DRAFT Annual Report to the Sam Hamilton Memorial Reserve
November 2012

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Abstract
Monitoring is being conducted in the Bull Creek watershed to determine effects, if any, of shaft construction and tunneling associated with the construction of the Jollyville Transmission Main (JVTM) for Water Treatment Plant #4 (WTP4). Monitoring includes City of Austin, Travis County, and private preserves and generally consists of evaluating water levels and taking water quality samples from stream, springs, and groundwater wells. This data is being used in adaptive management during the construction of the JVTM. Monitoring to date has shown no surface water quality impacts from JVTM construction, and has shown some impacts to water levels in the deep groundwater system (lower Glen Rose) which have not been shown to transmit to the shallow groundwater system (upper Glen Rose, Walnut, and Edwards). Age dating of the groundwater using tritium ion analysis supports this model, and has unexpectedly shown that groundwater from the deep system and also as high as the Edwards/Walnut contact is pre-modern water (before 1950), whereas surface water is postmodern.

Issue

Infrastructure related to Water Treatment Plant 4 will be constructed near and below the Sam Hamilton Memorial Reserve and Balcones Canyonlands Bull Creek Preserve. The design of both the JVTM and WTP4 have been subject to the Environmental Commissioning process (EC) conducted by the City of Austin's Watershed Protection Department. The EC process integrates environmental review and oversight into the design process to meet defined environmental goals that generally exceed minimum regulatory requirements. The City's EC process includes environmental monitoring along the length of the transmission main to detect environmental impacts from JVTM construction.

The monitoring program is designed to meet these objectives from the relevant Environmental Commissioning documents for WTP4:

- Document baseline hydrology, and stream and spring water quality prior to construction;
- Monitor during and following construction to detect possible changes from baseline conditions; and
- Identify changes from baseline conditions attributable to WTP4 from other changes that are observed in the watershed.

Project Status
As of October 2012, the WTP4 shaft, Four Points shaft, and Jollyville Reservoir shaft (all outside of the BCP) have been completely excavated, as well as Reach 1 of the tunnel (from Four Points to the WTP4 shaft). The Reach 2 and Reach 3 tunnels are currently being excavated. The Reach 2 tunnel has just crossed into the BCP on the west side of its alignment as of mid-October.

Methods & Data Analysis

The study area includes in the COA Bull Creek Preserve Franklin tract, the upstream Lanier tract, the original Bull Creek plant site, the WTP4 site, points along Bull Creek and associated tributaries, and a number of wells along Spicewood Springs Road including one on the Jollyville Reservoir site. **The only site located in the Sam Hamilton Memorial Reserve is Ribelin Spring, which serves only as a reference site. No impacts are expected in the Reserve.**

At surface and spring sites, water levels are calculated via installed TROLL and flow-meter and water quality parameters measured both in the field with a multi-meter sonde and in the lab.

Water quality samples are analyzed by DHL labs for the suite of parameters noted above. Water levels and environmental conditions such as rainfall and probe readings are noted and analyzed by staff.

Age dating samples have been taken at a wider array of sites within the BCP than the standard JVTM sites and have been included in Appendix 1. They were analyzed by LCRA for the suite of parameters below and for tritium. These samples were only drawn once and will not be repeated.

Results

The data collected in the Travis Co. BCP are attached an excel file from the sites and methodologies listed below:

Site	Water Quantity	General Water Quality	Age Dating
Ribelin Spring	Manual flow measurements	Yes	Yes

Table 1: Data taken in the BCP for JVTM impact monitoring

Analysis of monitoring results for the entire study through June of 2012 are attached in the Nov 2011-June 2012 Quarterly Data Report (Appendix 2). Results from June 2012-present have not yet been formally reported. However, preliminary analysis shows no effect so far on water level in groundwater wells from early tunneling into the BCP along the stretch from the Four Points shaft to Spicewood Springs, usually referred to as "Reach 2".

Tunneling has just crossed the western boundary of the COA BCP along the tunnel alignment as of mid-October 2012.

Essential to the monitoring program is a conceptual groundwater model developed by DB Stevens as part of the Preliminary Groundwater Assessment for the project. The model proposed two separate groundwater systems underlying the project area; one close to the surface that responded to rain events and serves as the source of the water for area springs and streams (the 'shallow' groundwater system) and a deeper groundwater system near tunnel horizon that is poorly connected to the surface. INTERA personnel are currently in the process of updating the model given what we have seen in the data so far, which has been supportive. Shaft excavation and tunneling outside of the BCP has resulted in drops in water level in the deep groundwater system, but so far we have seen no drops in water level in the shallow system that would indicate a vertical connection with the deeper system, and no drops at all within the BCP.

Conclusions

As reported in Appendix 1, shaft excavation and tunneling in areas outside of the BCP have shown drops in water level in the deep groundwater system but not the shallow. Because of poor vertical connectivity within the system, modeling indicates a low probability of affecting surface water availability as a result of tunneling underneath the BCP associated with this project.

Appendix 1

Age Dating of Groundwater in the Balcones Canyonlands Preserve

Appendix 1
Groundwater Age-Dating Monitoring in the Balcones Canyonlands Preserve

David Johns

October 31, 2012

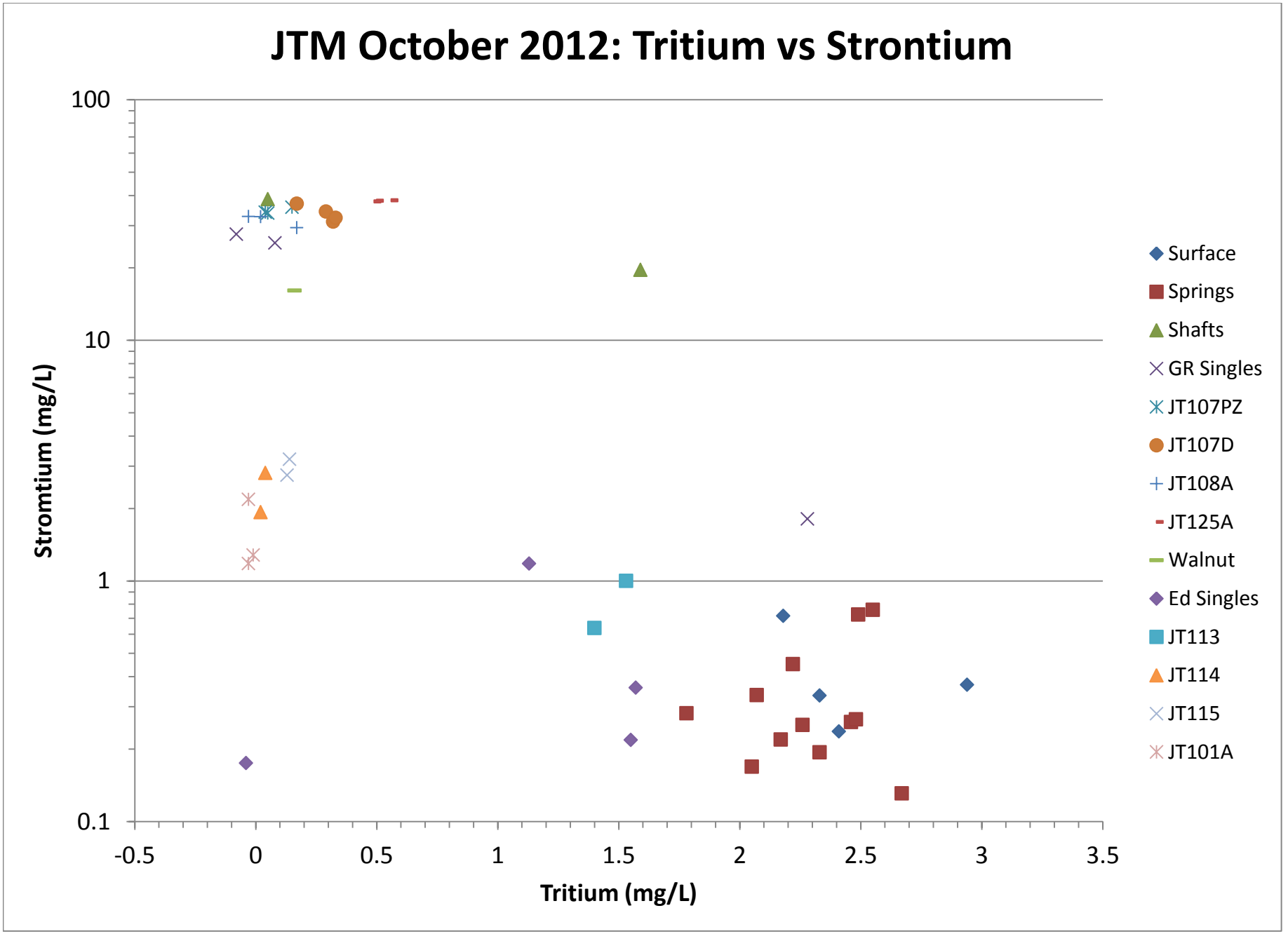
A conceptual groundwater model was proposed for the Jollyville Plateau area comprised of (1) a shallow system tens of feet thick feeding springs and creeks documented by groundwater tracing and (2) a deeper system greater than 100 ft below the surface poorly connected to the shallow system. Water samples were collected to determine geochemical characteristics and the relative age of water in each system testing the hypothesis that the shallow system would have younger and less chemically evolved water than the deep system. Water samples were collected from four surface water sites, 11 different springs and 17 wells ranging from >30 ft to >200 ft deep. Springs included those discharging from the Edwards, Walnut, Glen Rose formations as well as terrace deposits adjacent to the channels. Wells were screened in all three formations also. Sample collection began in April 2012 and was largely completed by August.

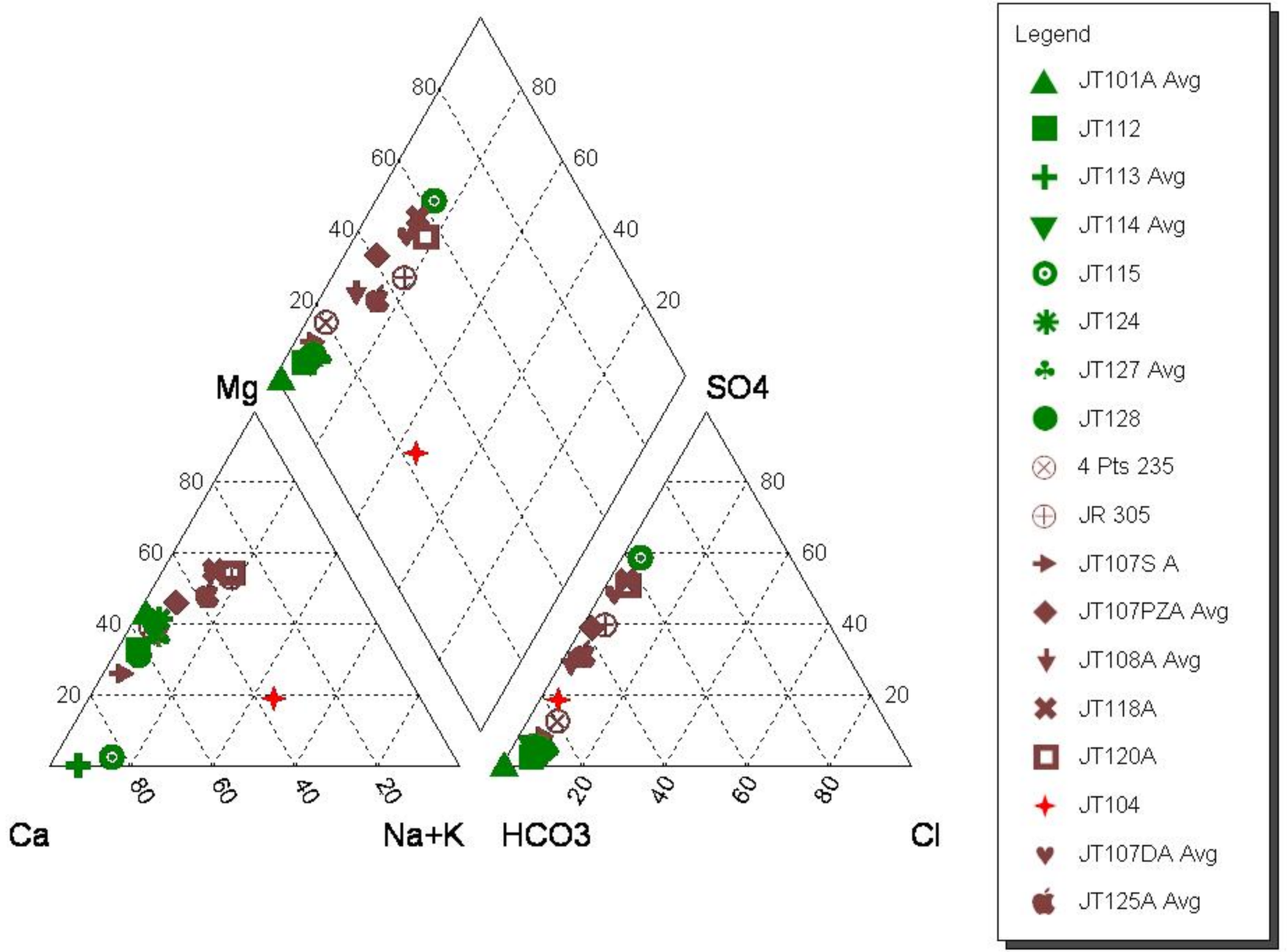
Geochemical signatures of surface and shallow groundwater are CaHCO3 evolving to greater enrichment in Mg and SO4 in deeper groundwater (Figure 1). Ion chemistry of the springs, creeks and shallow wells are largely identical with the exception of the Colorado River having significantly higher ion concentrations. In addition, Tanglewood and Spider Springs also have elevated ion concentrations due to impacts from urbanization. Chemistry in deeper wells (Glen Rose) is characterized by higher ion concentrations, particularly strontium, fluoride, sulfate, and potassium and lower Ca/Mg ratios (i.e. shallow water has more calcium and deeper water has more magnesium).

Interpretation of the tritium results is in progress and the following discussion is preliminary and subject to change (Table 1). Tritium results (Figure 2) indicate that the springs and creeks contain modern water (from precipitation since 1950) averaging 2.3 and 2.5 Tritium Units (TU) respectively. The deeper system (all Glen Rose wells) contains mostly pre-modern water (recharged before 1950) averaging 0.19 TU. A couple of Glen Rose wells have values in the range of 0.3 and 0.5 TUs which suggests there is mixing of pre-modern and modern water The shallow groundwater system (Edwards and Walnut wells), contains locations with a mix of modern and pre-modern water or surprisingly only pre-modern water. For example, Edwards wells JT124, JT114, and JT101A are all characterized by pre-modern water with values between -0.4 and 0.4 TUs. Six Edwards and Walnut wells, JT104, JT109, JT112, JT113, JT115, JT127 and JT128 appear to contain a mix of pre-modern and modern water, ranging from 0.13 to 1.57 TUs. Results in JT112 and JT128 are likely due to introduction of surface water used in tracer injections. JT113 and JT115 may also be influenced by tracing water since tracers were detected in those wells. However, natural mixing of older and younger water may also be occurring. JT104 and JT109 may have natural mixing within the Walnut. JT127 is adjacent to the Jollyville shaft and had a large drop in the local water table prior to sampling with may have influenced the tritium results.

Results indicate that in the Jollyville Plateau, there is a shallow groundwater system feeding the springs and creeks that is characterized by recently recharge water

(modern water). Most groundwater in wells is either a mix of modern and pre-modern water or only pre-modern. Additional data analysis is on-going.


JTM October 2012: Tritium vs Strontium
Stromtium (mg/L)
100
10
1
0.1
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
Tritium (mg/L)
Surface
Springs
Shafts
GR Singles
JT107PZ
JT107D
JT108A
JT125A
Walnut
Ed Singles
JT113
JT114
JT115
JT101A


Mg
SO4
Ca
Na+K
HCO3
Cl
80
60
40
20
Legend
JT101A Avg
JT112
JT113 Avg
JT114 Avg
JT115
JT124
JT127 Avg
JT128
4 Pts 235
JR 305
JT107S A
JT107PZA Avg
JT108A Avg
JT118A
JT120A
JT104
JT107DA Avg
JT125A Avg

SITE	DATE	TEMP	SP COND	DIS OXY	PH	CALCIUM mg/L	MAGNESIUM mg/L	POTASSIUM mg/L	SODIUM mg/L	STRONTIUM mg/L	CHLORIDE mg/L	FLUORIDE mg/L	SULFATE mg/L	ALKALINITY mg/L	TRITIUM TU	NOTES
Surface Water																
LkA Low Water Crossing	4/17/2012 1350	16.12	484	13.62	8.24	42.8	22.1	3.92	25.2	0.37	42.2	0.24	26.9	164	2.94	Generally very different from creek chem. (except sulfate and strontium)
Bull Ups Gaas	4/17/2012 1310	19.80	618	1.86	7.22	109	14.7	0.821	10.2	0.237	21.7	0.12	25.3	280	2.41	
Bull Dwns WTP4	4/17/2012 1140	19.01	576	3.90	7.31	103	15.7	0.468	9.54	0.334	17.6	0.12	21.1	264	2.33	
Bull at Trib 7	4/17/2012 0855	17.71	541	6.68	7.85	95.1	15.1	0.616	8.45	0.715	16.7	0.12	19.3	249	2.18	
Springs																
Tanglewood Spr	4/17/2012 1440	20.79	1022	7.77	7.22	154	31.2	1.96	33.8	0.219	76.4	0.25	70.4	364	2.17	These values are not the same as those from JT127 (see qtr data rept for June 2012)
Spider Spr	5/1/2012 0955	22.48	1053	5.92	7.05	154	35	1.1	29.3	0.194	56.5	0.2	51.5	410	2.33	
Powerline Spr	4/17/2012 1215	18.90	627	8.44	7.37	126	14.5	0.321	6.7	0.131	13	0.12	12.6	313	2.67	Ion balance betw 11-12%
Gaas Spr	4/17/2012 1320	19.14	668	7.04	7.01	118	25	0.398	8.97	0.282	14.4	0.18	13.1	340	1.78	Ion balance betw 11-12%
Cistern Spr	4/17/2012 0940	19.64	583	8.14	7.30	106	20	0.229	4.54	0.335	8.15	0.13	8.25	300	2.07	Ion balance betw 11-12%
Pit Spr-bank	4/17/2012 0910	18.28	544	4.92	7.57	95	15.1	0.595	8.38	0.758	16.7	0.13	19.9	252	2.55	
Pit Spr-channel	5/1/2012 0925	18.76	542	2.90	7.12	92.8	12	0.52	7.78	0.724	14.2	0.09	16.5	247	2.49	
Lanier Spr	4/17/2012 1005	18.10	600	6.29	7.22	109	15.6	0.499	9.35	0.451	17.6	0.12	21.2	279	2.22	
Ribelin Spr	4/17/2012 1045	17.95	586	8.72	7.30	104	17.7	0.706	9.23	0.259	18.7	0.15	17.3	272	2.46	
Ribelin Spr dup	4/17/2012					101	17.1	0.69	9	0.252	18.7	0.15	17.4	270	2.26	
4 Points Spring 1	8/8/2012 1055	NT	568	NT	7.41	105	17.60	0.26	6.84	0.169	10.30	0.15	12.4	301	2.05	West of Riverplace
4 Points Spring 2	8/8/2012 0925	NT	675	NT	7.22	122	17.50	0.47	11.80	0.266	21.70	0.13	30.1	322	2.48	Below 4 Pts Dr
Wells and Shafts																
4 Pts - 235 ft	5/18/2012 0940	NT	NT	NT	NT	80.9	34.9	2.32	7.53	19.6	15.7	0.35	35.7	284	1.59	55 ft into Glen Rose
JR - 305 Ft	5/22/2012 1210	NT	NT	NT	NT	59.3	66.5	23.4	29	38.6	20.5	3.51	188	330	0.05	35 ft into Glen Rose
JT118A	5/24/2012 1215	21.59	1107	5.57	7.07	85	87.2	18.8	26.7	27.6	19.4	3.76	303	317	-0.08	Ion balances over 25%, sulfate value??
JT120A	6/14/2012 1040					75.8	87.8	25.1	37.4	25.4	23.2	3.76	299	332	0.08	Field parameters measured in office
JT107S-A	7/19/2012 1140	21.51	571	7.71	7.14	127	29.1	1.49	8.71	1.81	12.3	0.19	24.4	324	2.28	
JT107PZ-A	6/26/2012 1110	21.48	874	2.00	7.07	154	79.9	16	14.9	35.7	7.93	3.12	182	541	0.15	Initial sample
JT107PZ-A	7/3/2012 1055	21.68	876	3.57	7.05	84.2	70	14	15.2	34.1	8.29	2.92	177	130	0.04	Middle sample. Poor ion balance, don't use in avg
JT107PZ-A	7/5/2012 1410	22.68	880	2.23	7.10	127	72.4	14.4	15.6	33.8	8.3	2.81	170	338	0.05	Final sample after purge
JT107PZ-A Avg		21.95	876.67	2.60	7.07	121.7	74.1	14.80	15.2	34.5	8.2	2.95	176.3	336.3	0.08	
JT107D-A	8/8/2012 1305	26.26	801	3.75	7.23	65	65.1	13.6	18	37	8.49	2.96	164	320	0.17	Initial sample, no purge, probably don't use to average although values are not as far off as 108, poor ion balance, OK to use
JT107D-A	8/9/2012 0855	24.38	1061	1.62	7.03	71.9	76.1	15.9	22.6	34.3	11.1	3	234	308	0.29	Middle sample, purge half done, really poor ion balance
JT107D-A	8/9/2012 1410	29.86	1164	4.56	7.18	82	85.3	17.5	26.1	31.1	13.5	3.23	296	306	0.32	Final sample, purging complete, tubing in sun, really poor ion balance
JT107D-A (dup)	8/9/2012 1420					82.7	85.7	17.9	26.3	32.3	13.6	3.24	297	304	0.33	Dup sample, really poor ion balance
JT107D-A Avg		26.83	1009	3.31	7.15	75.4	78.1	16.2	23.3	33.7	11.7	3.11	247.8	309.5	0.3	
JT108A	7/5/2012 1025	20.61	864	1.67	7.12	174	71.8	14.6	21.2	29.4	10.5	2.53	162	670	0.17	Initial sample, poor ion balance
JT108A	7/5/2012 1507	21.01	906	1.41	7.14	313	90.6	15.5	26.2	32.6	9.86	2.82	186	610	0.02	Middle sample, poor ion balance
JT108A	7/19/2012 1315	23.31	905	3.02	7.24	81	67.3	10.9	23.5	32.7	9.72	2.84	181	325	-0.03	Purge sample, not sure how to average - all 3???, Ca and Alk different in last sample, use all three
JT108A Avg		21.64	891.67	2.03	7.17	189.33	76.57	13.67	23.63	31.57	10.03	2.73	176.33	535.00	0.05	
JT125A	8/10/2012 0930	23.50	921	3.07	7.10	68.3	61.2	18	19.3	38	14.8	2.85	128	344	0.5	Initial sample, no purge, poor ion balance
JT125A	8/10/2012 1100	24.08	921	0.90	7.04	63.6	61.1	18.1	18.3	37.8	14.7	2.88	128	330	0.49	Final sample, purging complete, poor ion balance
JT125A (dup)	8/10/2012 1110					63.6	30.9	18.1	18.2	38.2	14.7	2.86	126	330	0.56	Dup sample, average all 3, really poor ion balance
JT125A Avg		23.79	921.00	1.99	7.07	65.17	51.07	18.07	18.60	38.00	14.73	2.86	127.33	334.67	0.52	
JT104	5/29/2012 1305	26.93	852		7.50	88.3	28.1	6.62	123	16.1	16.2	3.72	87.7	459	0.16	
JT109	5/1/2012 1005	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	0.69	Insufficient water for field parameters or ion sample
JT124	5/29/2012 1150	23.90	592	5.20	6.97	72.3	34.4	0.924	8.58	0.175	13.5	2.27	7.88	298	-0.04	
JT127	8/2/2012 1230	26.50	788	NT	7.60	107	42.8	0.759	28.4	0.218	40.1	0.4	31.5	378	1.55	
JT113	6/5/2012 1215	22.51	2010	2.98	11.82	183	0	8.37	12.1	1	16.2	0.44	14.5	367	1.53	Really high pH and SC for Edwards, poor ion balance
JT113	7/26/2012 1210	23.34	1470	4.16	11.48	160	0.703	4.34	10.4	0.637	14.8	0.47	27.5	476	1.4	pH and SC remain high after pumping 3 well volumes, average both
JT113 Avg		22.93	1740	3.57	11.65	171.5	0.4	6.36	11.3	0.82	15.5	0.46	21.0	422	1.47	
JT114	6/5/2012 0940	21.81	605	7.88		99.9	40.3	1.24	14.7	2.81	10.4	0.23	20.1	312	0.04	Initial sample, poor ion balance
JT114	6/5/2012 1005	21.81	594	6.99	5.21	79.9	36.8	0.876	8.41	1.93	10	0.24	13.8	322	0.02	Purge sample, not too different from initial sample, average both
JT114 Avg		21.81	600	7.44	5.21	89.9	38.6	1.06	11.6	2.37	10.2	0.24	17.0	317	0.03	
JT115	6/1/2012 0935	NT	NT	NT	NT	145	2.73	3.95	25.9	3.2	11.9	0.44	206	164	0.14	Very screwy chem for Ed well, plots like GR well
JT115	8/2/2012 1438	26.50	781	NT	7.60	79.5	19.5	4.03	10.8	2.75	11.2	0.41	98	144	0.13	Use last one??, Poor ion balance
JT115 Avg		26.50	781	NT	7.60	112.3	11.1	3.99	18.4	2.98	11.6	0.43	152	154	0.14	
JT112	6/12/2012 1430	22.77	616	6.23	7.08	87.1	27.9	0.779	8.17	1.18	12.7	0.18	7.12	310	1.13	
JT128	6/12/2012 1530	21.01	513	7.84	7.16	72.6	22	0.558	8.08	0.36	13	0.19	9.38	246	1.57	
JT101A	6/19/2012 0905	21.93	474	6.37	7.47	139	165	4.88	6.97	2.18	0	0.31	0	2030	-0.03	Initial sample, poor ion balance, do not use in average
JT101A	6/19/2012 1345	22.68	467	7.91	7.24	152	36.4	1.51	5.68	1.18	7.65	0.35	3.85	344	-0.03	Purge sample, poor ion balance
JT101A	7/26/2012 1110	21.95	474	7.83	7.45	227	47.7	2.14	5.97	1.28	7.66	0.34	3.9	446	-0.01	Re-sample based on odd ion chemistry, average last 2, tritium is average of lab dup runs
JT101A Avg		22.32	471	7.87	7.35	189.5	42.05	1.83	5.83	1.23	7.66	0.35	3.88	395	-0.02	

Samples
Clear = surface and springs
Brown = Glen Rose
Blue = Walnut
Green = Edwards

Appendix 2

Jollyville Transmission Main Environmental Monitoring Report
November 2011 – June 2012

Jollyville Transmission Main Environmental Monitoring Report November 2011- June 2012

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ABSTRACT

Monitoring is being conducted in the Bull Creek watershed to determine effects, if any, of shaft construction and tunneling associated with the construction of the Jollyville Transmission Main (JVTM) for Water Treatment Plant #4 (WTP4). The design of both the JVTM and WTP4 have been subject to the Environmental Commissioning process (EC) conducted by the City of Austin's Watershed Protection Department. The EC process integrates environmental review and oversight into the design process to meet defined environmental goals that generally exceed regulatory requirements.

The City's EC process includes environmental monitoring along the length of the transmission main to detect environmental impacts from JVTM construction. Monitoring includes City of Austin, Travis County, and private preserves and generally consists of evaluating water levels and taking water quality samples from surface water, springs, and groundwater wells. This data will be used to observe environmental conditions in the project area and will be used, if needed, in adaptive management during the construction of the JVTM. The monitoring program is designed to meet these objectives from the Environmental Commissioning Plan for WTP4:

- Document baseline hydrology, and stream and spring water quality prior to construction;
- Monitor during and following construction to detect possible changes from baseline conditions; and
- Identify changes from baseline conditions attributable to WTP4 from other changes that are observed in the watershed.

MONITORING PLAN OVERVIEW

Sites
This project currently conducts monitoring at 24 wells, 5 stream sites and 4 springs. For detailed site information, see Table 1.

Timeline
This project is broken into three phases: Baseline (Spring 2011- Fall 2011), Construction (Fall 2011-Spring 2013) and Post-construction (Spring 2013 – Fall 2013). Earlier baseline water-level data was also collected from monitoring wells as they were installed beginning in November 2010.

Recent Activities
The November 2011 - June 2012 period comprises construction-phase monitoring and collection of baseline period data for surface flow sites. Construction at the Four Points shaft is complete, Reach 1 tunneling is underway in the Glen Rose Formation, and Jollyville Reservoir shaft construction began October 28th 2012 and has been excavated through the Edwards and Walnut Formations and into the Glen Rose Formation ending at a total depth at 350 ft on June 18.

Identification of a previously unknown Jollyville Plateau Salamander (JPS) site in Tributary 4 near the Spicewood shaft site initiated the adaptive management process, resulting in substantive changes to the environmental controls and monitoring plan at that site.

Baseline data collection is complete for all wells and surface sites. Due to record drought, very little water quality data was taken from surface sites during the original baseline period (June-September 2011). Baseline surface water data was collected between December 2011 and March 2012 and consisted of 9 of the planned 12 samples, although subsequent sampling can be considered to be baseline as well, as construction has not progressed to any location that could potentially impact those sites.

Changes to Monitoring Plan
A number of changes to the monitoring plan were made as part of the EC adaptive management process. These changes are detailed in Table 2.

RESULTS

Four Points Shaft Impact Monitoring

Monitoring sites (see Table 1):

- Wells:
  - JT-112 screened at Edwards/Walnut contact approximately 120 feet in a downgradient direction from the shaft (continuous monitoring and water quality samples taken)
  - JT-128 screened at Edwards/Walnut contact (continuous monitoring); immediately adjacent to shaft
- Surface sites:
  - Bull Creek above WTP4, downstream from shaft location (continuous monitoring and water quality samples taken)

Four Points Groundwater Elevations

Site preparation at Four Points began on September 7, 2011. Shaft excavation began in early October, and beginning on November 15, 2011 the groundwater layer above the Edwards/Walnut contact was reached and excavated through, resulting in water-level declines in the JT-112 and JT-128 wells (see figure 1).

After a permeable ring, cementitious grout, and liner plates were installed in the shaft at the lower part of the Edwards and the excavation proceeded, it became clear that the wells were not showing a recovery in water level, and that the groundwater from the Edwards at that elevation was continuing to drain into the shaft. While the rate of flow never exceeded the design limit for the shaft of 10 gpm, continuing water level declines in the wells were a consequence of the very low flow rate of 2 to 3 gallons per minute into the shaft. As part of the EC adaptive management process, the decision was made to inject a hydrophobic grout behind the shaft liner plates into the spaces between cementitious grout pours to further reduce groundwater inflow (Report on Adaptive Management Process for Four Points Shaft Groundwater Loss, February 2012).

To check for an expanding zone of influence from the shaft inflow on groundwater in the Edwards, a continuous monitoring device (TROLL) was installed in the nearby JT-113 reference well. In addition, the JT-114, JT-115, and JT-101A wells were monitored with e-lines several times a week. Stable or slowly rising water levels in these wells indicated that the zone of influence from shaft construction likely did not expand into these wells (Figure 2) and was limited to the immediate vicinity of the shaft. .

A contaminant transport analysis was conducted due to concerns over the phthalate content of the grout (30-60%) and the possible toxic effect on salamanders in a nearby spring. Results of a thorough hydrogeologic assessment indicated that concentration levels were unlikely to reach the Lowest Effects Concentration limit of 0.1 mg/L even at the shaft permeable ring (Assessment of Potential Di-n-butyl phthalate Concentration in Groundwater from Hydro Active Cut Grout Emplacement at the Four Points Shaft April 4, 2012), and no transport above that concentration was predicted beyond the shaft.

The grout injection was performed on 1/27/12. Afterwards, groundwater levels in the nearby wells began to recover and are still rising at this time (May 10, 2012; Figure 1). JT-128 has reached full recovery; JT-112 has recovered to within 0.75 feet of its original level of 977.6. The JT-128 well experienced flooding from surface inflows after significant rain events during the reporting period but returned to previous levels within hours. As recovery is above preconstruction levels, the TROLL in 128 was removed and dedicated to the Spicewood shaft wells while JT-128 levels are monitored monthly using an e-line.

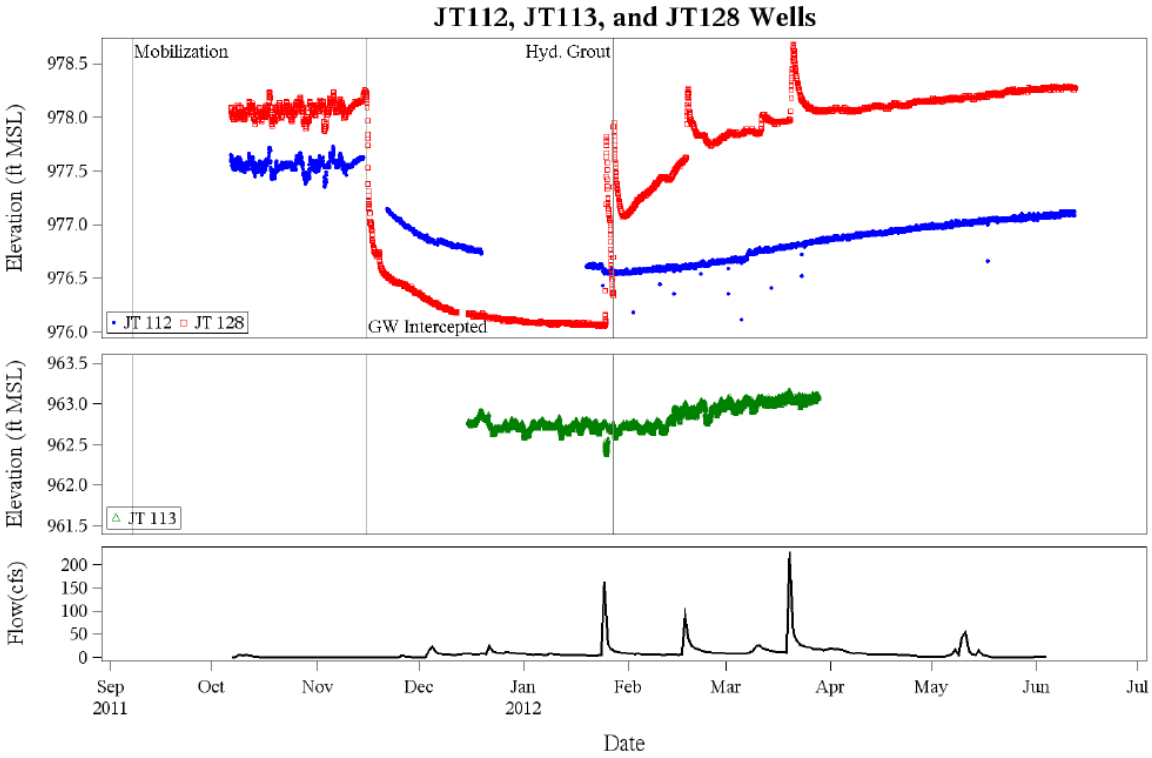


Figure 1. Fall and subsequent recovery of water levels in JT112 and JT128. JT113 shows an increase with rainfall events.

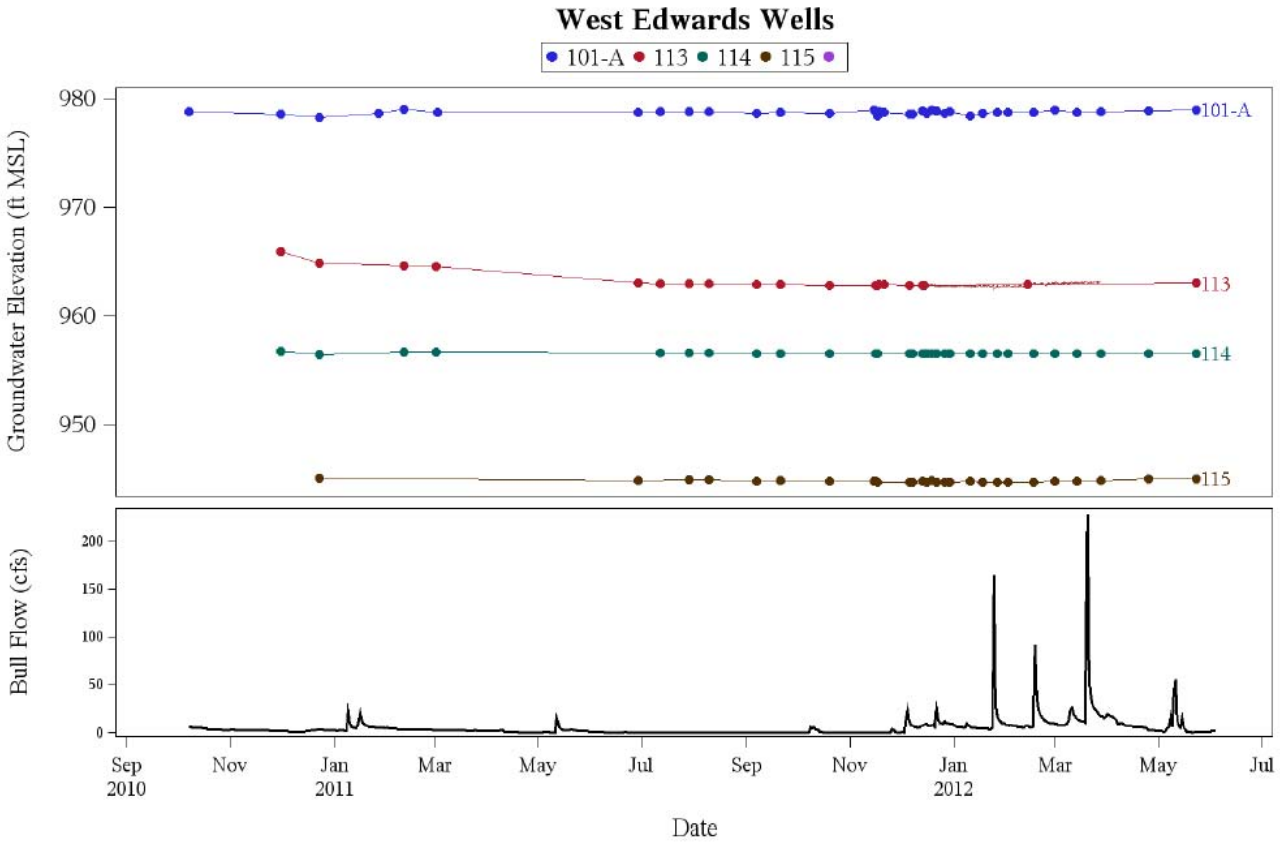


Figure 2. Stability of water levels in nearby wells indicates drop in groundwater inflow to the Four Points Shaft did not expand to these wells.

Four Points Water Quality

Twenty water quality samples were taken from JT-112 and ten from Bull Creek above WTP4 (BCAW) and tested for physical and chemical parameters (see list). All parameters fell within expected range and below TCEQ screening levels with the following exceptions:

- JT-112 TSS rose to 60 mg/L on February 22, 2012 after a baseline period of non-detects. This spike is attributed to a significant rain event.
- JT-112 Ammonia peaked at 0.43 mg/L (above TCEQ levels of 0.33 mg/l?) on September 7, 2012, before excavation began. This level is attributed to natural variability in ammonia concentrations.
- BCAW registered Zinc levels of 0.564 mg/l on April 5, 2012. In general, this site had experienced no significant zinc during this study's baseline period. This value is higher than the 99th percentile of historic measurements for this site. In comparison to citywide stormwater runoff event concentrations, however, median zinc values from COA's most recent assessment range from approximately 6 mg/L in undeveloped areas to 300 mg/L in densely developed areas. An accompanying spike in zinc at the reference spring Tanglewood, not connected to the Four Points shaft area, is supportive of a stormwater runoff explanation for this event.
- No phthalates have been detected at JT-112 or Gaas spring for the sampling period.

Jollville Reservoir Shaft Impact Monitoring

Monitoring sites (see Table 1):

- Monitoring at this shaft is via the JT-127 well, screened in the Edwards and equipped with continuous water level monitoring equipment and a bladder pump to withdraw water quality samples from the well.

Jollyville Reservoir construction began October 28, 2011 and as of June 18, 2012 it had reached total depth.

JT-127 Groundwater Elevations

The JT127 monitoring well is screened at the base of the Edwards at the contact with the underlying Walnut. The water level in JT-127 indicated by the continuous monitoring has been prone to sudden shifts. In all cases, reported levels have been verified with an e-line. The first of these was a three-foot jump in September 2012 before construction began onsite (see JVTM Quarterly Data Report 11.13.12). Subsequently it showed a 2-foot drop on 12/21/11 and a 1-foot rise on 1/5/12. Normal variability for this well tends to be ~0.2 – 0.4 ft (associated with a combination of barometric and earth tide effects).

On February 10, 2012, just after the project excavated through the bottom of the Comanche Peak formation and back into the Edwards, water level in JT-127 experienced a 56.5 foot drop over a 24-hour period. Water levels had been about 70 ft below ground previous. Geologically, the Comanche

Peak interfingers within the Edwards in this area. The EC Team currently believes that the Comanche Peak acts as a flow barrier within the Edwards and makes the Edwards below the Comanche Peak a confined aquifer. Shaft excavation released the groundwater pressure and caused the drop in the local water potentiometric surface. Groundwater inflows into the JR shaft did not change significantly during this event as indicated by pumping records and visual observations.

This water level drop in the Edwards does not appear to present an environmental threat because of the following:

- Closest spring with known salamander habitat (Tanglewood Spring) is about 4700 ft west of JR shaft, and are likely beyond the possible zone of shaft influence.An Edwards well (JT-124A) approximately 4380 ft away between the shaft and near Tanglewood Spring did not indicate any significant water level change near or since the time of the drop at JT-127;
- Observations of Tanglewood Spring did not indicate any significant changes in discharge flow or other characteristics;
- Once the JVTM project is complete in 2014, the JR shaft will be backfilled with tunnel sediment. The need for further measures will be evaluated.

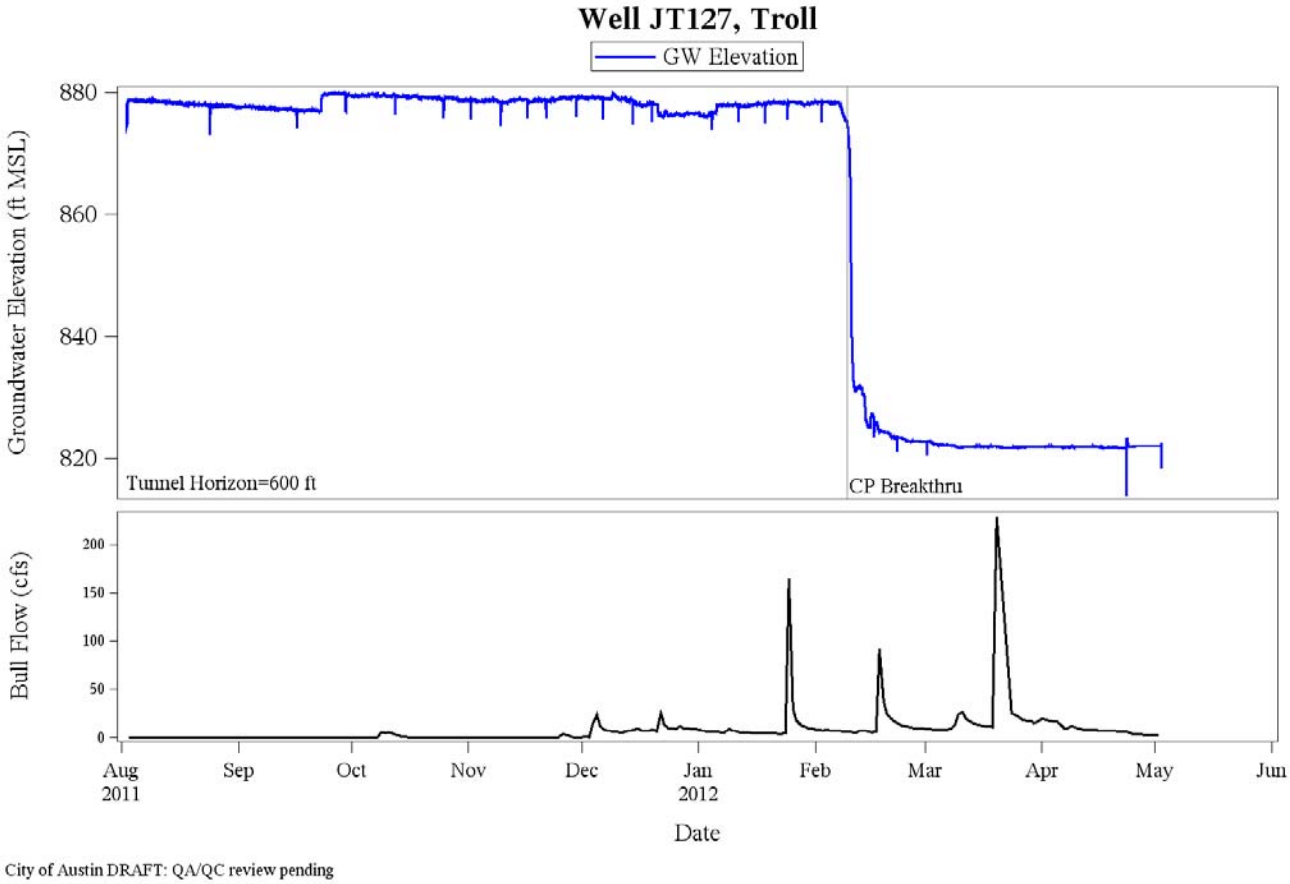


Figure 3 . 56.5 foot water level drop in the JT-127 well at the Jollyville Reservoir shaft site occurred as the bottom of the Comanche Peak/ Edwards contact was mined through. Vertical lines in the hydrograph represent water quality sampling events.

JT-127 Water Quality

Twenty six groundwater samples pumped from the JT-127 well had physical and chemical parameters within the expected range with the exceptions below:

- TSS value was 45 mg/L on February 16, 2012 and then 99 mg/L on February 21. These values were shortly after the well registered the 56-foot drop and are probably indicative of water movement. Other, minor TSS values of 10-15 mg/L were similarly associated with the smaller jumps in water level. The TSS reading for this well is typically non-detect.

- A number of parameters either spiked or decreased temporarily in December (12/6, 12/14, and 12/19/11), and then increased to above baseline values thereafter (see Figure 4). The uniformity of the trends and the fact that they were seen in both field and lab parameters indicates different source waters before and after the change in December. We are continuing to analyze the data; possible explanations include borehole and drilling fluids being improperly flushed from the well after installation and a flushing of the area as excavation proceeded.

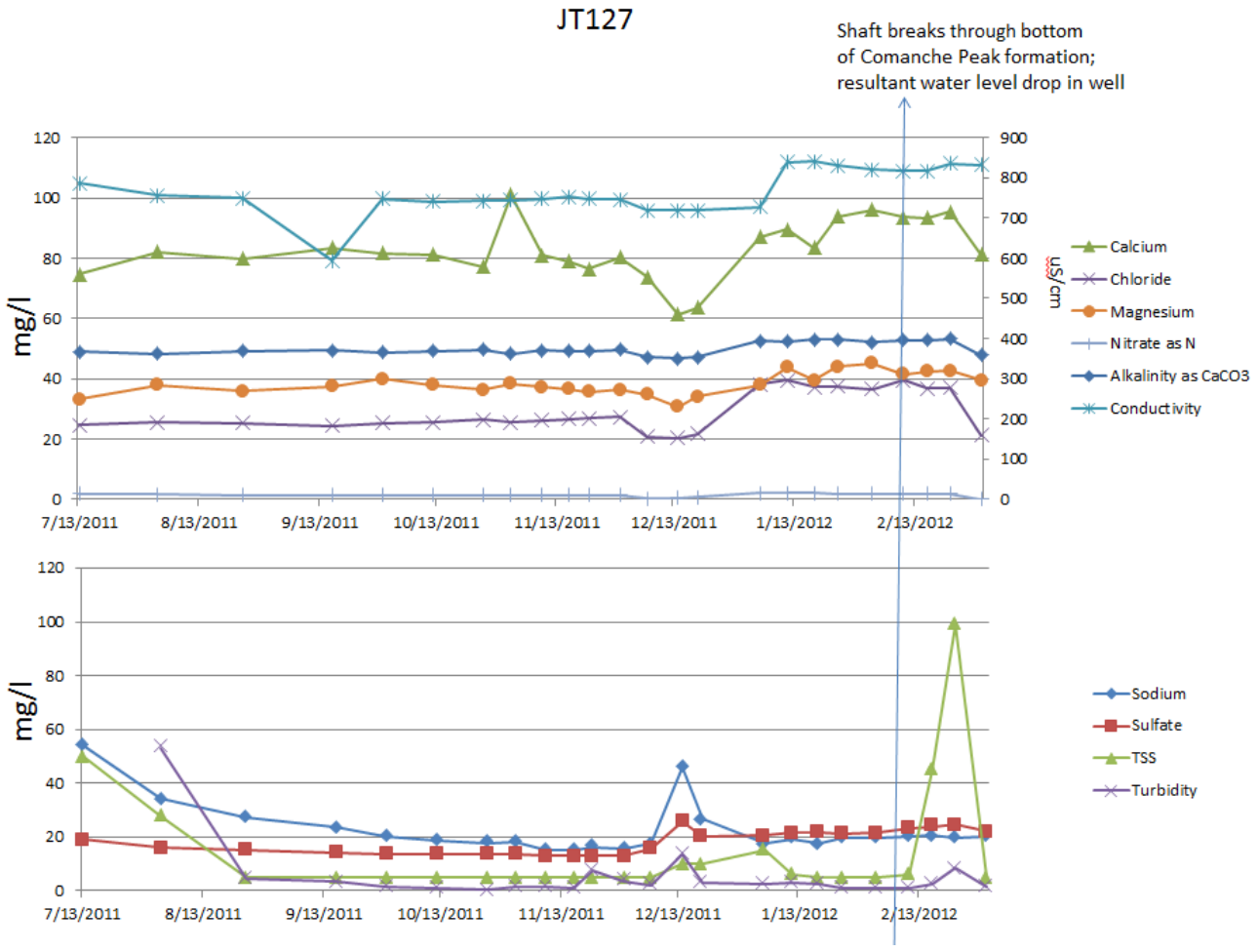


Figure 4. Water Quality parameters in JT-127 well over time. On upper graph, conductivity is plotted on second (right-hand) axis. All other parameters plotted on primary axis.

Spicewood Shaft Impact Monitoring

Monitoring sites (see Table 1):

- Wells:
  - JT-120A. Screened in Glen Rose. Not initially planned for monitoring program; added after JPS identified near site.
  - JT-130 (new well). Screened in Glen Rose just below soil layer. Not initially planned for monitoring program; designed and installed after JPS identified near site.
- Surface sites:
  - Trib 4 downstream from Spicewood Shaft (T4DS). Water quality and flow readings taken here to compare with Trib 4 Upstream of Spicewood Shaft (T4US) reference site.

Excavation has not started at the Spicewood Shaft as of this report. The site was prepared with E/S controls and the permanent fence installed as of late February. Initially no well monitoring was planned for this location, and the monitoring plan restricted monitoring to an upstream (of the shaft site) and downstream location on Trib 4 of Bull Creek.

However, on April 5, 2012 JVTM monitoring staff identified a Jollyville Plateau Salamander at the Trib 4 downstream site, which was confirmed by the COA salamander biologist the following day as a populated site with 20 salamanders present. The Environmental Commissioning Coordination Group met and initiated the adaptive management process, resulting in a redesign of the shaft lining, enhanced E/S controls, and modification to the monitoring plan (May 10, 2012, S4 Adaptive Management Report). As part of that process, it was recognized that the Trib 4 Upstream monitoring site was likely to capture more potential site runoff than was previously thought. Changes to the monitoring plan in the light of the new JPS site included:

1. A third streamflow monitoring location added on Trib 4 (Trib 4 Above Spicewood Springs Road, T4AR) to more accurately capture upstream conditions.
2. A new well (JT-130) was drilled (5/21-22/12) at the Spicewood shaft and screened in a porous dolomitic horizon that is at the same elevation as the newly discovered salamander location.
3. As the working shafts at Four Points and Jollyville Reservoir have both been completed and the water levels are stable, the continuous monitoring devices will be relocated from JT-127 (Jollyville Reservoir Shaft) and JT-128 (Four Points shaft) to JT-120A and JT-130 at the Spicewood Shaft. Monitoring of JT-127 and JT-128 will continue using an e-line.
4. The salamander population will be monitored once before, during, and after the construction of the shaft (should be approximately monthly), and then quarterly until completion of shaft and tunneling activities associated with the JVTM in Spring 2013.

Water Quality/ Quantity Monitoring Results at T4US, T4DS

- In general, contaminants rose and fell at the T4 upstream and T4 downstream sites together (Sodium, Sulfate, Chloride). Nitrates have been rising steadily at both sites.
- There is a fairly consistent~0.6 cfs gain in streamflow between the upstream and downstream site (measured with a Marsh-McBirney meter), but there are no obvious inputs between the

two. COA staff geologists are continuing to investigate a large pool in the channel for a spring.

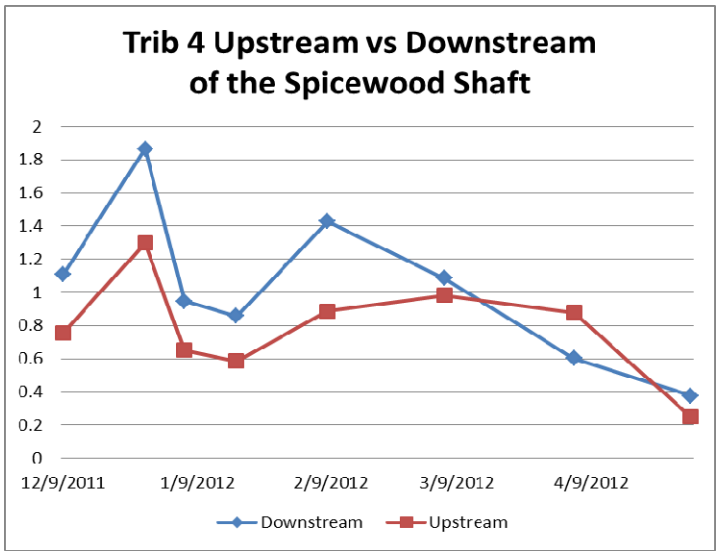


Figure 5. A gain of ~0.6 cfs in flow has been fairly consistent between the upstream and downstream sites, but no obvious input has been located between the two.

Tunnel Impact Monitoring

Tunneling of Reach 1 (Four Points Shaft to Water Treatment Plant shaft site) with the tunnel boring machine (TBM) began in mid April, and was 4169 feet into the tunnel as of June 25, 2012. Monitoring sites are situated along the length of the tunnel, with one monitoring well along Reach 1 (JT-110A). This well experienced a decrease in water level of approximately 15 ft as the tunnel passed. The beginning of the decline was seen when the tunnel was approximately 400 feet from the well and passed within about 100 feet from the well on June 5. There was about a 16-foot water level drop from June 1-10 with water level gently dropping by less than one foot from June 10-20 (i.e., water level is stabilizing). The closest tunnel location with observed water inflows was at about 430 feet before passing the well and occurred for less than a 24-hr period. The sudden water-level drop observed in JT-110A is related to hydraulic connection with the tunnel. The minimal inflows observed reflect the relatively low hydraulic conductivity and limited connection within the Glen Rose at this location. We are continuing to further analyze this data and the potential implications.

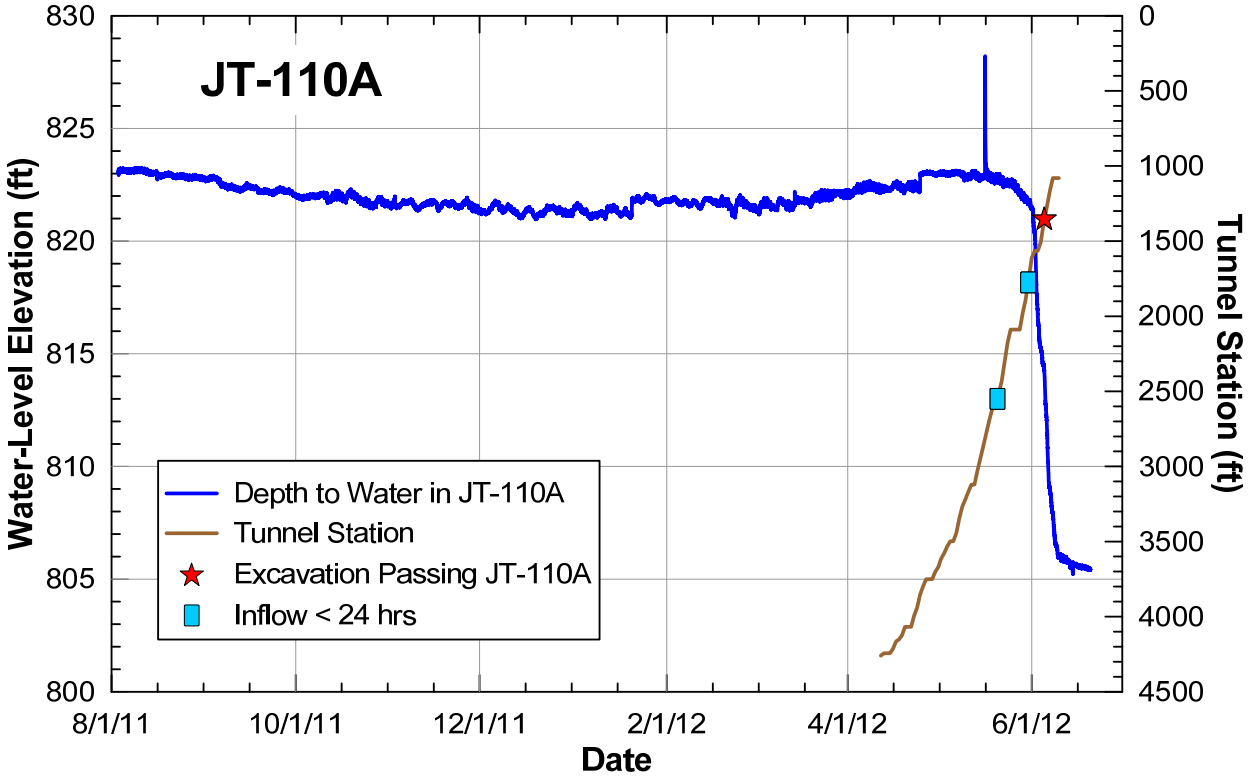


Figure 6. JT-110 monitoring well completed at tunnel depth on the west side of the tunnel alignment shows water level drop as JVTM tunnel passes.

Reference Sites

Surface reference sites (Trib 4 Upstream of Spicewood Shaft, Tanglewood Spring, and Ribelin Spring) show increases in spring flow consistent with rainfall, although Tanglewood continues to increase in recent flow regardless of a decrease in rainfall. Water Quality physical and chemical parameters are within expected range, with the exception of a zinc hit at Ribelin Spring in April. The elevated zinc level of 0.029 mg/L on 4/19/12 is low for undeveloped areas (6 mg/L citywide) and is attributable to stormwater runoff.

Well reference sites were either essentially flat (JT-101A, JT-113, JT-114, JT-115, and deepest layers of B-8, B-9, B10), responded to lake level (B-4a, B-5b), responded to seasonal decline and recovery (JT-124A, JT-118A, JT-104A) or responded to a combination of rainfall and summertime regional pumping / wintertime recovery (JT-125; see "Evaluation of Water Level Trends in Glen Rose Groundwater Monitoring Wells JT-125A and JT-126, March 2012) .

SUMMARY

Environmental monitoring along the length of the tunnel alignment has shown the construction of the Jollyville Transmission Main to result in changes to groundwater levels (JT-110A; under further analysis) and no evident changes to surface water quality or quantity at this date. Excavation of the Four Points shaft resulted in temporary depression of Edwards groundwater levels nearby which have since fully recovered at JT-128 and are continuing to recover at JT-112 after hydrophobic grouting of the permeable ring. Excavation of the Jollyville Reservoir shaft resulted in a 53-foot drop in water level at JT-127 after the confining Comanche Peak layer was mined through. No further significant

change in water level at JT-127 due to construction is expected until the shaft is backfilled at completion of the project. Water quality parameters at the Jollyville Reservoir shaft are undergoing further analysis. Identification of an active JPS site near the Spicewood Shaft resulted in enhancements to the E/S Controls and significant changes to the monitoring plan with an increase in locations and frequency.

TABLES AND FIGURES

Facility Monitored	Site	Rationale	Parameter	Baseline Sampling Events Taken/Planned	Construction Phase Sampling Events Taken/Planned	Post-Construction Sampling Events Planned	Formation
Four Points Shaft	JT-112	Shaft location dye traces to this well within 3 weeks. Contaminants, if any, will be more mobile in the Edwards and potential impacts of water interception more significant.	Water level	Continuous/ Telemetered TROLL	Continuous/ Telemetered TROLL	Continuous/ Telemetered TROLL	Edwards/Walnut Contact
			Water quality	6/6	weekly (14/14) and then quarterly (1/9)	None	
	JT-128	Proximity to shaft	Water level	6/6	Continuous/ Telemetered TROLL from 10/5/11 until repair in May 2012, then monthly e-lines (22 planned)	None	Edwards/Walnut Contact
	Bull Creek above WTP4	Downstream from shaft locations	Water level	Continuous/ Bubbler Station	Continuous/ Bubbler Station	Continuous/ Bubbler Station	N/A
			Water quality	9/12*	only if shaft or tunnel water is discharged to surface (1/4)**	None	N/A
Jollyville Reservoir Shaft	JT-127	Near shaft location to monitor Edwards formation; contaminants, if any, will be more mobile in the Edwards and potential impacts of water interception could be more significant	Water level	Continuous/ Telemetered TROLL/ bladder pump	Continuous/ Telemetered TROLL/ bladder pump	e-lines; TROLL pulled for Spicewood shaft wells	Edwards
			Water quality	6/6	weekly during excavation past well depth (20/20) and then quarterly (0/8)	None	Edwards
Spicewood Shaft****	JT-120A	Near shaft location to monitor Glen Rose formation; added into monitoring program after JPS identified near shaft in April 2012.	Water level	n/a***	continuous	continuous	Glen Rose

	JT-130	In between shaft location and JPS stream reach; added into monitoring program after JPS identified near shaft in April 2012.	water level	n/a***	twice weekly until TROLL installation; then, continuous	continuous	Glen Rose
	Trib 4 Downstream of Spicewood Shaft	Downstream from shaft locations	Water level	8/12*	monthly until shaft construction (3/4), weekly during shaft construction (0/12) and then monthly thereafter (0/7)	None	n/a
			Water quality	8/12*	monthly until shaft construction (3/4), weekly during shaft construction (0/12) and then monthly thereafter (0/7)	None	n/a
Jollyville Transmission Main Tunnel	JT-107D-A	Near where tunnel alignment is beneath Bull Creek	Water level	Continuous	TROLL pulled in November and monthly e-lines taken (7) until re-installation in May 2012	Continuous	Glen Rose
	JT-107PZ-A	Near where tunnel alignment is beneath Bull Creek	Water level	Continuous	Continuous	Continuous	Glen Rose
	JT-107S-A	Near where tunnel alignment is beneath Bull Creek	Water level	Continuous	Continuous	Continuous	Glen Rose
	JT108	Near where tunnel alignment is beneath Bull Creek	Water level	Continuous	Continuous	Continuous	Glen Rose
	JT110A	Western end of tunnel	Water level	Continuous	Continuous	Continuous	Glen Rose
	JT126	Eastern end of tunnel	Water level	Continuous	Continuous	Continuous	Glen Rose
	Lanier Spring	Proximate to tunnel alignment; presence of metal flume	Water level	Continuous	Continuous	Continuous	Glen Rose
			Specific Conductance	Continuous	Continuous	Continuous	Glen Rose
	Pit Spring	Proximate to the tunnel alignment below Bull Creek. Distrubuted discharge along	Water level	6/6	4/36	none	Glen Rose

		the bank near the channel bottom eliminates the opportunity for direct flow measurement					
	Bull Creek above WTP4	Proximate to the tunnel alignment below Bull Creek. Distributed discharge along the bank near the channel bottom eliminates the opportunity for direct flow measurement	Water level	Continuous	Continuous	Continuous	n/a
	Bull Creek at Tributary 7	Available historical surface water monitoring data; captures flow discharging from Pit Springs, combined with any stream flow	Water level	Continuous	Continuous	Continuous	n/a
			Specific Conductance	Continuous	Continuous	Continuous	n/a
	Bull Creek at Spicewood Springs 7th Crossing	Located on Bull Creek just downstream of the last point where the Jollyville Transmission Main parallels Bull Creek	Water level	Continuous	Continuous	Continuous	n/a
Reference Sites	Trib 4 Upstream of Spicewood Shaft (T4US)	Characterizes background surface water condition. Discontinued and replaced by Trib 4 upstream of Spicewood road (T4AR) in April 2012 after site was understood to drain more to the northeast than originally thought.	Water level	6/6	monthly until shaft construction (7/7), and then 3 times (1/3) to establish relationship with T4AR. Replaced by T4AR.	None	n/a
			Water quality	6/6	monthly until shaft construction (7/7). Replaced by T4AR.	None	n/a
	Trib 4 Above Spicewood Road (T4AR)	Characterizes background surface water condition. Replaced T4US in April 2012 after site was understood to drain more to the northeast	Water level	n/a***	monthly to establish baseline and relationship with T4US (1/3) and then weekly during shaft construction (12), monthly thereafter (9)	None	n/a

		than originally thought.	Water quality	n/a***	monthly (1/3) and then weekly during shaft construction (12), monthly thereafter (9)	None	n/a
	Tanglewood Spring	Significant spring with habitat	Water level	6/6	4/36	None	
			Water quality	6/6	4/36	None	n/a
	Ribelin Spring	Significant spring with habitat/ characterizes background conditions	Water level	6/6	3/36	None	n/a
			water quality	6/6	3/36	None	n/a
	JT-101-A		Water level	6/6	20/36*	None	Edwards
	JT-113		Water level	6/6	7/36* (continuous TROLL from 12/7 to 4/19)	None	Edwards
	JT-114		Water level	6/6	20/36*	None	Edwards
	JT-115		Water level	6/6	20/36*	None	Edwards
	B-4		Water level	n/a***	9/0	None	Glen Rose
	B-5		Water level	n/a***	9/0	None	Glen Rose
	B-8		Water level	n/a***	9/0	None	Glen Rose
	B-9		Water level	6/6	9/36	None	Glen Rose
	B-10		Water level	6/6	9/36	None	Glen Rose
	JT-118A		Water level	6/6	11/36	None	Glen Rose
	JT-104A		Water level	6/6	11/36	None	Walnut
	JT-124A		Water level	6/6	11/36	None	Edwards
	JT-125A		Water level	6/6	11/36	None	Glen Rose

*for surface water sites, baseline samples unable to be taken during 2010-2011 drought.

**shaft/tunnel water discharged to surface at Four Points once, during week of 5/1/12

***site not in initial plan. For details on plan changes, see table 2

****changes from initial plan due to discovery of JPS site in early 2012. For details on plan changes, see Spicewood Shaft section

Table 1. Summary of monitoring sites

Date	***Change to Monitoring Plan***
10/2011	Decision to increase water quality sampling at JT-112 and JT-127 to weekly pulls during shaft construction. Dual purpose of increasing scrutiny of water quality parameters due to change in construction method and added benefit of increasing EC presence onsite.
12/2011	Decision to start taking e-line readings weekly to more closely monitor expanding zone of influence from Four Points shaft
12/7/11	Decision to pull 108 troll (convenient) and install in 115 to check for expanding zone of influence from Four Points shaft. This was later amended to the closer 113 well.
2/2012	East E-lines: Increased to biweekly from monthly to more closely monitor Glen Rose groundwater increase
1/24/12	Grout Injection monitoring begins at JT-112 and Gaas Springs. This is the first sample for Phthalates pre-injection. The property owner of Gaas springs (the closest spring site to 4pts shaft according to dye trace) permits access and site is added into grout injection and regular WQ monitoring schedule on a weekly basis until further notice.
2/8/11	West e-lines: reduced to biweekly readings from weekly to balance workload. Zone of influence unlikely to affect wells due to rise in JT-128 and JT-112
2/23/12	JT-127: Once mining is past the screened interval for this well (probably next week), water quality pulls will be quarterly rather than weekly. Quarterly water quality pulls will test for surface impacts.
2/23/12	JT-112: Phthalate analysis is still important, and should proceed every week for 8 weeks and then monthly for a year from the date of grout injection. The rest of the parameter suite (Alkalinity, Metals, etc.) can be dropped as excavation is below the screened interval for this well.
2/23/12	Gaas Spring: Should be tested for phthalates at same interval as above 112.
4/3/12	Decision to abandon 109 as is not used in monitoring plan
4/19/12	Move troll in 113 to 108 once more. This will allow the rental cable to be returned to In-Situ.
4/19/12	Change sampling frequency for Gaas spring to once monthly for the next 4 months, and then quarterly.
4/24/12	(ECCG Meeting) In light of identification of new JPS site, relocate TROLLs from JT-128 (Four Points) and JT-127 (Jollyville Reservoir) to JT-120A and JT-130 (Spicewood Shaft) to provide continuous monitoring during shaft construction.
4/25/12	(Data Review Meeting) Discontinue T4US and establish new T4AR site further upstream to better capture conditions upstream of Spicewood shaft. It was decided that the current T4US site was likely to see more shaft site runoff than originally thought.

Table 2: Changes to monitoring plan

Parameter Purpose	
Potentiometric level	Detects groundwater interception by shafts or tunnel
Surface water level	Detects groundwater interception by shafts or tunnel as reflected by a decrease in spring or base channel flow
Temperature	Indicator of impacts from discharge of shaft and tunnel water to surface waterways
pH	Indicator of impacts from discharge of shaft and tunnel water to surface waterways
Specific conductance	Indicator of impacts from discharge of shaft and tunnel water to surface waterways
Total Suspended Solids (TSS)	Indicator of impacts from discharge of shaft and tunnel water to surface waterways
Standard anions and cations: Ca, Mg, Na, SO4, HCO3, Cl	Indicator of impacts from discharge of shaft and tunnel water to surface waterways
Nitrate	Associated with blasting by-products, fertilizers
Ammonia	Associated with blasting by-products, fertilizers
Phosphate	Associated with fertilizers
Copper	Associated with drilling and mining operations, vehicular and equipment use
Chromium	Associated with drilling and mining operations, vehicular and equipment use
Zinc	Associated with drilling and mining operations, vehicular and equipment use
Total Petroleum Hydrocarbons (TPH)	Associated with drilling and mining operations, vehicular and equipment use
Di-n-butyl phthalate	Associated with hydrophobic grout injection at Four Points Shaft
Rainfall	Correlating factor measured by others
Tunnel and shaft inflow	Correlating factor measured by contractor
Tunnel surface discharge	Correlating factor measured by contractor

Table 3. Water Quality Parameters measured

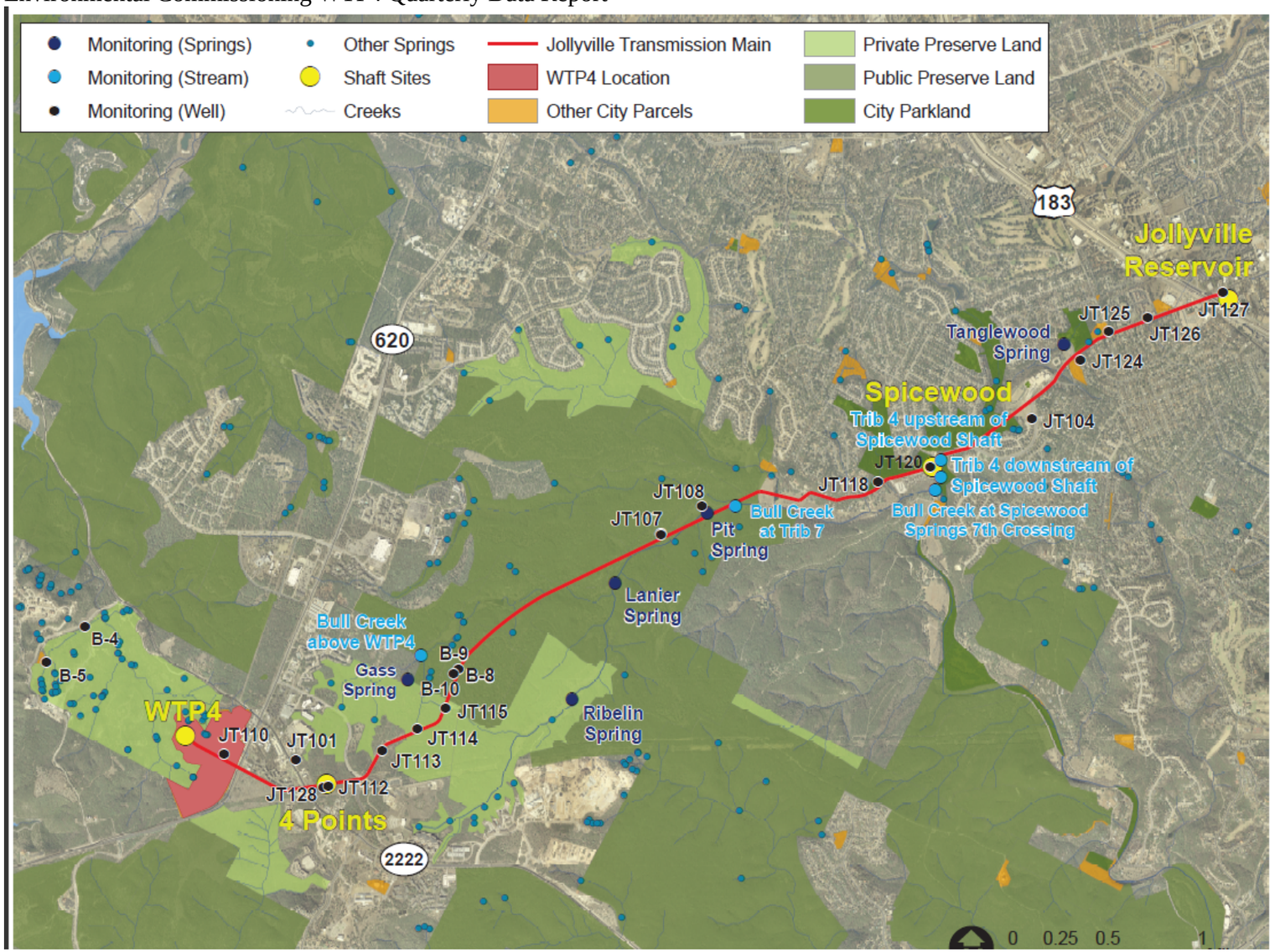
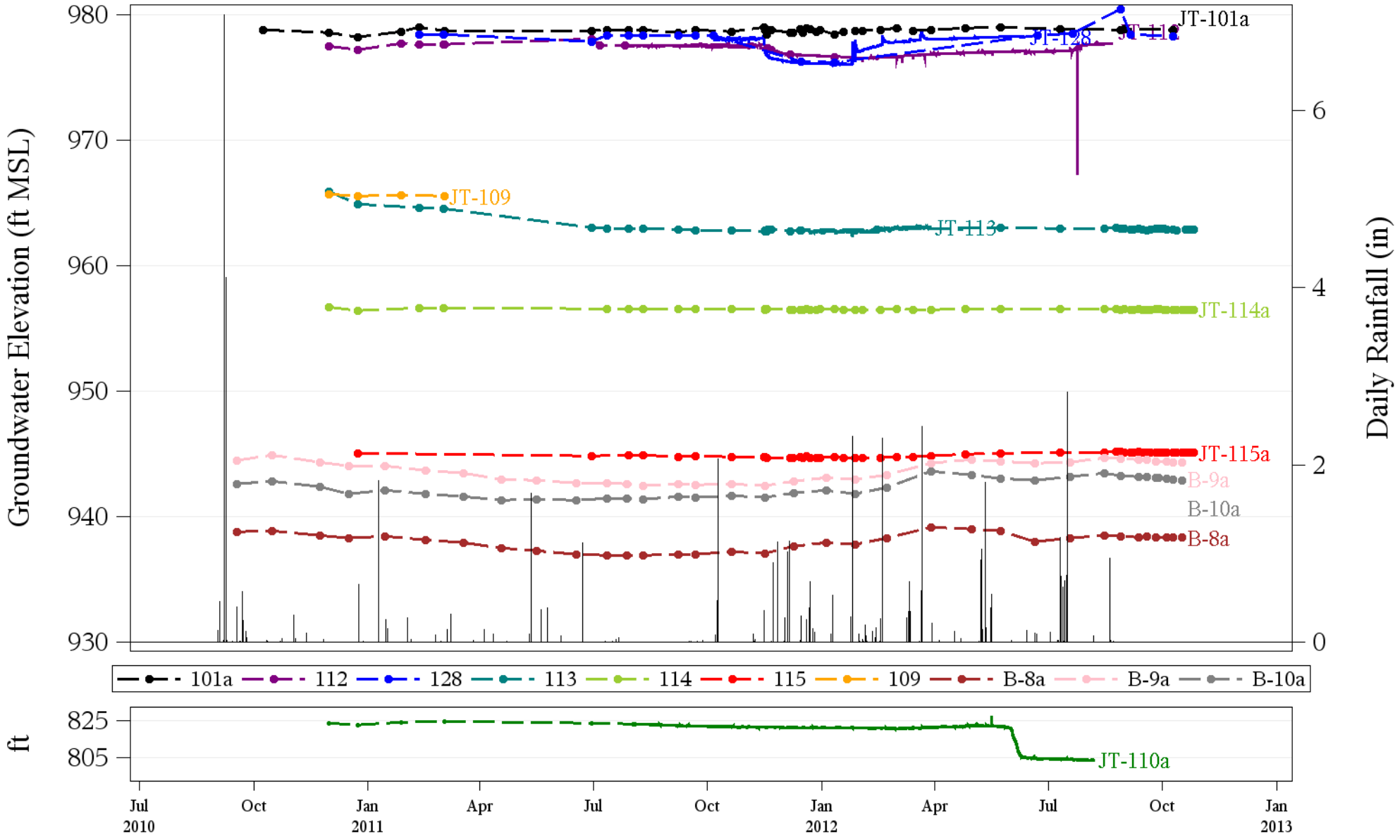


Figure 3: Monitoring Site Map

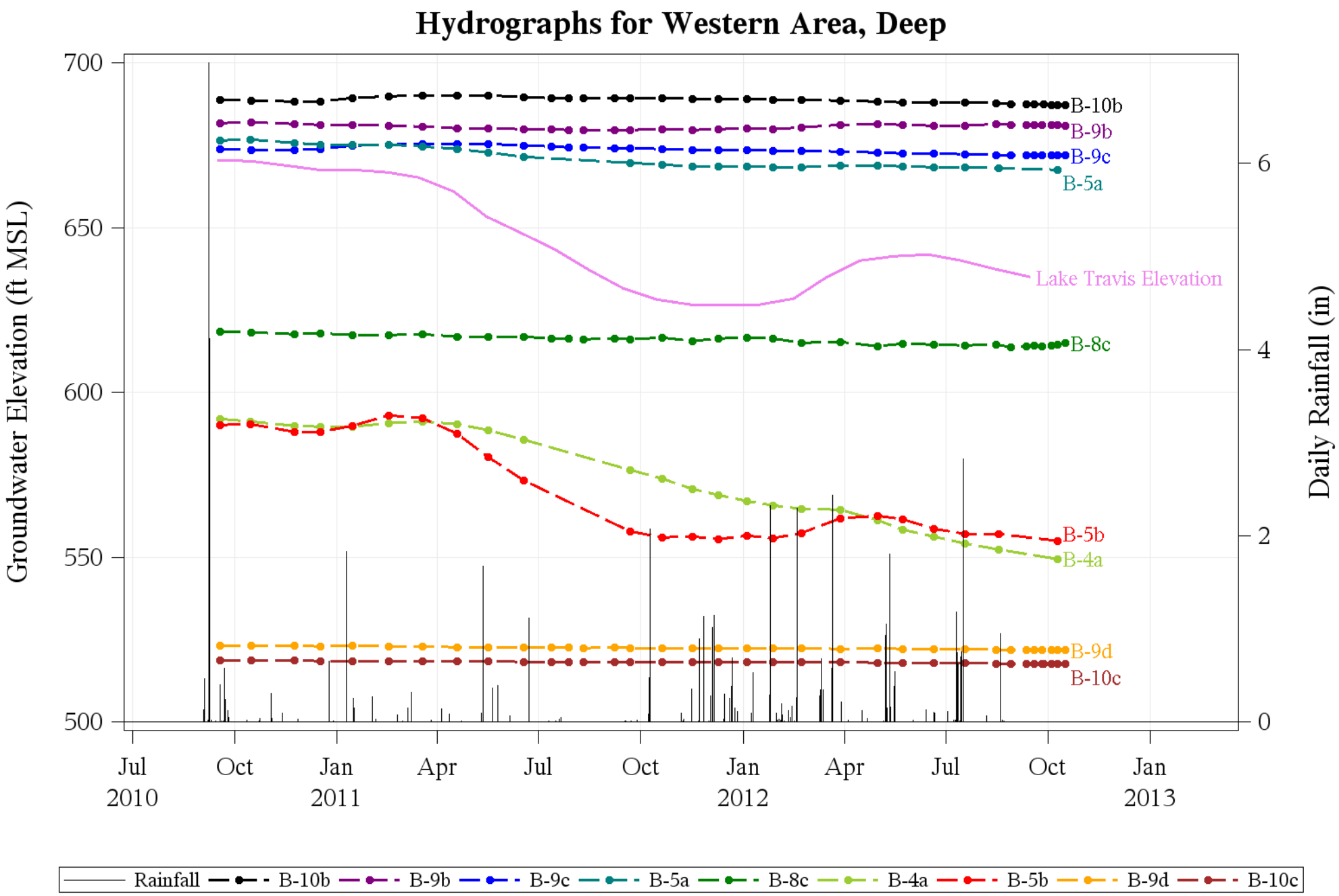
Appendix 3

JVTM Monitoring Graphs

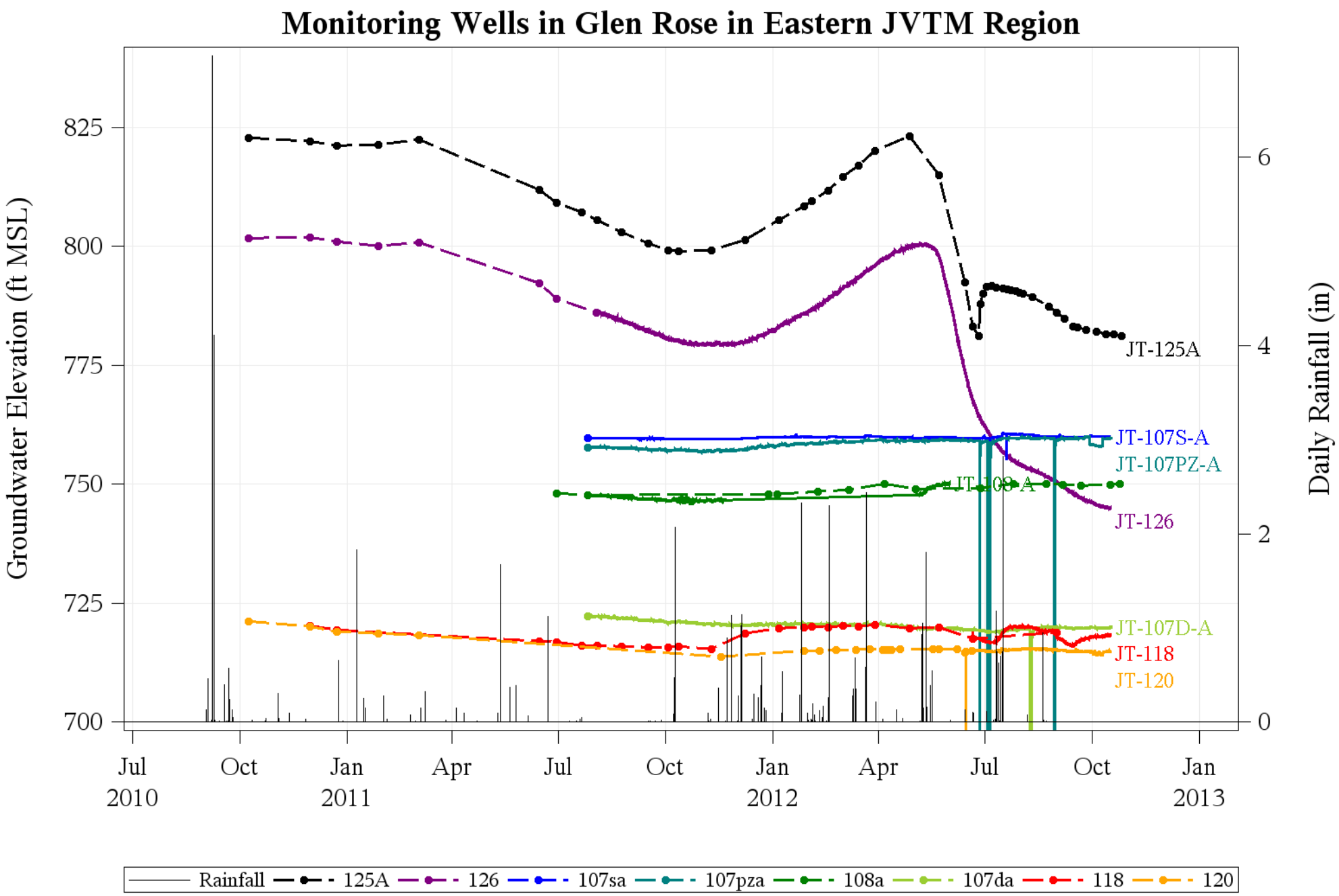
Hydrographs for Western Area, Shallower



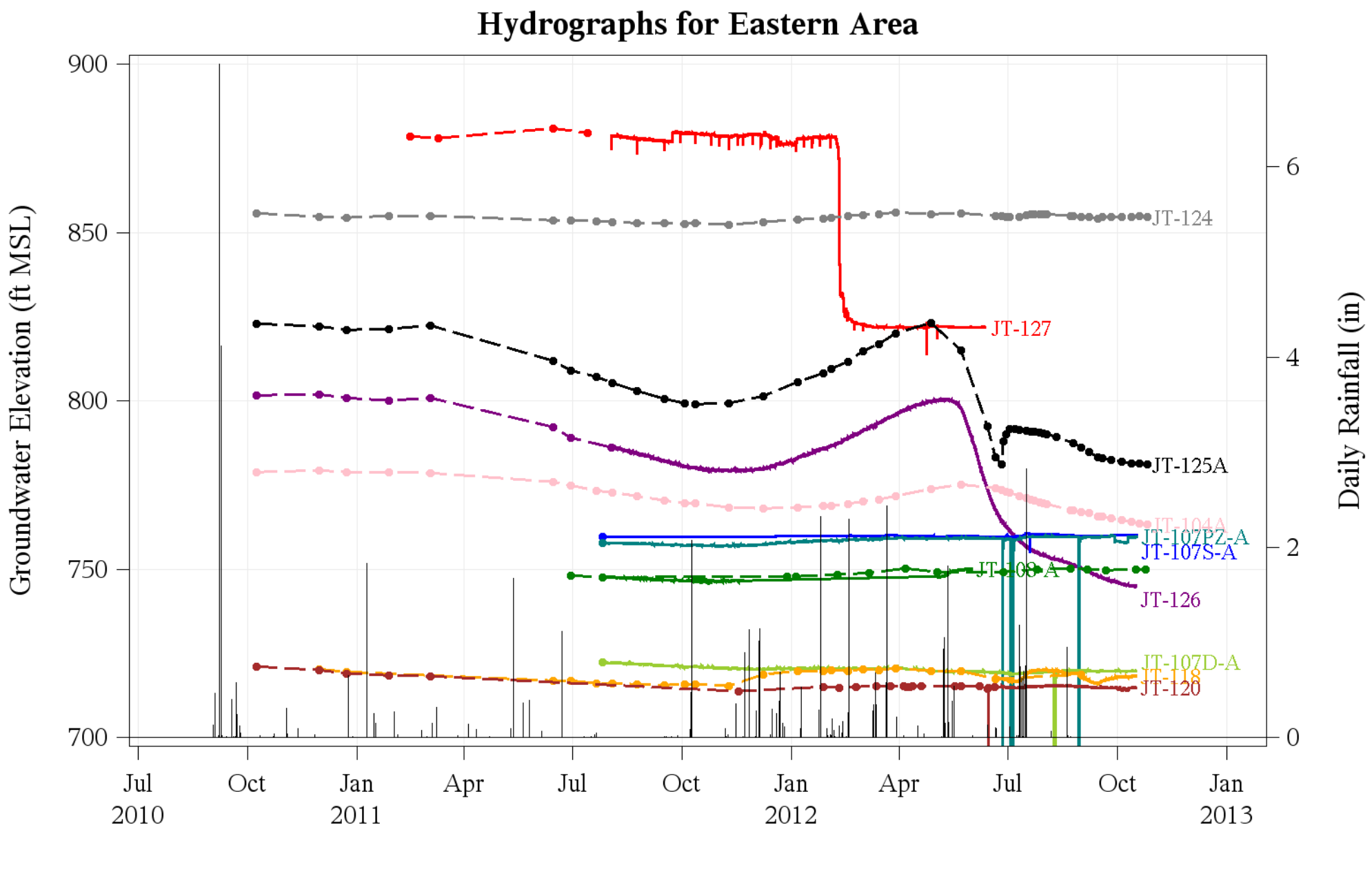
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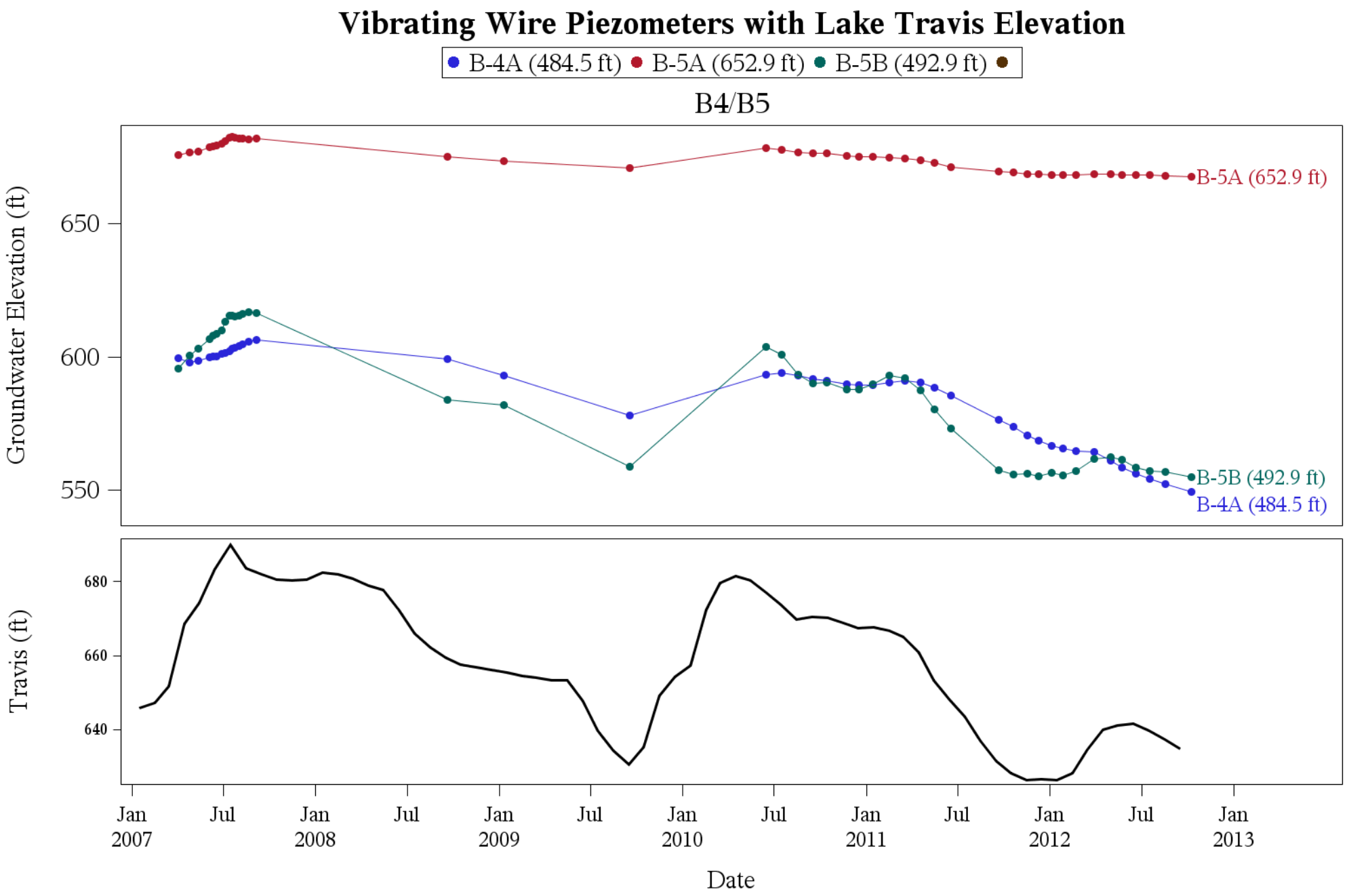
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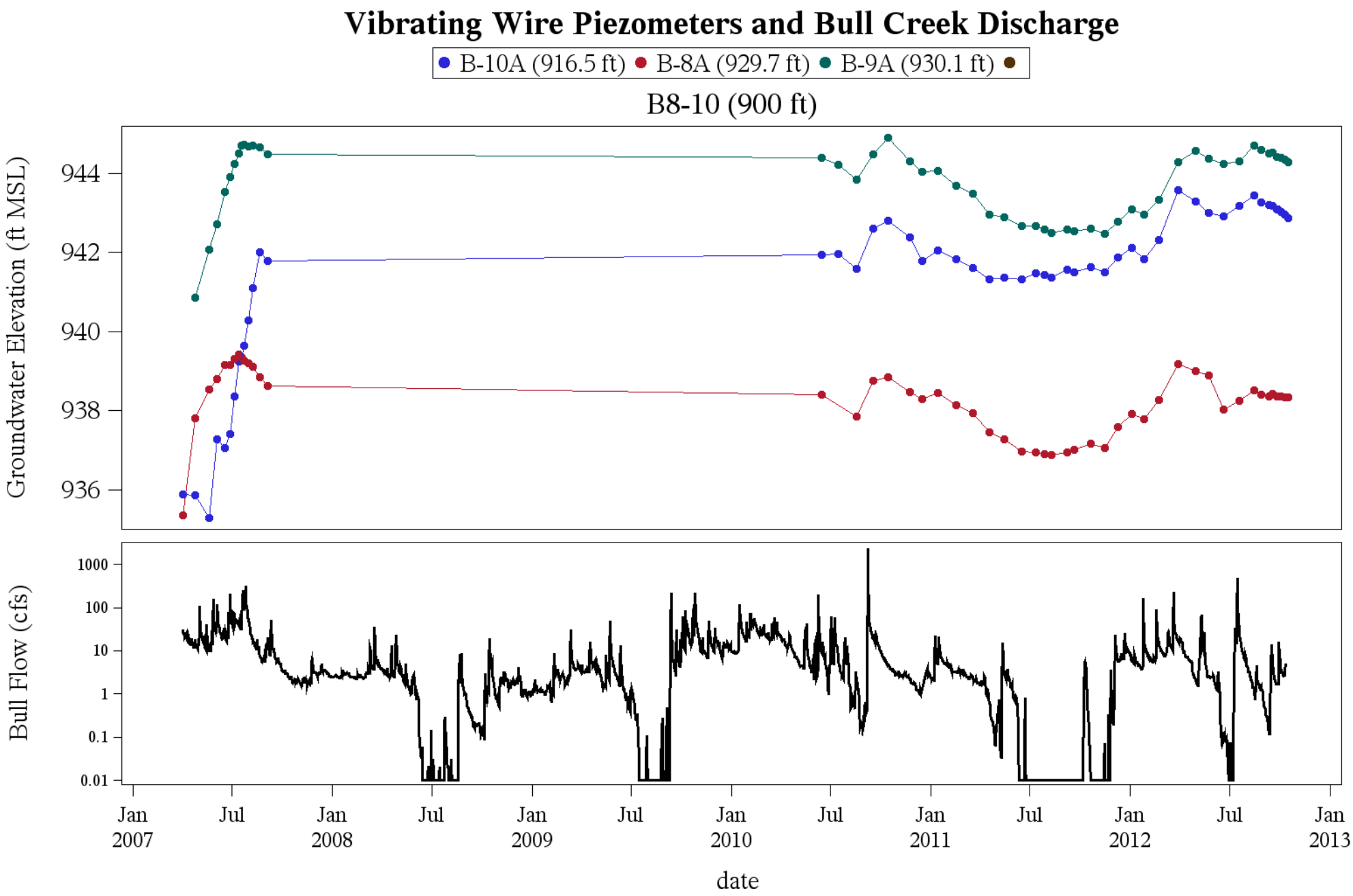
City of Austin DRAFT: QA/QC review pending

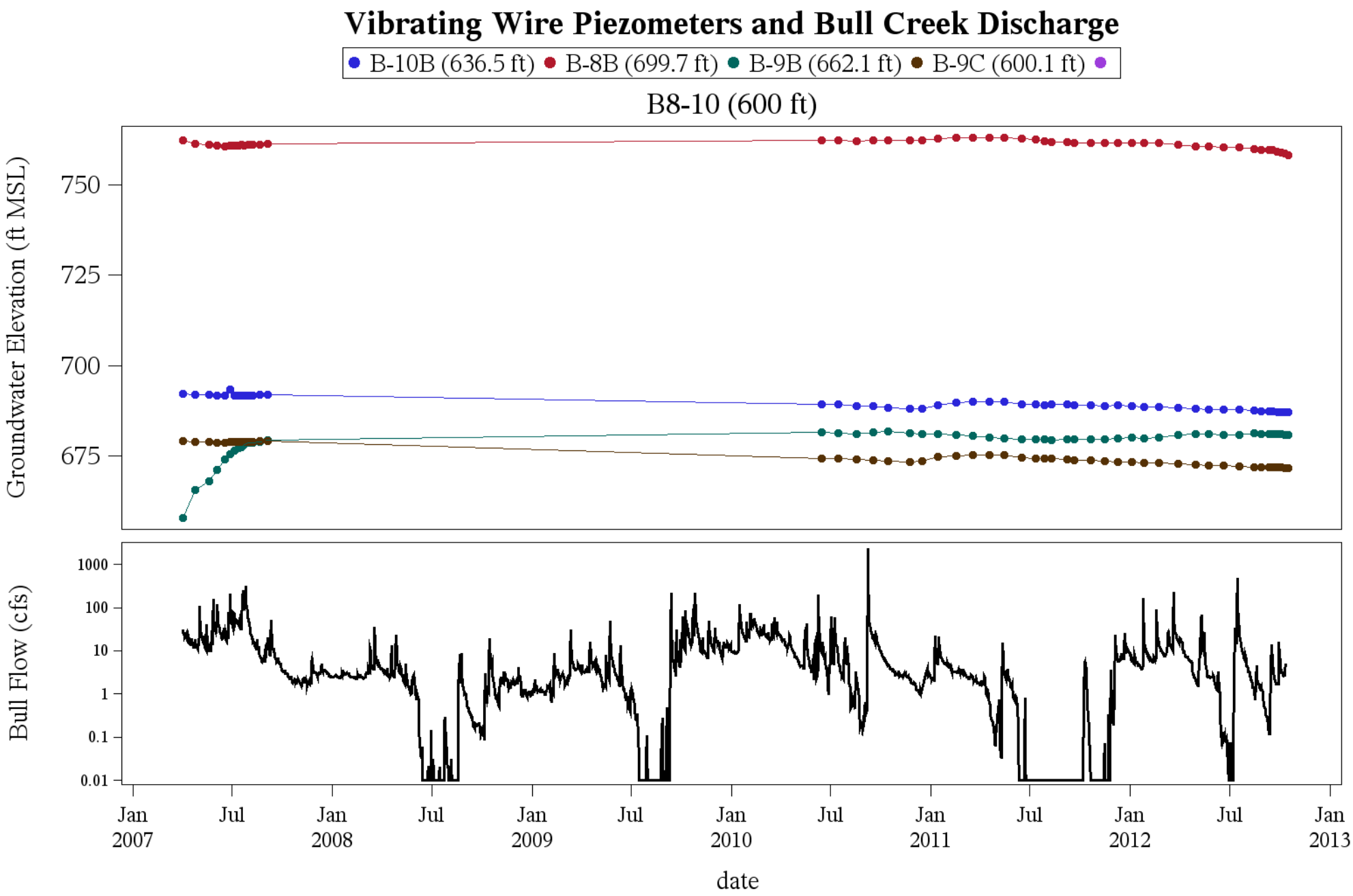


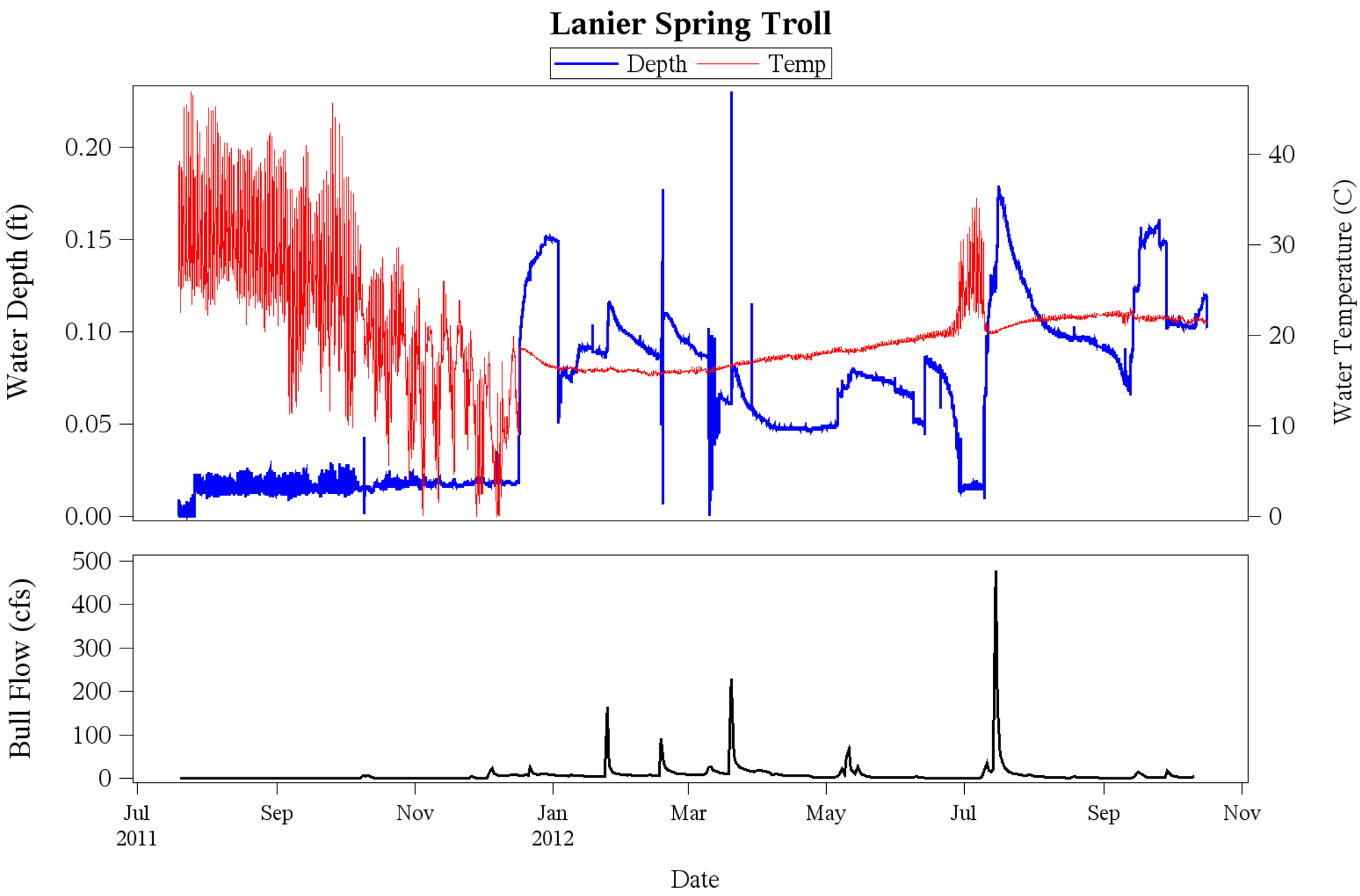
City of Austin DRAFT: QA/QC review pending

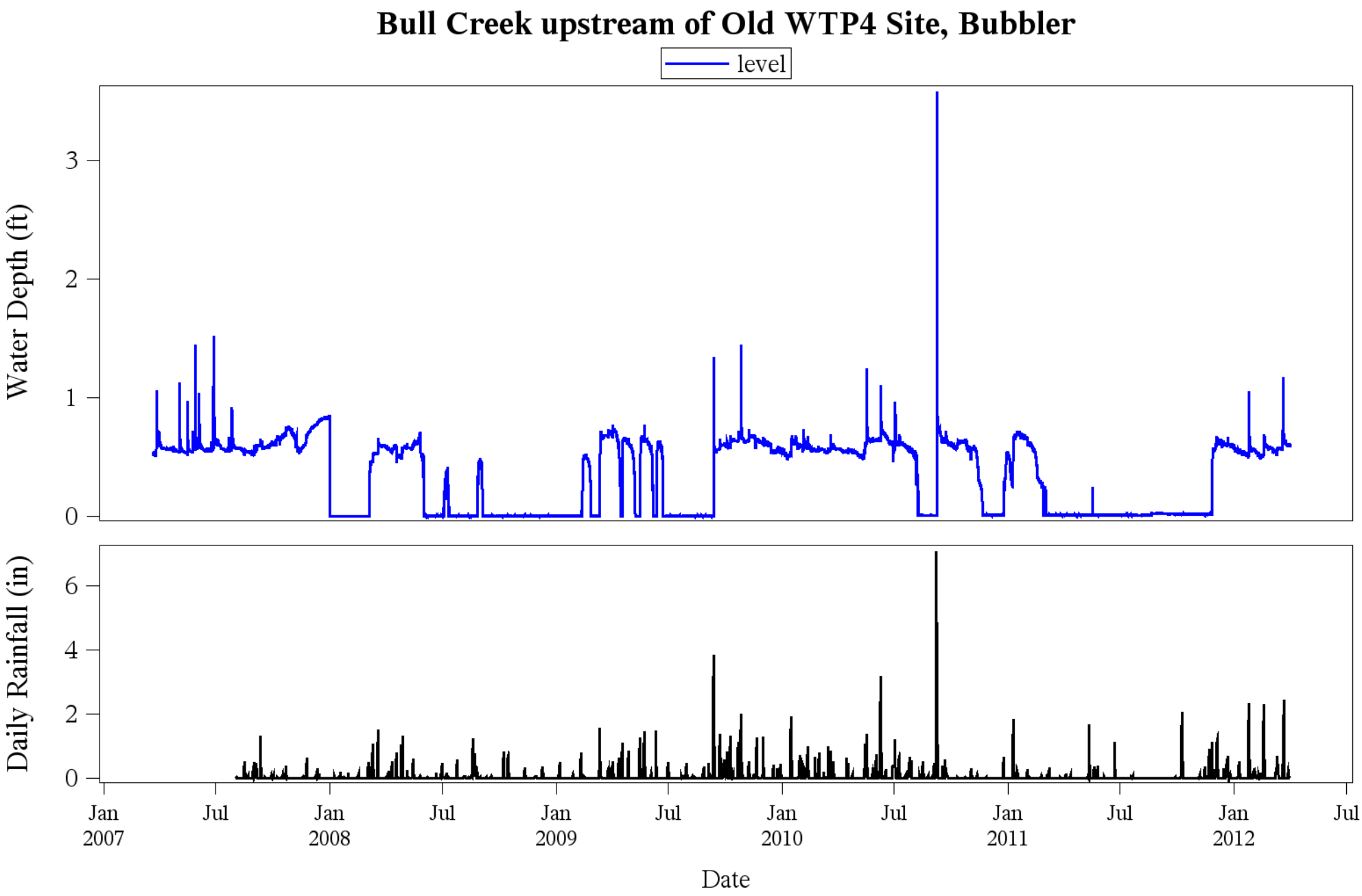


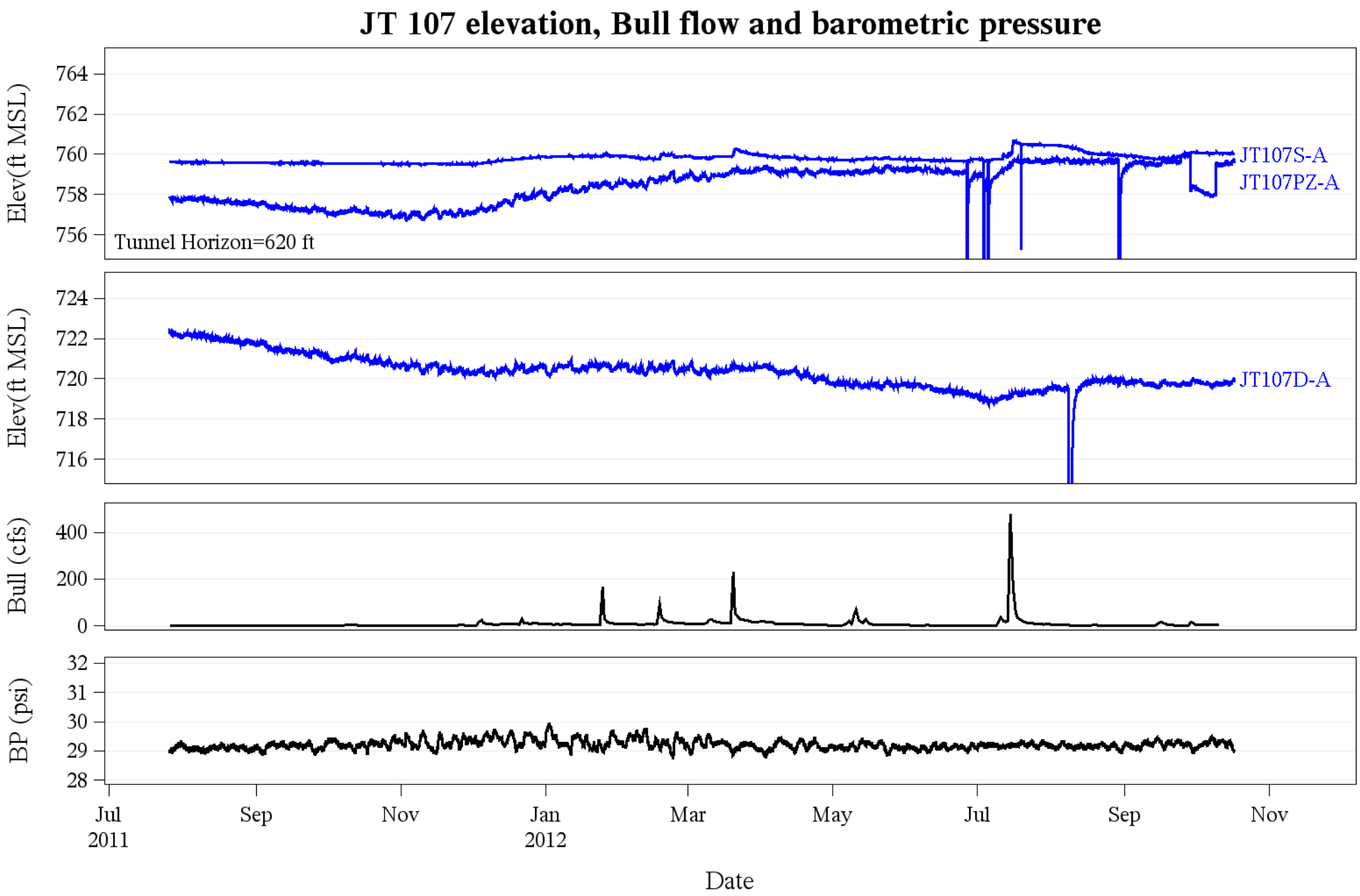
City of Austin DRAFT: QA/QC review pending


Vibrating Wire Piezometers and Bull Creek Discharge
B-10A (916.5 ft)
B-8A (929.7 ft)
B-9A (930.1 ft)
B8-10 (900 ft)
Groundwater Elevation (ft MSL)
944
942
940
938
936
Bull Flow (cfs)
1000
100
10
1
0.1
0.01
Jan 2007
Jul
Jan 2008
Jul
Jan 2009
Jul
Jan 2010
Jul
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
date

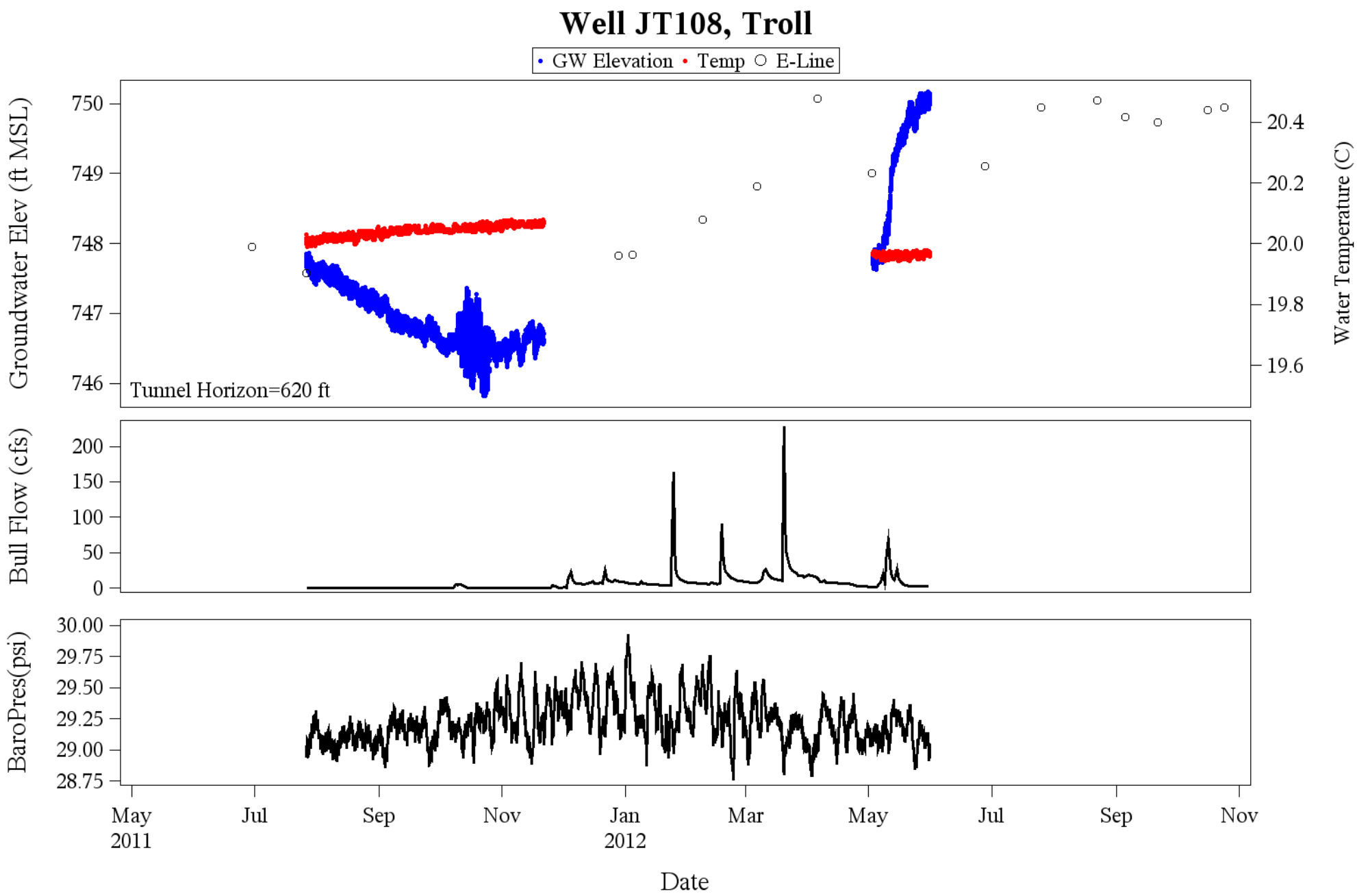

Vibrating Wire Piezometers and Bull Creek Discharge
B-10B (636.5 ft)
B-8B (699.7 ft)
B-9B (662.1 ft)
B-9C (600.1 ft)
B8-10 (600 ft)
Groundwater Elevation (ft MSL)
750
725
700
675
Bull Flow (cfs)
1000
100
10
1
0.1
0.01
Jan 2007
Jul
Jan 2008
Jul
Jan 2009
Jul
Jan 2010
Jul
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
date

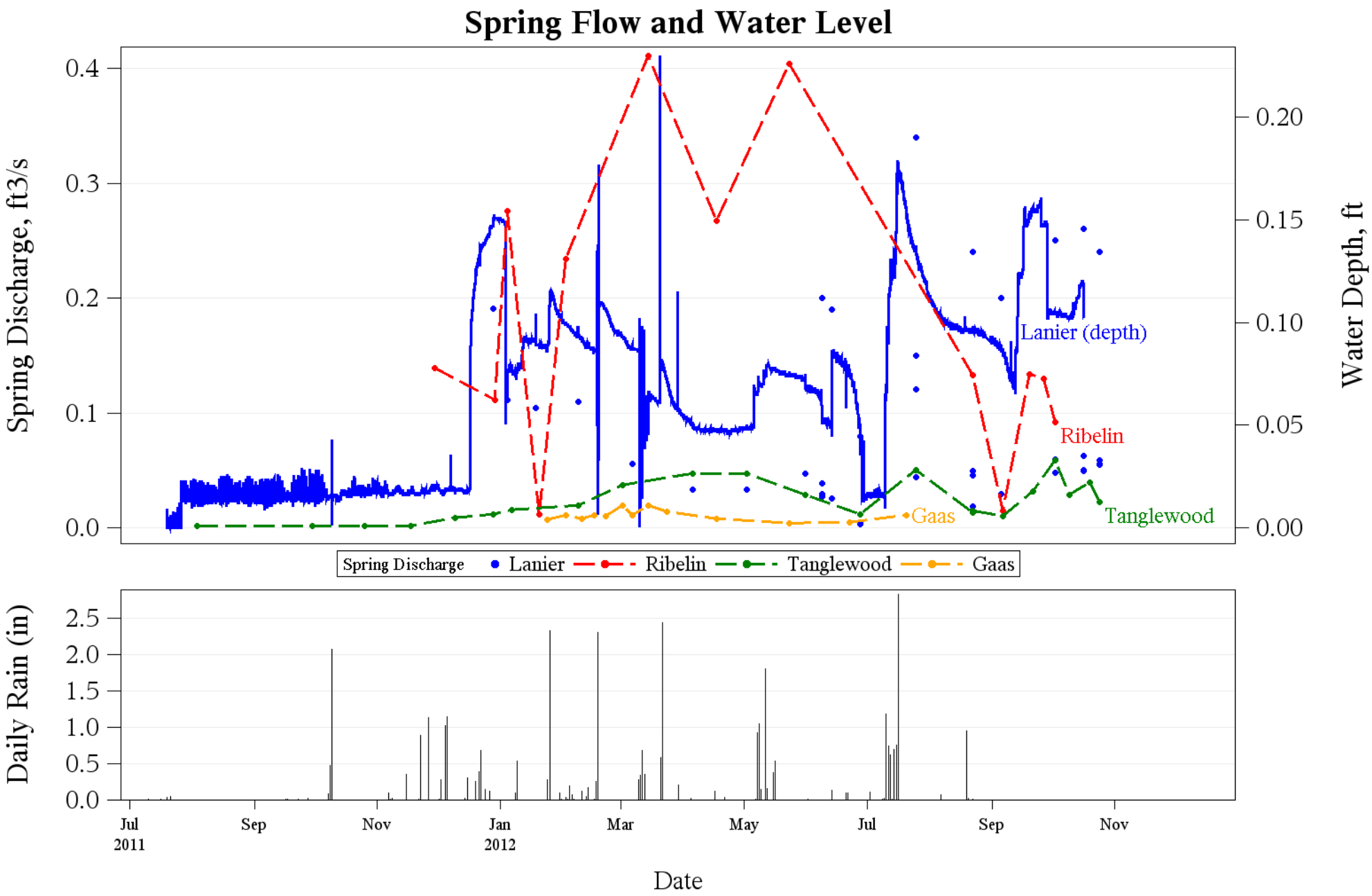

Lanier Spring Troll
Depth
Temp
Water Depth (ft)
0.20
0.15
0.10
0.05
0.00
Water Temperature (C)
40
30
20
10
0
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date


Bull Creek upstream of Old WTP4 Site, Bubbler
level
Water Depth (ft)
0
1
2
3
Daily Rainfall (in)
0
2
4
6
Jan 2007
Jul
Jan 2008
Jul
Jan 2009
Jul
Jan 2010
Jul
Jan 2011
Jul
Jan 2012
Jul
Date

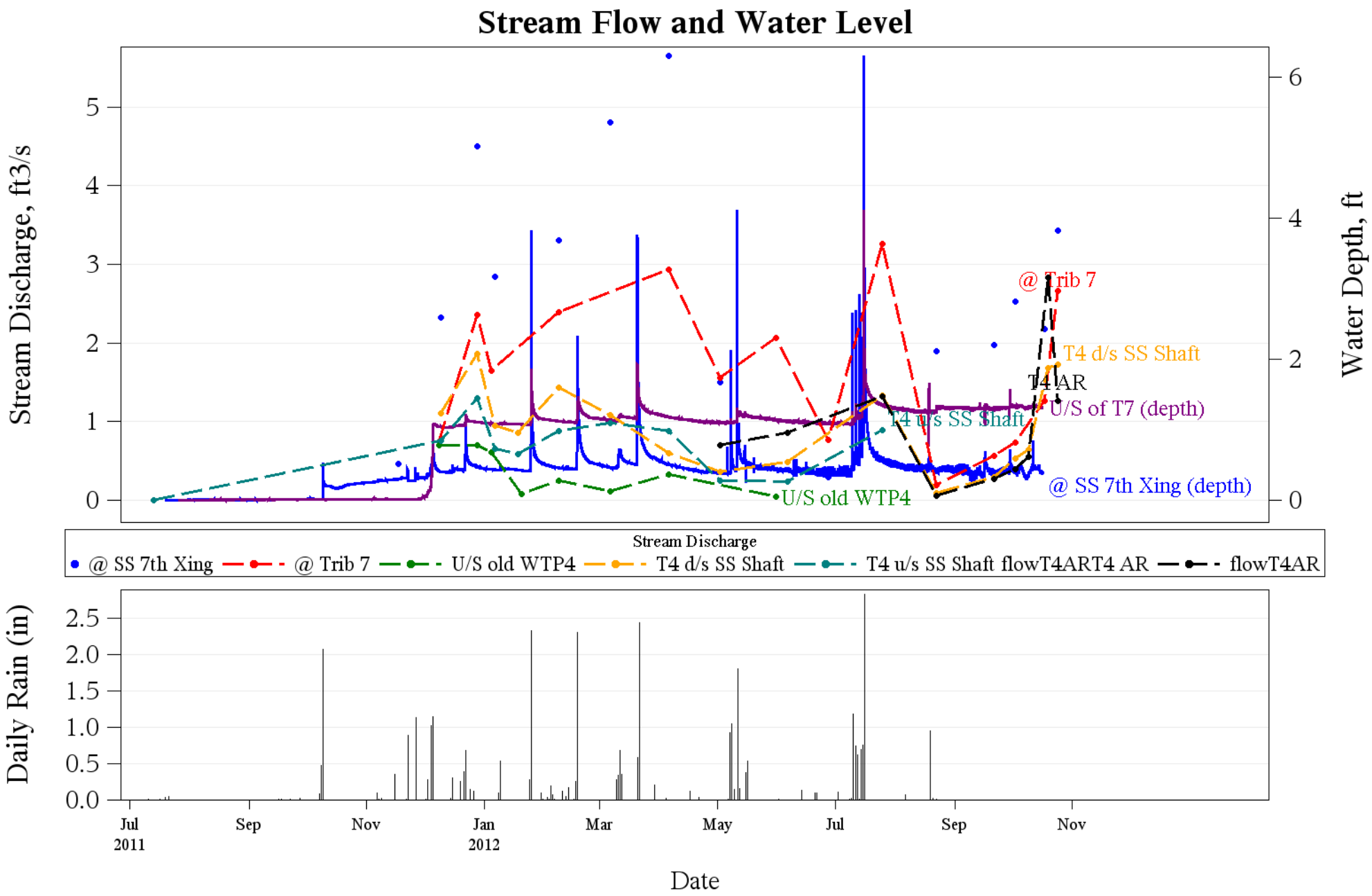


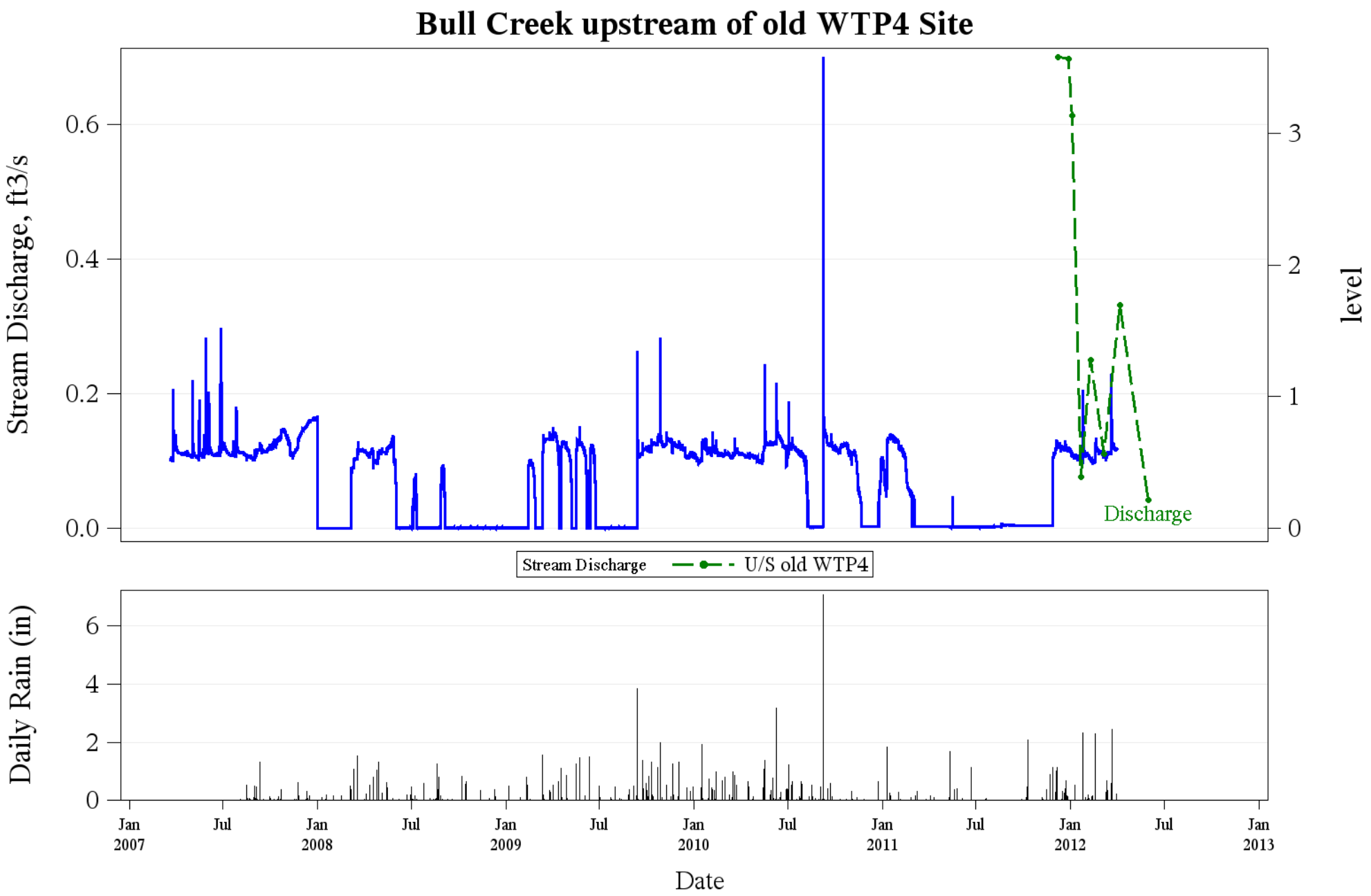
City of Austin DRAFT: QA/QC review pending


Well JT108, Troll
GW Elevation
Temp
E-Line
Groundwater Elev (ft MSL)
750
749
748
747
746
Tunnel Horizon=620 ft
Water Temperature (C)
20.4
20.2
20.0
19.8
19.6
Bull Flow (cfs)
200
150
100
50
0
BaroPres(psi)
30.00
29.75
29.50
29.25
29.00
28.75
May
2011
Jul
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

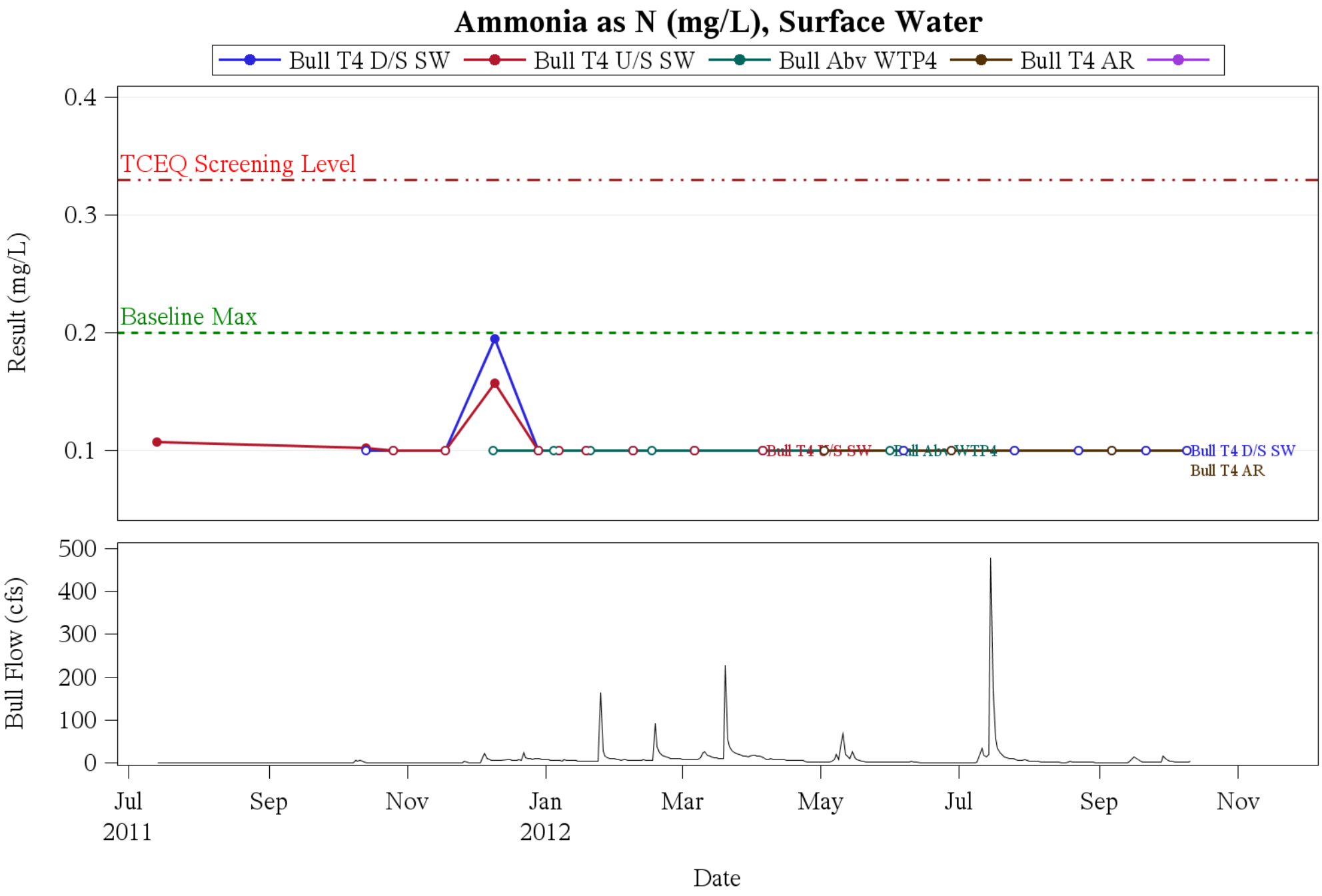


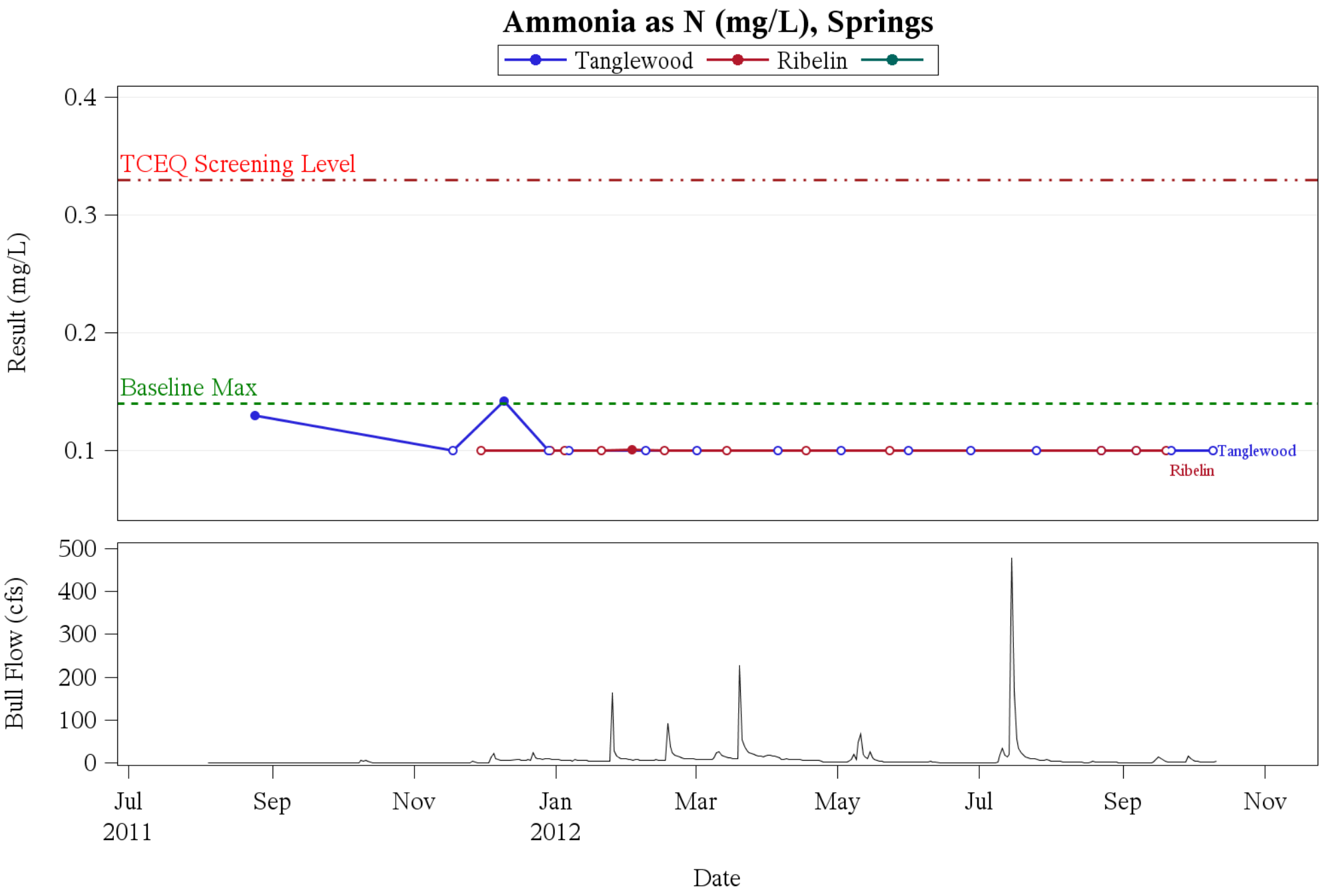
City of Austin DRAFT: QA/QC review pending

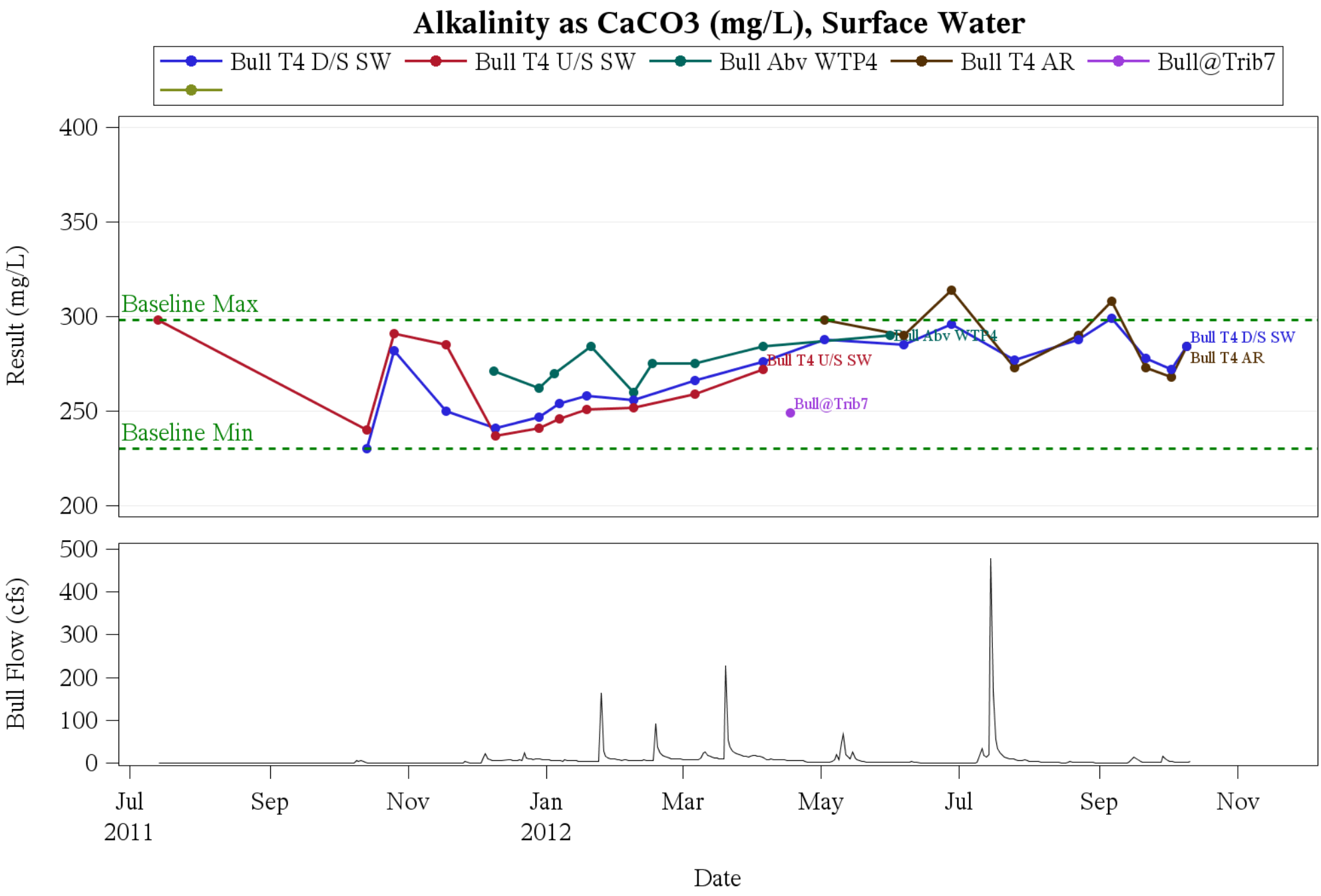

Stream Flow and Water Level
Stream Discharge, ft3/s
Water Depth, ft
@ Trib 7
T4 d/s SS Shaft
T4 AR
U/S of T7 (depth)
T4 u/s SS Shaft
@ SS 7th Xing (depth)
U/S old WTP4
Stream Discharge
@ SS 7th Xing
@ Trib 7
U/S old WTP4
T4 d/s SS Shaft
T4 u/s SS Shaft flowT4ART4 AR
flowT4AR
Daily Rain (in)
Jul 2011
Sep
Nov
Jan 2012
Mar
May
Jul
Sep
Nov
Date

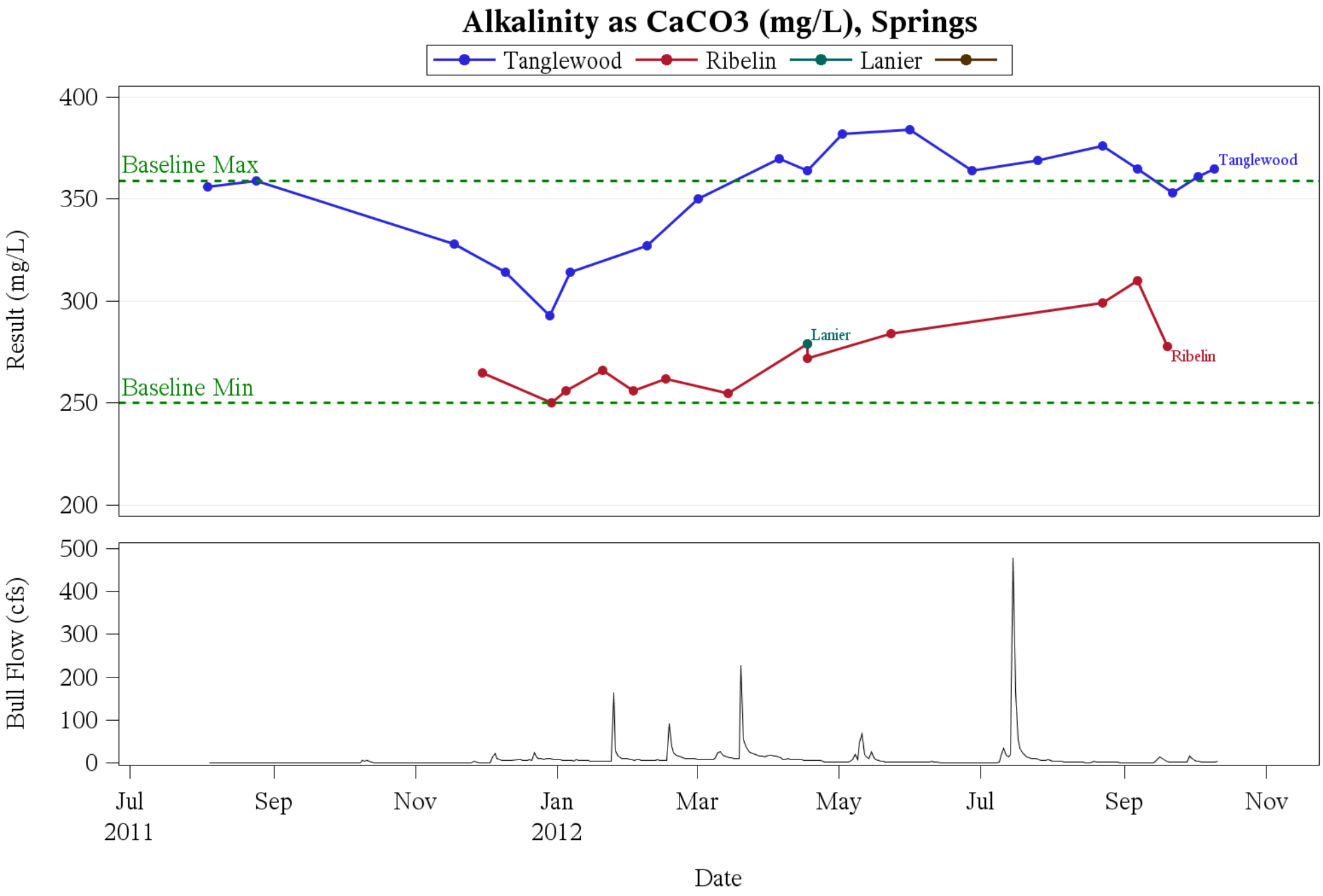


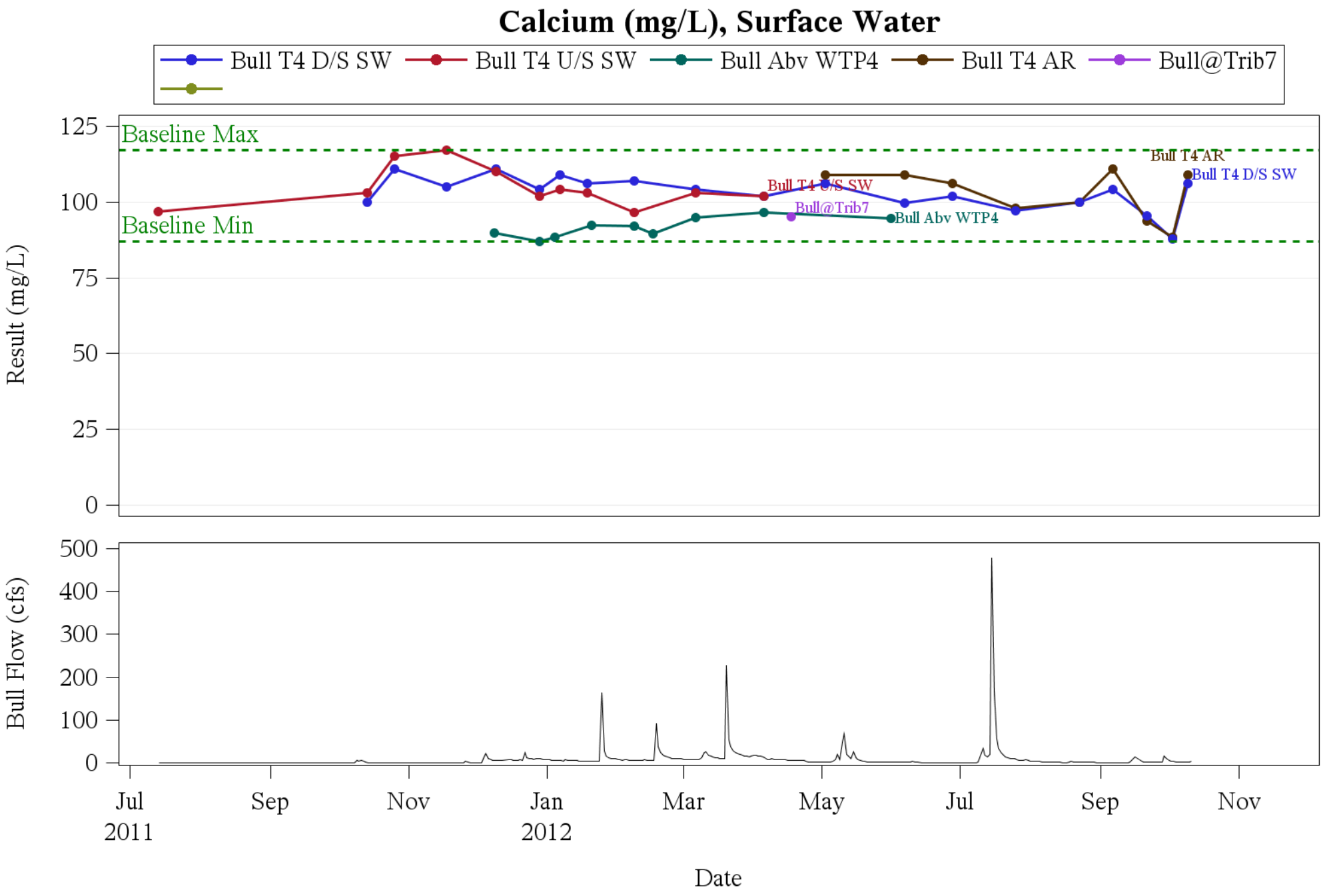
City of Austin DRAFT: QA/QC review pending

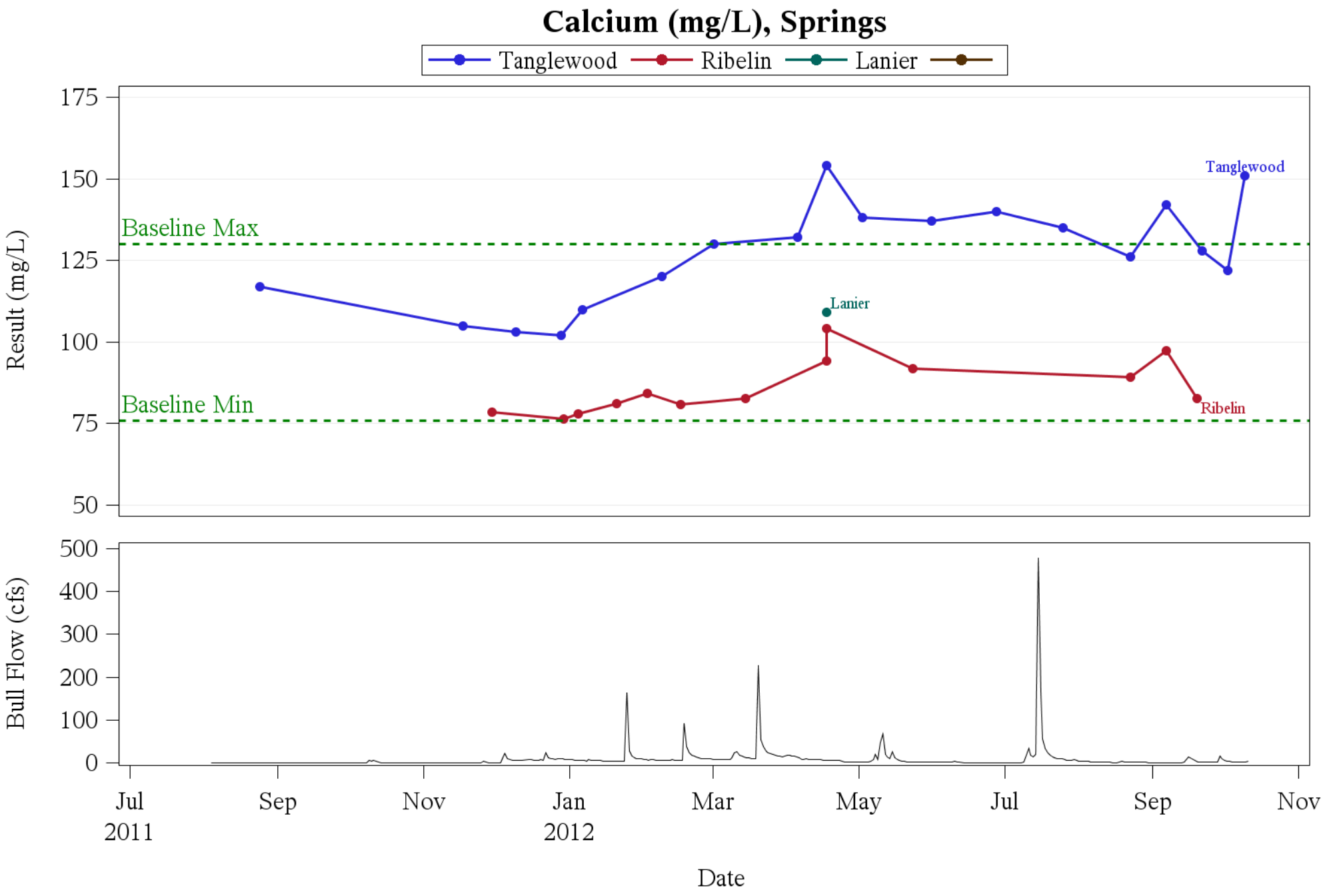

Ammonia as N (mg/L), Surface Water
Bull T4 D/S SW
Bull T4 U/S SW
Bull Abv WTP4
Bull T4 AR
TCEQ Screening Level
Baseline Max
Result (mg/L)
0.4
0.3
0.2
0.1
Bull T4 D/S SW
Bull T4 AR
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

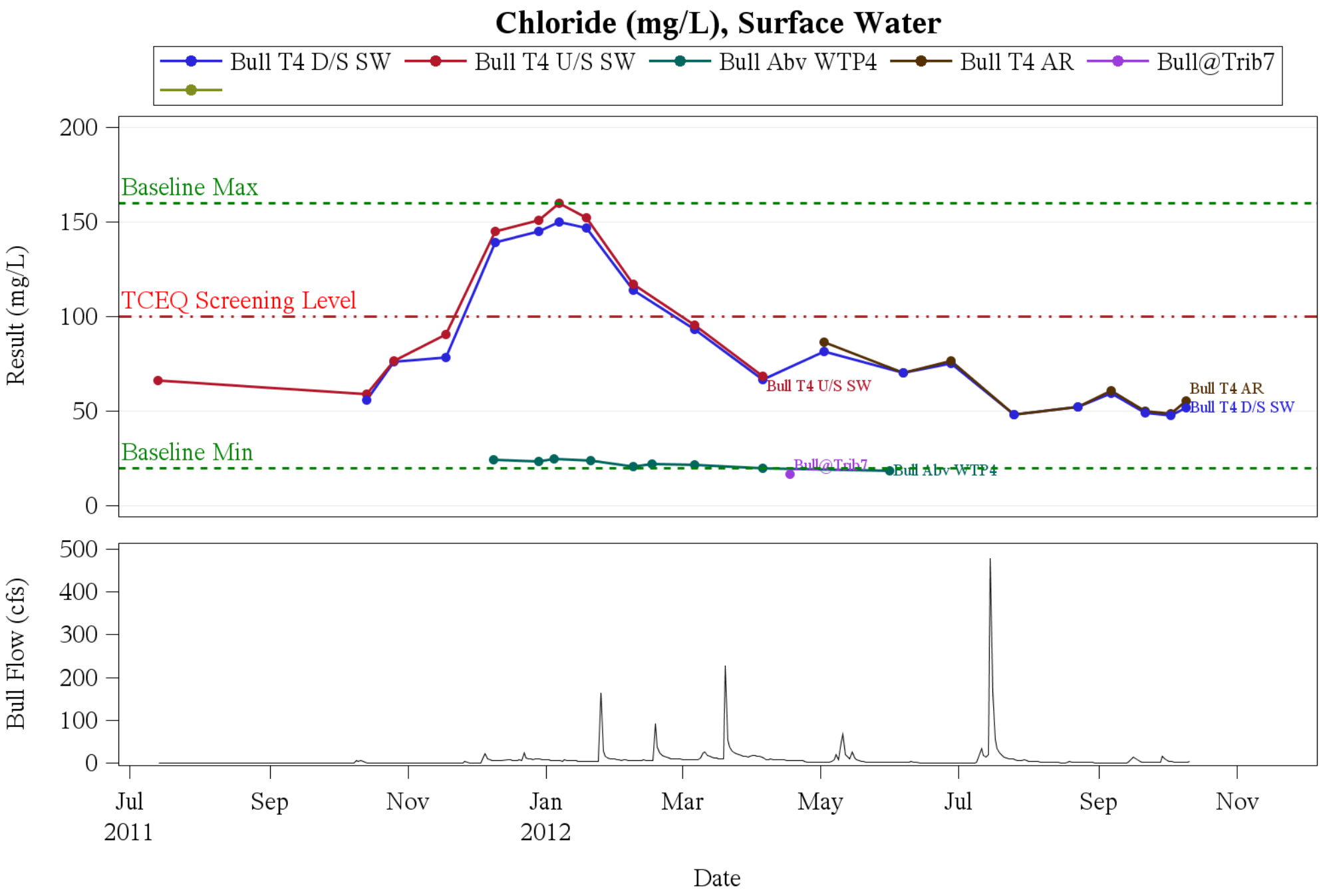

Ammonia as N (mg/L), Springs
Tanglewood
Ribelin
0.4
0.3
0.2
0.1
TCEQ Screening Level
Baseline Max
Result (mg/L)
Tanglewood
Ribelin
500
400
300
200
100
0
Bull Flow (cfs)
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

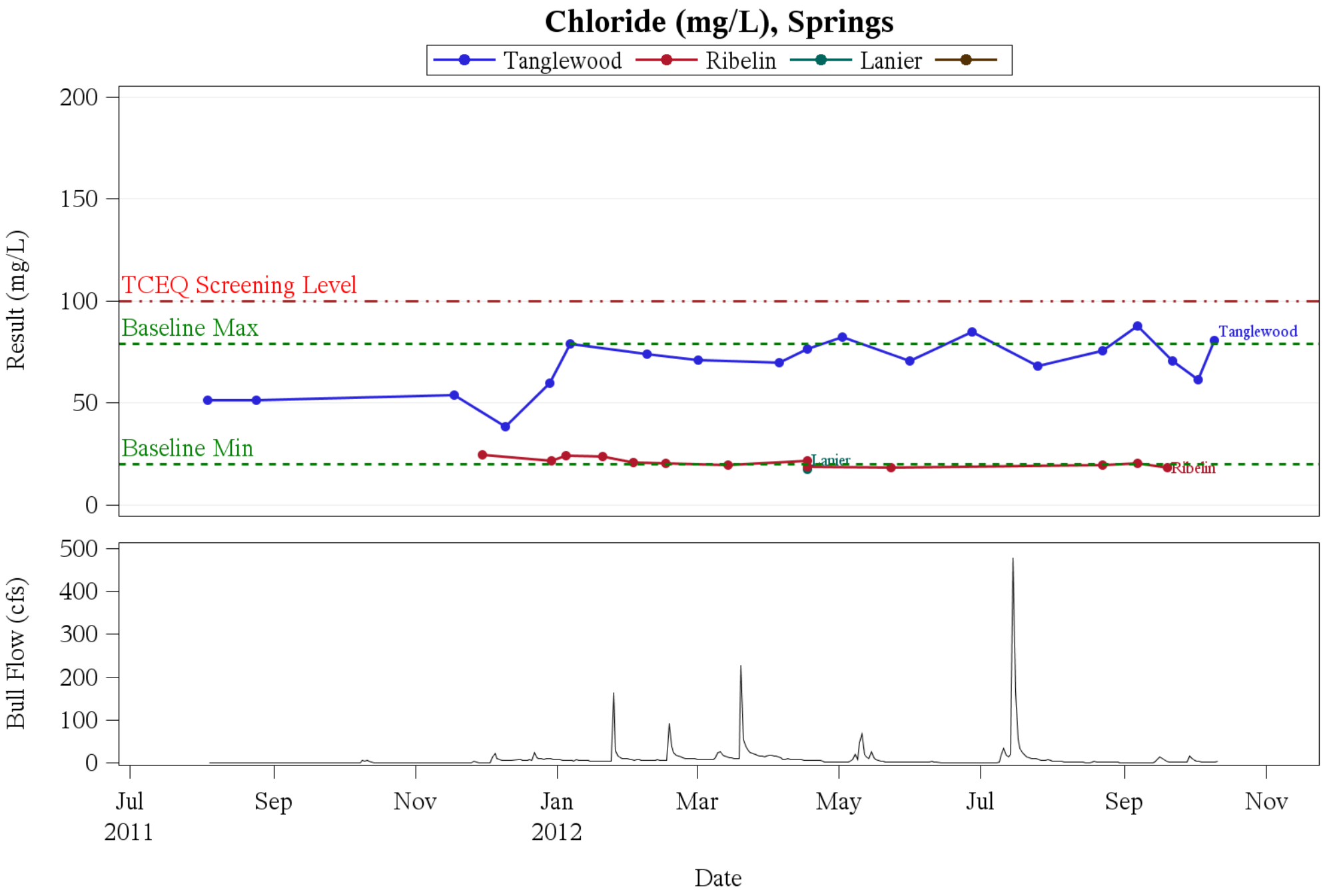

Alkalinity as CaCO3 (mg/L), Surface Water
Bull T4 D/S SW
Bull T4 U/S SW
Bull Abv WTP4
Bull T4 AR
Bull@Trib7
Result (mg/L)
400
350
300
250
200
Baseline Max
Baseline Min
Bull T4 D/S SW
Bull T4 AR
Bull Abv WTP4
Bull T4 U/S SW
Bull@Trib7
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

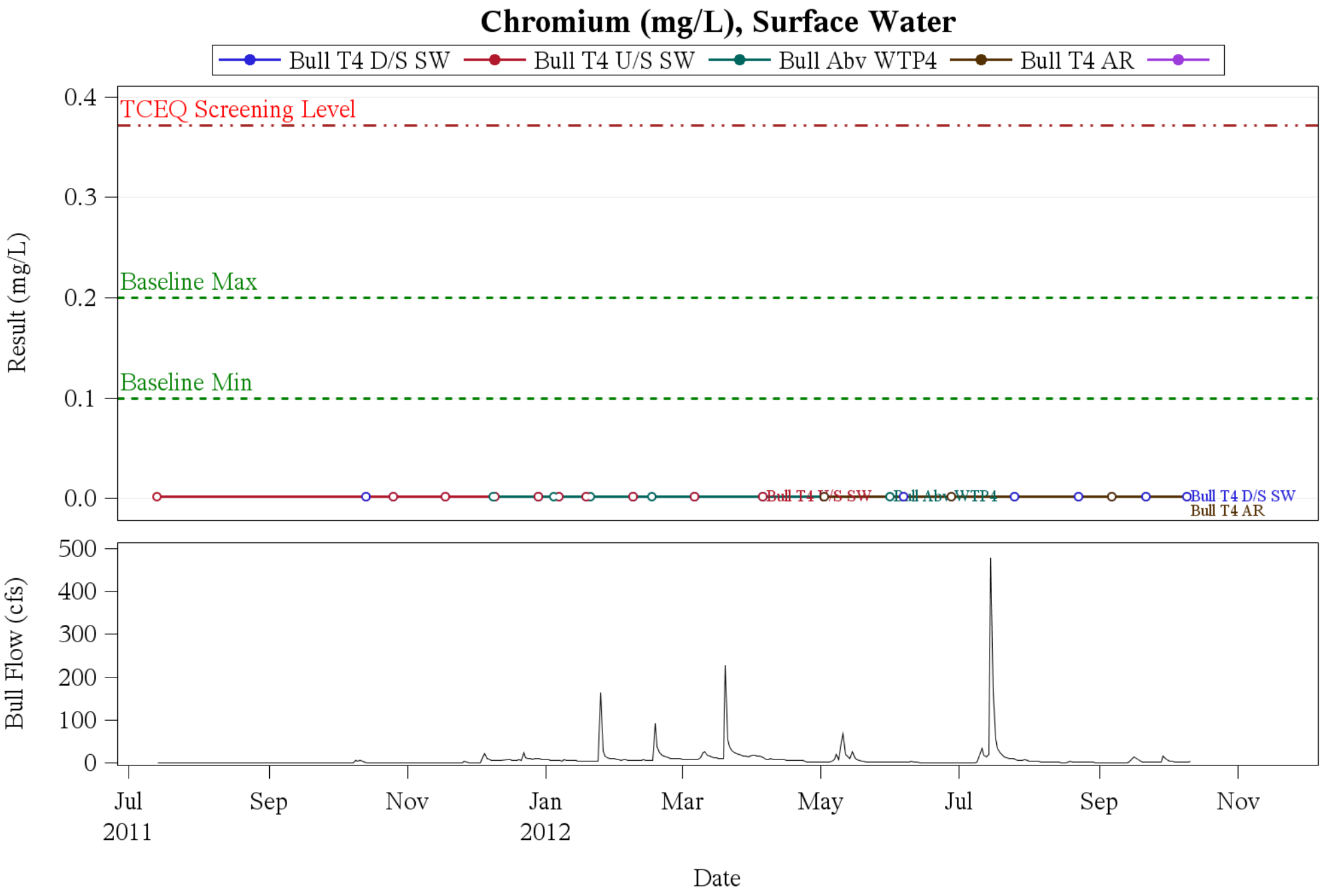

Alkalinity as CaCO3 (mg/L), Springs
Tanglewood
Ribelin
Lanier
Result (mg/L)
400
350
300
250
200
Baseline Max
Baseline Min
Tanglewood
Lanier
Ribelin
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

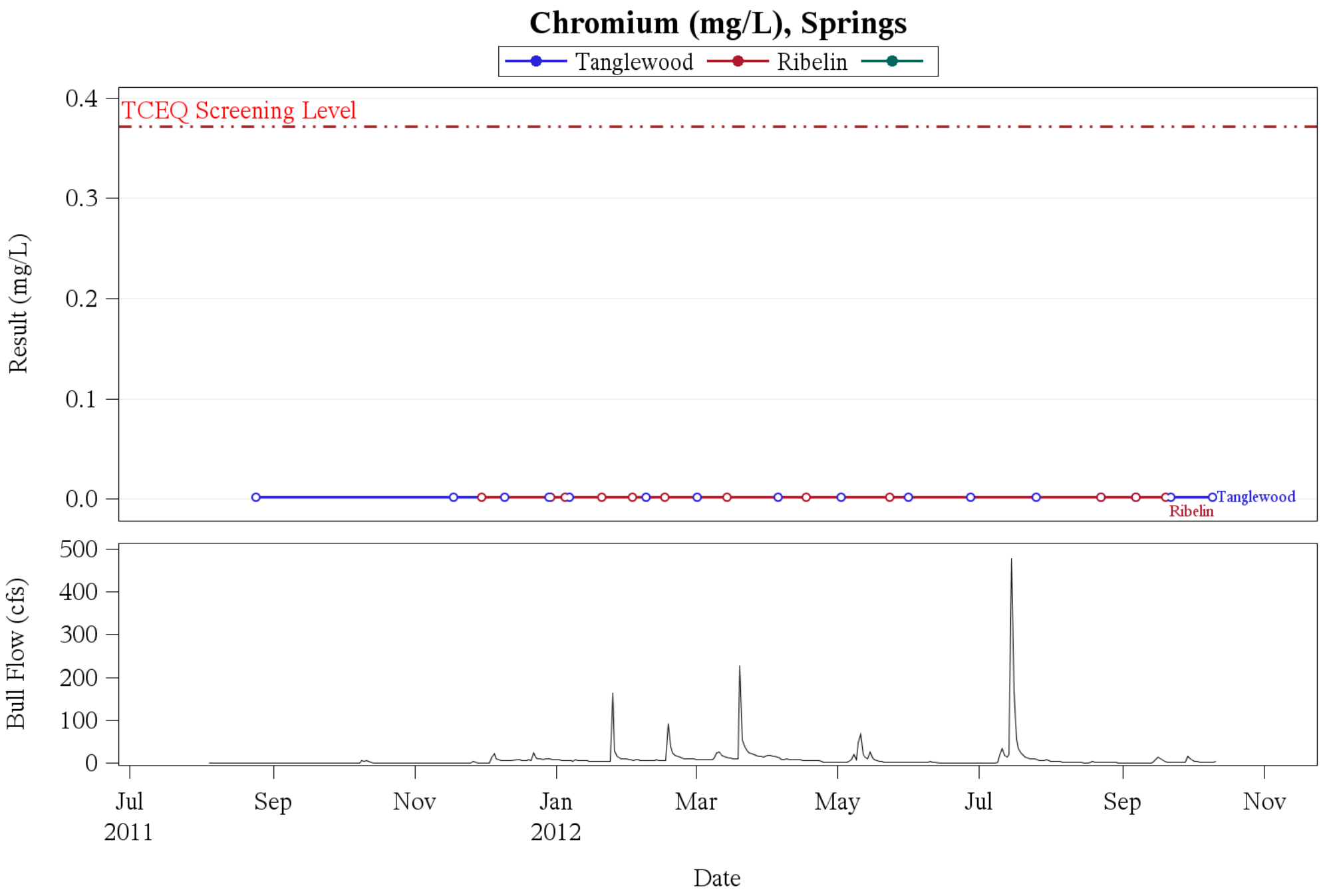

Calcium (mg/L), Surface Water
Bull T4 D/S SW
Bull T4 U/S SW
Bull Abv WTP4
Bull T4 AR
Bull@Trib7
Baseline Max
Baseline Min
Result (mg/L)
125
100
75
50
25
0
Bull T4 AR
Bull T4 D/S SW
Bull T4 U/S SW
Bull@Trib7
Bull Abv WTP4
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

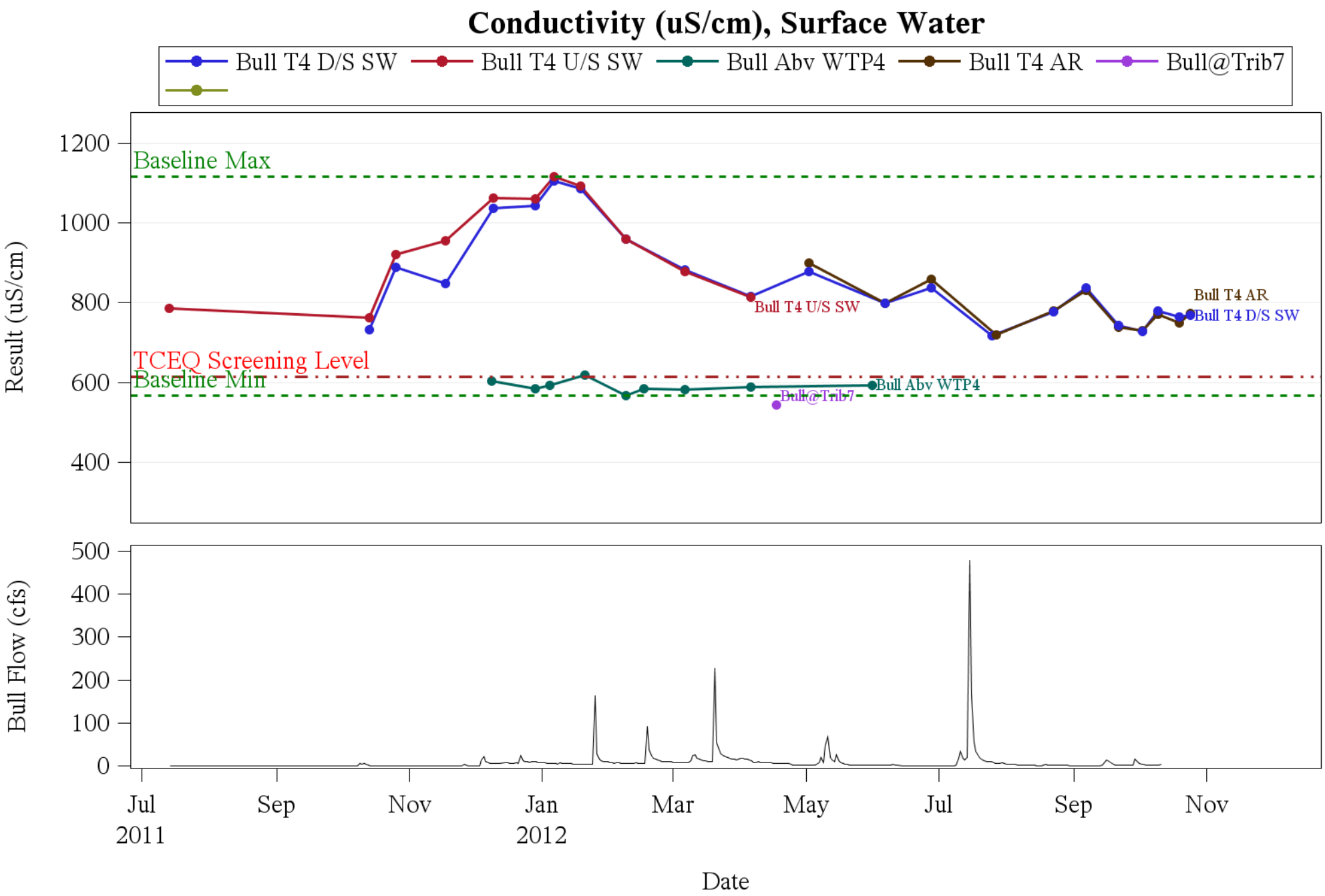

Calcium (mg/L), Springs
Tanglewood
Ribelin
Lanier
175
150
125
100
75
50
Result (mg/L)
Baseline Max
Baseline Min
Tanglewood
Lanier
Ribelin
500
400
300
200
100
0
Bull Flow (cfs)
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

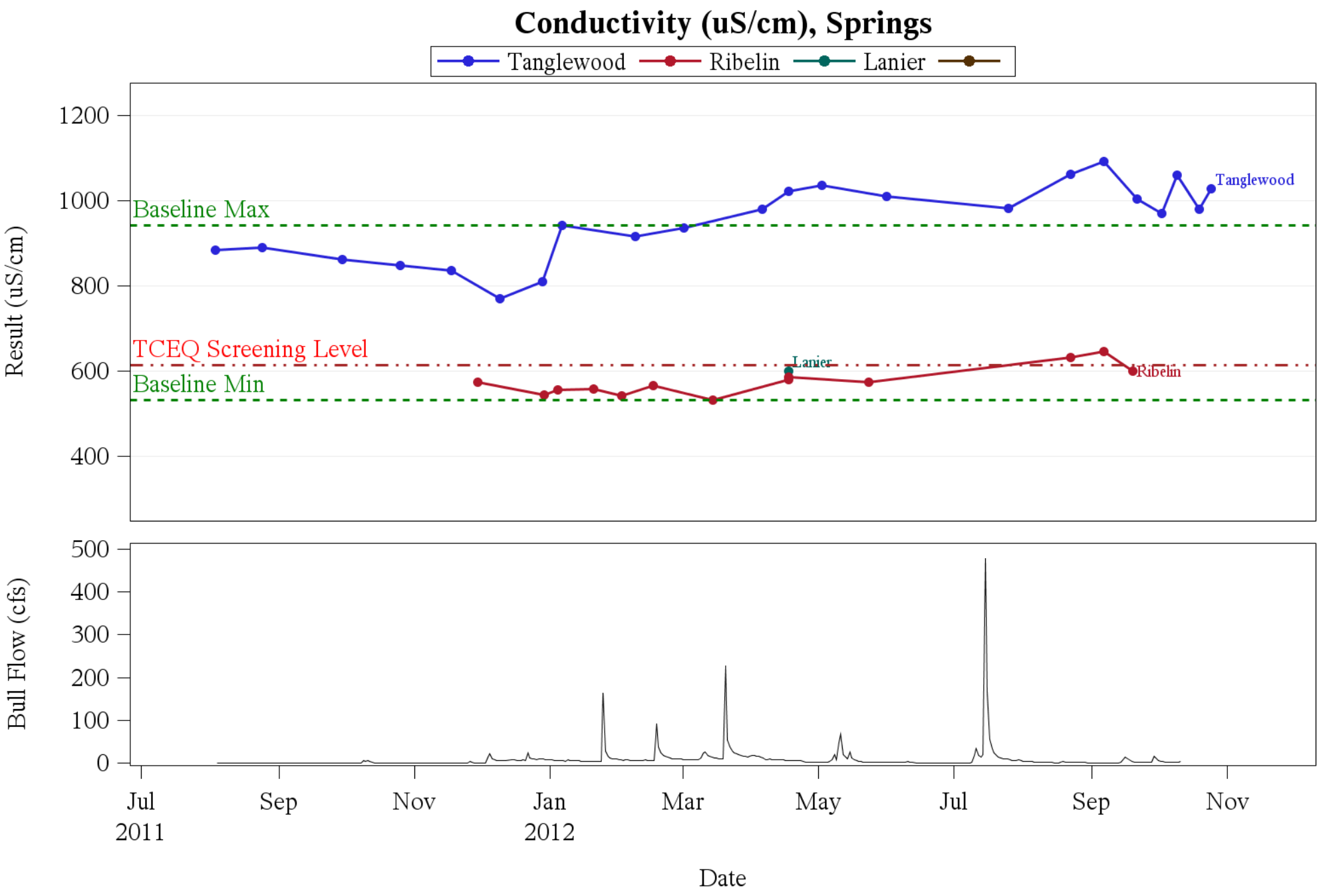

Chloride (mg/L), Surface Water
Bull T4 D/S SW
Bull T4 U/S SW
Bull Abv WTP4
Bull T4 AR
Bull@Trib7
Result (mg/L)
200
150
100
50
0
Baseline Max
TCEQ Screening Level
Baseline Min
Bull T4 U/S SW
Bull T4 AR
Bull T4 D/S SW
Bull@Trib7
Bull Abv WTP4
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

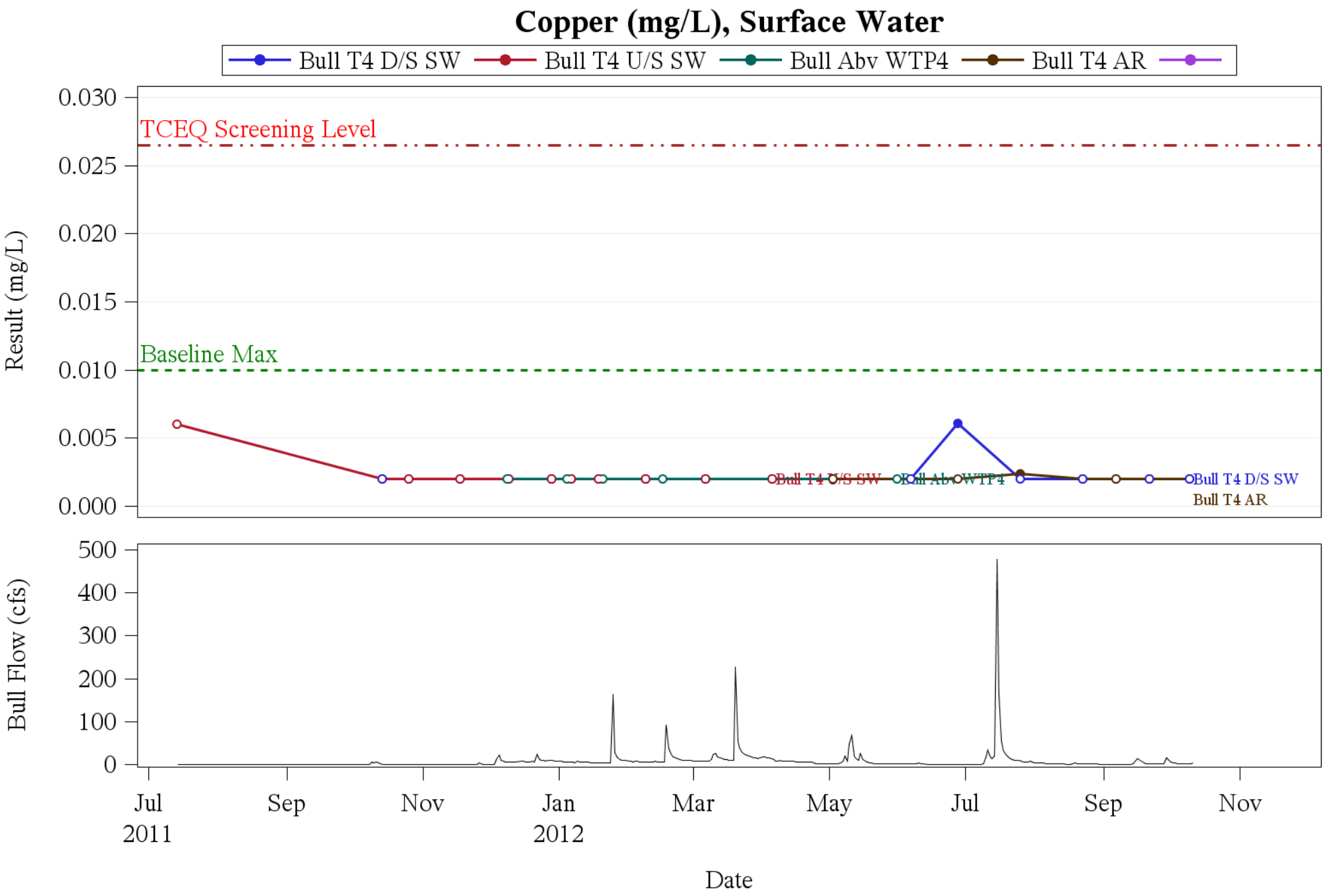

Chloride (mg/L), Springs
Tanglewood
Ribelin
Lanier
Result (mg/L)
200
150
100
50
0
TCEQ Screening Level
Baseline Max
Baseline Min
Tanglewood
Lanier
Ribelin
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

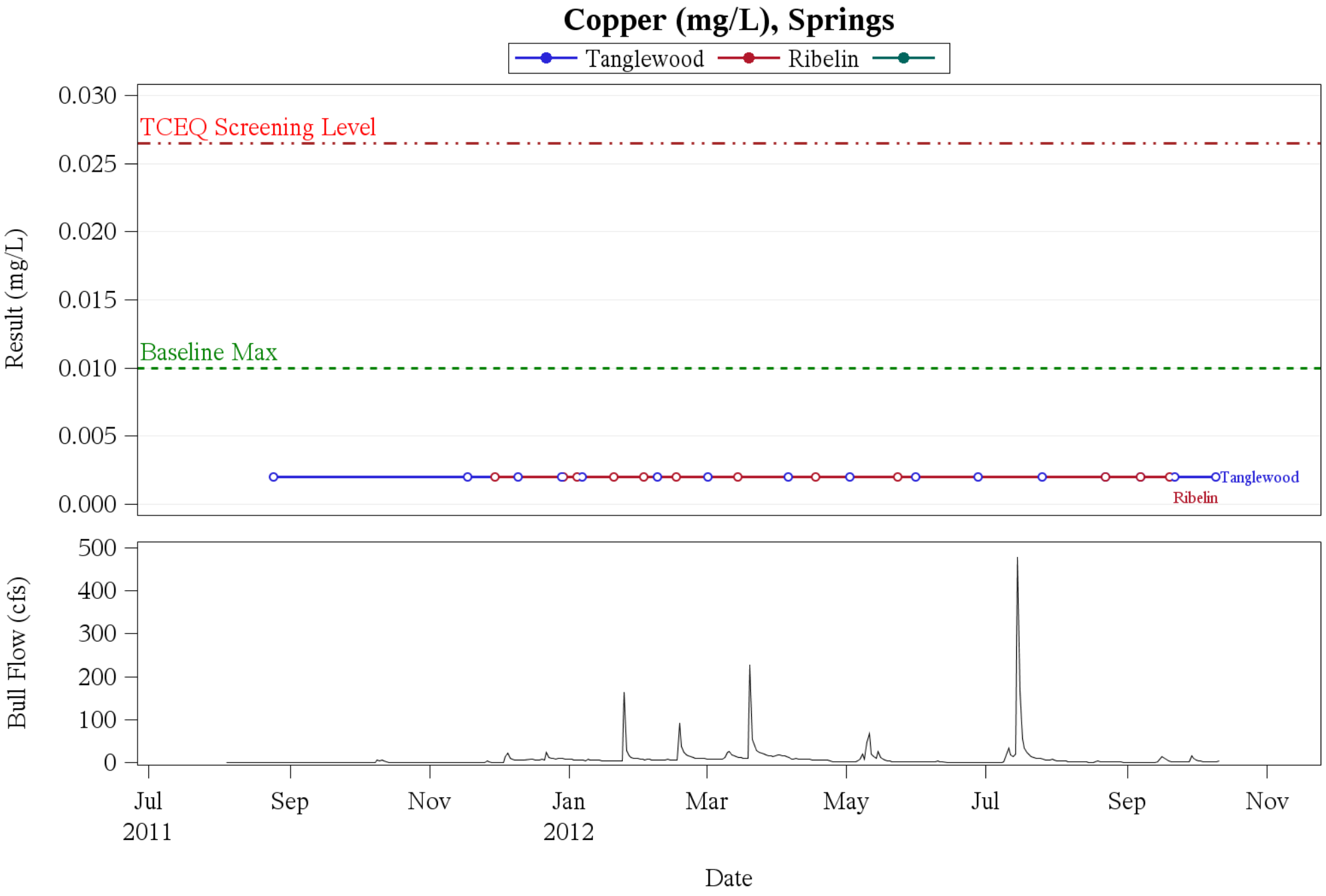

Chromium (mg/L), Surface Water
Bull T4 D/S SW
Bull T4 U/S SW
Bull Abv WTP4
Bull T4 AR
TCEQ Screening Level
Baseline Max
Baseline Min
Result (mg/L)
0.4
0.3
0.2
0.1
0.0
Bull T4 U/S SW
Bull Abv WTP4
Bull T4 D/S SW
Bull T4 AR
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

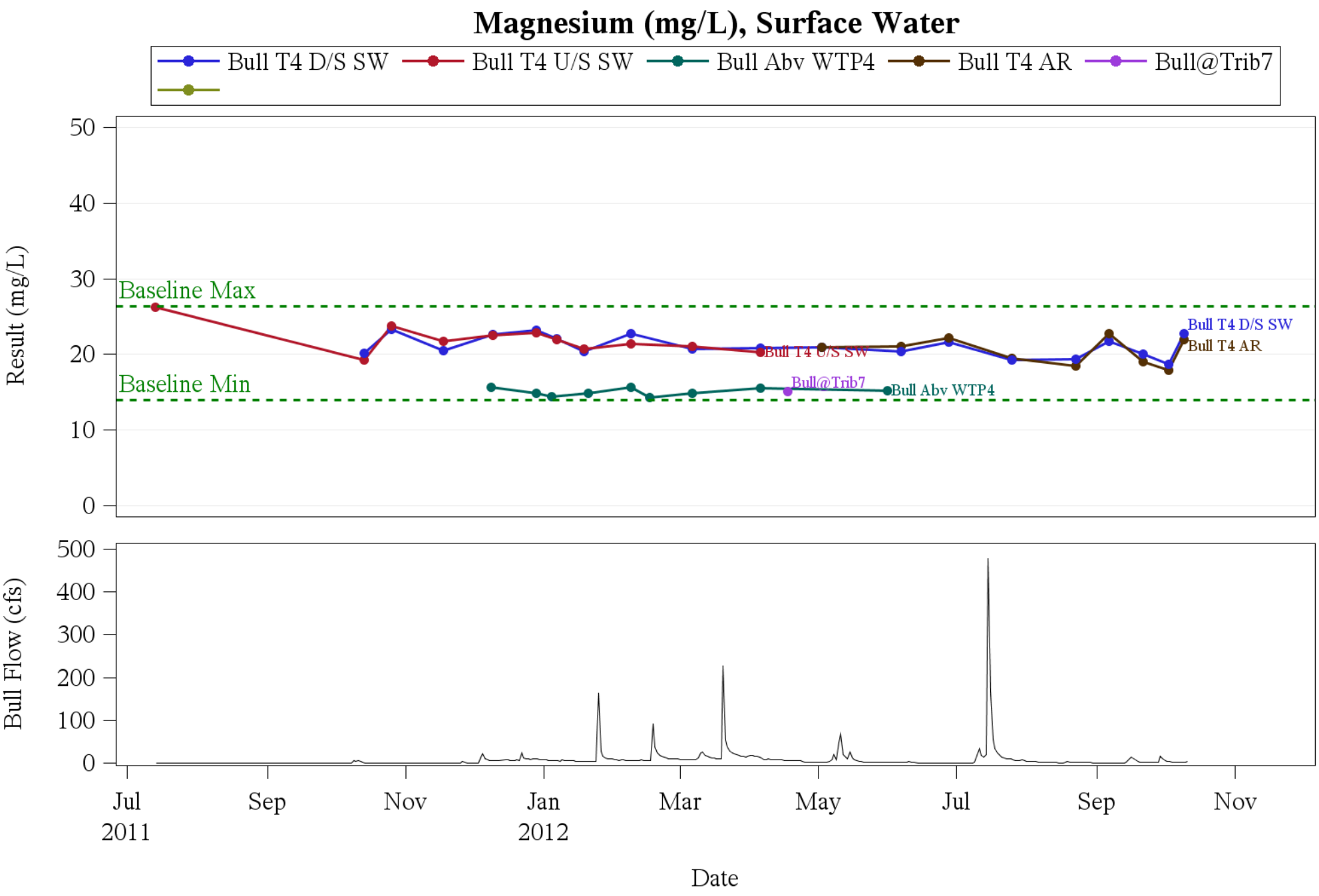

Chromium (mg/L), Springs
Tanglewood
Ribelin
TCEQ Screening Level
Result (mg/L)
0.4
0.3
0.2
0.1
0.0
Tanglewood
Ribelin
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

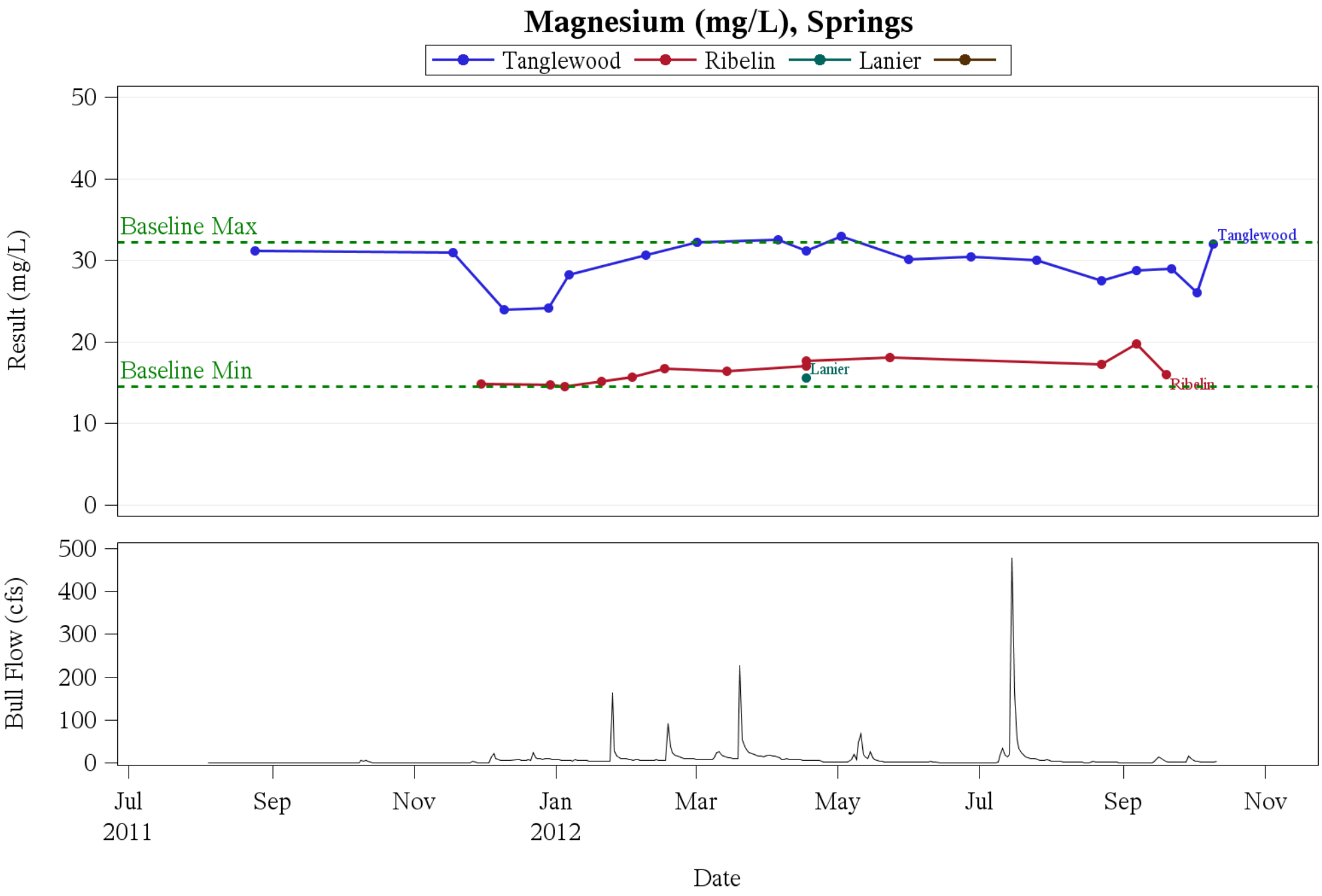

Conductivity (uS/cm), Surface Water
Bull T4 D/S SW
Bull T4 U/S SW
Bull Abv WTP4
Bull T4 AR
Bull@Trib7
Result (uS/cm)
1200
1000
800
600
400
Baseline Max
TCEQ Screening Level
Baseline Min
Bull T4 U/S SW
Bull T4 AR
Bull T4 D/S SW
Bull Abv WTP4
Bull@Trib7
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

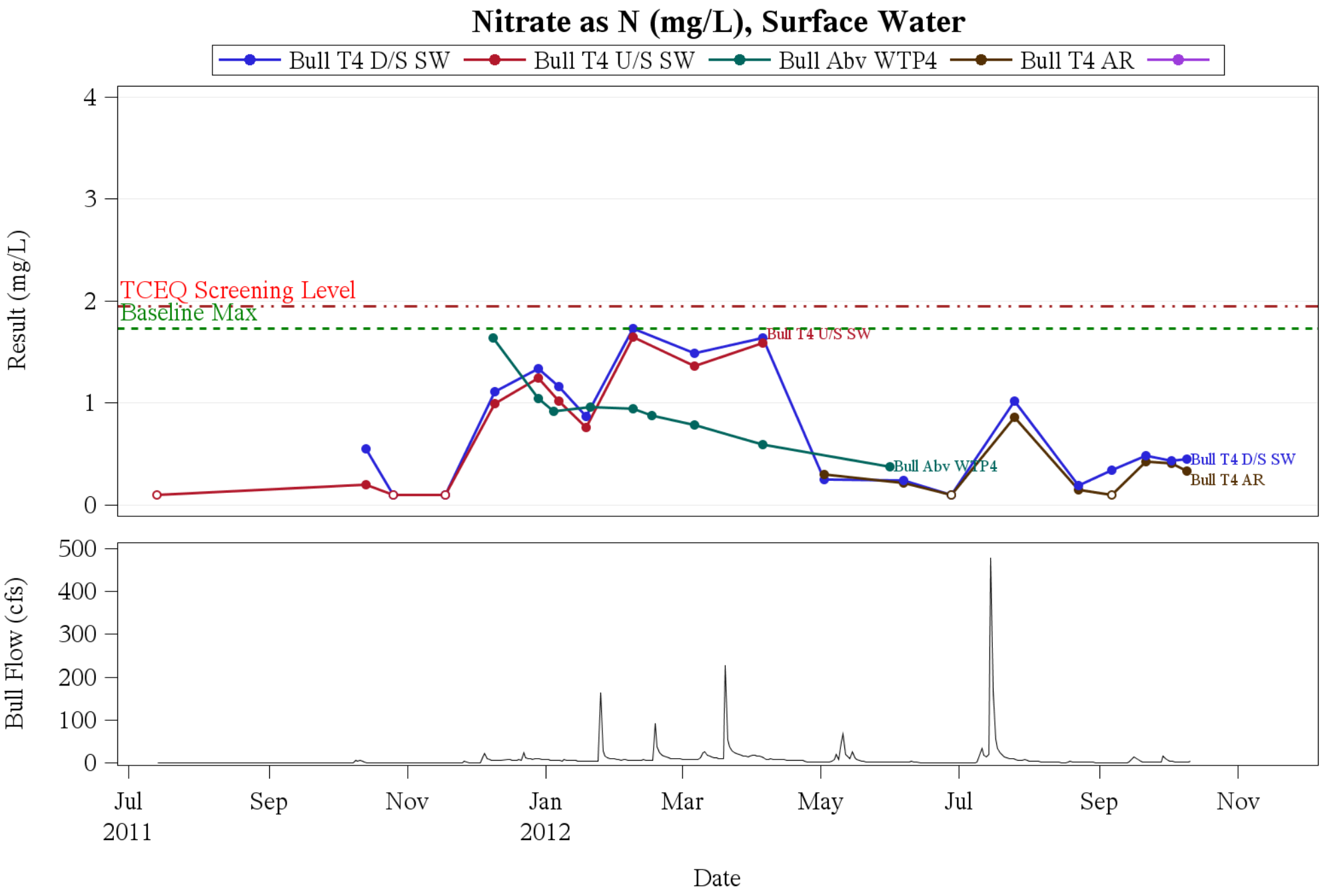

Conductivity (uS/cm), Springs
Tanglewood
Ribelin
Lanier
1200
1000
800
600
400
Result (uS/cm)
Baseline Max
TCEQ Screening Level
Baseline Min
Tanglewood
Lanier
Ribelin
500
400
300
200
100
0
Bull Flow (cfs)
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

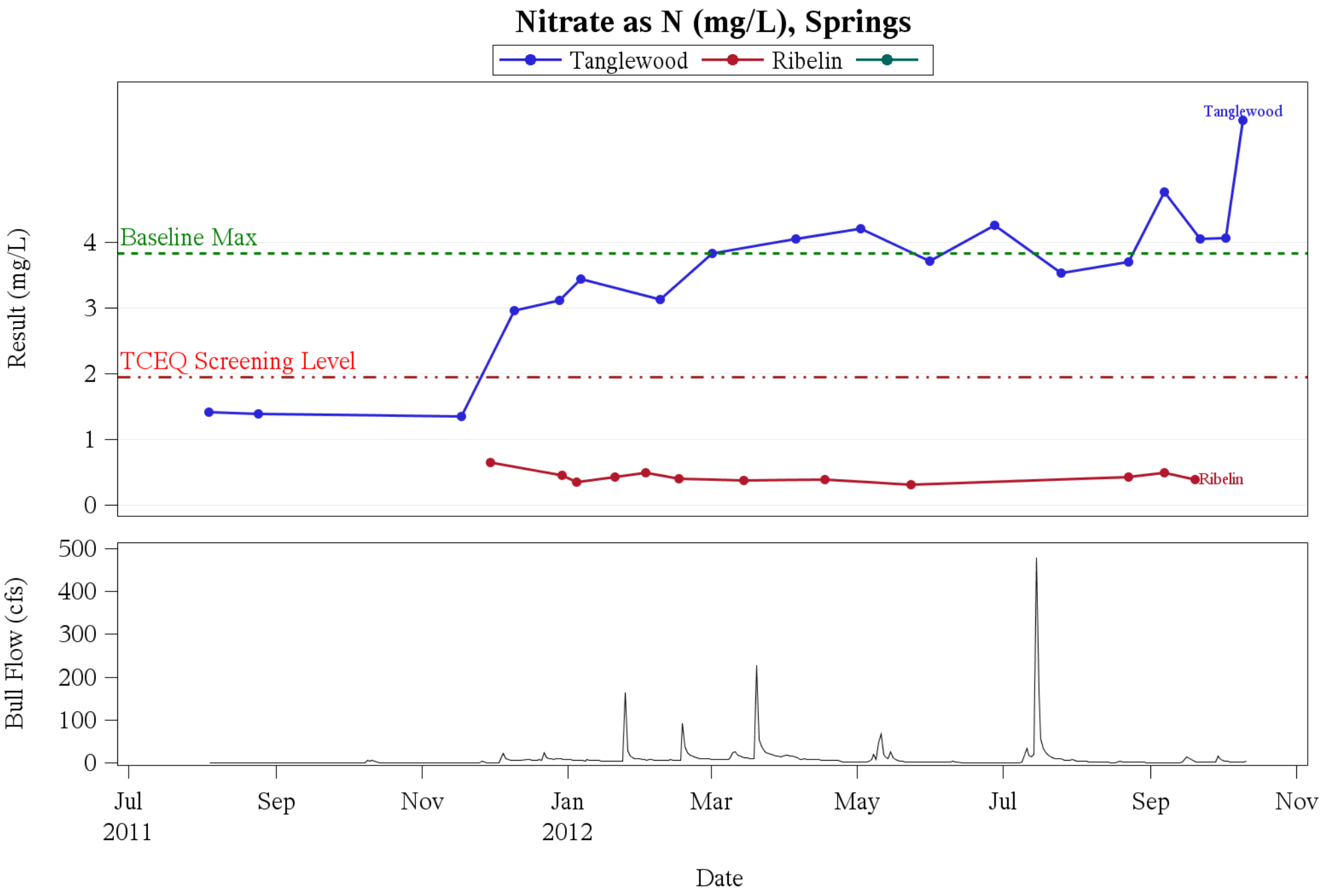

Copper (mg/L), Surface Water
Bull T4 D/S SW
Bull T4 U/S SW
Bull Abv WTP4
Bull T4 AR
TCEQ Screening Level
Baseline Max
Result (mg/L)
0.030
0.025
0.020
0.015
0.010
0.005
0.000
Bull T4 U/S SW
Bull Abv WTP4
Bull T4 D/S SW
Bull T4 AR
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

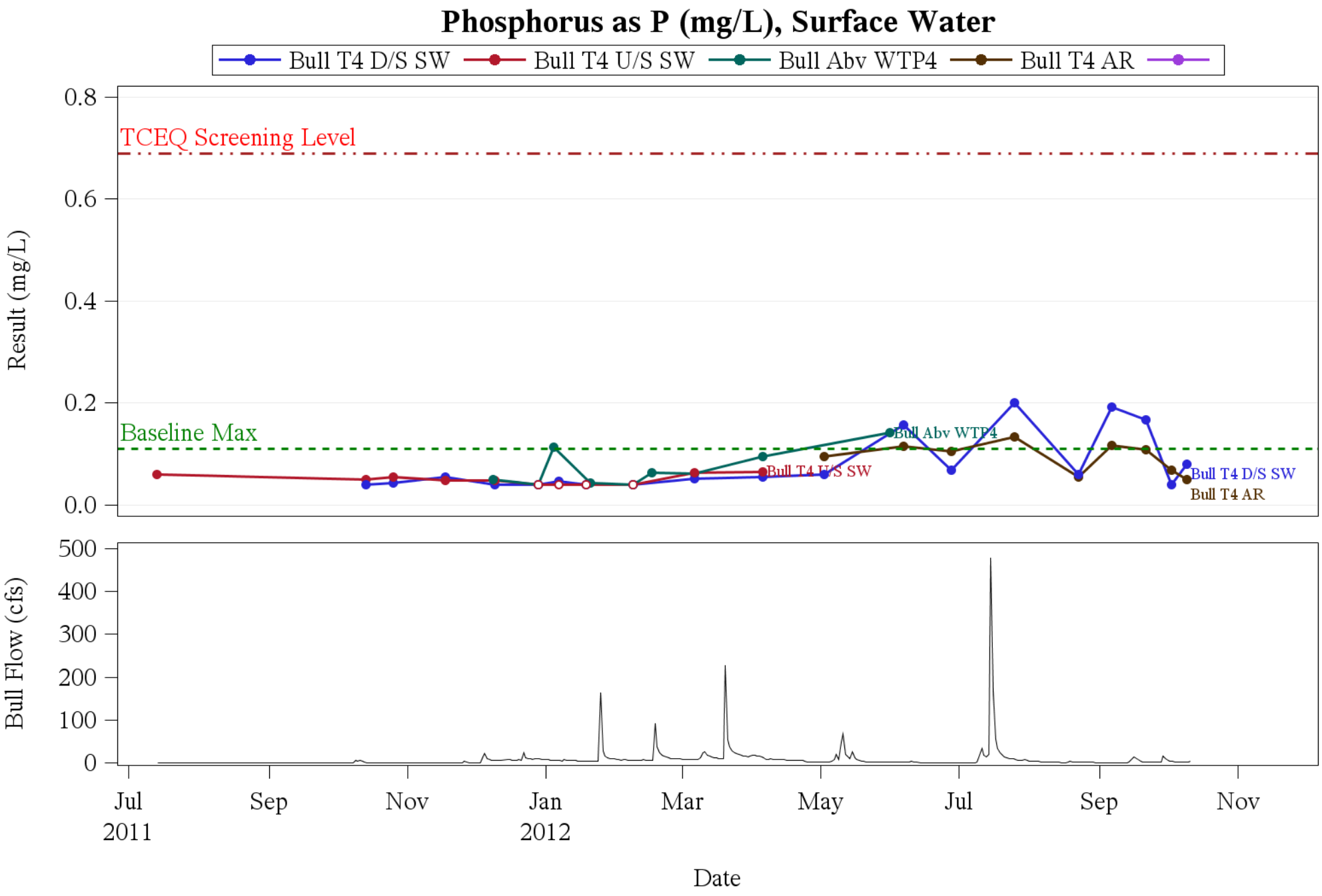

Copper (mg/L), Springs
Tanglewood
Ribelin
0.030
0.025
0.020
0.015
0.010
0.005
0.000
Result (mg/L)
TCEQ Screening Level
Baseline Max
Tanglewood
Ribelin
500
400
300
200
100
0
Bull Flow (cfs)
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

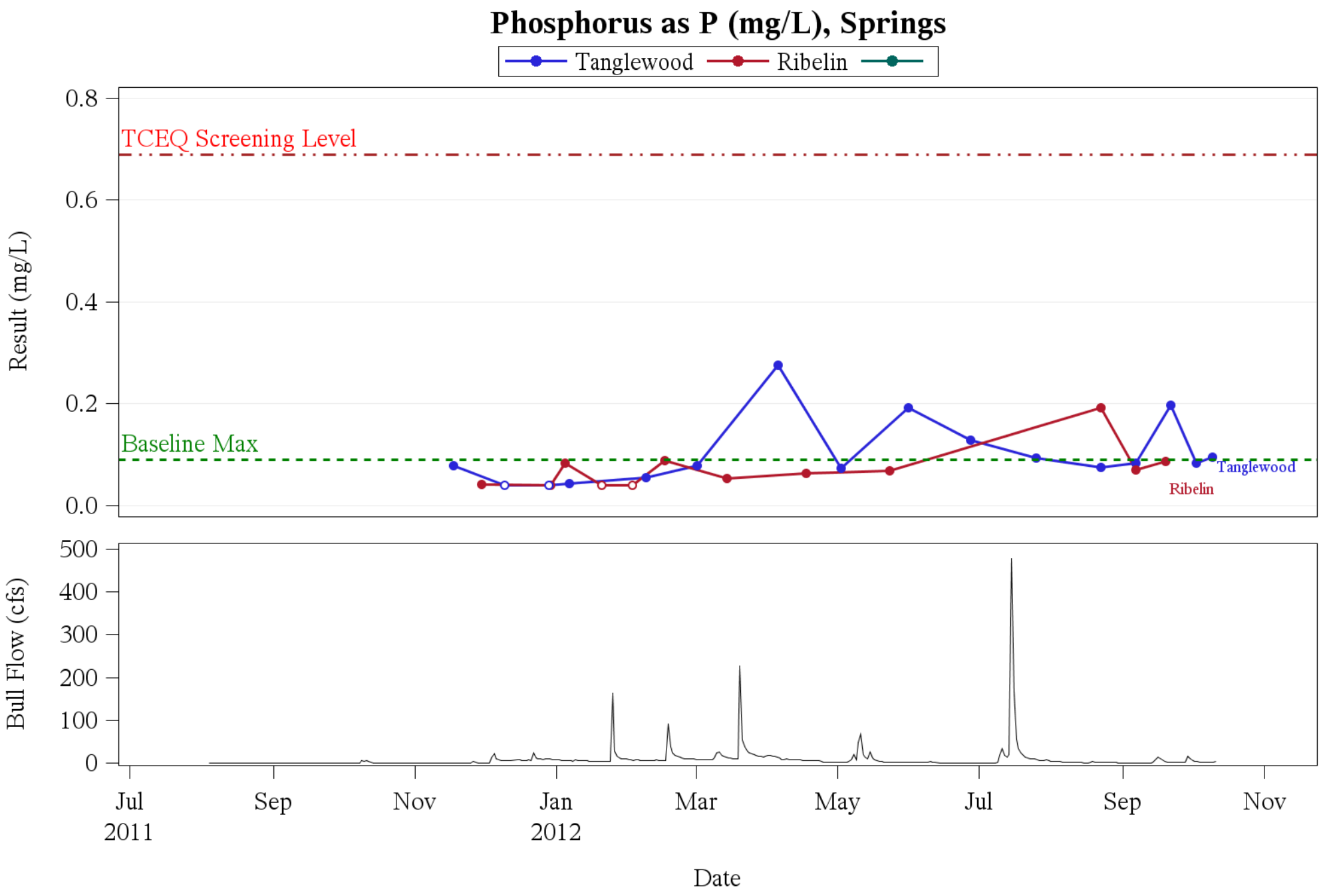

Magnesium (mg/L), Surface Water
Bull T4 D/S SW
Bull T4 U/S SW
Bull Abv WTP4
Bull T4 AR
Bull@Trib7
Result (mg/L)
50
40
30
20
10
0
Baseline Max
Baseline Min
Bull T4 D/S SW
Bull T4 AR
Bull T4 U/S SW
Bull@Trib7
Bull Abv WTP4
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

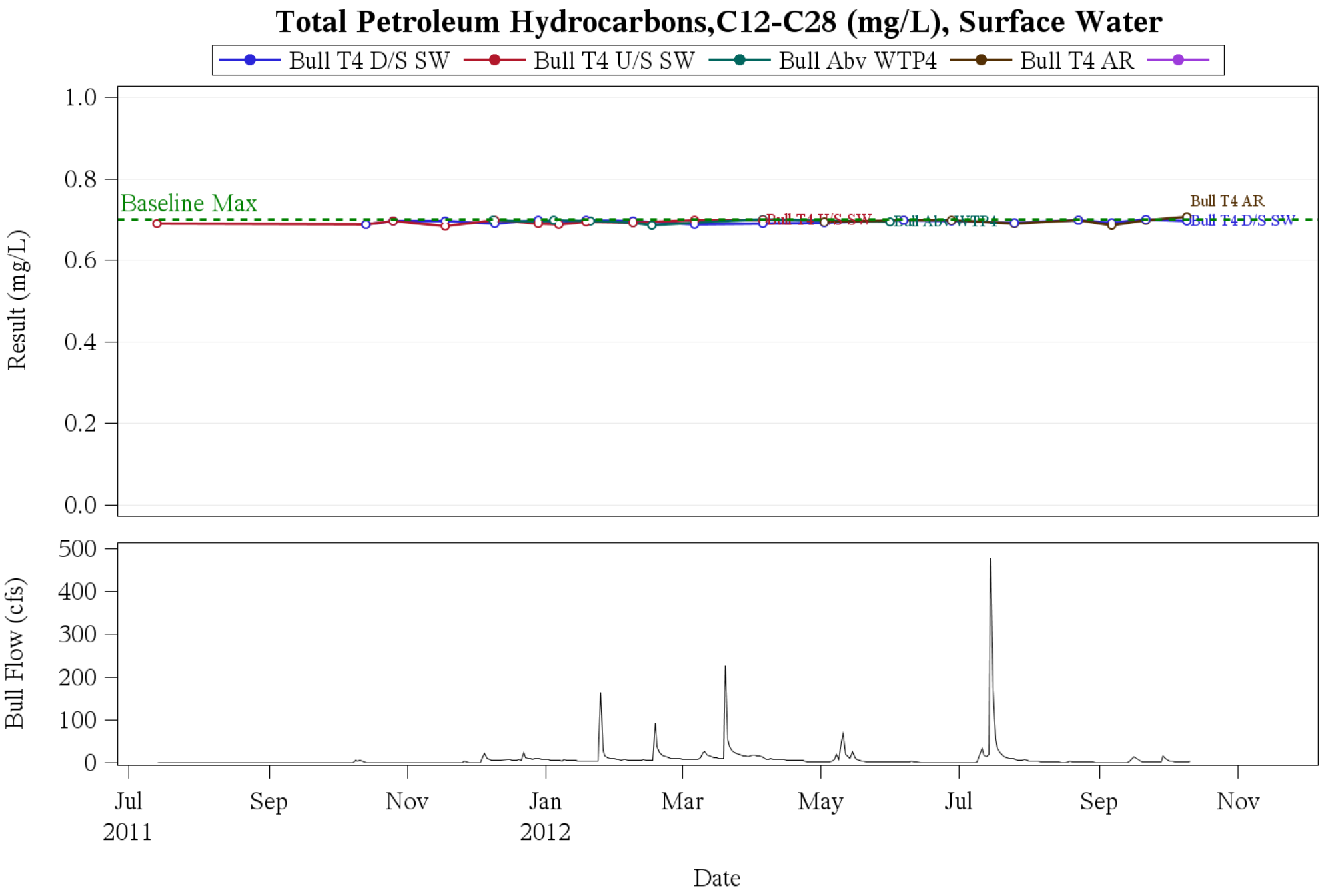

Magnesium (mg/L), Springs
Tanglewood
Ribelin
Lanier
Result (mg/L)
50
40
30
20
10
0
Baseline Max
Baseline Min
Tanglewood
Lanier
Ribelin
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

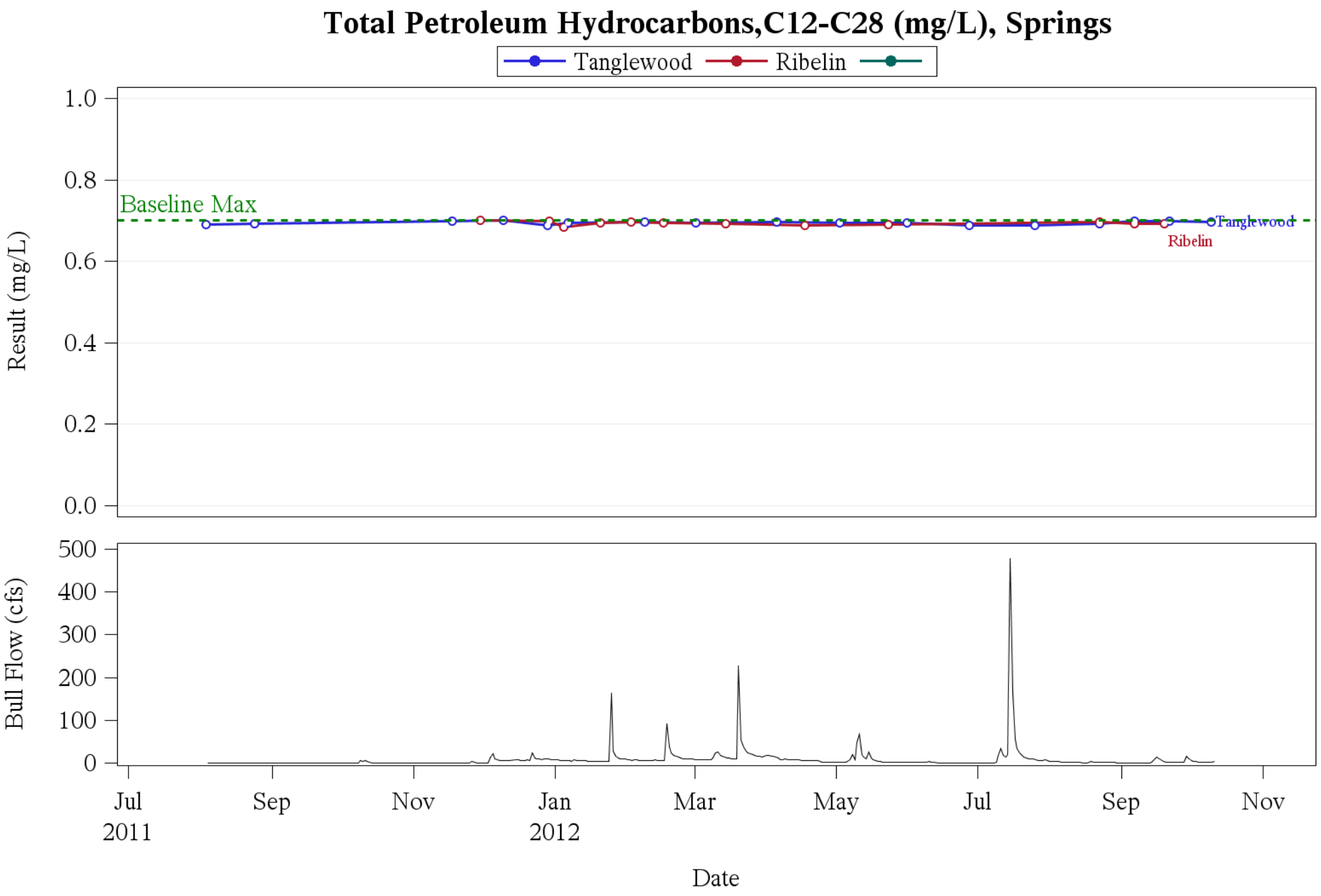

Nitrate as N (mg/L), Surface Water
Bull T4 D/S SW
Bull T4 U/S SW
Bull Abv WTP4
Bull T4 AR
Result (mg/L)
TCEQ Screening Level
Baseline Max
Bull T4 U/S SW
Bull Abv WTP4
Bull T4 D/S SW
Bull T4 AR
Bull Flow (cfs)
Jul 2011
Sep
Nov
Jan 2012
Mar
May
Jul
Sep
Nov
Date

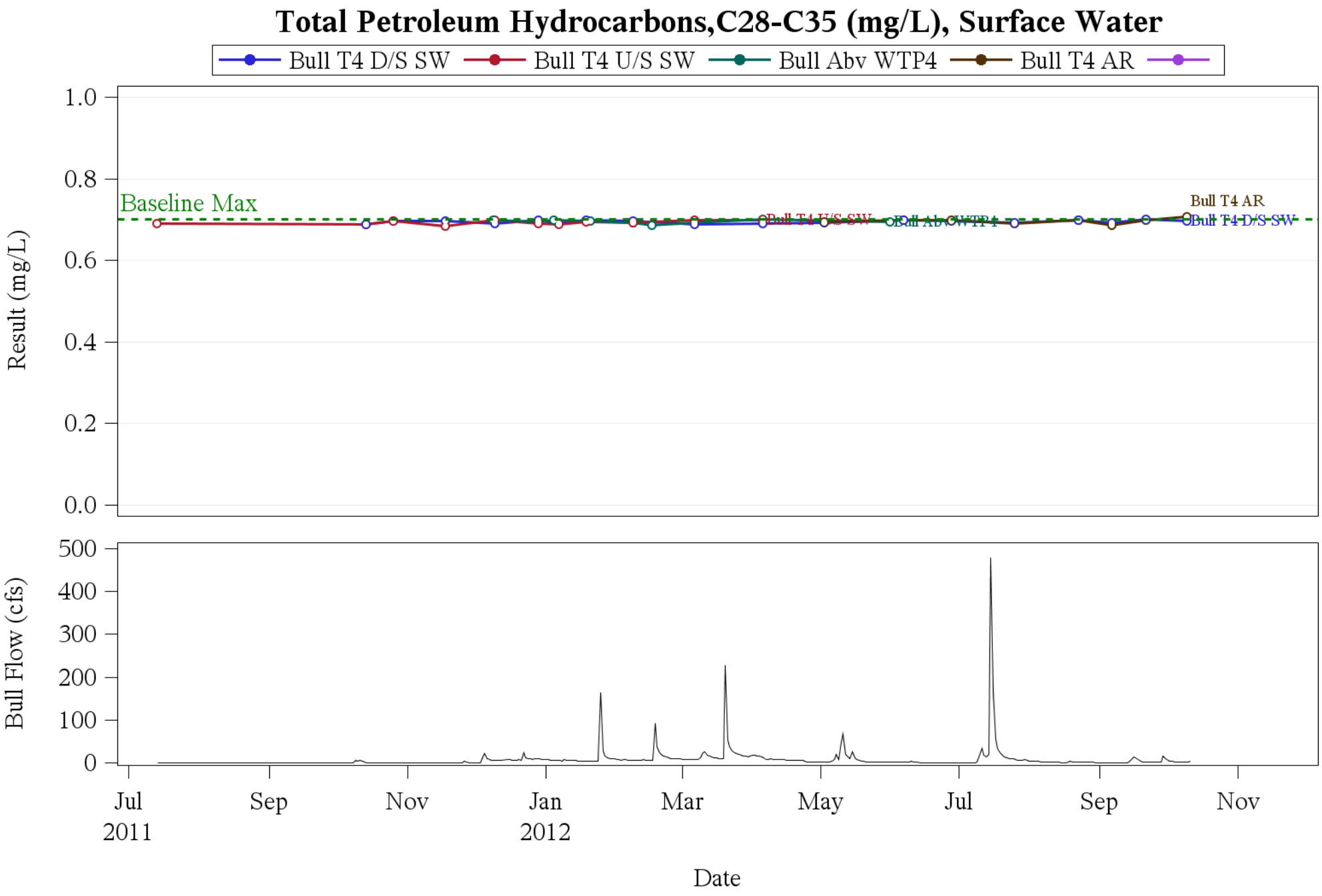

Nitrate as N (mg/L), Springs
Tanglewood
Ribelin
Result (mg/L)
Baseline Max
TCEQ Screening Level
Tanglewood
Ribelin
0
1
2
3
4
Bull Flow (cfs)
0
100
200
300
400
500
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

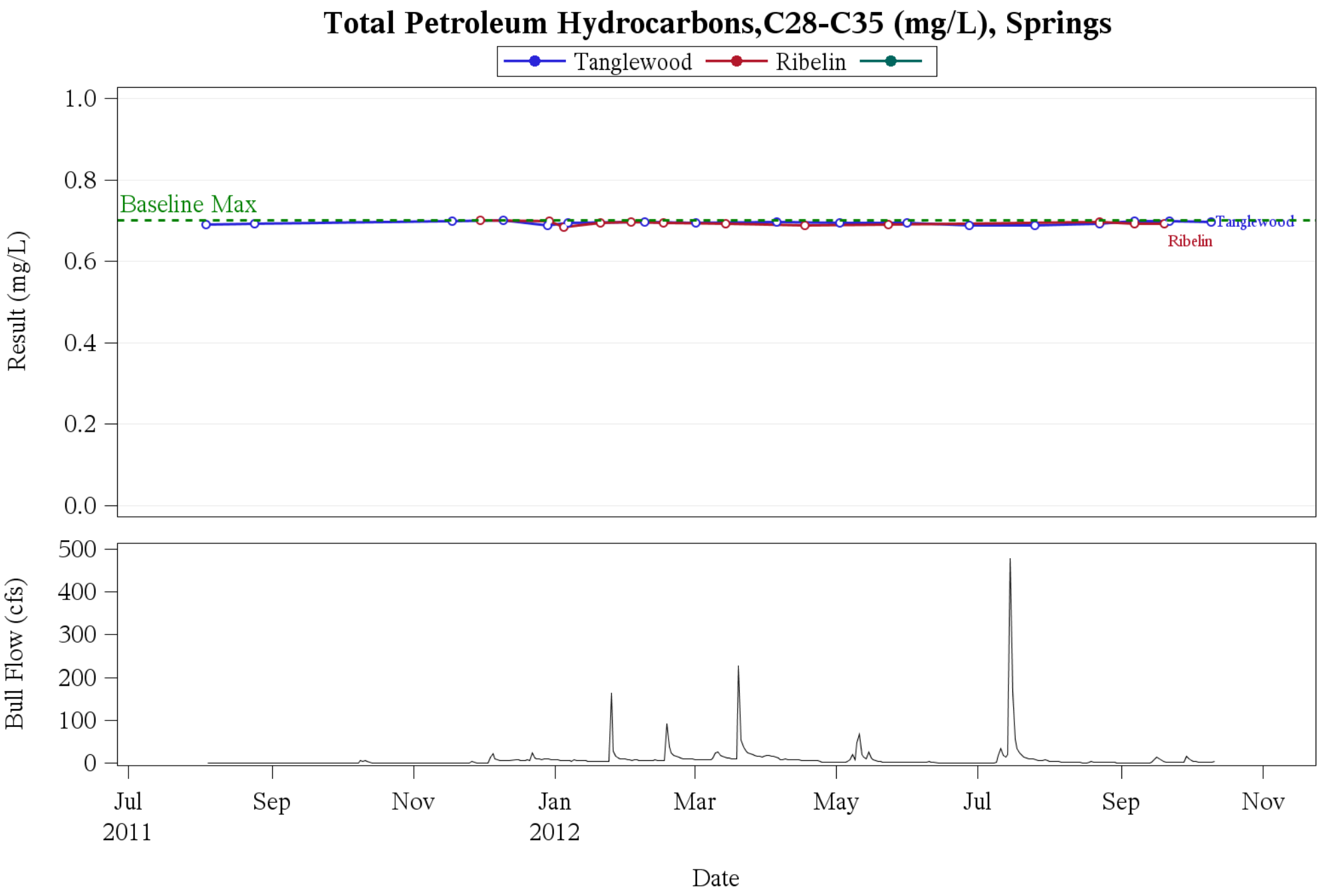

Phosphorus as P (mg/L), Surface Water
Bull T4 D/S SW
Bull T4 U/S SW
Bull Abv WTP4
Bull T4 AR
TCEQ Screening Level
Baseline Max
Result (mg/L)
0.8
0.6
0.4
0.2
0.0
Bull Abv WTP4
Bull T4 U/S SW
Bull T4 D/S SW
Bull T4 AR
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

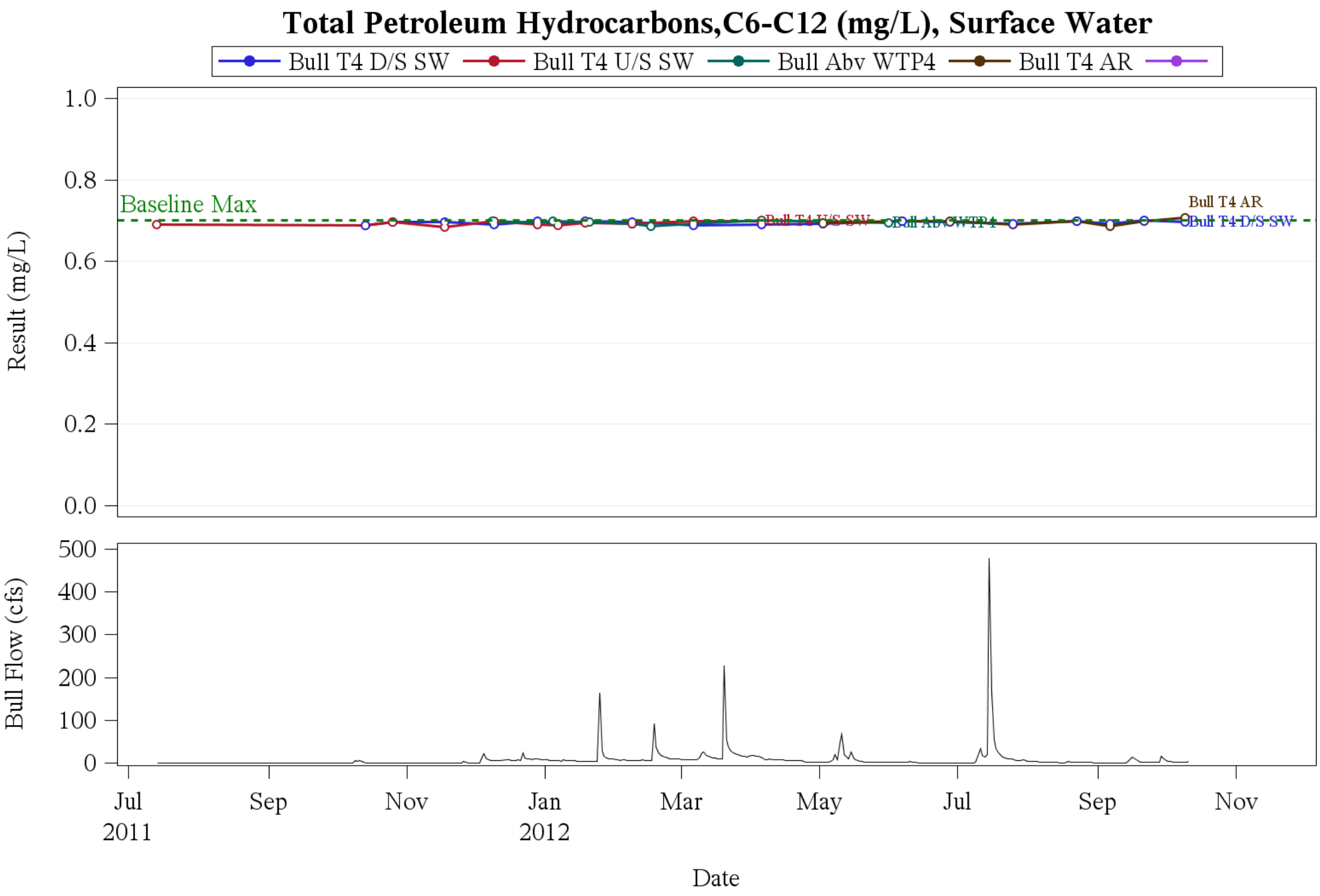

Phosphorus as P (mg/L), Springs
Tanglewood
Ribelin
0.8
0.6
0.4
0.2
0.0
Result (mg/L)
TCEQ Screening Level
Baseline Max
Tanglewood
Ribelin
500
400
300
200
100
0
Bull Flow (cfs)
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

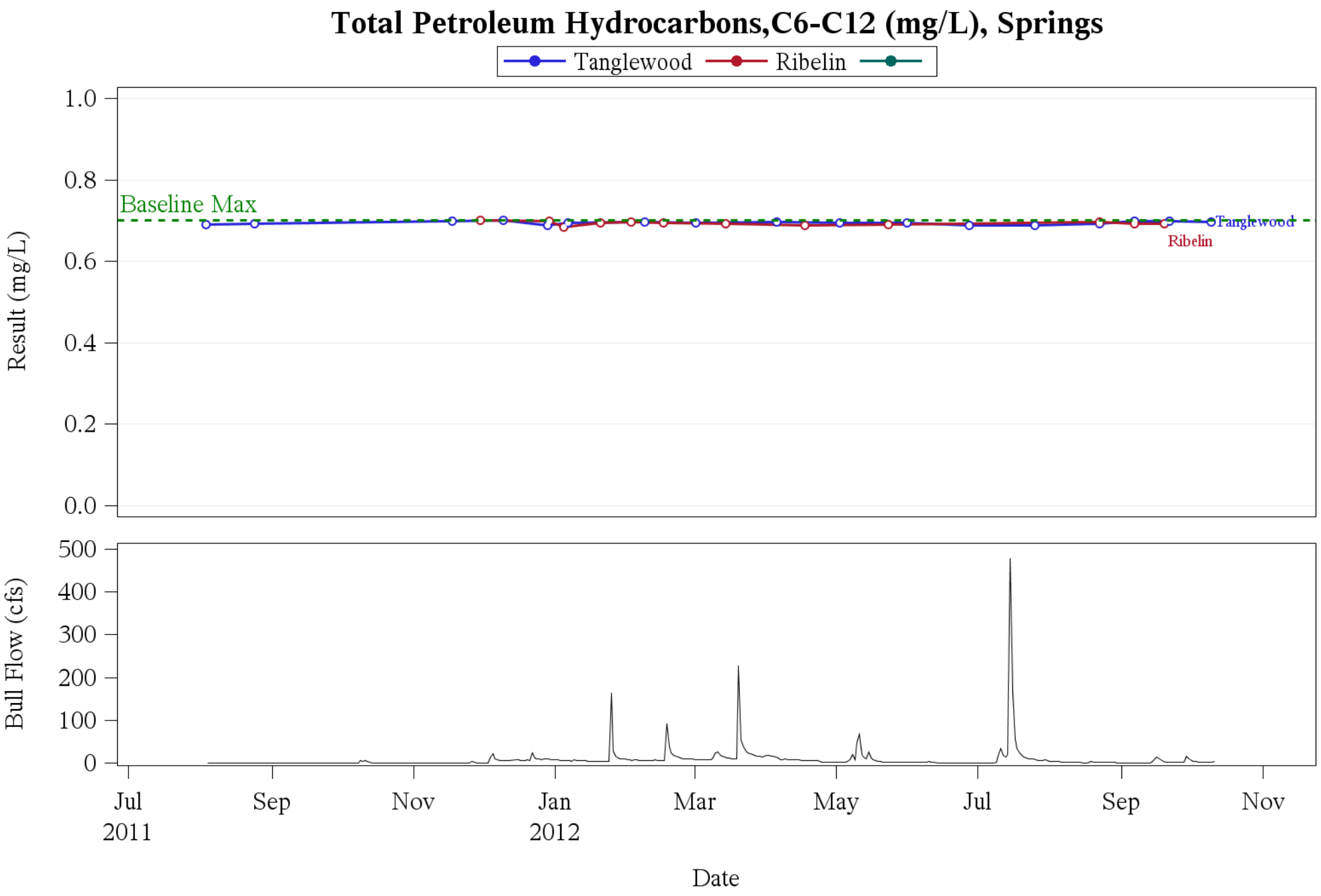

Total Petroleum Hydrocarbons,C12-C28 (mg/L), Surface Water
Bull T4 D/S SW
Bull T4 U/S SW
Bull Abv WTP4
Bull T4 AR
Result (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
Baseline Max
Bull T4 AR
Bull T4 U/S SW
Bull Abv WTP4
Bull T4 D/S SW
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

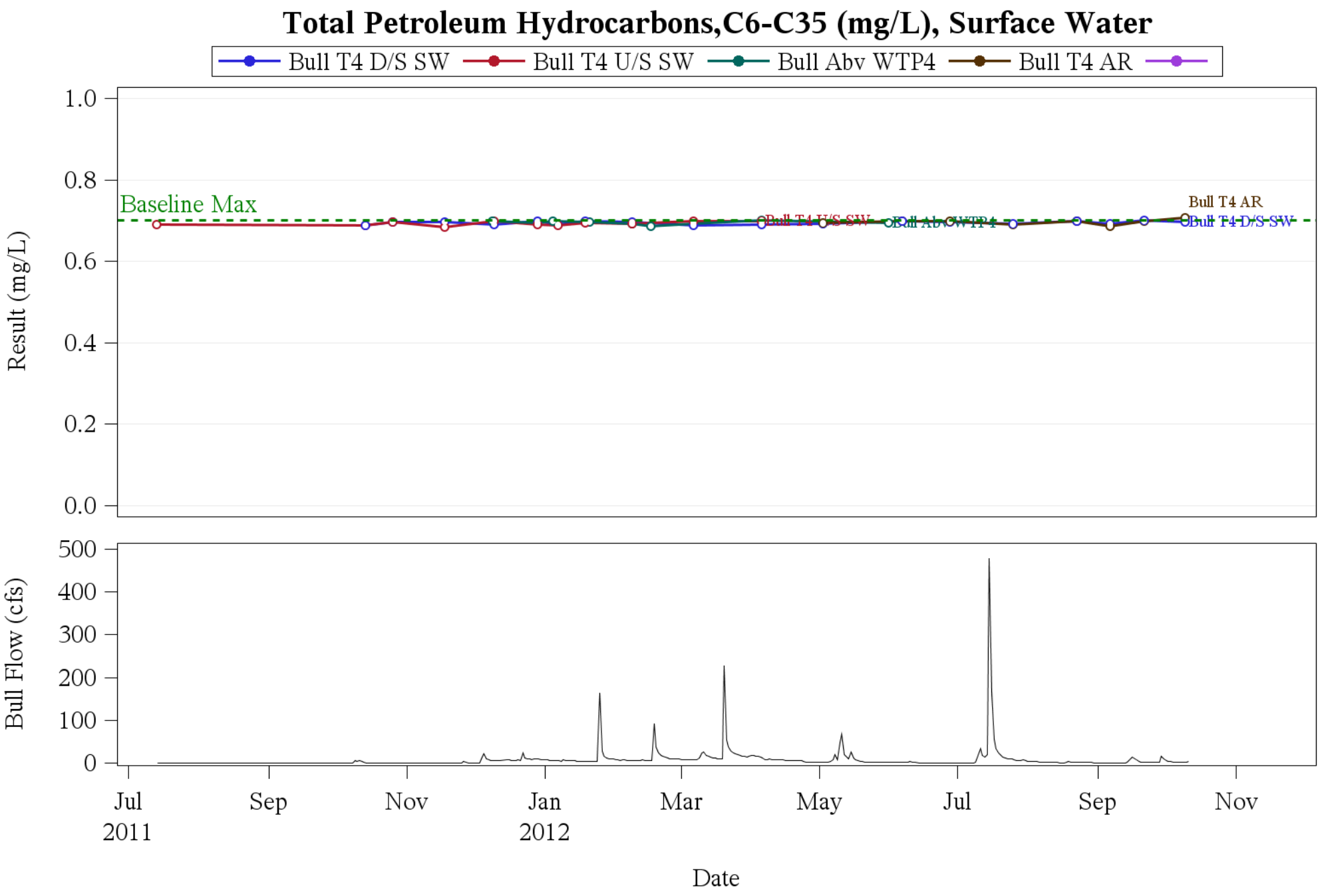

Total Petroleum Hydrocarbons,C12-C28 (mg/L), Springs
Tanglewood
Ribelin
Result (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
Baseline Max
Tanglewood
Ribelin
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

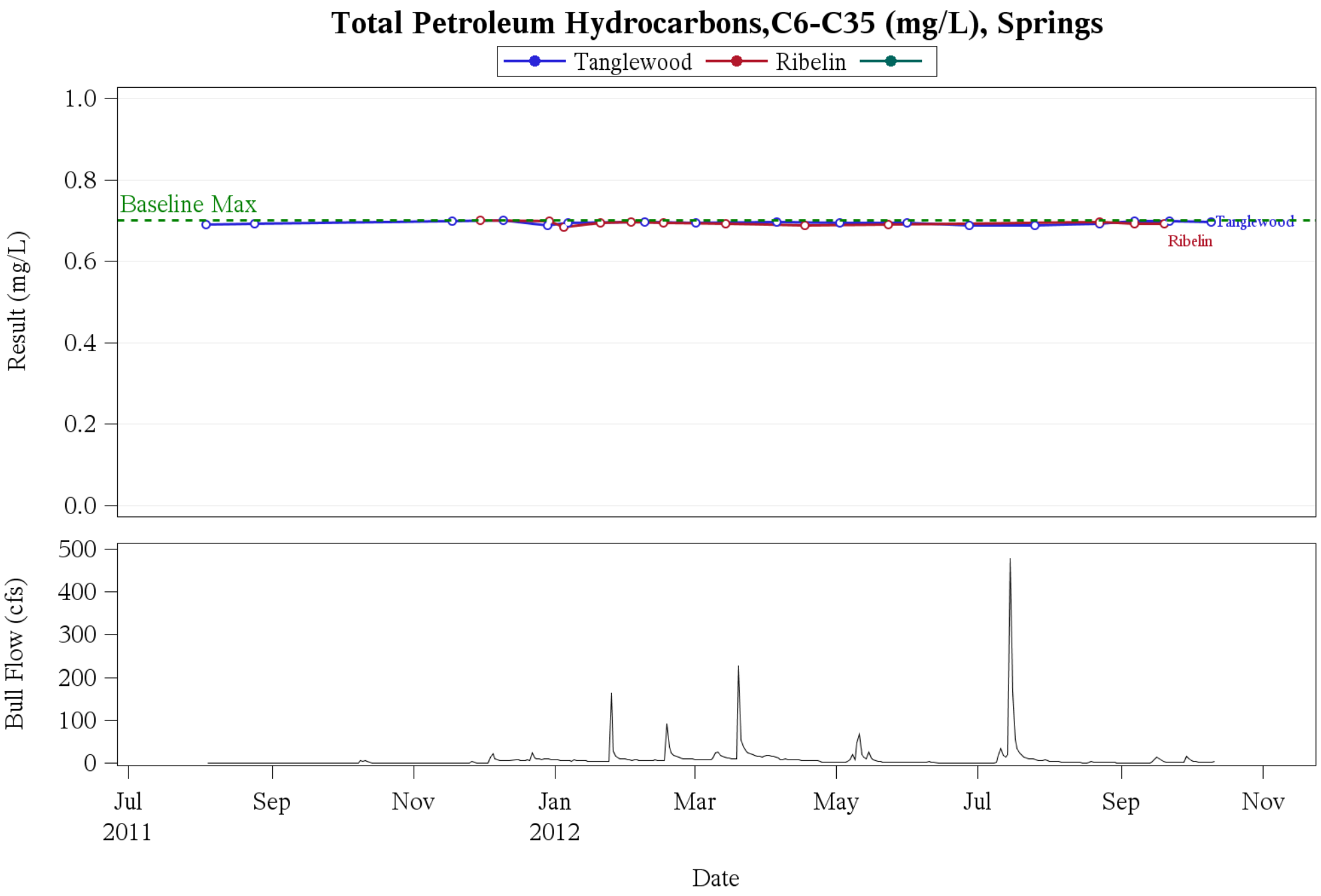

Total Petroleum Hydrocarbons,C28-C35 (mg/L), Surface Water
Bull T4 D/S SW
Bull T4 U/S SW
Bull Abv WTP4
Bull T4 AR
Result (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
Baseline Max
Bull T4 AR
Bull T4 U/S SW
Bull Abv WTP4
Bull T4 D/S SW
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

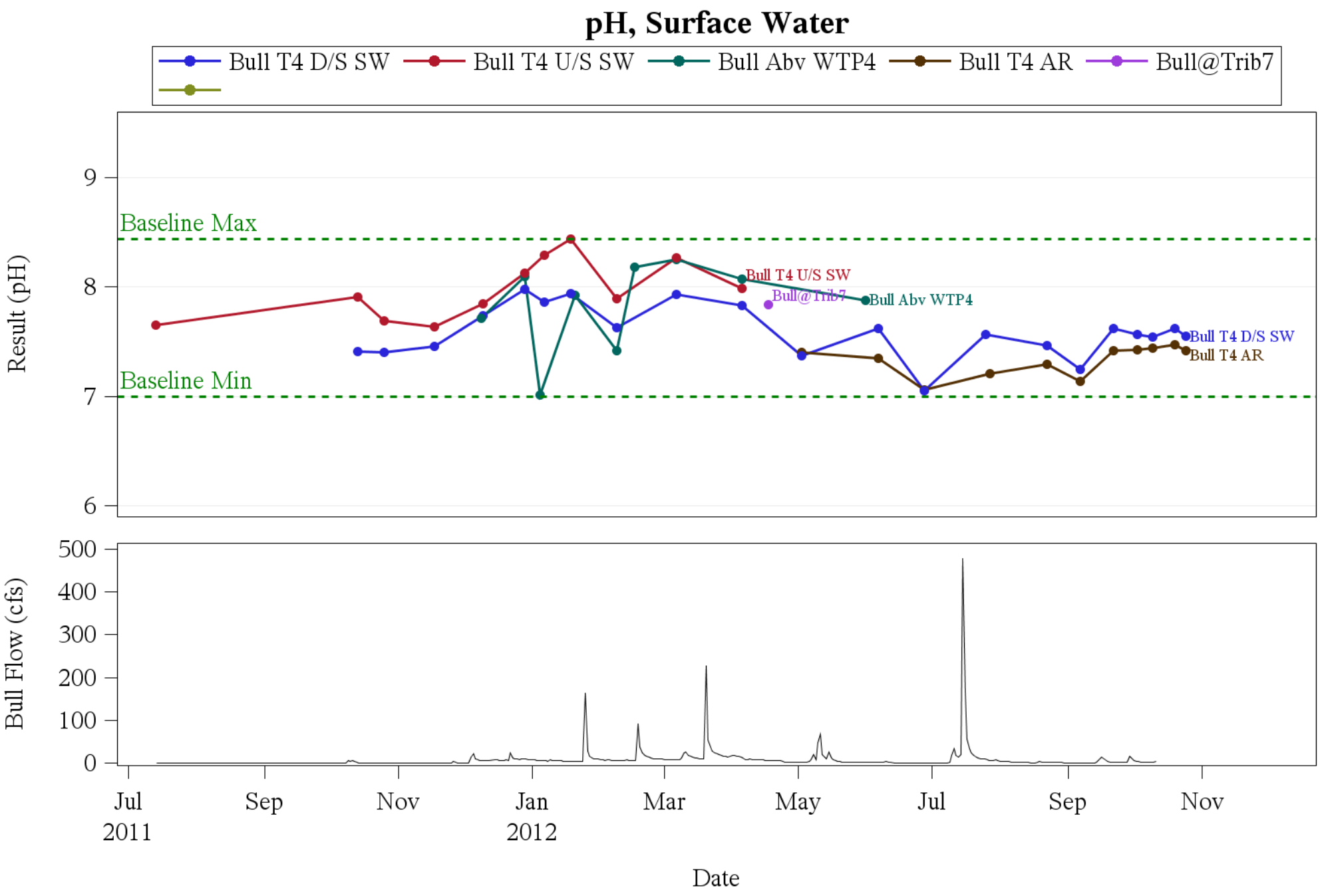

Total Petroleum Hydrocarbons,C28-C35 (mg/L), Springs
Tanglewood
Ribelin
Baseline Max
Tanglewood
Ribelin
Result (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

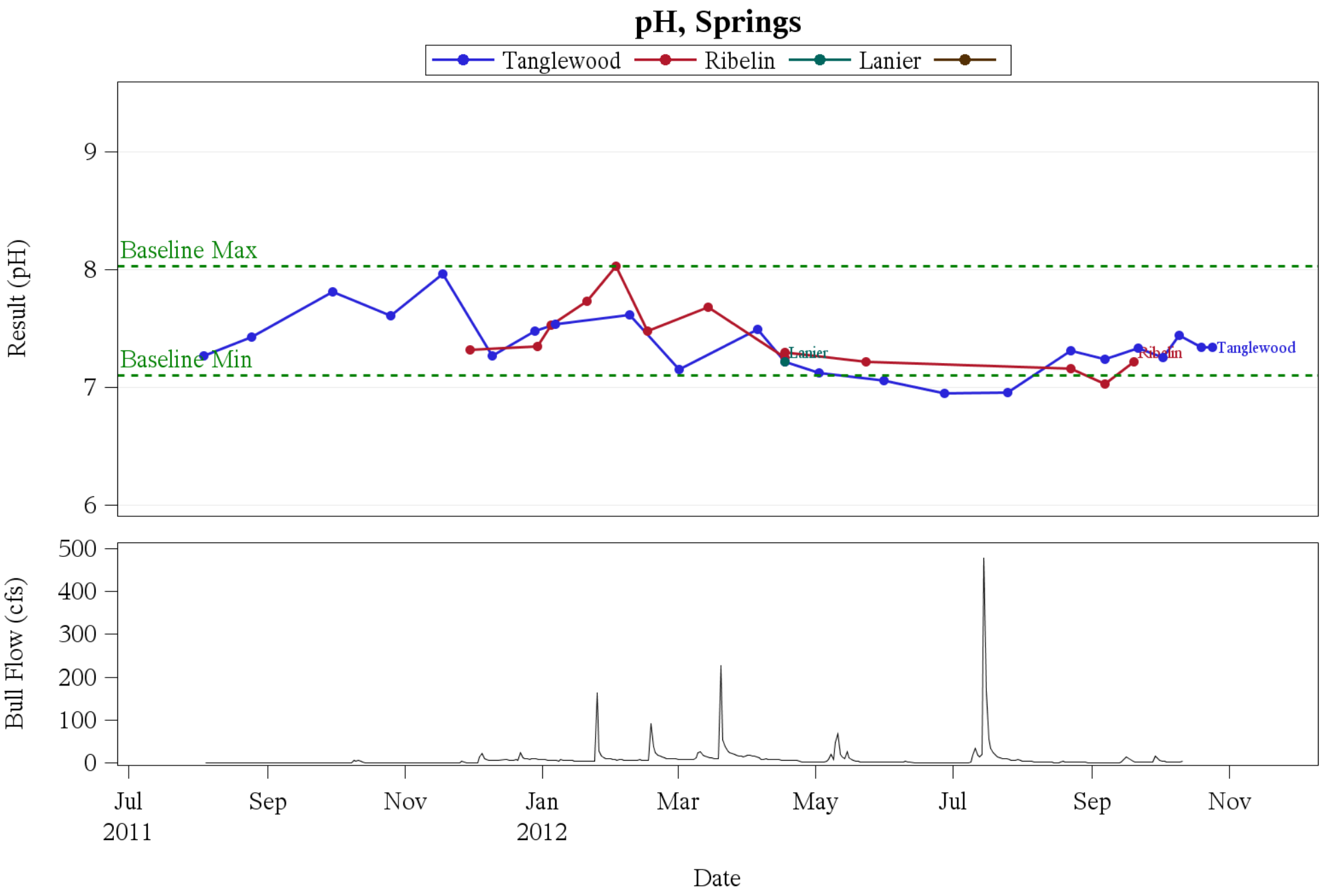

Total Petroleum Hydrocarbons,C6-C12 (mg/L), Surface Water
Bull T4 D/S SW
Bull T4 U/S SW
Bull Abv WTP4
Bull T4 AR
Result (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
Baseline Max
Bull T4 AR
Bull T4 U/S SW
Bull Abv WTP4
Bull T4 D/S SW
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

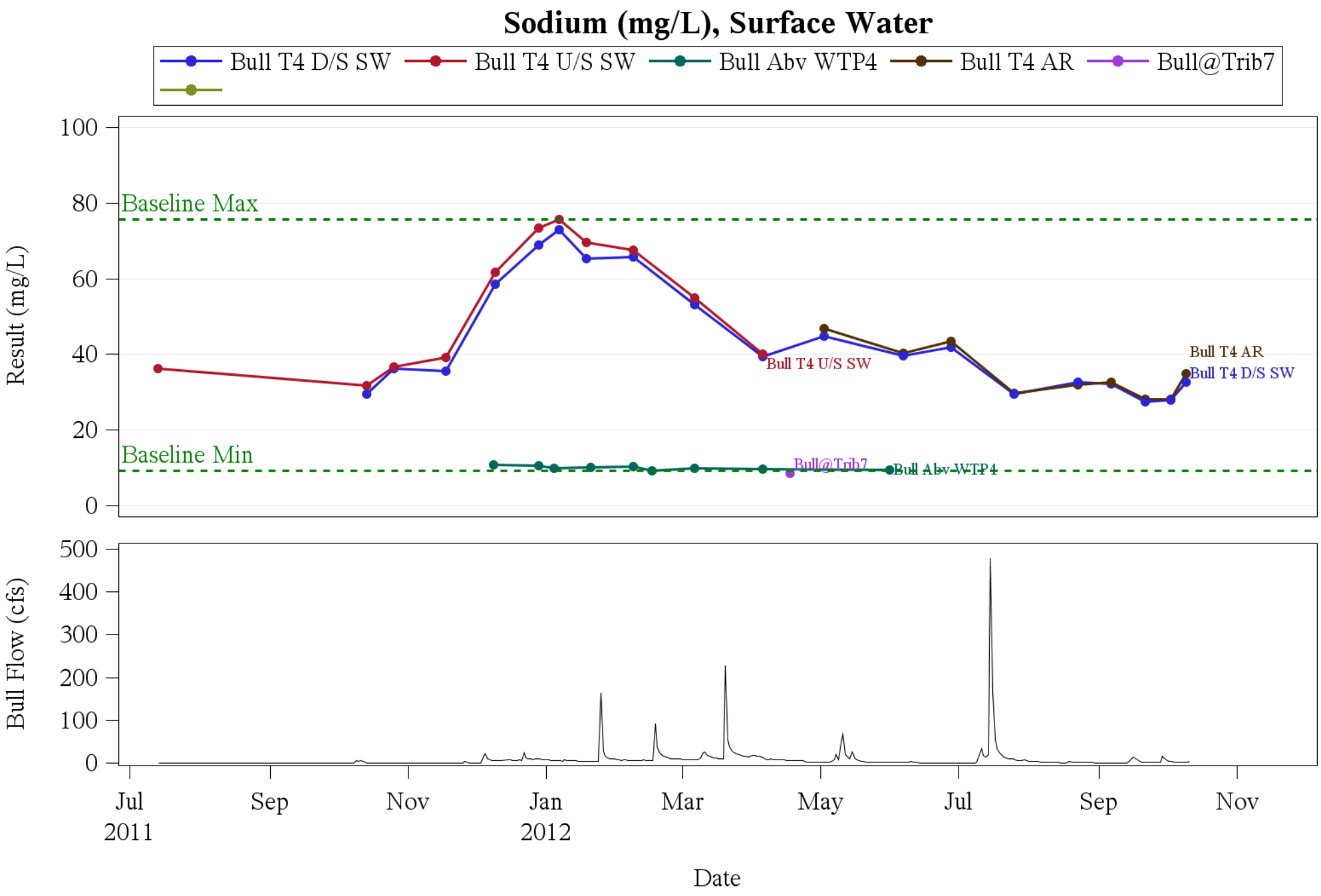

Total Petroleum Hydrocarbons,C6-C12 (mg/L), Springs
Tanglewood
Ribelin
1.0
0.8
0.6
0.4
0.2
0.0
Result (mg/L)
Baseline Max
Tanglewood
Ribelin
500
400
300
200
100
0
Bull Flow (cfs)
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

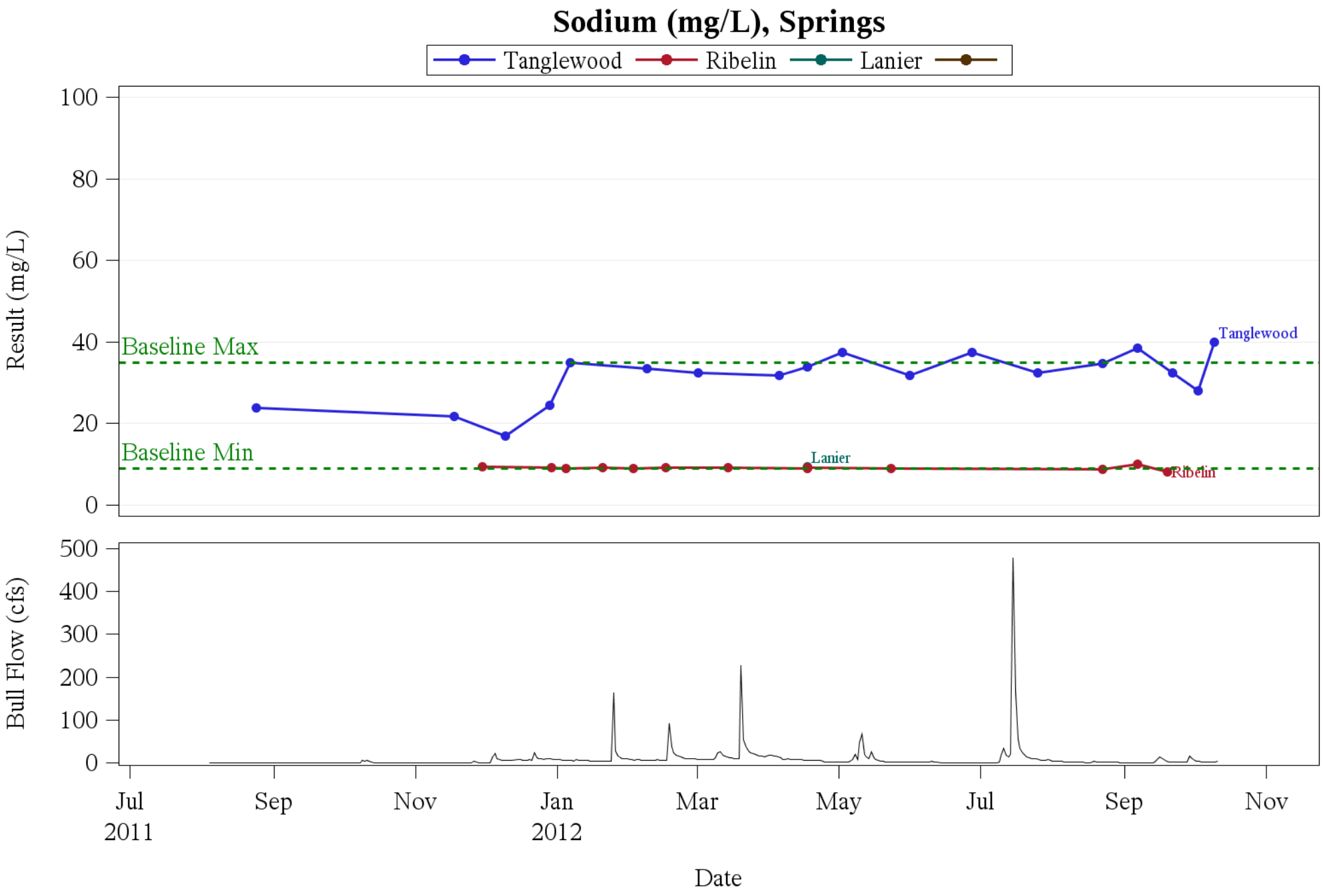

Total Petroleum Hydrocarbons,C6-C35 (mg/L), Surface Water
Bull T4 D/S SW
Bull T4 U/S SW
Bull Abv WTP4
Bull T4 AR
Result (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
Baseline Max
Bull T4 AR
Bull T4 U/S SW
Bull Abv WTP4
Bull T4 D/S SW
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

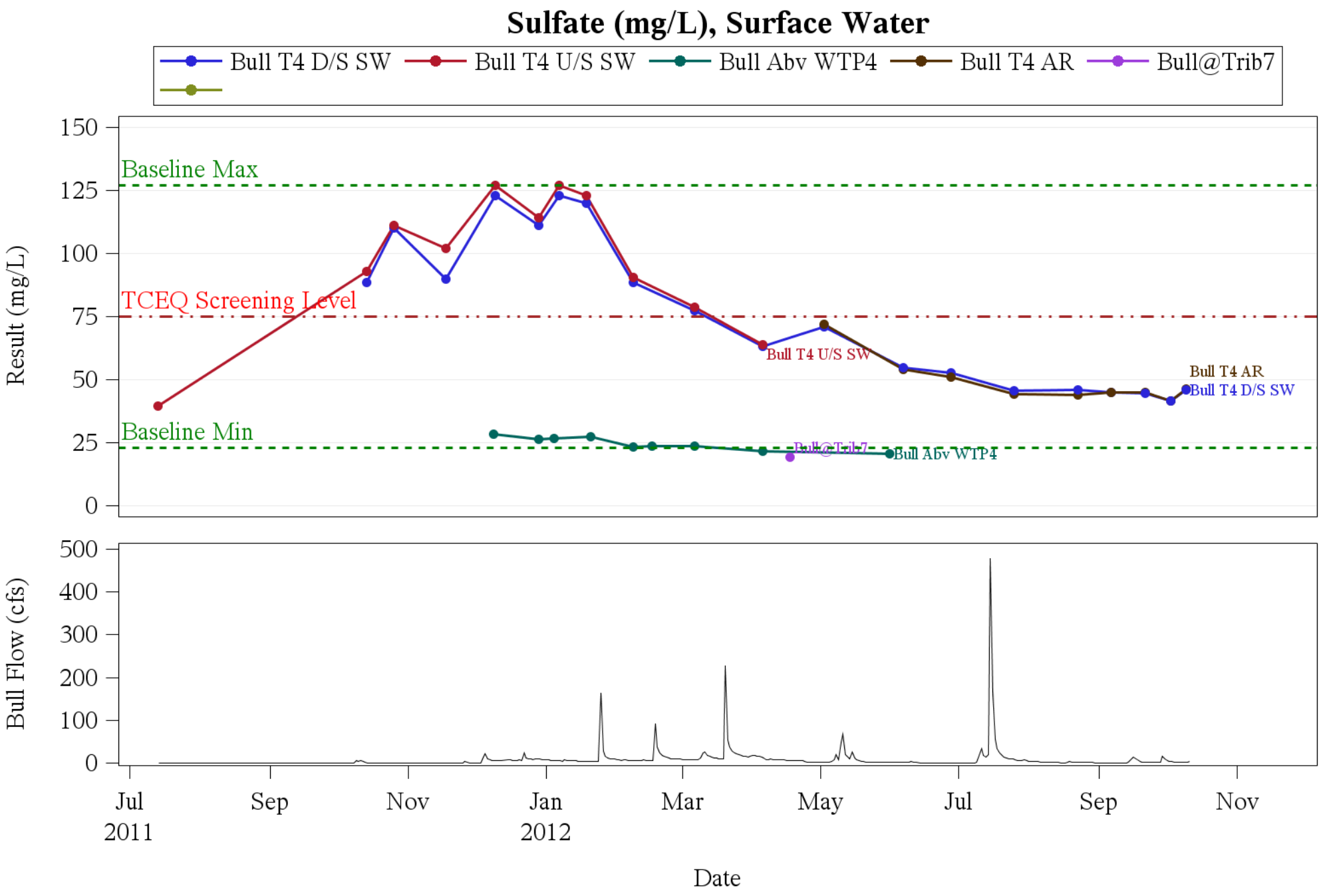

Total Petroleum Hydrocarbons,C6-C35 (mg/L), Springs
Tanglewood
Ribelin
Result (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
Baseline Max
Tanglewood
Ribelin
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

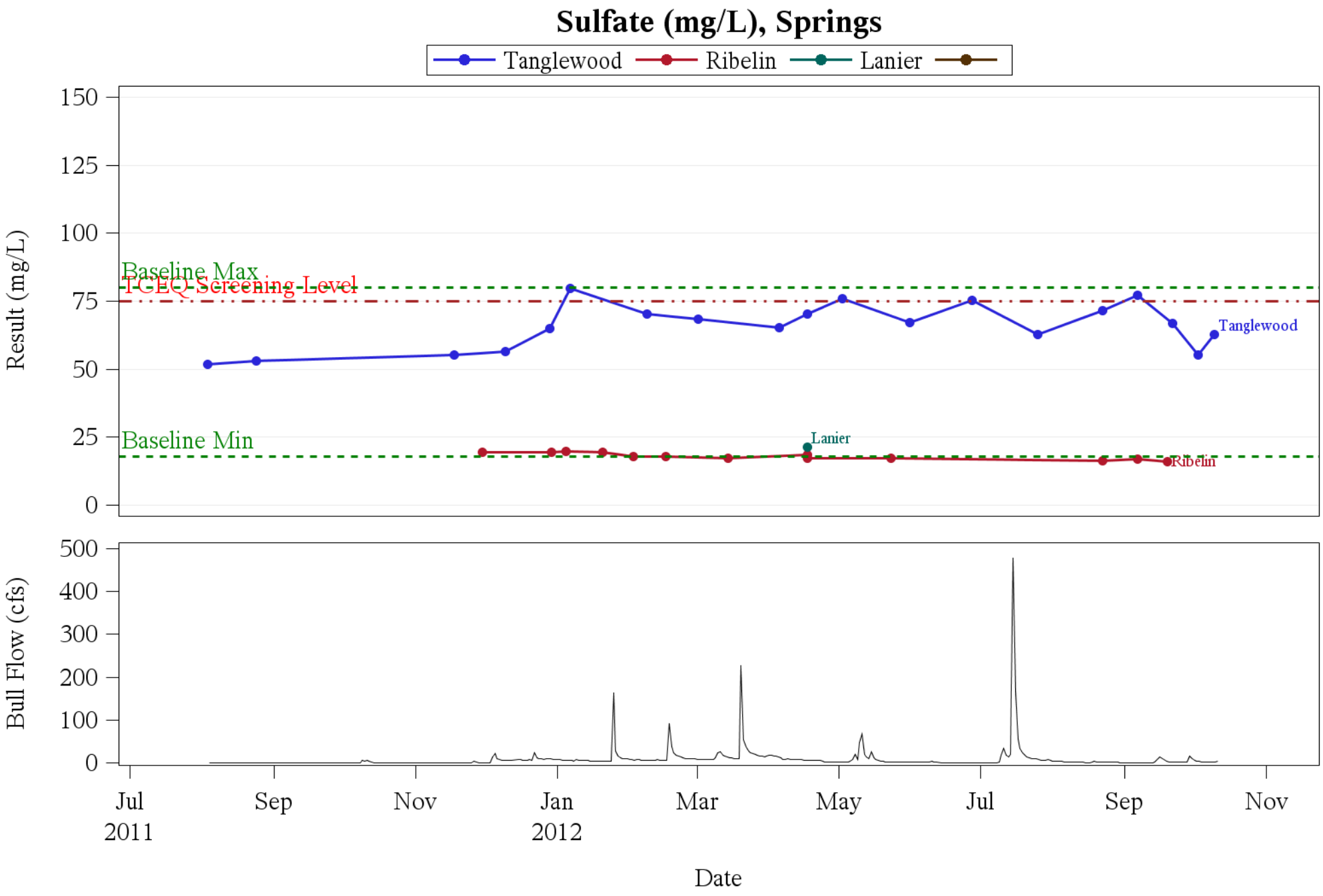

pH, Surface Water
Bull T4 D/S SW
Bull T4 U/S SW
Bull Abv WTP4
Bull T4 AR
Bull@Trib7
Result (pH)
9
8
7
6
Baseline Max
Baseline Min
Bull T4 U/S SW
Bull@Trib7
Bull Abv WTP4
Bull T4 D/S SW
Bull T4 AR
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

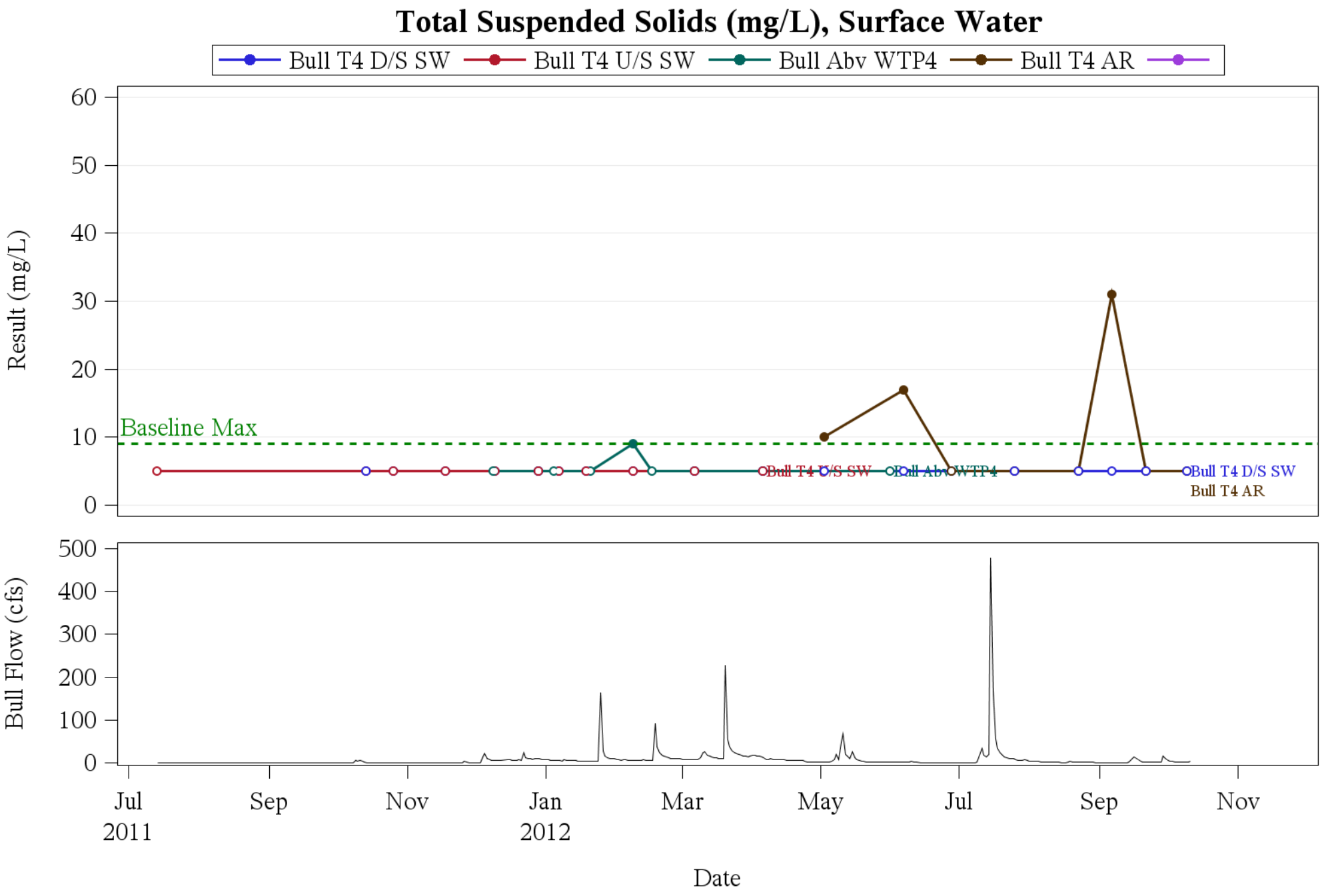

pH, Springs
Tanglewood
Ribelin
Lanier
Result (pH)
9
8
7
6
Baseline Max
Baseline Min
Lanier
Ribelin
Tanglewood
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date


Sodium (mg/L), Surface Water
Bull T4 D/S SW
Bull T4 U/S SW
Bull Abv WTP4
Bull T4 AR
Bull@Trib7
Result (mg/L)
100
80
60
40
20
0
Baseline Max
Baseline Min
Bull T4 U/S SW
Bull T4 AR
Bull T4 D/S SW
Bull@Trib7
Bull Abv WTP4
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

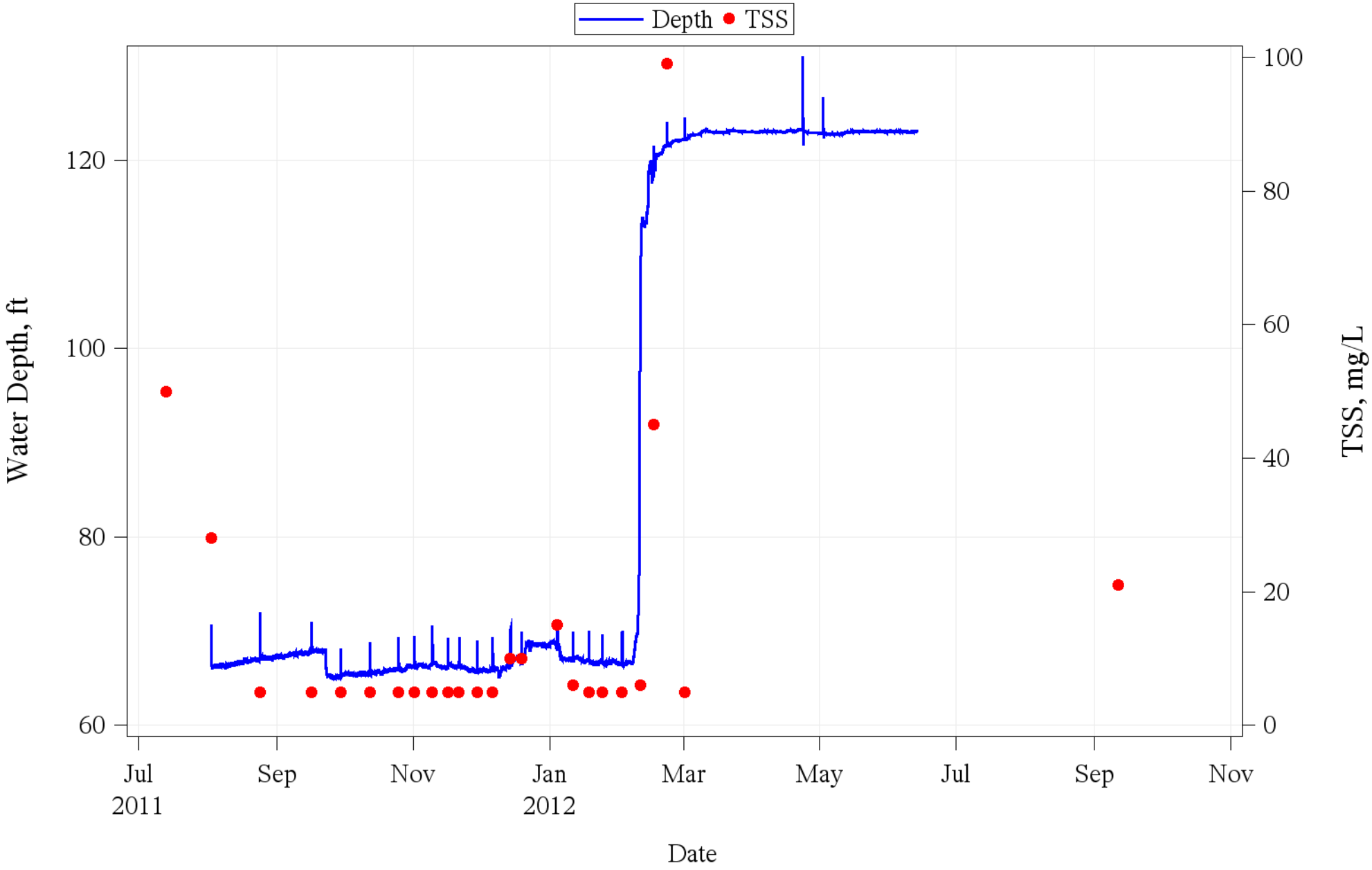

Sodium (mg/L), Springs
Tanglewood
Ribelin
Lanier
Result (mg/L)
100
80
60
40
20
0
Baseline Max
Baseline Min
Tanglewood
Lanier
Ribelin
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date


Sulfate (mg/L), Surface Water
Bull T4 D/S SW
Bull T4 U/S SW
Bull Abv WTP4
Bull T4 AR
Bull@Trib7
Baseline Max
TCEQ Screening Level
Baseline Min
Result (mg/L)
150
125
100
75
50
25
0
Bull T4 U/S SW
Bull T4 AR
Bull T4 D/S SW
Bull@Trib7
Bull Abv WTP4
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

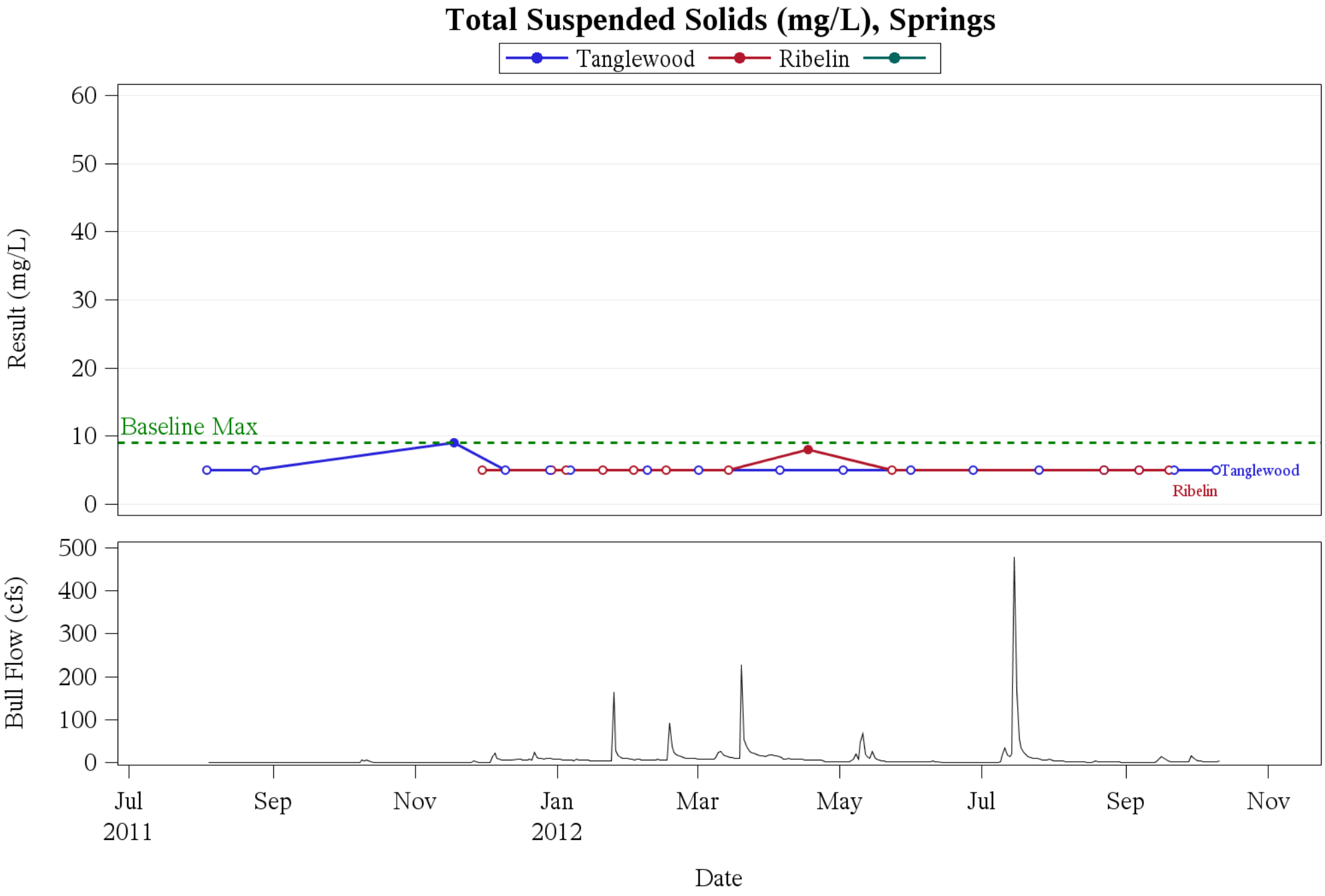

Sulfate (mg/L), Springs
Tanglewood
Ribelin
Lanier
Result (mg/L)
150
125
100
75
50
25
0
Baseline Max
TCEQ Screening Level
Baseline Min
Tanglewood
Lanier
Ribelin
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

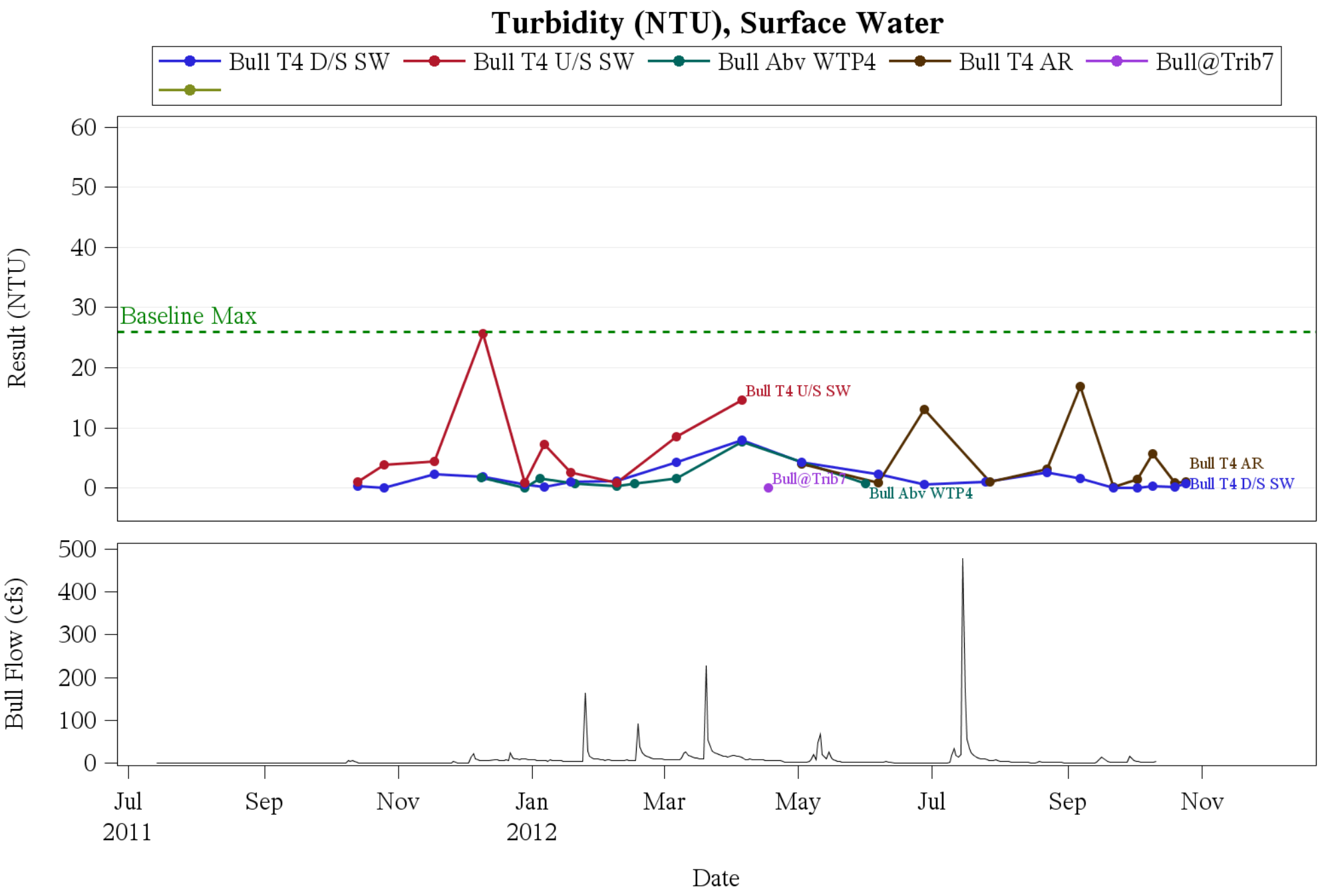

Total Suspended Solids (mg/L), Surface Water
Bull T4 D/S SW
Bull T4 U/S SW
Bull Abv WTP4
Bull T4 AR
Result (mg/L)
60
50
40
30
20
10
0
Baseline Max
Bull T4 U/S SW
Bull Abv WTP4
Bull T4 D/S SW
Bull T4 AR
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

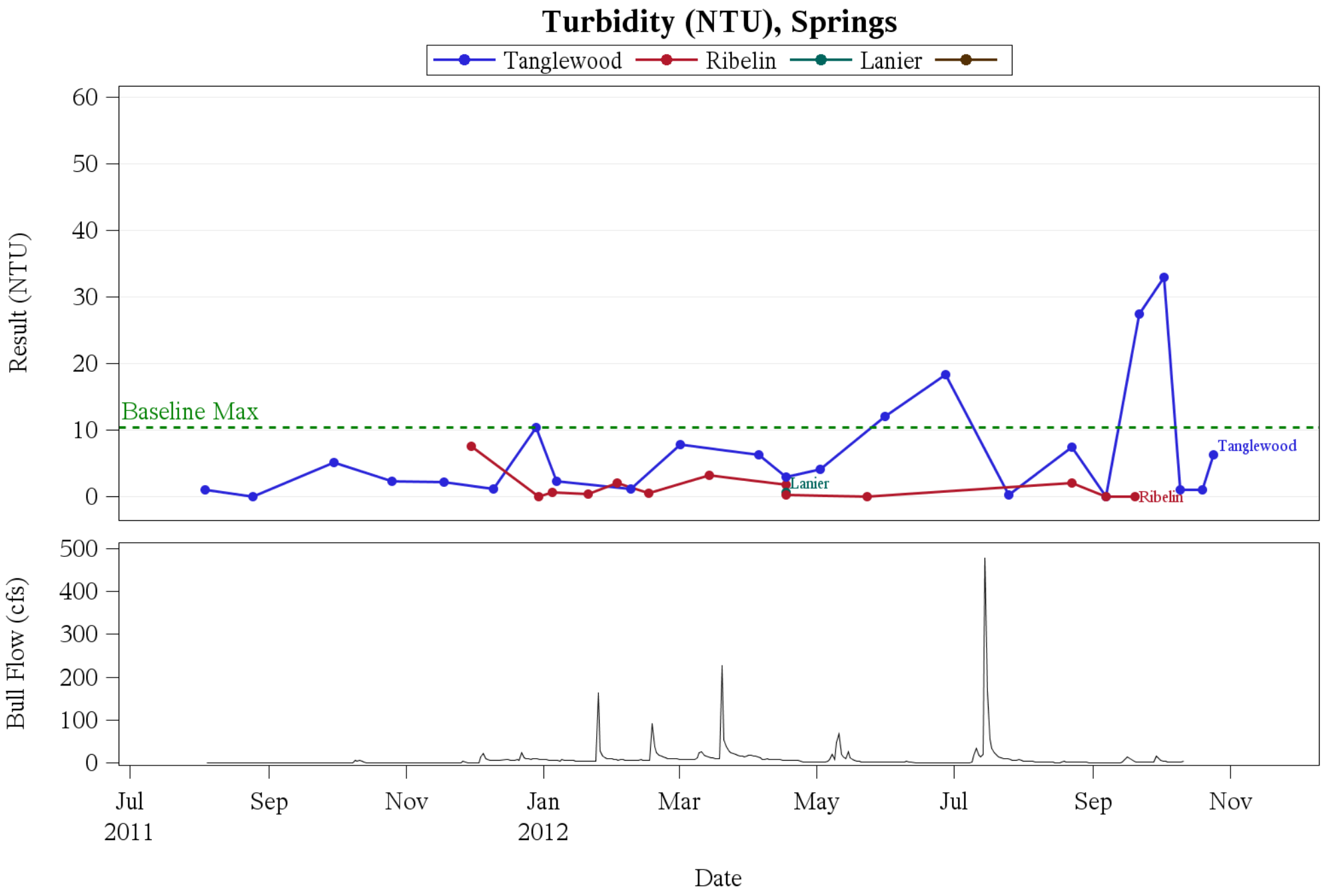
JT127 Well Level and Total Suspended Solids

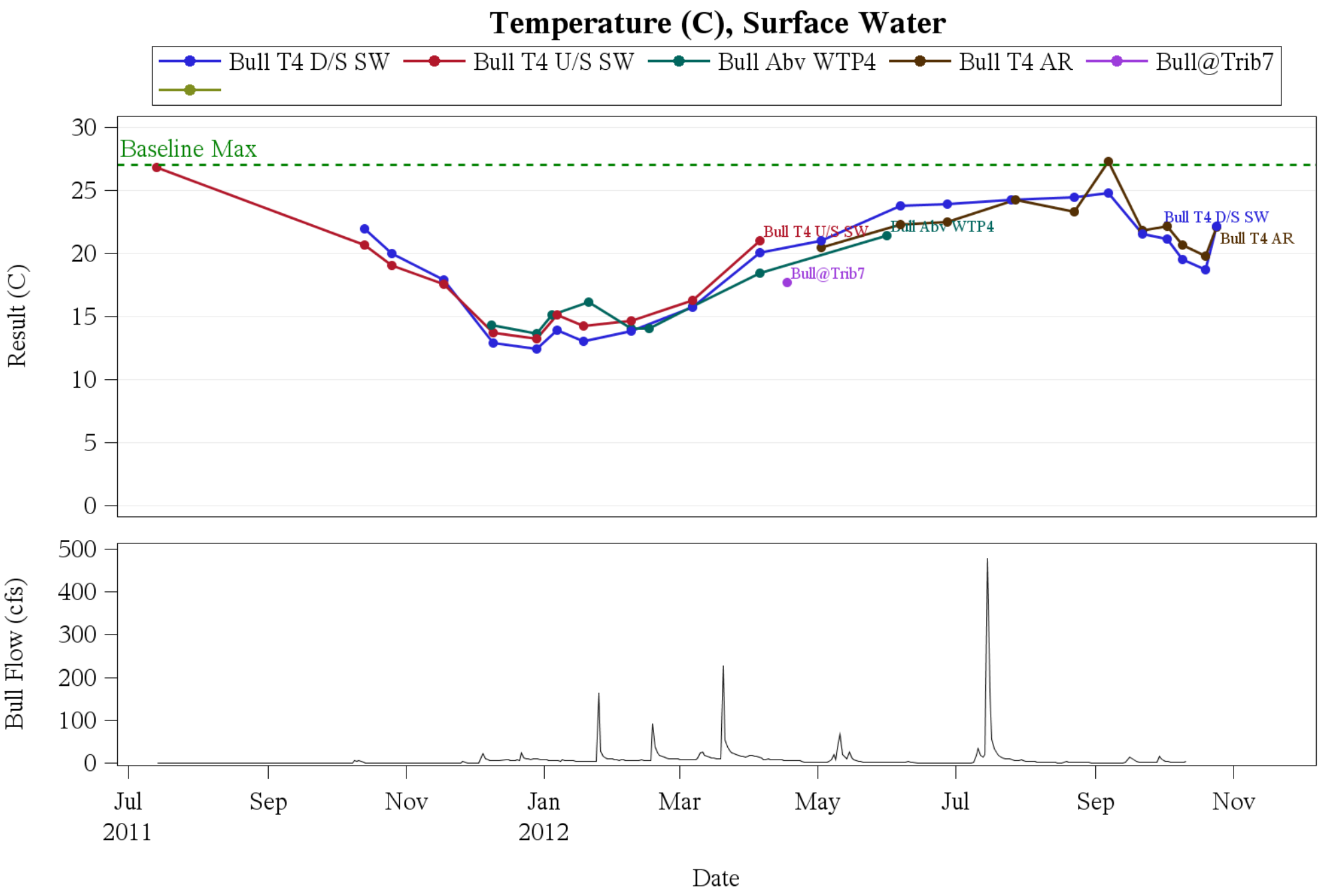


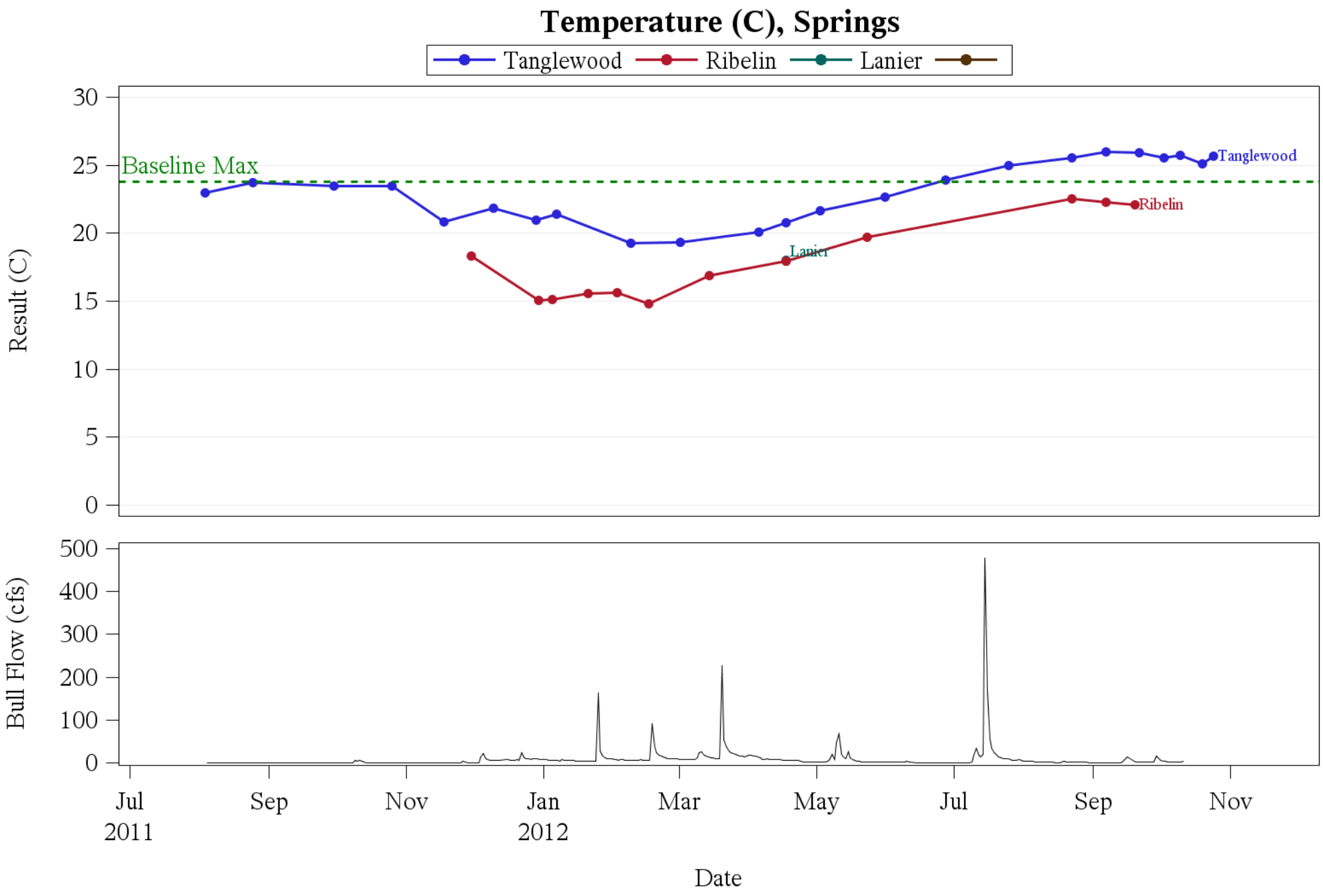
City of Austin DRAFT: QA/QC review pending

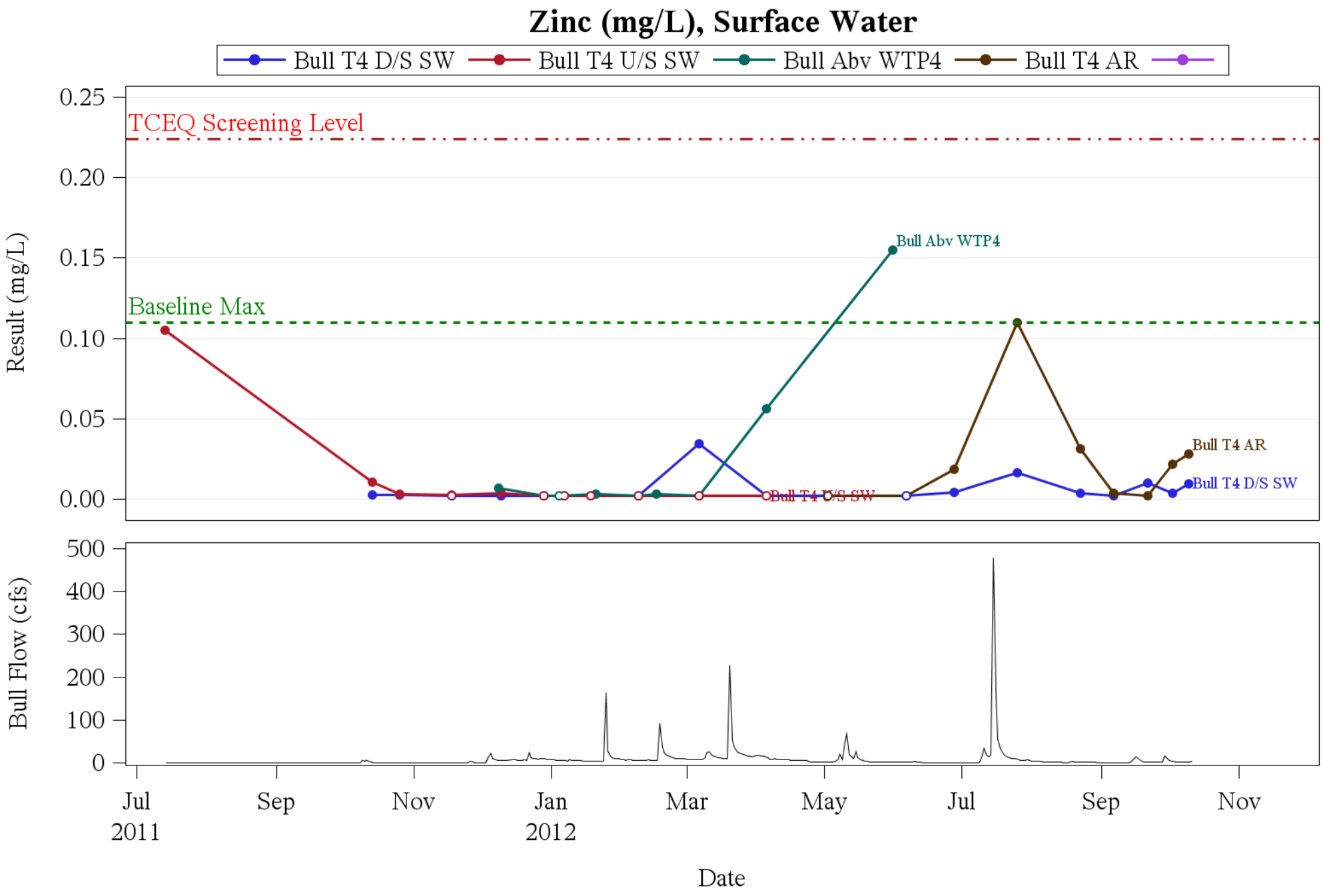

Total Suspended Solids (mg/L), Springs
Tanglewood
Ribelin
Result (mg/L)
60
50
40
30
20
10
0
Baseline Max
Tanglewood
Ribelin
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date

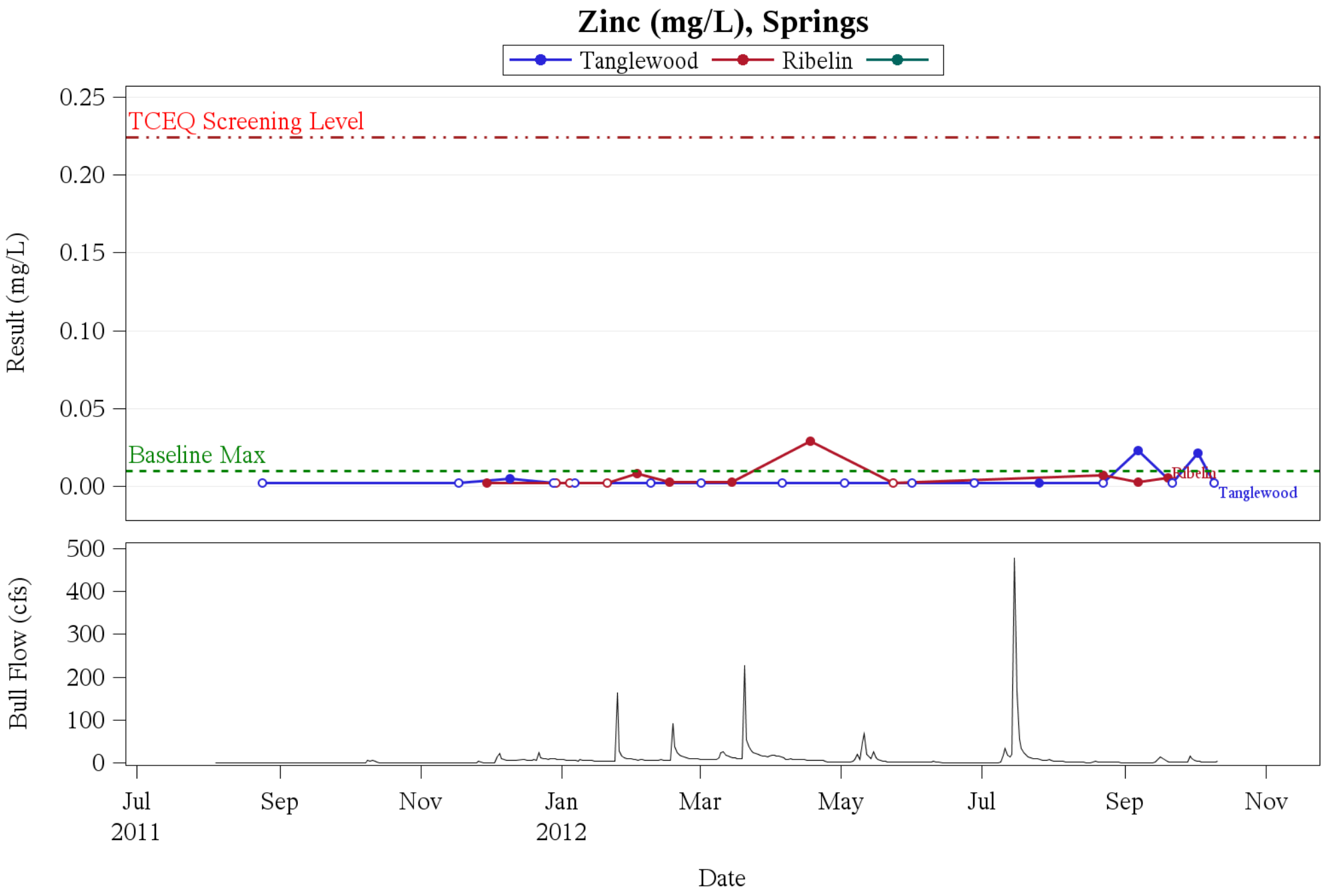

Turbidity (NTU), Surface Water
Bull T4 D/S SW
Bull T4 U/S SW
Bull Abv WTP4
Bull T4 AR
Bull@Trib7
Result (NTU)
60
50
40
30
20
10
0
Baseline Max
Bull T4 U/S SW
Bull@Trib7
Bull Abv WTP4
Bull T4 AR
Bull T4 D/S SW
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date


Turbidity (NTU), Springs
Tanglewood
Ribelin
Lanier
Result (NTU)
60
50
40
30
20
10
0
Baseline Max
Tanglewood
Lanier
Ribelin
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date


Temperature (C), Surface Water
Bull T4 D/S SW
Bull T4 U/S SW
Bull Abv WTP4
Bull T4 AR
Bull@Trib7
Baseline Max
Result (C)
30
25
20
15
10
5
0
Bull T4 U/S SW
Bull Abv WTP4
Bull@Trib7
Bull T4 D/S SW
Bull T4 AR
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date


Temperature (C), Springs
Tanglewood
Ribelin
Lanier
Result (C)
30
25
20
15
10
5
0
Baseline Max
Tanglewood
Ribelin
Lanier
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date


Zinc (mg/L), Surface Water
Bull T4 D/S SW
Bull T4 U/S SW
Bull Abv WTP4
Bull T4 AR
TCEQ Screening Level
Baseline Max
Result (mg/L)
0.25
0.20
0.15
0.10
0.05
0.00
Bull Abv WTP4
Bull T4 AR
Bull T4 D/S SW
Bull T4 U/S SW
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date


Zinc (mg/L), Springs
Tanglewood
Ribelin
TCEQ Screening Level
Baseline Max
Result (mg/L)
0.25
0.20
0.15
0.10
0.05
0.00
Ribelin
Tanglewood
Bull Flow (cfs)
500
400
300
200
100
0
Jul
2011
Sep
Nov
Jan
2012
Mar
May
Jul
Sep
Nov
Date