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

FY 2007
FINAL REPORT

Watershed Protection and Recovery for Jordan Creek, Juneau, AK

July 2007

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PROJECT #:ACWA-07-07
PROJECT TITLE: Watershed Protection and Recovery for Jordan Creek, Juneau, AK

Project Description and Purpose

The purpose of this monitoring effort was to characterize the water quality of Jordan Creek in the Mendenhall Watershed (Figure 1), to compare the water quality to Alaska state standards, to evaluate the effects of urbanization in the watershed (e.g. sediment, fecal coliform, and road salt inputs).. The stream corridor of Jordan Creek has undergone extensive development, and it has been suffering from low flow levels, including complete drying out at some sites, and declines in salmon usage. A suite of water quality parameters was collected at three representative sites on Jordan Creek every two weeks from July 2006-June 2007, following on several years of previous monitoring efforts.

Jordan Creek flows through the eastern edge of the Mendenhall Valley and drains an area of about 3 mi^2 (Host and Neal, 2004). The upper reaches of Jordan Creek originate along the western edge of Thunder Mountain and are relatively undeveloped, while the lower reaches downstream from Egan Drive are bounded by parking lots apartment complexes and professional malls. Degradation of the riparian zone has occurred where buildings, parking lots, and roads have encroached on the stream channel.

The specific goals of this project included:

- To document existing water quality conditions in Jordan Creek and make comparisons to historic data
- To assess the impacts of road salt, human/pet waste (in the form of fecal coliform) and sediment dumping on the water quality of Jordan Creek

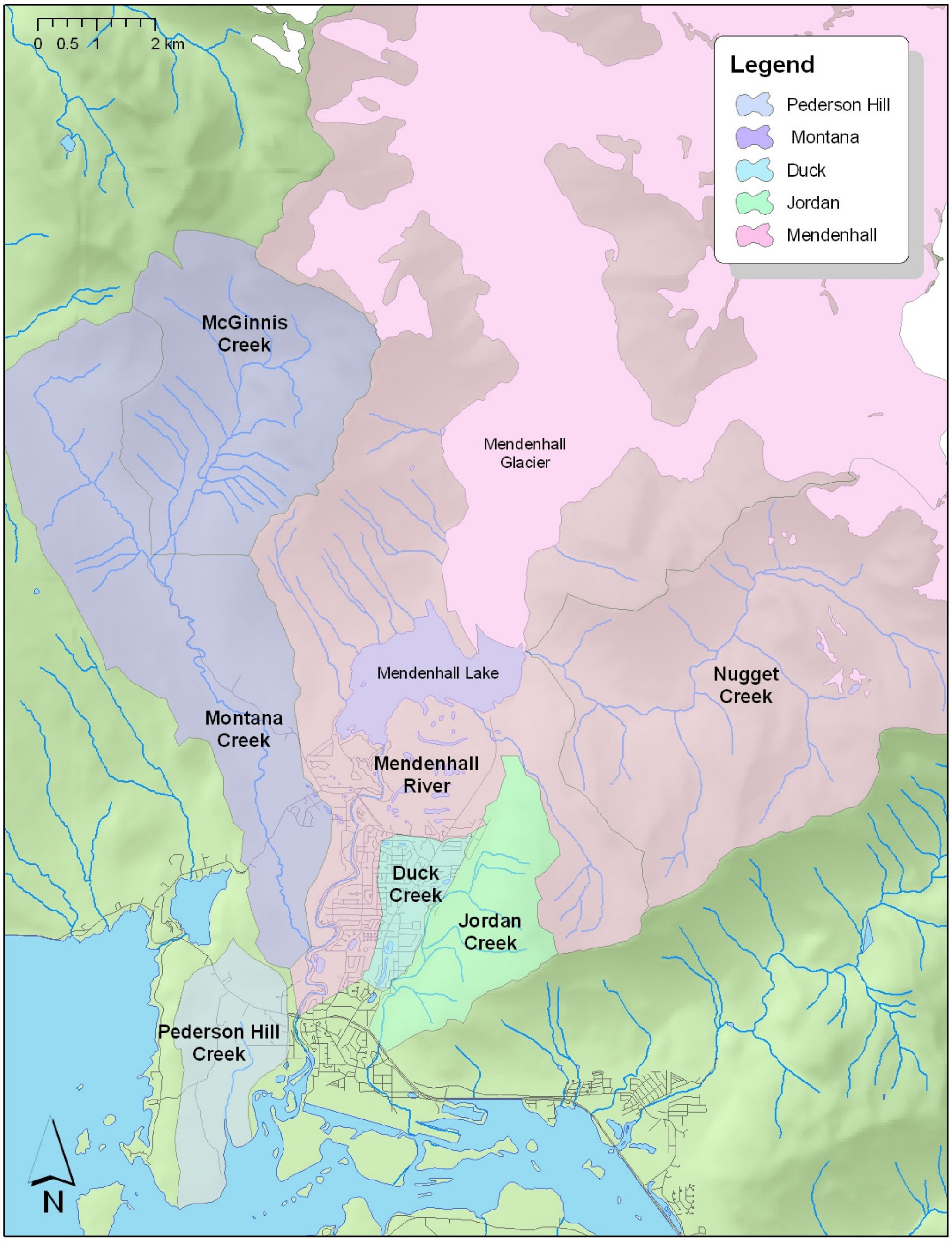

Figure 1: *Location of Jordan Creek watershed and other watersheds in the Mendenhall Valley, Juneau.*

I. Water Quality Monitoring Project

Research Design

The location of the Jordan Creek water quality monitoring sites was kept consistent with previous years' efforts, with three sites along the stream (Table 1, Figure 2). Jordan Creek watershed is 2.6 square miles (above the Jordan C sample site), a large portion of which is suburban development in the Mendenhall Valley.

Table 1. *Stream sample locations along Jordan Creek. Latitude and longitude coordinates were measured using GPS in April, 2006 and are reported in the North American Datum 1983.*

Site Code	Site Description	Latitude	Longitude
JC-A	Jord C @ Amalga Dr	58.38726067004	-134.56351114001
JC-B	Jord C @ Super 8 Motel	58.36616032005	-134.57784830000
JC-C	Jord C @ Yandukin Footbridge	58.35917610005	-134.57835674000

Sample sites on Jordan Creek represent differently impacted areas of the watershed. The JC-A site is upstream, closest to the headwaters of Jordan Creek on the western flank of Thunder Mountain, at the bridge crossing on Amalga Drive. JC-B is located immediately downstream of where Jordan Creek flows under Egan Drive at the site of the US Geological Survey streamgage. JC-C is located at the edge of the Juneau airport property, just upstream from the fish weir operated by the Alaska Department of Fish and Game.

Stream sampling was conducted from July 2006 to June 2007. Samples were collected in the morning (between 8am and 1 pm) in the same sequence each time, in order to minimize compounding diel variations in water quality parameters. On three events (in October, March, and June) diel variations were monitored by sampling every 4 hours over a 24 hour period. No operating stream gauge was available past January, 2006 (before that the USGS operated a stream gage at JC-B); and we manually gaged the discharge at JC-B. Water quality data collected for Jordan Creek during the project is shown in Appendices A and B of this report.

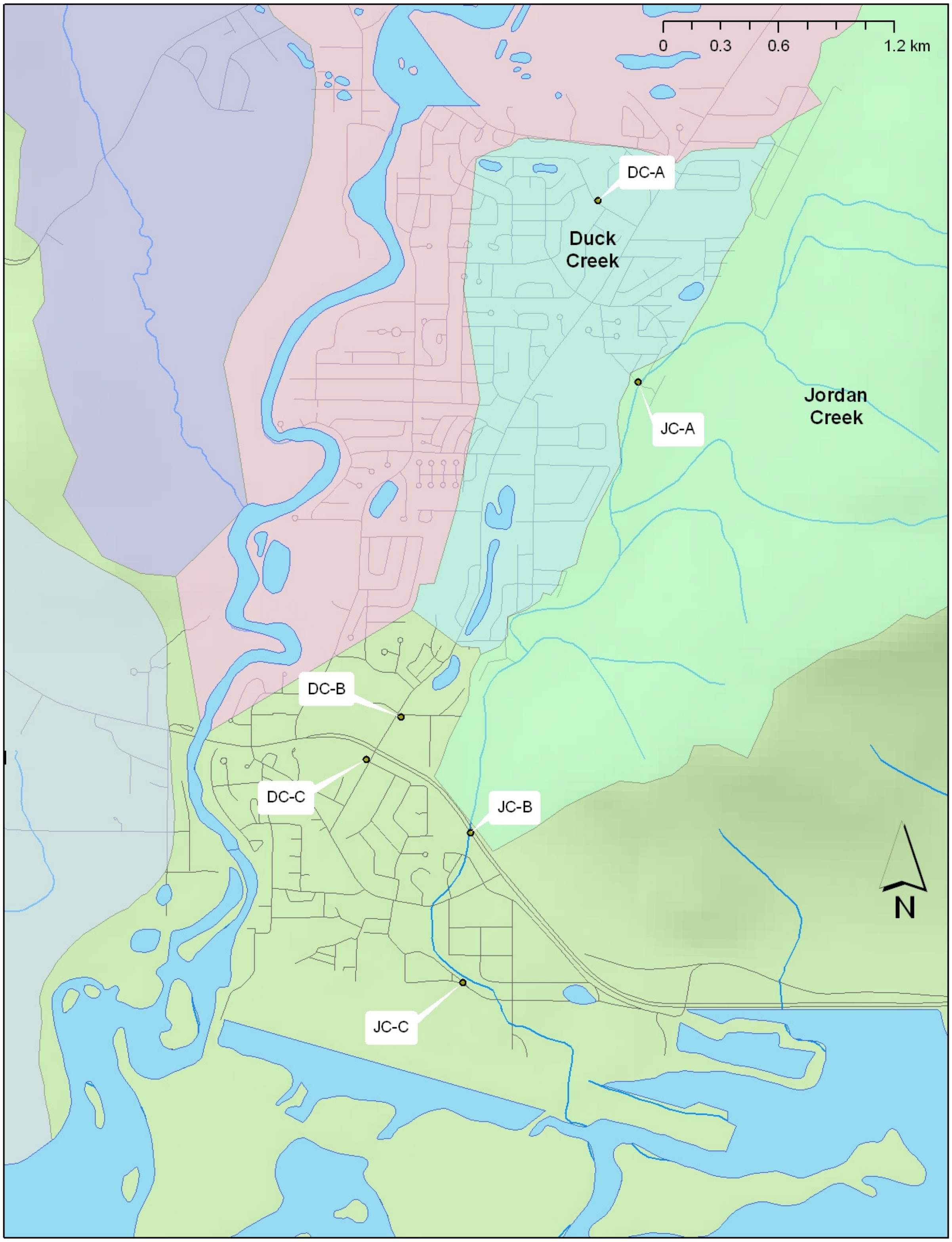

Figure 2. *Map of the Mendenhall Valley and sample sites used in the study on Jordan Creek. Also shown are sample sites for the companion study along neighboring Duck Creek (DC-A,B,C).*

Water quality parameters at the three sample sites were measured bi-monthly throughout the project period (except for one bi-monthly sample missed on 12/30/2006). 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 within 6 hours of sample collection. 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. Additional waters samples were taken in separate bottles in the field, filtered in the lab within 6 hours through 0.45 µm membrane filter into 125 mL polyethylene bottles, and frozen until analysis by Ion Chromatograph for cations and anions, as described below:

Analysis by Ion Chromatograph:
Adherence to data quality requirements was verified by running an intermediate standard solution every 10 measurements. Failure of the calculated concentration to fall within +/- 10% of its known value initiated reestablishment of the calibration curve. As an added quality control measure, every 10^{th} sample measurement was duplicated with the requirement that the relative percent deviations of duplicated analyte concentrations fall within +/- 10%.

a) Anions. A 25 µL aliquot of the neutral sample was analyzed for chloride, nitrate, nitrite, sulfate and phosphate concentrations on a Dionex DX500 Ion Chromatography system with ion suppression and conductivity detection. The analytes were separated on an IonPac AS12 4 mm x 250 mm column preceeded by an IonPac AG12 guard column using sodium carbonate (Na_2CO_3)/sodium hydrogen carbonate ($NaHCO_3$) eluent at 1.5 mL min^{-1}. Peaks were identified and quantified by comparison of retention times and peak areas with standards.

b) Cations. A 25 µL aliquot of the neutral sample was analyzed for sodium, potassium, ammonium magnesium and calcium concentrations on a Dionex DX500 Ion Chromatography system with ion suppression and conductivity detection. The analytes were separated on an IonPac CS12 4 mm x 250 mm column preceeded by an IonPac AG12 guard column using sulfuric acid eluent (30 mM) at 1 mL min^{-1}. Peaks were identified and quantified by comparison of retention times and peak areas with standards.

Fe analyses:

Total dissolved iron was determined spectrophotometrically via the Ferrozine method (Violler et al, 2000). In brief, ferrozine solution was added to an aliquot of the acidified sample. An aqueous solution of hydroxylamine hydrochloride was added next, thus assuring all iron was present as iron(II). The sample was buffered to pH = 9 with ammonia/ammonium acetate buffer and the absorbance of the resulting iron(II)-ferrozine complex measured. Using a modification of Beer's Law, the concentration of dissolved iron was determined by comparison to standard solutions of known concentration. Data quality requirements were verified by running an intermediate standard solution every 10 measurements. Failure of the calculated concentration to fall within +/- 10% of the known value initiated reestablishment of the calibration curve.

Water Quantity and Quality on Jordan Creek

Water Quantity

Although continuous discharge data were unavailable for Jordan Creek in 2006-2007, examination of historic data at the site as well as field observations and occasional measurements, indicates that Jordan Creek is generally a small, flashy stream that responds to and recovers quickly from local precipitation events. The Jordan Creek watershed is comprised largely of suburban development in the Mendenhall Valley, although the creek also receives water from the northwest side of Thunder Mountain. Streamflow in Jordan is derived primarily from rainfall and shallow groundwater, as a result, streamflow is relatively flashy, responding quickly to the large frontal rainstorms typical of fall and winter in the Juneau area. Large winter storms, particularly rain on snow events, can also cause streamflow to rise dramatically. Streamflow in Jordan decreases substantially during the late spring and early summer during periods of low rainfall.

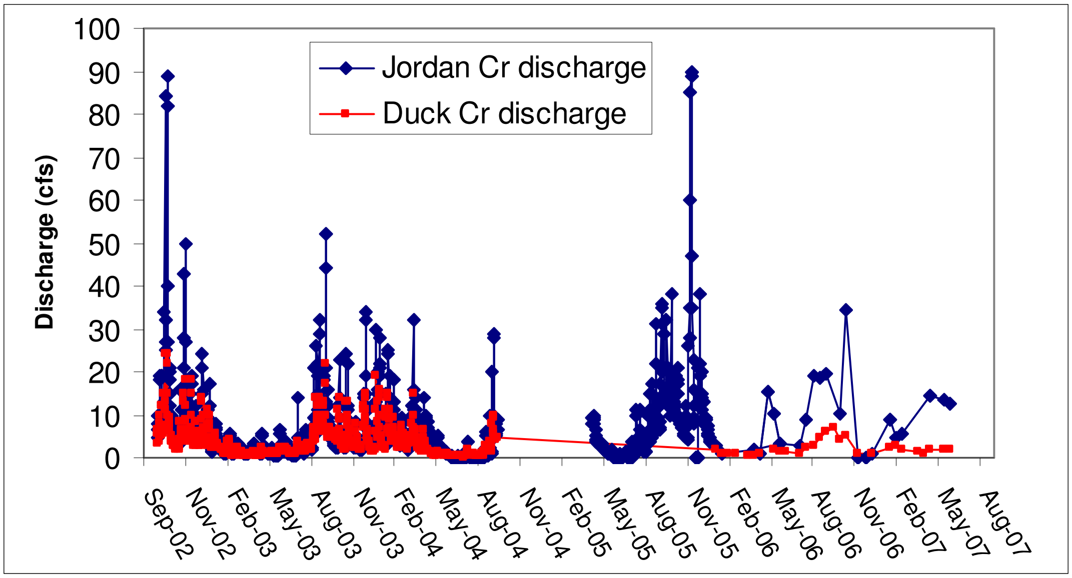

Figure 2. *Discharge on Duck and Jordan Creeks. Data based on USGS stream gage data through December, 2006. Data since January 2006 are based on manually gaging using a pygmy flow meter. Duck Creek discharge was measured at site DC-B, and Jordan Creek discharge was measured at JC-B.*

At the uppermost site (JC-A), water was always present, indicating a steady groundwater input that persisted even during freezing, snowy weather conditions. JC-B was iced over or dry and filled in with snow for much of the winter and early spring (on 11/17/2006, 12/3/2006, 3/4/07, 3/24/07, and 4/6/07.) JC-C was icy or completely dry during much of the late fall/early winter of 2006, and again in March to mid-April in 2007 (on 11/17/2006, 12/3/2006, 12/16/2006, 3/4/07, 3/24/07, 4/6/07). Loss of flow is an obvious major concern for salmonids attempting to utilize Jordan Creek as habitat for rearing, spawning, and egg incubation.

Discharge during the study year was measured by the authors on most sampling events. Measurements indicate that flow reached 35 cfs on 10/21/2006, although higher flows may easily have been missed by our sampling design. Generally, discharge tended to be less than about 15 cfs. On all dates measured between November, 2006 and April, 2007, flow did not exceed 9 cfs. The three flow measurements made between late April and early June, 2007 read between 13-15 cfs.

Figure 3a. *Site JC-A on 3/27/07. Flowing water was present at the site on all sampling events, even during the winter.*

Figure 3b. *Site JC-B, showing Jordan Creek filled in with snow and no visible streamflow on 3/27/07.*

Figure 3c. *Site JC-C on 3/27/07 filled in completely with snow, as seen from Yandukin Drive. The channel is barely visible from the road. Flow resumed in the channel in approximately mid-April.*

Water Quality

a) Dissolved oxygen, conductivity, and pH

Dissolved oxygen was generally good at the 3 Jordan Creek sites, and typically ranged between 8 and 15 mg/L (Table 2, 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). DO levels at JC-B and JC-C were typically higher than at JC-A (Table 2).

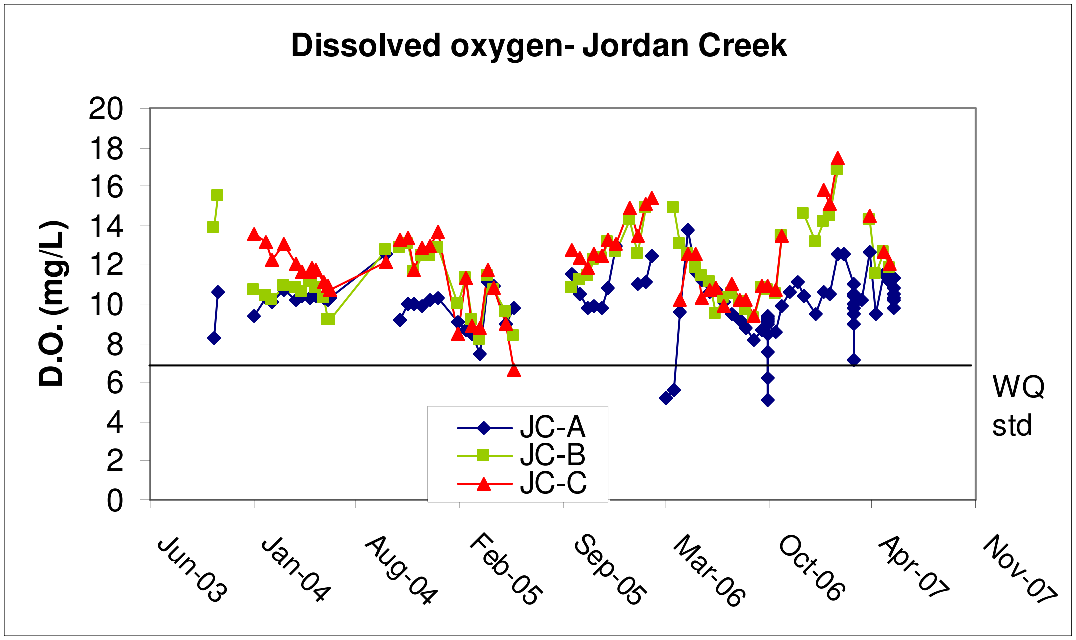

Figure 4. *Dissolved oxygen at the 3 Jordan Creek sites. Graph shows D.O. data for this project year as well as previous data collected by UAS (beginning in 10/2003).*

Conductivity is a measure of ionic strength and, as such, reflects the load of total dissolved solids in the water column. Conductivity values measured on Jordan Creek were generally about 50% of the values measured in Duck Creek but are substantially higher than conductivity on more pristine local streams like Montana Creek (Hood, unpublished data). Conductivity tended to decrease moving downstream in Jordan Creek, which suggests that either inflows to the Creek below the JC-A site have a lower ionic strength or that that dissolved solids are removed by precipitation or biological uptake. The relatively high conductivity in upper Jordan Creek is a likely a result of inputs of ions such as nitrate and sulfate from anthpogenic sources as well as inputs of iron from groundwater. Conductivity concentrations in FY07 were in the same range as values measured the three years prior (Figure 5). Average conductivity was highest at JC-A, reflected the larger influence of groundwater (typically higher in ionic strength than surface water) compared with the other 2 sites (Table 2).

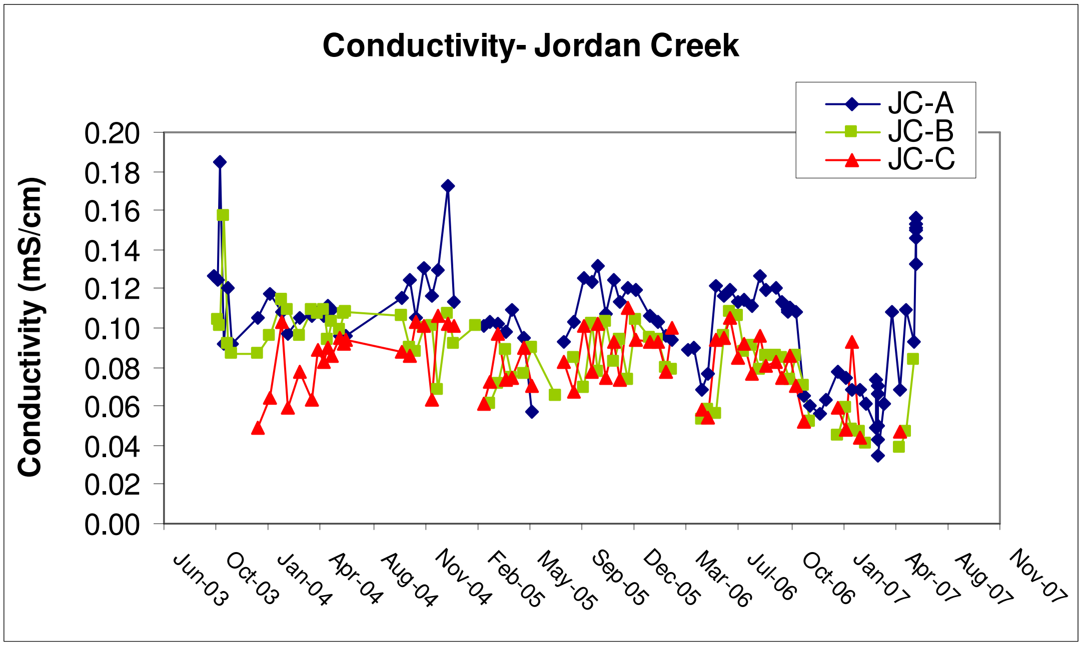

Figure 5. *Conductivity values at the 3 sampling sties on Jordan Creek. Graph includes data from prior study years as well..*

Table 2. Average values (standard deviation in parentheses) for water quality parameters during the period August, 2005 to June, 2006 at 3 sites on Jordan Creek.

site	DO (mg/L)	Cond (µS/cm)	pH	Turb (NTU)	TSS (mg/L)
JC-A	10.2 (1.3)	0.091 (0.027)	6.3 (0.6)	1.0 (0.9)	0.8 (1.2)
JC-B	12.2 (2.1)	0.067 (0.019)	6.4 (0.6)	3.6 (1.8)	4.3 (4.2)
JC-C	12.3 (2.5)	0.071 (0.018)	6.5 (0.8)	6.6 (5.3)	8.9 (9.5)

Values for pH varied mostly between 6.0 and 7.0 during the study period, which is generally consistent with values from the previous years (Figure 6). pH values showed no seasonal signal and average values were similar at the three sites (Table 2). On three events we examined the diel variation at JC-A by sampling every 4 hours for every 24 hours, and we found no clear diel signal, indicating that sampling at any time of day is probably representative of stream conditions. Many pH measurements showed values of <6.5, the state water quality standard for the growth and propogation of fish, shellfish, and other aquatic life. A few particularly low values were recorded in the winter (January and February) on cold snowy days, which may be a result of meter malfunctioning in the cold weather or of conditions being dominated by a combination of direct snow influence and groundwater contributions to the stream. Lower pH values are likely caused by iron-rich groundwater intrusion, which becomes the dominant source of water during cold and dry climatic periods. The oxidation of reduced species prevalent in anaerobic groundwater produces significant acidity as a side-product. Values for pH tended to be lowest at JC-A, which is the uppermost site heavily influenced by groundwater input.

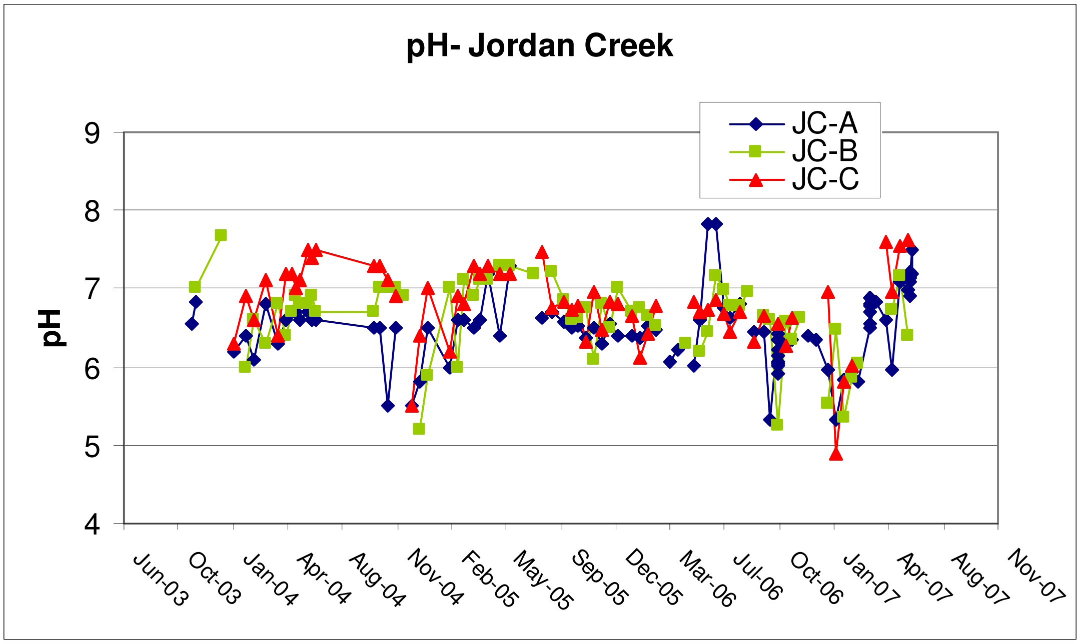

Figure 6. *pH values at the 3 sampling sties on Jordan Creek. Graph includes data from year prior study years.*

b) Interstitial dissolved oxygen
In an effort to evaluate the dissolved oxygen conditions in the Jordan Creek hyporheic zone, at depths at which fish eggs incubate and are used by macroinvertebrates that require oxygenated water, we installed 10 interstitial DO samplers in upper Jordan Creek. Pipes were spaced approximately evenly along in the 1 km reach above site JC-A. K Koski (of the Nature Conservancy), an aquatic ecologist who has been heavily involved in Jordan and Duck Creek research, participated in 2 site visits to provide expertise on locating salmon spawning sites into which we installed the pipes. Pipes were constructed of 1 inch diameter x 4 foot long PVC pipes that were slotted between 6-12 inches below the surface water- streambed boundary.

We measured the dissolved oxygen on 18 occasions between 5/15/06 and 10/16/06 by lowering a calibrated D.O. probe into the standpipe and taking 3 readings of dissolved oxygen, and taking another triplicate reading of the adjacent surface water dissolved oxygen for comparative. Results are presented in Table 3 below (for July 20 on; earlier data are in the in the FY06 report (Nagorski et al., 2006)), which shows that interstitial dissolved oxygen levels were typically in the range of 40-70% saturation (5-9 mg/L). Alaska water quality standards state that in no case may DO be less than 5 mg/L to a depth of 20 cm in interstitial waters of gravel used by anadromous or resident fish for spawning. Based on our results, the water quality standards were met on 73 of 82 measurements of interstitial D.O. This is consistent with the results from earlier in the summer of 2006, when 81 of 89 mesaurements in the same standpipes complied with water quality standards. The violations from July-October occurred in 4 of the 10 pipes on up to 3 of their 9 measurements; however, most of those violations were slight. The lowest values measured were 3.7 mg/L on two occasions in Pipe #6.

Table 3. Interstitial DO in 10 standpipes at 6 inches below the streambed of upper Jordan Creek. Values highlighted in yellow are those than fell below the water quality standard of 5 mg/L. N/A values are from pipes that were no longer present later in the summer (unknown fate).

	7/20/06	8/6/06	8/26/06	9/3/06	9/10/06	9/17/06	9/24/06	10/1/06	10/16/06
(% saturation)									
Pipe 1	55.4	57.2	54.4	54.1	73.4	67.0	79.2	68.1	82.1
Pipe 2	58.2	59.4	49.8	49.5	66.8	61.9	68.7	59.4	77.0
Pipe 3	49.8	44.5	51.4	57.1	76.6	58.5	55.3	34.7	60.0
Pipe 4	44.2	37.2	43.3	35.2	56.0	49.3	41.7	49.6	N/A
Pipe 5	47.8	71.8	54.1	56.4	66.2	55.6	50.1	52.0	67.7
Pipe 6	72.7	58.5	30.4	30.4	67.9	58.7	73.1	50.7	40.5
Pipe 7	39.0	46.7	61.0	42.6	55.8	54.2	67.5	58.5	N/A
Pipe 8	52.1	51.8	56.5	N/A	N/A	N/A	N/A	N/A	N/A
Pipe 9	53.6	48.7	42.6	43.5	58.6	55.4	65.6	42.4	79.4
Pipe 10	44.4	38.7	47.3	35.3	43.5	34.4	54.9	51.1	47.5
(mg/L)									
Pipe 1	6.8	7.0	6.7	6.6	9.1	8.3	9.8	8.4	10.2
Pipe 2	7.1	7.3	6.0	5.8	7.9	7.5	8.2	7.1	9.4
Pipe 3	6.2	5.6	6.2	6.8	9.3	7.1	6.7	4.2	7.3
Pipe 4	5.5	4.7	5.3	4.4	6.8	6.1	5.2	6.2	N/A
Pipe 5	6.1	9.0	6.8	6.7	7.9	6.7	6.0	6.2	8.3
Pipe 6	8.8	7.2	3.7	3.7	8.1	7.1	8.8	6.1	4.9
Pipe 7	5.0	5.9	7.3	5.2	6.9	6.7	8.3	7.2	N/A
Pipe 8	6.5	6.4	7.1	N/A	N/A	N/A	N/A	N/A	N/A
Pipe 9	6.8	6.0	5.3	5.2	7.1	6.7	7.9	5.1	9.7
Pipe 10	5.6	4.9	5.6	4.2	5.2	4.1	6.5	6.1	5.7

Dissolved iron

Levels of dissolved iron found in samples from the three Jordan Creek sites are presented in Figure 7. The data indicate higher levels at the JCB and JCC relative to those at JCA during most of the year. The elevated dissolved iron levels at JCB and JCC are likely due to changes imposed upon the stream corridor in order to accommodate development in those areas. The new stream paths tend to cut into anaerobic groundwater sources, thus allowing water that is rich in reduced iron to mix with the aerobic stream water. On a seasonal basis all three of the sites show higher dissolved iron levels for the months August through February. After February, levels decrease and generally remain low through June. Discharge records indicate water levels in Jordan Creek are usually lowest during the months of May and June. At site JCA, samples were collected every 3-4 hours for a 24 hour period to check for diurnal-noctural variations. During the October 2006 diel sampling event, Fe concentrations showed no detectable variation. However, during the March 2007 24- hour sampling event, Fe concentrations spanned the range of all concentrations found during the rest of the study year. This finding indicates that small-scale monthly and seasonal trends are probably not detectable in light of the high degree of daily variation. Daily variation may result from short-term changes in groundwater input vs surface runoff during rains, or from slight photosynthetically-driven variations in the reduction-oxidation potential in the water that may transfer particulate iron into dissolved iron and vice versa. Results from the June 2007 diurnal-noctural sampling event are not yet available *(an updated report will be submitted to DEC when those are done).*

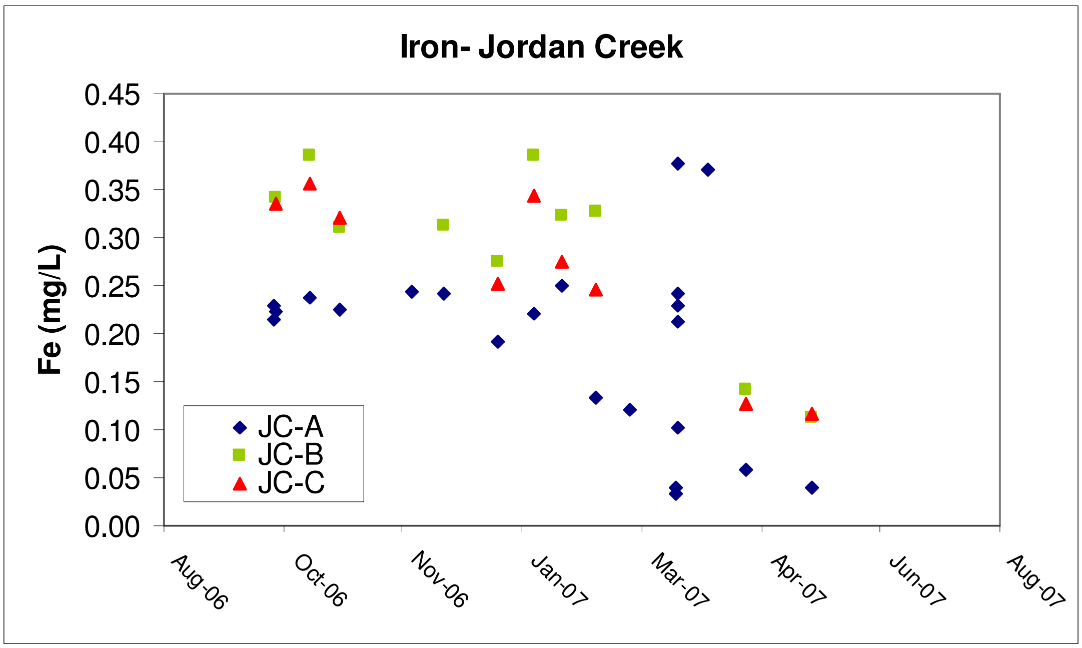

Figure 7. *Dissolved iron in Jordan Creek between October 2006-May 2007*

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 Jordan Creek, water clarity is generally quite high and well within water quality standards for the state of Alaska. Average turbidity at the sample sites ranged from 1.0 to 6.6 NTU, which are well below levels of water quality concern. Turbidity generally increased moving downstream on Jordan Creek. Turbidity also tended to be more flashy at JC-C than at the other 2 sites, possibly due to the influence of the Egan Drive crossing immediately upstream of the sampling site (Figure 8). 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 periods of intense rainfall and high discharge. These results do however show that Jordan Creek does not have chronic problems with high turbidity.

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. Similar to the trends in turbidity, values for TSS were relatively low (average 0.8-8.9 mg/L at the three sites) on Jordan Creek (Table 2) and consistently about 50% of TSS values measured on Duck Creek. Still TSS values measured at Jordan Creek—particularly at JC-C—had several values that were higher than the high values of previous study years (Figure 9). Both turbidity and TSS were highest during the fall, when large rain events were more common and likely resulted in greater influxes of adjacent sediment and other particles into the stream.

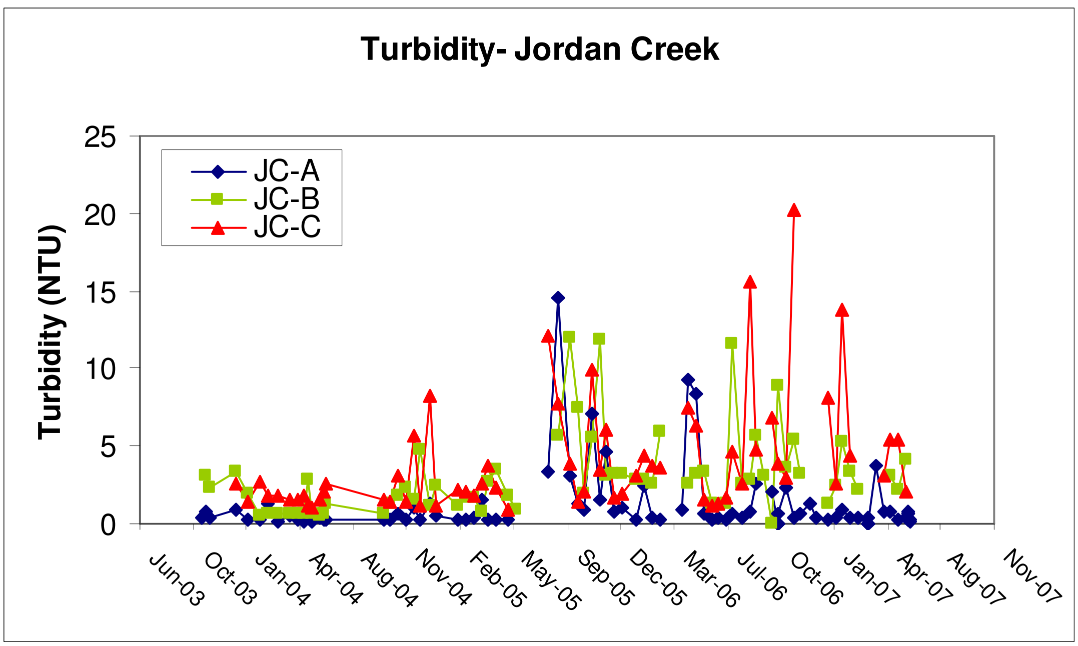

Figure 8. *Turbidity (NTU) at the three Jordan Creek sites.*

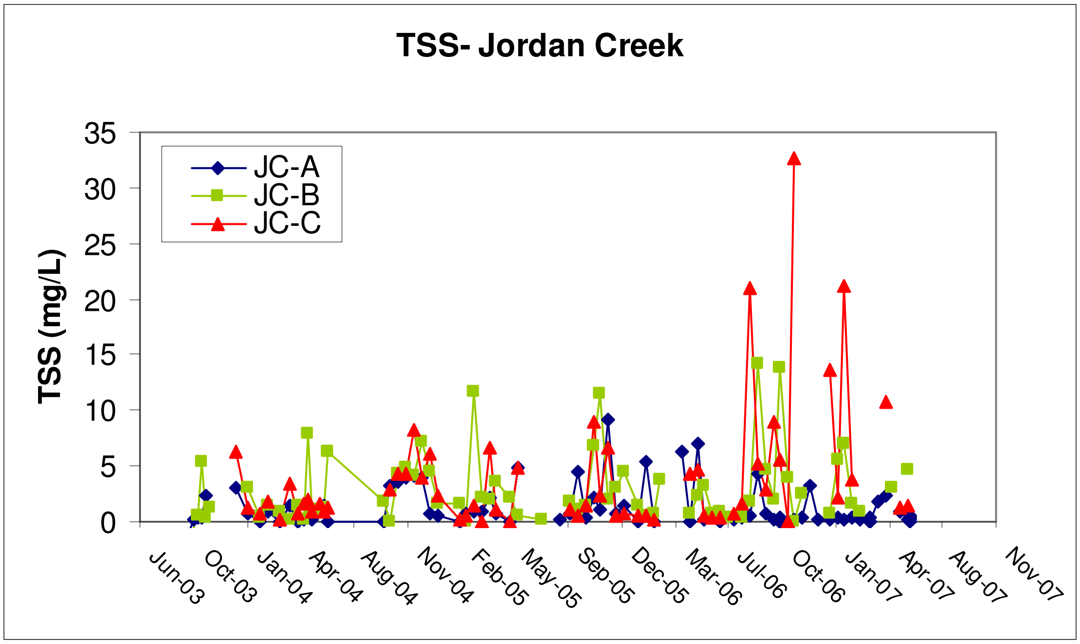

Figure 9. *Total suspended solids (TSS, in mg/L) at the 3 Jordan Creek sites.*

d) Water temperature

Water temperature in Jordan Creek shows strong seasonal variation, despite the flashy (event-controlled) discharge patterns on the stream. Figure 10 shows the temperature at the 3 Jordan Creek sites. Comparison of water temperature at the three locations along Jordan Creek indicates that upstream site JC-A has generally lower summertime and warmer wintertime temperatures than does JC-B (Table 2),which is further indication of the groundwater upwelling at the sites because groundwater maintains a more stable temperature than does surface water. No exceedences of the Alaska water quality standard for spawning and incubation areas (13 ºC) (DEC, 2006).occurred during this study year, although they have been documented in the past.

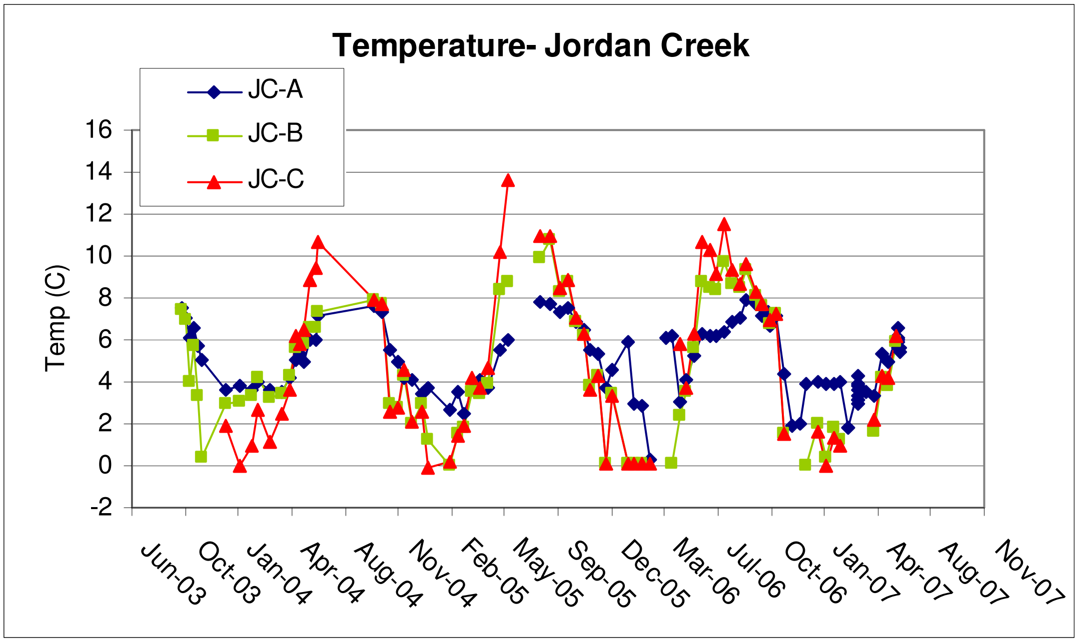

Figure 10*: Water temperature at the three sampling locations on Jordan Creek. Data shown include data collected in previous study years..*

e) Anions and cations

The extent to which the application of salts on roads in the Mendenhall valley may be affecting water quality was evaluated by examination of dissolved ion data. Road salts used in the City and Borough of Juneau include NaCl, and $MgCl_2$; therefore Cl, Na, and Mg concentrations should be good indications of the salting. While increases in ionic concentrations are evident at JC-B and JC-C in the spring, concentrations are low (mostly <4 mg/L) and far below levels of concern (Figures 11-13). However, Cl and Na levels spiked on 2 events to levels (up to 24 mg/L Cl), but these levels are still below water quality standards. The 2 events with relatively high Cl and Na were on 2/4/07 and 5/19/07. Both events could easily be attributed to road salt runoff, even in mid-May, as the heavy snow year led to large snow banks in the Mendenhall Valley that were still melting out well into May. The US Environmental Protection Agency sets the secondary maximum contamination level for chloride at 250 mg/L, the chronic freshwater criterion at 230 mg/L, and the acute freshwater criterion is 860 mg/L (EPA, 2006). Although the levels found were far from exceeding EPA standards, they do indicate that road runoff is reaching the creek and other contaminants associated with road runoff not analyzed as part of this study are likely also entering Jordan Creek at unknown concentrations.

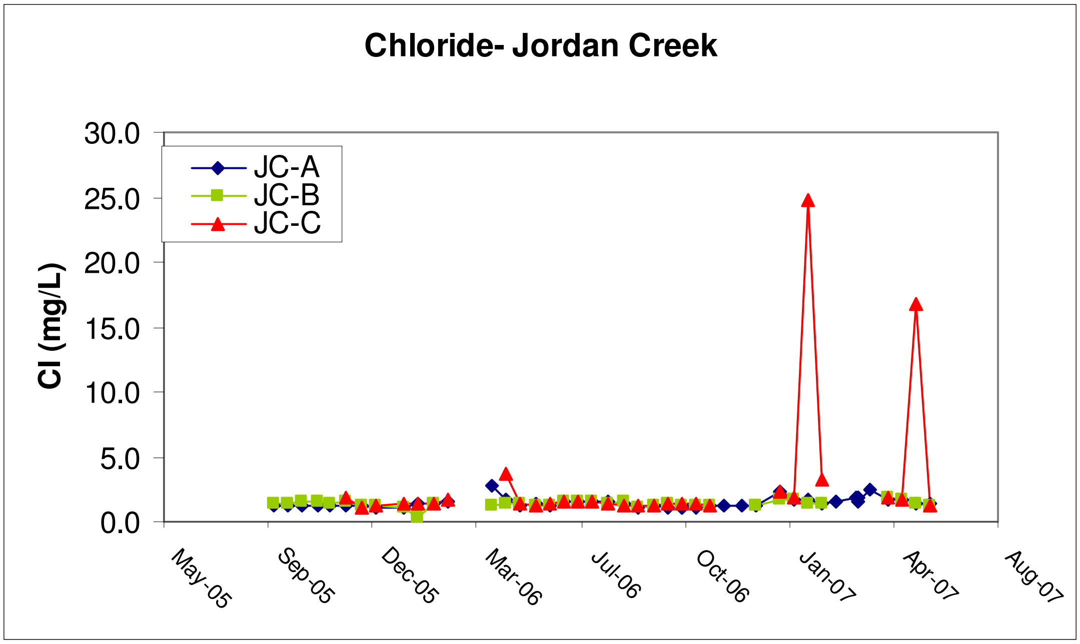

Figure 11. *Chloride concentrations in Jordan Creek August 2006-June 2007 (FY 06 and FY07).*

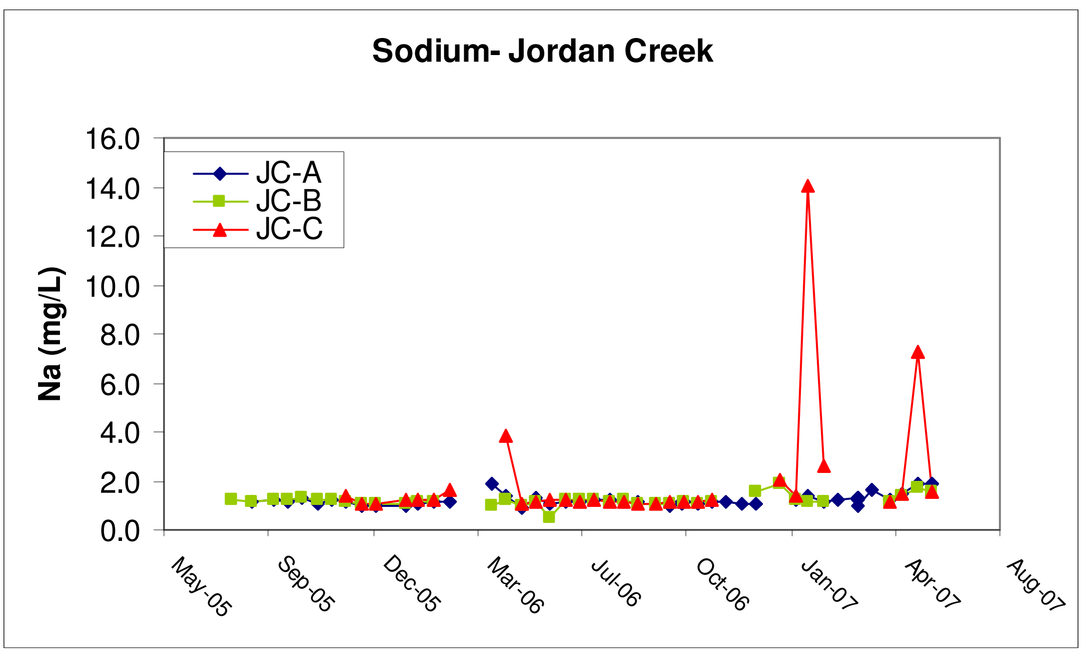

Figure 12. *Sodium concentrations in Jordan Creek in FY06 and FY07.*

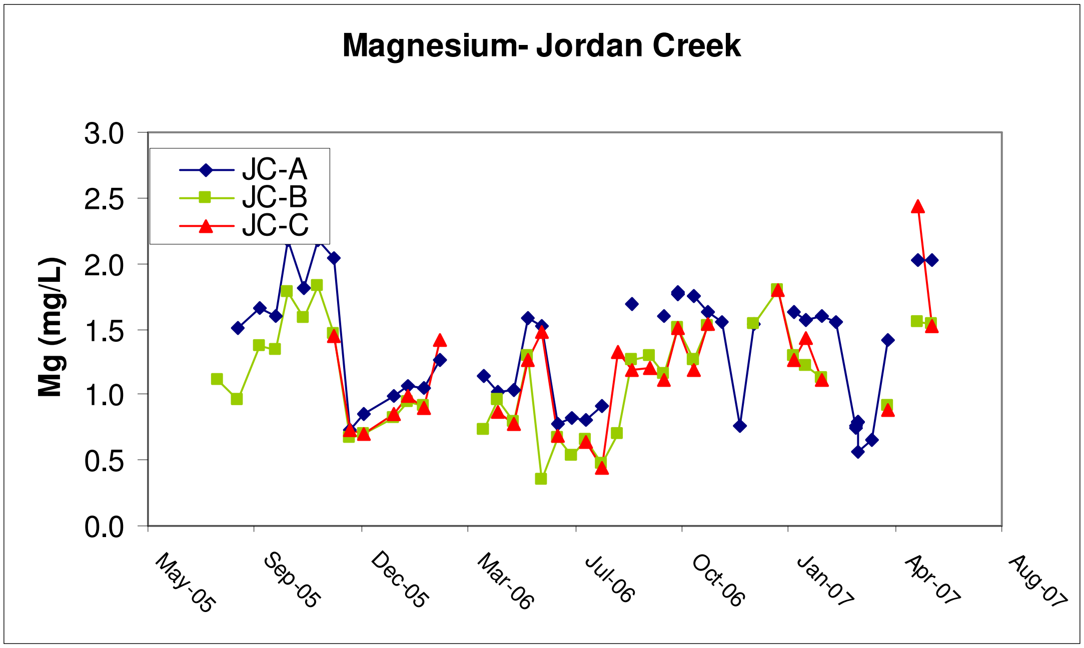

Figure 13. *Magnesium concentrations in Jordan Creek in FY06 and FY07.*

Other anions and cations measured indicated that fluoride concentrations in Jordan Creek are <0.2 mg/L; nitrate concentrations are 0.1-0.7 mg/L; sulfate concentrations were consistently between 3-8 mg/L; ammonium concentrations were <0.2 mg/L; potassium was consistently between 1.0-2.6 mg/L; magnesium levels were between 0.4-2.4 mg/L; and calcium was between 9-22 mg/L.

f) Fecal coliform

We collected fecal coliform samples on 6 occasions in Jordan Creek. Analytica Laboratories (Juneau, Alaska) provided the sample bottles and conducted the lab analyses.

Results show that most samples in Jordan Creek fell below the limits provided by the Alaska DEC water quality standards, but on 3 of the 6 occasions, one or two of the sample sites exceeded one of the standards for fecal coliform. There are several levels of standards for fecal coliform, ranging from drinking water standards to aquacultural, industrial, and recreational contact (Table 3). Drinking water standards, the most stringent at 20 FCU/100 mL was violated in Jordan Creek on the following dates: at JC-B and JC-C on 10/19/2006, at JC-C on 4/9/07, and at JC-B on 6/29/07. No violations for other types of uses were found, indicating a low level of fecal coliform concern in Jordan Creek.

Table 3. *Excerpt from State of Alaska Department of Environmental Conservation list of water quality standards.*

(2) FECAL COLIFORM BACTERIA (FC), FOR FRESH WATER USES (See note 1)	
(A) Water Supply (i) drinking, culinary, and food processing	In a 30-day period, the geometric mean may not exceed 20 FC/100 ml, and not more than 10% of the samples may exceed 40 FC/100 ml. For groundwater, the FC concentration must be less than 1 FC/100 ml, using the fecal coliform Membrane Filter Technique, or less than 3 FC/100 ml, using the fecal coliform most probable number (MPN) technique.
(A) Water Supply (ii) agriculture, including irrigation and stock watering	The geometric mean of samples taken in a 30-day period may not exceed 200 FC/100 ml, and not more than 10% of the samples may exceed 400 FC/100 ml. For products not normally cooked and for dairy sanitation of unpasteurized products, the criteria for drinking water supply, (2)(A)(i), apply.
(A) Water Supply (iii) aquaculture	For products normally cooked, the geometric mean of samples taken in a 30-day period may not exceed 200 FC/100 ml, and not more than 10% of the samples may exceed 400 FC/100 ml. For products not normally cooked, the criteria for drinking water supply, (2)(A)(i), apply.
(A) Water Supply (iv) industrial	Where worker contact is present, the geometric mean of samples taken in a 30-day period may not exceed 200 FC/100 ml, and not more than 10% of the samples may exceed 400 FC/100 ml.
(B) Water Recreation (i) contact recreation	In a 30-day period, the geometric mean of samples may not exceed 100 FC/100 ml, and not more than one sample, or more than 10% of the samples if there are more than 10 samples, may exceed 200 FC/100 ml.
(B) Water Recreation (ii) secondary recreation	In a 30-day period, the geometric mean of samples may not exceed 200 FC/100 ml, and not more than 10% of the total samples may exceed 400 FC/100 ml.
(C) Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife	Not applicable.

Table 4. *Fecal coliform data results for Jordan Creek in FY07*

Date	Site	Fecal Coliform (CFU/100mL)
10/19/2006	JC-A	18.3
10/19/2006	JC-B	46.7
10/19/2006	JC-C	82.0
4/9/2007	JC-A	8.33
4/9/2007	JC-B	<2.0
4/9/2007	JC-C	42.0
4/24/2007	JC-A	5.00
4/24/2007	JC-B	3.00
4/24/2007	JC-C	6.00
5/31/2007	JC-A	6.00
5/31/2007	JC-B	4.00
5/31/2007	JC-C	ND
6/12/2007	JC-A	6.00

6/12/2007	JC-B	6.67
6/12/2007	JC-C	6.67
6/29/2007	JC-A	4.00
6/29/2007	JC-B	96
6/29/2007	JC-C	4.00

Summary and conclusions

Streamflow on Jordan Creek in 2006-2007 appeared to be generally in the range of average flows in previous years, although our occasional measurements cannot compare adequately to historic data that were supported by 15-min increment measurements by the former USGS gaging station on the stream. A record-breaking snowfall in the winter of 2006-2007 resulted in dry, snow-filled channels along many segments of Jordan Creek throughout much of the winter. Otherwise, Jordan Creek flow continued to be flashy and responding and recovering quickly to storm events that are difficult to capture on bimonthly systematic sampling designs.

The water quality of Jordan Creek in 2006-2007 was in most respects similar to that of previous years, with some small differences, and generally considerably better than water quality in neighboring Duck Creek. Dissolved oxygen (D.O.) levels in Jordan Creek surface water conformed to water quality standards on all sampling occasions (not the case in 2005-2006), and D.O. levels in interstitial water in the upstream reaches were acceptable for 73 of 82 measurements between July and October, 2006. Conductivity values were similar to those of previous years, but pH values were generally lower than in previous years, often dipping below the state water quality standard for the growth and propogation of fish, shellfish, and other aquatic life. Dissolved iron levels showed no seasonal trend and relatively high variability on one of the 24-hour sampling events when samples were taken every 4 hours, indicating complex diurnal-nocturnal fluctuations in dissolved iron levels. Turbidity values in Jordan Creek were well within the water quality standards, and total suspended solids values in the creek were typically about half of those in neighboring Duck Creek. Water temperature was good, with no exceedences of state water quality standards (unlike in previous years). Anion and cation data appear to show influx of road salts into Jordan Creek in the springtime. While no water quality standards were violated for chloride (associated with the sodium and/or magnesium chloride in the road salt), the detection of road salt impacts in the stream may indicate that other road runoff contaminants may be entering the stream as well. Fecal coliform samples, collected on 6 occasions during the study period, show that most samples in Jordan Creek fell below all the limits provided by the Alaska DEC water quality standards. However, on 3 of the 6 occasions, one or two of the sample sites exceeded (reaching up to 96 FCU/100mL) the strictest of the several standards for fecal coliform (that is for drinking water, which has a limit of 20 CFU/100mL).

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Appendix A. Water quality data collected on Jordan Creek during the period July 2006 – August, 2007.

Date	Time	Site	DO %	DO mg/L	Temp ˚C	Cond [a]	pH	Turb (ntu)	TSS mg/L	Q (cfs)
7/13/2006	11:52	JC-A	81.7	10.1	6.4	0.11	6.6	0.60	0.20	
7/28/2006	12:11	JC-A	77.5	9.5	6.8	0.11	6.8	0.44	0.29	
8/12/2006	11:37	JC-A	75.5	9.2	7.1	0.13		0.71	0.50	
8/25/2006	11:25	JC-A	73.3	8.7	8.0	0.12	6.5	2.55	4.33	
9/10/2006	11:57	JC-A	68.3	8.1	7.7	0.12	6.4		0.78	
9/24/2006	10:56	JC-A	72.2	8.7	7.2	0.11	5.3	2.05	0.19	
10/6/2006	12:10	JC-A	77.4	9.3	7.1	0.11	6.4	NA	NA	
10/6/2006	15:00	JC-A	77.5		7.3	0.11	6.3	NA	NA	
10/6/2006	18:00	JC-A	62.8	7.6	7.2	0.11	6.3	NA	NA	
10/6/2006	21:00	JC-A	41.9		7.0	0.11	6.2	NA	NA	
10/6/2006	23:55	JC-A	75.1	9.1	6.9	0.11	6.1	NA	NA	
10/7/2006	3:20	JC-A	75.0	9.1	6.9	0.11	6.0	NA	NA	
10/7/2006	6:30	JC-A	69.6	8.5	6.8	0.11	6.1	NA	NA	
10/7/2006	9:30	JC-A	75.5	9.3	6.7	0.11	5.9	NA	NA	
10/7/2006	12:00	JC-A	73.4	9.0	6.8	0.11	6.0	0.64	0.38	
10/21/2006	11:50	JC-A	71.3	8.6	7.1	0.11	6.3	2.31	NA	
11/3/2006	9:45	JC-A	76.8	9.9	4.4	0.07	6.3	0.45	0.20	
11/17/2006	12:05	JC-A	76.8	10.6	1.9	0.06		0.64	0.29	
12/3/2006	10:25	JC-A	80.5	11.1	2.0	0.06	6.4	1.34	3.24	
12/16/2006	10:29	JC-A	79.3	10.4	3.9	0.06	6.3	0.42	0.20	
1/8/2007		JC-A	72.0	9.4	4.0	0.08	6.0	0.27	0.21	
1/23/2007	11:38	JC-A	81.3	10.7	3.9	0.07	5.3	0.33	0.29	
2/4/2007	13:06	JC-A	80.4	10.5	3.9	0.07	5.8	0.86	0.10	
2/18/2007	10:52	JC-A	96.1	12.6	4.0	0.07	5.9	0.43	0.30	
3/4/2007	11:00	JC-A	90.7	12.6	1.8	0.06	5.8	0.38	0.20	
3/23/2007	18:00	JC-A	83.4	11.0	3.6	0.05	6.5	NA	NA	
3/23/2007	22:00	JC-A	52.8	7.1	3.1	0.07	6.9	NA	NA	
3/24/2007	2:00	JC-A	72.7	9.8	3.1	0.07	6.8	NA	NA	
3/24/2007	6:00	JC-A	71.7	9.0	3.0	0.04	6.9	NA	NA	
3/24/2007	10:00	JC-A	72.6	9.5	3.3	0.07	6.9	NA	NA	
3/24/2007	12:15	JC-A	78.7	10.4	3.8	0.05	6.8	0.42	0.30	
3/24/2007	14:00	JC-A	76.5	10.0	3.9		6.7	NA	NA	
3/24/2007	18:00	JC-A	80.7	10.5	4.3	0.03	6.6	NA	NA	
4/6/2007	10:25	JC-A	76.6	10.2	3.5	0.06	6.8	3.80	1.77	
4/22/2007	11:48	JC-A	94.9	12.6	3.4	0.11	6.6	0.71	2.30	
5/5/2007	12:45	JC-A	74.1	9.4	5.3	0.07	6.0	0.82		
5/19/2007	11:33	JC-A	90.9	11.6	4.9	0.11	7.1	0.27	0.87	
6/2/2007	11:25	JC-A	89.6	11.1	6.1	0.09	7.0	0.37	0.19	
6/7/2007	8:00	JC-A	83.8	10.3	5.9	0.15	7.2	0.585	0	
6/7/2007	12:00	JC-A	91.1	11.3	6.1	0.13	6.9	0.605	0.39	
6/7/2007	16:00	JC-A	92.3	11.3	6.6	0.15	7.1	0.27	0.58	
6/7/2007	20:00	JC-A	87.1	10.8	6.0	0.15	7.1	0.795	0.38	
6/7/2007	23:50	JC-A	81.5	10.2	5.6	0.15	7.2	0.315	0.19	
6/8/2007	4:00	JC-A	83.6	10.5	5.4	0.16	7.5	0.3	<BDL	
6/8/2007	8:00	JC-A	77.5	9.8	5.6	0.16	7.2	0.155	<BDL	

7/13/2006	10:15	JC-B	90.7	10.3	9.7	0.09	6.8	2.61	0.29	2.6
7/28/2006	10:45	JC-B	90.3	10.5	8.7	0.08	7.0	2.87	1.84	9.0
8/12/2006	10:12	JC-B	60.3	6.9	8.4	0.06		2.74	14.24	19.2
8/25/2006	10:15	JC-B	85.5	9.7	9.4	0.09	6.7	3.13	4.70	18.6
9/10/2006	9:51	JC-B	78.8	9.3	8.1	0.09	6.6	NA	2.00	19.6
9/24/2006	10:02	JC-B	90.7	10.8	7.7	0.07	5.3	8.89	13.75	NA
10/7/2006	11:00	JC-B	87.4	10.7	6.8	0.09	6.6	3.59	3.94	10.35
10/21/2006	10:00	JC-B	86.8	10.5	7.2	0.07	6.3	5.35	NA	34.54
11/3/2006	9:08	JC-B	96.0	13.4	1.6	0.05	6.6	3.27	2.60	NA
11/17/2006		JC-B	no flow							No flow
12/3/2006		JC-B	no flow							No flow
12/16/2006	9:10	JC-B	100.1	14.6	0.0	0.05	5.5	1.30	0.78	0.85
1/8/2007	11:00	JC-B	95.5	13.2	2.0	0.06	6.5	2.47	5.51	NA
1/23/2007	9:12	JC-B	98.8	14.2	0.4	0.05	5.3	5.31	7.07	8.65
2/4/2007	10:45	JC-B	104.6	14.5	1.8	0.05	5.9	3.29	1.67	4.73
2/18/2007	10:03	JC-B	119.5	16.8	1.2	0.04	6.0	2.16	0.97	5.58
3/4/2007		JC-B	no flow							
3/24/2007		JC-B	no flow							
4/6/2007		JC-B	no flow							
4/22/2007	10:00	JC-B	102.3	14.3	1.6	0.04	6.7	3.04	3.01	14.53
5/5/2007	11:55	JC-B	89.1	11.6	4.2	0.05	7.2	2.14		NA
5/19/2007	9:39	JC-B	96.7	12.7	3.8	0.08	6.4	4.16	4.66	13.27
6/2/2007	9:30	JC-B	96.3	11.9	5.9	0.08	7.4	2.16	1.83	12.70
7/13/2006	9:56	JC-C	90.6	9.9	11.5	0.09	6.5	4.64	0.69	
7/28/2006	10:09	JC-C	96.2	11.0	9.3	0.08	6.7	2.64	1.67	
8/12/2006	10:34	JC-C	87.7	10.2	8.7	0.10		15.6	20.98	
8/25/2006	9:51	JC-C	89.3	10.2	9.7	0.08	6.3	4.82	5.29	
9/10/2006	9:58	JC-C	79.8	9.4	8.3	0.08	6.7		2.91	
9/24/2006	9:40	JC-C	91.6	10.9	7.8	0.07		6.77	9.00	
10/7/2006	10:10	JC-C	90.0	10.9	6.9	0.09	6.6	3.83	5.58	
10/21/2006	9:46	JC-C	88.5	10.7	7.3	0.07	6.3	2.96	NA	
11/3/2006	9:08	JC-C	96.0	13.4	1.6	0.05	6.6	20.25	32.59	
11/17/2006		JC-C	no flow							
12/3/2006		JC-C	no flow							
12/16/2006		JC-C	no flow							
1/8/2007	10:45	JC-C	no flow		1.6	0.06	7.0	8.06	13.70	
1/23/2007	8:45	JC-C	108.6	15.8	0.0	0.05	4.9	2.525	2.12	
2/4/2007	10:30	JC-C	107.5	15.1	1.3	0.09	5.8	13.8	21.25	
2/18/2007	9:45	JC-C	122.8	17.4	1.0	0.04	6.0	4.43	3.83	
3/4/2007		JC-C	no flow							
3/24/2007		JC-C	no flow							
4/6/2007		JC-C	no flow							
4/22/2007	9:36	JC-C	104.9	14.5	2.2		7.6	3.05	10.77	
5/5/2007	11:45	JC-C	91.3		4.3	0.05	7.0	5.35		
5/19/2007	9:25	JC-C	97.1	12.6	4.2		7.6	5.4	1.25	
6/2/2007	8:55	JC-C	98.6	12.1	6.2		7.6	2.125	1.48	

Appendix B. Water quality data collected on Jordan Creek during the period July 2006 – July, 2007. Anions and cation data.

Date	Site	F	Cl	nitrate	SO4	Na	K	Mg	Ca	Fe
7/13/2006	JC-A	0.1	1.6	0.45	7.05	1.19	1.28	0.81	14.47	
7/28/2006	JC-A	0.1	1.5	0.49	6.98	1.19	1.37	0.91	14.25	
8/12/2006	JC-A	0.1	1.4	0.56	7.44					
8/25/2006	JC-A	0.1	1.1	0.47	7.00	1.15	1.97	1.70	19.13	
9/10/2006	JC-A	0.1	1.2	0.20	4.95					
9/24/2006	JC-A	0.1	1.1	0.37	5.60	0.99	2.01	1.59	17.27	
10/6/2006	JC-A									
10/6/2006	JC-A	0.1	1.2	0.43	6.39	1.18	2.19	1.76	15.58	0.21
10/6/2006	JC-A									
10/6/2006	JC-A	0.1	1.1	0.43	6.42	1.10	2.13	1.76	17.26	0.23
10/6/2006	JC-A									
10/7/2006	JC-A	0.1	1.1	0.43	6.43	1.11	2.13	1.79	19.07	0.22
10/7/2006	JC-A									
10/7/2006	JC-A									
10/7/2006	JC-A									
10/21/2006	JC-A	0.1	1.1	0.46	6.18	1.06	2.12	1.76	18.88	0.24
11/3/2006	JC-A	0.1	1.2	0.47	6.62	1.15	1.90	1.63	18.53	0.23
11/17/2006	JC-A	0.1	1.2	0.39	6.96	1.16	1.51	1.55	15.27	
12/3/2006	JC-A	0.2	1.2	0.42	6.93	1.03	1.10	0.76	8.03	0.24
12/16/2006	JC-A	0.1	1.2	0.46	6.78	1.10	1.29	1.53	15.18	0.24
1/8/2007	JC-A	0.2	2.2	0.50	4.12					0.19
1/23/2007	JC-A	0.1	1.6	0.56	6.54	1.24	1.61	1.64	17.30	0.22
2/4/2007	JC-A	0.1	1.8	0.52	6.49	1.39	1.44	1.56	15.66	0.25
2/18/2007	JC-A	0.1	1.4	0.52	6.55	1.13	1.37	1.61	15.44	0.13
3/4/2007	JC-A	0.1	1.5	0.51	6.47	1.19	1.25	1.56	14.70	0.12
3/23/2007	JC-A	0.1	1.8	0.27	4.51	1.27	0.79	0.75	10.79	0.04
3/23/2007	JC-A	0.1	1.8	0.28	4.49	1.24	0.82	0.76	10.85	0.03
3/24/2007	JC-A	0.1	1.8	0.29	4.89	1.25	0.84	0.79	11.33	0.10
3/24/2007	JC-A	0.1	1.8	0.29	4.58	1.27	0.83	0.79	11.29	0.21
3/24/2007	JC-A	0.1	1.8	0.28	4.72	1.27	0.83	0.79	11.22	0.38
3/24/2007	JC-A	0.1	1.8	0.27	4.73	1.29	0.82	0.79	11.20	
3/24/2007	JC-A	0.1	1.8	0.27	4.73	1.29	0.82	0.79	11.20	0.23
3/24/2007	JC-A	0.1	1.6	0.21	3.59	0.99	0.62	0.56	8.47	0.24
4/6/2007	JC-A	0.1	2.4	0.17	3.97	1.60	0.67	0.66	8.64	0.37
4/22/2007	JC-A	0.1	1.7	0.80	6.48	1.19	1.75	1.42	17.73	0.06
5/5/2007	JC-A	0.0	1.7	0.86	7.19	1.47	2.02		18.34	
5/19/2007	JC-A	0.2	1.4	0.87	7.33	1.85	2.50	2.02	17.61	0.04
6/2/2007	JC-A	0.2	1.3	0.83	6.93	1.86	2.55	2.02	19.40	
6/7/2007	JC-A									
6/7/2007	JC-A									
6/7/2007	JC-A									
6/7/2007	JC-A									
6/7/2007	JC-A									
6/8/2007	JC-A									
6/8/2007	JC-A									

7/13/2006	JC-B	0.15	1.52	0.19	5.58	1.22	0.64	0.66	12.73	
7/28/2006	JC-B	0.15	1.44	0.15	5.38	1.18	0.54	0.47	11.14	
8/12/2006	JC-B	0.15	1.47	0.26	6.25	1.21	1.00	0.70	13.51	
8/25/2006	JC-B	0.10	1.13	0.21	5.57	1.09	1.01	1.27	13.07	
9/10/2006	JC-B	0.10	1.20	0.20	4.95	1.07	1.17	1.29	12.98	
9/24/2006	JC-B	0.10	1.39	0.15	4.02	1.07	1.22	1.15	10.65	
10/7/2006	JC-B	0.10	1.27	0.25	5.41	1.13	1.41	1.51	12.74	0.34
10/21/2006	JC-B	0.10	1.30	0.19	4.39	1.04	1.17	1.26	11.82	0.39
11/3/2006	JC-B	0.10	1.21	0.32	6.12	1.18	1.34	1.52	15.49	0.31
11/17/2006	JC-B	No flow								
12/3/2006	JC-B	No flow								
12/16/2006	JC-B	0.15	1.27	0.27	5.47	1.52	1.02	1.54	10.12	0.31
1/8/2007	JC-B	0.14	1.62	0.25	2.95	1.87	1.61	1.80	12.98	0.27
1/23/2007	JC-B	0.11	1.64	0.29	5.01	1.21	0.90	1.29	12.40	0.39
2/4/2007	JC-B	0.11	1.44	0.25	5.08	1.15	0.80	1.22	11.26	0.32
2/18/2007	JC-B	0.11	1.46	0.21	4.28	1.15	0.69	1.13	9.86	0.33
3/4/2007	JC-B	No flow								
3/24/2007	JC-B	No flow								
4/6/2007	JC-B	No flow								
4/22/2007	JC-B	0.10	1.81	0.33	4.75	1.16	0.79	0.92	10.79	0.14
5/5/2007	JC-B	0.05	1.66	0.41	5.71	1.41	1.05		13.57	
5/19/2007	JC-B	0.16	1.42	0.48	6.44	1.71	1.41	1.56	15.25	0.11
6/2/2007	JC-B	0.16	1.21	0.45	5.86	1.57	1.38	1.53	15.15	
7/13/2006	JC-C	0.15	1.55	0.18	5.58	1.25	0.71	0.64	12.74	
7/28/2006	JC-C	0.15	1.44	0.14	5.34	1.15	0.56	0.44	10.99	
8/12/2006	JC-C	0.10	1.23	0.25	6.14	1.18	1.07	1.32	14.52	
8/25/2006	JC-C	0.11	1.18	0.20	5.27	1.08	1.00	1.19	12.30	
9/10/2006	JC-C	0.10	1.24	0.20	4.82	1.09	1.15	1.21	12.42	
9/24/2006	JC-C	0.10	1.41	0.15	4.04	1.13	1.24	1.12	10.98	
10/7/2006	JC-C	0.10	1.34	0.24	5.54	1.16	1.42	1.50	14.76	0.34
10/21/2006	JC-C	0.10	1.36	0.20	4.40	1.10	1.20	1.19	11.70	0.36
11/3/2006	JC-C	0.10	1.29	0.31	6.11	1.24	1.36	1.54	15.63	0.32
11/17/2006	JC-C	No flow								
12/3/2006	JC-C	No flow								
12/16/2006	JC-C	No flow								
1/8/2007	JC-C	0.15	2.24	0.35	4.52	2.03	1.60	1.79	12.38	0.25
1/23/2007	JC-C	0.11	1.88	0.28	4.92	1.37	0.90	1.27	12.13	0.34
2/4/2007	JC-C	0.12	24.70	0.23	4.72	14.03	1.12	1.43	10.84	0.28
2/18/2007	JC-C	0.11	3.31	0.19	4.11	2.58	1.00	1.11	9.39	0.24
3/4/2007	JC-C	No flow								
3/24/2007	JC-C	No flow								

4/6/2007	JC-C	No flow								
4/22/2007	JC-C	0.10	1.84	0.32	4.66	1.17	0.76	0.89	10.53	0.13
5/5/2007	JC-C	0.06	1.71	0.41	5.65	1.46	1.08		13.22	
5/19/2007	JC-C	0.21	16.78	0.16	4.79	7.28	3.73	2.44	22.23	0.12
6/2/2007	JC-C	0.16	1.20	0.42	5.77	1.54	1.34	1.52	14.17	