DEPARTMENT OF ENVIRONMENTAL CONSERVATION
NONPOINT SOURCE POLLUTION PROGRAM
ACWA NPS WATER QUALITY GRANT

FY 2008
FINAL REPORT

Watershed Protection and Recovery for Vanderbilt Creek, Juneau, AK

July 2008

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PROJECT #:ACWA-08-08
PROJECT TITLE: Watershed Protection and Recovery for Vanderbilt Creek, Juneau, AK

Project Description and Purpose

In FY 2008 we began implementation of the monitoring strategy for Vanderbilt Creek that was developed by the JWP in FY 2007. After writing up a QAPP, we began monitoring with our first field sampling event in November, 2007. Subsequent sampling events took place in February, March, and June, 2008. Water quality monitoring focused on turbidity and total suspended solids (TSS), which have been identified as factors impairing the stream, and other basic water quality parameters (pH, dissolved oxygen, specific conductance, and temperature) were measured as well. Samples were taken during various times of the year to represent the spectrum of hydrologic and climatic conditions in the local area (i.e. high flow event from fall rainstorms; low flow winter conditions; spring runoff; and warmer summer period). On each of the 4 events, we collected samples 2-3 times per day for 3 days each at 3 sites in the creek.

The specific goals of this project included:

- To evaluate the variation in water quality over short time periods (9-10 sampling events over 3 day periods) in order to check for diel- and event- scale variation. Vanderbilt Creek appears to be similar to other streams its size in the Mendenhall Valley (e.g. Duck and Jordan Creeks) and is likely a very flashy stream that responds and recovers quickly to climatic and hydrologic variations.
- To document existing water quality conditions in Vanderbilt Creek and to evaluate how conditions change from upstream to downstream, as the stream flows through an urbanized/industrial area

Figure 1: *Location of Vanderbilt Creek in the Lemon Creek Valley, Juneau.*

I. Water Quality Monitoring Project

Research Design

Table 1. *Stream sample locations along Vanderbilt Creek.*

Site Code	Site Description	Latitude	Longitude
VC-A	Vand C above Home Depot	58°21'28.85"	-134°28'34.24"
VC-B	Vand C nr Vanderbilt Hill Rd	58°21'14.07"	-134°29'18.52"
VC-C	Vand C below Western Auto	58°20'57.47"	-134°29'32.52"

Sample sites on Vanderbilt Creek represent differently impacted areas of the watershed. The VC-A site is futhest upstream, taken from the channel along the steep hillside adjacent to Home Depot. This site is meant to represent the unimpacted portion of the watershed. The site is accessible by walking the Lemon Creek trail and continuing toward the trees at the first switchback (going against the trail toward the private residences on the Lemon Creek Trail road). VC-B is located within the residential neighborhood upstream of the Vanderbilt Hill Road crossing. This site is downstream of Home Depot, Costco, numerous smaller businesses in the Lemon Creek valley, and several road crossings. VC-C is located immediately downstream of the gas station in the Western Auto parking lot, where Vanderbilt Creek flows alongside Vanderbilt Hill Road toward Egan Drive and Gastineau Channel.

Stream sampling was conducted from November, 2007 to June 2008. We focused our efforts during 4 specific time periods of FY08 : one fall rainstorm event; one low flow winter period, one high flow spring runoff event, and one warm, dry summer event. Although we targeted our fall sampling event around a forecasted rainstorm, it ended up hardly materializing, resulting in no noticeable change in flow at the stream. Low-flow events in the winter generally show little to no change, and so we sampled once intensively during this period as well. For the spring event, we targeted a warm spring period when snow melted rapidly, in order to characterize the potential influx of sediment into the stream from the winter road buildup. A warm, summer sample served the purpose of focusing on potential violations in water quality for stream temperature and dissolved oxygen levels. On each of the 4 events, we collected samples 2-3 times per day for 3 days. Parameters measured included: pH, dissolved oxygen, specific conductivity, temperature, turbidity, total suspended sediment, and discharge.

No operating stream gauge was available; and we manually gaged the discharge at VC-C one or two times during each sampling event. Water quality data collected for Vanderbilt Creek during the project is shown in the Appendix of this report.

Water temperature, conductivity, and pH were measured in the field using a YSI multi-probe unit. Dissolved oxygen was measured using a dedicated D.O. meter. Both meters were calibrated in the laboratory at the beginning of each sampling event. All in situ parameters were measured and recorded 3 times; averages of the triplicate values are presented in this report. Grab samples were also collected and returned to the UAS lab for analysis of turbidity, and total suspended sediment (TSS). Turbidity measurements for each event were bracketed by standard checks and were made in the field or within 6 hours of sample collection in the laboratory. TSS samples were obtained by weighing the mass of particulates retained on a glass microfiber filter following a vacuum driven filtration of at least 300 mL of sample. TSS filtrations were made within 48 hours of sample collection. Duplicate analyses were performed on 10% of samples to check for precision.

Habitat condition, Water Quantity, and Water Quality on Vanderbilt Creek

Anecdotal information on habitat quality

Conversations with landowners near site VC-B reported that they observed zero salmon in Vanderbilt Creek in 2007, which is the first time this occured in the decades they have lived there. One landowner, who has lived in the valley since childhood, recalled that salmon (mostly pinks and cohos) were plentiful when he was a young boy. The stream, they claimed, looks very different in that it is no longer a cobble-bed/gravel bed stream bottom but is now filled in with fine sediment. They also said that the stream frequently looks very silty on sunny days, when one would expect it to be running clear, but instead looks like it does after a rain event.

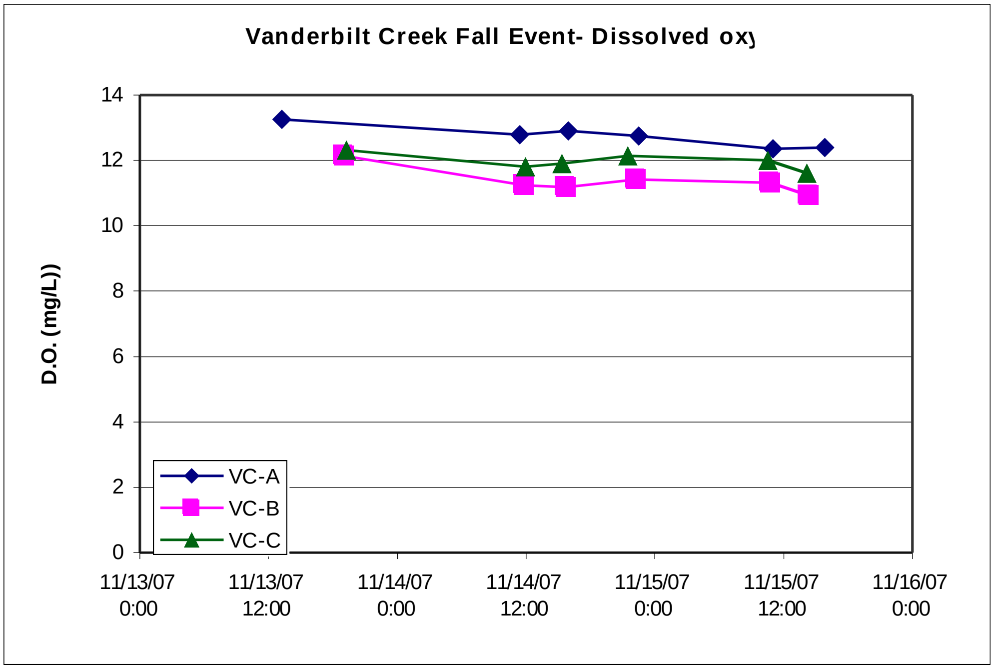
Water Quantity

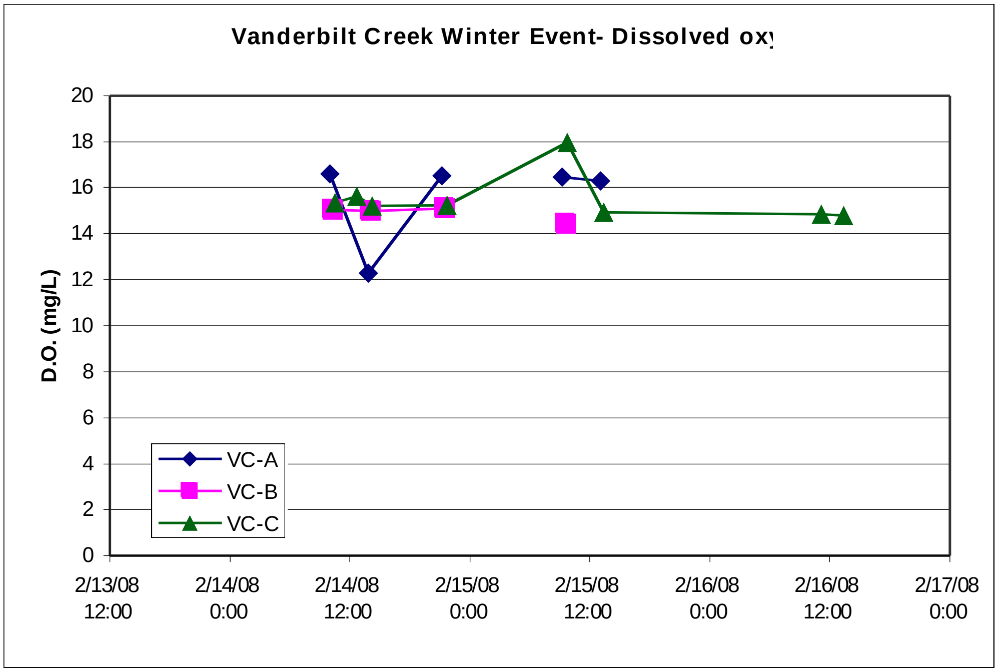
Although continuous discharge data were unavailable for Vanderbilt Creek, the stream's size and grade generally resembles that of the small, flashy streams of the neighboring Mendenhall Valley (e.g. Jordan Creek and Duck Creek) that respond to and recover quickly from local precipitation events. Vanderbilt Creek watershed is comprised largely of suburban development in the Mendenhall Valley. Discharge at VC-C on our sampling dates was always fairly low (1-2 cfs).

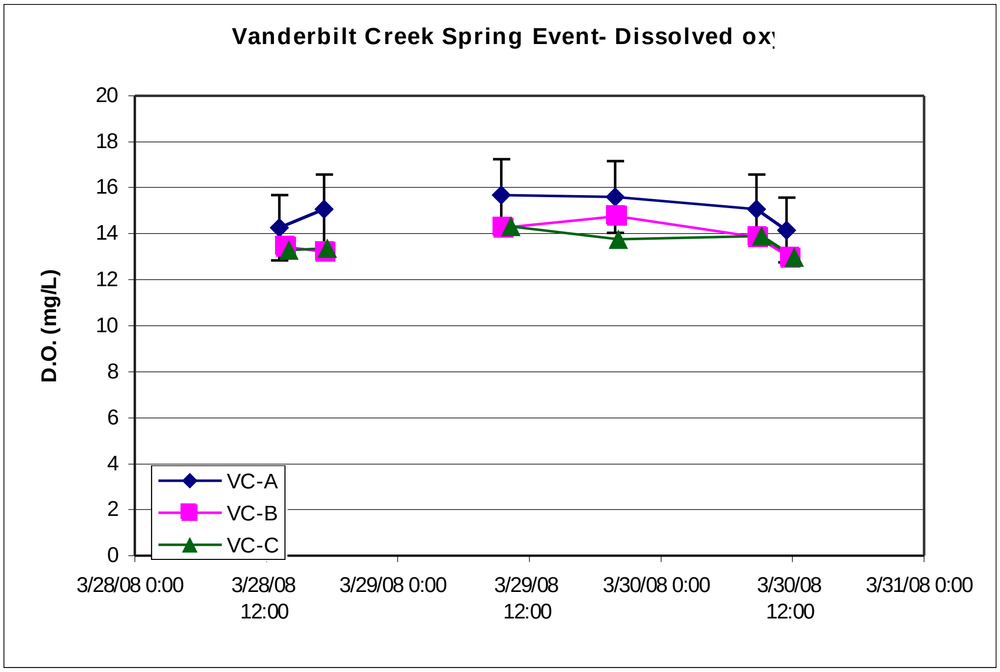
Water Quality

a) Dissolved oxygen, conductivity, and pH

Dissolved oxygen was very good at the 3 Vanderbilt Creek sites, and typically ranged between 11 and 16 mg/L (Figure 4). No values fell below the State of Alaska water quality limit of 7.0 mg/L for the growth and propogation of fish, shellfish, and other aquatic life (DEC, 2006). Dissolved oxygen tended to be highest at the most upstream site, VC-A.


Vanderbilt Creek Fall Event- Dissolved ox
D.O. (mg/L))
14
12
10
8
6
4
2
0
VC-A
VC-B
VC-C
11/13/07 0:00
11/13/07 12:00
11/14/07 0:00
11/14/07 12:00
11/15/07 0:00
11/15/07 12:00
11/16/07 0:00


Vanderbilt Creek Winter Event- Dissolved ox
D.O. (mg/L)
20
18
16
14
12
10
8
6
4
2
0
VC-A
VC-B
VC-C
2/13/08 12:00
2/14/08 0:00
2/14/08 12:00
2/15/08 0:00
2/15/08 12:00
2/16/08 0:00
2/16/08 12:00
2/17/08 0:00



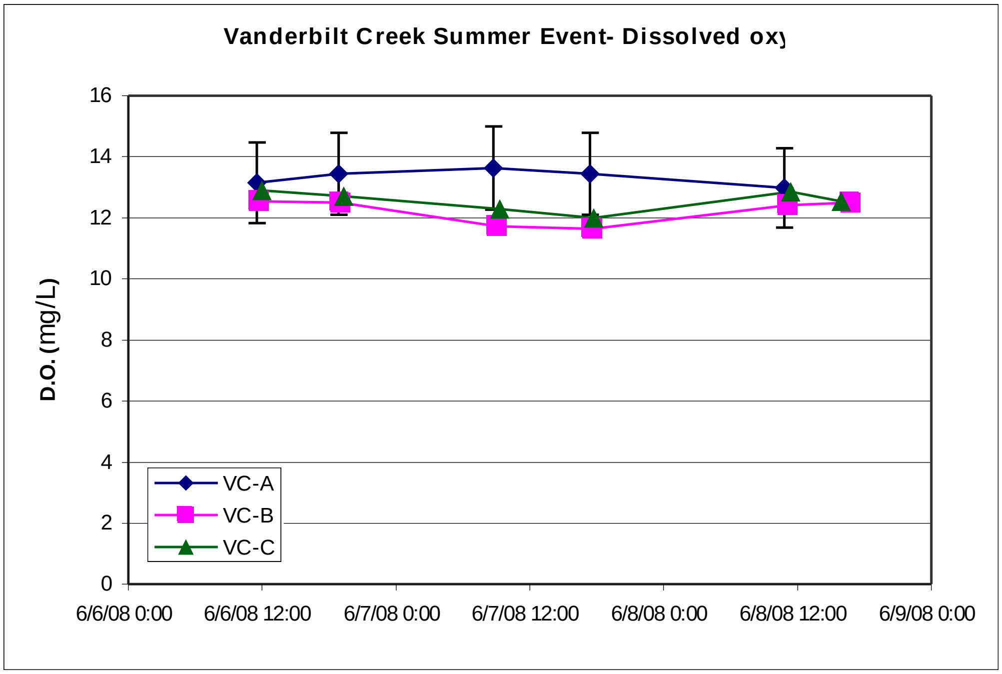
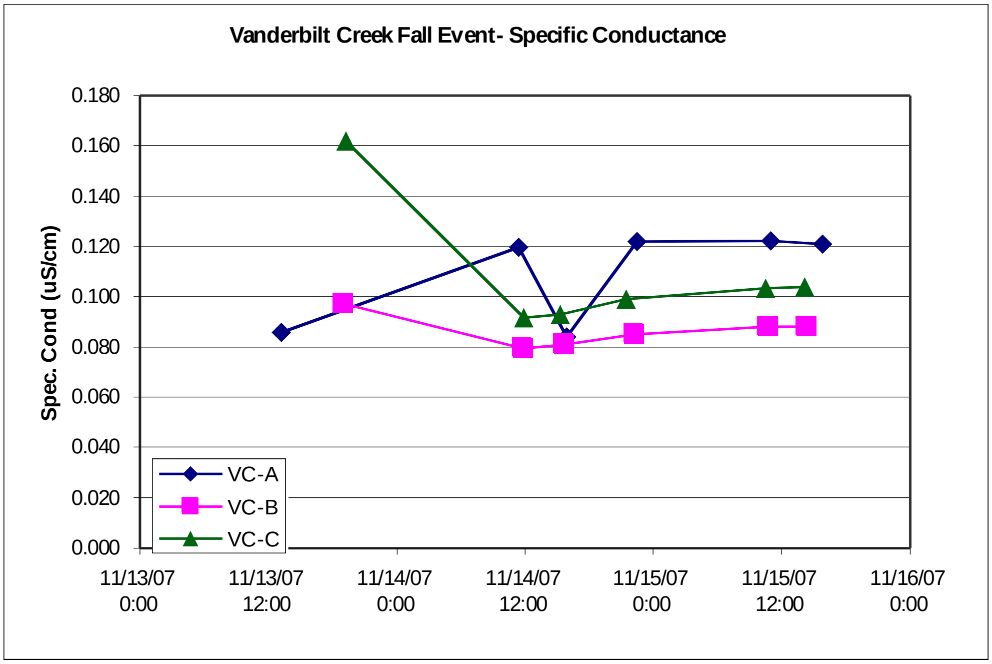
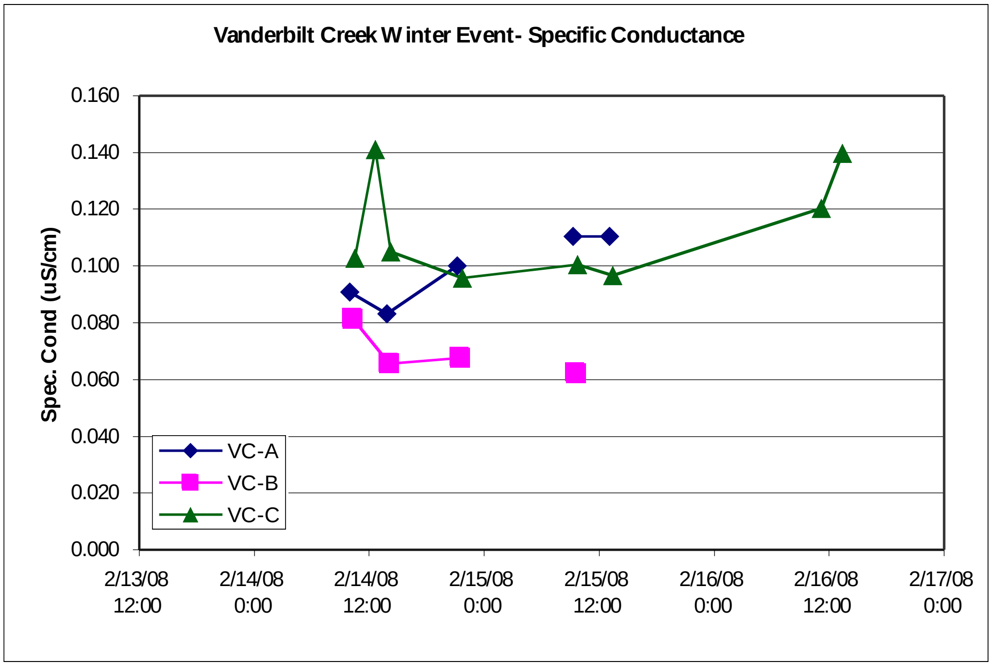


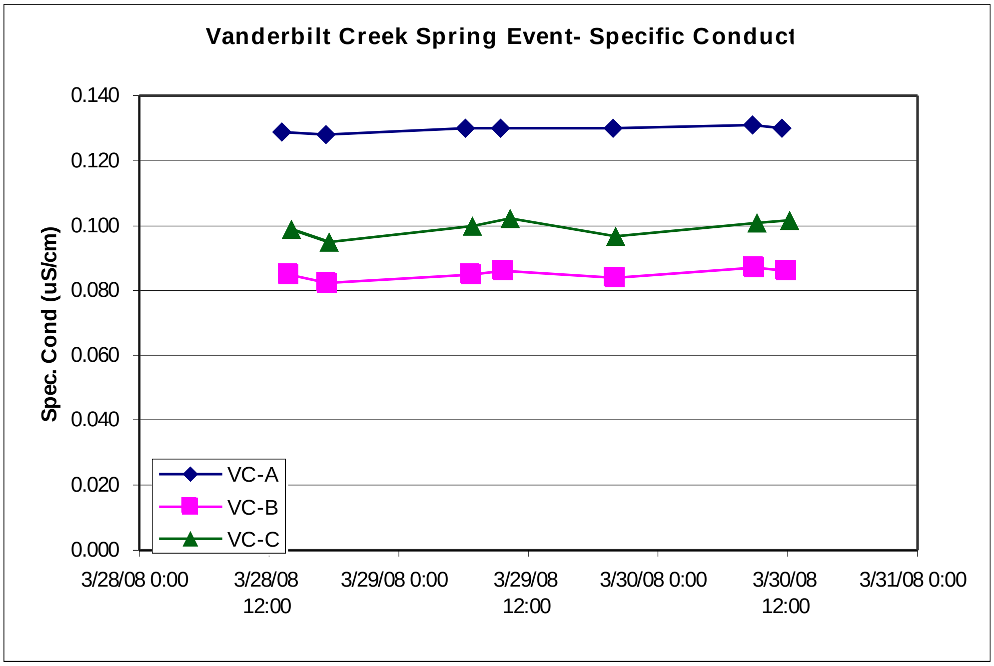
Figure 4. *Dissolved oxygen (in mg/L) at the 3 Vanderbilt Creek sites on each of the 4 seasonal sampling events.*

Conductivity (or specific conductance, which is essentially temperature-corrected conductivity) is a measure of ionic strength and, as such, reflects the load of total dissolved solids in the water column. The specific conductance in Vanderbilt Creek varied in terms of relative values at the three sites on each of the sampling events. During the fall, winter, and spring events, specific conductance was usually highest at

VC-A, but the opposite was true for the summer event. Specific conductance values in Vanderbilt Creek were similar to those in Jordan Creek.







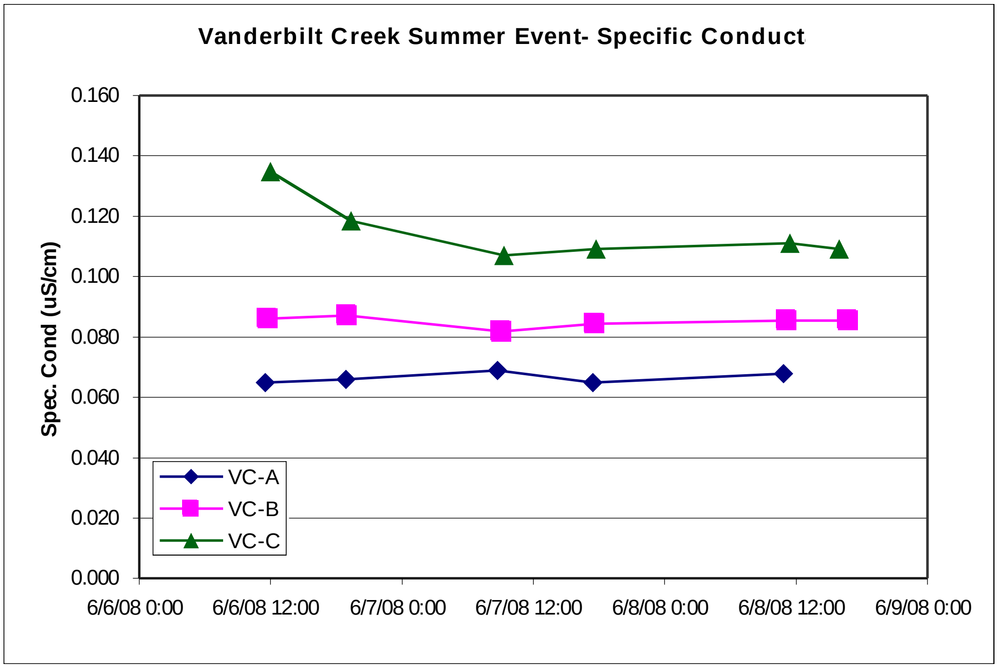
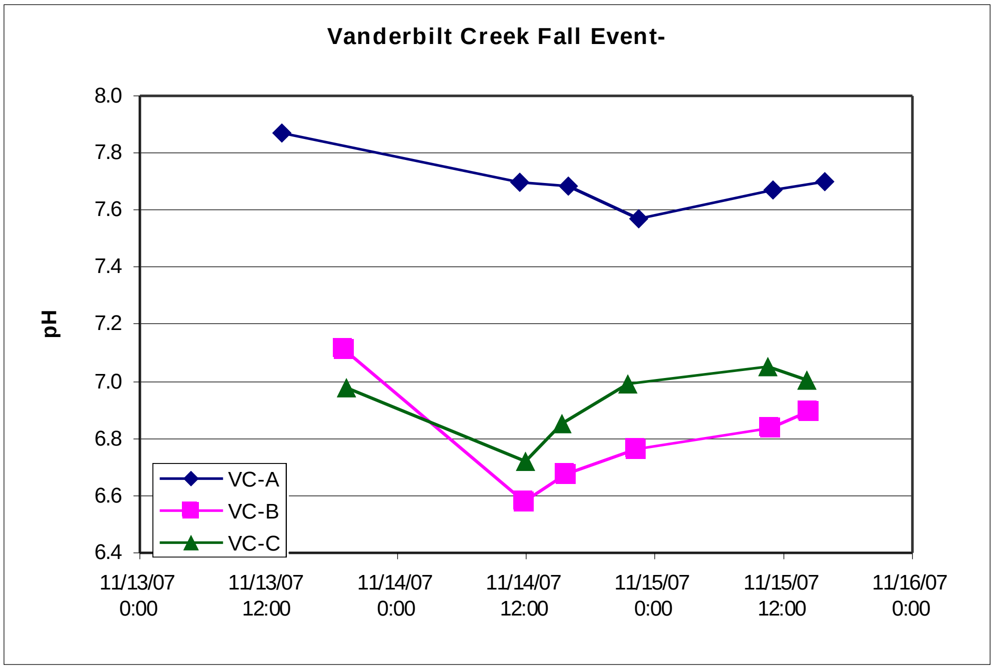
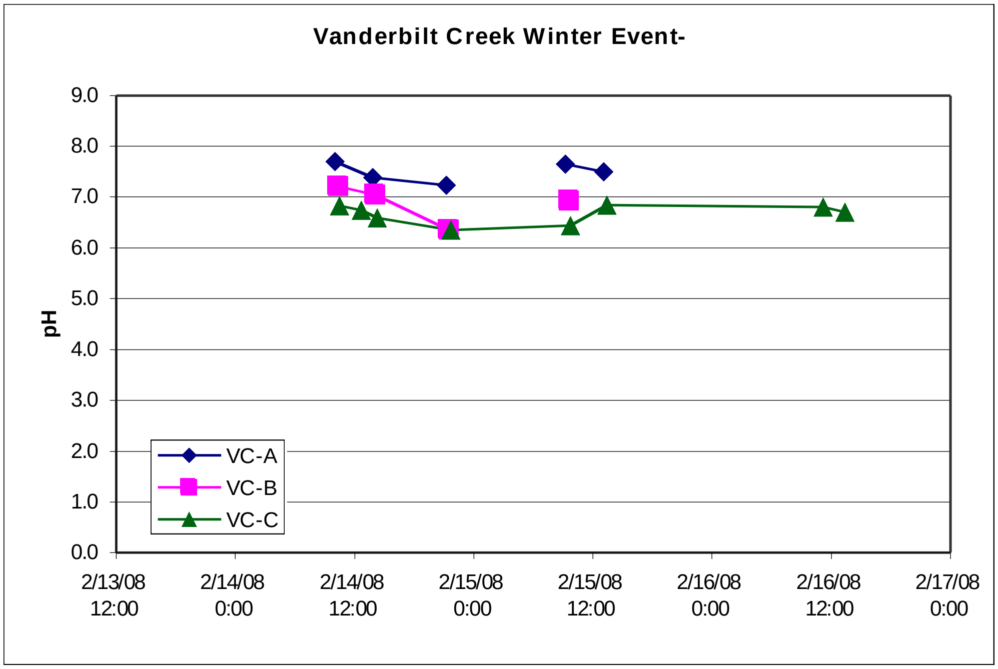


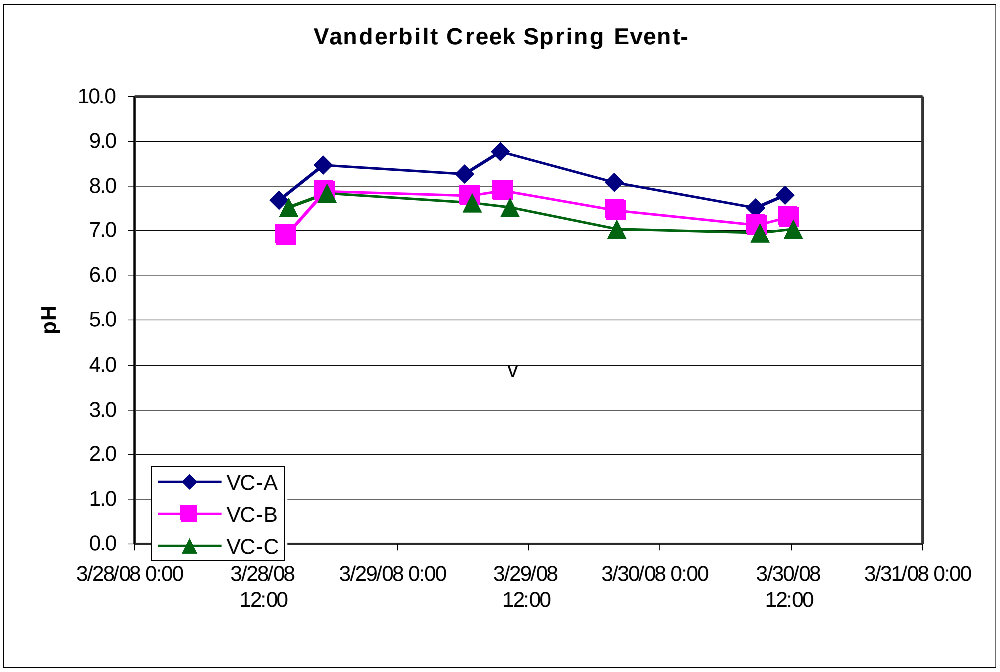
Figure 5. *Conductivity values at the 3 Vanderbilt Creek sites on each of the 4 seasonal sampling events.*

Values for pH varied mostly between 6.3 and 8.6 during the study period. pH values varied among the 3 sites. The pH at VC-A was about 1 unit higher than at VC-B and VC-C in the fall, half a unit higher in the summer, and similar in the winter and spring. A diel trend at the sites was measurable during the summer event, with pH rising during the day and falling during the night (attributable to photosynthesis and respiration reactions driving carbonate chemistry in the stream). Most pH measurements showed values of

>6.5, complying with the state water quality standard for the growth and propogation of fish, shellfish, and other aquatic life. The only exceptions were a couple of measurements at VC-C during the winter event, when two values were at 6.35 and 6.44. (These values are barely below the standard).







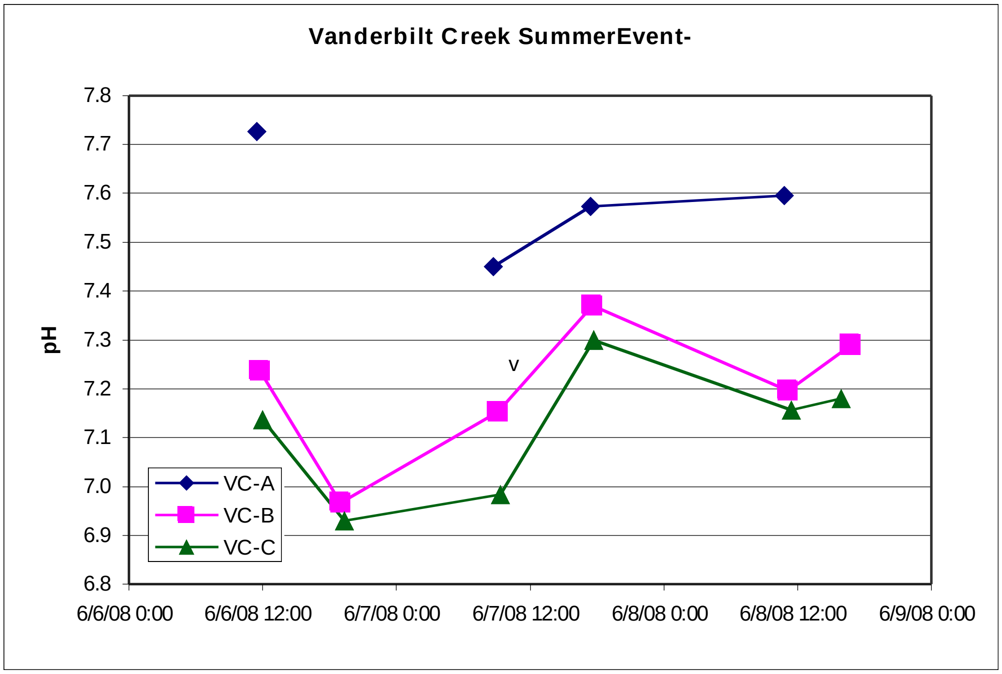
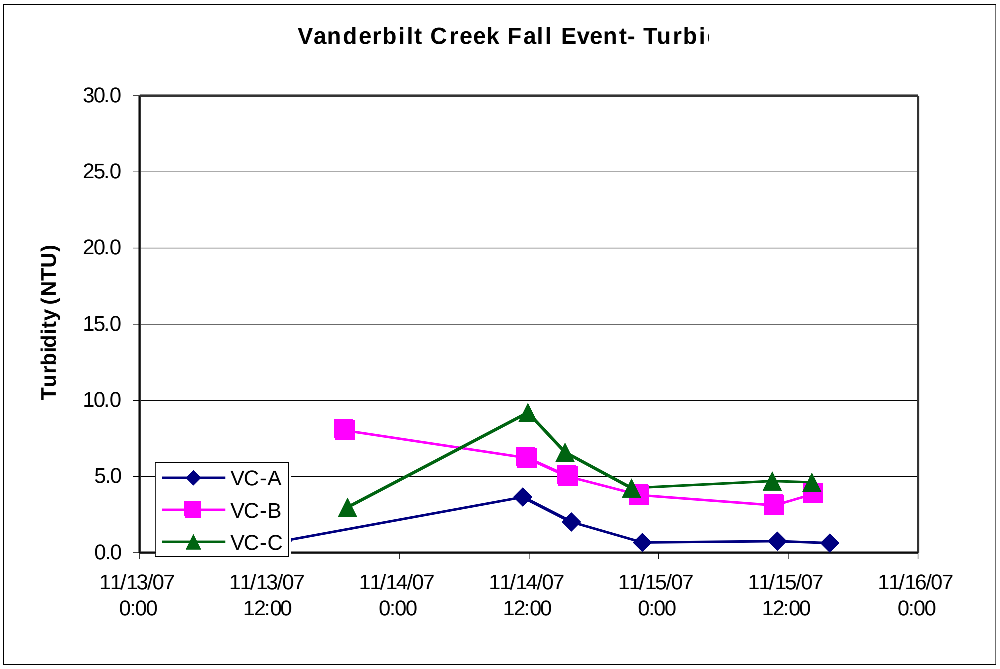


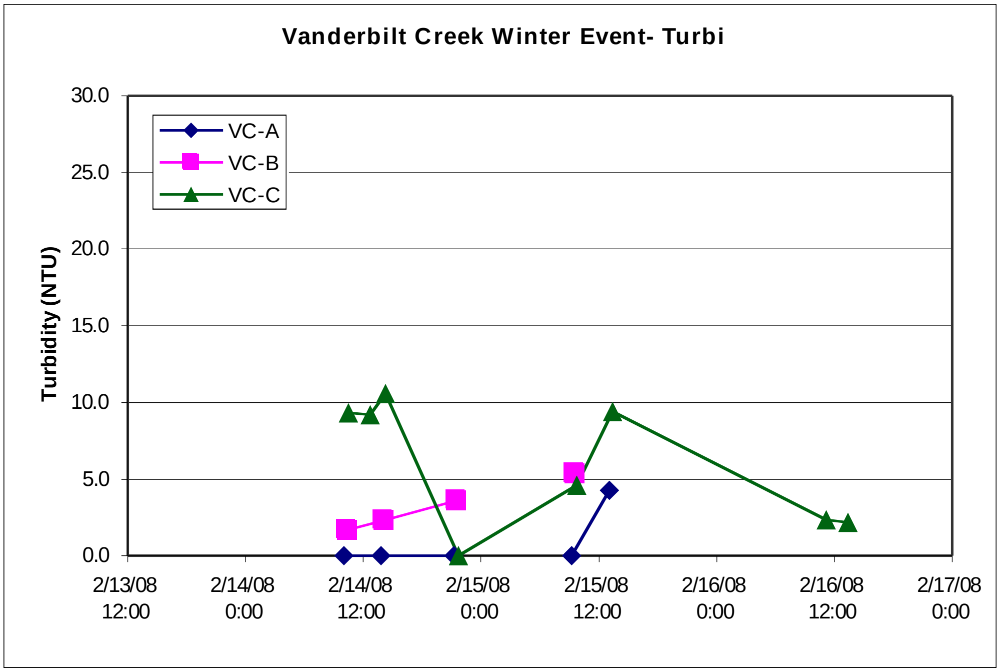
Figure 6. *pH values at the 3 sampling sties on Vanderbilt Creek for the 4 sampling events.*

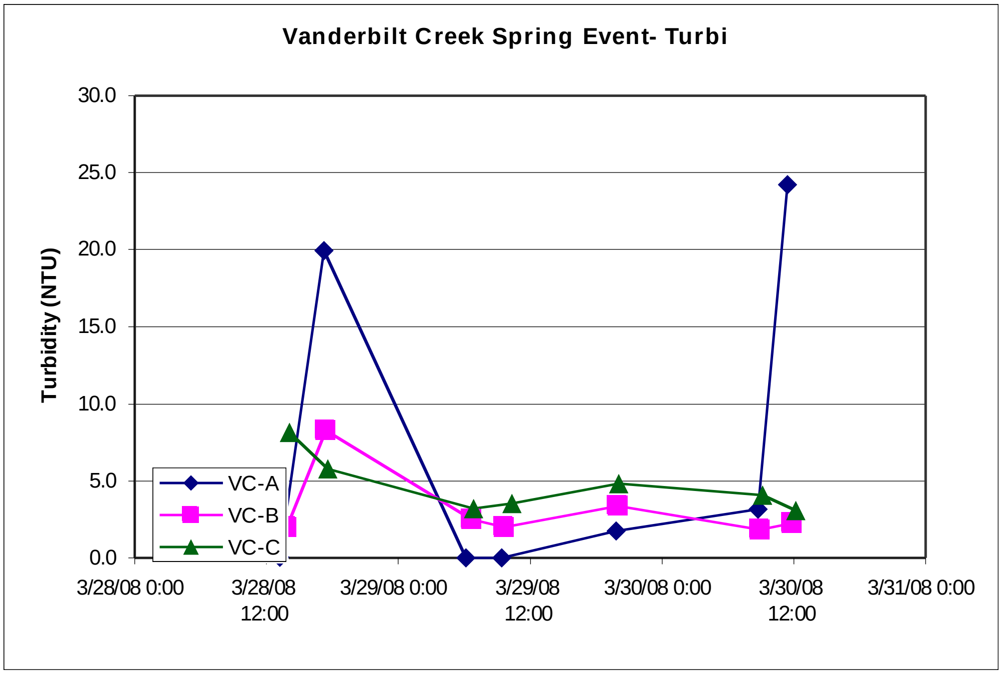
c) Turbidity and Total Suspended Solids (TSS)

The state of Alaska water quality standards for turbidity dictate that to protect fish and wildlife, turbidity may not exceed 25 nephelometric turbidity units (NTUs) above natural background conditions. Turbidity is not a direct measurement of solids, but is related to the amount of suspended material in the water column because it is a measure of light attenuation due to absorption and reflection by solids. Turbidity can be expected to closely parallel total suspended solids (TSS).

On Vanderbilt Creek, water clarity is very high and well within water quality standards for the state of Alaska, at least during the periods on which we sampled (Figure 7). Turbidity values at the sites were typically between <1 to 4 NTU, which are well below levels of water quality concern. Only a couple of samples had turbidity values much different than that: VC-B and VC-C had turbidites of 6-9 NTU during the early portion of the fall sampling event; VC-C's turbidity fluctuated within the 2-11 NTU range during the winter event; VC-A had a couple of anomalously high (20 and 24 NTU) turbidity readings during the spring event, although it was noted that the samples were difficult to obtain beneath the snow cover. Turbidity did not exihibit diel variations nor clear trends upstream or downstream. It is important to note that weekly sampling is not always adequate for characterizing problems with high turbidity because turbidity impairments can be highly time-specific and are often associated with short time periods of intense rainfall and high discharge.




Vanderbilt Creek Winter Event- Turbi
Turbidity (NTU)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
VC-A
VC-B
VC-C
2/13/08 12:00
2/14/08 0:00
2/14/08 12:00
2/15/08 0:00
2/15/08 12:00
2/16/08 0:00
2/16/08 12:00
2/17/08 0:00


Vanderbilt Creek Spring Event- Turbi
Turbidity (NTU)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
VC-A
VC-B
VC-C
3/28/08 0:00
3/28/08 12:00
3/29/08 0:00
3/29/08 12:00
3/30/08 0:00
3/30/08 12:00
3/31/08 0:00

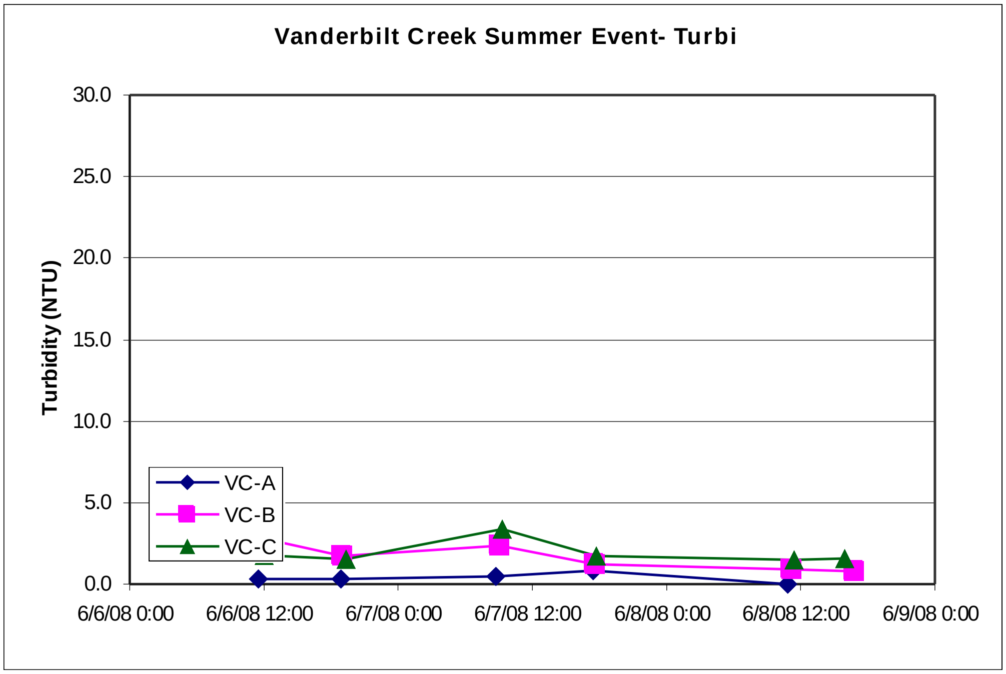
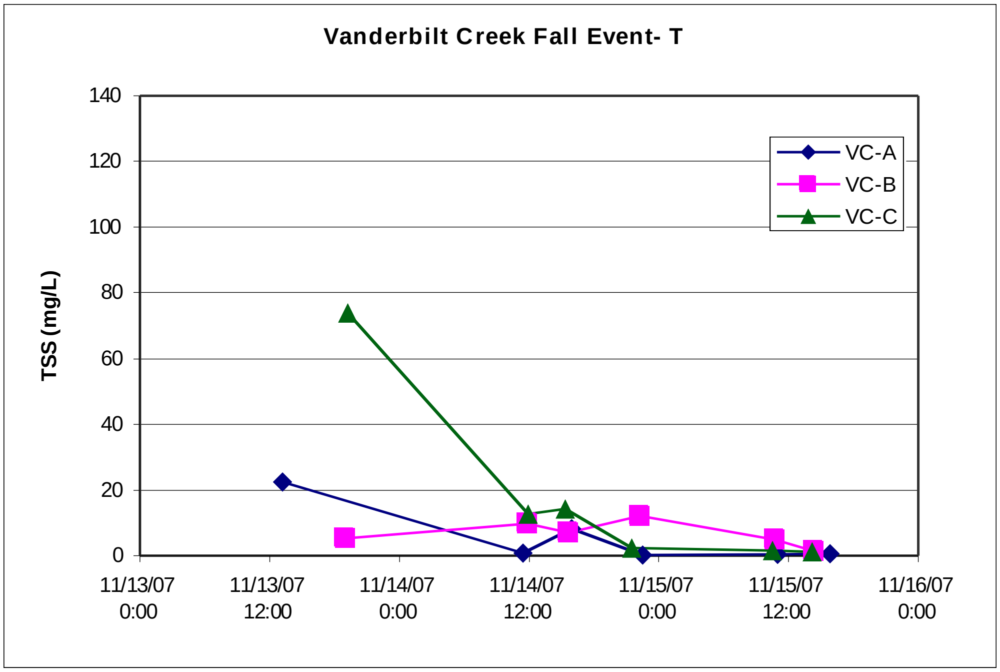
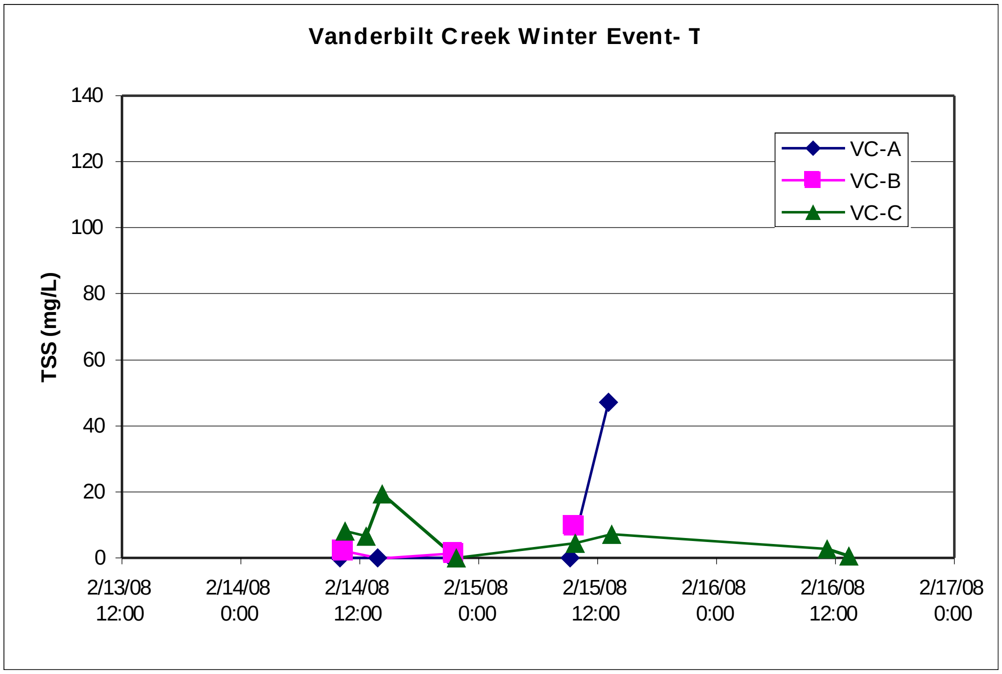


Figure 7. Turbidity (NTU) for the 3 Vanderbilt Creek sites during the 4 sampling events

Total suspended solids (TSS) refers to solids that are not dissolved in solution and can be removed by filtration. Suspended solids include both organic particles and inorganic, mineral particles, both of which can contribute to turbidity. TSS profiles for each seasonal sampling event were clearly different. During the fall event, TSS was elevated at VC-A and VC-B during the start of the rain (which again, never became a substational rainstorm as forcasted). During winter, values were low for those sites where samples were obtainable (sites were frozen over or filled in with snow during many of the winter sampling attempts). TSS was highest at VC-A during the spring event. Again this may have been due to the unavoidable large pieces of plan detrital material at the site, where the channel was small/intermittent and diverted through a pipe in one section TSS values in the summer were very low (<2 mg/L).


Vanderbilt Creek Fall Event- T
TSS (mg/L)
140
120
100
80
60
40
20
0
VC-A
VC-B
VC-C
11/13/07 0:00
11/13/07 12:00
11/14/07 0:00
11/14/07 12:00
11/15/07 0:00
11/15/07 12:00
11/16/07 0:00


Vanderbilt Creek Winter Event- T
TSS (mg/L)
140
120
100
80
60
40
20
0
VC-A
VC-B
VC-C
2/13/08 12:00
2/14/08 0:00
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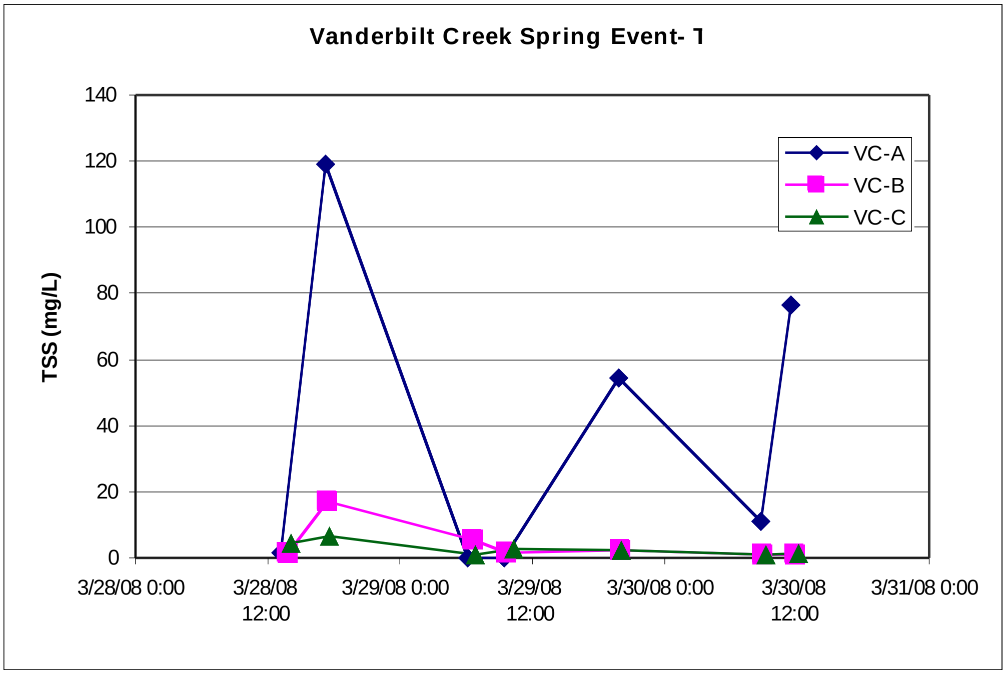
2/17/08 0:00



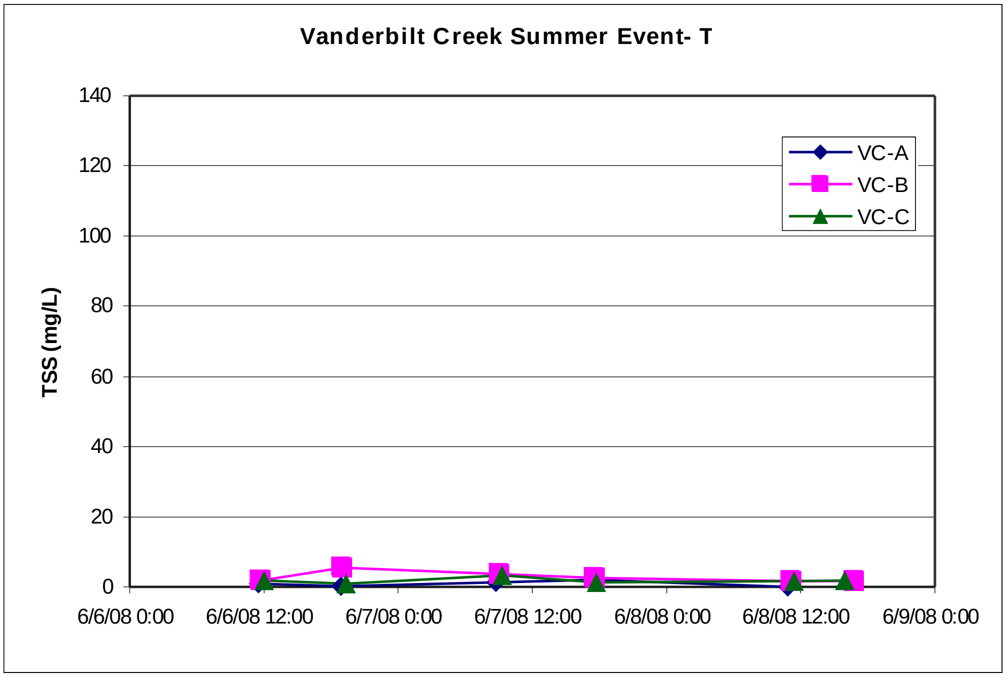
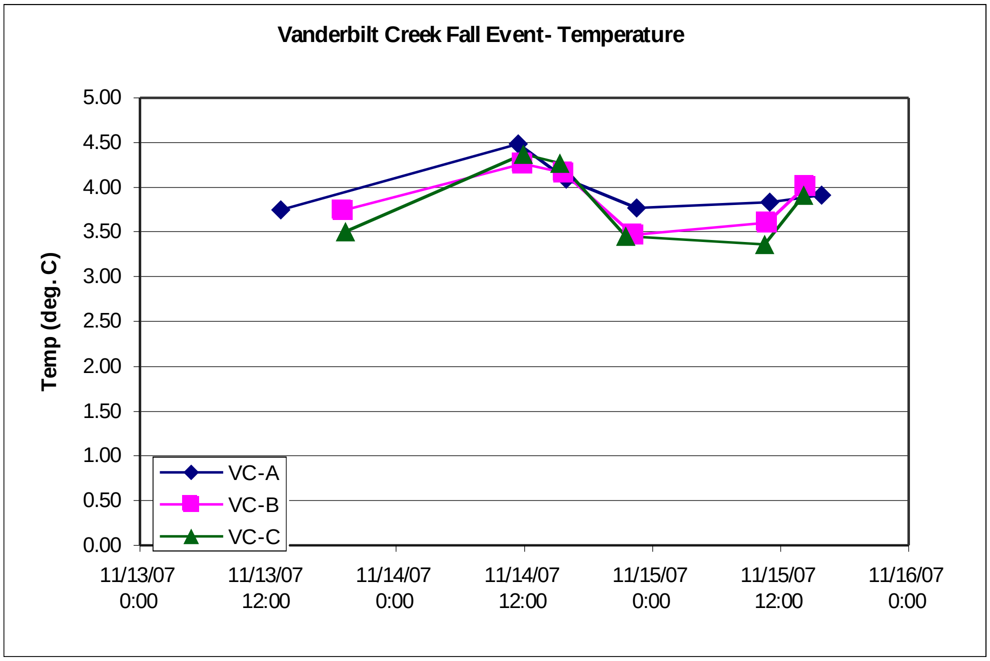
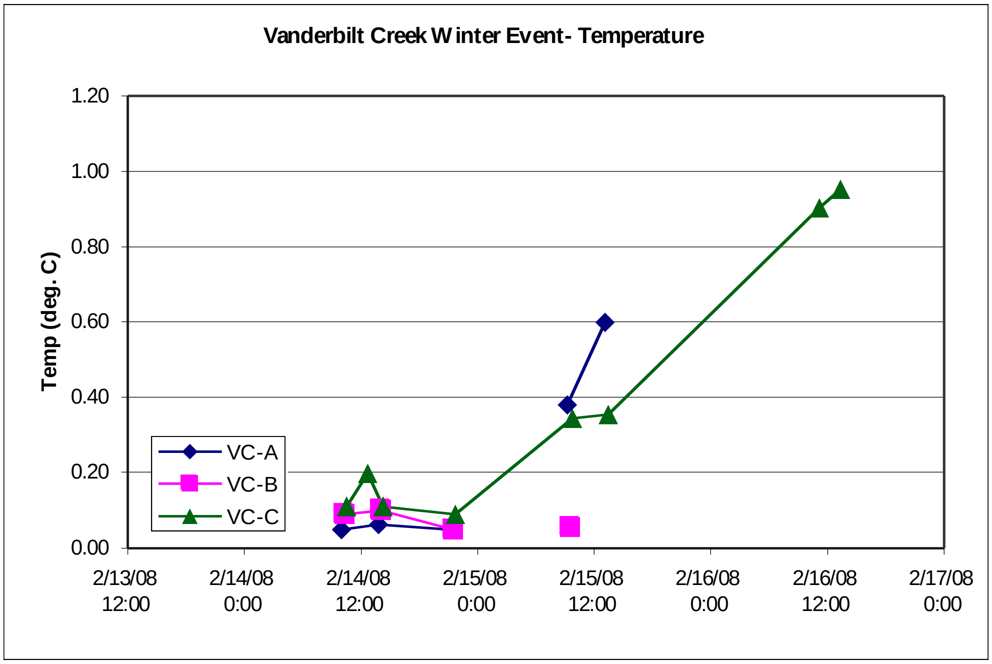


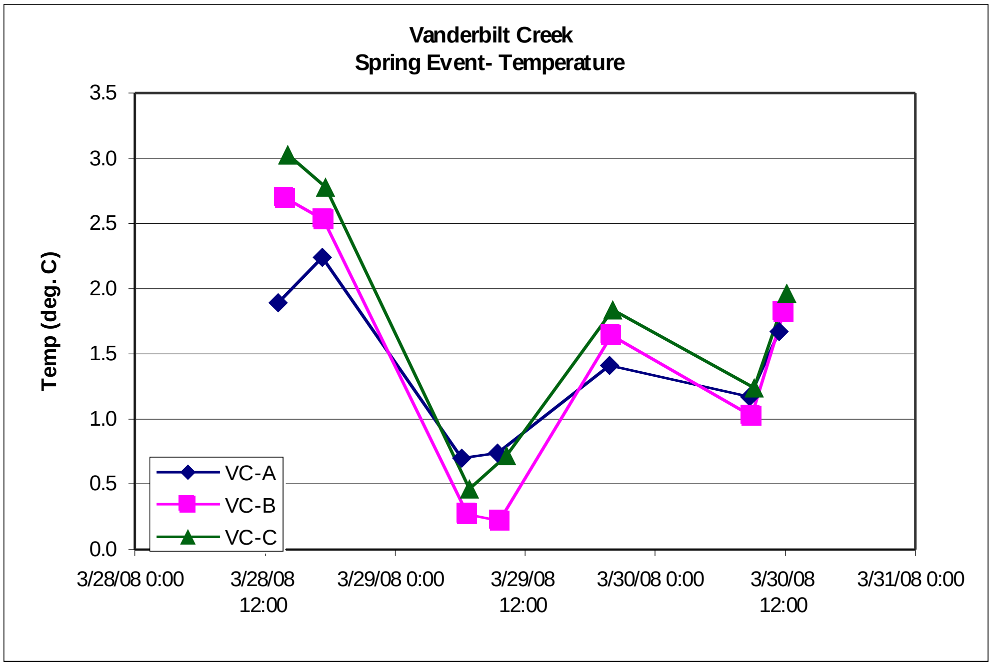
Figure 8. *TSS at the 3 Vanderbilt Creek sites.*

d) Water temperature

Water temperature in Vanderbilt Creek shows strong seasonal variation. As expected temperatures were warmest during the summer event (reaching almost 10°C in June). Diel variation was apparent during the fall, spring, and summer events. The spring event showed by far the greatest differences between day and night, as daytime temperatures were fairly warm and resulting in significant snowmelt No exceedences of the Alaska water quality standard for spawning and incubation areas (13 ºC) (DEC, 2006).occurred during this study year.







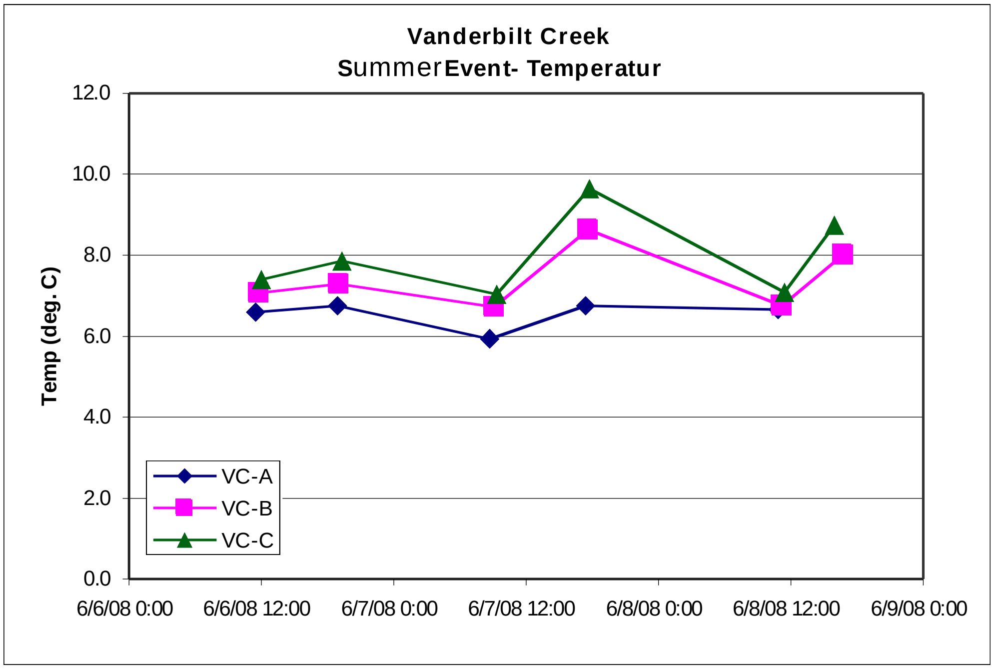


Figure 10*: Water temperature at the three sampling locations on Jordan Creek. Data shown include data collected in previous study years..*

Summary and conclusions

Vanderbilt Creek was intensively measured for pH, dissolved oxygen, specific conductance, temperature, turbidity, and TSS during 4 discrete 3-day periods between November, 2007- June, 2008. All parameters met state water quality standards. However, it is important to note that no particularly high flow events were captured in our sampling efforts, and it is likely that the bulk of sediment is moved during such events. During the low flow events we measured, TSS and turbidity were low, but these are measures of particulates suspended in the water column. The stream had low discharge and little energy during our sampling events, and most sediment was settled on the streambed. Fine sediment input to Vanderbilt Creek is a major concern due to the degradation of salmon spawning habitat caused by this gravel infill. Future efforts should be directed at continuous turbidity measurements in the stream (so as to be sure to capture high flow and transport events), quantification of fine sediment infill into the streambed, and measurements of dissolved oxygen levels in the hyporheic zone. Stream bioassessments would be highly valuable monitoring tools as well. Surface water sampling should be conducted on a more frequent scales for all basic water quality parameters, although keeping in mind that pH, temperature, and possibly dissolved oxygen, exhibit substantial natural diurnal-nocturnal variations.

Appendix. Water quality data collected on Vanderbilt Creek during the period November, 2007- June 2008. All temperature, specific conductance, DO, and pH values are based on averages of triplicate readings.

Site Name	Date and Time	Temp (deg C)	Q (cfs)	Spec. Cond. (uS/cm)	DO (%sat)	DO (mg/L)	pH	Turb (NTU)	TSS (mg/L)
FALL									
average VC-A	11/13/07 13:13	3.75		0.086	100.5	13.25	7.87	0.77	22
average VC-A	11/14/07 11:25	4.48		0.120	98.8	12.78	7.70	3.64	1
average VC-A	11/14/07 15:55	4.09		0.084	97.7	12.90	7.68	2.03	8
average VC-A	11/14/07 22:30	3.77		0.122	96.6	12.74	7.57	0.66	0
average VC-A	11/15/07 11:00	3.83		0.122	93.9	12.36	7.67	0.74	0
average VC-A	11/15/07 15:50	3.91		0.121	94.4	12.40	7.70	0.65	1
average VC-B	11/13/07 19:00	3.74		0.097	92.1	12.14	7.11	8.04	5
average VC-B	11/14/07 11:50	4.26		0.079	86.4	11.24	6.58	6.22	10
average VC-B	11/14/07 15:40	4.16		0.081	85.7	11.18	6.68	4.99	7
average VC-B	11/14/07 22:15	3.47		0.085	85.8	11.41	6.76	3.78	12
average VC-B	11/15/07 10:45	3.60		0.088	84.7	11.31	6.84	3.13	5
average VC-B	11/15/07 14:20	4.01		0.088	83.4	10.93	6.90	3.87	1
average VC-C	11/13/07 19:15	3.50	2.20	0.162	92.8	12.32	6.98	2.98	74
average VC-C	11/14/07 11:55	4.37		0.092	90.9	11.80	6.72	9.22	13
average VC-C	11/14/07 15:20	4.27	1.80	0.093	91.5	11.91	6.85	6.61	14
average VC-C	11/14/07 21:30	3.45		0.099	91.2	12.13	6.99	4.26	2
average VC-C	11/15/07 10:30	3.36		0.103	90.0	12.00	7.05	4.73	1
average VC-C	11/15/07 14:10	3.91		0.104	88.3	11.60	7.01	4.61	1

Site Name	Date and Time	Temp (deg C)	Q (cfs)	Spec. Cond. (uS/cm)	DO (%sat)	DO (mg/L)	pH	Turb (NTU)	TSS (mg/L)
WINTER									
Site Name									
average VC-A	2/14/08 10:00	0.05		0.091	113.8	16.61	7.70	N/A	N/A
average VC-A	2/14/08 13:50	0.06		0.083	83.6	12.27	7.39	N/A	N/A
average VC-A	2/14/08 21:13	0.05		0.100	112.1	16.51	7.23	N/A	N/A
average VC-A	2/14/08 0:00								
average VC-A	2/15/08 9:15	0.38		0.110	114.0	16.45	7.64	N/A	0
average VC-A	2/15/08 13:05	0.60		0.110	113.7	16.30	7.50	4.28	47
average VC-A	2/16/08 0:00								
average VC-A	2/16/08 0:00								
average VC-B	2/14/08 10:20	0.09		0.081	103.3	15.04	7.21	1.67	2
average VC-B	2/14/08 14:05	0.10		0.066	102.8	14.98	7.04	2.32	0
average VC-B	2/14/08 21:30	0.05		0.068	103.3	15.08	6.34	3.60	1
average VC-B	2/14/08 0:00								
average VC-B	2/15/08 9:35	0.06		0.062	98.8	14.42	6.93	5.34	10
average VC-B	2/15/08 0:00								
average VC-B	2/16/08 0:00								
average VC-B	2/16/08 0:00								
average VC-C	2/14/08 10:30	0.11		0.103	105.3	15.34	6.83	9.32	8
average VC-C	2/14/08 12:40	0.20		0.141	107.5	15.63	6.75	9.21	7

average VC-C	2/14/08 14:15	0.11	1.30	0.105	104.2	15.19	6.58	10.60	19
average VC-C	2/14/08 21:43	0.09		0.096	104.5	15.23	6.35	N/A	N/A
average VC-C	2/15/08 9:45	0.34		0.100	100.7	17.95	6.44	4.62	4
average VC-C	2/15/08 13:25	0.35		0.097	102.9	14.93	6.84	9.40	7
average VC-C	2/16/08 11:09	0.90	1.10	0.120	104.1	14.83	6.80	2.33	3
average VC-C	2/16/08 13:21	0.95		0.140	103.9	14.79	6.70	2.19	1

Site Name **SPRING**	Date and Time	Temp (deg C)	Q (cfs)	Spec. Cond. (uS/cm)	DO (%sat)	DO (mg/L)	pH	Turb (NTU)	TSS (mg/L)
average VC-A	3/28/08 13:12	1.89		0.129	102.9	14.24	7.68	0.06	2
average VC-A	3/28/08 17:15	2.24		0.128	109.7	15.07	8.46	19.93	119
average VC-A	3/29/08 6:09	0.70		0.130			8.27	N/A	N/A
average VC-A	3/29/08 9:25	0.74		0.130	109.5	15.67	8.76	N/A	N/A
average VC-A	3/29/08 19:50	1.41		0.130	111.0	15.59	8.08	1.77	54
average VC-A	3/30/08 8:44	1.17		0.131	106.5	15.07	7.51	3.17	11
average VC-A	3/30/08 11:27	1.67		0.130	101.4	14.15	7.80	24.20	76
average VC-B	3/28/08 13:50	2.70		0.085	98.8	13.40	6.89	2.00	1
average VC-B	3/28/08 17:25	2.53		0.082	96.9	13.19	7.88	8.27	17
average VC-B	3/29/08 6:41	0.27		0.085			7.78	2.50	5
average VC-B	3/29/08 9:40	0.22		0.086	98.1	14.25	7.90	2.00	2
average VC-B	3/29/08 20:00	1.64		0.084	98.0	14.75	7.44	3.37	2
average VC-B	3/30/08 8:55	1.02		0.087	97.5	13.83	7.12	1.83	1
average VC-B	3/30/08 11:51	1.82		0.086	93.0	12.93	7.31	2.27	1
average VC-C	3/28/08 14:05	3.03		0.099	98.7	13.27	7.52	8.17	5
average VC-C	3/28/08 17:35	2.78		0.095	98.7	13.35	7.84	5.80	7
average VC-C	3/29/08 6:50	0.46		0.100			7.63	3.20	1
average VC-C	3/29/08 10:20	0.72	2.60	0.102	99.9	14.31	7.53	3.53	3
average VC-C	3/29/08 20:05	1.84		0.097	99.1	13.76	7.03	4.83	2
average VC-C	3/30/08 9:10	1.24		0.101	98.4	13.90	6.94	4.07	1
average VC-C	3/30/08 12:10	1.97	2.20	0.102	93.8	12.97	7.03	3.07	1

Site Name **SUMMER**	Date and Time	Temp (deg C)	Q (cfs)	Spec. Cond. (uS/cm)	DO (%sat)	DO (mg/L)	pH	Turb (NTU)	TSS (mg/L)
average VC-A	6/6/08 11:30	6.58		0.065	107.2	13.14	7.73	0.30	0.8
average VC-A	6/6/08 18:53	6.75		0.066	110.0	13.43		0.32	0.2
average VC-A	6/7/08 8:43	5.94		0.069	109.3	13.62	7.45	0.47	1.2
average VC-A	6/7/08 17:25	6.75		0.065	110.2	13.44	7.57	0.82	2.0
average VC-A	6/8/08 10:50	6.65		0.068	106.0	12.98	7.60	N/A	N/A
average VC-A	6/8/08 16:38								
average VC-B	6/6/08 11:45	7.06		0.086	103.5	12.54	7.24	2.82	1.8
average VC-B	6/6/08 19:01	7.28		0.087	103.7	12.50	6.97	1.74	5.4
average VC-B	6/7/08 9:05	6.72		0.082	98.4	11.73	7.15	2.38	3.7
average VC-B	6/7/08 17:37	8.63		0.084	99.9	11.63	7.37	1.21	2.6
average VC-B	6/8/08 11:10	6.75		0.085	101.7	12.41	7.20	0.89	1.6
average VC-B	6/8/08 16:46	8.01		0.085	102.9	12.49	7.29	0.80	1.6
average VC-C	6/6/08 12:00	7.40		0.135	108.7	12.90	7.14	1.79	1.9
average VC-C	6/6/08 19:20	7.85		0.118	107.0	12.71	6.93	1.53	1.0
average VC-C	6/7/08 9:20	7.03		0.107	101.3	12.28	6.98	3.40	3.2

average VC-C	6/7/08 17:44	9.64	0.109	105.4	12.00	7.30	1.72	1.4
average VC-C	6/8/08 11:25	7.07	0.111	106.1	12.85	7.16	1.48	1.6
average VC-C	6/8/08 15:56	8.74	0.109	107.8	12.54	7.18	1.58	1.8