Nose Creek Watershed Partnership
Long-Term Water Monitoring Strategy

Revised December 4, 2009 – Final Report

Nose Creek Watershed Partnership

Palliser Environmental Services Ltd.

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1.0 INTRODUCTION

Effective watershed management includes monitoring the state of air, land and water resources. Monitoring water resources in terms of its physical, chemical and biological character allows managers to determine if water meets requirements for various uses, including human and livestock health and ecological (aquatic) needs and health. Water monitoring can also provide insight into land management practices as runoff quality is reflected in surface water bodies (i.e., stormwater from urban and rural landscapes). Flow volumes may increase or decrease according to changes in land cover. Water monitoring is a critical decision-support system for any water management program (United States Geological Survey (USGS) 1995). With appropriate water quality data, land managers can make decisions that will help protect the integrity of water bodies for future generations.

The Nose Creek Watershed Partnership completed the Nose Creek Watershed Water Management Plan in 2007. On completion, the City of Airdrie, City of Calgary, MD of Rocky View and Alberta Environment agreed to implement the recommendations within the Plan to the best of their ability. One of the recommendations in the plan was to integrate the current water quality monitoring that is conducted by various agencies, municipalities and organizations into a comprehensive program that avoids duplication of effort and promotes sharing of information. Palliser Environmental Services Ltd. was retained to develop a comprehensive long term water monitoring strategy for the Nose Creek watershed that is consistent with the recommendations and implementation actions of the Nose Creek Watershed Water Management Plan (2006) and the Water Quality Objectives set for Nose Creek in the Bow River Basin Water Management Plan (2008).

2.0 SUMMARY OF WATERSHED CONCERNS

Runoff Volumes

- Impervious surfaces are increasing runoff volumes

Point sources (Figure 1 and Figure 2)

- Agricultural sources (i.e., wintering sites, confined feeding operations, on-stream watering and unmanaged livestock access)
- Calgary Airport - stormwater outfall (1)
- City of Airdrie - stormwater outfalls (38 as of 2004)
- City of Calgary - stormwater outfalls (80 as of 2004)
- Town of Crossfield - treated effluent release; stormwater
- Balzac complex – stormwater outfalls
- Acanthus Resources Ltd. – surface runoff runoff
- Procor Sulphor Services Inc. – surface runoff
- Amoco Canada Petroleum – surface runoff

Point source pollution is the release of contaminants through the outlet of a single conduit, such as a pipe or ditch.

Non-point source pollution, on the other hand, does not originate from one location. Diffuse runoff from land and pollutants deposited from the atmosphere cannot be attributed to a single point of origin.

Non-point sources

- Runoff from agricultural land (i.e., fertilized cropland, pastures)
- Runoff from golf courses

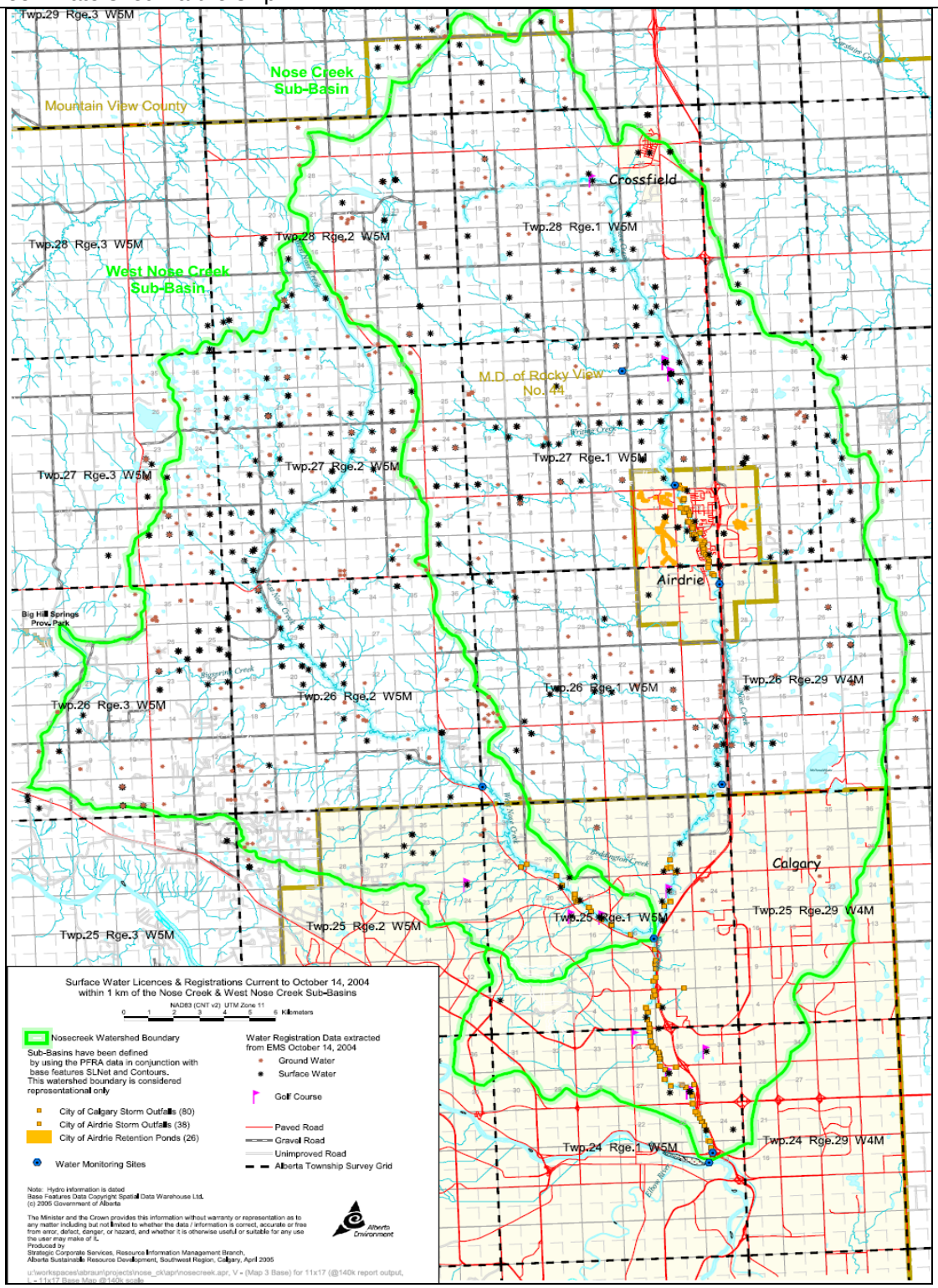

Figure 1. Map of Nose Creek watershed showing stormwater outfalls within Airdrie and Calgary, 2005.

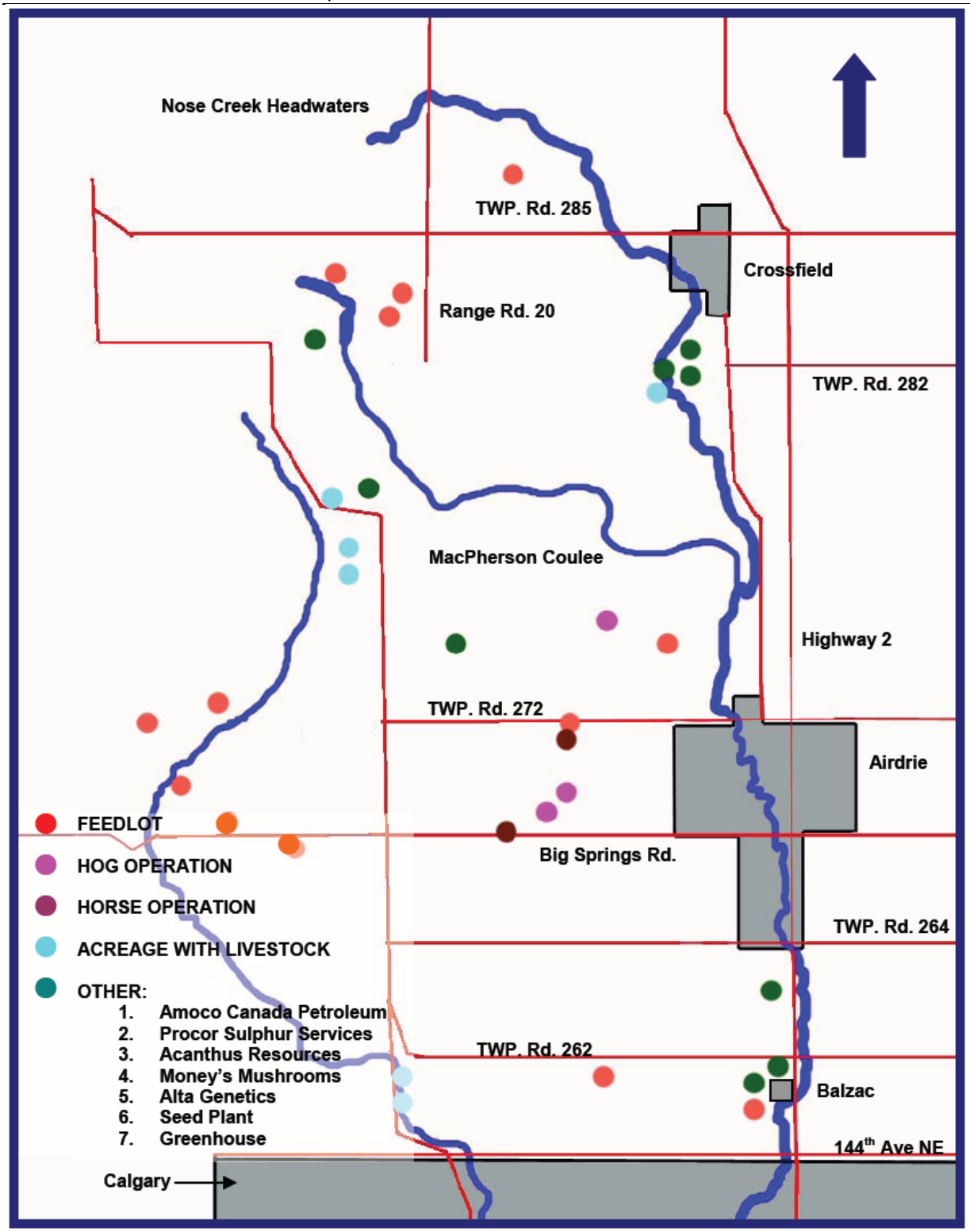

Figure 2. Map showing agricultural and industrial sites within the Nose Creek watershed above the City of Calgary (from Moxham 2002).

3.0 OBJECTIVES

The objectives for a water quality monitoring program in the Nose Creek watershed are to:

1. Respond to the recommendations in the Nose Creek Watershed Water Management Plan and the Bow River Basin Watershed Management Plan, Phase I: Water Quality Objectives,

2. Measure ambient water quality and quantity in Nose Creek and West Nose Creek to evaluate conditions with respect to established objectives and guidelines,

3. Maintain long-term records to examine trends in relationship to land cover and land use activities within the watershed, and

4. Report and disseminate findings to the public.

Since the Nose Creek watershed is under intense development pressure, it is recommended that a monitoring program be established that will span at least the next 10 years, with a program review occurring every 5 years.

4.0 GUIDING PRINCIPLES

Guiding principles for the Long-Term Water Monitoring Strategy will be:

- Collaborative - avoids duplication of effort and shares costs among partners
- Consistent, high quality data
- Reliable – samples are collected and analysed using proper protocol and certified laboratories
- Cost efficient – collects only essential data
- Timely presentation of results in a manner readily understood by the public (e.g., water quality index) – analyses data and report results on an annual basis

5.0 WATER MONITORING GUIDELINES, STANDARDS, OBJECTIVES AND CRITERIA

- Alberta Surface Water Quality Guidelines (Alberta Environment 1999)
- Bow Basin Watershed Management Plan, Phase 1: Water Quality (BRBC 2008)
- Canadian Council of Ministers for the Environment (CCME 1999)
- Nose Creek Watershed Water Management Plan (Palliser Environmental Services Ltd. 2007)
- Riparian Health Assessment for Streams and Small Rivers – Field Workbook (Fitch et al. 2001)

The Canadian Council of Ministers of the Environment (CCME) 1999) and Surface Water Quality Guidelines for Use in Alberta (Alberta Environment 1999) are frameworks for quantitative and qualitative measures of water quality indicators to support designated uses. Levels of protection required for each designation have been identified for drinking water, recreational use and aesthetics, protection of aquatic life, agricultural use (i.e. irrigation and livestock water) and industrial supplies. Alberta Environment (1999) defined levels of protection in a variety of ways, including:

Guidelines - Recommended limits of parameters that will support and maintain a designated water use. They are given as numerical concentrations or narrative statements.

Standards - Enforceable environmental control laws, set by government. Standards are typically applied to effluent or emissions by industry to maintain a level of environmental quality.

Objectives - Numerical concentrations or narrative statements that have been established to support and protect the designated uses of water at a specific site.

Criteria - Scientific data evaluated to derive recommended limits of parameters for water use.

6.0 SUMMARY OF WATER MONITORING ACTIVITY BY ORGANIZATION

The following summarizes the water monitoring activities by the main organizations working in the watershed, including discharge, water quality, fisheries and riparian assessments.

6.1 Water Quantity

Historically, Environment Canada, Water Survey of Canada, has measured discharge (i.e., flow) from Nose Creek at three sites (Table 1). Nose Creek at Calgary was located near Beddington Trail which drained an area of 893 km^2, including West Nose Creek. Nose Creek near Mouth was located at about Centre Avenue and drained an area of 986 km^2 (Madawaska Consulting 1999). Currently Environment Canada maintains one site on Nose Creek above Airdrie (Table 1). Alberta Environment continues to measure discharge at Nose Creek near the Mouth.

On West Nose Creek, discharge has been measured intermittently (Table 1). Two sites were established; one near Calgary, upstream of the City Limits, and the other near the confluence with Nose Creek. Currently, the University of Calgary measures discharge upstream of the City Limits and AENV will re-establish the site near the confluence with West Nose Creek.

Table 1. Summary of gauging stations on Nose Creek and West Nose Creek.

Date	Station	Location	N	W	Drainage Area
Nose Creek					
1911-1986	05BH003	Nose Creek at Calgary (includes West Nose Creek)	51° 7' 20''	114° 2' 45''	893 km^2
1980-1989 2000, 2001 2003-2008[z]	05BH901[a] Recorder (30 min interval – continuous during open season)	Nose Creek near Mouth	51° 3' 0'' 51 02' 52.7"	114° 1' 0'' 114 01' 11.3"	986 km^2
2005-2008	05BH014	Nose Creek above Airdrie	51° 18' 42''	114° 1' 39''	247.1 km^2
West Nose Creek					
1982-1995 2003, 2008[b]	05BH904 Recorder (daily+extreme) 1992 (5 min intervals) 1995 (15 min intervals)	West Nose Creek near Calgary Upstream of City Limits	51°12' 30"	114° 9' 40"	247 km^2
Aug 2002 to May 2003	Recorder (5 min intervals)	Near the Confluence of Nose Creek[c]	-	-	-

[a]Environment Canada site (1980-89); Maintained by Alberta Environment since 2000. The station is located under the Memorial Drive overpass EAST bound downstream from the old WSC gauging location but maintains the same station number 05BH901.
[b]Re-established in 2008 – no available details.
[c]A gauging station will be re-established here by AENV in 2009.

6.2 Water Quality

6.2.1 Alberta Environment

Alberta Environment has collected numerous samples for water quality in Nose Creek and West Nose Creek at nine instream sites and at two stormwater outfalls (Table 2). The frequency and duration of sampling, as well as sample parameters evaluated varied considerably at individual sites and among the nine sites. Samples have been collected from 1975 to as recently as 2004.

Table 2. Summary of Alberta Environment's water monitoring strategy at various sites in the Nose Creek watershed. **Also sampled by City of Calgary 2003 to 2008.

Site Location	Year	# of Sample Dates
Nose Creek Above Airdrie AB05BH0300	1980 1999 2000 2001 2007 to 2009	23 8 9 5 Not Available
Nose Creek below Airdrie AB05BH0310	1980 1999 2000 & 2001 2002 2007 to 2009	26 8 10 3 Not Available
Nose Creek near City Limits (Hwy 564) AB05BH0320	1980	33
Nose Creek above confluence with West Nose Creek AB05BH0330	1980	40
West Nose Creek at Hwy 722 AB05BH0340	1995	9
West Nose Creek on Mountain View Road off of Symons Valley Road** AB05BH2590	2001	6
West Nose Creek at 24 Street NW AB05BH0350	1980	34
West Nose Creek above confluence with Nose Creek AB05BH0360	1980	41
City of Calgary Storm Sewer # 27 (residential) AB05BH0250	1980	103
City of Calgary Storm Sewer # 13 (commercial) AB05BH0260	1980	32
Nose Creek near 144th Avenue** AB05BH2600	2001	6
Nose Creek near the Mouth AB05BH0370, 0380, 0390	1975 1980 1981 & 1982 1985 1986 1993 1994 1995 & 1996 2000 2001 2002 2004	1 85 1 11 1 16 3 2 53 56 47 2

6.3 City of Calgary

The City of Calgary monitors water quality at three sites in the Nose Creek watershed: Nose Creek at the Mouth (sampled since 1995); and Nose Creek at the City Limits (15 Street NE) and West Nose Creek at the City Limits (Mountain View Road NW), both sampled since 1999 (Table 3). Samples are analysed for a variety of physical, chemical and bacteriological parameters (Table 4) and were generally collected monthly from January through December (Table 5). The analytical data is always subject to QA/QC validation, but the database information has not gone through validation (i.e. transcription errors, etc.). Data collected from 1995 through 2001 was compiled in the four water quality reports completed for the NCWP from 1999 through 2002 (Madawaska Consulting 1999-2002). Data collected from 2002 through 2009 has not been compiled into a report.

Table 3. Summary of water monitoring sample locations sampled by the City of Calgary.

Site Name	Dates	Description	Location
WNC-01	1999-2009	West Nose Creek at City Limits at Mountain View Road NW	51.18328, 114.131
NOC-01	1995-2009	Nose Creek at Mouth (corresponds to AB05BH901 at Memorial Drive)	51.04523, 114.02
NOC-02	1999-2009	Nose Creek at City Limits (15 St. NE)	51.18575, 114.01

Table 4. Summary of parameters monitored by the City of Calgary every 4 weeks, except where noted (2008).

Routine Parameters			
pH		Hardness	
Conductivity (Field, YSI Model 85)		Colour	
Water Temperature (Field, YSI Model 85)		Total Suspended Solids	
Air Temperature (Field)			
Turbidity		Dissolved Oxygen, mg/L (Field, YSI Model 85)	
Alkalinity		Dissolved Oxygen, % Sat (Field, YSI Model 85)	
Nutrients			
Phosphorus, Total		Total Kjeldahl Nitrogen	
Phosphorus, Total Dissolved			
Anions Group			
Chloride		Nitrate+Nitrite	
Fluoride		Nitrite	
Nitrate		Sulphate	
Cations Group			
Ammonium		Potassium	
Calcium		Sodium	
Magnesium			
Organic Carbon			
Total Organic Carbon			
Silica *(Quarterly)*			
Silica			
Metals, Total *(Quarterly)*			
Aluminum	Cadmium	Manganese	Tin
Antimony	Chromium	Molybdenum	Titanium
Arsenic	Cobalt	Nickel	Uranium
Barium	Copper	Selenium	Vanadium
Beryllium	Iron	Silver	Zinc
Boron	Lead	Thallium	
Bacteria			
Total coliforms		*Escherichia coli*	

Stormwater Monitoring

The City of Calgary has been monitoring stormwater since 1994. From 2001 through 2003, eighteen urban areas with representative land uses were monitored to determine event mean concentrations (EMCs) for several parameters of concern identified by Alberta Environment. The EMCs were coupled with a hydrology model to estimate pollutant loading from stormwater. In more recent years, stormwater monitoring has focused on TSS loading from major storm trunks. In 2009, the City will monitor four major storm trunks. Two of the monitoring sites are located within the Nose Creek watershed. The City collects daily composite samples from May 1 to August 31 at these locations (P. Jerome, City of Calgary, pers. comm.)

6.4 City of Airdrie

The City of Airdrie has not collected water quality within a formal water quality monitoring program to date. In fall of 1998, there is record that the City collected 5 samples at or near Airdrie to evaluate stormwater impacts (Madawaska Consulting 1999); however, no results have been reported at this time.

Water quality monitoring is a requirement placed on developers during construction. In 2008, Genesis Land Developments collected water quality data to provide to the City of Airdrie. Results from this monitoring were reported in May, July and August and was limited to turbidity and total suspended solids data.

6.5 Town of Crossfield

The Town of Crossfield discharges its treated effluent into Nose Creek annually. As part of their licence, the Town is required to sample the effluent quality prior to discharge.

No information has been provided to date regarding monitoring in Nose Creek.

6.6 Calgary Airport Authority

The Calgary Airport Authority releases treated runoff to Nose Creek when their aerated retention pond is full and water quality objectives are met. The retention pond is sampled twice to ensure the effluent meets discharge criteria for seven parameters (Table 5). The Calgary Airport Authority informs Alberta Environment and the City of Calgary when the release occurs. Volumes are highly variable (Table 5) and releases typically occur before June to lower pond levels prior to the typical higher rainfall period. In 2007 and 2008, releases occurred in July. The Authority pumps effluent to the Bonnybrook Wastewater Treatment Plant during the entire de-icing season (September to May).

Table 5. Summary of monitoring parameters and results provided by the Calgary Airport Authority, 2004 to 2007.

Parameter	Range
BOD (mg/L)	<2 - 46
COD (mg/L)	20 - 55
TOC (mg/L)	5 - 18
Oil and Grease (mg/L)	<0.2 – 10.5
TSS (mg/L)	<1 - 29
pH (mg/L)	7.61 – 8.40
Glycol (mg/L)	<10 - <25
Pump Rate (L/s)	300
Discharge (m^3)	10,260 to 173,880

In 2009, the Calgary Airport Authority plans to collect water samples from Nose Creek upstream of Airport Trail and Deerfoot Trail above their stormwater outfall. Stormwater discharges to the creek via the City of Calgary's stormwater distribution network. A second sampling location will be implemented downstream of the outfall, at the Calgary Airport Authority boundary. This information will provide background data prior to stormwater release.

6.7 Nose Creek Watershed Partnership

In 1999, the Nose Creek Watershed Partnership contracted Madawaska Consulting to compile the results of historical water quality monitoring (1980 to 1999) (Madawaska Consulting 1999).

In addition, the Nose Creek Watershed Partnership requested Alberta Environment to re-initiate a water quality monitoring program in the watershed. Water quality samples were taken monthly at five sites (Table 6) by Alberta Environment and the City of Calgary from 1999 through 2001. In addition, Alberta Environment collected water quality samples at all five sites for pesticide analysis (monthly from May to August) and priority pollutant analysis (September) (Madawaska Consulting 2000).

Table 6. Summary of water quality monitoring program 1999 through 2001, Nose Creek watershed.

Number and Site	Location	1999	2000	2001
5 - Nose Creek above Airdrie (AB05BH0300)	Upstream of 8th Street, north of Hwy 567	May - Nov monthly	Jan - Aug monthly	Jan - Aug monthly
4 - Nose Creek below Airdrie (AB05BH0310)	Just west of Hwy 2, downstream of Big Springs Rd.	May - Nov monthly	Jan - Aug monthly	Jan - Aug monthly
3 - West Nose Creek at Calgary City Limits	At Mountain View Rd NW	Mar - Nov monthly	Jan - Sep monthly	Jan - Aug monthly
2 - Nose Creek at Calgary City Limits	Near 144 Avenue	Jan - Nov twice / month	Jan – Sep twice / month	Jan – Dec twice / month
1 - Nose Creek at the Mouth(AB05BH901)	At Memorial Drive	Mar – Nov monthly	Jan - Sep monthly	Jan - Dec monthly

Water samples were analysed for temperature, dissolved oxygen, total suspended solids, salinity and major ions, nutrients, bacteria, metals, pesticides and priority pollutants. Annual reports that summarized the water quality data were completed for the years 1999 and 2000. A final report was also completed that included a summary of the monitoring program from 1999 through 2001 (Madawaska Consulting 2002). To date, this is the most recent comprehensive report detailing water quality in the Nose Creek watershed.

Alberta Environment discontinued the sampling program in 2004 and planned to resume the program again in 2009. However, budget constraints did not allow the program to continue. Meanwhile, the City of Calgary has continued with monthly sampling at sites #1, 2 and 3.

6.8 Other Water Quality Monitoring Studies

Madawaska Consulting (1999) reported that the sources of total dissolved solids in Nose Creek were investigated using chemical and stable isotope analyses (Grasby et al. 1997). The same author reported that pesticides were sampled at two sites in the watershed as part of a study in the Western Headworks Canal (Byrtus 1999).

6.9 Fisheries Assessments

Limited fisheries data is available for the Nose Creek watershed and much of this information has been collected in an *ad hoc* manner (i.e., fish salvages, community awareness, biophysical impact assessments (BIAs) for specific projects). Fisheries information was collected from 2004 to 2007 by Trout Unlimited Canada and various consultants at a limited number of locations, while just three fisheries assessments were conducted on West Nose Creek (Table 7). Six species of forage fish have been documented in the Nose Creek watershed. One brown trout was captured in Laycock Park, the most downstream location that has been studied to date (Palliser Environmental Services Ltd. 2007).

Table 7. Historical fish sampling at Nose Creek and West Nose Creek, Alberta.

Sampling Organization	Date	Sampling Methods	Species Captured - Numbers	Location
Nose Creek				
Palliser Environmental Services Ltd.	October 9, 2007	minnow traps, electrofishing	brown trout – 1 white sucker – 22 longnose sucker – 6 lake chub – 11 longnose dace – 14 brook stickleback – 1	Laycock Park (Calgary)
Clearwater Environmental Consultants	May 8, 2006	electrofishing	white sucker – 2 lake chub – 3 longnose dace – 7 brook stickleback – 2	51.099366, -114.053352 (Calgary)
Pisces Environmental Consulting Services Ltd.	July 3, 2007	electrofishing, seine	white sucker – 87 lake chub – 14 brook stickleback – 158 fathead minnow – 168	51.174769, -114.019621 (Calgary)

Sampling Organization	Date	Sampling Methods	Species Captured - Numbers	Location
Pisces Environmental Consulting Services Ltd.	June 5, 2007	electrofishing, seine	white sucker – 90 longnose sucker – 1 lake chub – 112 longnose dace – 1 brook stickleback – 166 fathead minnow – 266	51.174769, -114.019621 (Calgary)
Pisces Environmental Consulting Services Ltd.	August 11, 2007	electrofishing	white sucker – 440 longnose sucker – 4 lake chub – 264 longnose dace – 57 brook stickleback – 96 fathead minnow – 163	51.178085, -114.011601 (Calgary)
Alberta Sustainable Resource Development	November 20, 2007	electrofishing	white sucker – 2 longnose sucker – 1 brook stickleback – 1	51.207284, -113.996951 (south of Airdrie)
Jacques Whitford Ltd.	May 19, 2004	electrofishing	white sucker – 13 lake chub – 7 longnose dace – 2 brook stickleback – 49	-immediately south of Big Hill Spring interchange (south limit of Airdrie)
Trout Unlimited Canada	June 3, 2006	electrofishing	white sucker – 12 lake chub – 38 longnose dace – 2 brook stickleback – 460 fathead minnow – 55	51.279913, -114.01088 (Directly below outfall of Airdrie Pond, Airdrie)
Trout Unlimited Canada	April 26, 2007	electrofishing	brook stickleback - 28 white sucker - 11 fathead minnow – 34 lake chub – 6	51.280098, -114.010198 (Airdrie)
Trout Unlimited Canada	June 2, 2007	electrofishing	brook stickleback - 6 white sucker - 43 fathead minnow - 23 lake chub – 19	51.280098, -114.010198 (Airdrie)
Clearwater Environmental Consultants	August 8, 2005	seine	lake chub – 34 brook stickleback – 11 fathead minnow – 6	Bridge Crossing at Highway 56 (Airdrie)
Trout Unlimited Canada	June 7, 2008	electrofishing	brook stickleback - 12 lake chubb - 3 fathead minnow – 27	Nose Creek Park in Airdrie
West Nose Creek				
Unknown	1998	minnow traps	white sucker lake chub brook stickleback	Near confluence with Nose Creek
EnviroConsult Inc.	October 2002	unknown	white sucker – 3 lake chub – 40 longnose dace – 5 brook stickleback – 12	Sampling conducted for Stoney Trail extension

Sampling Organization	Date	Sampling Methods	Species Captured - Numbers	Location
Dillon Consulting Ltd.	August 14, 2006	seine	white sucker – 2 lake chub – 39 longnose dace – 5 brook stickleback – 65 fathead minnow – 1	51.167894, -114.27601

6.10 Riparian Health Assessments

The Alberta Riparian Habitat Management Society (Cows and Fish) conducted a riparian health assessment in 2000 along 17.3 km of Nose Creek and 10.7 km of West Nose Creek (Cows and Fish 2001). Figure 3 summarizes the results of the study which indicate that the West Nose Creek riparian area is in slightly better condition than Nose Creek.

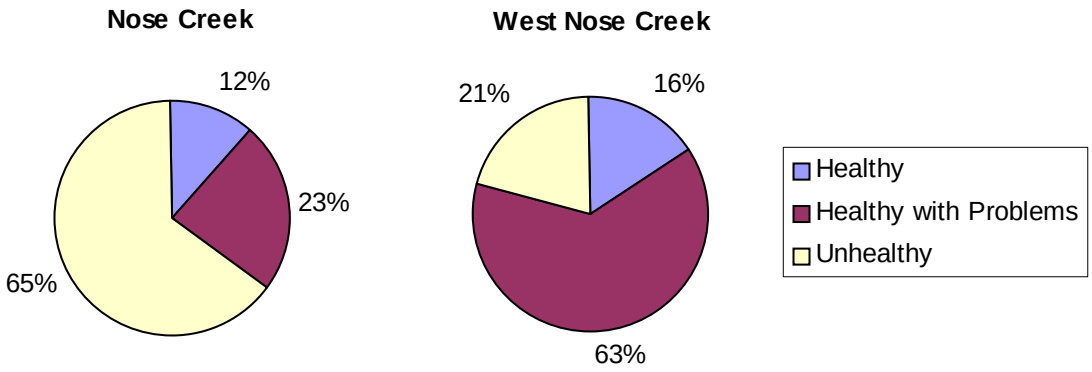

Figure 3. Results of riparian health assessments completed by Cows and Fish, 2000.

In 2007, Palliser Environmental Services Ltd. revisited 20 sites on Nose Creek and 22 sites on West Nose Creek (Palliser Environmental Services Ltd. 2007). Photos and observations compared current conditions with those observed by Cows and Fish in 2000 (Table 8 and Table 9).

For Nose Creek, the most common disturbance indicator for degraded sites was associated with development pressures such as channel realignment, golf courses and residential development. In order to preserve riparian areas it is recommended that approvals for development be in accordance with the Nose Creek Watershed Water Management Plan.

For West Nose Creek, the most common disturbance indicator for degraded sites was associated with cattle grazing. In order to preserve riparian areas it was recommended that the MD of Rocky View undertake an education and awareness program to assist with the implementation of best management practices (BMPs) for cattle grazing within riparian areas.

Although development pressures were not as evident at West Nose Creek, it is expected that development pressures will increase in the future. In order to preserve riparian areas it is recommended that approvals for development in West Nose Creek be in accordance with the Nose Creek Water Management Plan.

Table 8. Summary of benchmark photographic assessment of riparian health at Nose Creek.

= improved = unchanged = degraded

	Site Name	Bank Stability	Disturbance Indicators	Conditions Since 2000
RIPARIAN SITES PREVIOUSLY ASSESSED IN 2000				
Upstream	NOS15 - upper	moderately unstable to stable	mowing, soil stockpiling	degraded
	NOS15 - lower	moderately unstable	mowing	degraded
	NOS16 - upper	stable	cattle grazing	improved
	NOS16 - lower	stable	cattle grazing	unchanged
	NOS2 - upper	stable	flooding	unchanged
	NOS2 - lower	stable	none	unchanged
Midstream	NOS17 - upper	n/a	channel relocation, residential development	destroyed
	NOS17 - lower	stable	railroad tracks, housing, stormwater pond, mowing, landscaping	unchanged
	NOS4 - upper	stable	mowing/landscaping, bridge	improved
	NOS4 - lower	stable	mowing/landscaping, bridge, culvert	improved
	NOS19- upper	unstable to stable	cattle grazing	degraded
	NOS19 - lower	stable	cattle grazing, bridge	unchanged
Downstream	NOS10 - upper	moderately unstable	highway, power line, railroad, pedestrian pathway, power station	unchanged
	NOS10 - lower	moderately unstable	highway, power line, railroad, pedestrian pathway	unchanged
	NOS5 - upper	stable	bridge, culvert, riprap	unchanged
	NOS5 - lower	stable	bridge	improved
	NOS8 - upper	moderately unstable to stable	culvert, bridge, mowing	degraded
	NOS8 - lower	moderately unstable to stable	golf course, trails-human, flooding, bridge	degraded
	NOS9 - upper	unstable	bridge, power lines, railroad tracks, trails-human	degraded
	NOS9 - lower	moderately unstable	bridge, railroad tracks, trails-human	unchanged
	Site Name	**Bank Stability**	**Disturbance Indicators**	**Present Conditions**
RIPARIAN SITES ADDED IN 2007 – NEW				
Upstream	Twp. Rd. 255 - upper	stable	none	healthy
	Twp. Rd. 255 - lower	stable	cattle grazing	degraded
	Crossfield - upper	moderately unstable to stable	flooding	healthy
	Crossfield - lower	stable	cattle grazing	moderately impacted
Midstream	Highway 567 - upper	moderately unstable	Wide riparian area. Bridge, riprap, residential development, pathway	healthy
	Highway 567 - lower	stable	channel relocation, residential development	degraded
	NOS17 - upper (alt.)	stable	channel relocation, residential development, pathway	degraded
	Balzac - upper	moderately unstable	exposed banks, channel relocation	degraded
	Balzac - lower	moderately unstable	exposed banks, channel relocation	degraded
Down-stream	Country Hills Blvd. - upper	stable	bridge, moderate density of weeds	moderately impacted
	Country Hills Blvd. - lower	stable	bridge, moderate density of weeds	moderately impacted

Table 9. Summary of benchmark photographic assessment of riparian health at West Nose Creek.

= improved = unchanged = degraded

RIPARIAN SITES PREVIOUSLY ASSESSED IN 2000				
	Site Name	**Bank Stability**	**Disturbance Indicators**	**Conditions Since 2000**
Upstream	WNO7 - upper	unstable	cattle trails, flooding	unchanged
	WNO7 - lower	unstable	culvert, flooding	unchanged
	WNO9 - upper	moderately unstable	none	unchanged
	WNO9 - lower	unstable	flooding	unchanged
	WNO10 - upper	unstable	beaver, flooding	unchanged
	WNO10 - lower	unstable	cattle grazing, beaver	unchanged
	WNO15 - upper	unstable	cattle trails	degraded
	WNO15 - lower	unstable	flooding	unchanged
	WNO14 - upper	unstable	flooding, cattle trails	improved
	WNO14 - lower	unstable	flooding	unchanged
Midstream	WNO16 - upper	stable	cattle grazing, cattle trails, flooding	unchanged
	WNO16 - lower	stable	cattle grazing, cattle trails, flooding	unchanged
	WNO17 - upper	moderately unstable to unstable	cattle grazing, flooding	degraded
	WNO17 - lower	moderately unstable to unstable	cattle grazing, cattle trails, flooding	degraded
	WNO12 - upper	unstable	cattle grazing, cattle trails	degraded
	WNO12 - lower	moderately unstable	cattle grazing, cattle trails	degraded
	WNO11 - upper	moderately unstable	cattle grazing, cattle trails	degraded
	WNO11 - lower	moderately unstable	cattle grazing, cattle trails	degraded
Downstream	WNO19 - upper	stable	mowing/landscaping	unchanged
	WNO19 - lower	stable	mowing	degraded
	WNO18- upper	moderately unstable	none	improved
	WNO18 - lower	moderately unstable	trails - human, bridge, flooding	improved
RIPARIAN SITES ADDED IN 2007 – NEW				
	Site Name	**Bank Stability**	**Disturbance Indicators**	**Present Conditions**
Up-stream	Big Hills Springs Rd. - upper	stable	culvert	degraded
	Big Hills Springs Rd. - lower	stable	culvert, cattle trails	degraded

7.0 DATA TRENDS

Water quality monitoring data has been collected at irregular intervals over the past 30 years. Cross (1999) indicated that the most comprehensive water quality data dates back to 1980. In that study, Schonekess (1981) found that concentrations of various chemicals were generally lower in rural areas than at the urban sites for dry-weather or weekly sampling. During storm periods, concentrations increased greatly at urban sites and only slightly in rural areas. In some cases, water quality improved in the rural areas downstream of urban centres. In West Nose Creek, runoff from Beddington Heights was identified as contributing to poor water quality (Schonekess 1981). Furthermore, flows in the urban areas were found to increase from 10 to 60 times normal dry-weather flows during storm events.

More recent water quality studies (1999, 2000, 2001), undertaken by the Nose Creek Watershed Partnership, show similar water quality trends as historical data. Since 1980, total suspended solids have increased in West Nose Creek, indicating more sediment in the water (Cross 2002). Trend analysis was limited by the lack of a consistent, long-term water quality monitoring program during the last 30 years. Table 10 compares some water quality variables with water quality guidelines.

Table 10. Summary of present water quality (1999-2001) in comparison with recommended water quality guidelines and target compliance objectives set by the NCWP.

Variable	Target Compliance Objective (%)	Sample Compliance with Water Quality Guidelines[a] (%)	Water Quality Guidelines for Aquatic Life (mg/L)
pH	95	94	6.5 – 9.0
Dissolved Oxygen	95	49	5.0 – 9.5
Total Phosphorus (TP)	95	4	0.05
Soluble Reactive Phosphorus (SRP)		Not determined	No guideline
Total Nitrogen (TN)	95	7	1.0
Total Kjeldahl Nitrogen (TKN)		Not determined	No guideline
Ammonia-Nitrogen (NH_3-N)	95	92	0.08 – 2.5
Total Suspended Solids (TSS)	95	Not determined	Not greater than 10 above background
Biochemical Oxygen Demand (BOD_5)		Not determined	No guideline
Fecal Coliforms (FC)	95	59	200/100 mL[b]
Escherichia coli (E. coli)	95	66	200/100 mL

[a]Cross 2002
[b]Guideline for contact recreation

The main concerns identified were nutrients, total dissolved solids, fecal coliform bacteria, salinity and dissolved oxygen. In terms of metals, the main concerns were iron, aluminum, cadmium, chromium, manganese, selenium and mercury. Dicamba, and MCPA were the two most frequently detected pesticides that exceeded recommended water quality guidelines.

Since 1980, water quality trends in Nose Creek are:

- pH, total dissolved solids and copper are increasing at the Mouth
- dissolved phosphorus and lead are decreasing at the Mouth
- biochemical oxygen demand, total suspended solids, sulphate, aluminum and iron are increasing above Calgary

- potassium, nitrate and total coliform bacteria are decreasing above Calgary

8.0 LONG-TERM WATER MONITORING STRATEGY

8.1 Water Indicators

The indicators used in the Nose Creek Long-Term Water Monitoring Strategy are those that have a guideline, standard, objective or criteria established either by the Federal or Provincial governments, the Bow River Basin Council or the Nose Creek Watershed Partnership. Table 11 summarizes the indicators and water quality objectives and targets that have been established by the Bow River Basin Council and other government agencies. The NCWP may choose one of three options to adopt for the Long-Term Water Monitoring Strategy:

1) Monitor parameters that have been designated indicators by the Bow River Basin Council and others (Table 11),
2) Monitor parameters that are monitored by the City of Calgary (Table 4) ,
3) Reduce the number of parameters to only those essential for identifying changes in quality across the watershed, while maintaining some consistency with City of Calgary parameters (e.g., a subset of City of Calgary's monitoring program) (Table 12). This is the most economical program for a long-term strategy.

Table 11. Summary of indicators identified in the BRBC Watershed Management Plan. Note: ASWQG guidelines were identified where appropriate.

Indicator	WQO/Target
Water Temperature	Should not exceed 29^{o}C at any time or a 7 day mean of 24^{o}C.[a]
Dissolved Oxygen	5.0 mg/L (acute daily min); 6.5 mg/L (7-day avg)[b]
Attached Algae (Periphyton biomass defined as chlorophyll *a*)	No periphytic algal biomass that adversely affects users. 150 mg/m^2 maximum value during open water season.
Nitrate (Nitrate + Nitrite N)	1.5 mg/L. Eliminate levels that cause nuisance aquatic plant growth.
Total Ammonia	US EPA during the growing season for growth of aquatic vegetation. To apply outside of the mixing zone (AENV 1995). (0.08 – 2.5 mg/L ASWQG)
Total Nitrogen	1.0 mg/L[b]
Total Dissolved Phosphorus	To be developed.
Total Phosphorus	To be developed. Reduction in number of exceedences of the ASWQG (0.05 mg/L).
Total Suspended Solids	To be developed. Maintain and then reduce TSS loadings from current levels. (Not greater than 10 above background (ASWQG))
Pathogens as indicated by Fecal Coliforms	Meet 100 fecal coliforms per 100 mL (no single value to exceed objective at the point of withdrawal)
Pesticides and degradation products	Not recommended at this time. Should not exceed CCME guidelines for aquatic life in the river.
Metals	Should not exceed CCME guidelines for aquatic life in the river.*
Riparian Condition	W. Nose Creek: a healthy rating; Nose Creek: a healthy but with problems rating
Runoff, soil erosion and impervious areas	Impervious and runoff recommendations as detailed in the Nose Creek Watershed Water Management Plan.

[a]This is likely too warm if trout are to survive in Nose Creek.
[b]The Alberta Surface Water Quality Guideline.

Table 12. Recommended parameters for the Nose Creek Watershed Partnership.

Routine Parameters (Collected in-situ using muli-parameter water quality meter)	
Air Temperature Water Temperature pH	Conductivity Total Dissolved Solids Dissolved Oxygen, mg/L and % Sat
Nutrients	
Phosphorus, Total Phosphorus, Total Dissolved	Total Kjeldahl Nitrogen
Anions Group	
Chloride Fluoride Nitrate + Nitrite (as N)	Nitrite (as N) Sulphate
Cations Group	
Ammonium (as N) Calcium Magnesium	Potassium Sodium
Other	
Total Suspended Solids Carbonaceous Biochemical Oxygen Demand	Discharge (measured using water velocity meter)
Bacteria	
Fecal Coliforms	
Metals	
Monitored quarterly by the City of Calgary[a]	
Pesticides	
Monitored every three years by Alberta Environment[a]	
Optional	
Periphytic Chlorophyll *a* (to meet BRBC WMP recommendation)	

[a]There is likely no need for the NCWP to sample metals and pesticides beyond what is currently being done by City of Calgary and Alberta Environment. If these programs are terminated, the NCWP can re-visit the sampling requirements.

8.2 Sampling Locations

Aquatic ecosystems are in constant flux. The results of water quality monitoring programs are influenced by contamination sources, and

- weather conditions,
- hydrologic conditions (i.e., flow conditions),
- sampling frequency,
- spatial variability (i.e., sampling location), and
- temporal variability (i.e., time of day or year) (Cooke et al. 2000).

At the very least, water quality and quantity monitoring should occur upstream and downstream of each major centre in the watershed. However, to meet the objectives of the Long-Term Water Monitoring Strategy, a minimum of 10 sites are recommended (Table 13; Figure 4). Three of these sites are monitored by the City of Calgary and two sites were monitored by Alberta Environment on a five year rotation (i.e., three years consecutive monitoring followed by five years unmonitored). The latter two monitoring locations were terminated in 2009 due to budget constraints.

Overall,

- Sites should be easily accessible during all seasons and in all types of weather, and
- Sites should represent variety of land uses within the watershed.

Table 13. Surface water quality monitoring locations for the Nose Creek watershed. The sites marked in yellow continue to be monitored by the City of Calgary.

Site	Location
NC 1	Nose Creek Upstream of Crossfield (New)
NC 2	Nose Creek Downstream of Crossfield (New)
NC 3	Nose Creek above Airdrie (AB05BH0300) (Existing)
NC 4	Nose Creek below Airdrie (AB05BH0310) (Existing)
NC 5	Nose Creek at 15th Street (City Limits) (Existing)
NC 6	Nose Creek Upstream of confluence with West Nose Creek (ABO5BH0330) (Existing)
NC 7	Nose Creek at the Mouth (AB05BH2600) (Existing)
WNC 1	West Nose Creek Headwaters (New)
WNC 2	West Nose Creek Upstream Mountain View Rd NW (AB05BH2590) (Existing)
WNC 3	West Nose Creek Upstream of confluence with Nose Creek (AB05BH0360) (Existing)

Note: As the City of Calgary and City of Airdrie continue to expand, water monitoring locations should be added to document new city limits. Old City Limit sites should be phased out after three years.
Note: The sites NC3 and NC4 were monitored by AENV on five-year cycles for a duration of three years each cycle. In 2009, this program was cancelled due to budget constraints.

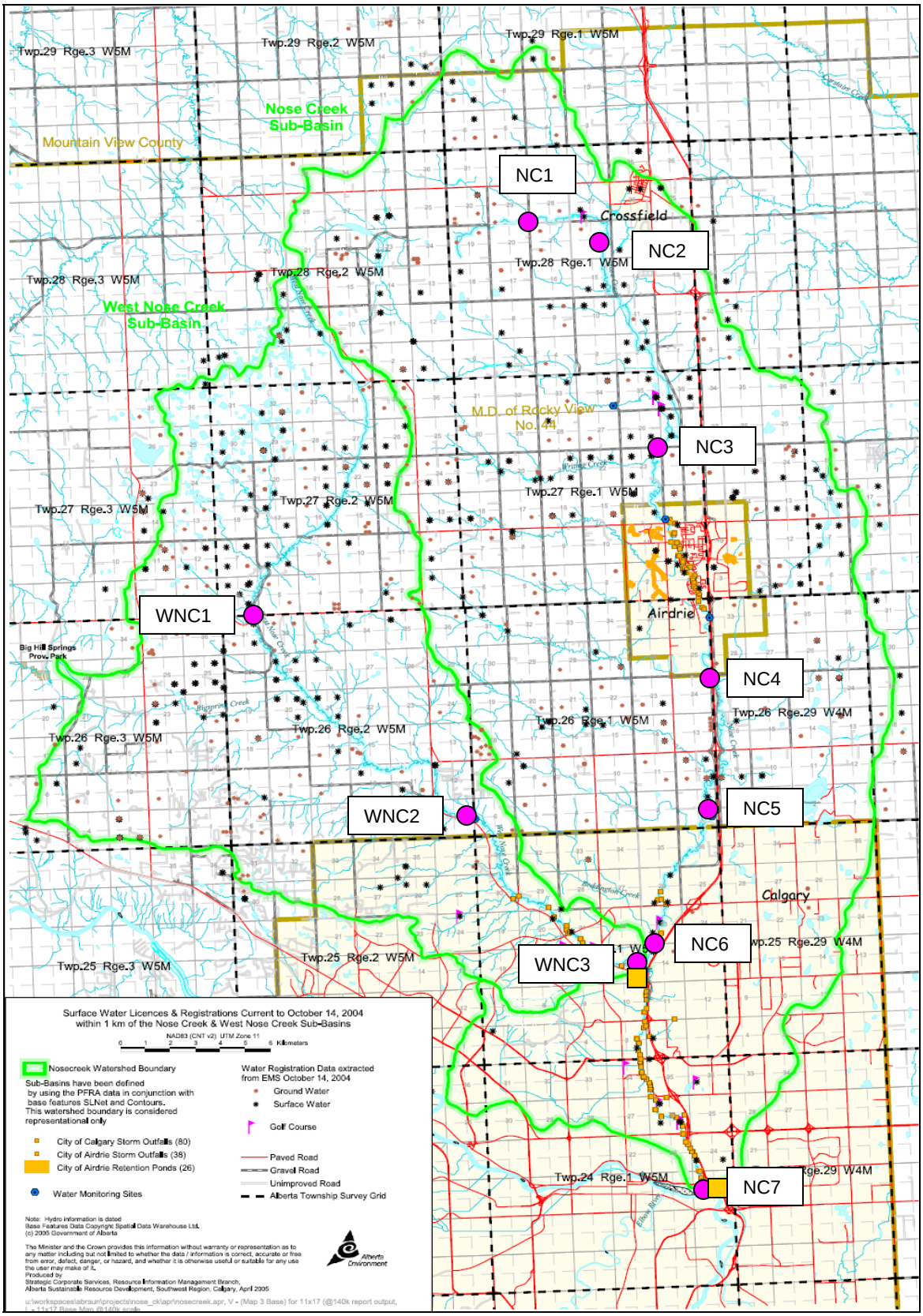

Figure 4. Map of proposed water quality monitoring sample locations for the Nose Creek watershed. Note sample locations are approximate.

Stormwater

In addition to surface water quality monitoring, stormwater monitoring is recommended to understand runoff water quality generated in urban centres. Historically, City of Calgary stormwater outfalls 13 (AB05BH0260) and 27 (AB05BH0250) were monitored by Alberta Environment to better understand runoff quality from commercial and residential areas, respectively. Currently, four stormwater outfalls are being monitored by the City of Calgary to determine the impacts of the City on TSS concentrations in the Bow River.

The City of Calgary should expand the TSS monitoring program to include the full parameter list outlined in Table 12 during large runoff events. In addition, two sites should be identified for similar monitoring in the City of Airdrie.

8.3 Frequency

Infrequent sampling of streams or sampling only during low flow periods may result in information that does not adequately characterize the stream's overall water quality. To fully describe water quality, the calculation of mass loads and flow proportionate sampling is required (Cooke et al. 2000).

Mass load is the total amount of a substance transported by a stream.

Flow proportionate sampling requires that more samples are collected during high flows and fewer samples collected during low flows.

In the Nose Creek watershed, water quality should be monitored twice per month from March through June and monthly from July through November at all sites. Nose Creek at the Mouth and West Nose Creek at the confluence with Nose Creek should each be sampled monthly from December through February. Spring runoff and rainfall events should be evaluated by monitoring more frequently, such as daily or bi-weekly, depending on the intensity and duration of the event.

8.4 Equipment Requirements

Optimally, stilling wells, equipped with a float pot and data logger, should be installed at each site to collect continuous flow data at 20 minute intervals. In addition, a staff gauge should be placed at each site for manually recording flow. However, equipment may be subject to vandalism. Alternatives may include a staff gauge with regular collection of discharge data using a water velocity meter at time of sampling. A flow curve may be generated from flow monitoring and calibrated to a staff gauge at each site. At each water quality sampling, the staff gauge should be read and recorded for future flow analysis.

8.5 Reporting

Although a variety of parameters have been collected in the past, there has been limited reporting of results. Annual reports should be prepared and a summary report completed every 3 to 5 years. The results should be disseminated to all Nose Creek Watershed partners and to the public at an Annual General Meeting or Annual Public Information Forum.

9.0 PARTNER ROLES AND RESPONSIBILITIES

There are a number of different roles to be filled to meet the objectives of the Long-term Water Monitoring Strategy (Table 14).

Table 14. Summary of partner roles and responsibilities.

Partner	Responsibility
NCWP	- Overall project management - Data storage - Results dissemination
AENV	- Data storage - Technical and financial support - Discharge data collection
Town of Crossfield, City of Airdrie, MD of Rocky View, Calgary Airport, City of Calgary, Bow River Basin Council	- Technical and financial support
University of Calgary	- Technical support - Data collection a. invertebrate sampling b. epilithic algae collection
Consultant/University of Calgary or NCWP	- Data collection and reporting

10.0 BUDGET REQUIREMENTS

10.1 Surface Water Quality

Table 15 summarizes the annual costs associated with the Long-Term Water Monitoring Program surface water quality element. The budget estimate may vary, annually, depending on labour and laboratory rates. The budget does not include GST or third party disbursements if laboratory costs must be covered. Discounts may be applied by the laboratory. The total cost can be divided among the NCWP partners according to the number of sites within each jurisdiction.

Table 15. Budget estimate for the 2010 water monitoring program using the reduced parameter list and consultant services for sites NC1, NC2, NC3, NC4, NC6 and WNC1. Costs for NC5, NC 7, WNC2 and WNC3 are covered by the City of Calgary.

Item	Description	Rates	Cost
Analytical Cost (TP, TDP, TSS, Fecal Coliforms)	10 trips x 6 sites = 60 samples + QA/QC	101.75 per sample	6,317.50**
Labour – sampling (discharge, pH, DO, Temperature, TDS, Conductivity)	April-June (2), once in each of July, August, September & October (10 trips)	170 hrs x 80.00/hr (includes 2 people for discharge measurements)	13,600.00
Labour - Reporting		30 hrs x 80.00/hr	2,400.00
Equipment	Swoffer velocity meter (75.00*) DO meter (50.00*), pH (20.00*) and TDS/Conductivity meter (10.00*)	10 x 155.00 per day	1,550.00
Mileage	10 trips	10 x 0.75 x 350 km	2,625.00
Office Fee (5% of Labour)			800.00
Total			**$ 27,292.50*** **

*Daily rate.
**Note that all sites will likely not be flowing throughout the entire sampling season. Costs will be reduced accordingly.
***GST not included.

Table 16. Approximate cost summary for each partner (updated for 2010).

Jurisdiction	Sites		Amount
Town of Crossfield	NC2		4,548.75
City of Airdrie	NC3 and NC4		9,097.50
MD of Rocky View	NC1, WN1		9,097.50
Calgary Airport Authority	NC 6		4,548.75
		Sub-Total	**$ 27,292.50**
City of Calgary	NC 5, NC 7, WN2, WN3		13,193.60[a]
		Total	**40,486.10**

[a]Note this work is ongoing for all sites, except WN3. Any costs incurred for these sites would be provided inkind. The City of Calgary has provided the estimate of $13,464.00 annually to monitor the three existing sites (NC5, NC7, WN3). Note that this cost includes a more comprehensive analytical package than the proposed monitoring program.

10.2 Other Indicators

10.2.1 Fisheries Assessment

A fisheries assessment is recommended at 8 sites in the watershed, to take place every 5 years. Five sites should be located on Nose Creek and 3 sites should be located on West Nose Creek (Table 17).

Table 17. Summary of costs associated with a fisheries assessment in the Nose Creek watershed.

Activity	Description	Time	Rate	Cost
Mileage		3 trips	$ 0.65/km	$ 975.00
Manpower (P.Bio.+ technician)	3 sites on WNC, 4 sites on NC	3 days/12 hrs per day	$ 185.00/hr	$ 6,660.00
Equipment	Backpack Electrofisher	3 days	$ 200.00/day	$ 600.00
Report		40 hours	$ 125.00/hr	$ 5,000.00
			Total	**$ 14,235.00**

10.2.2 Riparian Health Assessment

Riparian health assessments and/or inventories should be completed every 10 years, by the Alberta Riparian Habitat Management Society (Cows and Fish). The 10 year rotation may be staggered such that a few sites are monitored every year, and all sites would be revisited within a 10 year timeframe. Landowners should be encouraged to take photos of their riparian areas at regular intervals at sites consistent with those described in Palliser Environmental Services Ltd. (2007).

Table 18. Summary of costs associated with riparian health monitoring in the Nose Creek watershed.

Activity	Timeframe		Cost
Cows and Fish Program	10 year interval or staggered with a few sites monitored each year	$ 800.00 per polygon, 30 sites	$ 24,000.00

11.0 REFERENCES

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Appendix A. BRBC WQO Recommendations for Nose Creek

Total Suspended Solids WQO and research: A total suspended solids WQO should be developed for Nose Creek. Research is required to identify the anthropogenic causes of total suspended solids in Nose Creek and how it compares in quantity to natural causes (NCWP; Long-Term: 2013-2014).

Dissolved Oxygen Monitoring: Enhanced monitoring of DO is required to better characterize and understand low nocturnal DO concentrations (AENV/City of Calgary; Short-Term Goal: 2008-10).

Periphyton Biomass: Future water quality monitoring should include the collection of periphyton biomass (as chlorophyll *a*). (AENV; Short-Term: 2008-10)

Peak and Base Flows: Further research is needed to compare the frequency and magnitude of base and peak flows. Storm events should remain within the range of pre-development conditions (pre-1970s) (NCWP; Short-Term: 2008-10).

Total Phosphorus Reductions: Responsible for working to reduce total phosphorus and total dissolved phosphorus. Conduct research into the primary productivity of Nose Creek (NCWP; Medium-Term: 2011-2012).

Enhanced stream and stormwater flow monitoring at various points throughout the system is needed to assist in the identification of the impervious and runoff targets (City of Calgary; Short-Term Goal: 2008-10)

Appendix B. Work Plan 2009 (as designed at the February 6, 2009 meeting)

- Analyse existing data

- Collect samples from 6 existing sites (same parameters as typical)
  - NC Airdrie Upstream – discharge, AENV sampling
  - NC Airdrie Downstream – AENV sampling
  - NC Calgary City Limits – Calgary sampling
  - NC Mouth – discharge, Calgary sampling
  - WNC Calgary City Limits – discharge, Calgary sampling
  - WNC at the mouth – AENV

- Implement discharge measurements on Nose Creek Downstream of Airdrie
  - Maybe model M. Hayashi's gauging station set up
  - Ultrasonic sensors - $ 2000.00 (Yin – from suppliers)
  - Vented pressure transducers – more maintenance

- Reporting and data sharing 2009
  - University of Calgary, Environmental Science 502 class to prepare results of the 2009 sampling year and provide by September 2010 (C. Ryan to oversee this process and ensure report is completed to high standard).

Appendix C. Summary of water quality parameters measured in the City of Calgary's water quality monitoring program from 2003 through 2007.

Parameter	2003	2004	2005	2006	2007
Water Temperature	x	x	x	x	x
TSS	x	x	x	x	x
TDS	x	x	x	x	x
pH, DO, Cond.	X	x	x	x	X (pH not at mouth)
P. Alk.	X	x	x	x	x
T. Alk.	X	x	x	x	x
BOD	X	x	x	x	x
Total P	X	x	x	x	x
DRP	X	x	x	x	x
Na	X	x	x	x	x
K	X	x	x	x	x
Ca	X	x	x	x	x
Mg	X	x	x	x	x
TKN	X	x	x	x	x
NH3-N	X	x	x	x	x
Cl	X	x	x	x	x
NO3	X	x	x	x	x
SO4	X	x	x	x	x
Be	X	x	x	x	x
B	X	x	x	x	x
Al	X	x	x	x	x
Ti	X	x	x	x	x
V	X	x	x	x	x
Cr	X	x	x	x	x
Mn	X	x	x	x	x
Fe	X	x	x	x	x
Co	X	x	x	x	x
Ni	X	x	x	x	x
Cu	X	x	x	x	x
Zn	X	x	x	x	x
As	X	x	x	x	x
Se	X	x	x	x	x
Sr	X	x	x	x	x
Mo	X	x	x	x	x
Ag	X	x	x	x	x
Cd	X	x	x	x	x
Sn	X	x	x	x	x
Sb	X	x	x	x	x
Ba	X	x	x	x	x
Hg	X	x	x	x	
Tl	X	x	x	x	x
Pb	X	x	x	x	x
U	X	x	x	x	x
Total Coli.	X	x	x	x	x
Fecal Coli.	X	x	x	x	x
Fecal Strep.	X	x	x	x	x
E.Coli.	X	x	x	x	x

Appendix D. Summary of the City of Calgary water quality monitoring program.

	Sample Year				
	2003	**2004**	**2005**	**2006**	**2007**
Nose Creek - Mouth					
Frequency	Monthly	Monthly	Monthly	Monthly	Monthly
Start Date	January	February	January	January	January
End Date	December	December	December	December	November
# of samples	13	12	13	13	12
Notes	2 samples collected in December	No sample collected in January	2 samples collected in October	2 samples collected in August and October; No sample collected in September	2 samples collected in October
Nose Creek - City Limit					
Frequency	Every two weeks	Every two weeks - Feb - April	Monthly	Monthly	Monthly
		Monthly - May - December			
Start Date	March	February	March	January	March
End Date	November	December	December	December	November
# of samples	19	14	11	13	10
Notes			2 samples collected in October	2 samples collected in August and October; No sample collected in September	2 samples collected in October
West Nose Creek – City Limit					
Frequency	Monthly	Monthly	Monthly	Monthly	Monthly
Start Date	February	February	January	January	March
End Date	November	December	December	December	November
# of samples	10	12	13	13	10
Notes		2 samples collected in November	2 samples collected in October	2 samples collected in August and October; No sample collected in September	2 samples collected in October

Appendix E. Summary of Alberta Environment's surface water monitoring locations in the Nose Creek watershed.

STATION #	OTHER #	STATION_DESCRIPTION	STATION_NAME	M_LATITUDE	LONGITUDE
AB05BH0300	00AL05BH2400	ABOVE AIRDRIE	NOSE CREEK	51.3015	1140129
AB05BH0310	00AL05BH2450	BELOW AIRDRIE	NOSE CREEK	51.26472	1140008
AB05BH0319		100M U/S COUNTRY HILLS BLVD (112 AVE NE, ALSO HWY#564) AT STORM SEWER PROJECT, U/S N43 STORM OUTFALL	NOSE CREEK	51.15653	1140212
AB05BH0320	00AL05BH2550	NEAR CALGARY CITY LIMITS SEC HWY 564	NOSE CREEK	51.15389	1140152
AB05BH0330	00AL05BH2600	ABOVE CONFLUNCE WITH WEST NOSE CREEK	NOSE CREEK	51.13056	1140237
AB05BH0340	00AL05BH2625	AT HWY 722	WEST NOSE CREEK (BEDDINGTON CREEK)	51.21111	1140950
AB05BH0350	00AL05BH2650	AT 24TH STREET NW CALGARY	WEST NOSE CREEK	51.15917	1140656
AB05BH0360	00AL05BH2700	ABOVE CONFLUNCE WITH NOSE CREEK	WEST NOSE CREEK	51.13028	1140252
AB05BH0370	00AL05BH2750	NEAR THE MOUTH-MEMORIAL DRIVE	NOSE CREEK	51.04639	1140108
AB05BH0390	00AL05BH2800	NEAR THE MOUTH	NOSE CREEK	51.04611	1140113
AB05BH2590		ON MOUNTAIN VIEW ROAD OFF OF SYMONS VALLEY ROAD	WEST NOSE CREEK	51.18986	1140824
AB05BH2600		NEAR 144 AVENUE	EAST NOSE CREEK	51.18686	1140012

Appendix F. Average concentrations recorded from April to September in 1999 and 2000 at Nose Creek and West Nose Creek (Moxham 2002).

Reach #	4,5,6	4	3	2	1					
Madawaska Sites:	Site 1	Site 3	Site 2	Site 4	Site 5			Guidelines		
Location	Nose Creek at mouth	West Nose Creek above Calgary	Upstream of Calgary	Downstream of Airdrie	Above Airdrie	Drinking Water	Livestock Watering	Irrigation	Aquatic Life	Recreation
Temperature (^{0}C)	11	9	8.5	11.5	9					
pH (pH units)	8.4	8.4	8.7	8.3	8.4	6.5-8.5			6.5-9	
Dissolved Oxygen (mg/L)	9	9.5	7	10	6.5				5-9.5	
Total Suspended Solids (mg/L)	50	15	25	30	12					
Total Dissolved Solids (mg/L)	750	625	850	750	745	500	3000	500-3500		
Sodium Adsorption Ratio	2.1	1.8	3.9	3.7	3.1			3-9		
Calcium (mg/L)	80	75	55	50	52		1000			
Sodium (mg/L)	100	90	180	155	150	200				
Potassium (mg/L)	6	7	10	9.5	14					
Sulphate (mg/L)	180	150	200	180	175	500	1000			
Chloride (mg/L)	45	20	55	60	45	250		100		
Total Phosphorus (mg/L)	0.17	0.15	0.29	0.25	0.65				0.1	
Dissolved phosphorus (mg/L)	0.002	0.007	0.008	0.1	0.55				0.005	
Total Kjeldahl Nitrogen (mg/L)	1	0.9	2	1.5	2				1	
Nitrate/Nitrite (mg/L)	0.9	0.2	0.2	0.2	0					
Ammonia (mg/L)	0.3	0.25	0.3	0.1	0.08					
BOD (mg/L)	3.5	4	4	N/A	N/A					
Fecal Coliform (#/100mL)	600	150	105	50	101	0		100		200
Escherchia coli (#/100mL)	300	200	100	50	90					200
Aluminum (ug/L)	1050	350	550	50	10				100	
Chromium (ug/L)	4	3.5	3.5	1.8	1				2	
Copper (ug/L)	15	14	20	3	2				4	
Iron (ug/L)	1350	700	999	50	50	300			300	
Lead (ug/L)	5.5	1	2	1	0.5	10			7	
Manganese (ug/L)	80	40	70	5	10	50		200		
Mercury (ug/L)	0.15	0.11	0.18	0.001	0.001	1	3		0.1	
Molybdenum (mg/L)	3	2.2	4.4	3.3	1.7					
Uranium (ug/L)	4.5	3.8	4	3.9	2.8			10		
Zinc (ug/L)	24	15	18	15	5				30	
2,4-D (ug/L)	0.5	0	0.5	0.7	0.1	100	100		4	
Atrazine (ug/L)	0.07	0.001	0.003	0.001	0.001	5	60	10	2	
Dicamba (ug/L)	0.006	0.003	0.004	0.001	0.001	120	122	0.006-0.6	10	
MCPA (ug/L)	0.03	0.001	0.028	0.04	0.035		25	0.03-0.16	2.6	
Mecoprop (ug/L)	0.1	0	0.09	0.15	0.001					

Note: Red highlight indicates a guideline exceedence.