# ST. CLAIR RIVER AREA OF CONCERN



1/31/2012

Review of Status of Beneficial Use Impairment #7: Added Costs to Agriculture and Industry



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## **1.0 Introduction**

In the Stage 1 St. Clair Remedial Action Plan (RAP) Report (1991), one reason that *added cost for agriculture or industry* was identified as an impaired Beneficial Use (BUI) was that food processors in Wallaceburg temporarily shut down following the October 1990 ethybenzene spill from Dow Chemical. The plants remained closed until the water supply system could be flushed. The food processors that had originally experienced added costs in 1990 no longer operate in Wallaceburg. This report is intended to evaluate whether or not, in recent years, industry or agriculture has experienced any added costs of this nature.

According to the current (1995 Stage 2 Binational Report) delisting criteria:

"This BUI will be considered restored when [there are] no plant shutdowns attributable to water quality over a two year period. No added costs for the disposal of contaminated sediment."

The delisting criteria for the St. Clair River AOC are currently being revised. The proposed revised delisting criteria (2010) have been amended to state:

"this BUI will be considered restored when there are no significant additional costs required to use raw St. Clair River water for agriculture and industrial purposes".

In this assessment, in order to evaluate whether or not industry or agriculture has experienced added costs the following steps were taken:

- A telephone survey of industrial and commercial Permit to Take Water (PTTW) holders
- A comparison of available water quality data to Canadian Council of Ministers of the Environment (CCME) *Water Quality Guidelines for the Protection of Agriculture* specific to irrigation.
- A comparison of available water quality data to the Ontario Ministry of Agriculture Food and Rural Affairs (OMAFRA) guidelines for container-grown ornamentals

## 2.0 Status Assessment Method

## 2.1 Added Cost to Industry

A telephone survey of industrial and commercial Permit to Take Water (PTTW) holders was conducted in February 2011. Additional industrial and agricultural non-PTTW holders were also contacted in order to get comprehensive feedback. Sarnia-Lambton Environmental Association (SLEA), Tahgahoning Enterprises, and two Lambton County/Chatham-Kent farmers were contacted. Participants were asked if industry or agriculture had experienced costs related to using raw water from the St. Clair River.

None of the respondents indicated any additional cost of using raw water from the St. Clair River. Industry used water for cooling, pipeline testing, golf course irrigation, and other industrial purposes without added cost (Table 2.1; Appendix A). One industrial permit holder held a PTTW for over 25 years (1982 to 2009), without any issues. Ontario Power Generation Inc. (Lambton Generating Station) reported no additional cost. Gilvesy Enterprises Inc., which uses water for cooling, reported having to change filters more regularly due to zebra mussel (Dreissena polymorpha) presence. This invasive species is dispersed throughout the Great Lakes Basin and as such, is not an Area of Concern (AOC) specific issue. Another industry respondent from Terra International noted an added cost of water separation, but the process is required as part of an industrial process, independent of water quality. Two golf courses: St. Clair River Golf and Curling Club and St. Clair Parkway Golf Course reported no additional costs of using raw St. Clair River water. SLEA, a group that represents 20 industrial manufactures in the Sarnia-Lambton area reported that the 20 industrial manufacturers that it represents reported no additional cost of using raw St. Clair River water. Tahgahoning Enterprises, a 4,700-acre band-owned farm, located at Walpole Island First Nation indicated that St. Clair River water is not used for irrigation. It uses river water for mixing chemicals without additional cost. Two Lambton County/Chatham Kent farmers contacted indicated that they did not have any issues and did not know of any other farmers that had experienced added costs of using raw St. Clair River water. One of the farmers has drawn water from Snye River drainage since the 1990s to irrigate cucumbers and tomatoes. He filters the water, as is common practice, but does not have any additional cost of water treatment. Overall, the survey which represented a cross-section of industrial and agricultural users indicated no extra cost incurred to use St. Clair River water for industrial or agricultural purposes.

These findings mirror industry comments reported in the draft report *BUI #7 – Added Costs to Agriculture or Industry* (March 31, 2010) and the 2009 Draft RAP Update report. Two companies (Suncor Energy and Imperial Oil) which used raw water from the St. Clair River for cooling were contacted previously. They indicated no additional problem or cost associated with using the raw water from the St. Clair River. St. Clair River Country Club, which uses the St. Clair River for irrigation also reported using the water without extra cost.

Specific		
Purpose	Client Name	Response
Cooling Water	Shell Canada Products	No added cost
Cooling Water	Gilvesy Enterprises Inc.	No added cost. Filters replaced due to zebra mussel
Other - Industrial	Terra International (Canada) Inc.	No added cost - Water separation - not relevant – industrial
		process that occurs regardless of water quality. Fish
		deterrent system, certain species, away from intakes (not
		relevant). There is a new chlorination system.
Other - Industrial	Ontario Power Generation Inc.	No cost
	(Lambton Generating Station)	
Golf Course	Sarnia Golf and Curling Club	Water goes into a pond and used directly, no additional costs.
Irrigation	Limited	
Golf Course	The Corporation of the Township of	No problems with water, it is used in raw form.
Irrigation	St. Clair	
Cooling Water	DOW Chemical of Canada Ltd.	No cost while operating - sold to new company. Surrendered
		permit.
Other - Industrial	Sunoco Inc., Suncor Energy	No cost
Industrial	SLEA	No added cost to 20 industrial manufacturers that they
		represent.
Agriculture –	Tahgahoning Enterprises	No added cost, but St. Clair River water is not used for
water wagon, not		irrigation, it is used for mixing chemicals.
irrigation		
Agriculture	Cucumber and Tomato Farmer	Used water from Snye Drainage since 1990s without added
		cost.
Agriculture	Lambton County Farmer*	No added cost that he is aware of for farmers using raw
		water from the Snye or Chanel Ecarte for irrigation.

#### Table 2.1. 2011 Survey of St. Clair River PTTW Holders

\*Lambton County Wheat Board, past president; Ontario Wheat Board, past Lambton Director; Lambton County Soy Board; Lambton Storage Association, negotiation committee 1998 – 2007; Rural Lambton Stewardship Network and Ag Care.

## 2.2 Added Cost to Agriculture

Since none of the operators of the agricultural sector had a PTTW for the St. Clair River, water quality analysis was used to attempt to further quantify added costs to agriculture to use raw St. Clair River water. Available water quality data were compared to the CCME *Water Quality Guidelines for the Protection of Agriculture* specific to irrigation and to OMAFRA guidelines for container-grown ornamentals.

### 2.2.1 Comparison of St. Clair River Water Quality to CCME Guidelines

The report "Concentrations and Trends of Nutrients, Trace Metals and Organic Contaminants in the St. Clair River 1987-1999" summarizes the concentrations of nutrients, major ions, trace metals and organic contaminants in water and/or suspended sediment for samples collected over the 13-year period 1987/88 to 1999/2000 from the head and mouth of the St. Clair River. At the river's head, samples were collected at the Lambton Water Treatment Plant in Point Edward, north of Sarnia. At the mouth, a station was located in Port Lambton in an abandoned water pumping station (Figure 2.1).

Annual arithmetic means and standard deviations were calculated for the inorganic water quality parameters (i.e., pH, conductance, major ions, nutrients and metals). These values were compared to CCME Water Quality Guidelines for Protection of Agriculture (Irrigation) (Appendix B). Of the parameters measured, CCME guidelines exist for Chloride ions (Cl), and metals: Aluminum (Al), Cadmium (Cd), Cobalt (Co), Iron (Fe), Lithium (Li), Manganese (Mn), Nickel (Ni), Lead (Pb) and Vanadium (V). The application of road salt for winter road maintenance is an important source of chloride to the environment. Other sources of chloride in the environment include effluents from chemical industries, oil well operations, sewage, irrigation drainage, and refuse leachates. Most toxic metal pollution comes from mining activities and individual sources, such as wastewater-treatment plants and air emissions. Metals tend to attach themselves to dust particles and sediment, and thus can persist in stream beds and banks of urban or industrial streams. None of the annual arithmetic means exceeded CCME guidelines for any year (Table 2.2).

**Figure 2.1. Sample Locations** 



Numb	er of T	imes A	nnual A	rithme	tic M	ean Ex	ceede	d the C		Guide	lines
Major I	ons	Metals	5								
Pt. Edward	d										
Years	Chloride	Years	Aluminum	Cadmium	Cobalt	Iron	Lithium	Manganese	Nickel	Lead	Vanadium
1987-1999	0	1988-1999	0	0	0	0	0	0	0	0	0
Port Lamb	oton										
Years	Chloride	Years	Aluminum	Aluminum	Cobalt	Iron	Lithium	Manganese	Nickel	Lead	Vanadium
1987-1999	0	1988-1999	0	0	0	0	0	0	0	0	0
CCME Guideline (ug/L)	Variable*		5000	5.1	50	5000	2500	200	200	200	100

#### Table 2.2: Number of Times the Annual Arithmetic Mean Exceeded the CCME Guidelines

CCME Guidelines = Water Quality Guidelines for the Protection of Agriculture

\*The guideline for chloride varies depending on the crop. The most stringent guideline is for almonds, which range from 100 – 178 μg/L.

#### 2.2.2 Comparison of St. Clair River Water Quality to OMAFRA Guidelines

Where possible, St. Clair River water quality was also compared to the OMAFRA guidelines for container-grown ornamentals.

Electroconductivity (EC) estimates the amount of total dissolved salts (TDS) or the total amount of dissolved ions in the water. EC is controlled by geology (e.g., limestone leads to higher EC because of the dissolution of carbonate ( $nCO_3$ ) minerals), wastewater from sewage treatment plants and septic systems, urban runoff, agricultural runoff and atmospheric inputs. The acceptable range for EC according to OMAFRA is less than 1.75 mmho/cm, for most container woody crops and less than 1.0 mmho/cm for herbaceous perennials. The annual arithmetic mean for EC measured at the Pt. Edward (head) and Port Lambton (mouth) stations ranged from 0.211 to 0.224 and 0.214 to 0.230 mmho/cm, respectively (Table 2.3). These values are well below the OMAFRA guidelines.

The acceptable range for chloride is less than 140 ppm for most container woody crops and less than 100 ppm for most herbaceous perennials/greenhouse crops. The annual arithmetic mean for chloride measured at the Pt. Edward (head) and Port Lambton (mouth) stations ranged from 5.83 to 7.03 and 6.41 to 9.11 ppm, respectively. According to the Thames-Sydenham and Region Watershed Characterization Summary Report for the St. Clair Region (December, 2008) the maximum levels at Wallaceburg and Bkejwanong Territory water treatment plants (WTPs) were less than 30 ppm (Table 2.3). The values meet the OMAFRA guidelines as well as the Ontario Drinking Water Standard (ODWS) objective of 250 ppm and the Environment Canada value of 210 ppm for toxicity to aquatic species.

#### Table 2.3 Comparison of St. Clair River Raw Water to Guidelines for Container-Grown Ornamentals.

	EC (soluble salts in mmho/cm)	Chloride (Cl in ppm)
Pt. Edward (head) annual arithmetic mean range 1987- 1999*	0.211 to 0.224	5.83 to 7.03
Port Lambton (mouth) annual arithmetic mean range 1987- 1999*	0.214 to 0.230	6.41 to 9.11
Wallaceburg WTP	n/d	<30ppm
Walpole Island WTP	n/d	<30ppm
Acceptable Range for Most Herbaceous Perennials/Container Woody Crops	< 1.75 mmho/cm	< 140 ppm
Acceptable Range for Most Herbaceous Perennials/Greenhouse Crops	< 1.0 mmho/cm	< 100 ppm
*NI		

\*No data for 1988

## 3.0 Summary and Conclusions

The results of these analyses support changing the status *added cost for agriculture or industry* beneficial use impairment (BUI) from "*impaired*" to "*unimpaired*". Survey respondents did not indicate any relevant added costs to use St. Clair River water. Respondents indicated experiencing added costs related to zebra mussels control, but since this invasive species occurs throughout the Great Lakes Basin, it is not considered relevant as an AOC issue. Water quality analysis did not indicate that agriculture sector users incur any extra cost to use raw St. Clair River water for irrigation.

## References

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http://www.sourcewaterprotection.on.ca/downloads/assessment\_reports/SCRCA/Appen dices/A5-WC\_Summary/StClair-Summary.pdf

## Appendix A 2010 Added Cost to Agriculture and Industry Survey of PTTW Holders

				штм	Max	Max	Max Hrs	Max Litres				Evpiny	Data				Dato/Timo	
Taking Type	Source	Easting	Northing	Zone	Day	per Year	per Day	Minute	Major Category	Specific Purpose	Taking Type	Date	Issued	Client Name	Municipality	Contact Information	contacted	Conclusion
Surface Water	St. Clair River	380942	4751347	17	3E+08	365	24	220000	Industrial	Cooling Water	Surface Water	2010/12/31	19/12/2005	Shell Canada Products	St. Clair	Christina Zimmer, Shell Sarnia Manufacturing Centre Community Liaison Officer, (519) 481- 1135.	07/02/2011 9:00	no cost
Surface Water	St. Clair River	379618	4742267	17	960000	3	16	1000	Industrial	Pipeline Testing	Surface Water	2009/06/30	12/08/2008	Robert B. Somerville Co. Limited	St. Clair	No contact	expired permit	no phone #/ expired permit
Surface Water	St. Clair River	385165	4758871	17	5E+06	365	24	9092	Industrial	Cooling Water	Surface Water	2016/01/31	10/01/2006	Gilvesy Enterprises Inc.	Samia	John Gilvesy, Seaway Centre Samia 519-842-6444 info@firstsarniaplace.com	07-Feb-11	no cost replace filters, zebra mussel
Surface Water	St. Clair River	380350	4735850	17	4E+07	365	24	30240	Industrial	Cooling Water	Surface Water	2016/01/31	14/12/2005	CM Greenfield Power Corp.	St. Clair	OPA - Media and Public Relations T. 416-969-6307 or 1-800-797-9604Susan Dennison Corporate Communications Manager T. 312-582-1423	February 7, 2011, 9:10	unable to contact anyone from OPA
Surface Water	St. Clair River	380350	4735850	17	2E+08	365	24	158987	Industrial	Other - Industrial	Surface Water	2016/01/31	14/12/2005	Terra International (Canada) Inc.	St. Clair	Tom Croskery x1292 161 Bickford Courtright, ON N0N 1H0 (519) 867-2739	February 7, 2011, 9:13am	No cost - Water separation, millions of dollars - not relevant - industrial process that occurs regardless of water quality. Fish deterrent system, certain species, away from intakes (not relevant). There is a new chlorination system.
Surface and Ground Water	St. Clair River Great Lakes	384740	4759742	17	299520	150	12	416	Recreational	Other - Recreational	Surface and Ground Water	2018/03/31	11/04/2008	The Corporation of the City of Sarnia	Sarnia	very small amount	non- industrial/a gricultural	non-industrial/agricultural
Surface and Ground Water	St. Clair River	379531	4739155	17	4E+09	365	24	3E+06	Industrial	Other - Industrial	Surface and Ground Water	2018/02/20	11/03/2008	Ontario Power Generation Inc. (Lambton Generating Station)	St. Clair	Corporate Head Office 700 University Avenue Toronto, Ontario Canada, M5G 1X6 Main Switchboard: (416) 592-2555 Toll Free: (877) 592-2555 General Inquiries: webmaster@opq.com LGS 519-867-2663 Michelle McKay (michelle.mckay@opg.com	February 7, 9:57	no cost
Surface Water	St. Clair River	384125	4761667	17	1E+06	180	24	757	Commercial	Golf Course Irrigation	Surface Water	2016/07/31	21/07/2006	Sarnia Golf and Curling Club Limited	Point Edward~Point Edward	General manager, John Bond 500 Errol Road West Sarnia, ON N7V 2B9 (519) 336-2201	February 7, 2011, 10:03	Water goes into a pond and used directly, no additional costs.
Surface Water	St. Clair River	380182	4744407	17	2E+06	180	12	2361	Commercial	Golf Course Irrigation	Surface Water	2015/04/30	18/04/2007	The Corporation of the Township of St. Clair	St. Clair	Matt LaFontaine Golf course manager 519- 867-2160	07/02/2011, 11:31 am	No problems with water, it is used in raw form
Surface Water	St. Clair River	378532	4727847	17	1E+06	365	24	1140	Industrial	Cooling Water	Surface Water	2009/05/31	21/03/2005	Chinook Global Limited	St. Clair	Address: 224 Holt Line W Sombra, ON, NOP 2H0 Phone: 519-892-3411 Fax: 519-892-3417 NONE of the phone #'s online work, tried 4	expired permit	expired permit, could not contact
Surface Water	St. Clair River PUMPHOUSE #1	382659	4755275	17	9E+08	365	24	590980	Industrial	Cooling Water	Surface Water	2009/12/15	16/04/1982	DOW Chemical of Canada Ltd.	City of Sarnia	Dow Chemical Canada Inc. Sarnia Plant 1425 Vidal Street South P.O. Box 3030 Sarnia, Ontario N7T 8C6 Dave Short (519) 337-6679- no additional cost, sold, surrender the water permit, no added cost, taking water was not an additional cost.	February 7, 2011, 11:07 am	no cost while operating - sold to new company, had to surrender permit

Taking Type	Source	Easting	Northing	UTM Zone	Max Litres per Day	Max Days per Year	Max Hrs per Day	Max Litres per Minute	Major Category	Specific Purpose	Taking Type	Expiry Date	Date Issued	Client Name	Municipality	Contact Information	Date/Time contacted	Conclusion
Surface Water	St. Clair River PUMPHOUSE #2	382473	4755122	17	7E+08	365	24	501878	Industrial	Cooling Water	Surface Water	2009/12/15	16/04/1982	DOW Chemical of Canada Ltd.	City of Samia	Dow Chemical Canada Inc. Sarnia Plant 1425 Vidal Street South P.O. Box 3030 Sarnia, Ontario N7T 8C6 Dave Short (519) 337-6679- no additional cost, sold, surrender the water permit, no added cost, taking water was not an additional cost.	February 7, 2011, 11:07 am	no cost while operating - sold to new company, had to surrender permit
Surface Water	St. Clair River	381102	4750184	17	2E+07	365	24	15900	Industrial	Cooling Water	Surface Water	2017/06/30	24/07/2007	St. Clair Power, L.P.	St. Clair	OPA - Media and Public Relations T. 416-969-6307 or 1-800-797-9604 Susan Dennison Corporate Communications Manager T. 312-582-1423	February 7, 2011, 9:10	Unable to contact anyone from OPA
Surface Water	ST. CLAIR RIVER	382020	4754622	17	1E+07	365	24	78700	Industrial	Other - Industrial	Surface Water	2011/04/30	23/04/2001	Sunoco Inc., Suncor Energy	City of Sarnia	Sarnia Refinery Suncor Energy Products Inc. P.O. Box 307, 1900 River Road Sarnia, Ontario Canada N7T 7J3 T: (519) 337-2301 F: (519) 332-3309	February 7, 2011, 10:25 am	no cost
Surface Water	ST. CLAIR RIVER (BACK-UP)	381983	4754548	17	2E+06	3	1	37900	Industrial	Other - Industrial	Surface Water	2011/04/30	23/04/2001	Sunoco Inc., Suncor Energy	City of Sarnia	see above	February 7, 2011, 10:25 am	no cost
Surface Water	St. Clair River	384091	4761613	17	275000	180	8	568	Miscellaneous	Other - Miscellaneous	Surface Water	2009/03/31 1:00:00 AM	05/05/1999	Centre by the Bay	City of Sarnia	expired permit	expired permit	expired permit
														SARNIA Lambton Environmental Association (represents: Shell Canada Products, Terra, Suncor and OPG)			February 7, 2011, 10:25 am	
														Tahgahoning Enterprises		Rr 3 Stn Main, Wallaceburg ON, N8A 4K9 Phone: 519-627-0881	September 29, 2011	
														Francis Dobler		(519)436-3558, janfran@kent.net	October 3, 2011	Local cucumber and tomato farmer has had no added cost of using irrigation water from Syne drainage. Thinks a system of notifying farmers downstream of chemical valley of spills. Same [process as municipal water systems? Currently, when he hears media advisory indicating spills, he will suspend irrigation temporarily, without cost. He did express some concern about the repercussions of not be informed of a spill.
														Joe Kerr		(519) 627-3461, joker@kent.net, Lambton County Wheat Board (past president); Ontario Wheat Board (past Lambton Director); Lambton County Soy Board; Lambton Storage Association (negotiation committee 1998 – 2007); Rural Lambton Stewardship Network and Ag Care.	October 3, 2011	Not aware of any farmers that use St. Clair River water directly. Does have contacts who use Chenal Ecarte and Snye water. Passed on Francis Dobler's name. 99.9 % sure that there are no added costs of using raw St. Clair river water for irrigation in those areas.

## Appendix B

Analysis of "Concentration and Trends of Nutrients, Major Ions, Trace Metals and Organic Contaminants in the St. Clair River (1987-1999) to Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for Protection of Agriculture (Irrigation)

Major	lons			Meta	s																										
Pt. Edward	CI			Pt. Edward	Alumir	num		Cadmi	um		Cobalt			Iron			Lithiun	n		Manga	anese		Nickel			Lead			Vanad	ium	
Mean	mg/L	n	S.D.	(dissolved)	μg/L	n	S.D.	μg/L	n	S.D.	μg/L	n	S.D.	μg/L	n	S.D.	μg/L	n	S.D.	μg/L	n	S.D.	μg/L	n	S.D.	µg/L	n	S.D.	μg/L	n	S.D.
1987	6.07	12	0.5	1987	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1988	6.09	21	0.4	1988	18.76	21	10	<0.10	21	0	0.1	21	0	24.33	20	33.97	1.1	21	0.13	0.63	21	0.31	0.52	21	0.16	0.29	21	0.2	0.2	21	0.08
1989	5.83	3	0.3	1989	27.33	3	21	<0.10	3	0	0.1	3	0	1.6	12	0.25	0.73	8	0.3	0.42	3	0.1	0.3	3	0.1	0.6	3	0.26	0.13	3	0.06
1990	5.95	12	0.5	1990	23.08	12	16	<0.10	12	0	0.15	12	0.05	16.03	12	10.45	1.83	3	0.15	0.5	7	0.14	0.59	12	0.28	0.31	12	0.25	0.23	12	0.06
1991	6.05	21	0.6	1991	47.29	21	42	<0.10	21	0	0.1	21	0	20.69	21	19.01	1.89	21	0.11	0.61	21	0.28	0.36	21	0.13	0.26	21	0.24	0.24	21	0.1
1992	6.49	15	0.3	1992	48.8	15	31	<0.10	15	0	0.1	15	0	29.67	15	31.89	1.95	15	0.16	0.71	15	0.23	0.43	15	0.14	0.2	15	0	0.21	15	0.05
1993	6.1	8	0.3	1993	65.75	8	54	<0.10	8	0	0.1	8	0	14.1	8	14.67	1.86	8	0.11	0.59	8	0.16	0.6	8	0.38	0.21	8	0.04	0.26	8	0.07
1994	6.07	10	0.3	1994	28.09	11	28	<0.10	11	0	0.1	11	0	16.21	11	13.08	1.91	11	0.07	0.58	11	0.22	0.52	11	0.15	0.21	11	0.03	0.19	11	0.03
1995	6.52	9	0.7	1995	57.6	10	57	<0.10	10	0	0.11	10	0.03	40.56	10	42.21	1.73	10	0.29	1.04	10	0.72	0.52	10	0.15	0.27	10	0.15	0.31	10	0.16
1996	7.03	24	0.5	1996	20.23	23	24	<0.10	23	0	0.14	23	0.07	15.89	23	18.46	1.53	23	0.23	0.67	23	0.33	0.48	23	0.14	0.25	23	0.13	0.27	23	0.2
1997	6.92	21	0.7	1997	18.14	21	14	<0.10	21	0	0.1	21	0	17.5	21	14.41	1.5	21	0.18	0.59	21	0.32	0.42	21	0.09	0.23	21	0.07	0.22	21	0.06
1998	6.62	21	0.6	1998	24.52	17	31	<0.10	21	0	0.1	21	0.02	23.99	21	32.3	1.48	21	0.27	0.7	21	0.49	0.42	21	0.1	0.22	21	0.07	0.22	21	0.09
1999	6.85	19	0.6	1999	25.41	22	44	<0.10	17	0	0.13	17	0.07	32.39	17	66.55	1.38	17	0.48	0.73	17	0.55	0.47	17	0.13	0.34	17	0.18	0.26	17	0.14

Port Lambton			Port Lambton	Alumiı	num		Cadmiu	um		Cobalt			Iron			Lithiu	m		Manga	anese		Nickel			Lead			Vanad	ium		
Mean	mg/L	n	S.D.	Mean (dissolved)	μg/L	n	S.D.	μg/L	n	S.D.	μg/L	n	S.D.	μg/L	n	S.D.	μg/L	n	S.D.	μg/L	n	S.D.	μg/L	n	S.D.	μg/L	n	S.D.	μg/L	n	S.D.
198	7.94	14	1.2	1987	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
198	9.01	25	0.8	1988	39.24	14	557	<0.10	25	0	0.1	25	0	39.29	25	35.9	1.17	25	0.15	1.06	25	0.79	0.56	25	0.14	0.41	25	0.35	0.23	25	0.09
198	9 9.11	22	1.2	1989	38.59	25	22	0.11	22	0.04	0.13	22	0.05	34.95	22	27.57	1.58	22	0.14	0.87	22	0.34	0.51	22	0.16	0.35	22	0.22	0.25	22	0.1
199	0 8.79	14	1.1	1990	31.21	22	15	0.1	13	0	0.13	14	0.05	19.57	14	13.23	1.84	14	0.17	0.73	14	0.28	0.6	14	0.28	0.35	14	0.26	0.27	14	0.09
199	8.31	22	1.3	1991	61.04	14	20	<0.10	23	0	0.12	23	0.07	28.92	23	23.2	1.99	23	0.11	0.83	23	0.32	0.49	23	0.32	0.28	23	0.23	0.27	23	0.08
199	2 8.95	25	0.9	1992	43.24	23	38	<0.10	25	0	0.1	25	0.02	26.2	25	20.1	1.96	25	0.18	0.82	25	0.44	0.51	25	0.15	0.21	25	0.04	0.23	25	0.05
199	3 7.28	21	1.1	1993	60.5	25	29	<0.10	22	0	0.1	22	0	18.35	22	13.31	1.95	22	0.1	0.78	22	0.38	0.62	22	0.24	0.22	22	0.06	0.22	22	0.06
199	6.48	15	0.3	1994	53.44	22	45	<0.10	16	0	0.11	16	0.03	21.88	16	9.75	1.94	16	0.13	0.73	16	0.22	0.66	16	0.21	0.2	16	0	0.24	16	0.07
199	6.41	16	0.3	1995	87.12	16	51	<0.10	17	0	0.13	17	0.1	27.62	17	20	1.87	17	0.26	1.18	17	0.76	0.69	17	0.21	0.35	17	0.18	0.26	17	0.1
199	6.81	24	0.3	1996	46.04	17	80	<0.10	24	0	0.15	24	0.1	20.1	24	15.73	1.51	24	0.25	0.79	24	0.45	0.52	24	0.16	0.29	24	0.15	0.26	24	0.09
199	6.92	21	0.5	1997	26.33	24	62	<0.10	21	0	0.11	21	0.05	19.55	21	13.29	1.53	21	0.2	0.7	21	0.53	0.41	21	0.18	0.25	21	0.09	0.22	21	0.06
199	6.47	20	0.6	1998	22.9	21	34	<0.10	20	0	0.14	20	0.06	24.67	20	19.47	1.5	20	0.5	0.62	20	0.32	0.44	23	0.11	0.23	20	0.07	0.22	20	0.05
199	9 6.59	18	0.2	1999	19.17	20	18	<0.10	17	0	0.15	18	0.05	20.45	18	31.58	1.25	18	0.24	0.6	18	0.38	0.42	18	0.11	0.27	18	0.11	0.22	18	0.08

Port Lambton Mean mg/L n S.D.			Port Lambton Mean	Alumir	num		Cadmin	um		Cobalt		Iron		Lithium		Manga	anese		Nickel		Lead			Vanadi	um	
Mean	mg/L n	S.D.	(dissolved)	μg/L	n	S.D.	μg/L	n S.C	D.	µg/L n	S.D.	μg/L	n S.D.	μg/L n	n S.D.	μg/L	n	S.D.	μg/L n	S.D.	μg/L	n	S.D.	μg/L	n S	.D.
Detection Limit	0.05		Det. Limit (µg/L)	0.2			0.1			0.1		0.4		0.1		0.1			0.2		0.2			0.1		
р	0.003		value (student t)	0.01						0.008		0.21		0.093		0.003			0.008		0.458			0.181		
CCME Guideline	Variable*			5000			5.1			50		5000		2500		200			200		200			100		

CCME Guideline= Water Quality Guidelines for the Protection of Agriculture

\*The guideline for chloride varies depending on the crop. The most stringent guideline is for almonds, which range from 100 – 178 mg/L.