APPENDIX A

GROUNDWATER USE

APPENDIX A.1: Municipal Groundwater Supply Survey Information

Municipality	System	PTTW #	System C of A #	Water Use			Pop. Served	System Flow Rates			System Capacities	
				Commercial %	Industrial %	Residential %		Average Daily m3/day	Per Capita* L/day/person	Max Daily m3/day	Design m3/day	Permitted m3/day
Middlesex Centre	**Melrose**	00-P-1319	7-1289-90-006(1)	0%(1)	0%(1)	100%(1)	217(1)	56.4(1,2)	259(1,2)	81.25(1,2)	277(9)	554(8)
	Komoka-Kilworth	89-P-1067	7-1168-94-957(1)	9%(1,2)	1%(1,2)	90%(1,2)	2600(1)	658(1,2)	253(1,2)	1011(1,2)	1814(9)	6546(8)
	Birr	86-P-1004	7-0154-75-006(1)	0%(1)	0%(1)	100%(1)	68	15.7(1,2)	231(1,2)	17.4(1,2)	88(9)	88.3(8)
Thames Centre	**Dorchester**	76-P-1011, 90-P-1024	0125-56MQV (4)				4800(4a)	1855(4a)	386(4,2)	3979(4a)	n/a	5400(4)
	Thorndale	95-P-1009(7)	7-0724-75-006 (7)	0%(6)	0%(6)	100%(6)	336(7)	80(7a)	238 (7,2)	461(7a)	n/a	409(7)
Central Elgin	**Belmont**	81-P-1012, 74-P-15	6345-57BV9P(6)	5%(6)	0%(6)	95% (6)	1840(5a)	500 (5a)	272(5a)	1108 (5a)	1800 (5)	1800 (5)
Strathroy Caradoc	**Strathroy**	00-P-1337, 00-P-1335, 74-P-1015, 89-P-1094, 93-P-0005,	n/a	30%(3b)		70% (3b)	12000(3)	6000(3a)	500 (3a,2)	12252(3a)	12476(3)	15053(3a)
	Mt Brydges	91-P-0036	n/a	0%	0%	100%	2300(3)	930(3a)	400(3a)	3394(3a)	3110(3)	3110(3)

Data Sources

1 Section C General Information Sheets, OSTAR funding Application

2 Calculations performed in this report

3 Strathroy-Caradoc Groundwater Management Study, IWC, 2001; a) value represents 1999 usage; b) value represents 1998 usage

* total water use (including commerical/industrial)/population

4 Dorchester Water Supply EA, Stantec Consulting, 2002 a) data for 1999

5 Belmont Area Water Sa) 2001 data

6 Estimated

7 Engineers Report, Thorndale Groundwate a) 2000 data

8 MOE Permits to Take Water

9 2002 Annual Compliance Report, verbel communication, M. Lubey, Middlesex Centre staff

n/a not available

APPENDIX A.2: SUMMARY OF POTABLE WATER SUPPLY BY POPULATION

MUNICIPALITY	Water Supply Type	1991	1996	% Municipal Surface Water Supply	# Municipal Surface Water Supply Users	# Municipal Groundwater Supply Users	# Private Well Users	2001	% Municipal Surface Water Supply	# Municipal Surface Water Supply Users	# Municipal Groundwater Supply Users	# Private Well Users	COMMENTS
Thames Centre		**11630**	**12377**					**13125**					1996 & 2001 data & Growth Rate (%) from Census Canada Data
-North Dorchester		8134	8657	0%	0			9179	0%	0			From Middlesex County Conprehensive Water Servicing Study (Dillon 1997)
-Dorchester	Municipal GW System	4143	4409			4409		4675			4675		
-Remaining Rural Area	Private GW Wells	3991	4248				4248	4504				4504	
-West Nissouri		3496	3721	0%	0			3945	0%	0			From Middlesex County Conprehensive Water Servicing Study (Dillon 1997)
-Thorndale	Municipal GW System	664	707			336	371	750			356	393	
-Remaining Rural Area	Private GW Wells	2832	3014				3014	3196				3196	
SUB TOTALS					0	4745	7633			0	5031	8093	
Lucan Biddulph		**4207**	**4312**					**4388**					1996 & 2001 data & Growth Rate (%) from Census Canada Data
-Lucan	LHWSS	1934	2085	100%	2085			2211	100%	2211			From Middlesex County Official Plan & Conprehensive Water Servicing Study (Dillon 1997)
-Biddulph		2273	2227	15%	334			2177	15%	327			From Middlesex County Official Plan & Conprehensive Water Servicing Study (Dillon 1997)
-Granton	Private GW Wells					0					0		Note: GW wells to be decommissioned and LHWSS to service community
-Remaining Rural Area	Private GW Wells						1893					1850	
SUB TOTALS					2419	0	1893			2538	0	1850	
Middlesex Centre		**13023**	**13843**					**14664**					1996 & 2001 data & Growth Rate (%) from Census Canada Data
-Lobo		5787	6142					7347					From Middlesex County Official Plan & Conprehensive Water Servicing Study (Dillon 1997)
-Kilworth	Municipal GW System	396	420	0%	0	420		1300			1300		Note: GW wells to be decommissioned and LHWSS to service community - latest estimate is 2600 on Komoka Kilworth system
-Komoka	Municipal GW System	396	420	0%	0	420		1300			1300		Note: GW wells to be decommissioned and LHWSS to service community
-Remaining Rural Area	Private GW Wells	4996	5302	0%	0		5302	4747	0%			4747	
-London		4766	5072					4819					From Middlesex County Conprehensive Water Servicing Study (Dillon 1997)
-Arva	LHWSS	291	309		309			314		314			
-Ballymote	LHWSS	88	94		94			89		89			
-Birr	Municipal GW System	177	189			63	126	179			63	116	
-Denfield	LHWSS	177	189		189			179		179			
-Ilderton	LHWSS	1506	1603		1603			1523		1523			
-Melrose	Municipal GW System	221	235			200	35	224			200	24	Note: GW wells to be decommissioned and LHWSS to service community
-Remaining Rural Area	Private GW Wells	2305	2453				2453	2311				2311	
-Delaware		2470	2629					2498					
-Delaware	LHWSS	932	1091	100%	1091			1120	100%	1120			Note: GW wells to be decommissioned and LHWSS to service community
-Remaining Rural Area	Private GW Wells	1538	1538				1538	1378				1378	
SUB TOTALS					3286	1103	9454			3225	2863	8576	
Strathroy Caradoc		**17440**	**19073**					**20706**					1996 & 2001 data & Growth Rate (%) from Census Canada Data
-Strathroy	Municipal GW System	11032	12070	0%		12070		13107	0%		13107		From Middlesex County Official Plan & Conprehensive Water Servicing Study (Dillon 1997)
-Caradoc		6408	7003	0%				7599	0%				From Middlesex County Official Plan & Conprehensive Water Servicing Study (Dillon 1997)
-Mount Brydges	Municipal GW System		2300			2300		2600			2600		
-Remaining Rural Area	Private GW Wells		4703				4703	4999				4999	
SUB TOTALS					0	14370	4703			0	15707	4999	
North Middlesex		**6944**	**7055**					**7839**					1996 & 2001 data from Census Canada Data & From Middlesex County Official Plan & Conprehensive Water Servicing Study (Dillon 1997)
-East Williams	Private GW Wells	1397	1419	50%	710		710	1503	50%	752		752	From Middlesex County Official Plan & Conprehensive Water Servicing Study (Dillon 1997)
-McGillivray	Private GW Wells	1950	1981	100%	1981			1999	100%	1999			From Middlesex County Official Plan & Conprehensive Water Servicing Study (Dillon 1997)
-West Williams	Private GW Wells	959	974	75%	731		244	1003	75%	752		251	From Middlesex County Official Plan & Conprehensive Water Servicing Study (Dillon 1997)
-Parkhill	LHWSS	1757	1785	100%	1785			2401	100%	2401			From Middlesex County Official Plan & Conprehensive Water Servicing Study (Dillon 1997)
-Ailsa Craig	LHWSS	881	895	100%	895			933	100%	933			From Middlesex County Official Plan & Conprehensive Water Servicing Study (Dillon 1997)
SUB TOTALS					6102	0	953			6837	0	1002	
Adelaide Metcalfe		**3067**	**3162**					**3257**					1996 & 2001 data from Census Canada Data & From Middlesex County Official Plan & Conprehensive Water Servicing Study (Dillon 1997)
-Adelaide		2050	2065	0%			2065	2080	0%	0		2080	From Middlesex County Official Plan & Conprehensive Water Servicing Study (Dillon 1997)
-Metcalfe		1017	1097	0%			1097	1177	0%	0	0	1177	From Middlesex County Official Plan & Conprehensive Water Servicing Study (Dillon 1997)
SUB TOTALS					0	0	3162			0	0	3257	
Southwest Middlesex		**6330**	**6711**					**7077**					1996 & 2001 data from Census Canada Data & From Middlesex County Official Plan & Conprehensive Water Servicing Study (Dillon 1997)
-Wardsville		454	456	0%			456	458	0%	0		458	From Middlesex County Official Plan & Conprehensive Water Servicing Study (Dillon 1997)
-Glencoe	Municipal SW System	2237	2584	100%	2584	0	0	2932	100%	2932	0	0	From Middlesex County Official Plan & Conprehensive Water Servicing Study (Dillon 1997)
-Ekfrid & Remaining Rural Area	Private GW Wells	2299	2345	0%			2345	2375	0%	0		2375	From Middlesex County Official Plan & Conprehensive Water Servicing Study (Dillon 1997)
-Mosa	Private GW Wells	1340	1326	0%			1326	1312	0%	0		1312	From Middlesex County Official Plan & Conprehensive Water Servicing Study (Dillon 1997)
SUB TOTALS					2584	0	4127			2932	0	4145	
Newbury		**438**	**430**					**422**					1996 & 2001 data from Census Canada Data & From Middlesex County Official Plan & Conprehensive Water Servicing Study (Dillon 1997)
-Newbury	Municipal Supply	438	430	100%	430			422	100%	422			From Middlesex County Official Plan & Conprehensive Water Servicing Study (Dillon 1997)

APPENDIX A.2: SUMMARY OF POTABLE WATER SUPPLY BY POPULATION

MUNICIPALITY	Water Supply Type	1991	1996	% Municipal Surface Water Supply	# Municipal Surface Water Supply Users	# Municipal Groundwater Supply Users	# Private Well Users	2001	% Municipal Surface Water Supply	# Municipal Surface Water Supply Users	# Municipal Groundwater Supply Users	# Private Well Users	COMMENTS
SUB TOTALS					430	0	0			422	0	0	
London	EAWSS & LHWSS		325669	98%	320669		5000	336539	99%	331539		5000	Servicing Study (Dillon 1997)
SUB TOTALS					320669	0	5000			331539	0	5000	
MIDDLESEX - not inc. LONDON			**66963**		**14821**	**20218**	**31926**	**71478**		**15954**	**23601**	**31923**	
					22%	30%	48%			22%	33%	45%	
Middlesex County Total			**392632**					**408017**					Servicing Study (Dillon 1997)
Elgin County BY MUNICIPALITY		**1991**	**1996**					**2001**					
Central Elgin			**11279**					**12360**					Servicing Study (Dillon 1997)
-Belmont	Municipal GW System	1364	1632	0%		1634		1788	0%		1788		From Village of Belmont Population Projection (Lapointe & Dillon 1994)
-Port Stanley	EAWSS	2223	2499	100%	2499			2739	100%	2739			
-Yarmouth TWP	Private GW Wells		7148	10%	715		6433	7833	15%	1175		6658	
SUB TOTALS					3214	1634	6433			3913	1788	6658	
Southwold			4273	50%	2137		2137	4487	50%	2244		2244	1996 & 2001 data from Census Canada Data & From Middlesex County Official Plan & Conprehensive Water Servicing Study (Dillon 1997)
SUB TOTALS					2137	0	2137			2244	0	2244	
Dutton Dunwich			**3603**					**3696**					1996 & 2001 data from Census Canada Data & From Middlesex County Official Plan & Conprehensive Water Servicing Study (Dillon 1997)
-Dunwich TWP	Private GW Wells		2288	0%			2288	2322	5%	116		2206	
-Dutton	EAWSS		1315	100%	1315			1374	100%	1374			
SUB TOTALS					1315	0	2288			1490	0	2206	
							3603					3696	
West Elgin			**5573**					**5464**					1996 & 2001 data from Census Canada Data & From Middlesex County Official Plan & Conprehensive Water Servicing Study (Dillon 1997)
-Rodney	EAWSS		1000	100%	1000			1000	100%	1000			
-Aldborough TWP	Private GW Wells		3042	0%			3042	3045	5%	152		2893	
-West Lorne	EAWSS		1531	100%	1531			1419	100%	1419			
SUB TOTALS					2531	0	3042			2571	0	2893	
Malahide			**8891**					**8809**					1996 & 2001 data from Census Canada Data & From Middlesex County Official Plan & Conprehensive Water Servicing Study (Dillon 1997)
-Malahide	EAWSS		6255	1%	63			6290	5%	315			
-South Dorchester TWP	Private GW Wells		1899	0%	0	0		1816	0%	0	0		
-Springfield			710	0%	0		8828	703	0%	0		8495	
SUB TOTALS					63	0	8828			315	0	8495	
Aylmer	EAWSS		**7022**					**7126**					1996 & 2001 data from Census Canada Data & From Middlesex County Official Plan & Conprehensive Water Servicing Study (Dillon 1997)
			7022	100%	7022	0	0	7126	100%	7126	0	0	
SUB TOTALS					7022	0	0			7126	0	0	
St. Thomas			**32250**					**35210**					From Town of St. Thomas Population Projection (Lapointe & Dillon 1999)
-St. Thomas	EAWSS		32250	100%	32250	0	0	35210	100%	35210	0	0	
SUB TOTALS					32250	0	0			35210	0	0	
Elgin County (w/o St.Thomas& Bayham) Total		**40641**			**16282**	**1634**	**22728**	**41942**		**17660**	**1788**	**22496**	
Percentage of total population					40%	4%	56%			42%	4%	54%	
STUDY AREA TOTALS			**433273**		**384022**	**21852**	**59654**	**449959**		**400362**	**25390**	**59418**	1996 & 2001 data from Census Canada Data & From Middlesex County Official Plan & Conprehensive Water Servicing Study (Dillon 1997)
Percentage of total population					89%	5%	14%			89%	6%	13%	

Source: Marshall, Macklin, Monaghan, "Draft Population Projections Report" (April 1996)
1. Calculated by Dillon Consulting Using Census Data and Previous Reports

APPENDIX A.3: Known Ontario Regulation 459 Georeferenced Wells

Municipality	Use	Well	MOE Well Record	Location	Township	Lot	Concession	Easting	Northing
Middlesex Centre	Melrose WTP	1	n/a		London	15	5	467950	4761000
		2	n/a		London	15	4	467950	4761000
	Komoka-Kilworth WTP	1	n/a		Lobo	32	5	466950	4754720
		2	n/a		Lobo	32	5	466950	4754720
		3	n/a		Lobo	32	5	466950	4754720
	Birr WTP	1	n/a		London	16	12	472970	4774160
		2	n/a		London	16	12	472970	4774160
Thames Centre	Dorchester WTP	HL-1	n/a	Well Field #1	North Dorchester	17	B SRT	495559	4757996
		PW-1	n/a	Well Field #3	North Dorchester	17	B SRT	496120	4757770
		PW-2	n/a	Well Field #3	North Dorchester	17	B SRT	496143	4757696
		PW-3	n/a	Well Field #3	North Dorchester	17	B SRT	496012	4757632
		PW-4A	n/a	Well Field #3	North Dorchester	17	B SRT	496016	4757747
		TW2-96	n/a	Well Field #3	North Dorchester	17	B SRT	496026	4757534
		TW3-96	n/a	Well Field #3	North Dorchester	17	B SRT	496143	4756520
		PW-7	n/a	Well Field #3	North Dorchester	17	B SRT	495972	4757737
	Thorndale WTP	Well 1	4107039	Pumphouse	West Nissouri	15	4	489001	4772675
		Well 2	4113332		West Nissouri	15	4	489005	4772669
	Anthony's Mobile Home Park, RR2 Dorchester, N0L 1G0	1	n/a	Dorchester	North Dorchester	n/a	n/a	495170	4756440
	Duttona Trailer Park, RR1 Wallacetown, N0L 2M0	1	n/a	Duttona	Dutton/Dunwich	6	10	461692	4714802

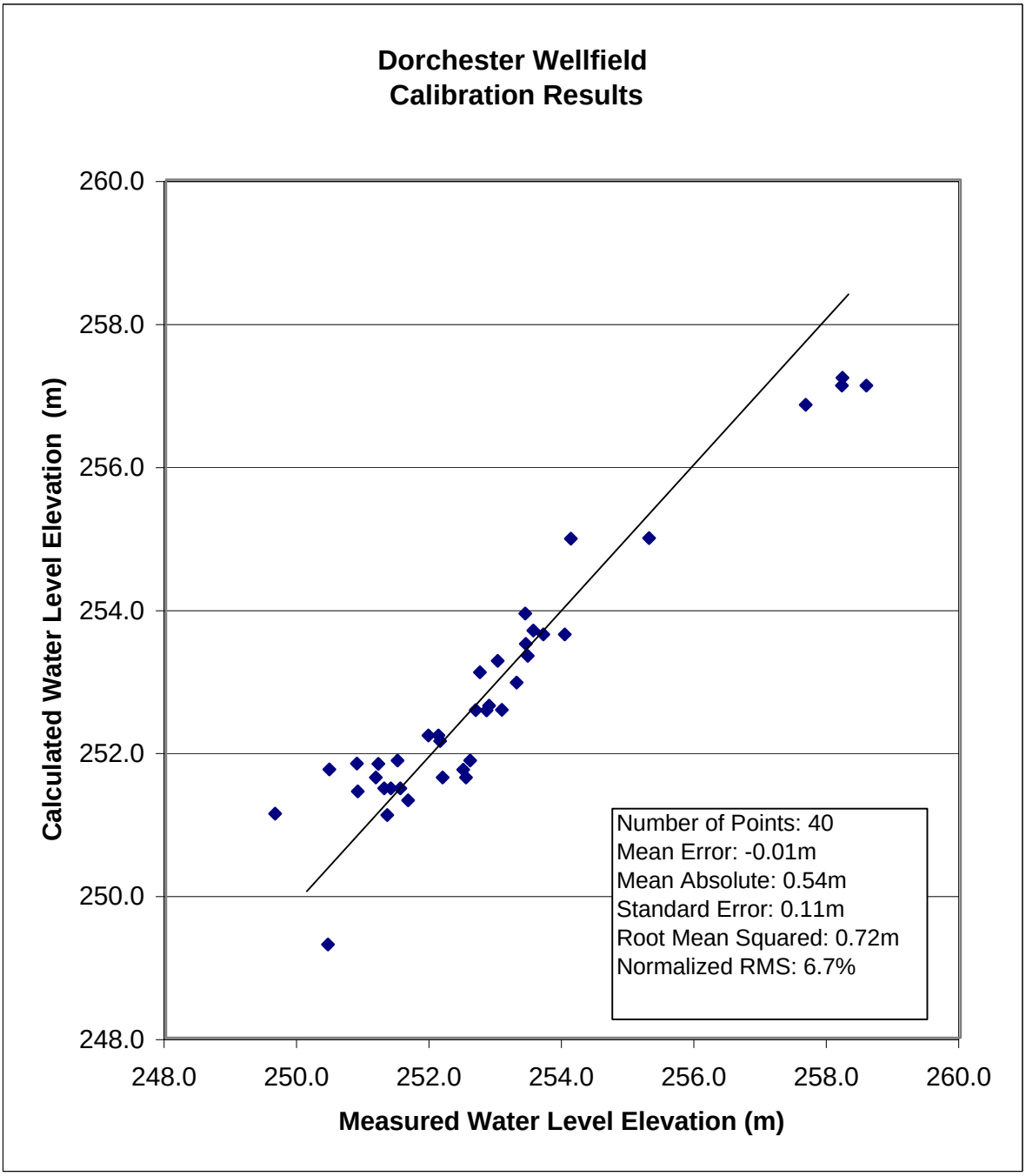
APPENDIX A.3: Known Ontario Regulation 459 Georeferenced Wells (continued)

Municipality	Use	Well	MOE Well Record	Location	Township	Lot	Concession	Easting	Northing
Central Elgin	Belmont WTP	1	2001938	Belmont	Village of Belmont	n/a	n/a	492925	4747700
		2	2002168	Belmont	Village of Belmont	n/a	n/a	492925	4747700
	Springwater Conservation Campground	1	n/a		Yarmouth	28	4	n/a	n/a
Strathroy Caradoc	Strathroy WTP	1,2,3	n/a	Frances St	Caradoc	1	12	449880	4755560
		4	n/a	English St	Caradoc	1	12	449820	4756030
		5	n/a	High St	Caradoc	1	5	449320	4755610
		6	n/a	Oxford St	Caradoc	1	10	448670	4755600
		8,9	n/a	York Ave	Caradoc	1	14	451190	4756240
		11B	4109944	Bosquart Field #1	Caradoc	12	8	451740	4754000
		11D	4109941	Bosquart Field #1	Caradoc	12	8	451700	4753980
		13	4111513	York Ave	Caradoc	14	A	4756108	4756108
		14	4112074	Bosquart Field #2	Caradoc	13	8	451792	4754178
		15	4112071	Bosquart Field #2	Caradoc	13	8	451675	4754213
	Mt Brydges WTP	1	4109308	Mt Brydges	Caradoc	22	3	461140	4752360
		2	4109309	Mt Brydges	Caradoc	22	3	461100	4752400

Notes: n/a = not available

APPENDIX B

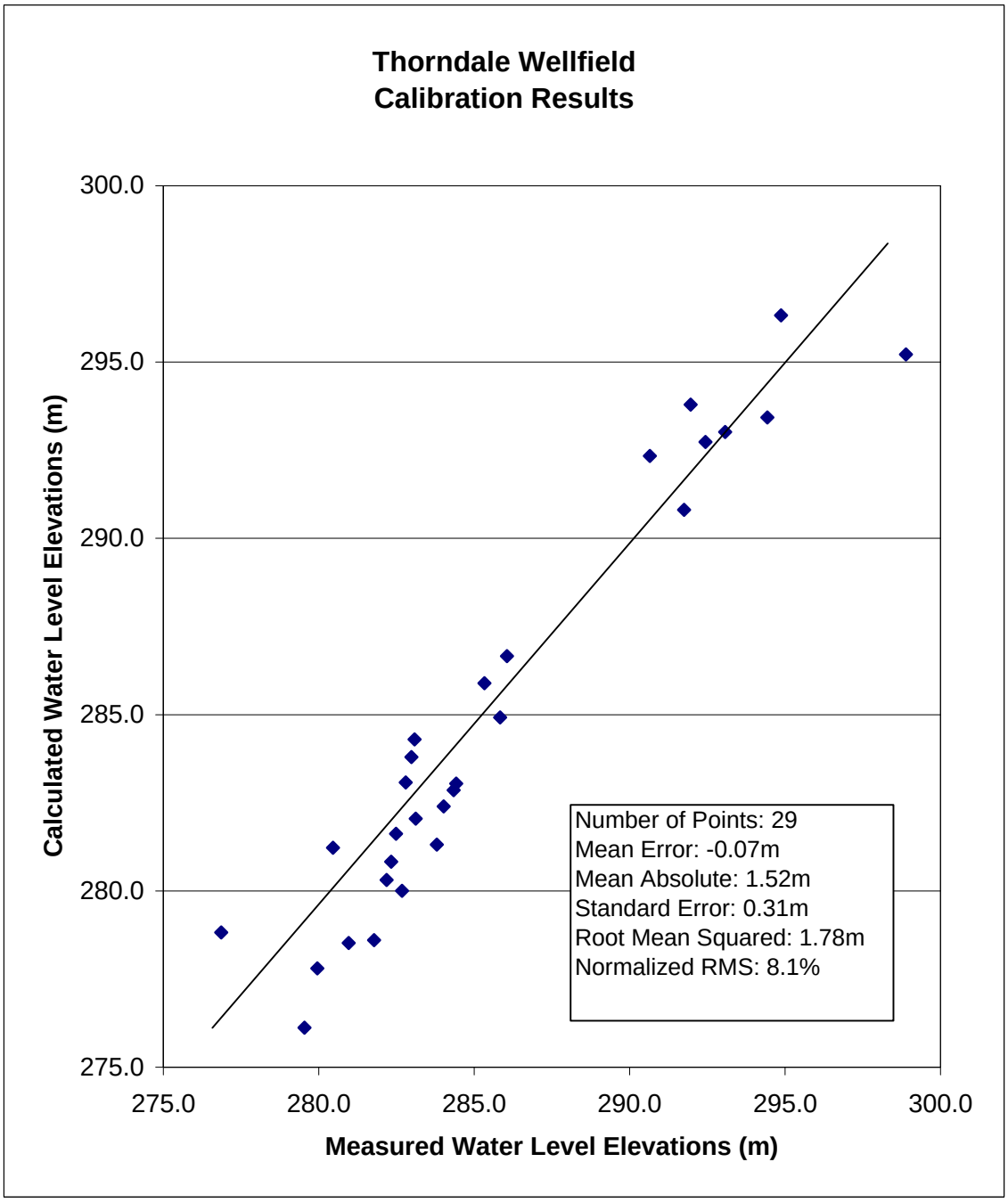
WELLHEAD PROTECTION AREA DELINEATION DETAILED DOCUMENTATION



MIDDLESEX - ELGIN
GROUNDWATER STUDY

CALIBRATION PLOT
DORCHESTER WELLFIELD

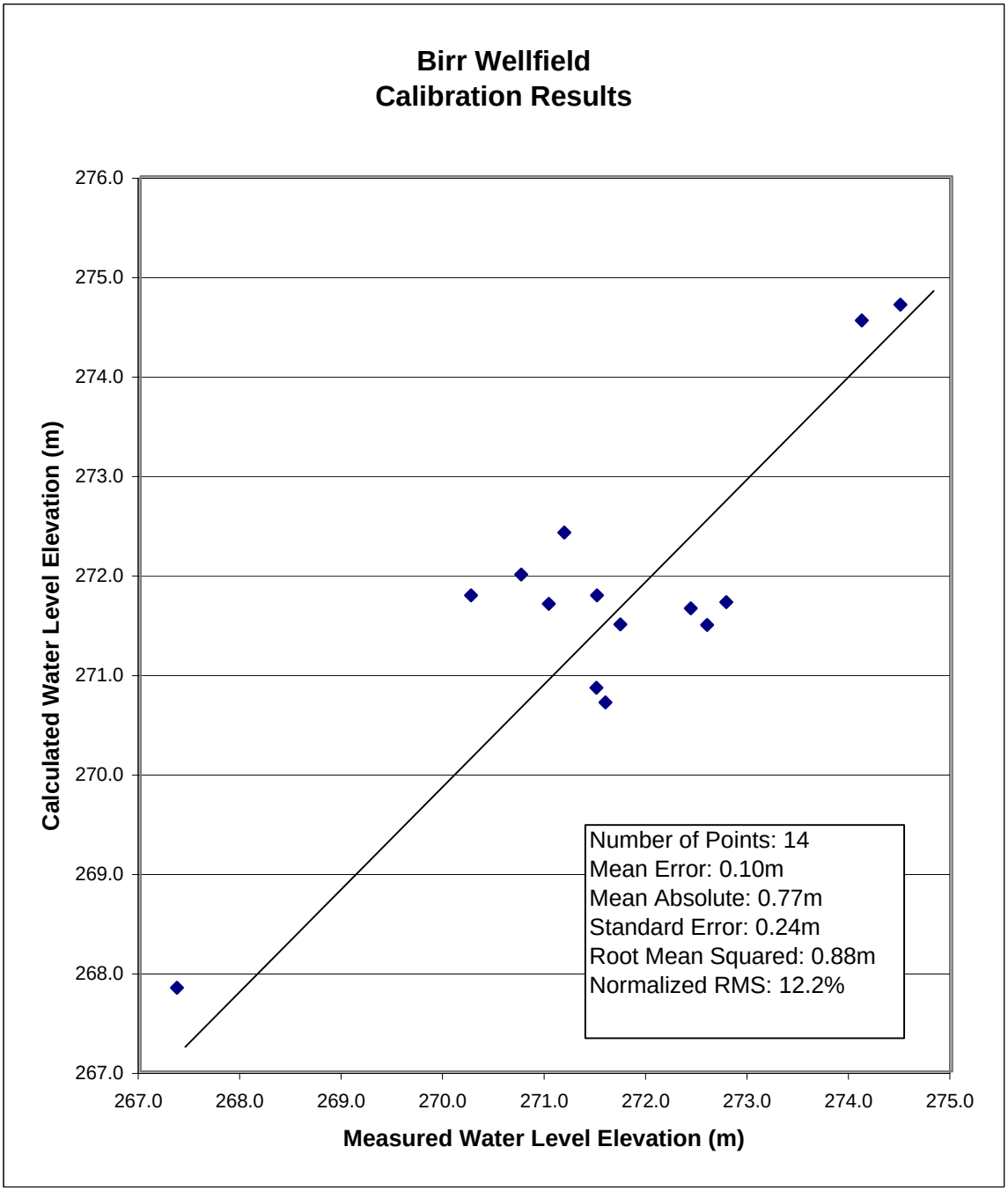
Figure B.1



MIDDLESEX - ELGIN
GROUNDWATER STUDY

CALIBRATION PLOT
THORNDALE WELLFIELD

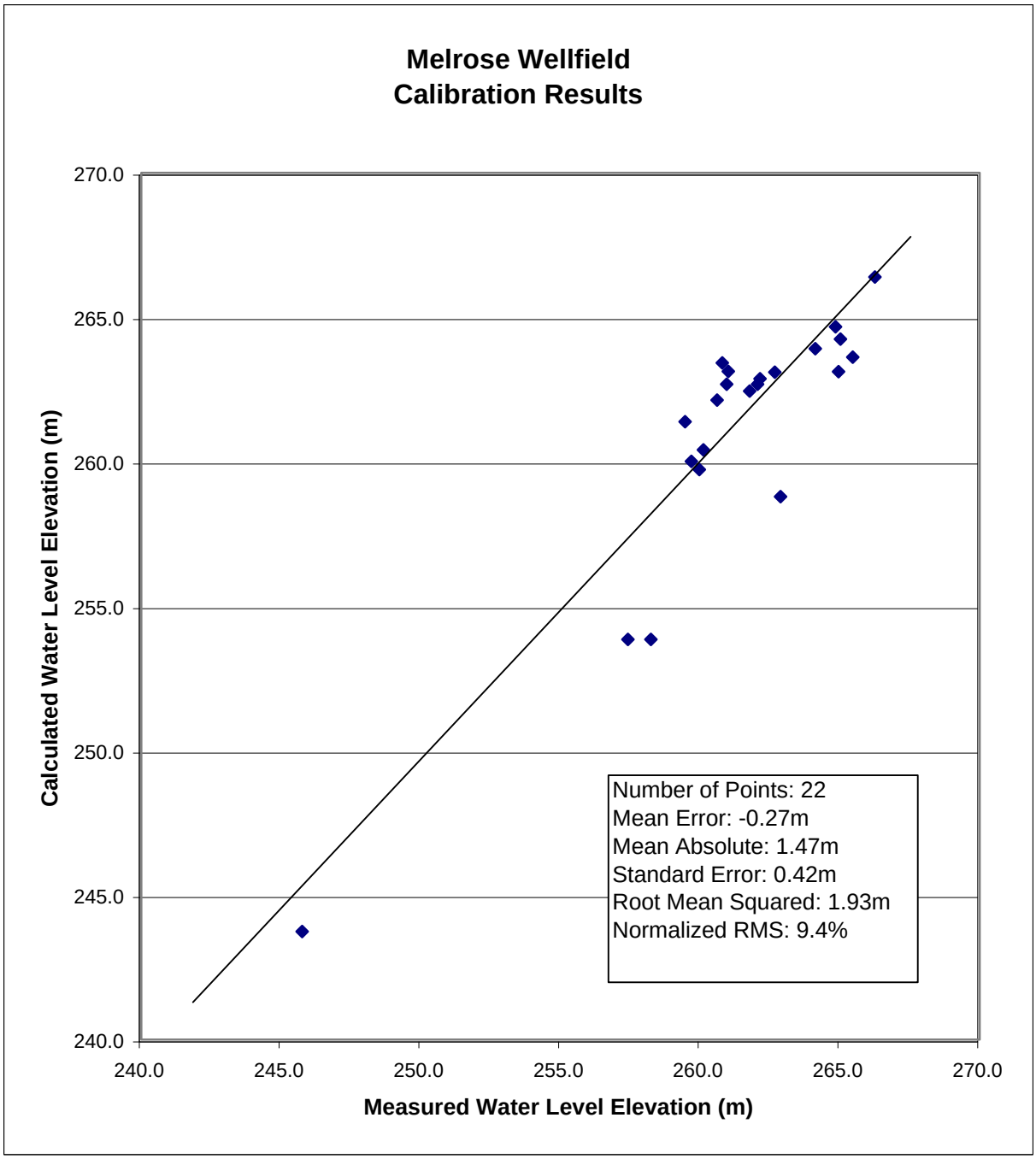
Figure B.2



MIDDLESEX - ELGIN
GROUNDWATER STUDY

CALIBRATION PLOT
BIRR WELLFIELD

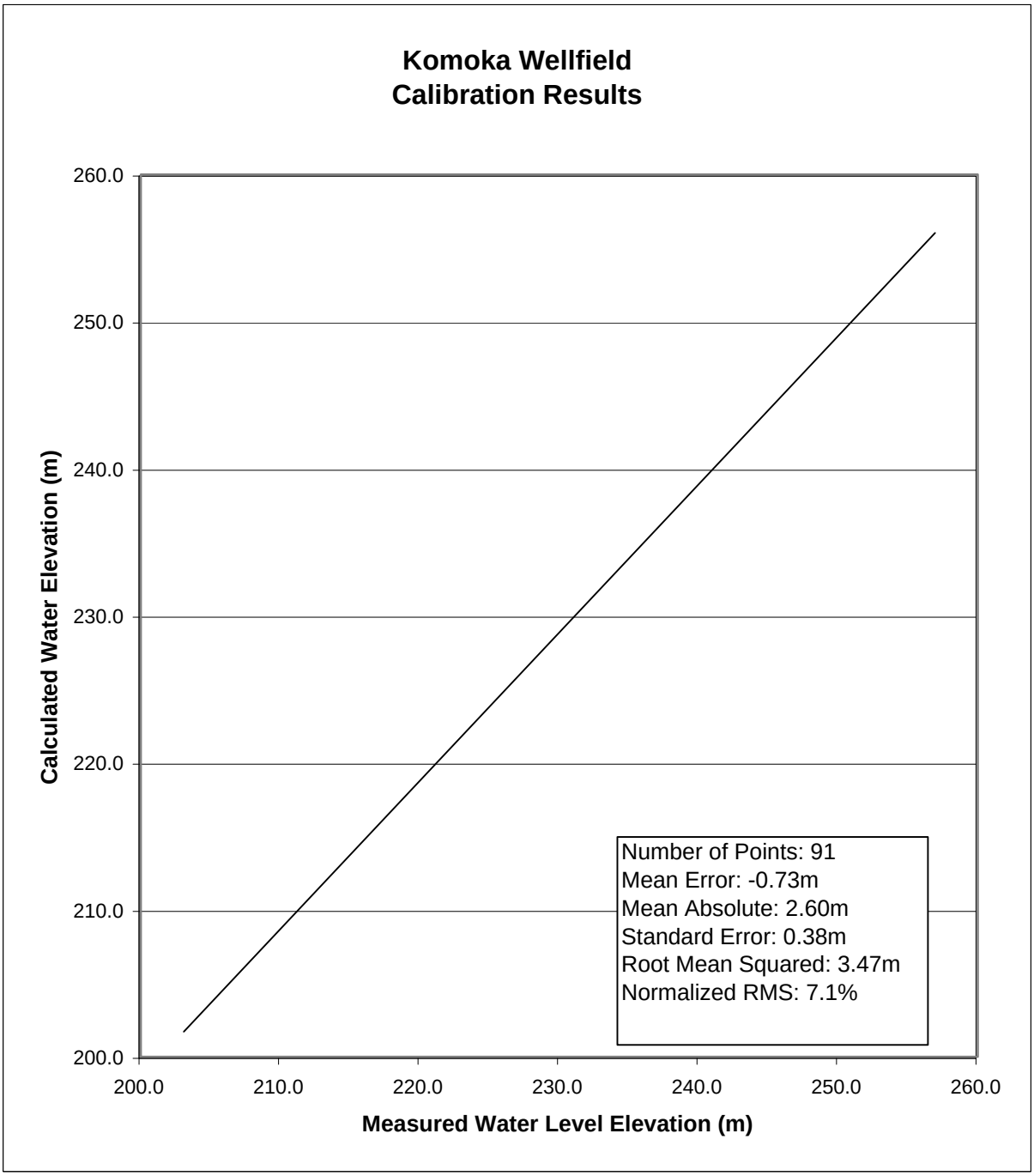
Figure B.3



MIDDLESEX - ELGIN
GROUNDWATER STUDY

CALIBRATION PLOT
MELROSE WELLFIELD

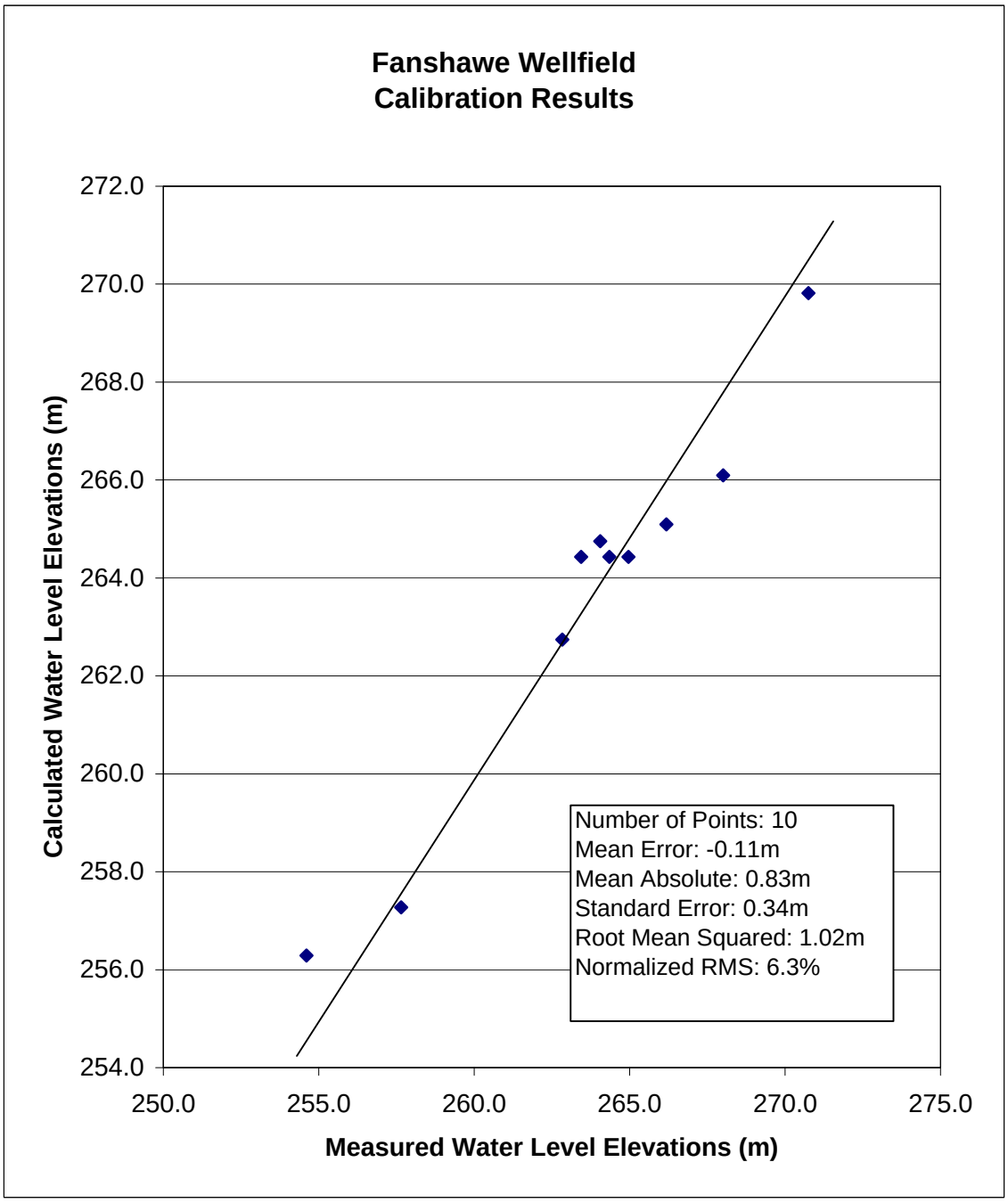
Figure B.4



MIDDLESEX - ELGIN GROUNDWATER STUDY

CALIBRATION PLOT KOMOKA WELLFIELD

Figure B.5



MIDDLESEX - ELGIN GROUNDWATER STUDY

CALIBRATION PLOT FANSHAWE WELLFIELD

Figure B.6

Detailed Results of Calibration for All Wellfields

Calibration Results for Dorchester Wellfield

MOE Well Number	UTM Easting	UTM Northing	Measured Head (m)	Calculated Head (m)	Residual (m)
4102939	496234	4759333	247.9	249.9	2.0
4102948	495554	4759583	250.4	249.3	-1.1
4102952	494574	4758702	250.9	251.4	0.6
4103005	498254	4758823	253.3	253.0	-0.3
4103011	495594	4758022	252.9	252.6	-0.2
4106550	498118	4758641	252.7	253.1	0.4
4106810	498318	4758451	255.3	255.0	-0.3
4107073	495644	4758230	252.1	252.2	0.1
4107074	495631	4758224	252.1	252.1	0.0
4107075	495635	4758213	252.0	252.2	0.3
4107161	495594	4758202	251.3	251.1	-0.2
4108889	494634	4758542	250.9	251.8	0.9
4109174	498474	4757822	258.6	257.1	-1.5
4109514	494614	4758762	251.5	251.5	0.0
4109515	494614	4758742	251.4	251.5	0.1
4109805	494634	4758642	252.2	251.6	-0.5
4109878	494614	4758683	252.5	251.6	-0.9
4110125	494594	4758883	249.6	251.1	1.5
4110324	494654	4758703	251.3	251.5	0.2
4110326	494654	4758683	251.2	251.6	0.5
4110327	494614	4758782	251.7	251.3	-0.3
4110328	494634	4758542	251.5	251.9	0.4
4110341	494514	4758582	250.5	251.8	1.3
4110487	494514	4758542	251.2	251.8	0.6
4110617	495214	4758003	252.7	252.6	-0.1
4110618	495194	4758002	252.8	252.6	-0.3
4110619	495294	4758023	253.1	252.6	-0.5
4110682	494679	4758562	252.6	251.9	-0.7
4110864	495009	4758572	252.5	251.7	-0.7
4110905	498294	4758457	254.1	255.0	0.9
4110990	498224	4757642	257.7	256.8	-0.8
4110991	498449	4757762	258.2	257.2	-1.0
4110992	498459	4757802	258.2	257.1	-1.1
4111336	496149	4757908	253.5	253.7	0.1
4111337	496019	4757957	253.5	253.3	-0.1
4111338	496034	4757842	254.0	253.6	-0.4
4111340	496129	4757978	253.4	253.5	0.1
4111342	496044	4757842	253.7	253.6	-0.1
4111343	496194	4757802	253.4	253.9	0.5
4111345	495974	4757942	253.0	253.3	0.3

Calibration Results for Thorndale Wellfield

MOE Well Number	UTM Easting	UTM Northing	Measured Head (m)	Calculated Head (m)	Residual (m)
4104114	487749	4772173	282.6	279.9	-2.67
4104125	487854	4772273	282.2	280.7	-1.49
4104153	489164	4772873	285.7	284.8	-0.90
4104157	487814	4774793	293.0	292.9	-0.04
4104789	489184	4772813	283.0	284.2	1.23
4104913	488534	4772533	283.0	282.0	-1.05
4105639	487654	4775198	291.9	293.7	1.85
4105861	489094	4772793	284.3	283.0	-1.37
4106361	489243	4774652	294.8	296.3	1.47
4106731	488315	4773101	286.0	286.6	0.62
4106804	488000	4773993	291.7	290.7	-0.93
4106899	487621	4774977	292.4	292.7	0.30
4107112	489092	4771339	279.5	276.0	-3.40
4107761	487894	4774443	290.6	292.3	1.70
4108894	489114	4772723	283.9	282.3	-1.61
4108922	488854	4771723	281.7	278.5	-3.16
4108953	486774	4773023	279.9	277.7	-2.13
4109192	487514	4775303	294.3	293.3	-0.99
4109263	487894	4772683	282.7	283.0	0.29
4109882	488334	4773023	285.2	285.8	0.58
4110071	488314	4772283	283.7	281.2	-2.48
4110222	488474	4772643	284.3	282.8	-1.47
4111056	488214	4775673	298.8	295.1	-3.66
4111278	488119	4772073	282.1	280.2	-1.86
4111299	488519	4772788	282.9	283.7	0.83
4111498	487064	4772738	276.8	278.7	1.98
4111504	487984	4772323	280.4	281.1	0.78
4111994	488709	4771679	280.9	278.4	-2.42
4112161	488169	4772347	282.4	281.5	-0.85

Calibration Results for Birr Wellfield

MOE Well Number	UTM Easting	UTM Northing	Measured Head (m)	Calculated Head (m)	Residual (m)
4102414	471093.5	4775043	267.4	267.8	0.48
4112527	472697.5	4773978	270.3	271.8	1.53
4111160	472833.5	4774313	270.8	272.0	1.24
4111900	472654.5	4774065	271.0	271.7	0.68
4106474	473034.5	4774179	271.2	272.4	1.24
4112272	472270.5	4774367	271.5	270.9	-0.64
4110835	472713.5	4774103	271.5	271.8	0.29
4110966	472203.5	4773943	271.6	270.7	-0.87
4112088	472573.5	4773988	271.7	271.5	-0.24
4112353	472643.5	4773944	272.4	271.7	-0.77
4112035	472589.5	4774014	272.6	271.5	-1.09
4110665	472693.5	4774063	272.8	271.7	-1.05
4108228	474113.5	4776223	274.1	274.5	0.44
4110965	474253.5	4773543	274.5	274.7	0.22

Calibration Results for Melrose Wellfield

MOE Well Number	UTM Easting	UTM Northing	Measured Head (m)	Calculated Head (m)	Residual (m)
4111330	469713.5	4760053	245.8	243.7	-2.01
4109533	467213.5	4759583	257.4	253.9	-3.57
4109532	467233.5	4759583	258.2	253.9	-4.39
4104406	466033.5	4760583	259.5	261.4	1.93
4105147	466223.5	4760453	259.7	260.0	0.33
4100978	466693.5	4760773	260.0	259.7	-0.24
4106141	468273.5	4762043	260.1	260.4	0.29
4110294	467333.5	4761923	260.6	262.1	1.54
4100971	465538.5	4761033	260.8	263.4	2.63
4110373	465613.5	4760843	260.9	262.7	1.74
4100964	465513.5	4761013	261.0	263.1	2.12
4100958	465783.5	4760723	261.8	262.4	0.68
4100963	465493.5	4760803	262.1	262.7	0.62
4106189	465643.5	4760963	262.1	262.9	0.73
4100953	465713.5	4760783	262.7	263.1	0.43
4111432	469543.5	4762723	262.9	258.8	-4.08
4110251	467613.5	4762983	264.1	263.9	-0.21
4101004	466933.5	4762943	264.8	264.7	-0.17
4111083	468178.5	4763298	264.9	263.1	-1.83
4106666	466399.5	4762229	265.0	264.2	-0.77
4106272	466980.5	4762514	265.5	263.6	-1.83
4101026	465443.5	4763183	266.3	266.4	0.13

Calibration Results for Komoka Wellfield

MOE Well Number	UTM Easting	UTM Northing	Measured Head (m)	Calculated Head (m)	Residual (m)
4100831	467004	4755053	205.2	209.2	4.1
4100812	466614	4754123	207.8	207.6	-0.2
4100810	466754	4754253	208.4	208.2	-0.2
4100822	466984	4754808	208.7	206.5	-2.2
4108873	466874	4754163	208.8	207.1	-1.7
4107299	468094	4756203	209.5	214.7	5.2
4100815	466974	4754843	209.9	206.5	-3.4
4105435	467934	4755933	210.4	214.1	3.7
4100820	466954	4754823	210.7	206.5	-4.2
4106425	467894	4755823	211.0	212.5	1.5
4107610	468074	4756233	211.3	214.7	3.4
4107008	466911	4755462	211.4	216.2	4.8
4100821	466954	4754823	211.6	206.5	-5.2
4100829	466964	4754863	211.7	206.5	-5.2
4100830	466974	4754943	211.9	208.6	-3.3
4107006	466941	4755510	212.2	215.4	3.2
4110705	467129	4755673	213.9	216.0	2.1
4105957	467814	4755873	214.0	213.7	-0.3
4100854	467874	4756293	214.1	216.7	2.6
4105436	467972	4756463	214.1	216.5	2.5
4106180	467854	4755903	214.2	213.7	-0.5
4106064	467884	4756393	214.3	217.3	3.0

Calibration Results for Komoka Wellfield (cont.)

MOE Well Number	UTM Easting	UTM Northing	Measured Head (m)	Calculated Head (m)	Residual (m)
4106485	467861	4755974	215.0	214.5	-0.5
4104746	467854	4756033	215.0	215.3	0.3
4105692	467944	4756501	215.1	218.0	2.9
4104790	467814	4756093	215.4	215.3	-0.1
4104603	467864	4756383	215.4	217.4	2.0
4104630	467914	4756093	215.4	214.8	-0.7
4110218	467874	4756063	215.6	215.3	-0.3
4105998	467824	4756193	216.8	216.0	-0.8
4104973	467794	4756173	217.2	216.6	-0.6
4105609	467714	4756013	219.5	215.5	-4.0
4104396	467754	4756153	221.9	216.7	-5.2
4104408	467814	4756523	226.0	218.9	-7.1
4104409	467804	4756503	227.3	218.9	-8.4
4100859	467594	4756323	227.3	219.3	-8.0
4104394	467744	4756423	227.7	218.9	-8.8
4100856	467644	4756523	230.2	220.2	-10.0
4110131	466994	4756103	230.6	222.4	-8.2
4100832	466083.5	4755843	233.5	228.3	-5.2
4107397	464613.5	4754963	233.7	232.5	-1.2
4109675	464913.5	4755023	233.9	232.0	-1.8
4107338	464553.5	4755023	235.1	233.7	-1.3
4107164	464513.5	4755043	235.1	234.3	-0.8
4111003	465113.5	4755543	235.2	233.6	-1.6
4107826	464563.5	4754993	235.3	233.7	-1.6
4107163	464493.5	4755083	235.4	235.0	-0.4
4100899	466933.5	4756963	235.5	230.3	-5.1
4111818	464512.5	4755203	236.3	236.1	-0.2
4110250	464233.5	4755243	236.4	237.2	0.8
4100867	464233.5	4755443	236.5	237.4	0.9
4100866	464243.5	4755463	236.8	238.0	1.2
4111541	464692.5	4755423	237.0	236.0	-1.1
4112351	464542.5	4755447	237.5	236.9	-0.6
4112349	464525.5	4755443	237.9	236.9	-1.0
4100894	465773.5	4756043	239.1	233.5	-5.7
4108248	463833.5	4756263	241.3	244.0	2.7
4106828	463685.5	4756248	241.9	245.3	3.4
4106238	463393.5	4756263	242.0	246.0	4.0
4105816	463863.5	4756223	242.2	244.0	1.7
4106389	463843.5	4756283	242.3	245.0	2.6
4106574	463794.5	4756224	242.4	245.2	2.7
4106623	464179.5	4756239	242.5	244.1	1.5
4106624	464114.5	4756305	242.7	244.7	2.0
4106625	464147.5	4756341	243.0	244.5	1.4
4106723	464164.5	4756264	243.1	244.1	0.9
4106470	464169.5	4756312	243.2	244.5	1.3
4106830	463733.5	4756264	243.4	245.2	1.8
4107331	463893.5	4756283	243.5	244.8	1.3
4106833	463905.5	4756291	243.5	244.8	1.3
4111080	464243.5	4756443	243.5	244.6	1.0
4106293	463903.5	4756333	243.5	245.1	1.6

Calibration Results for Komoka Wellfield (cont.)

MOE Well Number	UTM Easting	UTM Northing	Measured Head (m)	Calculated Head (m)	Residual (m)
4106655	464017.5	4756442	244.0	245.2	1.3
4106024	463803.5	4756323	244.0	245.3	1.3
4109052	464253.5	4756283	244.1	243.8	-0.3
4105592	463813.5	4756343	244.2	245.3	1.2
4105176	463873.5	4756383	244.2	244.8	0.7
4106651	463922.5	4756331	244.2	245.1	0.9
4106573	463781.5	4756348	244.2	245.5	1.2
4105530	463673.5	4756373	244.4	245.6	1.2
4109994	464313.5	4756523	244.9	244.6	-0.3
4106824	464110.5	4756572	245.3	245.3	0.0
4106825	464064.5	4756551	245.7	245.3	-0.3
4100910	466393.5	4758343	250.1	242.3	-7.8
4100907	463703.5	4757423	250.8	248.4	-2.4
4105003	465523.5	4757943	250.8	246.1	-4.7
4108729	463153.5	4756563	251.5	246.3	-5.2
4109055	463413.5	4757183	252.2	247.5	-4.7
4100939	463243.5	4758883	254.1	250.4	-3.7
4100938	463913.5	4757863	254.1	248.6	-5.6

Calibration Results for Fanshawe Wellfield

MOE Well Number	UTM Easting	UTM Northing	Measured Head (m)	Calculated Head (m)	Residual (m)
2002538	483713.7	4767083	262.7	262.7	-0.05
2002552	482873.7	4767633	266.1	265.0	-1.05
2002565	482983.7	4766273	257.6	257.2	-0.34
2002761	484073.7	4769503	270.7	269.8	-0.90
3403118	484133.7	4767382	264.3	264.4	0.12
3403149	484113.7	4767383	263.4	264.4	1.03
4100394	484133.7	4767382	264.9	264.4	-0.49
4100436	483393.7	4767602	264.0	264.7	0.74
4102593	483153.7	4767863	267.9	266.0	-1.87
4106342	482901.7	4766203	254.5	256.2	1.72

APPENDIX C

PUBLIC AND AGENCY CONSULTATION MATERIALS

See Separate File for Appendix C

APPENDIX D

SUMMARY OF THE EXISTING FEDERAL, PROVINCIAL AND MUNICIPAL FRAMEWORK: WATER RESOURCES PROTECTION

APPENDIX D

GROUNDWATER MANAGEMENT PRINCIPLES AND CONTEXT

1. Introduction

For this Groundwater Study, the main objective was to develop a detailed understanding of the groundwater resources in the Middlesex-Elgin Study Area. A final goal was to identify strategies to protect groundwater resources for current and future generations.

The topic of water resource management and protection is not new; it has long been a subject of attention and concern by many individuals, organizations and levels of government. A variety of programs, policies and legislation already exist or are currently in development that relate to the management and protection of groundwater. These are administered at the municipal, provincial or federal levels of government, or through conservation authorities and health units. Many funding initiatives and educational programs have also been undertaken by agricultural associations, schools, business and other interest groups.

Like many environmental issues, water resource issues extend across geographic and political boundaries and transcend individual sectors, disciplines and organizational mandates. The development of water resource protection solutions requires an integrated, multi-disciplinary, and multi-sector approach, involving partnerships, shared responsibilities, and the effective coordination of resources.

Given the above, the Groundwater Resource Management Strategy for Middlesex and Elgin was developed with reference to, and within the context of the existing regulatory and non-regulatory framework within Ontario. It is also founded on the recognition that a multi-disciplinary, integrated approach is necessary for successful implementation. This Appendix provides a summary of the basic principles and context for the Strategy in several sections which address the following:

- general principles for groundwater resource management
- the federal and provincial legislation, policies and programs for groundwater protection
- the groundwater protection policies and measures that are currently in place or in development in Middlesex and Elgin, and
- examples of “model”groundwater protection policies and initiatives that are in place in other

Ontario municipalities.

Appendix E presents the Strategy with a summary of:

- the key water resource management issues in Middlesex and Elgin as identified by the project team and stakeholders, and

- the range of water resource protection measures available to address the regional and local issues identified.

The background policy overview and the specific issues and measures summarized in these chapters provide a foundation for policy development, additional studies, and further implementation of the strategies identified.

The public and agency consultation carried out during the course of this study contributed significantly to the development of the Strategy. The consultation program included the following activities:

- distribution of a Study Initiation Press Release to local newspapers, and notices to municipalities, agencies and interest groups on the project contact list
- distribution of a Municipal Survey to municipalities in the study area to obtain local knowledge about groundwater systems, use and problems
- Public Open Houses held on June 12th and June 13th, 2002 in Belmont and Coldstream
- a Groundwater Protection Workshop held on January 22nd, 2003 attended by over 50 participants including representatives from local municipalities, conservation authorities, provincial ministries, agricultural associations, health units and interest groups
- Public Open Houses held on April 23rd and 24th, 2003 at the Keystone Complex in Shedden and at the Middlesex County building in London
- regular meetings with the 20-person Steering Committee composed of study area representatives.

The notices, invitation letters, information materials, sign-in sheets and comment forms for these activities are presented in Appendix C. The notes from the Groundwater Protection Workshop discussion groups are also included.

2. General Principles for Groundwater Resource Management

In conducting the research and consultation activities undertaken in developing the Groundwater Resource Management Strategy for Middlesex and Elgin, a number of common threads and

predominant themes have emerged among the many groundwater issues and protection measures identified. They represent the "first principles" of groundwater resource management and would be applicable in implementing any groundwater protection strategy, regardless of the local conditions and specific issues being addressed. These first principles are considered fundamental to any other individual or specific groundwater management measures and include the following:

- **Utilize planning tools for smart growth:** The existing land use planning regime in Ontario provides both the policy direction and mechanisms for a "multiple barrier" approach to groundwater protection. The Provincial Policy Statement issued under the Planning Act promotes wisely managed growth resulting in communities which are environmentally and economically sound, and specifically refers to the need to protect or enhance the quality and quantity of groundwater and surface waters. Municipal Official Plans, secondary plans, subwatershed plans, and stormwater management master plans can provide or contribute to overall policies for the management, wise use and protection of water resources. Zoning by-laws, development controls, site plans and by-laws for property standards, water use, and tree-cutting can play a key role at the issue or site-specific level. This can include directing growth to urban areas and rural settlement areas, to lands that are suitable for development. It would also involve implementation of servicing policies that encourage development on full or communal services, and discourage multi-lot development on individual services.

- **Adopt a watershed approach with Conservation Authority leadership:** Water resources - both surface and groundwater - are best understood, monitored, managed, protected and enhanced from a watershed ecosystem perspective. This allows comprehensive consideration of water balance, water quantity, and water quality, as well as water-related natural features, terrestrial resources, aquatic life, and other key ecosystem indicators. Groundwater resource management plans and activities should be undertaken within a watershed framework. The 36 Conservation Authorities in Ontario were founded on the watershed approach to resource management and, with local municipal support, they have provided leadership in water resource management for more than half a century. Their established structure and base of expertise provides a foundation for a continued leadership role in water resource management and, with appropriate funding and resources, they would be well placed to lead the development and implementation of a watershed-based approach to groundwater protection.

- **Better enforcement of existing rules:** An extensive array of laws and regulations already exist that specify requirements relevant to the protection of water resources. Additional resources for and improved enforcement of the existing regulatory requirements would be very beneficial in achieving groundwater resource management goals.

- **Coordination of activities among government and agencies:** Various federal and provincial government departments, municipalities, conservation authorities, and health units have responsibilities related to water resource management and protection. Improved communication and coordination of effort among these responsible parties, including working agreements, partnerships, and data and resource sharing, would result in more efficient use of available resources and greater effectiveness in management of the groundwater resources.

- **Encourage a "living strategy" with continuous improvement:** A groundwater resource management strategy will, at any point in time, be the product of the technical data available, the environmental context, and the laws and regulations in place during its development. Updates and improvements will be needed through further studies and ongoing monitoring to allow for appropriate refinements and improvements. Establishment of a regional Groundwater Strategy Implementation Committee would assist in the continuous improvement process.

- **Build upon and expand non-regulatory programs:** Regulation and enforcement have a role to play in providing safeguards for the environment and in ensuring the remediation of negative effects. However, non-regulatory initiatives are often more influential in raising awareness of environmentally sound practices and behaviours, and in encouraging such practices to become part of day-to-day activities. There are many non-regulatory programs in Ontario aimed at improving practices that have the potential to impact on water resources. These include the educational programs, stewardship activities, and funding initiatives that have been or are being undertaken by conservation authorities, agricultural associations, health units, and community groups, either individually or in partnership with provincial or municipal organizations. With appropriate funding and resources, these groups have the depth of experience and local knowledge needed to continue to develop and deliver these important non-regulatory components of groundwater protection and management.

3. Existing Context for Groundwater Protection in Ontario

As stated above, many laws and regulations are already in place that provide a good basis for the wise management and protection of resources. Many water resource management goals could be achieved through effective application of the existing rules and better enforcement of current requirements. Study participants have also suggested that water resource potection could be enhanced by strengthening some aspects of existing policy or regulatory documents, such as the Ontario Building Code and the Provincial Policy Statement.

The following subsections provide an overview of some of the key federal and provincial legislation,

policies and programs that are relevant to groundwater protection in Ontario. Selected non-regulatory programs are also highlighted. Further details regarding some of the provincial laws and regulations are provided in Appendix E in the discussions of the provincial role with respect to specific groundwater management issues.

3.1 Federal Programs and Initiatives

The federal government has little regulatory control over water resources including groundwater. However, there are a number of federal initiatives aimed at protecting groundwater as a resource as well as a drinking water supply.

Federal Water Policy

In 1987, the federal government introduced a Federal Water Policy. The water policy was initiated with the underlying philosophy that "…Canadians must start viewing water both as a key to environmental health and as a scarce commodity having real value that must be managed accordingly." Despite its date, many of the issues and strategies in the policy are still valid today.

The overall objective of the Federal Water Policy is "… to encourage the use of freshwater in an efficient and equitable manner consistent with the social, economic and environmental needs of present and future generations." Its two main goals are to 1) protect and enhance the quality of the water resource; and 2) promote the wise and efficient management and use of water. To reach these goals the policy identifies five strategies:

- Strategy 1: Water pricing – outlines the federal government's commitment to fair water pricing
- Strategy 2: Science leadership – outlines the federal government's role in providing national science leadership
- Strategy 3: Integrated planning – endorses an integrated long term planning process for water protection
- Strategy 4: Legislation – commits to renew, consolidate and otherwise strengthen existing federal legislation
- Strategy 5: Public Awareness – outlines the federal government's role in the promotion of public awareness of water issues.

Since the responsibility for water is diverse, the intention is that this policy be implemented through coordination with all levels of government. The Canadian Council of Resource and Environment Ministers is identified as one existing mechanism to encourage this coordination.

The Federal Water Policy also includes 25 specific policy statements covering a range of topics. For each of these, specific initiatives at the federal government level are described. The statements of specific policy that relate most to groundwater protection are: management of toxic chemicals, and groundwater contamination.

CCME Source to Tap

The Canadian Council of Ministers of the Environment (CCME) has initiated a program titled *From Source to Tap – Protecting our Water Quality*. This initiative involves a collaborative effort among CCME members and their federal, provincial and territorial colleagues and counterparts responsible for drinking water protection to ensure an integrated source to tap approach. The web site www.sourcetotap.ccme.ca includes information on research, monitoring and guidelines from across Canada related to the protection of water quality. As part of the Source to Tap initiative, a paper titled *From Source to Tap, The Multi-barrier Approach to Safe Drinking Water* was prepared in May 2002. Recognizing the integration between health and environmental issues, the paper "…serves as a template for the strategic alignment of Canadian Water Quality Guidelines, best management practices, research and monitoring with an integrated source to tap approach to drinking water protection." The proposed multi-barrier approach includes discussion of the following 'barriers':

- Legislative and policy frameworks
- Public involvement and awareness
- Guidelines, standards and objectives
- Research, science and technology
- Management
- Monitoring
- Source water protection and management
- Drinking water treatment
- Drinking water distribution systems.

Centres of Excellence

In 2001, the Government of Canada launched the Canadian Water Network, a new Network of Centres of Excellence. The Canadian Network of Centres of Excellence are partnerships among universities, industry, government and non-governmental organizations. The Canadian Water Network focuses on seven key research areas:

- Policy and governance
- Water resource management
- Water and public health
- Safe drinking water
- Wastewater management

- Infrastructure
- Groundwater and sediment protection.

The research efforts of this network are intended to help support the federal government's leadership in the management of our water resources.

Canada/Ontario Water Use and Supply Project

A federal-provincial assessment of water supply and use has been initiated for the Great Lakes basin to assess both current and future water use. This four and a half year project is being carried out by a study team that includes Environment Canada, the Ontario Ministry of Natural Resources, the Ontario Ministry of the Environment and Conservation Ontario.

Primary project goals are:

- To gain information on water supply (surface and groundwater source and abundance), water use and demand at a sub-basin level
- To make projections for the future and to consider the impacts of climate change
- To improve our understanding of the diversity of water resource conditions in the Great Lakes basin and the sensitivities of the system to future demands and climate change.

Alternatives to Road Salt

Environment Canada undertook a comprehensive 5-year study that determined that in sufficient concentrations, road salts pose a risk to plants, animals and the aquatic environment. While not intending to ban road salt, the federal government plans to develop management measures to reduce the impact of road salts on the environment.

3.2 Provincial Legislation and Policy

In the province of Ontario, a wide variety of laws, regulations and standards are in place that are relevant to water resource management and protection. These are central to the ability of the province, municipalities, conservation authorities, health units and others to achieve water conservation and protection goals.

This section highlights key provincial laws that have broad application to water resource management including:

- Planning Act

- Ontario Water Resources Act
- Environmental Protection Act
- Safe Drinking Water Act
- Health Protection and Promotion Act
- Ontario Building Code Act
- Sustainable Water and Sewage Systems Act
- Municipal Act
- Conservation Authorities Act.

Other provincial laws and regulations that address specific activities or water resource issues more directly - such as the *Nutrient Management Act*, *Pesticides Act*, and *Drainage Act* - are discussed in Appendix E.

Ontario Planning Act

The Planning Act establishes the municipal jurisdiction to regulate land use through a variety of tools including official plans, zoning by-laws, plans of subdivision and land severances. The Planning Act requires that municipalities have regard to the Provincial Policy Statement when making land use decisions.

Provincial Policy Statement

The Provincial Policy Statement (PPS) promotes "efficient, cost-effective development and land use patterns to stimulate economic growth and protect the environment and public health". Some of the policies that relate to groundwater protection include:

- Urban areas and resettlement areas will be the focus for growth;
- Full municipal servicing is preferred;
- Development and land use patterns which may cause environmental or public health and safety concern will be avoided;
- The quality and quantity of groundwater and surface water and the function of sensitive groundwater recharge/discharge areas, aquifers and headwaters will be protected or enhanced; and
- Natural heritage areas and features will be protected.

As noted above, municipalities must have regard for these policies when making planning decisions.

Official Plans

An Official Plan describes the local municipality or county policies on how lands in their jurisdiction

should be used. Plans are prepared and updated every five years. Generally, OPs control new land uses and have little influence over existing land uses.

An Official Plan can introduce specific policies related to groundwater management and protection including for example, the establishment of wellhead protection areas and the identification of appropriate uses within these areas, the establishment of areas of aquifer vulnerability and the identification of appropriate uses within these areas, minimum distance or separation criteria between certain land uses and surface waters, etc. Policies can range from proscriptive, such as the prohibition of high risk uses in certain areas for example, to more flexible policies that place the onus on the 'developer' to prove that their land use proposal does not result in a risk to groundwater.

Zoning By-Laws

Zoning by-laws are the mechanism to put the Official Plan policies into effect. They contain specific legally enforceable requirements that new development must comply with in order to obtain municipal approval.

Under Section 34 of the *Planning Act*, zoning by-laws can be passed for: "*prohibiting any use of land and the erecting, locating or using of any class or classes of buildings or structures on land…that is a sensitive ground water recharge area or head-water area or on land that contains a sensitive aquifer"*. Although there is clearly authority for municipalities to protect groundwater through zoning by-laws, zoning decisions must be supported by reliable aquifer and wellhead mapping and expert evidence on the potential for risk in the event that they are challenged at the Ontario Municipal Board. Zoning by-laws are also used to enforce any minimum distance or separation criteria established in the Official Plan.

Performance zoning is an alternative to conventional zoning. It provides both control and flexibility by imposing minimum "performance" levels for all land uses. This allows the zoning to reflect the individual characteristics of a site including the vulnerability of aquifers and wellheads. With a focus on groundwater protection, performance zoning could be established that prohibits/restricts development in areas of high aquifer vulnerability and then establishes appropriate uses, densities, etc. in other areas. Another approach would be to require applicants to prove that there is no risk to groundwater from their proposed land use.

Development Approvals

In order to subdivide land, an approved plan of subdivision or consent for land severance is required. Under the Planning Act, municipalities have clear powers to consider the impact of subdivisions and consents on groundwater resources as they relate to the "health, safety, convenience and welfare of

present and future inhabitants". In considering an application for plan of subdivision, municipalities look at such things as conformity with the Official Plan and zoning by-laws. Strong policies regarding the management and protection of groundwater in these documents give municipalities clear direction when making decisions on subdivision and consent applications.

Under Section 41 of the *Planning Act*, Official Plans can also identify areas where specific site plan control is required that goes beyond the requirements of the zoning by-laws. Site Plan control allows municipalities to require facilities for the disposal of storm, sewer and wastewater, as a condition of approval of new development or expansion of an existing use. However, there is no provision for preventing potential adverse impacts on groundwater. It has been suggested that a greening amendment be added to Section 41 of the Planning Act to empower the municipalities to require environmental protection measures to protect sensitive features and areas such as groundwater.

Planning Act Tools for Existing Uses

The Planning Act helps municipalities control future land uses however, it is limited in the extent to which it can assist in the control of existing uses. The Planning Act can only provide control on existing development when there are plans for expanding an existing use. Any expansion must comply with the Official Plan and Zoning by-laws including the minimum distance separation.

Ontario Water Resources Act

The *Ontario Water Resources Act*, administered by the Ministry of the Environment, is designed to protect surface water from contamination. Well construction permits and well contractor licenses are also covered under this legislation. OWRA approval must also be granted to establish, alter, extend or replace new or existing sewage or water works.

All water wells must comply with Ontario Regulation 903. This regulation made under the Ontario Water Resources Act, regulates the construction, use and abandonment of water wells.

Drinking Water Protection Regulation

In 2000, the Ministry of the Environment passed a Drinking Water Protection Regulation (Reg 459/00) under the Ontario Water Resources Act. This regulation requires that municipal waterworks (or large private systems) using groundwater as a source must, at a minimum, disinfect its drinking water supply. Treated water must also have an effective form of disinfection that continues to protect water quality as it passes through the distribution pipes.

This regulation also stipulates microbiological sampling requirements, the use of accredited

laboratories, appropriate notification of an adverse water sample, and the posting of a public notice and corrective action regarding drinking water.

Safe Drinking Water Act

The Safe Drinking Water Act was enacted by the Provincial government in 2002. This Act was developed to respond to recommendations from Commissioner Dennis O'Connor of the Walkerton Inquiry. The purpose of the Act is to gather together, in one place, all legislation and regulations relating to the treatment and distribution of drinking water. The Act does not include the protection of the source of the drinking water supply.

The act provides legislative authority to implement 50 of the 93 recommendations made in Commissioner O'Connor's Part Two Report including the authority to:

- Require mandatory licensing and accreditation of laboratories performing drinking water testing
- Set standards for drinking-water treatment, distribution, quality and testing
- Require the certification of drinking-water system operators
- Require municipal owners of drinking-water systems to obtain a license
- Create a standard of care obligation for municipalities
- Strengthen compliance and enforcement provisions.

It also requires the submission of an annual "State of Ontario's Drinking Water Report" to the legislature.

A new drinking water regulation was enacted under the *Safe Drinking Water Act* effective June 1, 2003. The Drinking Water Systems Regulation O.Reg. 170/03 replaces the former O.Reg. 459/00, the Drinking Water Protection Regulation for Larger WaterWorks Servicing Designated Facilities. This new O. Reg. 170/03 defines eight categories of drinking water systems, and specifies requirements related to drinking water systems approvals, operator training, minimum water treatment levels, operational checks, sampling and testing, and reports. Designated facilities serving vulnerable populations, one of the categories previously regulated by O.Reg. 505/01 and now addressed by O. Reg. 170/03, has been expanded to include children's camps in addition to schools, daycare centres, retirement and nursing homes.

Environmental Protection Act

The *Environmental Protection Act* provides for the *"protection and conservation of the natural environment"*. Section 4(1) of the Act gives the Minister the power to investigate and research pollution, waste management and litter. While groundwater is not specifically mentioned, there is

a potential connection between groundwater and the issues of pollution and waste management.

Under Section 6(1) of the Act, *"No person shall discharge into the natural environment any contaminant, and no person responsible for a source of contaminant shall permit the discharge into the natural environment of any contaminant from the source of contaminant, in an amount, concentration or level in excess of that prescribed by the regulations"*.

Section 9(1) stipulates the requirement for a Certificate of Approval to:

(a) *construct, alter, extend or replace any plant, structure, equipment, apparatus, mechanism or thing that may discharge or from which may be discharged a contaminant into any part of the natural environment other than water; or*

(b) *alter a process or rate of production with the result that a contaminant may be discharged into any part of the natural environment other than water or the rate or manner of discharge of a contaminant into any part of the natural environment other than water may be altered.*

Health Protection and Promotion Act

The purpose of this Act is to provide for the organization and delivery of public health programs and services, the prevention of the spread of disease and the promotion and protection of the health of the people of Ontario.

Public Health Units are created under the Health Protection and Promotion Act and overseen by a board of health. Under Section 62 of the Act, every board of health must appoint a Medical Officer of Health. With respect to drinking water, the Medical Officer of Health is the person who is responsible for alerting the public to unsafe water conditions. The *Safe Drinking Water Act* amends Section 62 of the Health Protection and Promotion Act to ensure that this position is expediently filled if it becomes vacant.

There are 37 public health units in Ontario that provide a wide range of programs that are outlined in the Mandatory Health Programs and Health Services Guidelines as established under the authority of the HPPA. One of these programs is the "Safe Water Mandatory Program".

Ontario Building Code

New buildings and expansion of existing buildings require a building permit under the *Building Code Act*. Some municipalities have used this building permit process as a trigger to require

additional studies related to potential environmental effects on groundwater.

Subsurface Sewage Disposal Systems (SSDS) (e.g., septic tank and leaching bed systems) that treat flows below 4,500 L/day are now regulated under the Building Code. The EPA (see Section 3.2.4) regulates systems that treat flow rates greater than 4,500 L/day.

Sustainable Water and Sewage Systems Act

The Sustainable Water and Sewage Systems Act, 2002 requires regulated municipalities to provide full cost reports to the Minister of the Environment on the water and wastewater services they provide to the public. The reports must include an inventory and management plan for the water/wastewater infrastructure, an assessment of the full cost of providing the water/wastewater services, and a summary of the revenue that will be obtained to pay for the services. The Act notes that the "full cost" of providing services includes not only capital, operating and financing costs but also includes any source protection measure related to the provision of water of wastewater services, including measures to protect the quantity or quality of any raw water supply. Municipalities are also required under the Act to prepare and approve a cost recovery plan which outlines how the full costs of water/wastewater services will be paid, and to maintain a dedicated reserve account for the revenues allocated for water/wastewater services.

Municipal Act

The new Municipal Act is the first comprehensive overhaul of Ontario's municipal legislation in 150 years. The Act gives municipalities a broad new flexibility to deal with local circumstances, and to react quickly to local economic, environmental or social changes. It enhances flexibility for innovative municipal service delivery, strengthens accountability to the public, and promotes safe, well-administered, economically healthy municipalities.

Under Section 130 of the Act, a *municipality may regulate matters not specifically provided for by this Act or any other Act for purposes related to the health, safety and well-being of the inhabitants of the municipality*.

Conservation Authorities Act

Section 28 of the *Conservation Authorities Act* enables Conservation Authorities to enact Regulations to require permits for works in and around watercourses, wetlands, valleys and floodplains. Through these Regulations, important watershed features and functions can be protected against potential harmful effects of filling, dumping, dredging or other works in specific defined areas. Throughout Ontario, in most cases Conservation Authorities also provide a 'one window'

service to assist in administering the Federal Fisheries Act which provides for the protection of fish habitats against harmful alterations due to work in and around water.

3.3 Other Provincial Policies and Reports

Report of the Walkerton Inquiry

The Ontario government has committed to implementing all Commissioner Dennis O'Connor's recommendations from both Part One and Part Two of the Report of the Walkerton Inquiry.

Part One of the Walkerton Inquiry Report deals with the causes of the Walkerton outbreak and how it could be avoided. Twenty-eight recommendations were made, some of which have been implemented.

Part Two of the O'Connor report includes 93 recommendations that set out a framework for water system management and accountability. It is Part Two that addresses the issue of source protection. With the Safe Drinking Water Act, 50 of the 93 recommendations are addressed. At the time the Safe Drinking Water Act was proposed, the province also introduced its plan to develop a watershed-source protection framework to address O'Connor's recommendations regarding the protection of water sources from contamination. The legislative teeth for this framework will likely reside in amendments to the Ontario Water Resources Act and the Environmental Protection Act. In November 2002, a 17-member Advisory Committee was established to guide the development of this framework. A draft framework is expected early in 2003. The draft framework will cover the minimum requirements to be included in a source protection plan, and the process for developing the plans.

Smart Growth

Smart Growth is the government's vision for promoting and managing growth in Ontario. It is a vision based on three principles: a strong economy, strong communities and a clean, healthy environment. One of the goals of the Smart Growth initiative is *"to protect the quality of our air, our land and our water by steering growth pressures away from significant agricultural lands and natural areas"*.

Recent government initiatives that support Smart Growth include:

- the Oak Ridges Moraine Conservation Plan, which will protect important water resources and significant natural features on the Oak Ridges Moraine
- public review of the Provincial Policy Statement, which is looking at how well the province's land-use planning policies are working and whether they are meeting Smart Growth goals

- new Municipal Act that will contribute to Smart Growth by giving municipalities more authority to set up corporations and involve private sector partners in the financing and undertaking of public projects
- Report of the Advisory Committee on Watershed-Based Source Protection Planning.

The Advisory Committee on Watershed-Based Source Protection Planning was established by the Minister of the Environment on November 15, 2003. The committee was given a mandate to provide advice to the government on a framework for watershed-based source protection planning, consistent with the 22 recommendations in the Part Two Report of the Walkerton Inquiry.

The Report of the Advisory Committee on Watershed-Based Source Protection Planning was presented to the Minister of the Environment on April 1, 2003. It contains 55 recommendations which address:

- a framework for source protection planning
- the general elements of a source protection planning process, and the suggested contents of a source protection plan
- strategies for managing risks to ground and surface waters, and
- the collection and ongoing management of information to support source protection planning.

The report endorses the need, which was highlighted by Justice O'Connor in the Walkerton Inquiry reports, for a multi-barrier approach to drinking water protection including contaminant barriers at the source, during water treatment, and at the end of the pipe in the water distribution system.

Section 2 of the report called "Framework Fundamentals" presents an overall foundation and direction for source protection planning in Ontario. Some of the key recommendations in this section are as follows:

- Recommendation 3: The goal of watershed-based source protection planning in Ontario is to protect human health through the protection of current and future sources of drinking water, including inland lakes, rivers and groundwater, from potential contamination and depletion through locally-developed watershed-based source protection plans.

- Recommendation 6: Decision-making that could have potential impacts on human health and affect water quality be guided by the following principles:

    - **Sustainability**: Water is essential for our health and ecosystem viability and must be valued as finite. Source protection plans should consider historical, existing, new

and future land uses when considering how to ensure clean sources of drinking water now and in the future.

- **Comprehensiveness**: All watershed-based source protection plans must take a precautionary approach that uses the best available science and is subject to continuous improvement as our knowledge increases. The plan must be defensible and have the flexibility to accommodate Ontario's diverse watersheds.
- **Shared Responsibility and Stewardship**: While the Ministry of the Environment has ultimate accountability for ensuring source water protection, responsibility for specific outcomes is shared among all water managers, users and land owners.
- **Public Participation and Transparency**: there must be open discussion and communication of the source protection planning process and its results, from development to implementation. Stakeholders and the public will have opportunities for meaningful input.
- **Cost Effectiveness and Fairness**: The costs and impacts on individuals land owners, businesses, industries and government must be clear, fair and economically sustainable. Source protection planning must access all information that is practical and reasonable and use technologies and risk management practices to maximize the protection of public health.
- **Continuous Improvement**: Source protection planning is built on a commitment to continuous improvement, including peer review, that requires ongoing support of all stakeholders to ensure successful implementation based on assessment, monitoring, evaluation and reporting, followed by appropriate modifications to the plan.

- Recommendation 7: A stand-alone piece of legislation for source water protection be developed that incorporates provisions related to source protection from other legislation so that the legislation will be as clear and comprehensive as possible.

- Recommendation 11: The province work with municipalities and other stakeholders to identify the appropriate types and scope of new municipal powers that should be made available for the purposes of source water protection, including dealing with funding issues. Then, the province should take steps to ensure that the agreed-upon list of new municipal powers is provided to municipalities so that they may use them to better protect source water and implement watershed-based source protection plans (refer to Advisory Committee Recommendations 33 and 34).

- Recommendation 12: Conservation authorities be the organization given responsibility for coordinating the development of watershed-based source protection plans wherever possible.

Further to Recommendation No. 7, above, the April 21st press release from the Ministry indicates

the government's intention to introduce legislation on source protection planning in the fall of 2003.

3.4 Non-Regulatory Programs

There a number of non-regulatory programs in existence aimed at improving practices that have the potential to impact on water resources. Most programs include one or more elements such as education and awareness, funding and data collection and sharing. Most of these programs have a funding base in either the provincial or federal government.

The following highlights non-regulatory programs related to agricultural practices, industrial practices and data collection and sharing. This is not intended to be an exhaustive description of non-regulatory programs but rather a sampling of what is currently available.

Rural Land Use and Agricultural Practices Improvement Programs

Environmental Farm Plans

Environmental Farm Plans (EFP) are documents voluntarily prepared by farm families to increase their awareness of the environment. The program was initiated through the Ontario Farm Environmental Coalition. This coalition includes the Ontario Federation of Agriculture, the Christian Farmers Federation of Ontario, the Ontario Farm Animal Council and AGCare [Agricultural Groups Concerned About Resources and the Environment].

Through the EFP process, farmers highlight environmental strengths on their farm, identify areas of environmental concern, and set realistic goals and time tables to improve environmental conditions. Technical expertise for this program is provided by the Ministry of Agriculture and Food. The program is administered by the Soil and Crop Improvement Association. Under this program, farmers prepare a plan that highlights actions to prevent environmental problems. Funding up to $1500 is available to participants to make improvements. Over 20,000 farms have participated since 1993.

Farming Best Management Practices Publications

The Ministry of Agriculture and Food has prepared a series of best management practices publications. This award-winning series presents affordable options for protecting soil and water resources on the farm, supports individual farm planning and decision-making in the short and long term, and works to harmonize productivity, business objectives and the environment. These publications and other information can be found on the Ministry's web site (http://www.gov.on.ca/OMAFRA/english/environment/index.html).

Healthy Futures for Ontario Agriculture

Healthy Futures for Ontario Agriculture is a program sponsored by the Ministry of Agriculture and Food in cooperation with the province's agri-food industry. One of the program initiatives relates to improving rural water quality. The program funds many agricultural improvements that would result in decreasing potential negative impacts on groundwater including:

- Well contractor services to improve well casing;
- Water testing services;
- Excavations services for the removal of underground fuel tanks;
- Farm septic system upgrades or remediation;
- Materials and services to establish permanent buffers between agriculture and natural areas (eg. trees, shrubs, vegetation, stones, tree protection, sprays);
- Fencing materials and services to restrict livestock access to watercourses;
- Erosion control measures to manage surface water run-off; and
- Storage/containment structures for pesticide, farm fuel, silage leachate, barnyard runoff.

Rural Clean Water Project

In partnership with Healthy Futures for Ontario Agriculture, many of the Conservation Authorities in Ontario have initiated a Clean Water Project. This project provides funding to property owners to make improvements that would help result in cleaner rural water. The grants cover a percentage of the cost of initiatives such as livestock restriction to watercourses, nutrient management plans, decommissioning of unused wells, fertilizer/chemical/fuel storage, septic system upgrades, etc.

Agricultural Environmental Stewardship Initiative

The Agricultural Environmental Stewardship Initiative (AESI) is a three year program (2000-2003) initiated by Agriculture and Agri-Food Canada. The program supports projects that address the regional impacts of agricultural practices on water, soil and air quality, biodiversity and greenhouse gas emissions. Projects could include education and awareness, technology transfer, stewardship tools including environmental clubs, environmental management systems and land use planning. The initiative is not intended to fund infrastructure.

Data Collection and Sharing

Provincial Water Resources Information Project (WRIP)

Initiated by the province in March 2000, WRIP aims to create an integrated, standardized water information system for Ontario as the foundation for effective knowledge-based water management decisions. The provincial groundwater studies will become part of this information system.

Groundwater Monitoring Network

Conservation Authorities throughout Ontario, in partnership with the Provincial Ministry of Environment, are implementing a network of monitoring wells to measure water levels, and water quality, on a long term basis. More than 175 stations were in place by the end of 2002 with more in development. The information on groundwater levels and quality obtained through this network will be valuable in the development of source protection plans.

Surface Water Quality

As a renewal and expansion of a previous Provincial program set up in partnership with 28 conservation authorities, UTRCA and other area conservation authorities have undertaken water quality testing at numerous sites in surface streams since 2000, followed by the issuance of "Water Quality Report Cards". The information provides support to watershed planning and management. Municipalities are also often involved in surface water quality testing associated with responsibilities such as their sewage treatment plants and other facilities.

Surface Water Quantity

Conservation Authorities throughout Ontario operate surface water stream flow gauges on various watercourses. Some stations are partially funded by Environment Canada and the Provincial Ministry of Natural Resources or the Ministry of the Environment under a federal-provincial cost sharing agreement.

Industrial Best Management Practices

Many industries and industry associations have adopted best management practices and environmental management plans. The Responsible Care Program of the Canadian Chemical Producers Association is one example. This program incorporates a number of components including:

- Awareness of the aspects of the operation that potentially could impact the environment;
- Development of a management program for each facility that includes training and reporting requirements, and a community consultation component;
- A requirement to use suppliers, contractors and distributors who also have an effective environmental management program;
- An audit program where the audit team includes industrial professionals and members of the public;
- Continuous self-improvement.

Generally, industries who adopt such a program are less likely to have operations that will result in a negative impact on groundwater quality or quantity.

Community Based Initiatives

EcoAction

EcoAction is an Environment Canada program providing financial support to community groups for action-oriented projects that have measurable, positive impacts on the environment. Environment Canada's priorities for this program include clean air and climate change, clean water and nature. Projects aimed at improving groundwater quality would be applicable.

Children's Groundwater Festivals

A number of communities in Ontario have held children's groundwater festivals to increase public information and education on groundwater and its importance. Over 3000 grade 3 and 5 students attended the 2001 Oxford Children's Groundwater Festival. Similar festivals have also been held in Durham Region and Waterloo/Wellington. The development of partnerships with local school boards is essential to the success of events such as these.

Friends of Watersheds Program in Essex Region

Through its Friends of Watersheds Program, ERCA provides organizational and technical support to numerous volunteer groups in planning and undertaking projects such as watercourse cleanups, habitat restoration, etc. For example, in 2002, the 'Yellow Fish Road' project enabled eight schools and community groups to mark more than 800 storm drains and deliver information 'door to door' about the proper way to dispose of hazardous chemicals. This project was also supported by the

CAW and the Essex Windsor Solid Waste Authority.

Watershed Based Plans/Studies

Watershed based technical studies and related protection/remediation plans, developed in conjunction with community partners, can be important or essential components of effective water resource management strategies. Comprehensive science-based watershed studies can provide an understanding of water quality/quantity issues, key factors effecting them, and important relationships between groundwater and surface water systems.

Subwatershed studies/plans such as those completed for London area subwatersheds address a broad range of issues, though with a primary focus on surface water rather than groundwater concerns. Recently, with an increasing focus on concerns such as droughts, crucial groundwater quality matters, and aquatic habitat, Conservation Authorities and others in some parts of the Province have undertaken more comprehensive and integrated watershed studies including water budget/balance studies, source protection plans, and related 'pilot' remediation projects.

4. Existing Groundwater Protection Policies in Middlesex and Elgin

The following is an overview of the existing groundwater protection policies and zoning restrictions found in selected examples of Official Plans and Zoning By-laws for Middlesex and Elgin Counties, and their lower tier municipalities. This policy analysis provided background information for the development of a Middlesex-Elgin strategy for groundwater protection.

4.1 Middlesex County

Middlesex County Official Plan, Consolidated Version, December 3, 1999

The Middlesex County Official Plan (OP) provides several policies which protect headwater areas, groundwater recharge areas and aquifers as they relate to Resource Management (Section 2.2) and Growth Management (Section 2.3).

In particular, the OP establishes a requirement in Settlement Areas for a Settlement Capability Study which would have regard to soil conditions, surface and groundwater conditions in order to provide

for adequate potable water and sewage treatment standards for future private developments.

When a development application is submitted for lands designated Natural Environment Areas on Schedule A of the OP, Natural Heritage Feature on Schedule C of the OP, or within 50 m of a Natural Feature, a Development Assessment Report (DAR) is required. The DAR is to include a description of the development, its surrounding environment, possible impacts on the natural environment, actions necessary to prevent any impacts, a rationale for the development and alternatives to the development. If the DAR is submitted as part of a development application, the local authority would have approval authority following consultation with the county and conservation authority. For a County OP amendment, approval of the DAR rests with the County in consultation with the conservation authority having jurisdiction and the province.

Other policies as they relate to Physical Services and Utilities (Section 2.4) encourage maintenance of private sewage systems in order to protect groundwater and surface water quality

City of London

City of London Official Plan, Office Consolidation, January 1, 2000

The City's Official Plan includes policies for the management and protection of groundwater. Large portions of the undeveloped parts of the City of London are designated "Groundwater Recharge Area" on Schedule B, "Floodplain and Environmental Features", to the Official Plan. The "Groundwater Recharge Area" is an overlay to the land use designations shown on Schedule A. Areas designated "Groundwater Recharge Area" include the Dingman Creek valley from the headwaters of the creek near Highbury Avenue, all the way to Riverbend. Another large area is located in the Fanshawe Park area in the northeast corner of the City.

Section 15 of the Plan includes the following objectives and policies for the "Groundwater Recharge Area":

- one of the Plan's Natural Heritage objectives is to protect, maintain and improve surface and groundwater quality. Other objectives for environmental protection pertain to contaminated lands, the rehabilitation of pits and quarries, abandoned oil and gas wells and environmentally sustainable farm practices

- areas designated "Groundwater Recharge Areas" include recharge areas, headwaters and aquifers. According to the Plan, the City will require the protection of the hydrological function of these sensitive areas through its planning approval processes.

Areas designated "Groundwater Recharge Area" are designated for other land uses on Schedule A, "Land Use Plan". A large portion of these areas is designated "Open Space" and "Agriculture". Permitted uses in the "Open Space" area (Section 15.3.2) include existing development and uses and expansion of existing uses, provided that the expansion protects the natural features and ecological functions of the area, passive recreational uses, harvesting of trees in accordance with responsible forestry management practices and conservation works. Permitted uses in the "Agriculture" area (Section 9.2) include general farming, livestock farming, cash crop farming, market gardening, specialty crops, nurseries, forestry, aquaculture and agricultural research. Policies to protect groundwater in the "Agriculture" area include:

- one of the objectives for this area is to promote farm practices which encourage the conservation of groundwater resources and other natural features

- for building permits for a new livestock building or structure, the Plan requires a certificate of compliance from MOE dealing with manure storage capacity, land base for manure spreading or alternative manure disposal method, water and noise pollution potential and dead animal disposal. According to the Plan, "where the proposed building or structure is not capable of being certified, the City will request the applicant to alter or abandon the project unless it results in an improvement in the farm operation"

- another important policy is included in Section 9.2.13 of the Plan which states that Council may develop programs in cooperation with the Province, the Conservation Authorities and other agencies or groups and landowners to promote the protection and enhancement of natural areas located in the "Agriculture" area, including groundwater recharge and discharge areas. "The intent of these programs is to promote environmental benefits without creating constraints for agricultural land management and farming operations"

- the Plan also includes measures for promoting the retention, responsible management and expansion of woodlots in the "Agriculture" area.

Other portions of the "Groundwater Recharge Areas" are designated "Extractive Industrial" in Lambeth and the Fanshawe Park area and for a range of urban uses.

Consistent with the Provincial Policy Statement on land use planning, Section 17.2.2 of the City's Official Plan includes a hierarchy of sanitary sewerage servicing options for new development. The preferred form of servicing is an extension from one of the City's centralized Sewage Treatment Plants. The least preferred form is individual on-site wastewater treatment systems. Individual systems serving more than five residential lots are discouraged. According to the Plan, "where it is feasible to provide sanitary sewerage services from a higher priority option, no other option shall be permitted".

Township of Lucan Biddulph

Township of Lucan Biddulph, Official Plan, 4th (DRAFT), May 2002 (Recently municipally approved)

The recently approved Draft Official Plan provides general statements that Natural Areas remain "free and clear of any non-essential buildings and structures." In considering impacts on Natural Areas as depicted on Schedule C of the OP, a development application may require a Development Assessment Report (DAR). The municipality will assess the quality of the Natural Area that is being affected, the change being proposed, the nature and scale of the development in the area and the natural features that may be impacted.

Township of Lucan Biddulph Zoning By-law, (DRAFT), November 2001

No regulations exist in the Zoning By-law that protect groundwater quality or quantity.

Zoning standards exist for lands zoned Open Space. These standards do not explicitly include groundwater or surface water standards, however it limits development. Also, any development proposed in areas depicted as Flood Regulated Areas and Fill Regulated Areas on the various Zoning By-law schedules are to be referred to the Conservation Authority for comments and necessary permits.

Township of Middlesex Centre

Official Plan of the Township of Middlesex Centre, Consolidated Version, December 2001

The Township of Middlesex has one Official Plan (OP) for the Township which includes the former Townships of London, Lobo and Delaware. Section 3.0 Policies for natural Areas and natural Hazard Areas provides a detailed set of policies that "protect, and wherever possible enhance, significant natural features and function from unacceptable impacts." Schedule A and Schedule B of the Plan depict Natural Areas and Natural Hazard Areas. Development is prohibited within Natural Areas. With regards to the Middlesex County OP, development may occur if justified and approved by the municipality via a Development Assessment Report (DAR). Consideration in the DAR must also be given to drainage works to ensure that no negative impacts on ecological functions will occur. It is also noted that any proposals that require significant groundwater or surface water from streams or ponds will only be considered if the Ministry of Environment has been consulted and has not ruled out any consideration for an application for a water taking permit. Such uses that may require significant water include golf courses and intensive agricultural uses. The OP also goes into great detail to define the boundary of Natural features, and the extent that adjacent lands may develop. In most cases a DAR is required and the OP describes what needs to be included in the DAR to satisfy the municipality.

The OP also considers capacity and effectiveness of existing municipal services and private services, and requires that updates to the County are provided every five years.

Finally, the OP also requires as part of the planning application process that consideration be given to storm water to prevent the increase in downstream flows above existing levels or degradation of water quality.

Township of Lobo Zoning By-law no.95-100, As Amended, September 1998

The township has an Environmental Protection Zone and Open Space Zone which protect and regulate conservation lands, parks, wetlands and significant natural areas. The zoning by-law under Section 3 (General Provisions) provides requirements for separation from adjacent barns, sewage treatment plants, watercourses, drains and ponds. Distances vary upon the types of uses and there influence on features such as watercourses. No regulations exist to protect groundwater.

Township of London Comprehensive Zoning By-law 6550/96, September 1996

The Zoning By-law has two zones which incorporate natural areas, Parks and Recreation Zone and Open Space Zone. The General Provisions section of the Zoning By-law provides for specific restrictions when considering Municipal Drains and Natural Watercourses, but no reference is made to groundwater protection.

Township of Delaware Comprehensive Zoning By-law, June 29, 1984

The Townships Zoning By-law dates back to 1984. It has two Zones which regulate watercourses and conservation areas. The Zones are Open Space and Hazard Lands. Both restrict any development and prohibit removal or fill. Specifically in the Hazard Lands zone, it clearly states that any lands zoned Hazard Lands on Map Schedule "E" are an overlay to all other zones and supersede all other provisions. No reference is made to groundwater protection.

Municipality of Thames Centre

Township of North Dorchester Official Plan, Consolidated Version, June 1997

The former Township of North Dorchester has specific policies for Groundwater Protection. Lands that are designated Groundwater Protection Zones are shown on Schedule A of the OP. The designation represents "the cones of influence of water well sites or fields which supply the Village of Dorchester". The policies do not permit any development and limit uses, such as agriculture and forestry, excluding livestock. The policy does recognize that once a well is discontinued or if the potential for contamination is mitigated to the satisfaction of the Ministry of the Environment, development may occur.

Township of North Dorchester Zoning By-law No. 20-95, Consolidated Version, January 2001

The Zoning By-law for the former Township of North Dorchester has three zones which protect environmentally sensitive lands. These zones are Open Space, Flood Plain and Environmental Protection. None explicitly mention groundwater or provide any regulation to protect groundwater.

Township of West Nissouri Official Plan, Consolidated Version, February 1994

There are no policies which make specific reference to groundwater protection, but groundwater is mentioned in the Physical Services section of the OP. It states that:

> "Although major deficiencies in the quality and quantity of water supply in the Village are not evident [Thorndale], the installation of a public water supply system serving both existing and future development is likely to be ultimately required, particularly as more development occurs. It will be appropriate, therefore, to ensure privately installed communal water systems (serving large scale development) are designed in a manner which facilitates their eventual integration into an overall system."

Township of West Nissouri Zoning By-law No. 63-91, Consolidated Version, January 2001

The former Township's Zoning By-law has no regulations regarding the protection of groundwater resources, but provides setback requirements from Municipal Drains and Watercourses.

4.2 Elgin County

City of St. Thomas

Official Plan of the St. Thomas Planning Area, As Approved and Amended, August 28, 2002

There are fifty-two amendments to the existing Official Plan of the City of St. Thomas. Information contained in the following summary is located in Amendment No. 42, enacted June 23, 1997, which explicitly includes the protection of groundwater quantity and quality.

The OP recognizes the need for Subwatershed studies in areas of new development to "ensure that the long-term health of the environment is maintained and/or enhanced as those lands are urbanized." (8.3.1.3) Ground Water and Service Water Policies (Section 8.3.2) state that prior to development, significant groundwater recharge and/or discharge must be identified. Lands outside a subwatershed Study Area must undergo a site-specific environmental impact study to identify and maintain recharge and/or discharge functions (8.3.2.1). The Plan requires the design and implementation of

current stormwater management techniques in new developments to preserve the quantity and quality of receiving watercourses (8.3.2.3).

The OP also contains Open Space and Conservation (5.10) land designations "to encourage land uses that contribute to the protection, maintenance, and enhancement of the quality and quantity of surface and groundwater resources in the Kettle Creek watershed." (5.10.2) Goals related to the Environment (Section 8.0) include reducing "the impact of urban drainage on the natural environment and to preserve and enhance the quality and quantity of ground and surface water." (8.2.1, iv)

Natural heritage features, areas identified by the Ministry of Natural Resources, and the Conservation Authorities are to be protected. Other policies within Amendment 42 address Hazard Lands, Wetlands, Fish Habitat, and Site Contamination.

Municipality of Central Elgin

Township of Yarmouth Official Plan, As Approved, October 1985

The Official Plan (OP) of the former Township of Yarmouth contains several policies to protect the quality of groundwater. One of the primary objectives of the Plan is to "support the protection of the natural environment."

The OP states that the development of new pits and quarries must consider effects to conservation lands, hazard prone areas, and lands within flood plain. (8.3.5). In addition, well operators must ensure that salt water, drilling fluid, oil refuse and any flammable products from a well do not contaminate any fresh water horizon (10.1.9).

Agricultural Policies (Section 2.3) of the OP recognize the importance of maintaining tree cover "for water retention and groundwater recharge purposes, run-off control, soil conservation, and wildlife habitat purposes." (2.3.11) Regulations within the OP also ensure proper water supply and sanitary waste disposal in areas in and outside the municipal service area. Development is restricted in Hazard Lands and Lake Erie Shoreline outlined in Schedule A.

The Village of Belmont Official Plan, 34 OP 0171, As Approved and Amended, April 17, 2001

The land-use of the former Village of Belmont is primarily residential. The source of water supply and distribution of the Village is comprised of two wells located in the Kettle Creek Valley system, an in-ground reservoir, a pumping station and a distribution system. The OP states that the current storage facility and the capacity of the well system are inadequate to meet existing demands.

A goal of the Village to "prevent any interference, reduction, alteration, pollution, and drainage problems in existing natural watercourses." As a result, an Environmental Area Plan is currently in effect to restrict development from lands associated with significant natural resources and/or natural hazards (3.10.1, Amend. No. 2, 04/22/97) No regulations exist to protect groundwater.

Municipality of West Elgin

Municipality of West Elgin, Official Plan of the former Township of Aldborough, Consolidated Version, June 2001

The Official Plan of the former Township of Aldborough provides specific regulations to protect the quantity and quality of groundwater in the Agricultural (Section 2.1), Restricted Agricultural (Section 2.2), Aggregate Resources (Section 2.3), and Rural Residential (Section 2.8) land uses.

One of the objectives of the Agriculture land use is to "prevent soil erosion and to protect surface and groundwater resources from undue depletion or contamination." (2.1, vii) The OP states that in Agricultural and Restricted Agricultural areas "all manure storage areas and feedlots shall be designed and located in a manner which prevents or at least minimizes the potential for contamination of water resource areas." (2.1.5, 2.2.4)

In order to establish a sand or gravel pit in Aggregate Resources lands, permission must be granted by the Township, in consultation with the Lower Thames Valley Conservation Authority (LTVCA), the Ontario Ministry of Natural Resources, and the Ontario Ministry of Environment (MOE). An environmental assessment (EA) may also be required to ensure a pit does not have the " potential to have a deleterious effect on the quantity or quality of groundwater resources."(2.3.6)

The OP policy for Rural Residential land use development states:

> "an adequate, potable, and independent groundwater supply shall be available or made available. Where a piped public water supply is not available and in view of the groundwater deficiencies throughout most of the Township, a condition may be applied to the granting of a land severance or plan of subdivision requiring the applicant to demonstrate the availability of an adequate water supply prior to the creation of the lot or lots." (2.8.3)

In the lands depicted as Special Policy Area 1 in Schedule A, however, "lands will only be permitted to be developed for residential purposes if serviced by a piped water supply." Development of Hamlets (Section 2.4) and Lakeshore Recreation (Section 2.7) requires that a water supply source be available prior to development of the lands. Finally, the OP outlines Hazard Lands, which include lands susceptible to flooding and erosion.

Municipality of West Elgin, Zoning By-law of the former Township of Aldborough, Consolidated Version, June 2001

The existence of a public water supply dictates the minimum lot area and lot frontage in several land uses, however; no regulations in the Zoning By-law of the former Township of Aldborough specifically relate to groundwater.

Municipality of West Elgin, Official Plan and Zoning By-law of the Village of Rodney, Consolidated Versions, June 2001, and Municipality of West Elgin, Official Plan and Zoning By-law of the Village West Lorne, Consolidated Versions, June 2001

Policies and regulations within the Official Plan and Zoning By-laws for the villages of Rodney and West Lorne do not contain information related to the protection of groundwater quality or quantity.

Municipality of Dutton-Dunwich

Municipality of Dutton/Dunwich, Official Plan, April 2001, 2001-16

The groundwater policies within the OP of the Municipality of Dutton-Dunwich are similar to the Municipality of West Elgin. The OPs share the same policies for groundwater protection in the following sections: Agriculture, Restricted Agriculture, and Aggregate Resources.

The Dutton-Dunwich OP policies for Residential (Section 2.4) development differ from West Elgin. The policies make a general statement that there shall be adequate municipal services to serve the proposed development.

Development of lands designated Special Policy Area No. 2 Port Talbot, where connections to public systems are not feasible, requires the submission of stormwater quality/quantity management plans. The plans must include hydrogeological and geotechnical studies and will be subject to review by the LTVCA and the MOE.

Policies pertaining to Hazards Lands have been defined in Section 4.0 of the OP. There are also regulations for damming and/or altering a watercourse. (4.1.9)

It should be noted that Duttona Beach has unique policies for Seasonal Residential, Parkland, Camping, Environmental Protection, Development Control, and Services delineated in Schedule C. Special servicing conditions apply to these areas, although there is no mention of groundwater protection.

Village of Dutton Restricted Area (Zoning) By-law, June 6, 1979

The Zoning By-law of the former Village of Dutton does not contain information to protect the quantity or quality of groundwater.

Township of Dunwich, Zoning By-law No. 89-30, 1983

The former Township of Dunwich Zoning By-law defines a well, public water supply and communal water supply in Section 2.0. The existence of a public water supply dictates the minimum lot area and lot frontage in several land uses, however; no regulations in the By-law specifically relate to groundwater.

Township of Malahide

Official Plan of the Township of Malahide, As Approved, March 9, 2003

The Official Plan of the Township of Malahide replaces the OP of the Township of Malahide, the

Township of South Dorchester, and the Village of Springfield. Although there is no mention of the protection of groundwater, the OP includes policies to protect natural resources.

Development of Storm Drainage and Facilities and Services must ensure that runoff does not negatively affect receiving water courses. Setbacks from Hazard Lands and the Lake Erie Shoreline have also been established to limit development in areas susceptible to flooding and erosion. Conservation Lands and Natural Heritage features have been delineated to protect natural resources.

5. Examples of Groundwater Protection Initiatives in Other Ontario Municipalities and Jurisdictions

5.1 County of Oxford

The County of Oxford relies heavily on groundwater to supply municipal wells and has carried out extensive work in the area of groundwater protection. The County is currently updating its Official Plan and in 2002 developed proposed policies related to land use in wellhead protection areas as well as vulnerable aquifer areas. The approach identifies three Categories of land use based on their potential risk to groundwater. Category A uses pose the highest risk and are prohibited from wellhead protection areas and areas of high aquifer vulnerability.

Following a period of extensive consultation, the County is now drafting a number of changes to the proposed policies. The changes currently being drafted include:

- revisions to the aquifer vulnerability mapping; the mapping is now being done according the method stipulated by the province for the identification of areas according to the Intrinsic Susceptibility Index (ISI); this will result in a somewhat different delineation of vulnerable areas
- wellhead protection areas are being defined according to 2, 5, 10 and 25 year capture zones; in addition, the “boundary lines” for high ISI areas will be adjusted to match the wellhead capture zone “boundary lines”, in cases where there is overlap
- based on U.S. experience, an approach will be defined to deal with situations where a groundwater resource feature “boundary line” bisects a property
- the concept of buffer zones around vulnerable aquifer areas has been eliminated
- the Category A, B and C lists of land uses are being revised
- Category A uses (highest risk uses) will still be completely prohibited in highly sensitive groundwater resource areas, based on the revised list

- for Category B and C uses, the opportunity will exist to provide proof, based on appropriate investigations/studies, that the proposed use will not have adverse effects.

5.2 Peel Region

Peel Region is currently preparing its second round of State of the Environment reports. These reports are a key tool for monitoring the health of Peel's environments. The purpose of the State of the Environment (SOE) program is to report regularly on the state of the environment in Peel as mandated in the "Keeping Track of Our Successes" section of the strategic plan. The first series of Peel state of the environment (SOE) reports was produced between 1995 and 1998. The three reports of this series, Atmosphere, Water and Land produced in 1995, 1996 and 1998 respectively, assist the Region in monitoring the changes in the condition of Peel's natural environment and identify potential impacts affecting the health of the residents of Peel. These reports play an important role as an information tool for residents of Peel and the general public. The water report documents the groundwater resources in Peel Region and the current use of groundwater through municipal wells.

The conclusion in 1996 was that:

- groundwater in the Town of Caledon is of good quality.
- there is evidence of increasing concentrations of nitrates and chlorides in specific Regional production wells.
- Private wells, specifically shallow bored or dug wells, may yield water of unacceptable quality.
- The availability of groundwater may be a limiting factor to growth and development in areas serviced by private wells or municipal communal wells.

5.3 Waterloo Region

As part of its Environmental Integrity vision, the Region of Waterloo in its “Regional Official Policies Plan – Planning for a Sustainable Community” (December 1998 Consolidation), states that:

> *Water resource protection, management and conservation continue to be primary objectives in the region…. and… the implementation of a Regional Strategy for water resource protection has resulted in improvements to water quality and a reduced likelihood of contaminating groundwater and surface water.*

The Region uses several tools to identify and protect water resources. One method is the undertaking

of a State of the Environment Report, which monitors indicators of environmental health. The primary goal of this report is to bring to the attention of government, the business community and the public, their collective responsibilities in ensuring that the environment will sustain future generations.

The second tool, more closely related to protecting sensitive groundwater areas is the Water Resources Protection Strategy. As described in the Water Resources policies of the Regional Plan, the strategy includes defining the location, nature and extent of potable water resources, identifying and evaluating potential threats to surface and groundwater quality, developing policies and programs to manage, reduce or eliminate these threats, and inform the community about water resource protection issues. As part of this program the Region monitors water taking; provides incentives for businesses and farmers to reduce their impact on water; encourages community involvement and increases awareness; and identifies, develops and supports policies and legislation to protect source water.

Currently, lands designated Sensitive Groundwater Areas are delineated on Map 4 of the Regional Plan, and lands identified by the Water Resources Protection Strategy or other hydrogeological and/or hydrological studies can be included to the Official Plan by way of amendment. All lands designated Sensitive Groundwater Areas, will not permit certain types of development as laid out in section 5.2.1.4 of the Regional Plan.

The Regional Plan also has policies on Groundwater Discharge Areas. The Regional Plan states that during the completion of watershed plans, comprehensive environmental impact statements, or community plans, Environmentally Significant Discharge Areas and Discharge Constraint Areas will be identified. These areas are to be designated by amendment to the Regional Plan on Map 1 or Map 2 and adhere to the policies of the Natural Resources section of the Regional Plan. Also, any development in lands designated Regional Environmentally Significant Discharge Areas within Environmentally Sensitive Policy Areas and Regionally Significant Natural Corridors, is prohibited. The Regional Plan also requires lower tier municipalities to include policies that identify and protect Local Environmentally Significant Discharge Areas.

As part of the Infrastructure policies of the Regional Plan, regard is given to the relationship between development approvals and the creation of effluent and its effect on private wells. The Region requires that studies are undertaken that meat the Region's Guidelines for Hydrogeological Studies For Privately Serviced Developments. The policies also state that a private well, if permitted, must be drilled with appropriate surface casing. The Regional Plan makes one exception in that for religious reasons, a private dug well can operate if deemed satisfactory by the Regional Medical Officer of Health.

5.4 Regional Municipality of Halton

In "The Regional Plan" (Official Plan for the Halton Planning Area, Regional Municipality of Halton, Office Consolidation, June 1999), groundwater protection policies are implemented in the form of an Aquifer Management Plan. The Aquifer Management Plan as discussed under the Land Stewardship Policies of the Regional Plan, is meant to provide information regarding groundwater resources to support long-term activity, identify areas which are susceptible to water quantity and quality issues, identify areas which will be able to sustain additional rural development while providing good quality water, examine the impact of private individual wastewater disposal systems on the quality of groundwater, and propose procedures for the on-going monitoring and protection of the aquifers.

The Regional Plan also requires the adoption of Rural Servicing Guidelines, in consultation with the Ministry of Environment, that would contain such items as design standards for private services, minimum lot sizes taking in to account infiltrative capacity of the soils and hydrogeological information, guidelines for hydrogeological studies, procedures for processing development applications on private services, and criteria by which the Medical Officer of Health determines a water supply to be inadequate.

5.5 County of Brant

The County of Brant in its Official Plan (November 2000) has specific Groundwater Protection policies as set out in its Land Use Management Strategy. The County is dependent on groundwater for its water requirements, and states that it will develop a Groundwater Protection Plan in consultation with Conservation Authorities and the Province. The Grand River Conservation Authority has produced a Grand River Regional Groundwater Study and corresponding maps which identify the following:

- Areas Vulnerable to Contamination;
- Overburden Thickness;
- Sand and Gravel Thickness;
- Upward Vertical Hydraulic Gradients;
- Downward Vertical Hydraulic Gradients;
- Potential groundwater Discharge Areas;
- Water Table Surface; and
- Depth to First Aquifer.

In addition to this study, additional studies have been produced for municipal wells in Paris, Burford, St. George and Brantford Airport to determine the area of immediate or primary influence.

The Groundwater Protection policies in the Official Plan also restrict certain uses in specific areas of the County, and any applications for industrial, commercial, aggregate extraction pits, golf courses or other specific uses within the Wellhead Protection Area (WHPA) will require detailed information and studies including possible monitoring of groundwater quality as part of the approval process. In the case of livestock operations, the County must approve a Nutrient Management Plan prior to permitting a new or expanded livestock operation, and the spreading of manure and sludge and the establishment of new intensive livestock operations are not permitted in the WHPA. WHPA's are depicted on Schedule 'A' of the Official Plan.

5.6 Oak Ridges Moraine Conservation Plan

The province of Ontario enacted legislation in 2001 to protect the Oak Ridges Moraine. The Oak Ridges Moraine Conservation Plan was prepared as a tool for implementing the legislation and it includes significant protection for groundwater.

The Oak Ridges Moraine Conservation Plan requires that local Official Plans establish wellhead protection areas around all existing and new wells for municipal water services, and prohibit certain uses that could affect the quality or quantity of groundwater reaching a well and land in areas of high aquifer vulnerability. According to the Plan, a wellhead protection area shall identify zones of contribution corresponding to 0-2 years of time of travel, 2-10 years of time of travel and 10-25 years of time of travel. The Conservation Plan also requires all local municipalities to comply with establishing wellhead protection areas by October 22, 2003 and prohibit certain uses that could affect groundwater by April 23, 2007.

The plan requires every municipality to delineate wellhead protection areas and areas of high aquifer vulnerability. Section 28 of the Oak Ridges Moraine Conservation Plan prohibits the following new uses in wellhead protection areas:

- Storage (except for personal use) of petroleum fuels, solvents, pesticides, herbicides and fungicides, construction equipment, inorganic fertilizers, road salt, and Severely Toxic Contaminants (listed in Schedule 3 of Regulation 347)
- Generation and storage of hazardous waste or liquid industrial waste.
- Waste disposal sites and facilities, organic soil conditioning sites, and snow storage and disposal facilities.

In addition, the following uses are prohibited within the zero to two year time of travel zone (unless they are for personal use):

- Storage of animal manure
- Animal agriculture
- Storage of agricultural equipment.

Similar prohibitions on new land uses exist for areas of high aquifer vulnerability with the addition of underground and above ground storage tanks. In addition to establishing appropriate land uses in areas where groundwater is vulnerable to contamination, the Plan requires that all major development be serviced.

5.7 Non-Point Source Protection - British Columbia Health Department

The Provincial government in British Columbia has done research into various methods available to regulators to assist in controlling non-point source pollution. Their initial conclusions are that as long as it is acceptable to the public, and it is cheaper and easier to not act responsibly people will continue to act irresponsibly. As an example the point to cleaning of paintbrushes and simply pours the cleaning fluid into a ditch. This is easier than taking the fluid to a recycling centre and it appears to be inconsequential. The consequences are seen by the government when a clean up of a polluted stream is required, but not by the individual. This concept applies to development proposals where an individual applicant may not see the benefits to conducting the business in an environmentally friendly manner, as it will cost more.

The challenge is to make it desirable to act responsibly. This can be done through several different approaches including:

- property tax breaks
- density bonuses
- retrofitting incentives
- tickets and fines
- grants
- performance bonds.

While some of these are provincial in scope, such as tax breaks and retrofitting incentives, local municipalities have the other tools available for their use in controlling the type of development that

is approved. These are not voluntary as there is a requirement for government involvement in funding these initiatives and in making regulations to permit or limit such activities.

5.8 Model Code for Water Quality – American Planning Association

The American Planning Association has created a series of model regulations for municipalities to use as templates. One of these relates to the protection of water quality. This emphasizes the need to keep the natural components of a development area in place to allow for recharge, and for the need to recognize the connection between surface water and groundwater. The need to have environmental policies as a whole that relate to how development interacts with the environment is the key to ensuring sustainability. The tools available to municipalities, in the Ontario context, such as limits on uses, density bonusing, density transfers, compact development, retention of sensitive areas, and definitions that reflect the actual changes to the land all must be used as a package to produce good development. If any municipality is looking for policy ideas this information is available through the American Planning Association.

APPENDIX E

SUMMARY OF THE GROUNDWATER MANAGEMENT STRATEGY

APPENDIX E

GROUNDWATER MANAGEMENT ISSUES AND MEASURES FOR MIDDLESEX AND ELGIN

1.0 Introduction

The identification of measures to manage and protect groundwater and related surface water resources requires consideration of:

- the land uses and activities that could affect groundwater quantity and/or quality
- the susceptibility of groundwater resources in general, and of specific groundwater resource features, to the effects of those uses and activities.

The groundwater resource management measures for Middlesex and Elgin are presented below according to these two areas of consideration. First, **land uses and activities that could affect groundwater resources** within the Study Area are described. For each use or activity, examples of the potential resource protection measures are summarized, including the **provincial role**, if any, the **municipal regulatory options**, and the **non-regulatory initiatives** that do or could contribute to groundwater protection in relation to the land use or activity being addressed.

Secondly, specific groundwater resource features are defined and described including **wellhead protection areas**, **water recharge areas**, and **ISI areas**. The locations of these special features within Elgin and Middlesex are identified, and the additional measures that could be taken to manage and protect these unique groundwater resource areas are defined.

The discussions of groundwater management measures in each section below highlight the multi-disciplinary and multi-sector approach needed for effective groundwater protection. **Regulatory measures** - including existing provincial laws and regulations, as well as the regulatory "tools" available to municipalities - are discussed. However, the **non-regulatory initiatives** that are identified have an equally if not more important role to play in the long-term management and protection of groundwater. These include the educational programs and funding initiatives that have been or could be undertaken by conservation authorities, agricultural associations, health units, and community groups, either individually or in partnership with provincial or municipal organizations. With appropriate funding and resources, these groups have the depth of experience and local knowledge needed to develop and deliver the necessary measures.

2.0 Land Uses/Activities That Can Affect Groundwater and Related Protection Measures

2.1 Wells, Septic Systems and Storage Tanks

Water Well Construction, Maintenance and Decommissioning

Issue Definition

The surface geology of the Middlesex-Elgin Study Area is predominated by surficial tills and clays. These provide an excellent protective cap over the deep aquifers, and serve to protect the deep aquifers from surface impacts. Open wells can provide easy and quick access through these protective layers, especially poorly constructed or abandoned wells. Dug wells and sand point wells are particularly susceptible to surface contamination, due to their shallow depth and nature of construction.

Proper construction of drilled wells assures that rapid access to the aquifer is eliminated. Likewise, proper decommissioning of abandoned wells through plugging the wells closes the route for rapid access to the aquifer. It is a good practice for any well that is no longer in use to be decommissioned; this practice is critical in areas where potential water contaminants are present due to surface activities. Proper grouting of the annulus space between the well casing and the drilled hole is also essential.

Provincial Role

Well construction and abandonment, or decommissioning, are regulated by Ontario Regulation 903, issued under the Ontario Water Resources Act and administered by the Ministry of the Environment. The regulation outlines the steps for the licensing of well drilling contractors and technicians, as well as the requirements for well construction and proper abandonment. The obligations of well owners are also specified, including the requirement to "maintain the well at all times" sufficiently to prevent the entry of contaminants, and to "forthwith abandon" and properly plug a well that is not being used, is dry, is producing non-potable water or was improperly constructed. In practice, this regulation has been interpreted within the industry to apply only to water wells and not to test wells, monitoring wells, or geotechnical boreholes (used for subsurface investigations). However, these investigative wells and boreholes can have similar characteristics to water wells, and can have similar potential to act as conduits for the entry of contaminants into the groundwater system.

In recent years, due to staff and financial shortages, the MOE has reduced the number of field staff available to observe, direct, or inspect proper well construction. The capability of the Ministry to enforce the Regulation 903 requirements has therefore diminished. Nevertheless, the drilling

industry within the Middlesex and Elgin Study Area has a good history of well driller licensing and most new wells have been constructed according to regulatory requirements. In addition, the Ontario Water Well Association is currently developing a compendium of best practices for their members. Also of note is the fact that well drillers must maintain liability insurance as they are responsible for any wells that they drill or decommission for a period of seven years.

Since January 2002, the province has provided funding to subsidize well upgrades (up to 67%) and well decommissioning (up to 64%). The program has been offered through OMAF, and administered by the Ontario Federation of Agriculture (OFA) under the Healthy Futures for Ontario program. Similar funding for well decommissioning up to a maximum of 70% has also been provided under the Clean Water Program. The funding programs are due to be terminated at the end of 2003.

It is recommended that the Provincial role with respect to well construction, maintenance and decommissioning be improved by:

- allocating more staff and resources to the inspection of well drilling activities
- providing funding to identify wells which need to be decommissioned
- continue funding programs for upgrades and decommissioning under the Clean Water Program and the OFA through the Healthy Futures for Ontario program
- providing educational materials to well drilling firms, residents, municipalities, organizations, and industries regarding the MOE role and the needs and advantages inherent in proper well construction
- developing an education program which details the vulnerabilities of shallow wells
- developing closer ties and communication with municipal water systems to notify residents and industries which connect to public water supplies of the decommissioning requirements
- instituting requirements for proper plugging of test holes similar to the rules for wells
- requiring pump installers to report pump locations and old wells to the Ministry, and to ensure that pump replacement and well retrofits are done properly.

On April 10, 2003, the Ontario government released a revised Regulation 903 that may serve to address some of these issues.

Municipal Regulatory Options

The legal authority regarding well construction and decommissioning is within the purview of the provincial government as described above. However, municipalities could use their powers related to development approvals and servicing to ensure that the requirements of Regulation 903 are being followed within the municipality. For example:

- municipalities could require proof of proper abandonment of unused water wells, monitoring wells or boreholes as a condition of development approval (i.e. for demolition permits, applications for consent, site plan approvals and subdivision approvals)

- municipalities could require proof of proper abandonment of unused water wells, monitoring wells or boreholes as a precondition for hook-up to a municipal water system; for hook-up of an existing hamlet this would require proof of decommissioning of all the individual wells; grants for municipal water hook-ups could include funding for well decommissioning, with provision to amortize the cost over several years

- a deposit system could be introduced whereby a deposit is paid prior to the drilling of investigative wells or boreholes on municipal lands or for municipal projects; the deposit would be returned once proper decommissioning has occurred

- municipal inspection duties for septic systems could be extended to/coordinated with inspection of wells

- routine bi-annual analysis of bacteriological and other parameters in private wells could be encouraged/mandated

- municipalities could request to be given the responsibility of inspecting wells under Regulation 903; for example, the Township of North Grenville in eastern Ontario has established detailed requirements for the construction of all wells including potable water and groundwater monitoring wells. Through a Memorandum of Understanding, with the MOE, the Township has been given powers to act as provincial well inspectors under Ontario Regulation 903. Under this agreement, the Township inspects all new wells during construction, with specific focus being placed on critical stages of construction including well casing and grouting. The Township has established hybrid well standards, which require strict well construction controls over and beyond what is regulated under Ontario Regulation 903. Enforcement of these standards is through the building permit by-laws. The Township also has by-laws requiring that the well driller, well technician and plumber provide proof of licensing to the Township.

<u>Non-Regulatory Initiatives</u>

The following non-regulatory initiatives could be implemented by municipalities, conservation authorities or interest groups:

- develop a closer working relationship with MOE to focus their efforts on particularly

troublesome local areas
- identify a group member to act as a local education and liaison representative regarding well drilling and decommissioning programs within the region
- develop an abandoned well identification and location program in conjunction with MOE to identify specific wells which require decommissioning
- provide educational forums on the need for and methods of well construction and decommissioning; this could include use of existing educational resources such as the video entitled "Well Aware" developed by a coalition of agencies with the Ministry of the Environment
- develop working relationships with water suppliers, municipalities, and other groups to educate residents and industries on well decommissioning needs and programs, and on the vulnerabilities of shallow wells
- initiate a mechanism whereby well test data collected by the Health Unit can be provided to the municipality for monitoring purposes.

Septic Tank Construction and Maintenance

Issue Definition

Septic tanks, or private sewage disposal systems, have long been recognized as a viable method for the collection and treatment of small quantities of sewage. In a properly operating septic system, biosolids are digested in a dedicated tank and the liquid effluent is allowed to seep gradually away through surface materials, which effectively clean and disinfect the effluent. The key maintenance requirement involves periodic removal of the biosolids from the holding tank.

A septic tank system that is properly constructed and maintained can effectively manage the sewage generated by a single household without significant impact on local groundwater quality. Problems with septic tank systems can occur when the effluent percolates too rapidly into the water table, is discharged directly into the water table, or percolates too slowly and overflows into the surrounding surface waters. Even properly constructed and maintained systems will impact groundwater if they are located too closely together. It is not recommended that septic tanks be located in close proximity to water supply wells due to the potential for direct connection, either through subsurface percolation or surface drainage.

Multi-lot developments can be of particular concern if too many septic tanks are placed in close proximity to each other, or there is a large single septic facility. In both of these cases, the septic systems can overwhelm the natural ability of the area to assimilate the large, concentrated volumes of effluent. Developments that incorporate "new technology" subsurface disposal systems can also pose a risk to groundwater resources due to the more complex equipment and increased maintenance

requirements. Also, it has been noted that in the Middlesex-Elgin Study Area, many septic systems empty to local drains without proper treatment.

Provincial Role

The design, construction, operation and maintenance of various classes of small, on-site sewage systems are regulated under the *Building Code Act*, which addresses systems with flows of up to 10,000 L/day serving one lot. The specific design, construction and operating requirements, including tank design criteria and percolation rates, are outlined in Part 8 of the Ontario Building Code. This section could be improved by incorporating a scale of separation distances based on the porosity of the soils between the sewage system and the well. Systems larger than 10,000 L/day and off-lot (communal) sewage systems are regulated under the *Ontario Water Resources Act*, with approvals issued by the Ministry of the Environment. The MOE also regulates waste approvals for the hauling of sewage and land application sites under Part V of the *Environmental Protection Act*.

Municipal Regulatory Options

A primary role for municipalities in minimizing septic system risks to groundwater is to use municipal planning tools, including Official Plans, zoning by-laws and development controls, to implement the "smart growth" principle noted earlier in this report. This would facilitate "doing things right in the first place" by directing growth to serviced areas or areas with optimum subsurface conditions. In cases where septic systems are to be installed, the implementation of the Building Code requirements regarding septic systems is a municipal responsibility. Municipalities are responsible for the issuance of building permits, inspections, and approvals for small, on-site systems, including septic systems. In some municipalities, these duties have been carried out by local Health Units on behalf of the municipality; otherwise the inspections and approvals are done by building department staff.

Municipalities are also required to ensure that "development utilizing individual on-site sewage systems proceeds at a density and scale which will not result in, or cause degradation of, groundwater resources in exceedance of acceptable limits", in accordance with the principles of MOE Guideline D-5 (MOE, 1996b). Muncipalities can require both a minimum lot size and minimum lot frontage to meet this requirement.

It would be practical for a municipality to require additional study prior to authorizing septic system permits or approvals to address local geology or water quality issues. In Central Elgin, a proposed by-law has been drafted which would, if approved, implement this requirement.

Non-Regulatory Initiatives

The proper use and maintenance of septic tanks is an area with significant non-regulatory options including the following:

- development and funding of a program to evaluate and repair existing non-functional septic tanks
- coordination with existing septic tank education programs
- developing studies to evaluate the impact of closely spaced septic tanks on groundwater and surface water quality
- public education on the proper maintenance and safe utilization of septic tanks
- public education regarding the disposal of hazardous materials into septic systems.

Underground Storage Tanks

Issue Definition

Underground storage tanks are used throughout Ontario for the storage of liquid chemicals, primarily petroleum products such as oil and gasoline. When underground tanks are properly constructed and maintained in sound condition, they provide secure and convenient storage for these essential supplies. However, if the structure of a tank is faulty, or its condition deteriorates, a leak may occur. Since underground tanks cannot easily be inspected, a leak could remain undetected for a significant period of time. This would pose a definite threat to groundwater quality, particularly if the leaking tank is located in an area where the subsurface materials are primarily composed of sands and/or gravel. In this environment, the leaking liquids would be able to percolate quite quickly into the water table. Many property owners have replaced their underground tanks with above-ground structures to overcome the environmental risks associated with the storage of fuels underground. However, underground tanks are considered to have some advantages over above-ground tanks in terms of reduced potential for fires or fire exposure.

Provincial Role

A variety of laws and regulations address one or more aspects of the transportation, handling and storage of fuels and other chemicals. These include:

- the federal *Transportation of Dangerous Goods Act (Canada)* and the *Dangerous Goods Transportation Act (Ontario)* which, as the titles imply, specify requirements for the transportation of various products and substances, including flammable and combustible liquids
- the provincial *Technical Standards and Safety Act, 2000* which came into effect in June 2001, under the Ministry of Consumer and Business Services. It is administered by the

privately-run Technical Standards and Safety Authority (TSSA). A fairly complex web of regulations, code adoption documents, codes, and protocols have been issued under the *Act* including:

- Ontario Regulation 210/01 (Oil and Gas Pipeline Systems) and the Oil and Gas Pipeline Systems Code Adoption Document
- Ontario Regulation 211/02 (Propane Storage and Handling) and the Propane Code Adoption Document
- Ontario Regulation 212/01 (Gaseous Fuels) and the Gaseous Fuels Code Adoption Document
- Ontario Regulation 213/01 (Fuel Oil) and the Fuel Oil Code Adoption Document
- Ontario Regulation 217/01 (Liquid Fuels), the Liquid Fuels Handling Code Adoption Document, and the Liquid Fuels Handling Code, and
- the Environmental Management Protocol for Operating Fuel Handling Facilities in Ontario (October 2001)

- Part 4 of the Ontario Fire Code (Ontario Regulation 388/97), issued under the *Fire Protection and Prevention Act, 1997*, which addresses fire safety requirements relevant to flammable and combustible liquids, in particular those used as a feedstock for industrial processes.

For several of the regulations under the *Technical Standards and Safety Act, 2000*, the existing Canadian national (CAN/CSA) standards are adopted in the "code adoption documents" as the rules that will apply in Ontario.

The above regulatory documents generally address how to safely handle and store fuels and chemicals, and how to prevent accidents such as leaks, spills and fires. These documents were not developed with the specific goal of protecting groundwater resources. However, implementation of many of the requirements and precautions outlined in these documents would, indirectly, have the effect of preventing impacts on groundwater. Rules for underground storage tanks are specifically noted in some of the documents as follows:

- under the Fuel Oil regulation, Ontario Regulation 213/01, distributors of fuel oil must provide the TSSA with the address of every fuel oil underground tank to which they supply fuel; the owners must have their underground tanks registered, appropriately upgraded, and inspected as required; rules for removal of underground tanks following permanent closure of a fuel handling facility are also specified
- the certification requirements for workers who install underground tanks are outlined in Ontario Regulation 216/01, Certification of Petroleum Equipment Mechanics
- requirements for underground tanks storing flammable and combustible liquids, where the tank capacity exceeds 230 liters, are specified in Part 4 of the Ontario Fire Code; Subsections 4.3.8 to 4.3.11 outline rules for underground tank installation, corrosion prevention, and

venting; Subsections 4.3.15 and 4.3.16 address leakage testing and detection; Section 4.10 specifies requirements for the temporary withdrawal of a tank from service, and for permananent removal and disposal of a tank.

Municipal Regulatory Options

There is an extensive regulatory regime in place related to underground storage tanks, including the provincial legislation and regulations noted above. Therefore, as with other groundwater impact issues, a municipal regulatory option would be to use municipal powers related to development approvals and servicing to ensure that the provincial requirements are being followed within the municipality. For example, municipalities could require proof of proper installation, registration, upgrading or removal of any underground storage tanks as a condition of development approval (i.e. for applications for consent, site plan approvals and subdivision approvals), or as a precondition for hook-up to a municipal water system.

Non-Regulatory Initiatives

The following non-regulatory initiatives could be implemented by municipalities, conservation authorities or interest groups:

- develop a working relationship with the TSSA to assist in the process of identification of underground tank owners and registration of the tanks
- identify a staff or group member to act as a local education and liaison representative regarding existing requirements, in particular the rules under the *Technical Standards and Safety Act* and the Fire Code
- provide educational forums on the need for and methods of proper underground storage tank installation, maintenance and removal.

Oil and Gas Wells

Issue Definition

Oil and gas exploration and production represent important economic activities in parts of southwestern Ontario, including the western portions of Middlesex and Elgin. Oil and gas resources are typically found in very deep geological formations laid down during the Cambrian, Mesozoic and more recent periods of the Paleozoic era. The installation of an oil or gas well involves drilling into these deep horizons, which are located much further underground than the layers containing the region's potable groundwater resources. Oil and gas wells therefore extend much deeper underground than water wells, and must be drilled through and beyond the fresh water bearing zones that are tapped for water. As a result, oil and gas wells can represent a threat to groundwater quality,

since they can intersect source aquifers. Numerous instances of shallow groundwater contamination by the oil production processes, whether from oil and gas production or brine disposal, have been reported in southwestern Ontario.

Provincial Role

A number of Ontario provincial regulatory documents apply to oil and gas exploration and production including:

- the *Oil, Gas and Salt Resources Act* administered by the Ministry of Natural Resources
- Ontario Regulation 245/97 titled "Exploration, Drilling and Production", issued under the *Oil, Gas and Salt Resources Act*
- R.R.O. 1990, Regulation 341 titled "Deep Well Disposal", issued under the Environmental Protection Act
- the *Ontario Energy Board Act, 1998* administered by the Ministry of Energy, and
- Ontario Regulation 210/01 titled "Oil and Gas Pipeline Systems", issued under the *Technical Standards and Safety Act, 2000*.

The *Oil, Gas and Salt Resources Act* contains provisions related to the requirement to obtain a licence for well activities; the appointment and powers of inspectors - including the power to order a well to be plugged if it is no longer active or is considered a hazard to the public or the environment; and the power of the province to issue drilling and production regulations. Ontario Regulation 245/97 which is issued under the *Act* specifies at the outset that oil and gas well operators must comply with the "Oil, Gas and Salt Resources of Ontario Operating Standards" published by the Ministry of Natural Resources. The regulation also contains details about the scope, fees and expiry of well licences; the spacing requirements for oil and gas wells; the requirements regarding the "pooling" or "unitization" of oil and gas interests; the prescribed amounts for well security trust funds to be used if a well becomes hazardous or is abandoned; the protection of gas storage areas; and the conditions for Ministry release of information obtained from operators.

The *Ontario Energy Board Act, 1998* provides for the appointment of an minimum five-member Ontario Energy Board with responsibilities related to the sale, transmission and conservation of electricity and gas. The Board's responsibilities related to gas include powers to designate gas storage areas, to approve or fix gas rates, and to appoint a director who can issue gas marketing licences. With respect to gas storage, subsection 38 (1) allows the Board to "authorize a person to inject gas into, store gas in and remove gas from a designated gas storage area....", while section 37 prohibits the injection of gas for storage into a geological formation unless it is a designated gas storage area. Part VI of the *Act* addresses permission to construct hydrocarbon transmission and distribution lines.

Regulation 341, "Deep Well Disposal", sets out the rules for the deep well disposal of liquid industrial waste into geological formations, including the standards for the location, maintenance and operation of the deep well disposal sites. Oil field brine from oil and gas drilling and production operations is specifically exempted from this regulation.

Ontario Regulation 210/01 applies to the design, construction, operation, and maintenance of pipelines systems for the transmission and distribution of oil and gas.

As indicated by the selected examples of provincial laws and regulations in the above review, existing rules provide a basis for the safeguarding of groundwater resources from oil and gas well activities. The Province could strengthen its role by improving the funding and staff resources available for field inspections of oil and gas operations.

Municipal Regulatory Options

The regulatory options for municipalities vis a vis oil and gas wells are similar to those mentioned in previous sections and would include the use of municipal powers related to development approvals and servicing to ensure that the provincial requirements are being followed within the municipality.

Non-Regulatory Initiatives

Non-regulatory initiatives could include the maintenance of at least an ongoing liaison with local Ministry of Natural Resources staff for the exchange of information and maintenance of a data base regarding both old and active oil and gas wells.

2.2 Use of Nutrients and Chemicals

Land Application and Storage of Nutrients

Issue Definition

Within the Study Area, and across Ontario, nutrients of various kinds are applied to farm lands, fields, and recreation areas such as golf courses in order to improve the productivity of the land and quality of the crops being produced. Land-applied nutrients most often consist of livestock manure, poultry manure or commercial fertilizers, but can also include municipal biosolids, septage, industrial pulp and paper sludge and other residuals. Nutrients can also be generated in the soil as a natural by-product of dead farm animal decomposition.

The use of nutrients for soil fertilization and optimum crop production is a widely accepted practice and is considered an essential component of many agricultural operations and recreation businesses. When handled properly and applied in reasonable amounts, nutrients do not normally pose a threat to groundwater resources. Water resource management concerns arise when nutrients are improperly handled or stored, applied in excessive amounts, used too close to water bodies, or when a leak or spill occurs. The risks to water resources include the potential for both chemical and biologic contamination.

It is important to adopt practices throughout the Study Area to protect water resources from the risks of contamination by land-applied nutrients. It is of particular importance where ground or surface waters are in close proximity to the areas of nutrient application, or when conditions are such that nutrients can move quickly to these water sources.

Provincial Role

Bill 81, the *Nutrient Management Act*, was introduced by the Government of Ontario in June 2001; the Act received Royal Assent in June 2002. The stated purpose of the Act is "to provide for the management of materials containing nutrients in ways that will enhance protection of the natural environment and provide a sustainable future for agricultural operations and rural development". The Act is intended to apply to all land-applied materials including livestock or poultry manure, commercial fertilizer, municipal biosolids, septage, industrial pulp and paper sludge and other residuals. It provides authority for the government to issue regulations governing various aspects of nutrient management including: the collection, storage and transportation of nutrient materials; the need for Nutrient Management Plans (NMPs) for the assessment of soil and crop nutrient needs and optimal application rates and methods; the establishment of an NMP registry; the specification of minimum distance separation requirements for land application and buildings to protect land and water; and the disposal, storage and transportation of dead farm animals.

To begin the process of implementing the Act, the province developed two sets of draft regulations under the Act outlining specific nutrient management requirements. The draft regulations were the subject of an extensive public consultation process which began in August 2002 and included thirty-four information sessions and other stakeholder meetings held over the fall and winter. On March 21, 2003, the Minister of Agriculture and Food announced a number of changes regarding the government's plans for implementation of regulations under the Act including the following proposals:

- July 1, 2003 would be the implementation date of the proposed regulations for all new or expanding Category IV livestock farms, defined as operations having 300 nutrient units or more, meaning more than 300 beef cows or 1,800 finishing pigs
- year 2005 would be the implementation date for existing Category IV livestock farms

- a provincial advisory committee would be set up to further examine specific nutrient management issues and provide recommendations to the government
- implementation dates for future regulations would be tied to the availability of cost-shared funding
- the MOE would have responsibility for compliance investigations and enforcement
- OMAF would provide community and on-farm assistance regarding nutrient management issues, and be involved in monitoring.

It was suggested by study participants that provincial funding should include subsidies to farmers for implementation of some aspects of the Act. It was also noted that an unintended impact of the Act has been an increase in tree-cutting applications to gain more land area for nutrient disposal.

Municipal Regulatory Options

With changing farm practices and the increased intensification of agriculture in recent years, nutrient management has become an issue of concern to many municipalities. In Ontario, municipalities have addressed the issue based on their general powers under the *Municipal Act* and the *Planning Act*. These include municipal powers, still in effect under the new *Municipal Act 2001*, to regulate in relation to health and welfare; to regulate the location, erection and use of buildings such as stables and barns; and to restrict the number of animals kept by any person. General powers under Sections 2 and 34 of the *Planning Act* have also been applied. By 2001, 54 local municipal by-laws were in place in Ontario addressing nutrient management issues, including by-laws in almost all local municipalities in Middlesex and Elgin.

One of the province's original goals in the development of the Nutrient Management Act was to create a comprehensive framework and a consistent, province-wide set of standards for nutrient management, in part to overcome inconsistencies in the proliferation of nutrient management by-laws across the province. However, the regulations required to implement the Act are not yet in place. Furthermore, these regulations may be phased in over several years. Until the provincial regulations have been finalized and enacted, the existing municipal by-laws and requirements will remain in effect. However, subsection 61(1) of the Act states: "A regulation supersedes a by-law of a municipality or a provision in that by-law if the by-law or provision addresses the same subject matter as the regulation". Therefore, existing municipal by-laws will be operative only if and until a provincial regulation or regulations addressing the subject matter have been enacted. After that, municipal regulatory powers with respect to nutrient management could be limited but would still include:

- powers under the *Planning Act* to regulate where agricultural and related activities take place, subject to provincial policy statements and the *Farming and Food Production Protection Act*

1998, and

- powers to regulate with respect to operations or activities not addressed by the regulations (e.g. smaller operations).

It is recommended that municipalities be involved in implementation duties such as review and approval of nutrient management plans and the maintenance of registries of nutrient management plans and strategies. At a minimum, municipalities should have ongoing access to this data.

Non-Regulatory Initiatives

Municipalities, conservation authorities, agricultural associations and other local groups will continue to have the opportunity to play a non-regulatory role in nutrient management education and implementation through initiatives such as the following:

- develop working relationships and, where appropriate, agreements with landowners, OMAF, and MOE to focus their efforts on locally important issues and areas of local concern
- identify a local education and liaison representative for nutrient management programs to be a point of contact for information, education, or potential violations
- provide educational forums for organization members, farmers, industries, and the general public on effective nutrient management practices
- farmers and livestock operation managers can seek to improve relationships with neighbours regarding nutrient management concerns.
- funding for farm/rural improvement projects. The Clean Water project was noted as an example of funding program being carried out on a pilot scale
- placement of covers and ends on drains. This is being examined by the Province and tested on a pilot scale
- tree planting/buffer strips/livestock fencing. The Conservation Authorities are carrying out pilot projects with CA and provincial funding
- MOE Swat Team could look at farm management. This is unlikely, however, due to limited staff
- education of farmers. Members of the group noted that farmers are already environmentally conscious and local farm associations have existing educational programs
- different areas may require different levels of nutrient management. Strathroy is an example of an area where more care should be taken when applying nutrients because of the sandy soil. Malahide was also noted as an example where nutrients applied in tobacco fields discharge through sand points to groundwater.
- soil testing by farmers (bore hole testing, water quality testing) could be encouraged.

Application of Pesticides and Herbicides

Issue Definition

Pesticides and herbicides (referred to generically as "pesticides") are used widely throughout the Study Area in both urban and rural areas. For agricultural operations, they provide an effective means to eliminate or control noxious plants and animal pests as part of the range of farm practices used to achieve optimum crop yield and livestock health. In urban areas, the outdoor use of pesticides by homeowners and municipalities is usually focussed on the maintenance of monoculture grassed areas with, for many, the goal of "golf green" lawns.

Effective pest control has obvious benefits. However, the improper, unnecessary or excessive use of pesticides can lead to water resource contamination, through run-off, airborne transport into wells and water bodies, or ground infiltration. As with many other activities that can affect water quality, there is a need to properly weigh the benefits of pesticide use against the potential environmental risks, particularly in relation to narrow aesthetic preferences. Where possible, less-risky alternatives for agricultural pest control and urban lawn care should be implemented.

Provincial Role

Pesticides are registered under the Canadian federal *Pest Control Products Act*. Rules regarding pesticide use are set out in Ontario's *Pesticides Act*. Key provisions of the *Pesticides Act* in relation to water resource protection include the following:

- Section 4 directly prohibits the use of a pesticide to a degree that would cause harm to the environment, property, health or safety
- Section 17 provides for the designation by the Minister of provincial officers who have authority to enforce the requirements of the *Act*, including powers to inspect, search, investigate and prosecute
- Sections 27 and 28 allow for the issuance of "stop orders" and "control orders" which require, in the case of a stop order, the immediate cessation of pesticide use or, in the case of a control order, the controlled use of the pesticide according to the specified rate or period of time.

Two of Ontario's preeminent environmental laws - the *Environmental Protection Act* (the *EPA)* and the *Ontario Water Resources Act* (the *OWRA*) - also have general relevance to the protection of water resources from pesticide impacts. The guiding provision of the *EPA* prohibits the unlawful or excessive discharge into the natural environment of any contaminant. The OWRA identifies that it is an offence to discharge any material into any waters, shore or bank that may impair water quality. Provincial officers under the *Pesticides Act* are given the authority to take action as appropriate under

the *Environmental Protection Act*, the *Nutrient Management Act*, and the *Ontario Water Resources Act*, over and above their other powers.

The provincial role could be strengthened through the provision of additional resources for investigation and enforcement of the existing laws. It has also been suggested that commercial pesticide applicators should be required to test the soil before applying the chemicals, and should only be permitted to apply them up to an identified maximum allowable concentration in soil.

Municipal Regulatory Options

The regulatory options for municipalities regarding pesticide use are limited as the primary regulatory powers rest with the province. However, municipal regulatory measures could include:

- eliminating the use of pesticides for certain uses through by-laws
- institute requirements for all property owners who apply pesticides to complete education and testing regarding pesticide use comparable to that required of farmers.

Non-Regulatory Initiatives

Best Management Practices (BMPs) have been developed and voluntarily applied for many years within the agricultural community in order to encourage and achieve environmental responsibility in agricultural production. These BMPs have included methods that help to reduce the potential for pesticides and nutrients to enter aquifers. In some cases, financial incentive programs have been applied to encourage the implementation of BMPs. Additional financial resources for BMPs could be established at the municipal level.

The concept of the Environmental Farm Plan was developed by OFEC in an effort to help farmers assess the environmental risk associated with their current farm practices, and to reduce this risk through the adoption of BMPs. The program is funded by Agriculture and Agri-Food Canada (AAFC) and the Ontario Agricultural Adaptation Council. Technical support is provided by the Ontario Ministry of Agriculture and Food. Farm operators are eligible for financial assistance to undertake action items that they have identified in their Environmental Farm Plan. The advantage of the EFP process to the farm community is that it is voluntary, self-directed and specific to the individual needs and situation of the farmer.

Finally, municipalities, conservation authorities and other groups could continue to support the existing urban area programs that promote “pesticide free” lawns and alternative ground covers, in conjunction with water conservation measures, and facilitate initiatives such as the Community Integrated Pest Management Plan undertaken by the City of London to reduce the non-residential

use of pesticides.

Use of Road Salt on Highways

Issue Definition

Road salt is applied during winter as an essential service to protect the safety of roadway users. Road salt application practices are a function of traffic volume, road geometry (e.g., curves, hills) and structures (e.g., bridges) with heavier applications where there is increased danger of icing conditions.

The use of salt to de-ice roads and highways has become an issue of some concern in recent years. Studies completed in other parts of Ontario have documented the increasing presence of chlorides in wells located near major highways. These levels are presumed to be a result of salt contamination seeping into the groundwater system. Road salt contamination is a potential threat to the groundwater quality, especially in areas where the major roads cross regions with surficial sand and gravel deposits.

Provincial Role

The MTO provides guidelines regarding the utilization of road salt and is responsible for maintaining Highway 401, the major thoroughfare across the Study Area.

Municipal Regulatory Options

As the various municipal governments throughout the Study Area have significant responsibilities for the care and maintenance of most roads in the region, the use of road salt has significant social, economic, and water quality considerations. The municipalities could consider alternatives to road salting.

An appropriate separation distance between major salt applications areas (e.g. Highway 401) and new development based on groundwater supply should be formulated. In the absence of an appropriate separation distance between a development and a major salt application area, a satisfactory supporting groundwater quality study should accompany the development application.

Determining a separation distance is problematic but should be based on past experiences. Presently, MTO policies on Corridor Control within the 401 area do not explicitly address road salt conflicts. Likewise, setbacks from County Roads are usually established for other reasons than avoidance of road salt impacts. However, the use of these control mechanisms to minimize road salt impacts to

water supplies could provide a foundation for future management plans.

Non-regulatory Initiatives

A review of County road salting activities should be undertaken to ensure optimum road salt application rates are used. However, the safety of the travelling public should be paramount in this review. Reductions in salting rates and transitions to the use of road-salt alternatives (e.g. sand) should only be undertaken where safety permits. This review should include the overall objectives of road maintenance, including the appropriateness of "bare pavement" objectives. Water quality monitoring sites could also be established near major roads and highways.

Spills

Issue Definition

Despite the best precautionary efforts, chemical spills can occur and potentially harm groundwater quality. In the Study Area, the potential for harmful spills exists as many chemicals are manufactured, handled and/or transported within the geographic area. The potential for significant releases may be especially high along main transportation corridors used for the shipment of commercial and industrial products. These routes include Highway 401, Highway 402, and CNR and CPR freight rail lines. In addition, significant quantities of chemicals are stored in the various industrial/commercial districts within the Study Area, in particular in London and St. Thomas.

Provincial Role

When a spill occurs, the primary responsible parties are the owner/handler of the spilled material and the Ministry of the Environment. The Fire department will be involved if called upon, or if the spill is considered a threat to life and property.

The individual, agency and/or company who owns the product or had control of the material at the time it was spilled is primarily responsible for all spill assessment, containment and remediation. The responsible party must cleanup the spill, dispose of contaminated debris, restore the environment and pay damages. Some manufactures within the Study Area have their own response teams and equipment to mitigate spill emergences.

The role of the Ministry of the Environment (MOE) is to ensure that those responsible contain and remediate the spill in accordance with provincial guidelines. Provincial laws that identify the roles and responsibilities of the involved parties are laid out under Part X of Ch. 19 of the *Environmental Protection Act*, and Section 16 of the *Ontario Water Resources Act*. Through these acts, the Ministry

can order those responsible to clean a site according to Ministry guidelines. If the responsible parties fail to comply, the ministry can undertake the cleanup and recover costs.

The MOE requires that spills of all hazardous materials be reported immediately to the Ministry. The MOE operates a Spills Action Centre (SAC) that is staffed 24 hours a day to receive reports of spills and to co-ordinate responses.

In the event a leak or spill occurs, the actions needed to deal with the presence or discharge of contaminants into the environment are regulated under the *Environmental Protection Act, 1990* and the *Ontario Water Resources Act, 1990*, administered by the Ministry of the Environment. The steps that can be taken by a property owner to assess, clean up, restore and redevelop a contaminated property are outlined in the MOE "Guideline for Use at Contaminated Sites in Ontario" (revised February 1997). The Environmental Management Protocol for Operating Fuel Handling Facilities in Ontario (October 2001) was designed to be consistent with and complementary to the MOE Guideline; it provides direction to fuel handling facilties (e.g. gas stations, bulk plants, marinas) regarding the reporting and management of petroleum products (e.g. gasoline, diesel, and fuel oil) that have escaped into the environment or inside a building.

If called upon, operational response to hazardous material spills is the responsibility of local fire departments.

Municipal Regulatory Options

Municipalities could use development approval powers to ensure that emergency response teams and protocols will be in place for any new development with the potential for chemical spills. Municipal response teams and protocols should also be developed in conjunction with fire departments and other emergency service personnel.

Non-Regulatory Initiatives

Risks to human health from chemical spills are further intensified if the spill is in a WHPA or a hydrogeologically sensitive area. In these areas, special spill management protocols may be required. For example, certain types of responses may differ in WHPAs as opposed to non-WHPA areas, depending upon the chemical involved and the location of the spill within the groundwater capture zone. It is recommended that a spill responder group, consisting of the County Fire Co-ordinator, Local Fire Departments, Health Units, and County and Township Officials could be established to discuss spill response in WHPAs. The spill responder group should also include hydrogeological expertise. Discussion should focus on the location of WHPAs as well as specific protocols and procedures for response in these zones. This group could also review response scenarios involving

first responders (such as local fire department, police, etc) to ensure that response protocols are clearly understood, and the response system is as streamlined as possible.

2.3 Large Agricultural and Industrial Operations

Aggregate Extraction and Reclamation

Issue Definition

Aggregate Extraction

Aggregate extraction operations are common in the Study Area and are an important part of the construction industry. Aggregate resources such as sand, gravel, and crushed stone are generally extracted from an open pit that can cause significant visual and physical impacts on the environment. There are several factors that determine the degree of impact an open pit aggregate mining operation will have on the groundwater environment. The main impacts associated with aggregate extraction are altering groundwater recharge patterns, lowering the groundwater table through dewatering, groundwater quality impacts, and alteration of localized groundwater flow direction.

Pits where extraction occurs below the water table are filled with water. These bodies absorb heat and elevate the temperature of the groundwater. IF a pit was located too close to a cold water stream or river, this temperature elevation may impact fish reproduction or habitat. Aggregate extraction operations may require setbacks from surface water bodies to minimize impact.

Surficial Cover Material

The native material at surface in the area of a aggregate pit determines the natural recharge patterns in the vicinity of the aggregate pit. If the native material at surface is a coarse grained, permeable material such as sand or gravel, the removal of this material as aggregate will have little effect on the local recharge patterns. However, if there is a fine grained material that is relatively impermeable, such as silt or clay, the removal of this material to expose the aggregate for mining will significantly increase the amount of recharge occurring locally. The removal of vegetation cover will also affect the recharge patterns as less water is lost to evapotranspiration, while more precipitation will recharge the groundwater table. Removal of vegetation will also accelerate erosion in the vicinity of the pit, which could negatively effect local surface water bodies.

Depth to Groundwater

Shallow groundwater conditions in a aggregate pit requires dewatering of the pit to allow the

physical extraction of the material using heavy equipment. Dewatering poses several potential problems impacting the groundwater and surface water environment. Dewatering will lower the water table and alter groundwater flow directions in the vicinity of the pit. The water pumped from the pit then has to be discharged in an area where it will not end up re-filling the pit through infiltration. This effects the natural water budgets on a local scale, and poses potential impacts to surface water quality such as sediment load or contamination. Aggregate mining operations that are located in areas with a deep groundwater table or raised geomorphic feature such as eskers may only effect the recharge patterns locally, if dewatering is not required.

Proximity to Surface Water Bodies

If dewatering is required to extract the aggregate, the lowering of the water table can potentially alter the quantity of base flow in creeks, streams, and rivers. This activity can also dry or destroy wetlands or ponds, thus impacting natural habitat.

Aggregate Washing

Large quantities of groundwater are often used to wash aggregate, in order to remove the fine grained fraction (silt and clay) from the desired clean coarse grained material. The use of this water can be independent of, or combined with water taking for dewatering purposes. There are potential environmental impacts (groundwater, surface water, erosion, etc.) associated with the taking and discharge of the washing water.

Quarries

Quarries present a unique set of potential environmental impacts in comparison to mining of unconsolidated Quaternary sediments. Exposing and subsequent quarrying of bedrock (usually limestone or dolostone in the Study Area) may lead to alteration of water levels and groundwater flow directions in the local area. These impacts on the groundwater environment are similar to impacts in quaternary deposits, but can be more significant, as many porous bedrock lithologies have high groundwater flow velocities. As a result, exposed bedrock aquifers are especially susceptible to contamination, and can effect groundwater quality over large areas relative to quaternary deposits.

Reclamation of Aggregate Pits

Groundwater quality may be adversely affected if spills or external sources of contamination occur in or close to gravel pits as they provide a direct conduit or access point for unnatural contaminants to enter the groundwater environment. This can occur during operation of the pit or after the pit is decommissioned if it is not properly reclaimed or restored. Unfortunately, the reclamation of

aggregate operations in the past were not carefully considered in terms of the potential impacts related to the manner in which the pits were reclaimed. There are several instances of gravel pits being converted to landfills. Highly permeable lithologies such as gravel and sand are not ideal for the disposal of refuse, as the decay of the refuse causes contamination to the groundwater environment.

Provincial Role

The provincial government, specifically the Ministry Of Natural Resources (MNR), addresses the issue of aggregate mining and reclamation in the *Aggregate Resources Act - R.S.O. 1990, c.A8.* The MNR is responsible for managing the *Aggregate Resources Act* as well as the Aggregate Resources of Ontaio, Provincial Standards (MNR, 1997), which describes the requirements for developing a quarry/pit below the water table. In addition, if water is to be taken in quantities in excess of 50,000 L per day for any purpose associated with the mining operation, the operator must apply to the Ministry of the Environment for a Permit to Take Water.

The *Aggregate Resources Act* is very long and addresses all of the aspects of aggregate mining in Ontario. The list below highlights the key aspects of the act.

Key aspects of the Aggregate Resources Act include:
General
- Purposes and administration of the act
- Application of the act
- Aggregate resources trust.

Licences, Wayside Permits, and Aggregate Permits
- Licences required by the act
- Requirements and procedure for obtaining licences
- Zoning by-laws
- Licence fees
- Duties of Licencees
- Annual compliance report requirements
- Transfer, surrender, revocation, and Suspension of licences.

Rehabilitation
- Application of Part
- Duty to rehabilitate site
- Rehabilitation security payments
- Entry upon a site for rehabilitation.

Offences and Penalties
- Offences
- Penalty
- Order for compliance
- limitation period.

Miscellaneous
- Several topics.

Municipal Regulatory Options

Municipalities have a role that is subsidiary to the provincial role in that the zoning by-laws, growth management strategies, and official plans for the municipality are reviewed by the provincial MNR in granting permits and licences.

Non-regulatory Options

In addition to complying with the Aggregate Resources Act, non-regulatory initiative that can be employed by aggregate operations may include consulting local environmental or conservation groups in the region before or during aggregate extraction activities. Establishing relationships with these organizations and consulting the Best Management Practices for several indirectly related conservation and environmental protection strategies could provide operators of aggregate mining operations with a good environmental image, and prevent possible impacts to the environment.

Intensive Livestock Operations

Issue Definition

A number of significant changes have occurred in the agricultural sector across Ontario, including an increase in the number of large or "intensive" livestock operations. Agribusinesses of this type have evolved in response to market demands and economic pressures, and have been facilitated by the availability of technologies that allow highly mechanized, less labour intensive farm operations.

Under the *Nutrient Management Act*, the province has provided a framework defining different levels or "degrees of intensity" of operations. Four categories of livestock operations have been defined as follows:

- Category IV: 300 nutrient units or more (more than 300 beef cows or 1800 finishing pigs)
- Category III: 150 to 300 nutrient units (150-300 beef cows or 900-1800 finishing pigs)

- Category II: 30-150 nutrient units (30-150 beef cows or 180-900 finishing pigs)
- Category I: less than 30 nutrient units (fewer than 30 beef cows or 180 finishing pigs).

As noted earlier in the section on "Land Application and Storage of Nutrients", the province has proposed that the draft nutrient management regulations be implemented on July 1, 2003 for new farms within the largest category (Category IV) and those expanding into that category.

One of the driving forces in the development of the new legislation was the increasing level of concern in many areas regarding the size and potential impacts of these large, intensive operations, especially those that fall into Categories III and IV. In Middlesex and Elgin, there are approximately 50 farms that would fall within that range. The concerns raised have focussed on issues such as the potential for odours, run-off of nutrients into streams, and potential for groundwater contamination.

The potential for the micro-organisms in manure to contaminate groundwater is one issue that was given particular attention in the wake of the drinking water tragedy in Walkerton, Ontario. It should be noted however that large numbers of micro-organisms can occur even in small quantities of manure. In addition, nutrient management does very little to reduce the risk of micro-organism contamination of groundwater; it limits the volumes applied but does not address the potential for manure to enter the groundwater system. This would require defining a minimum distance between the area of manure application and the water source (e.g. a water well). Therefore, groundwater contamination can be of concern with both the large intensive operations, as well as smaller farms.

Provincial Role

The key provincial legislation that addresses many of the issues related to intensive livestock operations is the *Nutrient Management Act*. It provides authority for the province to set rules regarding the application and storage of nutrients, odour-related setbacks and standards, the quality of nutrients being applied, and the need for studies to determine water contamination risks. Another provincial law relevant to intensive livestock operations is the *Farming and Food Production Act, 1998*. Of particular note is the fact that this law gives farmers the ability to challenge by-laws that restrict normal farm practices. The Provincial Policy Statement under Section 3 of the *Planning Act* likewise affirms that in prime agricultural areas agricultural uses and normal farm practices will be promoted and protected.

Municipal Regulatory Options and Non-regulatory Initiatives

The same comments regarding the municipal and non-regulatory roles in relation to nutrient management apply with respect to intensive livestock farm issues (see discussions of municipal regulatory options and non-regulatory initiatives under "Land Application and Storage of Nutrients"

in Section 2.2 above).

Solid Waste Landfills

Issue Definition

Effective waste management is a challenge faced in urban and rural areas throughout the world. In Middlesex and Elgin, as in most other parts of Ontario, municipalities have addressed this issue in part by implementing programs to encourage the reduction, reuse, and recycling of materials to reduce the volume of waste requiring disposal. For the residual waste materials, the most common method of disposal, and the method currently used across the study area, is disposal in a solid waste landfill.

In Ontario the steps required to site and develop a new landfill are highly regulated and subject to numerous requirements and approvals. The approval process for a new landfill is contingent upon completion of a variety of studies, including extensive hydrogeological investigations. These studies focus on assessing the potential for impacts on the environment including soil, air, groundwater, surface water, and the surrounding community, and on identifying ways to prevent or minimize effects. Modern landfills typically include a range of features and components designed to prevent impacts and to enable ongoing monitoring for early identification of any potential concerns.

Given the extensive development and monitoring requirements, new engineered landfills are not a major source of concern for water resources. Old or abandoned landfills are of much greater concern, due to the potential for the escape of contaminants into groundwater sources or the discharge of contaminated groundwater into surface water courses.

Provincial Role

As indicated above, the province has a significant role in the approval and regulation of solid waste landfills. The key provincial laws governing the planning, development and operation of a landfill are:

- the *Environmental Assessment Act*
- the *Environmental Protection Act*, and
- the *Planning Act*.

An overview of these acts was provided in Chapter 8. The requirements of other provincial legislation may also apply to specific aspects of landfill design and operation, including the requirements under Ontario's Building Code and Fire Code, the *Occupational Health and Safety Act*, and the *Ontario Water Resources Act*.

Municipal Regulatory Options

The primary role for municipalities with respect to landfills is to ensure that appropriate land use approvals are in place or can be obtained. For new landfills, this will often entail drafting amendments to the Official Plan and Zoning By-law, as well as taking the steps necessary for site plan approval. For landfill expansions, the appropriate Official Plan designations and zoning are often already in place. The specific role played by the municipality will vary depending upon whether they are the proponent of the landfill (i.e. it is municipally owned) or whether they are the "host" municipality to another private or public sector proponent. Either way, the landfill must be an approved use under the municipal policy documents.

Non-Regulatory Initiatives

A common non-regulatory initiative associated with solid waste landfills is the development of landfill liaison committees composed of community members who play a role in the ongoing monitoring of the landfill operations. Committee members are also normally kept informed of the results of ongoing monitoring results by the landfill operator, including any groundwater monitoring data. Another non-regulatory measure is the provision of financial compensation by the proponent to property owners within a specified distance of the landfill and/or to the host community. This is provided as a way of compensating for the negative nuisance effects from landfills that cannot be entirely prevented, such as noise, odour, litter or property devaluation.

2.4 Drainage and Water Taking

Overuse of groundwater for industrial and commercial activities and agricultural operations can cause depletion of groundwater quantities. Common industrial and agricultural practices that can have the potential to cause detrimental effects to the groundwater and surface water environment are addressed below.

Field Tile Drains

Issue Definition

Farms and agricultural operations cover a large percentage land area of the Study Area. Excess water on fields can hinder farming operations and destroy crops. In an attempt to overcome ponding of meltwater and precipitation in fields, field tile drains may be installed in the fields to carry off the excess and unwanted water. Field tile drains are especially important in areas with low permeability soils (such as clay soils). Field tile drains usually consist of a low lying sump, connected to a large diameter perforated plastic tube, that carries the water collected in the sump and though the perforations off the field to a discharge point.

Field drains are particularly important in the spring and fall when there is an abundance of water from melting snow and frost, as well as high precipitation. However, the spring and fall are also important periods of recharge for groundwater. There is some concern that field drains intercept a great deal of the precipitation that would naturally recharge the water table and discharge it to surface water bodies or municipal drains. If too much water is removed from the fields and discharged to a surface water body before groundwater recharge occurs, the water table may become lower over time due to the limited recharge. A similar phenomena has been observed in areas of urban development, where decreased infiltration due to low permeability ground cover results in lowering of local groundwater elevations.

Similarly, if field drains significantly alter the natural flow path of precipitation by discharging to a surface water body, natural surface water flow and budgets can be disrupted. This may result in alteration of the natural aquatic habitat, stream channel morphology, and water quality.

Field tile drains are essential in many agricultural operations. However, the effects that field drains pose to the groundwater and surface water environments should be considered in the design, construction and operation of the drainage systems to minimize environmental impacts.

Provincial Role

There is legislation from the Government of Ontario that addresses the implementation of new drains and field tile drains. This legislation consists of the *Drainage Act - R.S.O. 1990, c. D. 17*, the *Tile Drainage Act - R.S.O. 1990, c. T.8*, and the *Agricultural Tile Drainage Installation Act - R.S.O. 1990, c. A.14.*

These acts address the need for assistance in meeting the problems of obtaining a legal drainage outlet, properly engineered drainage system, and financing for installation of such a system.

The Drainage act discusses the following issues with respect to drains:

- various types of drains
- the procedural requirements in implementing the various types of drains (i.e., engineering reports, design plans, drainage agreements between the involved parties, etc.)
- maintenance of drains once constructed
- repair and improvement of drains
- abandonment of existing drains
- grants available for implementation of drainage systems.

The Tile Drainage Act is in place to make loans available for the drainage work done on a farm. Up to 75 % of the cost of the drain may be loaned from the provincial government, through the township

council. Verified costs for the construction, licence numbers of the equipment used to install the drainage system, inspection fees, and a complete plan for future reference must be provided in the loan application.

The Agricultural Tile Drainage Act provides for licencing of the contractors engaged in the business of installing drainage systems. This act does not apply to works completed within the confines of private property. The drainage system must comply with this act in order to be eligible for the financial assistance available through the Tile Drainage Act as described above.

If the drainage system is to discharge into a municipal drain that discharges into a surface water body or if the drain discharges directly to a surface water body, the water quality of the drained water must be considered and must meet the Provincial Water Quality Objectives (PQWO), in order to not adversely effect natural surface water quality.

Municipal Regulatory Options

The current role of municipalities in the construction or alteration of field tile drainage systems is to ensure that the system follows the approved design before connecting the drainage systems to the municipal drain system. The water from municipal drains that discharge to surface water bodies must meet the Provincial Water Quality Objectives (PWQO's), and as a result, the water quality of the water from field drains must be considered.

Non-Regulatory Initiatives

The main objective of a drainage system design should be to create a simple effective system that permits the required work to be completed in the fields, while minimize the inhibition of natural recharge. Discussion groups held during the completion of this study suggested that the government should change the focus of the Drainage Act from simply draining the land, to retaining as much water on the land as possible, without hampering farm operations. There are some components of a field tile drain design that can be incorporated to minimize effects on the groundwater and surface water environment.

System Design/Engineering

A well engineered drainage system can include a simple valving system that allows the amount of water and period of drainage to be controlled by shutting off or controlling the flow through the drainage system. This control allows the operator to only drain the required amount of water to prevent ponding or crop damage, and to utilize the fields at key times in the year. This control affords the local water table to recharge more naturally during periods when drainage is not essential, thus minimizing the effect on the groundwater table.

Other aspects of the farms operating procedure must also be considered in the drainage system design. The discharge point for the drainage system must be carefully considered. The drainage system can discharge to an irrigation pond, minimizing the amount of water needed to be pumped from an external source in the summer months, while also allowing for some groundwater recharge. Alternatively, the drainage system can discharge to another area capable of recharging the groundwater table, rather than to a municipal drain or surface water body.

Establishing natural recharge areas such as re-creation of historic wetland areas by the province, municipalities, as well as privately is another initiative that could reduce the stress placed on the groundwater environment from the unnatural inhibition of recharge.

Stormwater Retention/Detention Facilities

Issue Definition

The effect of storm water ponds on the groundwater environment can vary significantly. Factors such as soil type, pond construction technique, depth from surface to water table, and water quality within the pond determine if the storm water facility will alter local groundwater recharge rates, groundwater elevations, and the effect on groundwater quality.

Storm water facilities located on low permeability soils with substantial depth to the water table or significant water bearing formations will likely have minimal effect on groundwater elevations and quality. Similarly, if a storm water pond is lined with a low permeability liner, the groundwater environment is not likely to be affected as the liner effectively isolates the collected runoff from the water table (regardless of the depth to water). However, if an unlined storm water facility located on sandy or permeable soil types, artificial recharge may result from the pond. This may alter groundwater elevations in the vicinity of the pond, and may introduce surface water with adverse water quality (in the form of dissolved constituents such as salts) to the groundwater environment. Suspended solids are filtered out of the pond water and will not affect the groundwater.

The water quality of storm water from ponds that discharge directly to a natural surface water body, may adversely effect the natural water quality of the surface water body. Dissolved constituents, suspended solids, gas, oil, automotive fluids, sediment, pesticides, nutrients, and even the temperature of the pond water may create negative impacts on the natural water body.

Storm water control facilities are common in a variety of municipal infrastructure. There are a variety of regulations and suggested practices to follow in the design and construction of storm water control facilities to protect the groundwater and surface water environments.

Provincial Role

In June 1991, the Ministry of the Environment published a report entitled *Stormwater Quality Best Management Practice*s. The report documented experience with structural and non-structural Stormwater Management Practices (SWMPs) and concluded that they should be implemented in conjunction with new urban development and redevelopment.

Guidance, and a procedure for selecting appropriate SWMP designs is now provided in the report entitled "Stormwater Management Planning and Design Manual". Since the original introduction of the *Stormwater Quality Best Management Practices*, it has been determined that "integrated watershed planning" is the preferred means of defining the basis for SWMP design selection." Recognition of the importance of watershed and subwatershed-based planning has continued to grow since the release of the 1991 study.

Municipal Regulatory Options

Municipalities, conservation authorities, provincial agencies, and the public are all involved in developing Official plans, Growth Management Strategies, Watershed/Sub-Watershed Studies, and Environmental Management Plans. Land use regulations imposed by the municipality under the Planning Act is a regulatory control on stormwater management issues. The provincial role in regulating as stated in the MOE manual for stormwater management is very comprehensive and does not allow for independent municipal regulatory control of stormwater management. However, the municipality is actively involved in conjunction with the MOE in granting permits for completing stormwater management works.

Non-Regulatory Initiatives

Due diligence on the part of the engineering team and those responsible for approving the designs of stormwater management systems is important in creating a system that minimizes, or potentially benefits the local environment. Incorporating features such as habitat reconstruction is an example of how the localized environment can benefit from a carefully considered design process.

Incentives could be put forth by municipal or provincial authorities to encourage "wise" stormwater management.

Irrigation Pits and Ponds

Issue Definition

Farming operations require a water source to irrigate crops and provide water for livestock in the dry summer months as there is insufficient precipitation to produce quality crops and yields. Construction of an irrigation system using a natural or constructed irrigation pond can provide the

required water to operate a farm in the summer. However, depending on the type of system the farming operations employ, the physical characteristics of the farm, and the operation of the irrigation system a variety of environmental impacts may result.

Irrigation systems can vary in several respects including the geological/hydrogeological setting, pond type, conditions, water source, water demand, and delivery system. The main control on the extent of the effects of an irrigation system on the groundwater environment is the geological/hydrogeological setting that the system is constructed. Water demand, and the delivery system are not characteristics of the irrigation system that have a direct effect on the environment, so they are not discussed below.

Pond Types

There are four different types of ponds including:

- natural ponds
- dugout ponds
- bypass ponds
- impoundment ponds.

Natural ponds are found in topographical depressions where the shallow water table infills the pond. Dugout ponds are usually created in areas with a shallow water table and essentially mimic a natural pond by making a man-made topographic depression. Natural and dugout ponds in areas with a shallow water table are desirable as they do not require active pumping or extraction from an external water source. Subsequently, they have a minimal impact on the groundwater and surface water environments. However, contaminant spills in the proximity of a shallow water table pond is a potential pathway for contaminants to the groundwater environment. Pumping water from a shallow groundwater pond will only locally affect groundwater elevations in the vicinity of the pond. If a dugout pond is made in an area with a deeper groundwater table, an external source of water must be used to fill the pond.

Bypass ponds use an inlet conduit from a stream or river, to fill the pond, and an outlet to re-circulate and drain the pond. This requires proximity to the river and may unnaturally raise groundwater elevations near the pond. Care must be taken to not extract too much water from the stream or river, to avoid adverse impacts on the natural conditions in the surface water body.
Impoundment ponds are basically a small dam on non-continuous flow stream or in a valley. These ponds block natural runoff from the spring melt and catch any precipitation that falls within the man made catchment area. This type of pond can alter the groundwater elevations in the vicinity of the pond as well.

Water Sources

Water sources for an irrigation system include any one or a combination of the following:

- direct rainfall
- shallow groundwater
- field tile drainage system from farm
- artesian spring
- deep groundwater (water well)
- rivers or streams.

Direct rainfall, shallow groundwater, and artesian spring sources are sources that do not affect the groundwater environment. Water collected from field tile drains in the spring and fall seasons that is discharged into the pond is a cost effective means of conserving excess water for the dry summer months. However, the water that is collected from the field in the spring limits recharge at key intervals in the annual recharge cycle of the groundwater environment. When the water is used on the fields in the summer to irrigate crops, the vast majority of the water is lost to evapotraspiration and does not recharge the groundwater system. In this respect, irrigation systems using water drained from fields, can significantly alter the groundwater elevations locally.

Similarly, if a deep groundwater source is used (i.e. a well deeper than a dug pond can access), interference with neighbouring wells or surface water features (depending on the hydrogeological setting) may result.

The various characteristics of an irrigation system should be carefully chosen to maximize efficiency and cost effectiveness, while minimizing the potential effects to the environment.

Provincial Role

There are no direct regulations controlling the construction of ponds or irrigation works but there are issues that are indirectly related to irrigation systems that require approval from a variety of provincial ministries. The *Ontario Water Resources Act - O.Reg.285/99* requires a Permit to Take Water (PTTW) if an irrigation project is designed to require more than 50 000 L/day. This is acquired from the MOE by applying for a PTTW.

In applying for a PTTW the following information is required:

- the location of water taking
- proposed rate of water taking
- the number of days water is to be taken per year
- local physical characteristics

- purpose of water taking
- the surface water from which water is to be taken (or location of proposed well), or both
- a description of the proposed system
- supporting information if available or required (pre-application consultation with MOE, final plans and specifications, Hydrogeological reports, etc.).

If the construction of ponds is to be undertaken in proximity to highways, a Permit to Construct must be acquired from the Ministry of Transportation.

Provincial regulations also prohibit construction of ponds or irrigation infrastructure near or on streams and rivers to protect the natural riparian environment. In addition, care must be taken in the design of an irrigation system so that unwanted runoff directly into surface water bodies does not adversely affect the water quality in accordance with PQWO's.

The Conservation Authorities Act - R.S.O. 1990, c.27, enables Conservation Authorities to enact regulations to require permits for works in and around watercourses, wetlands, valleys, and floodplains. Through these regulations, important watershed features and functions can be protected against harmful effects of works undertaken in the aforementioned areas. *The Conservation Authorities Act* also allows a given conservation authority to administer the *Federal Fisheries Act*, which also protects fish habitat form works undertaken in or around water.

A wealth of information is available through the Ministry of Agriculture and Food (OMAF) *Best Management Practices* regarding the design and implementation of an irrigation system. The Best Management Practices offer information in determining the size, characteristics, design and hardware, the water source of the irrigation system, delivery systems, storage requirements, how to apply for a PTTW, water quality issues, capitol costs, safety of the irrigation system, and the environmental impact posed by irrigation systems. These best management practices should be consulted in the early stages of designing an irrigation system to prevent adverse environmental effects including groundwater and surface water impacts.

Municipal Regulatory Options

Municipalities are concerned with the implementation of irrigation systems as they can pose environmental damage, as well as damage to public and private property. Many farmers are constructing irrigation ponds close to roads, structures, and property lines. If there is failure of the pond walls or irrigation equipment (i.e., pumps), damage may result to roads and structures. It has been expressed by many municipalities that they are concerned with the lack of control they have over construction activities on private lands. Policies could be imposed in the future by municipalities, that would be consistent with the Best Management Practices put forth by the Provincial Government.

Non-Regulatory Initiatives

Owners of irrigation systems can employ a number of strategies to make efficient use of the water used for irrigation, thus minimizing the environmental effects associated with irrigation systems. The *Best Management Practices* provided by the Ministry of Agriculture and Food should be consulted and considered when implementing and operating an irrigation system.

Development of irrigation schedules and rural peer groups could also benefit the farmers and minimize environmental impacts associated with irrigation practices.

Groundwater Mining

Issue Definition

Groundwater mining results from extraction of groundwater from an aquifer that exceeds the natural ability of the groundwater environment to replenish (recharge) the supply of water. Groundwater mining may result form pumping water from an aquifer at a high rate not sustainable by the aquifer, alteration of natural recharge areas, or drought.

The results of groundwater mining are lowered groundwater elevations in aquifers, lowering of water levels in surface or drying of water bodies (in shallow, unconfined aquifers when mined), and subsidence of the ground due to extraction of water from pore space in pumped aquifer (uncommon, but possible in some aquifer types). The lowering of water levels may cause wells to go dry, and the subsidence may cause structural damage to buildings and existing structures.

For significant groundwater mining to occur, there must be considerable amounts of water being pumped from the ground. Applications for a permit to take such amounts of water (Permit to Take Water) must be submitted to the provincial authorities (Ministry of the Environment) review and approve the proposed pumping rate, consider other water users, and the local hydrogeological setting in approving permit applications. However, the onus is on the applicant to provide sufficient information to the MOE in order for them to assess the impacts that may result from issuing a PTTW. In doing so, usually groundwater mining and the associated effects can be avoided.

Provincial Role

There are no direct provincial regulations or legislation that addresses the issue of groundwater mining directly. However, studies such as this, which is an initiative put forth by the provincial government, and municipal governments, are intended to address issues such as groundwater mining through regional assessments of groundwater use.

The Ontario Water Resources Act - O.Reg. 185/99 broadly addresses the use of groundwater, and its conservation. As part of *the Ontario Water Resources Act*, applications for PTTW's are an

important mechanism in approving water taking activities in order to avoid groundwater mining. Details of the PTTW application process are provided above in the section discussing Irrigation Ponds and Pits. The PTTW process could be improved by requiring consideration of future water-taking for areas of long-term growth, and by having cumulative water-taking data available. There should also be a mechanism for water users to "surrender" the permit when it is no longer going to be used.

Municipal Regulatory Options

There are no official municipal regulatory mechanisms in place that deal directly with the issue of groundwater mining. However, a recent decision by Divisional Court concluded that water use or water taking activities are considered "land uses", under *the Planning Act*. *The Planning Act* gives municipalities the authority to use official plans and zoning by-laws to regulate water use. In this regard, if a municipality determines that water taking activities do not follow zoning by-laws or the official plan, they can exercise power both independent of, and alongside the provincial government's mandate to issue water taking permits.

Groundwater mining is only a problem in areas where groundwater is used by high volume water users such as agriculture, commercial operations (i.e., food processing), and industrial users (i.e., manufacturing plants, aggregate pits/washing, etc.). Careful land use and growth management plans are essential in curbing over consumption of groundwater thus preventing groundwater mining. Facilities that use high volumes of water should be located in areas designated to be used industrially or commercially by zoning by-laws and official plans with appropriate long term water supply and treatment capacity.

Non-Regulatory Initiatives

High volume water users should consider their choice of facility location and water supply in order to avoid long term water supply issues such as diminished yield as a result of groundwater mining. Established water users can also help to avoid groundwater mining issues by becoming familiar with their water supply system, their consumption, and learn to monitor water levels. Diligence in monitoring groundwater supplies can identify problems in the early stages and prevent significant damage by altering water use appropriately. Education programs to encourage the conservation and wise use of water should also be implemented to discourage groundwater mining and other forms of overuse. Local examples include the existing water conservation programs by the conservation authorities and the Municipality of Thames Centre.

Water Use During Periods of Drought

Issue Definition

During periods of drought water resources are at a premium. Drought limits the amount of both

surface water and groundwater available for consumption, industry, commercial activities, and irrigation. Drought conditions necessitate the prioritizing of water use to those uses deemed essential. Uses such as cosmetic watering (lawns, flower gardens, golf courses, etc.) are typically the first water use that are suggested to be avoided by local authorities such as conservation authorities or municipal governments.

Provincial Role
There are no provincial controls on water use during periods of drought.

Municipal Regulatory Options
Lawn watering bans are often imposed by municipal bodies when it becomes apparent that the rate of consumption is going to exceed the capacity of the municipal system to supply water to their residents. This is especially pertinent in communities with municipal water from groundwater sources. Drought conditions cause increased water consumption, but do not often significantly affect the amount of groundwater within the source aquifer.

Limiting residents water consumption is not necessarily due to the lack of groundwater in the groundwater environment, but more often due to the stress put on the distribution system in question. The infrastructure used to extract and distribute the groundwater is assigned a maximum capacity by the MOE through the applicable PTTW for the system in question.

Non-Regulatory Initiatives
As stated above in the definition of the issue of Water Use During Periods of Droughts, non-regulatory initiatives can be taken by the general public, farmers, commercial operations, and industry. During periods of drought, the onus should be placed on all water users to limit unnecessary water use to a minimum.

Use of simple water conservation measures such as rain barrels, cisterns for lawn irrigation, trickle irrigation systems, and the use of grey water for cosmetic watering should be encouraged on the municipal scale possibly with incentives. Fact sheets could be distributed with an emphasis on saving the consumer money, while stressing efficient and proper watering practices.

3.0 Protection Measures for Groundwater Resource Features

This section focusses on the additional protection measures that should be considered for the important groundwater resource features described in previous sections of this report including: wellhead protection areas, significant recharge/infiltration areas, and ISI areas where groundwater is more highly susceptible to contamination from surface activities.

3.1 Overview of Groundwater Resource Features

Wellhead Protection Areas:
Six wellhead protection areas (WHPAs) were identified for this study as described in Section 7. These areas represent the surface manifestation of the aquifer portions that contribute water to a well within a 2-year, 5-year and 25-year time frame. These WHPA's have been identified as the source for municipal drinking water supplies; it is therefore worthwhile to consider the need for additional management and protection measures within these zones. Typically, within the 2-year time of travel (TOT) zone surface activities which entail the use of very hazardous materials should be precluded or restricted. Within the larger 10-year and 25-year TOT zones, policies could be less restrictive.

Significant Recharge/Infiltration Areas
The long-term sustainability of ground water resources is based upon a balance between the quantity of water discharged from an aquifer, either through natural systems or wells, and the quantity of water recharged to the aquifer. In order to maintain the productive capacity of an aquifer it is important to preserve and, when possible, enhance the groundwater recharge component of this natural equation. It has long been understood that rapid groundwater infiltration is most likely where coarse grained, unconsolidated material is at or very near the surface. The maintenance of naturally occurring groundwater recharge rates is vital to the long-term viability of the local and regional groundwater resources. It is also vital that these recharge areas be kept free of potential hazards or contaminants in order to preserve groundwater quality.

Areas Defined According to the Aquifer Intrinsic Susceptibility Index (ISI Areas)
As detailed in Section 4 of the report, the general intent of groundwater intrinsic susceptibility mapping is to identify areas where groundwater is relatively more susceptible to impacts from surface contamination. The ISI map is developed by evaluating an Intrinsic Susceptibility Index for each well in the Water Well Record database, and extrapolating between the wells to define susceptible areas. The ISI map has three categories: low vulnerability areas with ISI values greater than 80, moderate vulnerability areas with ISI values between 80 and 30, and high vulnerability areas with ISI values less than 30.

There are several areas of uncertainty associated with the vulnerability mapping process including Water Well Record reliability and varying density of water wells. Due to these concerns, the aquifer vulnerability maps produced for this study are best used as a guidance tool for land use planners, and cannot be used on their own to make site specific decisions. They can be used as a coarse screening tool whereby the groundwater vulnerability is taken into account as one factor in the decision making process.

3.2 Management Strategies for Groundwater Resource Features

Management strategies for important groundwater resource features need to be based upon the vulnerability of the aquifer to surface activity. More intensive protection strategies are necessary for aquifers which are completely open to surface activities. For aquifers which have the luxury of significant cover, perhaps in the form of glacial till or clay layers, the surface activities have much less potential to impact the integrity of the aquifer. Management strategies can therefore focus more on maintenance of the protective layer. Regardless of geologic structure, groundwater resource features should have an active water monitoring program to provide advance warning of the potential for contaminant entry.

One commonly recommended strategy for important features such as WHPA's and high vulnerability ISI areas is the identification of sensitivity zones within which certain types of land uses/activities are either prohibited outright or are subject to restrictions and controls. Typically, land uses are grouped into categories based on the degree of risk that use and its activities would pose to groundwater. Appendix E-1 presents an example of Category A, B and C land uses, in which the Category A uses are considered to have the highest risk activities, while Categories B and C have the second and third highest risk respectively. Land uses that pose little concern for groundwater resources are not included on the lists.

In terms of policy development and regulatory controls such as zoning, municipalities can use the information regarding the groundwater features and the land use risk categories in one of two ways.

Under the ***prescriptive or conventional zoning approach***, the municipality identifies the category or categories of uses that are prohibited or permitted with restrictions within each of the zones. For WHPA's, the land uses are generally more restricted in the 2-year TOT and become less restrictive in the other zones. This approach is generally taken when the aquifer is very near the surface and little geologic protection is afforded.

With a ***performance zoning approach***, there is recognition that blanket restrictions may be inappropriate for a particular area or may be beyond the required scope of protection. Instead of simply restricting certain activities from the TOT zones, these operations may be required to perform site-specific studies to verify the presence of suitable protective geology, or offer materials handling mitigation which assures additional layers of protection for the groundwater resource. The approach is generally taken when the aquifer has an existing geologic protective layer and the municipality seeks to verify that the continuity of the protective layer is assured prior to issuing an approval for handling potentially hazardous substances within the TOT zones.

In protecting groundwater resource features, provisions should also be made for:

- sentry wells in WHPA's to provide an early warning of poor water quality and to enable contingency plans to be implemented well before there is unacceptable impacts on the water supply
- contingency plans for alternative drinking water supplies
- a spill response plan for handling unforeseen accidents within an area, and
- ecosystem enhancement projects, such as the development of new wetlands, to re-establish natural recharge potential in areas where groundwater recharge has significantly deteriorated due to development.

Consideration could also be given to the municipal purchase of land in sensitive groundwater resource areas as a means of maximizing control of the surface land uses, and to the provision of compensation to land owners where land use restrictions are imposed.