EVALUATION OF THE WATER QUALITY IMPACTS OF THE NOSE CREEK DEFLECTION STRUCTURES

Alberta Environment

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SUMMARY

Alberta Environment (AENV) installed deflection structures (groynes) in the Bow River immediately downstream from Nose Creek in the spring of 2001. The groynes were intended to enhance mixing of the outflow plume from Nose Creek with the Bow River, and thereby reduce the movement of nutrients and other material from Nose Creek to the Western Headworks (WH) Canal, which drains into Chestermere Lake. In the authorization for this project from Fisheries and Oceans Canada, AENV was required to monitor and report on the water quality impacts of this project on the Bow River and the WH Canal during 2001 and 2002.

This report is prepared in response to the monitoring requirements in the DFO authorization. It summarizes the data collected in the monitoring program in 2001, and evaluates whether the deflection structures caused any impact on water quality.

None of the results provide evidence that the deflection structures have caused either a deleterious impact, as indicated by a comparison with water quality guidelines, or statistically significant improvement in water quality in either the WH Canal or the Bow River downstream from the WH Canal diversion. Aside from coliforms, the tested variables rarely exceeded guidelines in the WH Canal at the Max Bell Arena sampling site, where impacts of any Nose Creek plume on water quality would be expected, either before (2000) or after the deflection structures were installed (2001). Differences in sampling location and lower precipitation appear to be the most likely cause of the lower coliform counts that were observed in 2001, compared to 2000, in the WH Canal at the Max Bell Arena site.

These results provide little evidence that a significant portion of the plume from Nose Creek entered the WH Canal during sampling, before or after the installation of the deflection structures. The conditions that favour entry of the plume from Nose Creek into the WH Canal remain poorly understood. Rainfall was well below average in July and August of both 2000 and 2001. The plume from Nose Creek may be more likely to enter the WH Canal during summer storm events with above average rainfall.

Although the concentration of most variables was quite high in Nose Creek, the mass of TP, TSS, and TKN contributed by urban runoff directly to the WH Canal was much greater than the mass of these variables in Nose Creek at the mouth in 2001.

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1.0 INTRODUCTION

Alberta Environment (AENV) installed deflection structures (groynes) in the Bow River immediately downstream from Nose Creek in the spring of 2001. The groynes were intended to enhance mixing of the outflow plume from Nose Creek with the Bow River, and thereby reduce the movement of nutrients and other materials from Nose Creek to the Western Headworks (WH) Canal, which drains into Chestermere Lake (Figure 1).

In the authorization for this project (AB00-519) issued by Fisheries and Oceans Canada (DFO) under the Fisheries Act, AENV was required to monitor and report on the water quality impacts of this project on the Bow River and the WH Canal during 2001 and 2002.

This report is prepared in response to the monitoring requirements in the DFO authorization. It summarizes the data collected in the monitoring program in 2001, and evaluates whether the deflection structures caused an impact on water quality as indicated by water quality guidelines. Results from 2000, before the deflection structures were installed, have been compared to data collected in 2001 following the installation of the deflection structures.

Where feasible, the mass flux of selected constituents was also estimated. Mass flux calculations estimate the total mass of material moving past a site during the period of sampling. These estimates should provide a better indication of the amount of material moving along the WH Canal than comparisons of concentration alone, which fluctuate with flow. These mass flux estimates were used to evaluate the sources of nutrients and other constituents entering the WH Canal. This information can be used to manage water quality in Chestermere Lake.

2.0 METHODS

Grab samples were collected at least fortnightly at all six sites in Figure 1, and water temperature, pH, conductivity and dissolved oxygen were measured on site using Hydrolab meters, with regular verification of dissolved oxygen by Winkler titration. Because conductivity was considerably higher in Nose Creek than in the WH Canal, and easily measured in the field, this variable was routinely measured in the Bow River along the left bank (facing downstream), centre and right bank at Cushing Bridge, to provide an indication of whether a plume from Nose Creek was detectable at that site.

All variables and sites were monitored as specified in the authorization, except that TP was not analysed on grab samples collected in May 2001. Flow was also gauged by AENV in Nose Creek near the mouth, so that mass transport in Nose Creek at the mouth, and along the canal to Chestermere Lake could be estimated. Final flow estimates were also obtained from the Water Survey of Canada for gauging sites on the Bow River at Calgary (05BH004), Elbow River below Glenmore Dam (05BJ001), the WH Canal near the Headgates (05BM015), and the WH Canal at Chestermere (05BM003). These flow estimates were used to estimate mass transport at the sampling sites.

These sites are all affected by urban runoff arising from brief storm events. To capture these storm events, automated ISCO samplers were used to collect daily composite samples for total suspended solids (TSS, as non-filterable residue (NFR)) and total phosphorus (TP) during June 2 to July 15, 2001, which is usually a period of high rainfall. ISCOs were installed at three sites: Nose Creek near the mouth; the WH Canal at the Max Bell Arena (near the intake); and in the WH Canal at Calgary City Limits (at 84 Street)(Figure 1).

The following quality assurance samples were regularly collected during automated sampling: (a) blanks, which consisted of double distilled water treated with reverse osmosis, remained in the sampler throughout the sampling period; (b) grab samples (replicates) near the sampler intake at the time of ISCO sampling; and (c) test of the intake hose to ensure there was no residual contamination. Either true duplicate splits or blanks were also regularly collected at grab sampling sites. All sampling followed field methods described in Alberta Environmental Protection (1993).

To permit numerical analysis, values less than detection limits were replaced by values one-half the detection limit. Data were then compared to the Alberta Surface Water Quality Guidelines (ASWQG) and the Canadian Environmental Quality Guidelines (CEQG) (AENV 1999, CCME 1999 and 2000).

To determine if apparent differences in concentration were statistically significant, or merely natural variation, data were first tested for seasonality using the Kruskal-Wallis Test for Seasonality in the water quality statistics package WQHYDRO (Aroner 2000). Differences in concentration between the WH Canal at Max Bell Arena site, and the Bow River upstream from Nose Creek site were then tested for statistical significance ($\alpha = 0.05$) using the Wilcoxon-Mann-Whitney Test, with a correction for seasonality as required. Results from each site in 2001 were also compared with results in 2000, and concentrations in the Bow River upstream from

Nose Creek were compared with concentrations at Cushing Bridge in 2001. The latter site was not sampled in 2000.

For each site, the mass flux of each variable over the May 14 to September 17, 2001 sampling period was estimated by six different methods using the computer program FLUX 5.1 (Walker, W.W. 1996). The method that produced the lowest coefficient of variation was selected for further analysis and presentation in each case. Different methods were sometimes selected for different variables because these methods varied in their accuracy depending on the relationship between flow and concentration for each variable (Walker, W.W. 1996). Whenever there were sufficient measurements, data were stratified by season or flow to reduce error and bias in the predictions. Estimates with a coefficient of variation < 0.2 were not considered suitable for mass balance analysis (Walker, W.W. 1996).

To evaluate whether urban runoff during the sampling period was typical of the Calgary area, precipitation data were obtained from the City of Calgary weather station at Forest Heights (Station 10) in 2000 and 2001, and compared to long-term precipitation measurements during 1884 – 2000 from the Environment Canada station at the Calgary International Airport.

3.0 RESULTS AND DISCUSSION

Daily precipitation and monthly total precipitation in 2000 and 2001 at Forest Heights, in northeast Calgary, and long-term average rainfall at Calgary International Airport are plotted in Figures 2 and 3.

Results of the 2000 and 2001 water quality sampling program are plotted in Figures 4 to 16. All relevant guidelines for each water quality variable are plotted on the figures. To facilitate comparisons between sites and between years, sample sizes and medians are tabulated in Tables 1 and 2. Mass flux estimates are presented in Table 3, and changes in mass between sites are in Table 4.

3.1 Comparison of Results to Water Quality Guidelines

None of the results collected in this study provide evidence that the deflection structures have caused either a deleterious impact, or significant improvement in water quality, in either the WH Canal or downstream in the Bow River at the Cushing Bridge site. Aside from coliforms, the sampled variables rarely exceeded guidelines in the WH Canal at the Max Bell Arena site, where impacts of any Nose Creek plume on water quality would be expected, either before (2000) or after (2001) the deflection structures were installed (Figures 4 to 16). Furthermore, these variables always complied with water quality guidelines in the Bow River, except for single fecal coliform measurements in 2001 in the Bow River upstream and downstream from the diversion to the WH Canal (Figure 4). As will be discussed in Section 3.2, higher coliform counts in the WH Canal at the Max Bell Arena site in 2000 compared to 2001 probably reflect sampling location and generally higher urban runoff in 2000, rather than beneficial impacts of the deflection structures on mixing of the plume from Nose Creek with the Bow River.

Fecal coliforms and *E. coli* in Nose Creek near the mouth frequently exceeded the CCME guidelines for contact recreation and irrigation, and total phosphorus exceeded the Alberta guideline in both 2000 and 2001 (Figures 4, 5 and 13). Nitrite and ammonia also occasionally exceeded CCME guidelines for the protection of aquatic life at this site, and dissolved oxygen sometimes fell below both the Alberta and CCME guidelines (Figures 6, 11, and 16).

3.2 Impact of the Deflection Structures on Water Quality

3.2.1 Differences in Concentration Between Sites

These results provide little evidence that a significant portion of the plume from Nose Creek entered the WH Canal during the sampling program, either before (2000) or after (2001) the installation of the deflection structures. The concentrations of most variables in the WH Canal at the Max Bell Arena and the Bow River upstream of Nose Creek were similar at the two sites in both years, which suggests that the plume from Nose Creek did not have an appreciable impact on water quality in the WH Canal (Table 1 and 2).

In 2000, both fecal coliforms and *E. coli* were significantly higher in the WH Canal at the Max Bell Arena than in the Bow River upstream from Nose Creek (Figures 4 and 5) and in 2001

Table 1 Median values of chemical variables in the Nose Creek deflection study, June 22 to August 10, 2000

VARIABLE	UNITS	Nose Creek near Mouth		W.H. Canal at Max Bell Arena above STO 001		W.H. Canal at 84 St. S.E. Shepard Road		W.H. Canal at Chestermere Lake		Bow River u/s Nose Creek (near Zoo)	
		No. of Samples	Median	No. of Samples	Median	No. of Samples	Median	No. of Samples	Median	No. of Samples	Median
Fecal Coliforms	no./100 mL	7	2400	7	120	7	340	7	530	7	38
Escherichia Coli	no./100 mL	7	720	7	98	7	180	7	210	7	11
Diss. Oxygen (field	mg/L	7	6.31	7	9.67	7	8.52	7	7.55	7	9.97
pH	units	7	7.64	7	8.23	7	8.19	7	8.17	7	8.50
Conductance	uS/cm	7	585	7	244	7	268	7	258	7	236
Water Temp	deg C	7	19.02	7	15.87	7	15.60	7	17.00	7	16.68
Nitrate	mg/L	7	0.715	7	0.066	7	0.124	7	0.135	7	0.062
Nitrite	mg/L	7	0.054	7	0.002	7	0.002	7	0.008	7	0.002
NFR	mg/L	44	68	43	9	43	26	0	--	0	--
TP	mg/L	46	0.128	43	0.010	43	0.025	4	0.017	4	0.006
TDP	mg/L	7	0.030	7	0.003	7	0.002	7	0.003	7	0.004
TKN	mg/L	7	0.93	7	0.09	7	0.18	7	0.24	7	0.10
NH_3	mg/L	7	0.10	7	0.01	7	0.01	7	0.01	7	0.01
Diss. Oxygen (lab)	mg/L	1	7.19	5	9.54	0	--	1	7.24	0	--
Air Temp	deg C	7	23	7	24	7	23	7	23	7	23
Discharge	m^3/s	7	0.834	0	--	0	--	0	--	0	--

-- = not analyzed

Table 2 Median values of chemical variables in the Nose Creek deflection study, May 14 to September 17, 2001

VARIABLE	UNITS	Nose Creek near Mouth		W.H. Canal at Max Bell Arena above STO 001		W.H. Canal at 84 St. S.E. Shepard Road		W.H. Canal at Chestermere Lake		Bow River u/s Nose Creek (near Zoo)	
		No. of Samples	Median	No. of Samples	Median	No. of Samples	Median	No. of Samples	Median	No. of Samples	Median
Fecal Coliforms	no./100 mL	10	355	10	57	10	41	10	27	10	55
Escherichia Coli	no./100 mL	10	205	10	25	10	11	10	5	10	35
Diss. Oxygen (field)	mg/L	10	8.19	10	9.53	10	10.00	10	9.34	10	9.67
pH	units	10	8.09	10	8.36	10	8.45	10	8.33	10	8.32
Conductance	uS/cm	10	1124	10	279	10	298	10	291	10	267
Water Temp	deg C	10	15.61	10	14.56	10	15.31	10	16.10	10	13.84
Nitrate	mg/L	10	0.712	10	0.042	10	0.034	10	0.022	10	0.047
Nitrite	mg/L	10	0.038	10	0.002	10	0.002	10	0.002	10	0.002
NFR	mg/L	51	44	50	7	50	27	10	13	10	3
TP	mg/L	49	0.119	48	0.012	48	0.025	8	0.005	8	0.002
TDP	mg/L	10	0.008	10	0.002	10	0.002	10	0.002	10	0.005
TKN	mg/L	10	1.20	10	0.16	10	0.24	10	0.20	10	0.09
NH_3	mg/L	10	0.02	10	0.01	10	0.01	10	0.01	10	0.01
Diss. Oxygen (lab)	mg/L	3	6.45	4	9.72	6	10.09	0	--	0	--
Air Temp	deg C	10	16	10	18	10	22	10	23	10	16

VARIABLE	UNITS	Bow River at Cushing Bridge[a]							
		No. of Samples	Composite Median	No. of Samples	Left Median	No. of Samples	Centre Median	No. of Samples	Right Median
Fecal Coliforms	no./100 mL	10	42	0	--	0	--	0	--
Escherichia Coli	no./100 mL	10	26	0	--	0	--	0	--
Diss. Oxygen (field)	mg/L	--	--	9	9.37	9	9.42	9	9.46
pH	units	--	--	9	8.45	9	8.42	9	8.45
Conductance	uS/cm	--	--	9	265	9	265	9	268
Water Temp	deg C	--	--	9	15.02	9	14.94	9	15.14
Nitrate	mg/L	10	0.033	0	--	0	--	0	--
Nitrite	mg/L	10	0.002	0	--	0	--	0	--
NFR	mg/L	10	3	0	--	0	--	0	--
TP	mg/L	8	0.004	0	--	0	--	0	--
TDP	mg/L	10	0.002	0	--	0	--	0	--
TKN	mg/L	10	0.13	0	--	0	--	0	--
NH_3	mg/L	10	0.01	0	--	0	--	0	--
Diss. Oxygen (lab)	mg/L	--	--	--	--	--	--	--	--
Air Temp	deg C	1	12	9	20	9	20	9	20

-- = not analyzed

[a] Bow R. at Cushing Bridge: a composite sample, and also sampled at a distance of 10, 50 and 90% from left bank

Table 3 Mass flux (coefficients of variation in parentheses) during May 14-September 17, 2001 at sites on Nose Creek, the Bow River and Western Headworks Canal Less reliable estimates (CV ≥ 0.2) are in bold italics

Variables[a]	TP kg	TDP kg	TSS kg	NO_2+NO_3 kg	TKN kg
Nose Creek Near the Mouth	1,413.6 (0.064)	***48.8 (0.536)***	952,357.2 (0.105)	5,386.6 (0.027)	7,583.5 (0.030)
WH Canal At Max Bell Arena	2,152.1 (0.172)	***849.4 (0.316)***	1,475,484 (0.150)	***9,458.2 (0.236)***	28,352.7 (0.154)
WH Canal At 84 St. S.E. Shepard Rd	5,666.9 (0.166)	***587.4 (0.257)***	4,359,857 (0.151)	8078.9 (0.195)	36,743.4 (0.140)
WH Canal at Chestermere Lake	2,440.1 (0.135)	***440.1 (0.223)***	2,408,446 (0.139)	***13,984.5 (0.539)***	41,612.4 (0.135)
Bow River upstream from Nose Creek	***12,689.8 (0.388)***	***10,978.1 (0.323)***	5,521,425 (0.154)	62,474.8 (0.083)	133,970.3 (0.112)
Bow River at Cushing Bridge (downstream from WH Canal Diversion)	***9,828.4 (0.349)***	***6,220.3 (0.404)***	4,543,645 (0.096)	41,375.8 (0.112)	145,255.4 (0.081)

[a] Abbreviations: TP (total phosphorus), TDP (total dissolved phosphorus), TSS (total suspended solids, as NFR), NO_2+NO_3 (nitrite+nitrate), TKN (total kjeldahl nitrogen)

Table 4 Changes in mass between sites on Nose Creek, the Bow River and the Western Headworks Canal during May 14-September 17, 2001

Variables[a]	TP kg	TSS kg	NO_2+NO_3 kg	TKN kg
Increase in mass along WH canal within city limits	3,514.8	2,884,373.0	-	8,390.7
Net increase in mass along WH canal between intake and Chestermere Lake	288.0	932,962.0	-	13,259.7
Total Nose Creek mass as % of potential mass loading to Chestermere Lake	58%	40%	-	18%
Change in mass in the Bow River between upstream and downstream sites	-	-977,780.0	-21,099.0	11,285.1

[a] Abbreviations: TP (total phosphorus), TSS (total suspended solids, as NFR), NO_2+NO_3 (nitrite+nitrate), TKN (total kjeldahl nitrogen)
hyphen = (CV of at least one loading estimate too high for mass balance calculation)

median TSS (as NFR) alone was significantly higher at this canal site than in the Bow River upstream from Nose Creek (Figure 12)(Table 1 and 2). None of the other differences in concentration between these two sites were statistically significant. Other variables were either similar in concentration at the two sites, or slightly lower in the canal. Higher concentrations of TSS in the WH Canal at Max Bell Arena compared to the Bow River (in 2001) may reflect the different sampling methods that were used at the two sites that year. The site at the WH Canal at Max Bell Arena was sampled daily during June 2 to July 15, 2001 using an automated sampler, which could account for occasional higher concentrations when storm events were sampled. Except for the single high measurement of 163 mg/L on June 6, 2001 (Figure 12), TSS was relatively low at both sites during most of the sampling period. The June 6, 2001 sample was collected between grab sampling dates, following a storm event (Figure 3).

These results provide no clear indication that enhanced mixing of the plume from Nose Creek has caused higher concentrations of these variables in the Bow River downstream from the WH Canal. In 2001, median water temperature, TP, and TKN were slightly higher in the Bow River at Cushing Bridge, downstream from Nose Creek, than in the Bow River upstream from Nose Creek (Figure 13 and 15, Table 2). However, the concentration of other variables typically high in Nose Creek (e.g., coliforms, nitrate, TSS) was either similar at these two sites or slightly lower at the downstream location (Table 2). Furthermore, none of the above differences in concentration between Bow River sites were statistically significant. Accordingly, these small differences in concentration probably reflect normal spatial variation rather than impacts of Nose Creek, or effects of the deflection structures.

Previous surveys (Sosiak 1996) in 1994 and 1995 found little evidence of Nose Creek impact on these variables in the Bow River prior to installation of the deflection structures. Although concentrations of these variables were very high in Nose Creek in these surveys, this tributary caused no appreciable downstream impact on the concentration or mass of these variables in the Bow River. During the 1995 survey, flow in the Bow River in this reach (212.5 m^3/s) was 802 times the flow in Nose Creek (0.265 m^3/s). This was apparently enough to dilute constituents contributed by Nose Creek, so that there was no resulting change in downstream concentration.

All variables were higher in Nose Creek than in the WH Canal in both years (Figures 4 to 16). Conductivity in Nose Creek was especially high (Figure 8). However, there was no evidence of higher conductivity along the left bank of the Bow River at Cushing Bridge where a plume from Nose Creek would be expected (Table 2). This suggests that constituents contributed by Nose Creek were well mixed with the Bow River at Cushing Bridge.

The concentration of TSS, TP, and TKN increased along the WH canal between Max Bell Arena and 84 Street Southeast (at Calgary City limits) both years (Figures 12, 13 and 15), presumably due to loading from urban storm water runoff. The concentrations of fecal coliforms, *E. coli*, nitrate, nitrite, and TDP only increased between these two sites in 2000 (Figures 4, 5, 10, 11, and 14), perhaps because 2000 was a wetter summer than 2001 with more urban runoff. During previous sampling (Sosiak 1994), TP concentrations and fecal coliform counts increased greatly in the WH Canal during storm events.

3.2.2 Differences in Concentration Between Years

There was little change in the concentration of most variables in the WH Canal at the Max Bell Arena following the installation of the deflection structures in 2001, compared to 2000 (Table 1 and 2). Accordingly, these results provide little indication of an appreciable change in mixing of the Nose Creek plume under the conditions that occurred in these years.

Median fecal coliform and *E. coli* counts and TSS were significantly lower in the WH Canal at Max Bell Arena in 2001 than in 2000 (Figure 4, 5, and 12). Coliform counts often exceeded guidelines at all the WH Canal sites in 2000, but rarely exceeded these guidelines at any site in 2001. Conductivity was significantly higher in 2001 than in 2000, both at this site on the WH Canal and in the Bow River upstream from Nose Creek (Figure 8). The fact that conductivity changed at both locations suggests that changes in conductivity in the WH Canal were not related to the deflection structures. None of the other variables were significantly different in concentration between years. Accordingly, any small differences in concentration between years probably reflect normal temporal variation rather than effects of the deflection structures (Table 1 and 2).

A small change in sampling location from 2000 to 2001 in the WH Canal at Max Bell Arena, and lower precipitation in 2001 appear to be the most likely causes of lower coliform counts and TSS. Samples were collected along the opposite bank and downstream from three storm sewers (IC1, IC2, IC3) in 2000, instead of the historic sampling site upstream from all storm sewers that was sampled in 2001. Furthermore, precipitation in this part of Calgary during the summer of 2001 was well below the long-term average near Calgary International Airport and well below 2000 rainfall, which probably reduced coliform loading from urban runoff (Figure 2). Furthermore, there were no significant changes between years in the concentration of other variables normally higher in Nose Creek than in the WH Canal at Max Bell Arena. Improved mixing of Nose Creek following the installation of the deflection structures may have contributed to lower coliform counts in the WH Canal at Max Bell Arena in 2001, but sampling location and differences in runoff seem more likely explanations for lower coliform counts in 2001.

A previous survey found elevated levels of TP, zinc and bis(2-ethylhexyl)phthalate in the WH Canal at the Max Bell Arena, and Nose Creek was thought to be the likely source of loading of these constituents to this site (Sosiak 1994). No other sampling programs have evaluated the impact of Nose Creek on the WH Canal. The conditions that favour entry of the plume from Nose Creek into the WH Canal remain poorly understood. Rainfall was well below average in July and August of both 2000 and 2001 (Figure 2). The plume from Nose Creek may be more likely to enter the WH Canal during summer storm events with above average rainfall.

3.3 Mass Flux to the WH Canal

Although the concentration of most variables was quite high in Nose Creek compared to the Bow River and WH Canal, the mass of each constituent was far greater in the Bow River and WH Canal at Max Bell Arena than in Nose Creek during the 2001 sampling period (Table 3). Acceptable mass estimates ($CV < 0.2$), could only be calculated at all sites for TSS and TKN.

The mass of TP, TSS and TKN increased greatly in the WH Canal between the Max Bell Arena and 84 St. SE at city limits (Figure 1)(Table 4) in 2001. This increase in the mass of these constituents is probably caused by material contributed by urban runoff within Calgary. The difference in mass between the intake of the WH Canal and Chestermere Lake is indicative of the net increase in mass along the canal. The net increase in TP mass was relatively small in 2001, only 288 kg (Table 4), while the net increase in TSS was 932,962 kg. Much of the TP and TSS that was contributed by urban runoff settled along the canal during the dry conditions that occurred in 2001 (Tables 3 and 4). In contrast, there was a large net increase in the mass of TKN along the WH Canal (Table 4), which suggests that urban runoff and other unidentified sources both within Calgary, and downstream from 84 St. SE, contributed additional TKN, that was mostly organic nitrogen (Table 2).

In spite of sedimentation along the canal, an estimated 2,408,446 kg TSS and 2440 kg TP entered Chestermere Lake from the WH Canal during the 2001 sampling program. This TP load was less than half the load estimated for 1992 (6928 kg) and 1993 (6609 kg)(Sosiak 1994). The lower TP load in 2001, compared to previous years, probably reflects very low rainfall and less urban runoff that year. Extrapolated over the entire operating season (April 23 – September 30), an estimated 2,665,123 (CV: 0.067) kg TSS may have entered Chestermere Lake in 2001.

The loading of TP, TSS and TKN to the WH Canal, presumably from urban runoff within city limits (Table 4), greatly exceeded the mass of each variable in Nose Creek at the mouth (Table 3) in 2001. The mass of TSS contributed by urban runoff was three times greater than the mass of TSS in Nose Creek at the mouth. Loading from both the Nose Creek watershed and urban runoff that drains directly into the WH Canal could be much higher in a wet year.

4.0 CONCLUSIONS

The main conclusions of this analysis are as follows:

1. None of the results collected in this study provide evidence that the deflection structures have caused either a deleterious impact, or significant improvement in water quality in either the WH Canal or the Bow River downstream from the WH Canal diversion.

2. These results provide little evidence that a significant portion of the plume from Nose Creek entered the WH Canal during sampling, before (2000) or after (2001) the installation of the deflection structures.

3. Differences in sampling location and lower precipitation in 2001 than in 2000 appear to be the most likely cause of lower coliform counts and TSS concentration in the WH Canal at the Max Bell Arena in 2001.

4. The conditions that favour entry of the plume from Nose Creek into the WH Canal remain poorly understood.

5. The mass of TP, TSS, and TKN contributed by urban runoff directly to the WH Canal was much greater than the mass of these variables in Nose Creek at the mouth in 2001.

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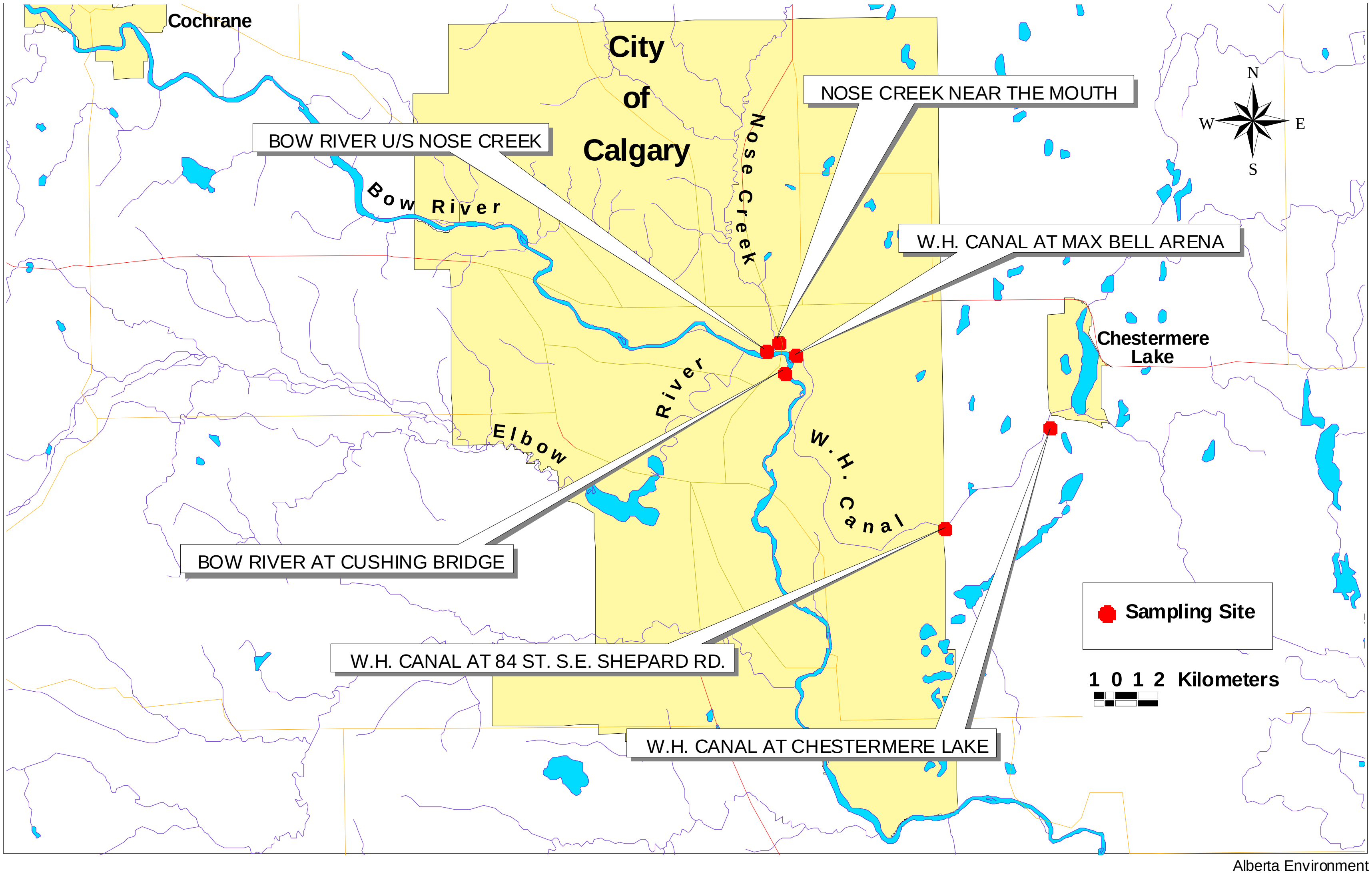


Figure 1 Water quality sampling sites, Nose Creek deflection study, 2000-2001

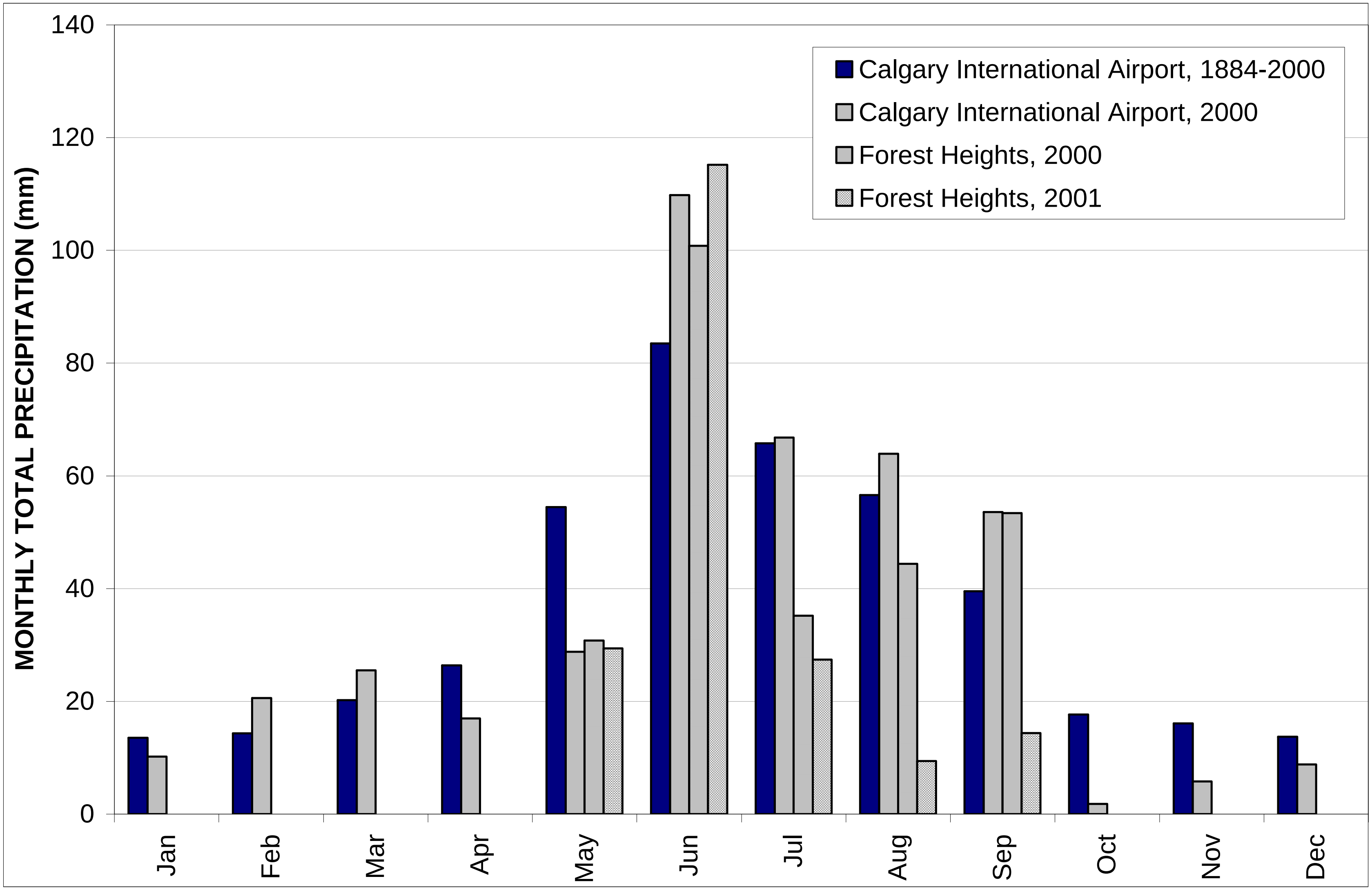


Figure 2 **Total monthly precipitation at Calgary International Airport, 1884-2000 and 2000 only, and 2000-2001 at Forest Heights**

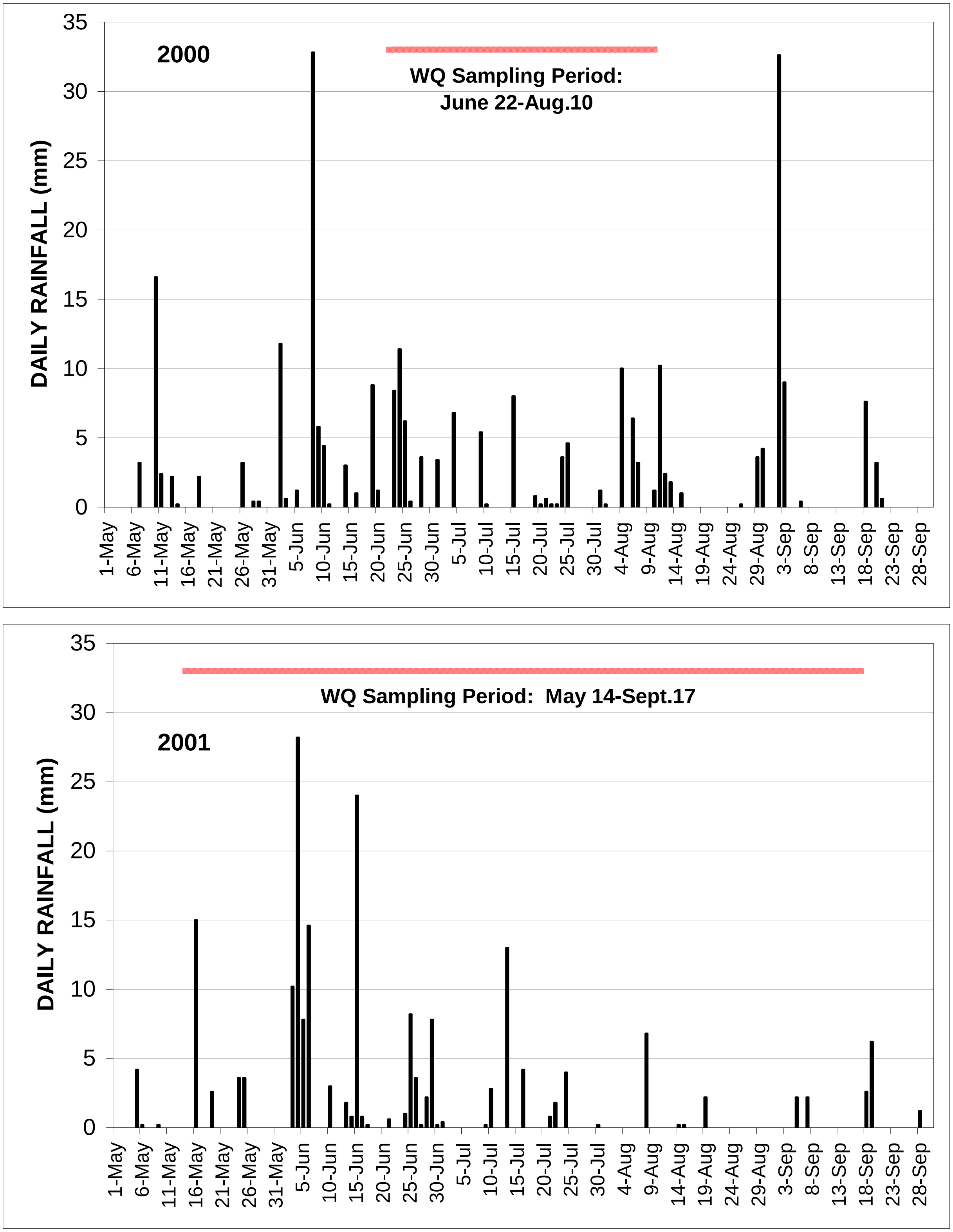
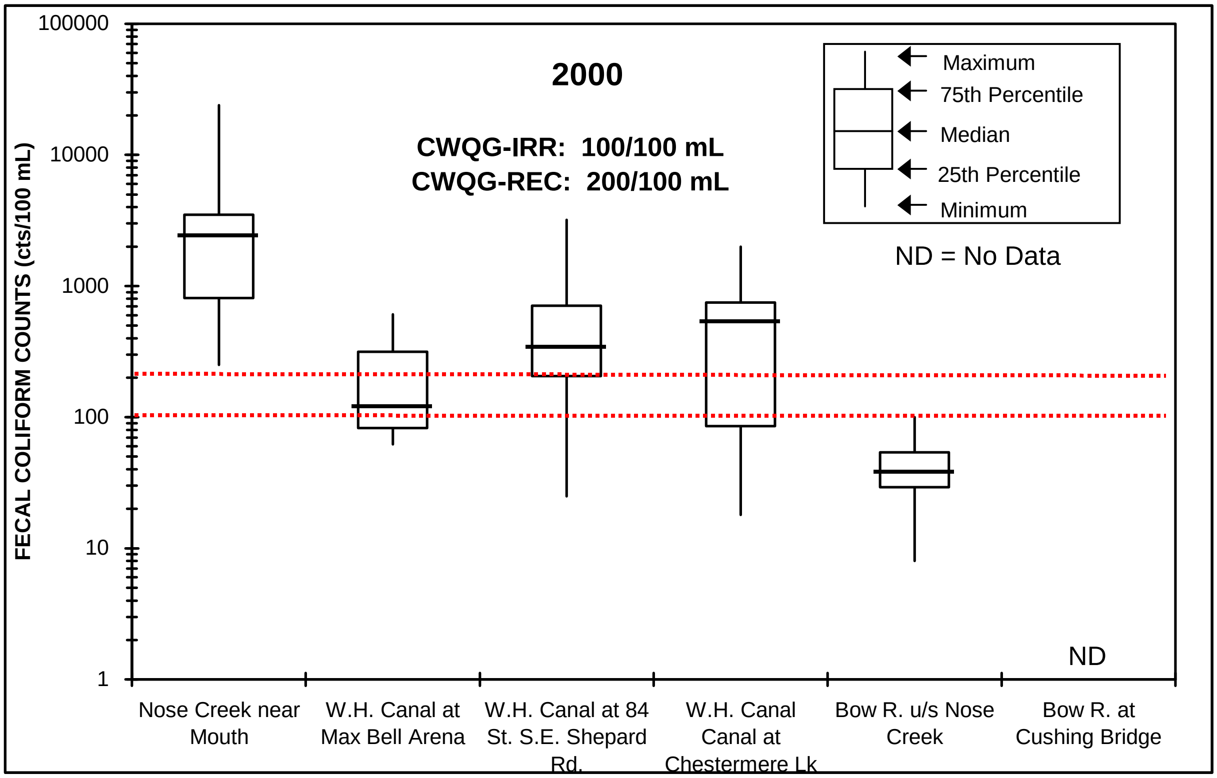


Figure 3 Daily rainfall data for the City of Calgary, Forest Heights station, May 1 to September 30, 2000 and 2001



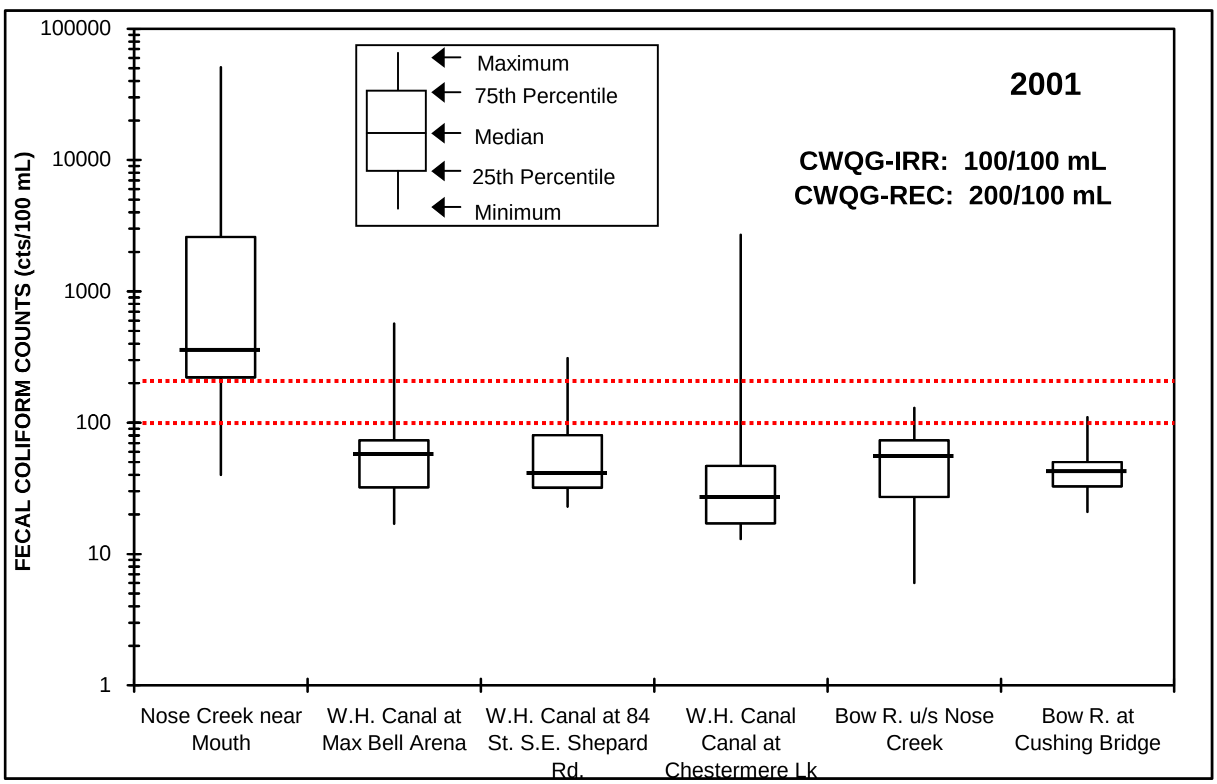


Figure 4 Fecal coliform counts, Nose Creek survey, June 22-August 10, 2000 and May 14 to September 17, 2001

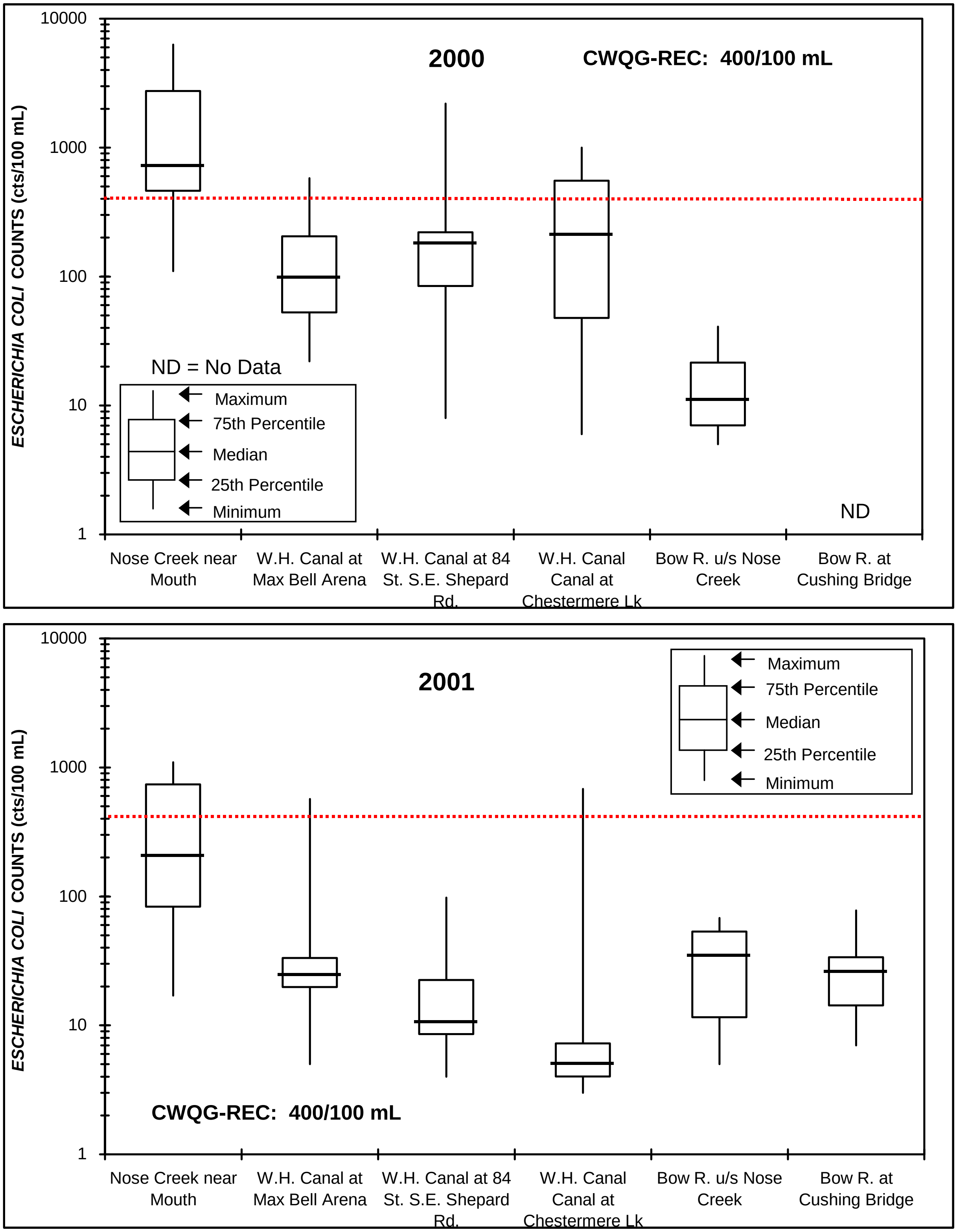


Figure 5 ***Escherichia coli*** **counts, Nose Creek survey, June 22-August 10, 2000 and May 14 to September 17, 2001**

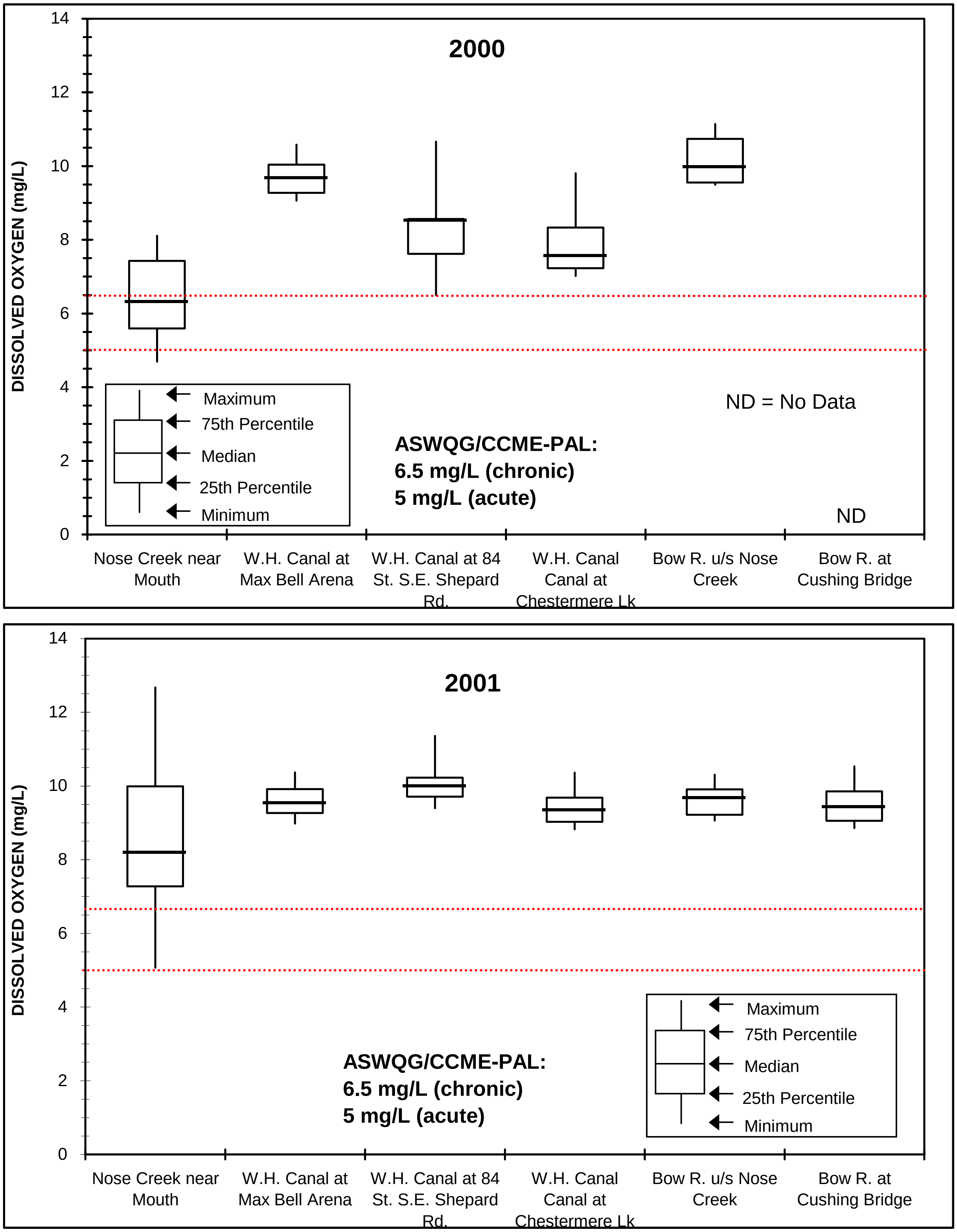
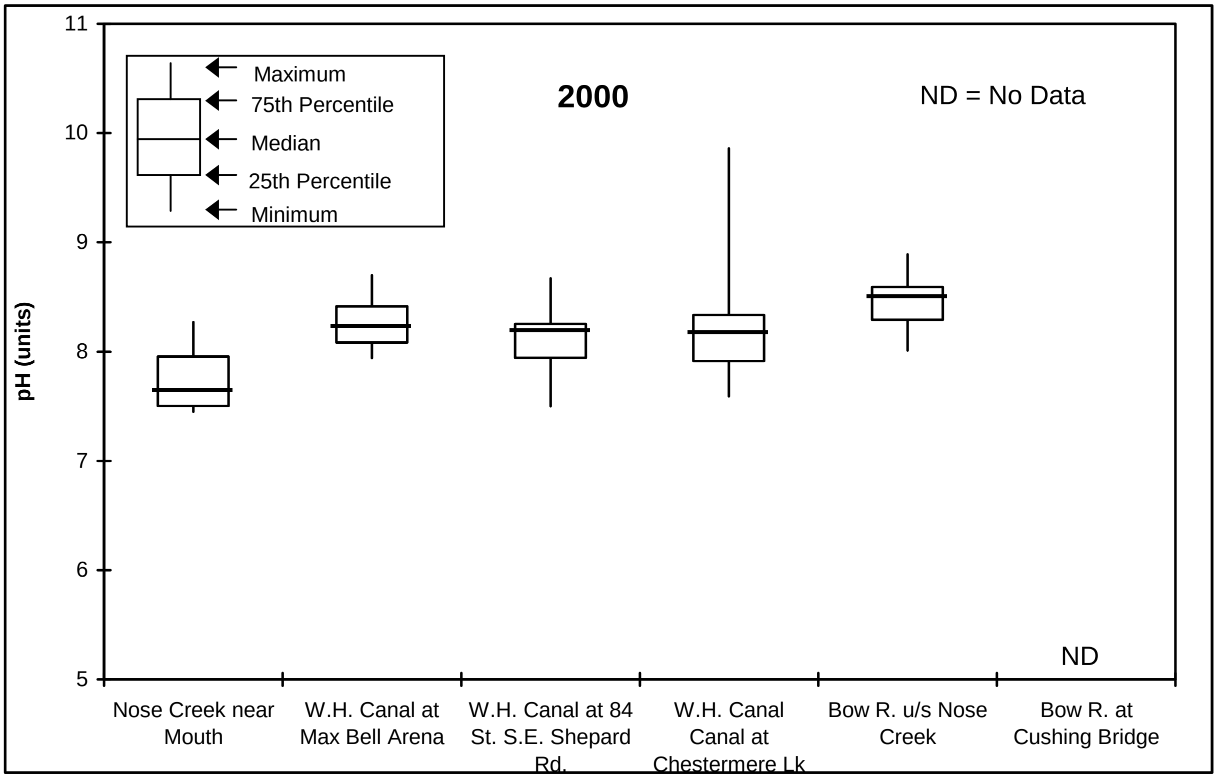


Figure 6 Dissolved oxygen, Nose Creek survey, June 22-August 10, 2000 and May 14 to September 17, 2001



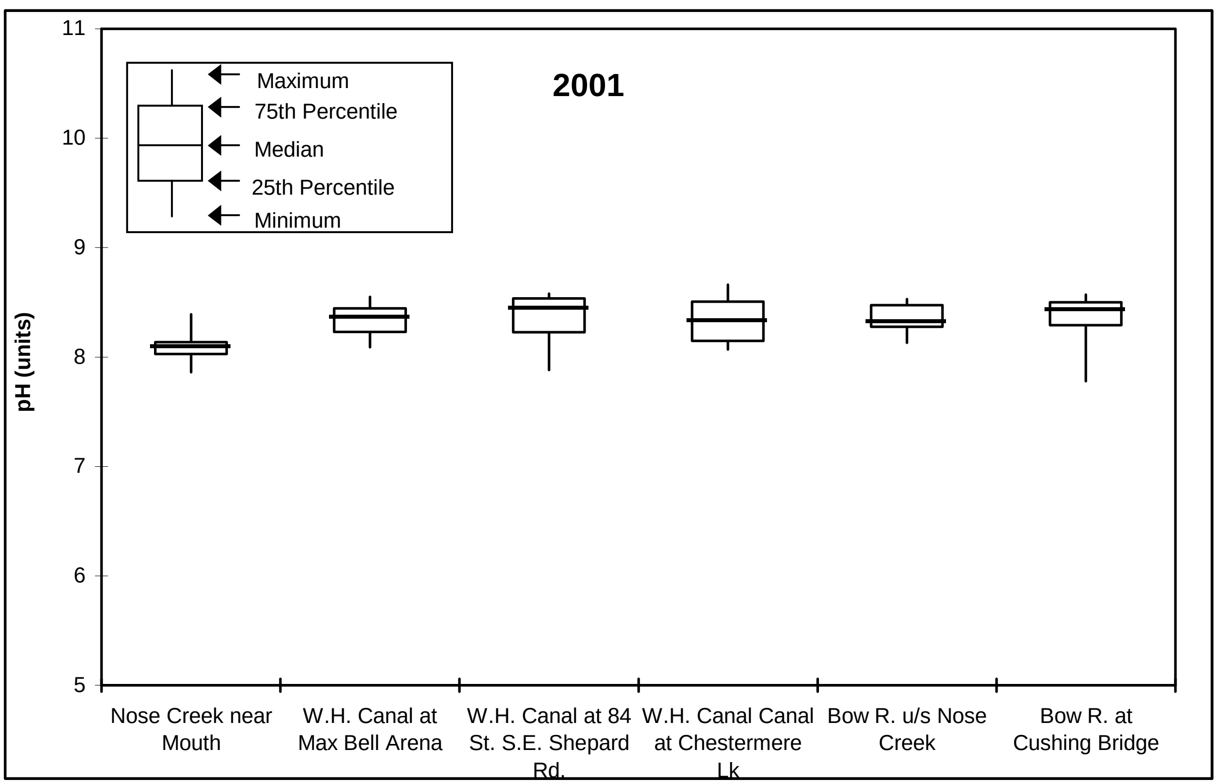


Figure 7 pH, Nose Creek survey, June 22-August 10, 2000 and May 14 to September 17, 2001

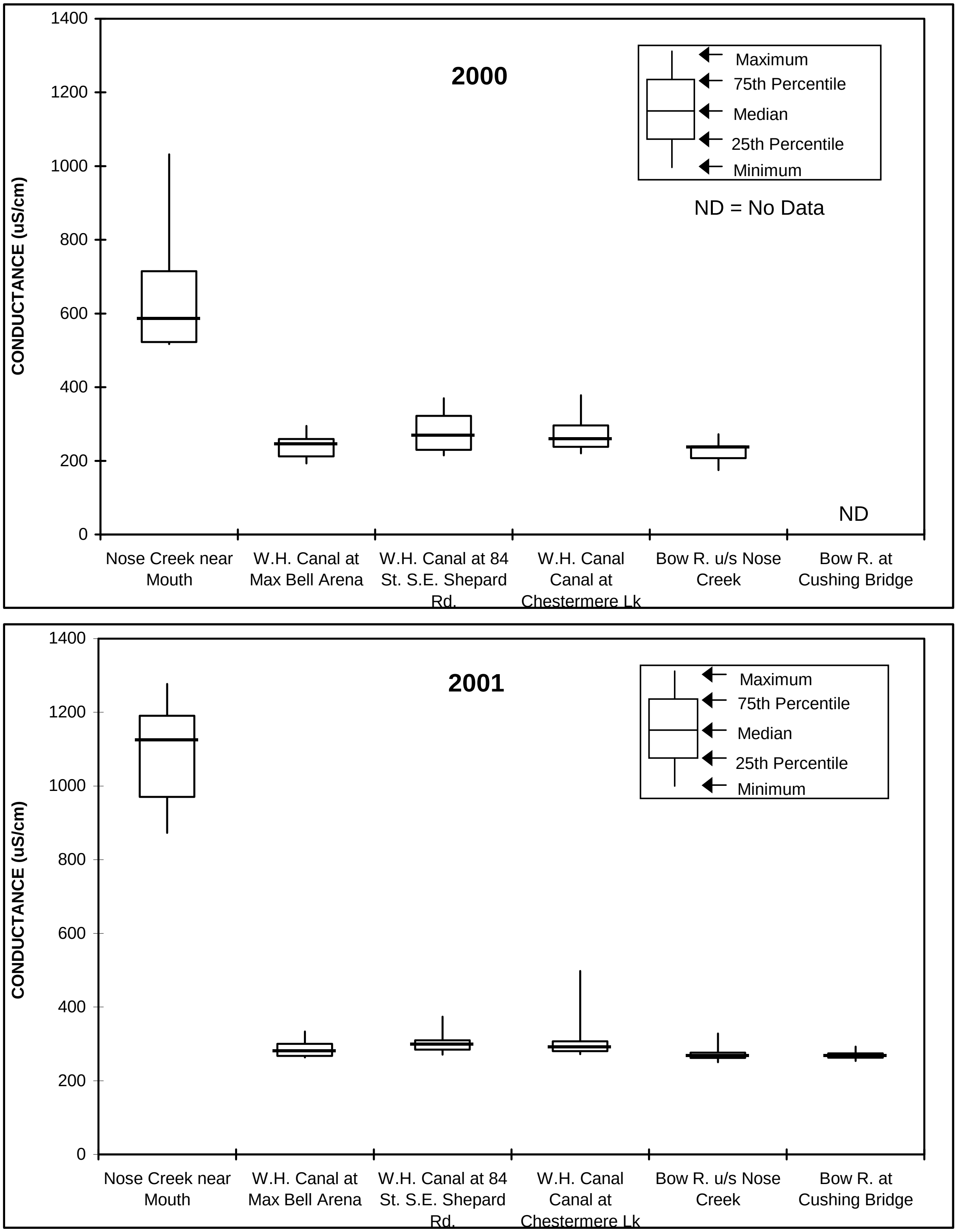


Figure 8 Specific conductance, Nose Creek survey, June 22-August 10, 2000 and May 14 to September 17, 2001

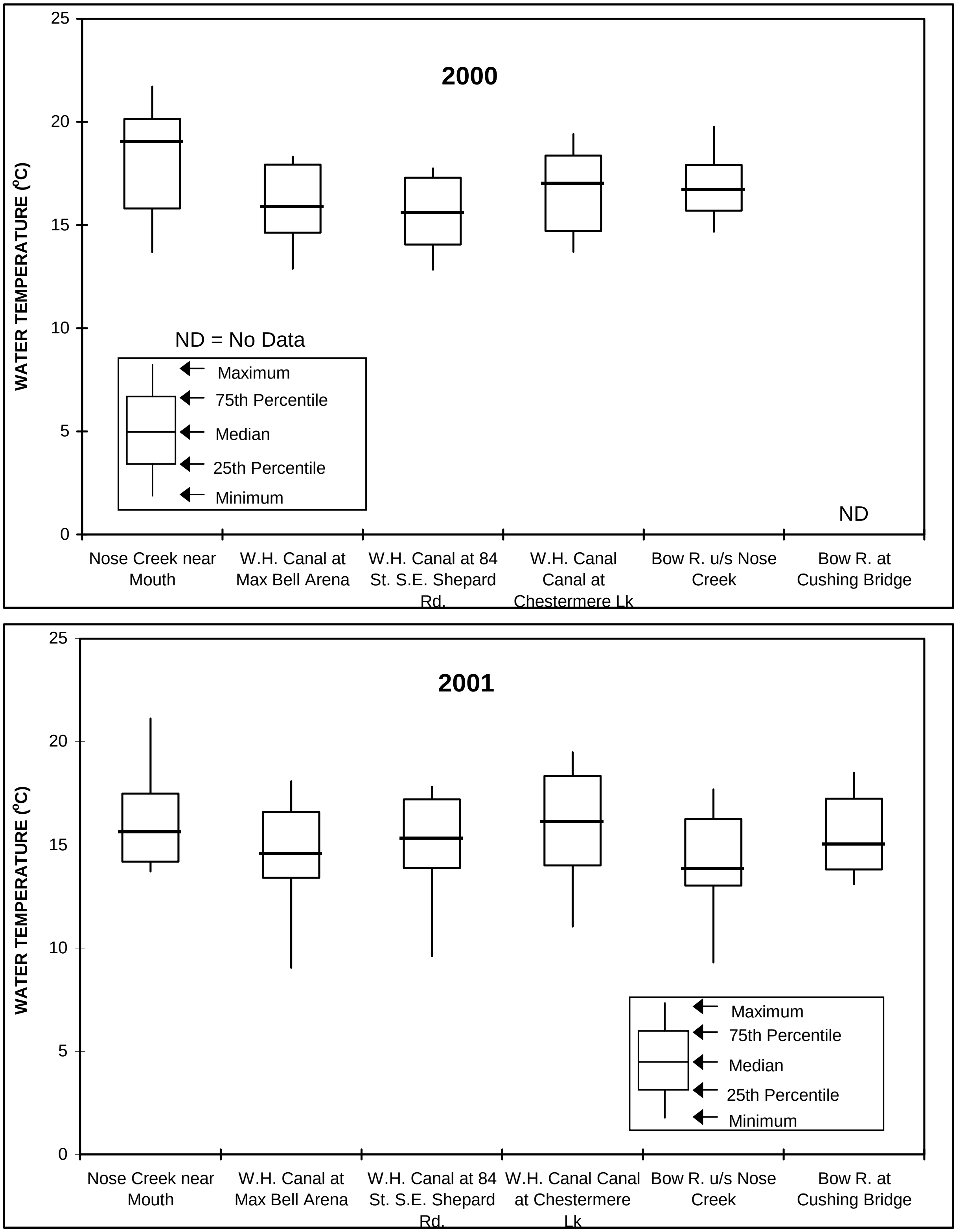


Figure 9 Water temperature, Nose Creek survey, June 22-August 10, 2000 and May 14 to September 17, 2001

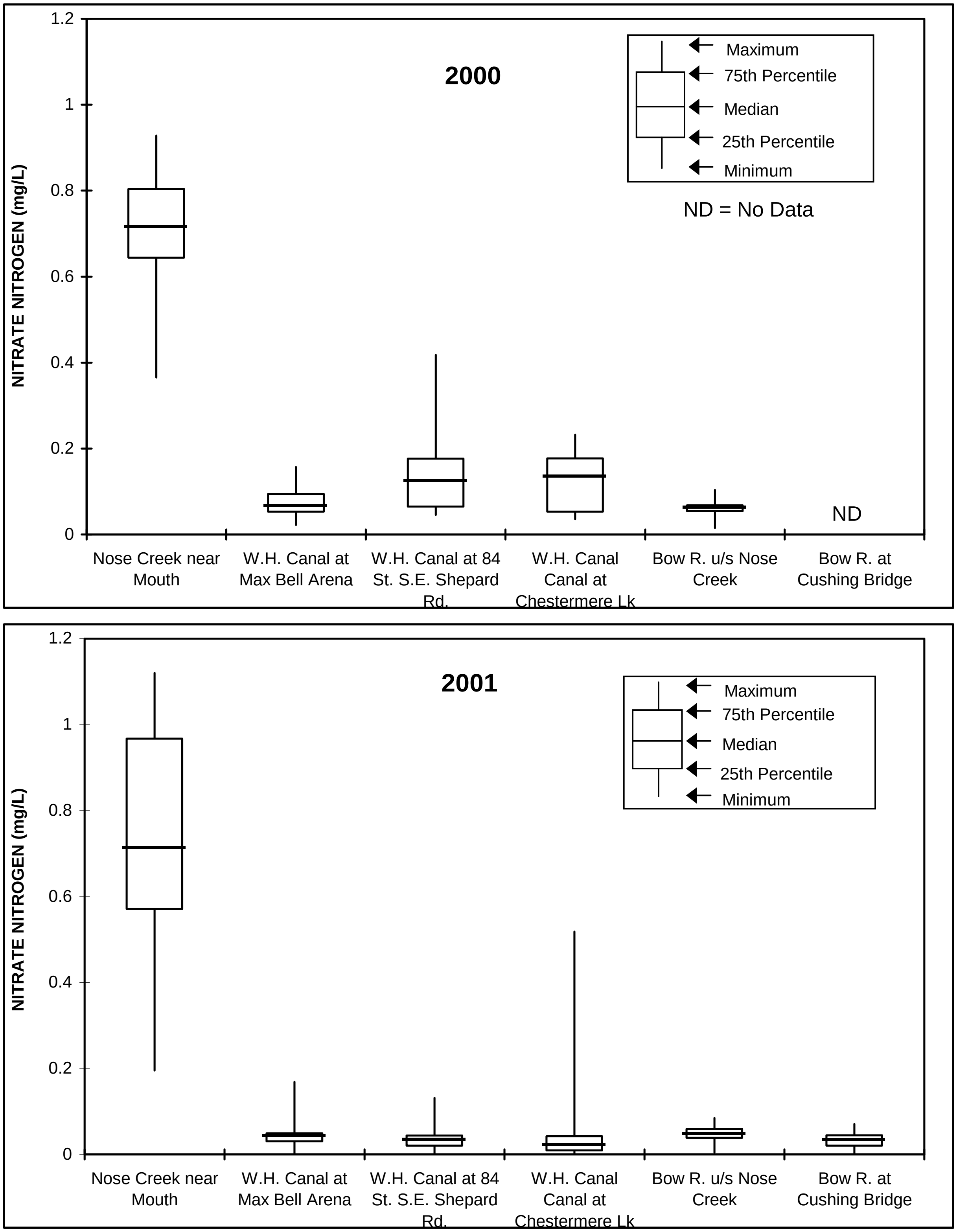
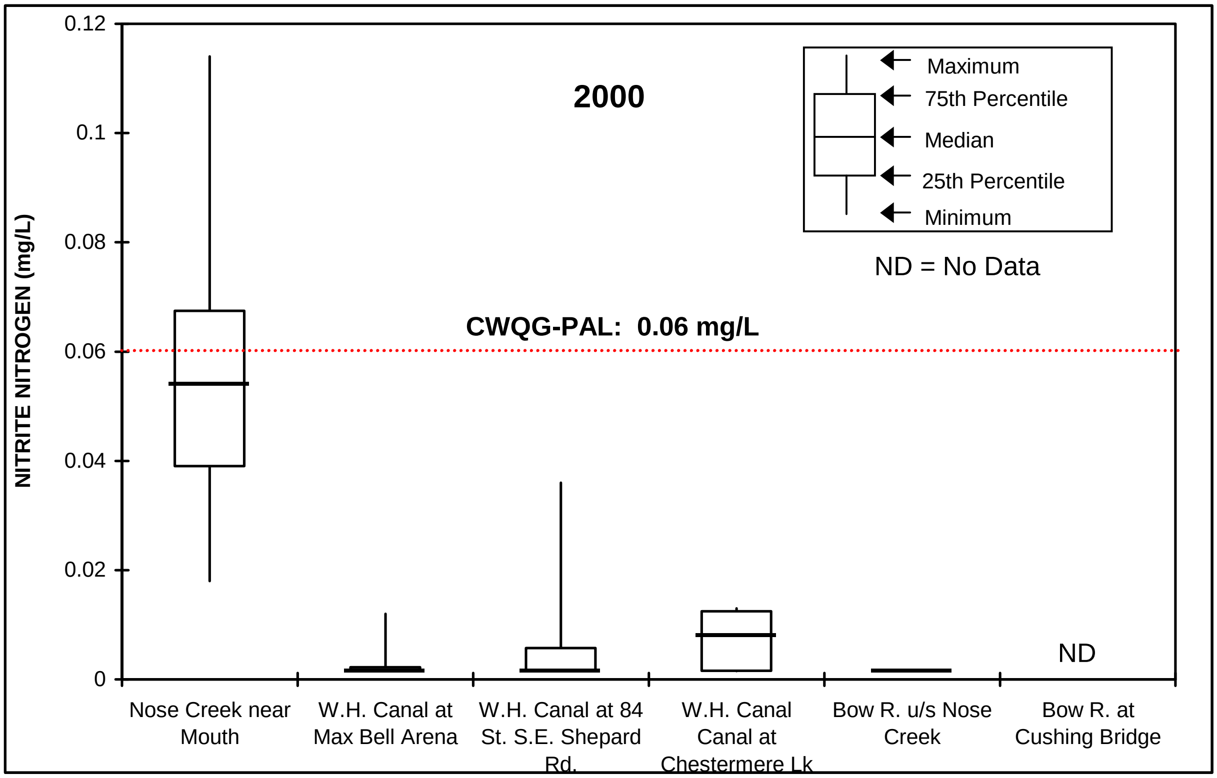


Figure 10 Nitrate nitrogen, Nose Creek survey, June 22-August 10, 2000 and May 14 to September 17, 2001



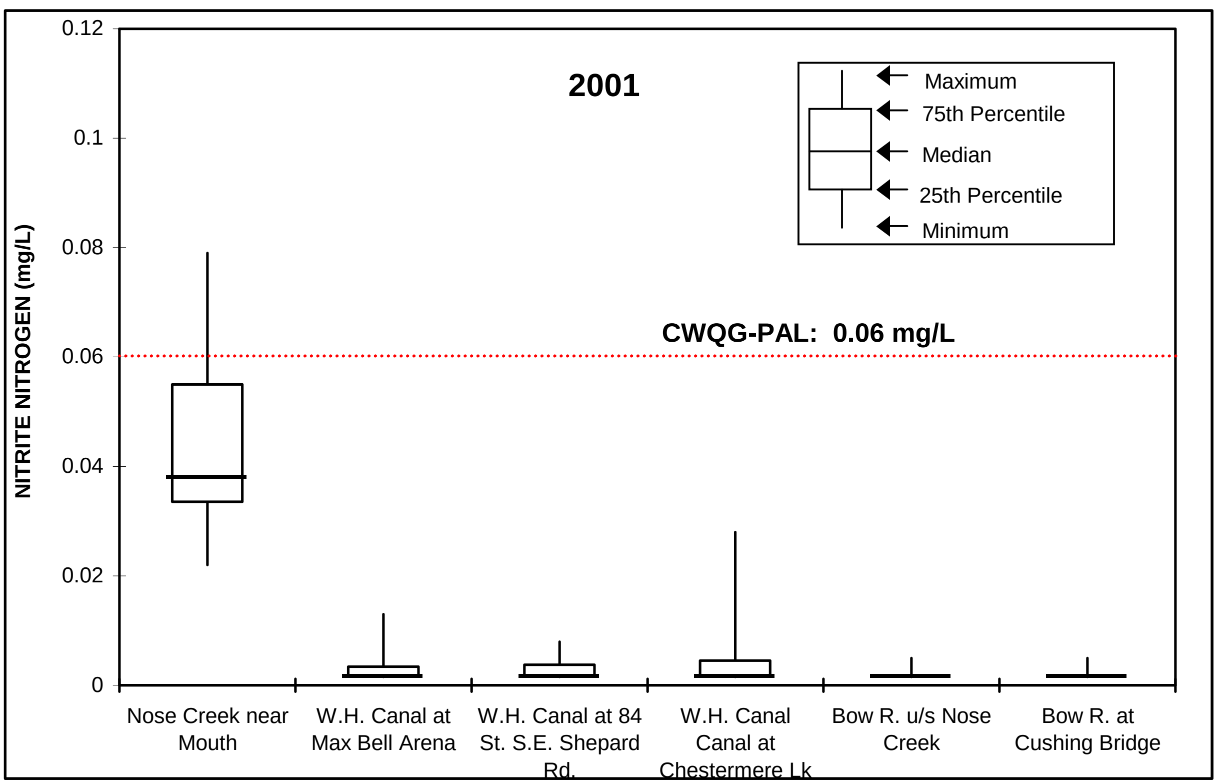
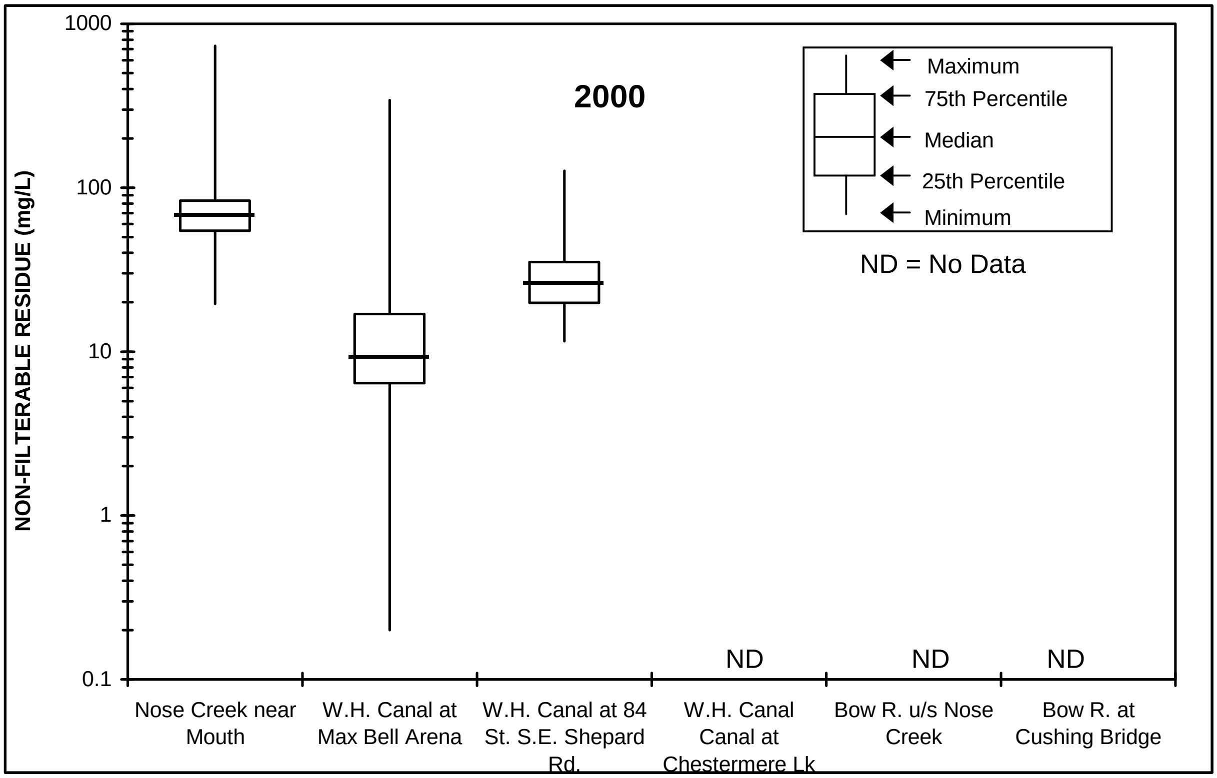


Figure 11 Nitrite nitrogen, Nose Creek survey, June 22-August 10, 2000 and May 14 to September 17, 2001



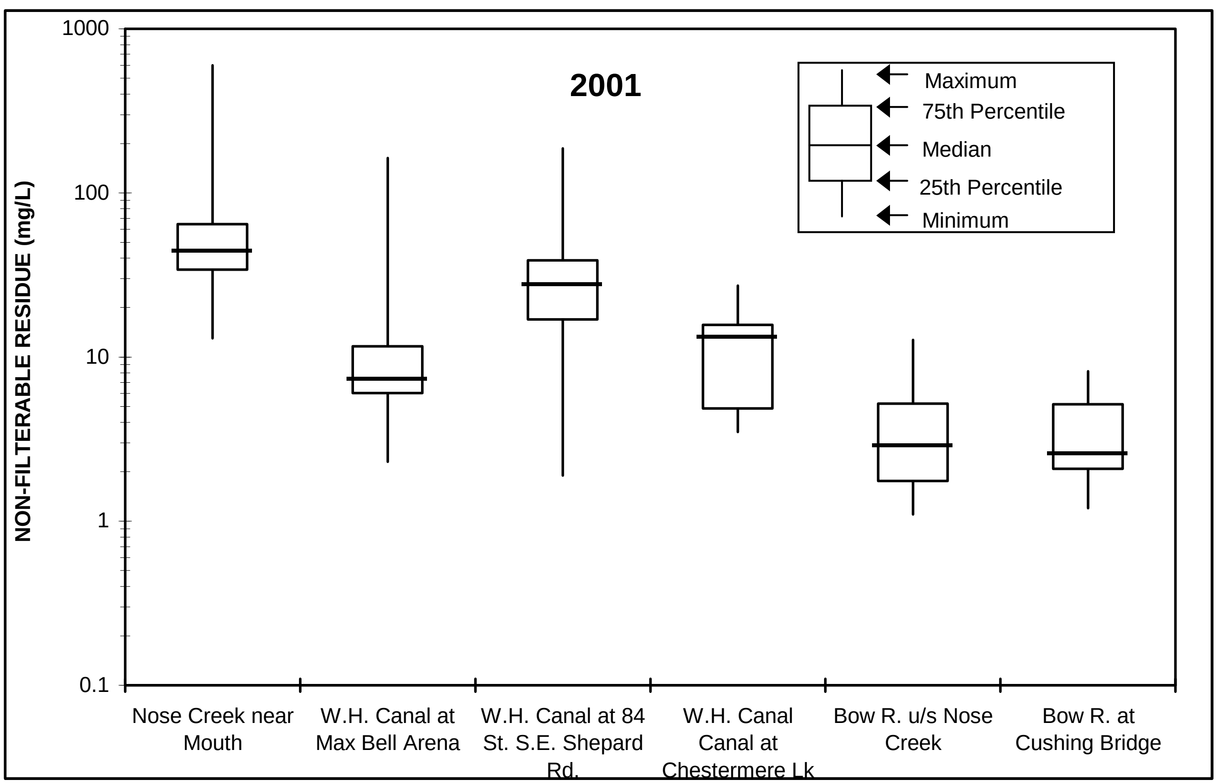
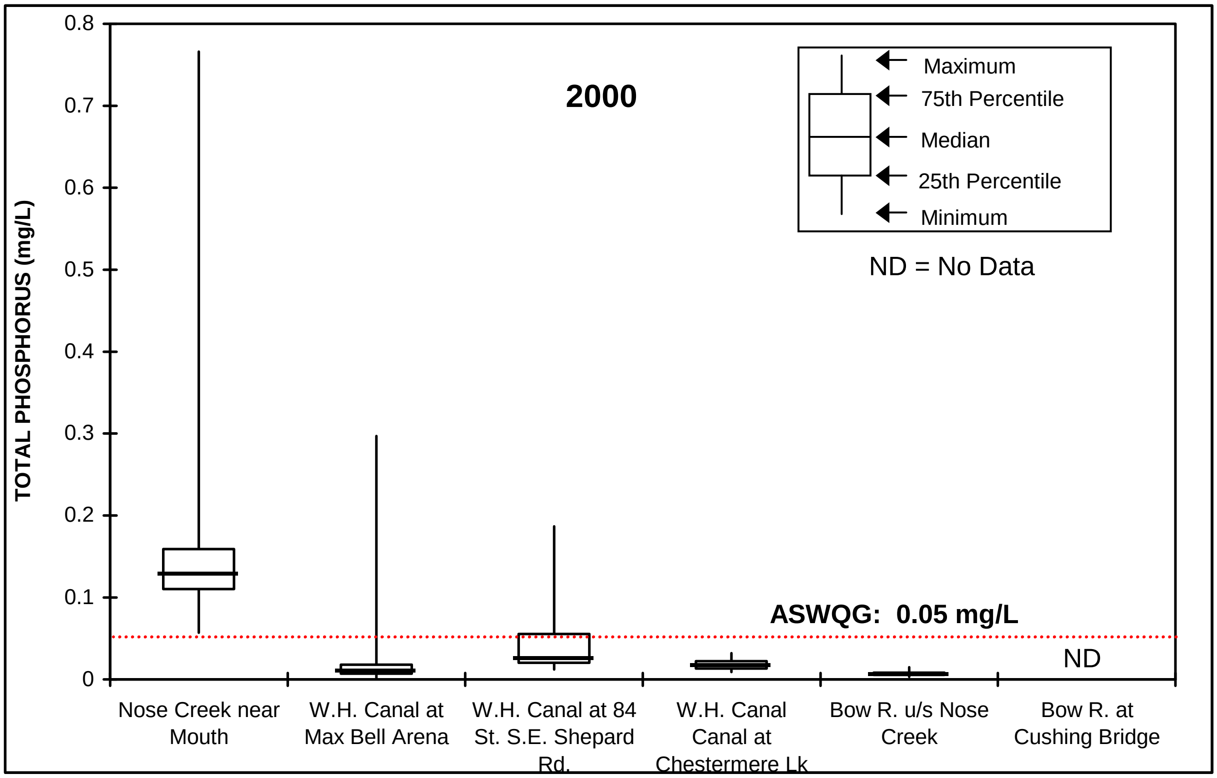


Figure 12 Total suspended solids (as non-filterable residue), Nose Creek survey, June 22-August 10, 2000 and May 14 to September 17, 2001



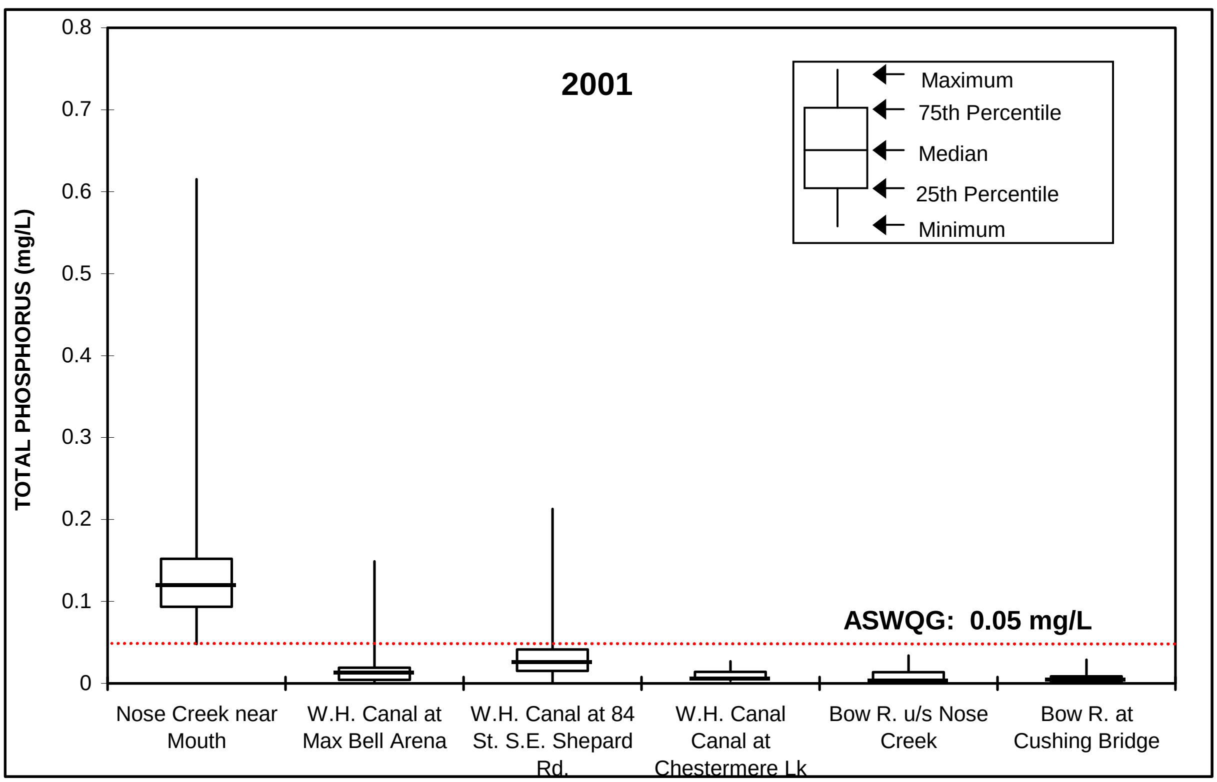


Figure 13 Total phosphorus, Nose Creek survey, June 22-August 10, 2000 and May 14 to September 17, 2001

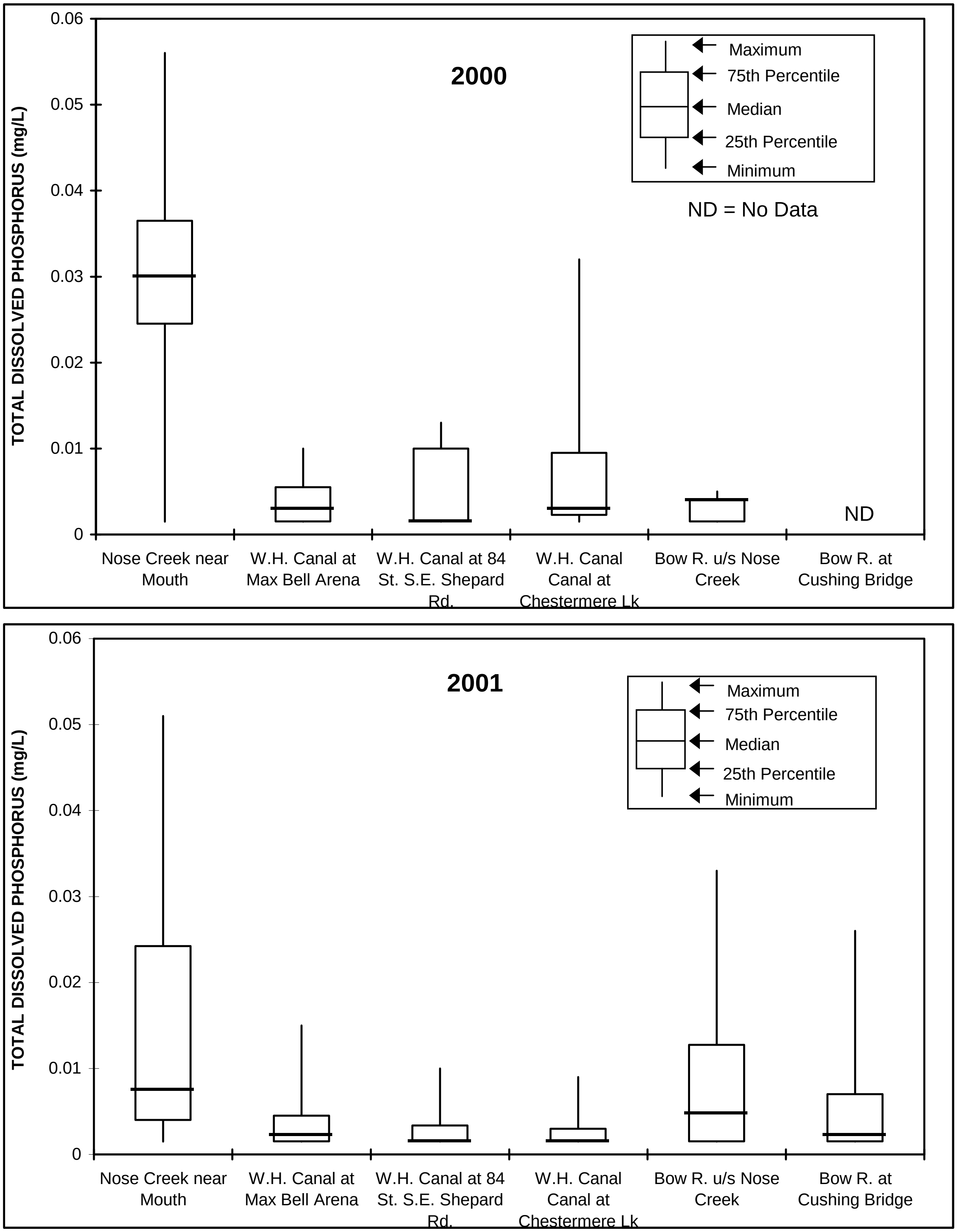


Figure 14 Total dissolved phosphorus, Nose Creek survey, June 22-August 10, 2000 and May 14 to September 17, 2001

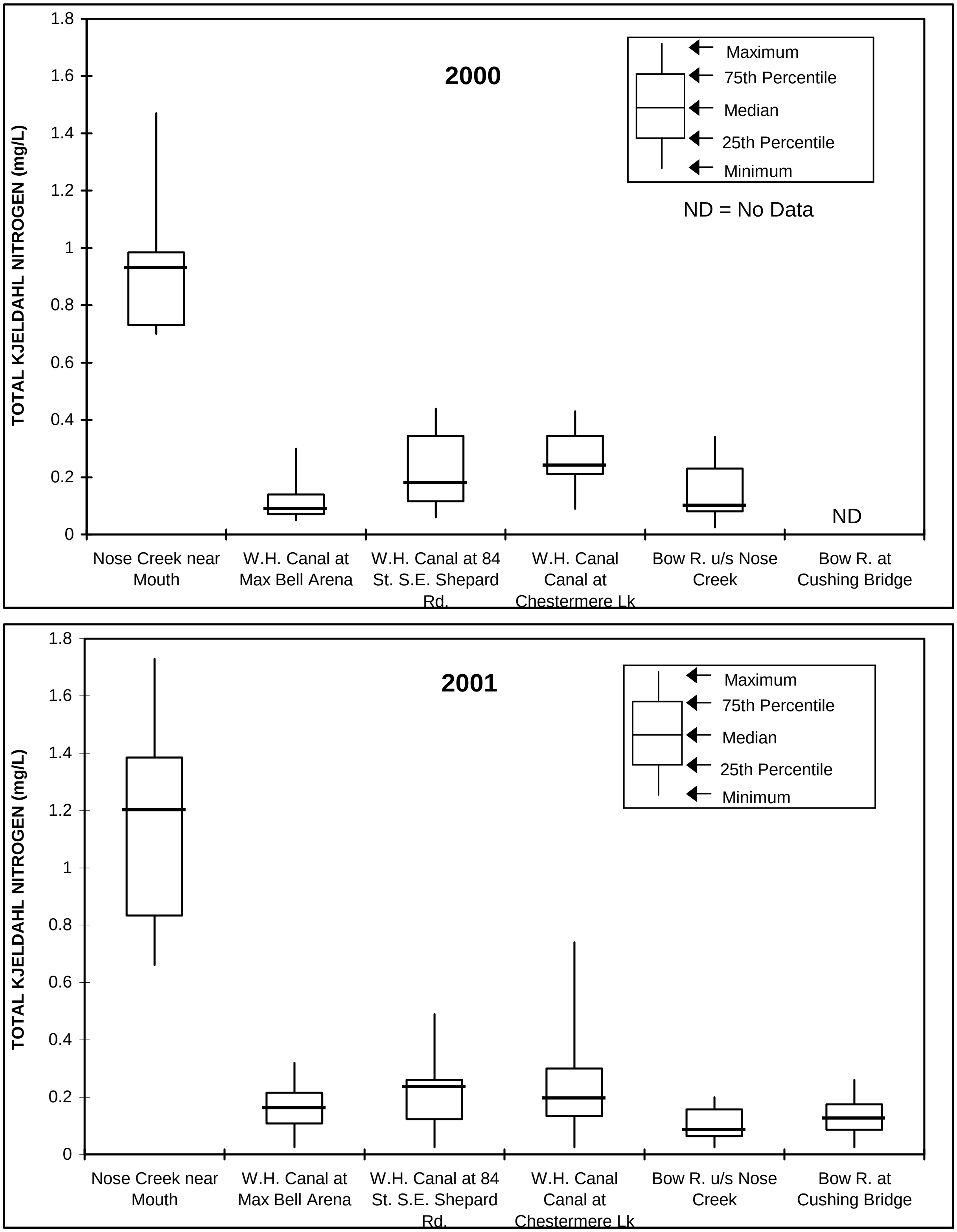
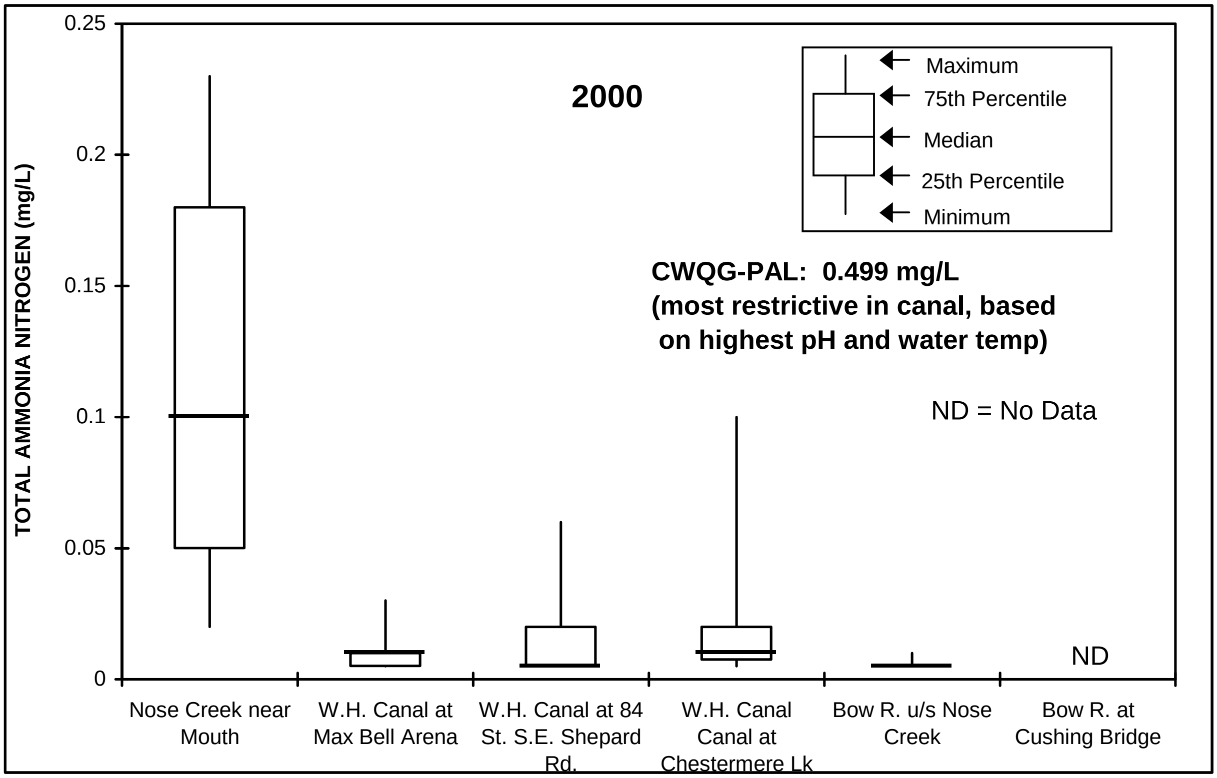


Figure 15 Total Kjeldahl nitrogen, Nose Creek survey, June 22-August 10, 2000 and May 14 to September 17, 2001



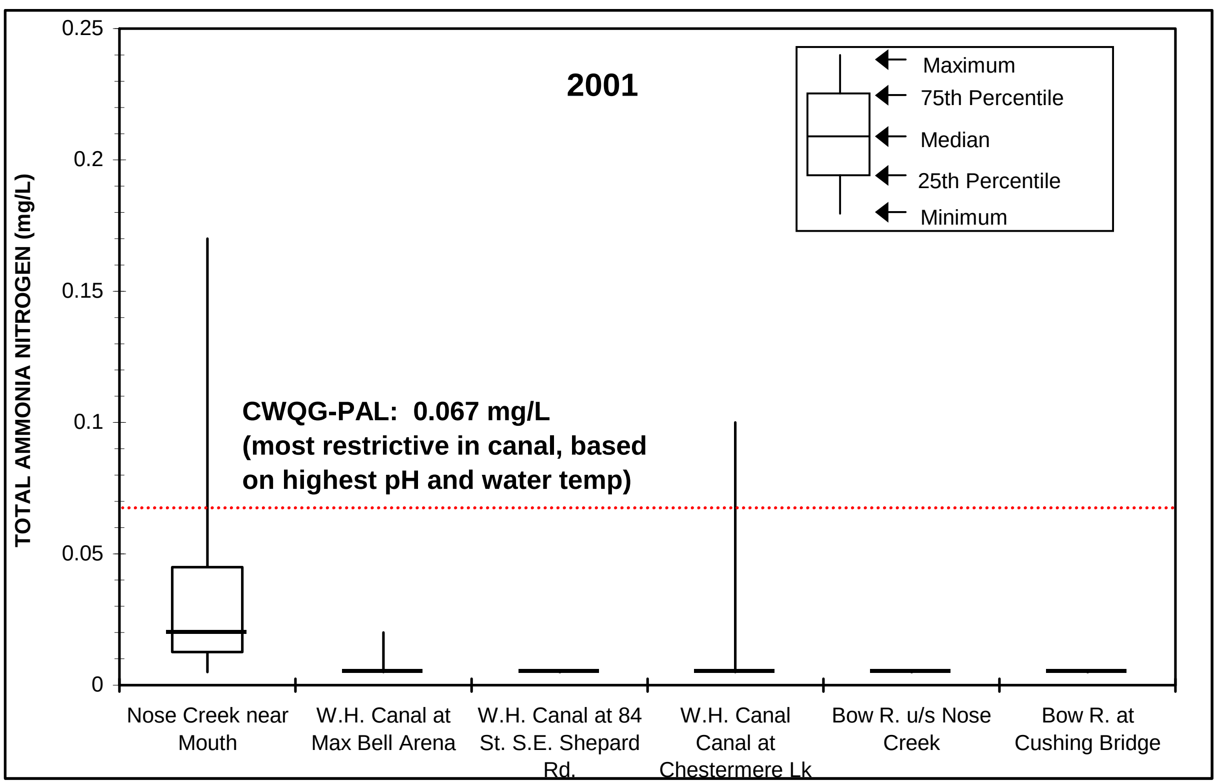


Figure 16 Total ammonia nitrogen, Nose Creek survey, June 22-August 10, 2000 and May 14 to September 17, 2001