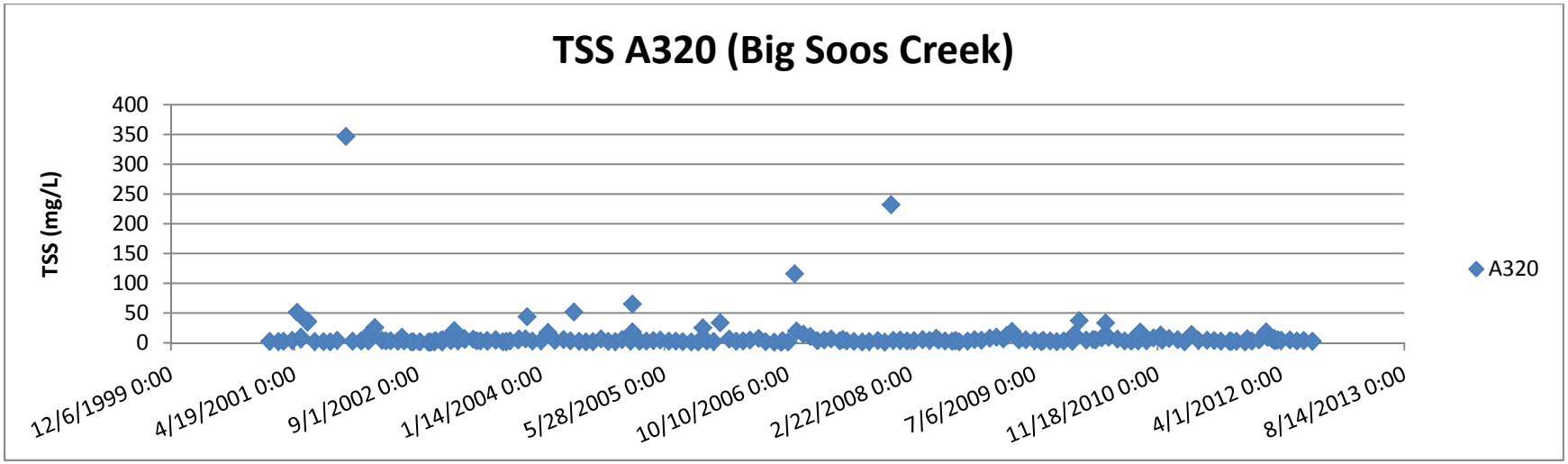
O321	max	min	mean
	84.8	1.0	7.5



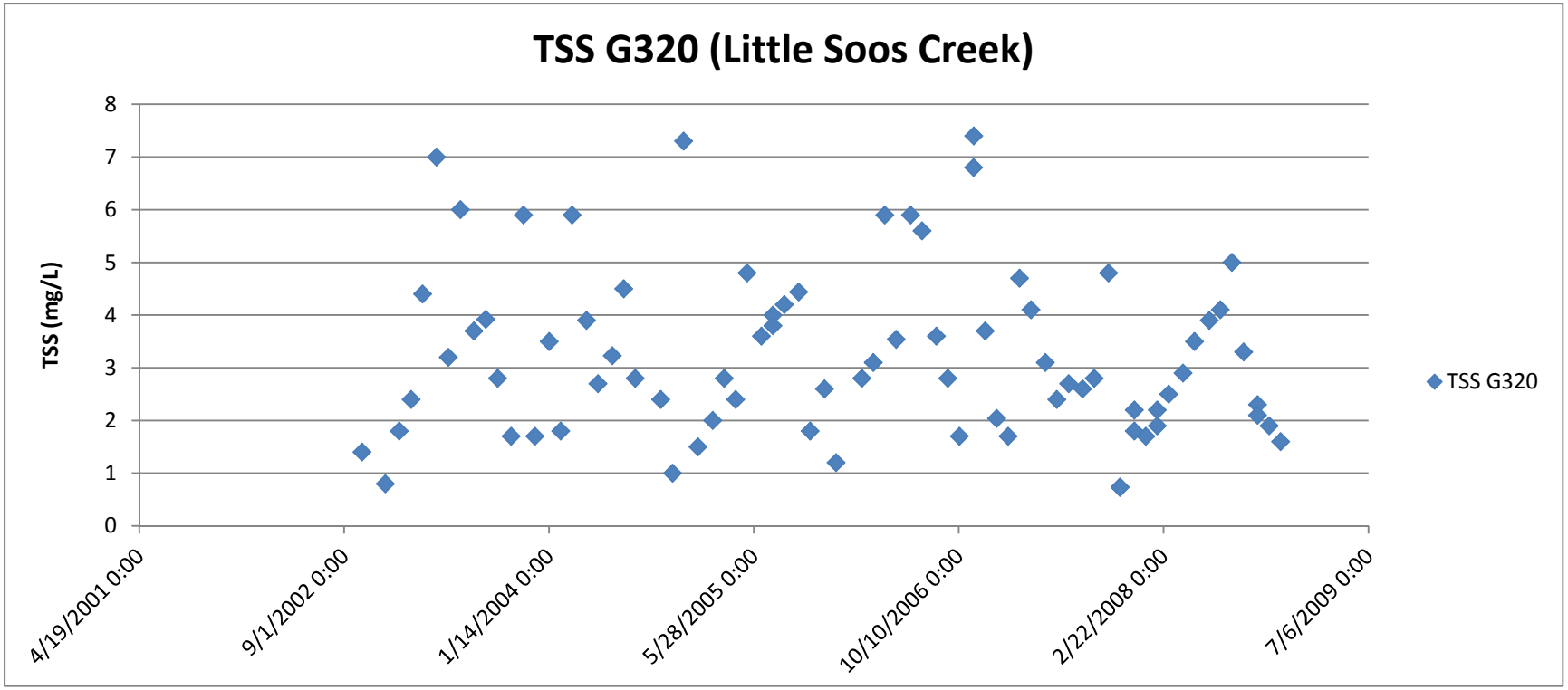
C320	max	min	mean
	4.3	0.5	1.8



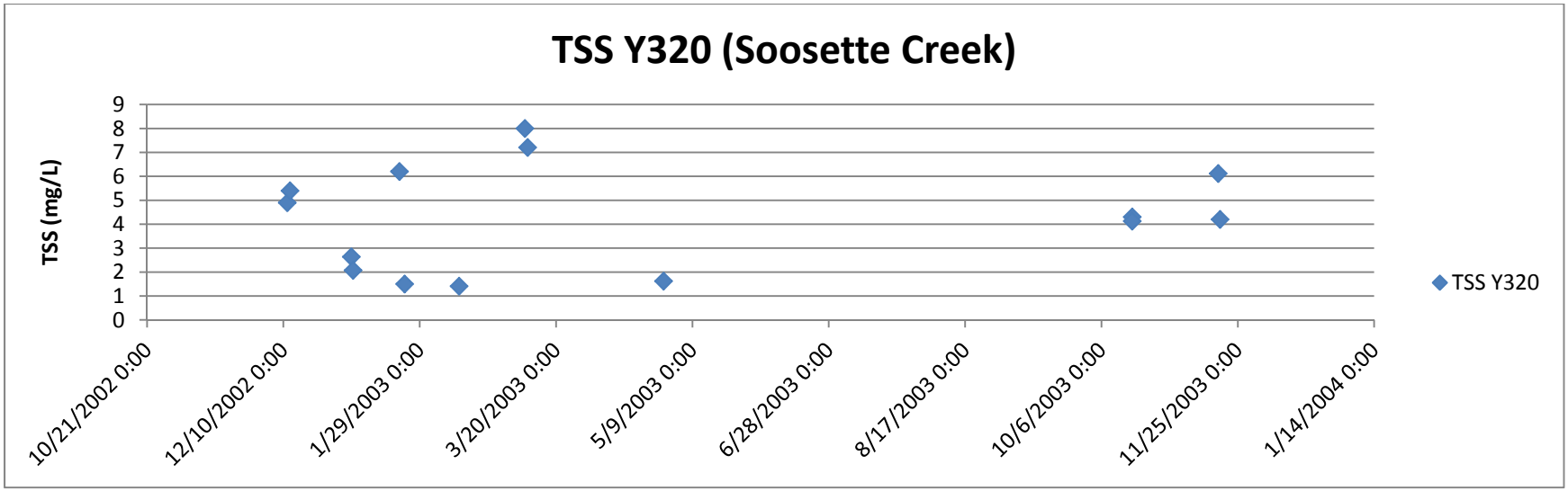
D320	max	min	mean
	8.69	0.6	2.7



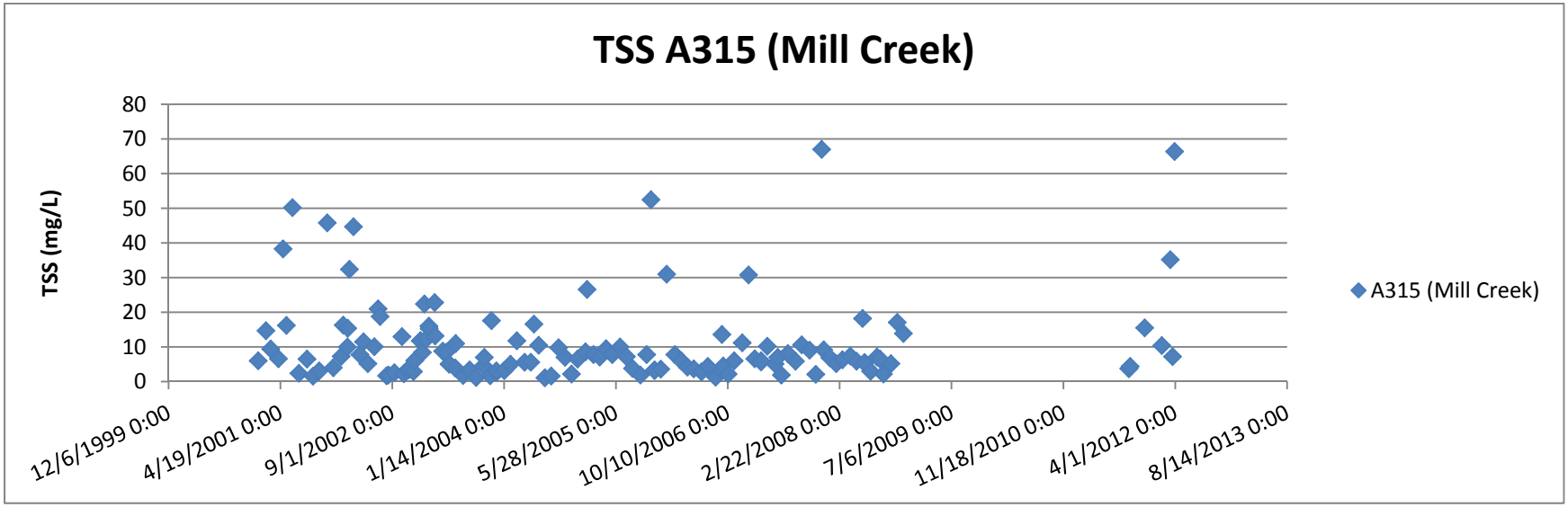
A320	max	min	mean
	347	1	10.3



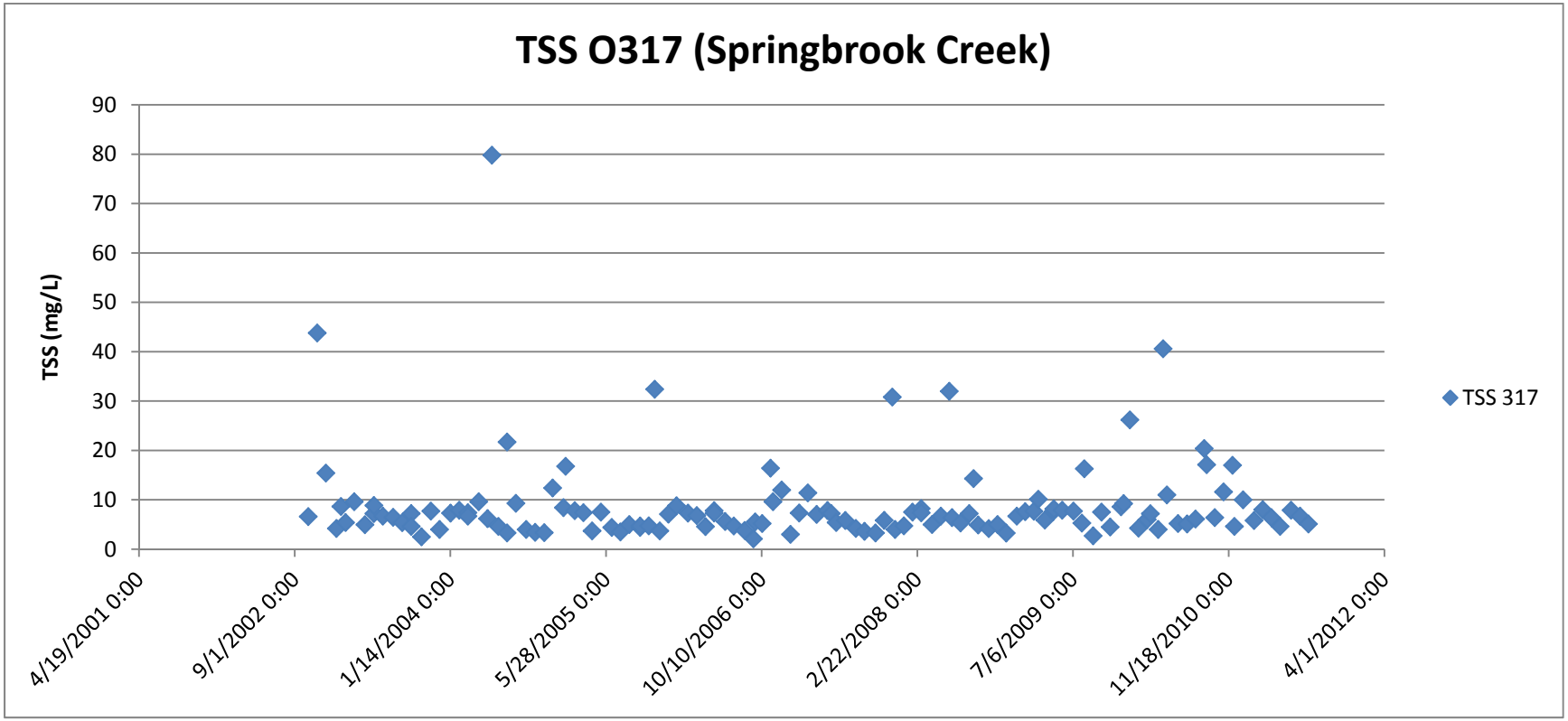
G320	max	min	mean
	7.4	0.73	3.2



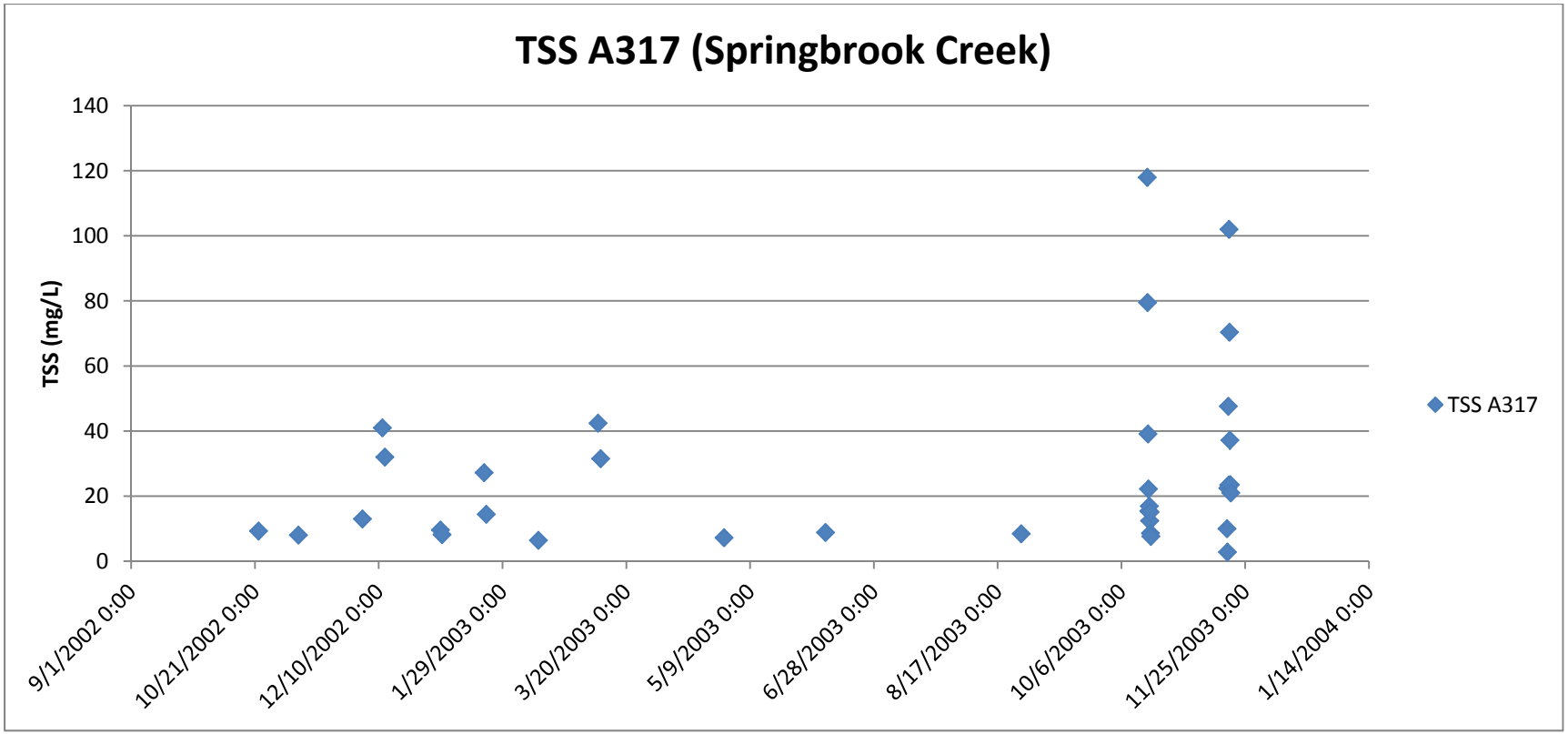
Y320	max	min	mean
	8.0	1.4	4.3



A315	max	min	mean
	67	1.1	10.6



O317	max	min	mean
	79.8	2.1	8.9



A317	max	min	mean
	118	2.8	27.5