5.0 HYDROGEOLOGY OF LAMALINE ADA

5.1 General Description of Area

5.1.1 Location, Extent & Access

The Lamaline ADA is located along the south coast of the Burin Peninsula, comprising an area of approximately 15,504 hectares, and encompassing an approximately 3 km wide stretch of coast extending from the Beach Point area, approximately 6 km south of the community of Fortune, eastward to the community of Lawn. The boundary of the Lamaline ADA is shown on Drawing No. 1034406-5-1 in Appendix 5a.

The Lamaline ADA overlaps the communities of Roundabout, Lord's Cove, Taylor's Bay, Point au Gaul, Lamaline, High Beach, Calmer, Point May, and Lories.

The main access to the Lamaline ADA is provided by Highway Route 220, a paved provincial highway from Marystown to Fortune that connects communities along the south coast of the Burin Peninsula. In addition, various paved and graveled secondary roads also provide access to some areas within the ADA.

5.1.2 Physiography, Topography & Drainage

The Lamaline ADA is located on the Burin Peninsula, which forms the southeastern extent of the physiographic region referred to as the Atlantic Uplands. This physiographic region is underlain by the remnants of an ancient peneplain that slopes in an easterly direction and is characterized by rugged bedrock-controlled ridges and northeast-southwest trending coastal bays and inlets. Locally, the Lamaline ADA occupies a low-lying, coastal area and is characterized by gently undulating to hummocky terrain that slopes southward to the coast and is bisected by small, north-south trending stream and river valleys that drain directly to the Atlantic Ocean. Elevations within the ADA are generally less than 75 m above sea level with isolated hills rising above this level. However, higher elevations are present in coastal areas in the eastern and western portions of the ADA, as well as in upland regions north of the ADA, with maximum elevations of up to 250 m above sea level present in the Eastern Hare Hills area, located approximately 10 km north of the ADA. Sand and rocky reef beaches are numerous along coastal areas within the ADA, and a series of barrier beaches enclose barachois ponds between Point May Pond and Taylor's Bay.

The Lamaline ADA encompasses the lower courses of several small stream and river systems, the most significant of which is Salmonier River. Other watercourses in the area include Snook's Brook, Lories Brook, Piercy Brook, Bob's Brook and Peter's Brook. The headwaters of these stream and river systems originate in the upland regions north of the ADA. In addition, numerous small, elongate ponds are also common in the area.

The Lamaline – Upper Hodges Pond Public Protected Water Supply Area (PPWSA) overlaps the Lamaline ADA and its drainage catchment area. No other PPWSAs are present in the area. However, the ADA borders the Point May – Shorts Pond unprotected water supply along its northern boundary.

5.1.3 Climate, Vegetation & Agricultural Land Use

The Lamaline ADA is located within the Eastern Hyper-Oceanic Barrens ecoregion, which occurs on the extreme south coast of the Burin and Avalon Peninsulas, with two additional areas on the northeast coast near Bay de Verte and Cape Freels. This ecoregion is characterized by an extreme oceanic climate with cold summers associated with frequent fog and strong winds, and relatively mild winters, with intermittent snow cover. No specific climate data is available for the Lamaline ADA. In lieu of this, climate data obtained from Environment Canada's nearby St. Lawrence monitoring station dating back to 1971 is used to characterized climatic conditions in the ADA. The monthly mean temperature in the area is 4.4°C, ranging from a high of 14.7°C in August to a low of -4.3°C in January. Average annual precipitation in the area is 1,564 mm, of which 85% falls as rainfall and 15% as snowfall. September and October are typically the wettest months, and July is typically the driest month (Environment Canada, 2008). In the ADA, there are an average of 1,034 growing degree days (base temperature 5^{o}C) for the year and 924 growing degree days for the vegetative season (i.e., May to September).

Vegetation in the Lamaline ADA generally consists of open heath and moss barrens, with occasional dense patches of stunted tree stands of black spruce and balsam fir. Extensive blanket bogs, with some slope and basin bogs occur in upland areas north of the ADA. Isolated hill tops have mostly exposed bedrock with poor vegetation. Based on agricultural land use information provided by the NL Department of Natural Resources Agrifoods Division, no significant commercial or non-commercial agricultural activities are currently carried out in the ADA, but rather the ADA is designated for future planning purposes.

5.2 Geology

5.2.1 Surficial Geology

The surficial geology of the Lamaline ADA is summarized in Drawing No. 1034406-5-2 in Appendix 5a, and is based on most recent 1:50,000 scale mapping of the area by Batterson and Taylor (2007), as well as a descriptions of surficial geology provided in Van de Hulst (1992), and Batterson and Taylor (2007). For the purposes of this study, surficial geological units on existing maps have been simplified into four (4) groups, including exposed bedrock, areas of bog, areas of till and areas of sand and gravel.

Till deposits are present throughout the ADA occurring as both thin discontinuous veneer (typically less than 1.5 m thick), and more extensive moraine deposits with local thicknesses up to 20 m. The veneer and moraine tills comprise a stony, loamy sand derived from the underlying volcaniclastic rocks. The veneer and moraine tills are locally eroded and dissected, particularly along stream and river channels. In addition, small areas of lineated till are locally present in the eastern portion of the ADA between Taylor's Bay and Roundabout that are associated with crag and tail features. Within the ADA, sand and gravel deposits of glacial outwash and fluvial origin are limited and generally confined to stream and river valleys, with the most significant occurrences of these deposits present along Snook's Brook, Lories Brook, Peter's Brook, Bob's Brook, and Salmonier River. Sand and gravel units shown in Drawing No. 1034406-5-2 in Appendix 5a also include un-subdivided marine terraces that contain various silt and clay deposits in addition to sands and gravels and occur along the stretch of coast from Point May to Lamaline. Along with glacial units, extensive deposits of organic and peaty soils are common throughout the ADA, overlying either till or bedrock. Numerous ridges and knobs of bedrock

outcrop are exposed within the till and various other surficial deposits that underlie the ADA, and typically occur as areas of high ground or coastal cliffs. Bedrock outcrops may be weathered and covered by a thin layer of angular, frost-shattered and frost heaved rock fragments, as well as be partially or fully concealed by thin mat vegetation and sparse forest. However, where exposed bedrock outcrops are commonly streamlined and display glacial striations. Streamlined glacial features in the area indicate southward-directed ice flow. Available well logs indicate an average overburden thickness in the Lamaline ADA and surrounding area of approximately 7 m.

5.2.2 Bedrock & Structural Geology

The bedrock geology of the Lamaline ADA is summarized in Drawing No. 1034406-5-3 in Appendix 5a, and is based on the regional 1:1,000,000 scale compilation mapping by Colman-Sadd, *et al.*, (1990), as well as descriptions of bedrock geology provided in O'Brien, *et al.* (1977), O'Brien, *et al.* (1999), and Batterson and Taylor (2007).

The Lamaline ADA lies within the Avalon tectonostratigraphic zone and is underlain by late Precambrian and Cambrian igneous and sedimentary rocks. The oldest rocks in the area underlie the majority of the ADA and comprise subaerial volcanic and coeval plutonic rocks and minor sedimentary rocks of the Marystown Group. The Marystown Group is conformably overlain by late Precambrian shoaling-upwards marine to terrestrial bimodal volcanic and sedimentary rocks of the Musgravetown Group. Along the eastern and western boundaries of the ADA, the Musgravetown Group sequence is disconformably overlain by younger Cambrian sedimentary rocks of the Adeytown and Harcourt Groups, which comprise red and green carbonate-bearing mudstones overlain by dark grey to black shale, siltstone and sandstone.

The Precambrian and Cambrian sedimentary and volcanic rocks that underlie the ADA have undergone regional-scale folding related to the Devonian Acadian orogenesis, and form the southern extent of a broad, regional northeast – southwest trending anticline, referred to as the Burin Anticline. Numerous high-angle faults are also common, the most significant of which is the Fortune Mountain Fault, located along the western boundary of the ADA, which separates volcanic rocks of the Marystown Group from the younger Cambrian sedimentary sequence. In addition, a series of joint sets and fracture zones occur within rocks underlying the ADA related to deformation.

5.3 Hydrogeology

5.3.1 Hydrostratigraphy

The groundwater potential of the various geological units within the Lamaline ADA was assessed utilizing available records for water wells completed within each unit obtained from the NLDEC-Water Resources Management Division Drilled Water Well Database for wells drilled between 1950 and March, 2008. The data provided in the well records are organized by community and includes information on the well depth and yield, well casing depth and diameter, depths to water bearing zone(s), plus data on the quality and use of the water and the driller's description of the depth and lithology of the overburden and bedrock units encountered.

A total of 28 drilled bedrock wells and 1 drilled surficial well from five communities in the ADA and surrounding area had adequate well data to evaluate the groundwater potential of various surficial and bedrock strata in the ADA. Since lithologic information provided in the well records was of insufficient

detail to define the bedrock encountered in each individual drilled well, the wells were assigned to their respective geologic units based on the community in which the wells were located and the corresponding underlying geologic unit, as shown on the bedrock geology maps provided in Drawing Nos. 1034406-5-3 in Appendix 5a.

The groundwater potential of each geological unit was quantified by assessing the reported well yields and depths from the records of wells completed within each unit. Reported yields for drilled wells in the Lamaline ADA and surrounding area is based on airlift testing carried out by the driller at the time of well installation to obtain a rough estimate of well capacity, and does not necessarily represent the short or long term safe yield of the well, or the groundwater yield characteristics of the corresponding aquifer. To accurately determine such values, aquifer testing, including step drawdown and constant rate pump testing must be conducted, ideally with monitoring of groundwater levels in nearby observation wells. No aquifer testing has been carried out on any of the drilled wells in the ADA and surrounding area. Therefore, in the absence of this data, the groundwater potential of the various geological strata in the Lamaline ADA is defined based on the estimated well yields obtained from the driller's records.

5.3.1.1 Surficial Hydrostratigraphic Units

The surficial deposits within the Lamaline ADA have been subdivided into two broad hydrostratigraphic units, including one comprised of till deposits, and the other predominantly of sands and gravels. The yield and depth characteristics of these units are summarized on Table 5.1. No water well information was available for the till deposits present in the ADA. Therefore groundwater potential within this overburden unit was inferred based on well records for similar overburden material in the St. John's ADA.

Till Deposits

The till deposits form both thin veneer or more extensive moraine deposits over much of the ADA and is comprised of a stony, loamy sand. There is no documented data on the groundwater potential of the till material in the Lamaline ADA. However, based on records of water wells within similar till material in the St. John's ADA, the range of yields from wells within the till can be expected to vary from 10 to 70 L/min at depths of 9.5 to 35 m. The average yield is estimated to be approximately 40 L/min at 21 m depth. However, median yield and depth estimates of 34 L/min at 20 m depth are more likely representative of the typical groundwater potential of this unit.

Sand and Gravel Deposits

Sand and gravel deposits of glacial outwash and fluvial origin are limited in the ADA and generally confined to stream and river valleys, with the most significant occurrences of these deposits present along Snook's Brook, Lories Brook, Peter's Brook, Bob's Brook, and Salmonier River. Marine-derived sand and gravel units also occur locally along coastal areas of the ADA. These deposits are potentially significant groundwater aquifers. Only one (1) well from the community of Lord's Cove was available to characterize the groundwater potential of this unit in the ADA. Based on limited data, wells within the sand and gravel in the ADA can be expected to yield 45 L/min at a depth of 18 m.

Table 5.1 Summary of Overburden Drilled Well Information for Lamaline ADA

Overburden Unit	Communities	No. of Wells	Well Depth (m)		Well Yield (L/min)	
			Mean (Median)	Range	Mean (Median)	Range
Till*	St. John's ADA	6	21.3 (19.6)	9.5 - 35	39.5 (33.5)	10 - 70
Sand & Gravel	Lord's Cove	1	-	18.3		45

* Groundwater yield estimates for the till deposits based on well data from the St. John's ADA

5.3.1.2 Bedrock Hydrostratigraphic Units

Well record information is available for all of the bedrock units located within the ADA, including the combined Precambrian bimodal volcanic and sedimentary rocks of the Marystown and Musgravetown groups and the combined Cambrian sedimentary rocks of the Adeytown & Harcourt groups. The well yield and depth characteristics of these various strata are summarized in Table 5.2.

Marystown & Musgravetown Groups

A total of 10 well records from the communities of Lamaline, Point au Gaul, and Taylors Bay were used to characterize the groundwater potential of the combined Precambrian bimodal volcanic and sedimentary rocks of the Marystown and Musgravetown groups, which underlie the majority of the ADA. Based on well data, the Marystown and Musgravetown groups strata are considered capable of providing wells with low yields, having water yields ranging from 1.4 to 32 L/min at well depths of 44 to 152 m, and an average yield of 11 L/min at 95 m depth. However, median yield and depth estimates of 9 L/min at 85 m depth are more likely representative of the typical groundwater potential of these units.

Adeytown & Harcourt Groups

A total of 18 well records from the community of Fortune were used to characterize the groundwater potential of the combined Cambrian sedimentary rocks of the Adeytown & Harcourt groups, which are present locally in the eastern and western portion of the ADA. Based on well data, the Adeytown & Harcourt groups strata are considered capable of providing wells with low to moderate yields, having water yields ranging from 0.2 to 270 L/min at well depths of 36 to 146 m, and an average yield of 25 L/min at 67 m depth. However, median yield and depth estimates of 5 L/min at 55 m depth are more likely representative of the typical groundwater potential of these units.

Table 5.2 Summary of Bedrock Drilled Well Information for Lamaline ADA

Rock Group	Rock Type	Communities	No. of Wells	Well Depth (m)		Well Yield (L/min)	
				Mean (Median)	Range	Mean (Median)	Range
Marystown & Musgravetown	Bimodal volcanic rocks and siliciclastic sedimentary rocks	Lamaline Point au Gaul Taylors Bay	10	95.4 (85.2)	44.4–152.4	10.6 (9.1)	1.4–31.8
Adeytown & Harcourt	Fine grained, siliciclastic sedimentary rocks, including minor unseparated limestone and volcanic rocks	Fortune	18	66.6 (54.9)	36–146.3	25.4 (5)	0.2-270

5.3.2 Groundwater Flow

The Lamaline ADA and surrounding area is underlain by an unconfined aquifer system contained within the overburden material and underlying shallow bedrock. The movement of groundwater through the overburden material is controlled by primary porosity, while groundwater flow within the underlying

bedrock can be expected to mainly occur within secondary openings, such as fractures and joints, and will be variable depending on the frequency and interconnection of these structural features.

Shallow groundwater flow within the ADA is controlled by water table conditions and local variations in topography. Groundwater is thought to be recharging along areas of high ground and discharging in various wet lowland areas, ponds, lakes and rivers, as well as along the coast. It is expected that the shallow groundwater system in the ADA will be largely controlled by surface runoff and local recharge, while at moderate depths the flow system may be influenced by lateral inflow of groundwater from up-gradient areas to the north. Based on a review of water well records for the area, groundwater levels are generally assumed to be within 5 m of the ground surface and to be a subdued reflection of the topography.

5.4 Water Quality

5.4.1 Surface Water Quality

Surface water quality data for the Lamaline ADA was limited to water quality monitoring data collected by the NL Department of Environment - Water Resources Management Division from the Lamaline - Upper Hodges Pond (WS-S-0395) protected public surface water supply over a monitoring period from 1996 - 2007. A summary of chemical data obtained from this surface water source over the monitoring period is provided in Table 5.3 in Appendix 5b, and is compared to the Canadian Drinking Water Quality Guidelines (CDWQG) (Health Canada, 2007), as well as the Canadian Council of Ministers of the Environment (CCME) Canadian Water Quality Guidelines for the Protection of Agricultural Water Uses (CWQG-AWU) (October, 2005).

Based on major ion chemistry, surface water in the ADA and surrounding area can be classified as a sodium-calcium-chloride-sulfate-bicarbonate ($Na\text{-}Ca\text{-}Cl\text{-}SO_4\text{-}HCO_3$) type water. Surface water in the area is soft, neutral to slightly acidic, and of low alkalinity. Classification of surface water according to dissolved-solids and specific conductance indicates fresh conditions.

With the exception of iron, manganese, pH, turbidity and color, concentrations of all other parameters tested meet CDWQG. The guidelines for iron, manganese, pH, turbidity and color are aesthetic objectives only and levels of these parameters detected at the surface water locations evaluated do not pose any health concerns, however problems may be experienced such as foul taste, deposition or staining in the case of iron, manganese, turbidity and color, and corrosion in the case of pH.

Further, the Lamaline - Upper Hodges Pond protected public surface water supply had concentrations of manganese over the monitoring period that exceeded CCME CWQG-AWU for irrigation water use.

Based on chemical data, surface water quality within the ADA is considered good, returning an average Canadian Water Quality Index (CWQI) value of 83. However, a negative Langelier Index in the Lamaline - Upper Hodges Pond protected public surface water supply indicates that water is unsaturated with calcium carbonate and will tend to be corrosive, leading to potential leaks in the distribution system. Treatment would be required to improve the aesthetic quality of the water. In addition, concentrations of manganese in the Lamaline - Upper Hodges Pond protected public water supply that exceeded CCME CWQG-AWU may limit usage of this surface water source as a potential agricultural water supply without appropriate treatment.

5.4.2 Groundwater Quality

The groundwater quality data for the Lamaline ADA consists of analyses from two (2) private drilled wells in the community of Fortune collected by the NL Department of Environment - Water Resources Management Division. A summary of chemical data obtained from these water wells is provided in Table 5.4 in Appendix 5b, and is compared to the Canadian Drinking Water Quality Guidelines (CDWQG) (Health Canada, 2007), as well as the Canadian Council of Ministers of the Environment (CCME) Canadian Water Quality Guidelines for the Protection of Agricultural Water Uses (CWQG-AWU) (October, 2005).

Based on major ion chemistry, shallow groundwater in the ADA can be classified as a calcium-sodium-bicarbonate-chloride-sulfate (Ca-Na-HCO_3-Cl-SO_4) type waters. Groundwater in the area ranges from moderately to very hard, neutral to slightly basic, and of moderate alkalinity. Classification of groundwater according to dissolved-solids and specific conductance indicates fresh conditions.

With the exception of iron, manganese, turbidity and zinc concentrations in several of the wells, concentrations of all other parameters tested meet CDWQG. The guidelines for iron, manganese, and turbidity are aesthetic objectives only and levels of these parameters detected in the wells do not pose any health concerns, however problems may be experienced such as foul taste, deposition or staining in the case of iron, manganese, turbidity and corrosion in the case of pH.

Further, one of the private water wells in Fortune had a concentration of zinc that exceeded CCME CWQG-AWU for irrigation water use.

Insufficient monitoring data was available to determine Canadian Water Quality Index (CWQI) values for groundwater in the ADA. However, available chemical data indicates that shallow groundwater in the ADA and surrounding area is generally of good quality. Treatment would be required to improve the aesthetic quality of the groundwater, as well as reduce zinc in areas where elevated levels of this parameter that exceed CDWQG are identified. Further, the elevated concentration of zinc that exceeded CCME CWQG-AWU in the water well at Fortune may limit usage of this groundwater source as a potential agricultural water supply without appropriate treatment.

5.5 Groundwater Recharge & Availability

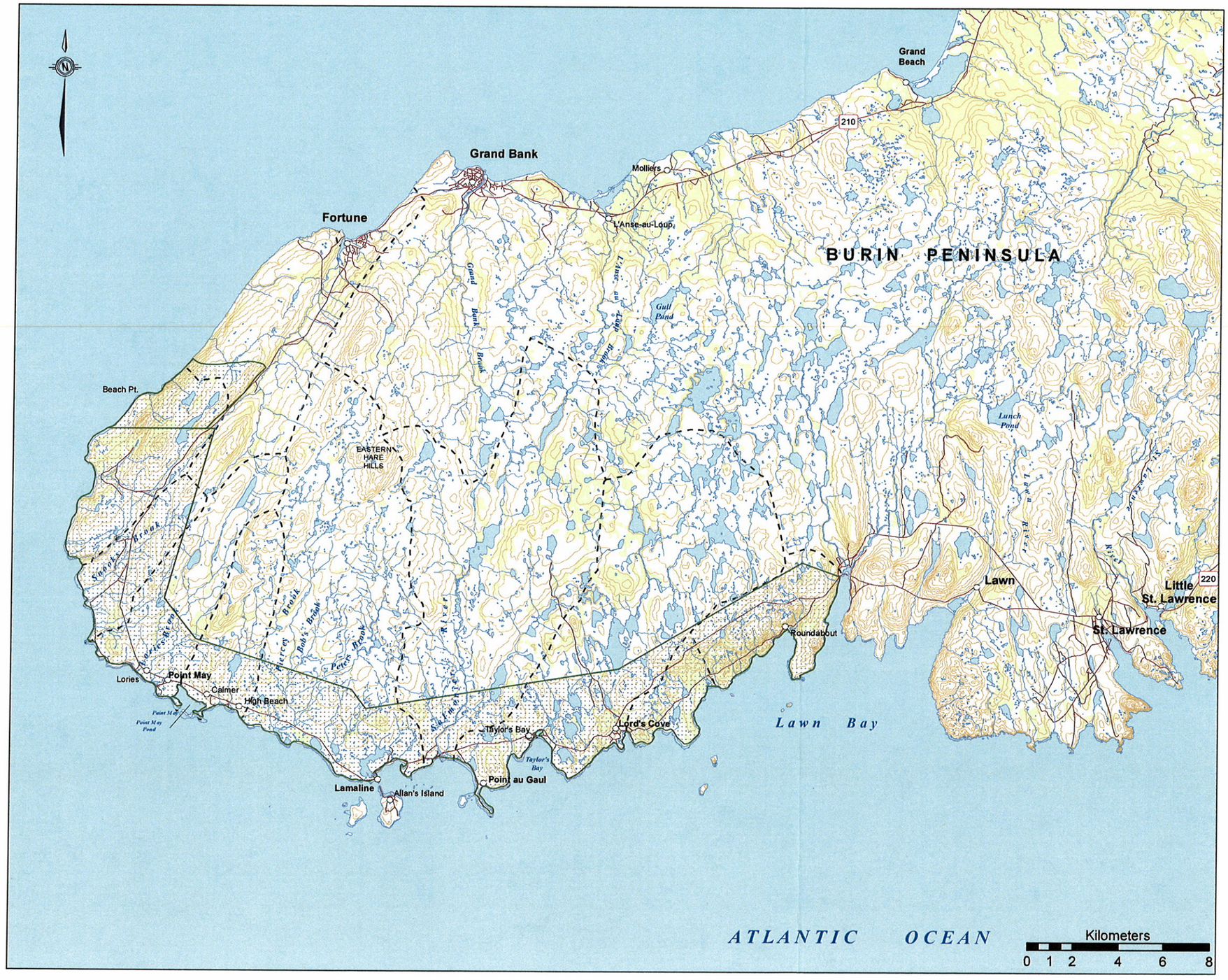
Recharge to the shallow groundwater system underlying the ADA is by direct infiltration of rainfall, after runoff and the requirements of evaporation and plant transpiration have been met, and is directly related to rainfall, infiltration characteristics and size of the recharge zone. A common practice in estimating the long term groundwater recharge for an area is to multiply the groundwater catchment area by the percent of precipitation estimated as able to infiltrate. The recharge to groundwater in the Lamaline ADA is estimated on the basis of a local groundwater catchment area equivalent to the area of the ADA of approximately 15,504 hectares, and a conservative recharge coefficient of 10% of the mean annual rainfall (i.e., 10% of 1,564 mm, equivalent to 156 mm). Based on these values, the groundwater recharge to the Lamaline ADA is estimated at $2.4 \times 10^7 m^3$/year or 1,560 m^3/hectares/yr.

Groundwater use within the Lamaline ADA is currently limited to minor individual domestic, industrial and public supply wells. No information is available regarding existing agricultural (i.e., irrigation and livestock) water demands in the Lamaline ADA, thus preventing an accurate balance of groundwater supply and demand to be estimated, and making it difficult to evaluate groundwater supply potential for future agricultural development in the area. However, considering the current, overall under-utilization

of groundwater in the area from other users, it is expected that an adequate supply of groundwater of sufficient quality is available to meet and/or augment water supply requirements for various existing and future agricultural needs in the ADA.

APPENDIX 5a

Drawings



- Drainage Catchment Area
- Agricultural Development Area
- Transportation Route
- Contour Line
- Waterbody
- Wetland/String Bog
- Vegetated Area

PROJECT TITLE:

HYDROGEOLOGY OF AGRICULTURAL DEVELOPMENT AREAS, NEWFOUNDLAND AND LABRADOR

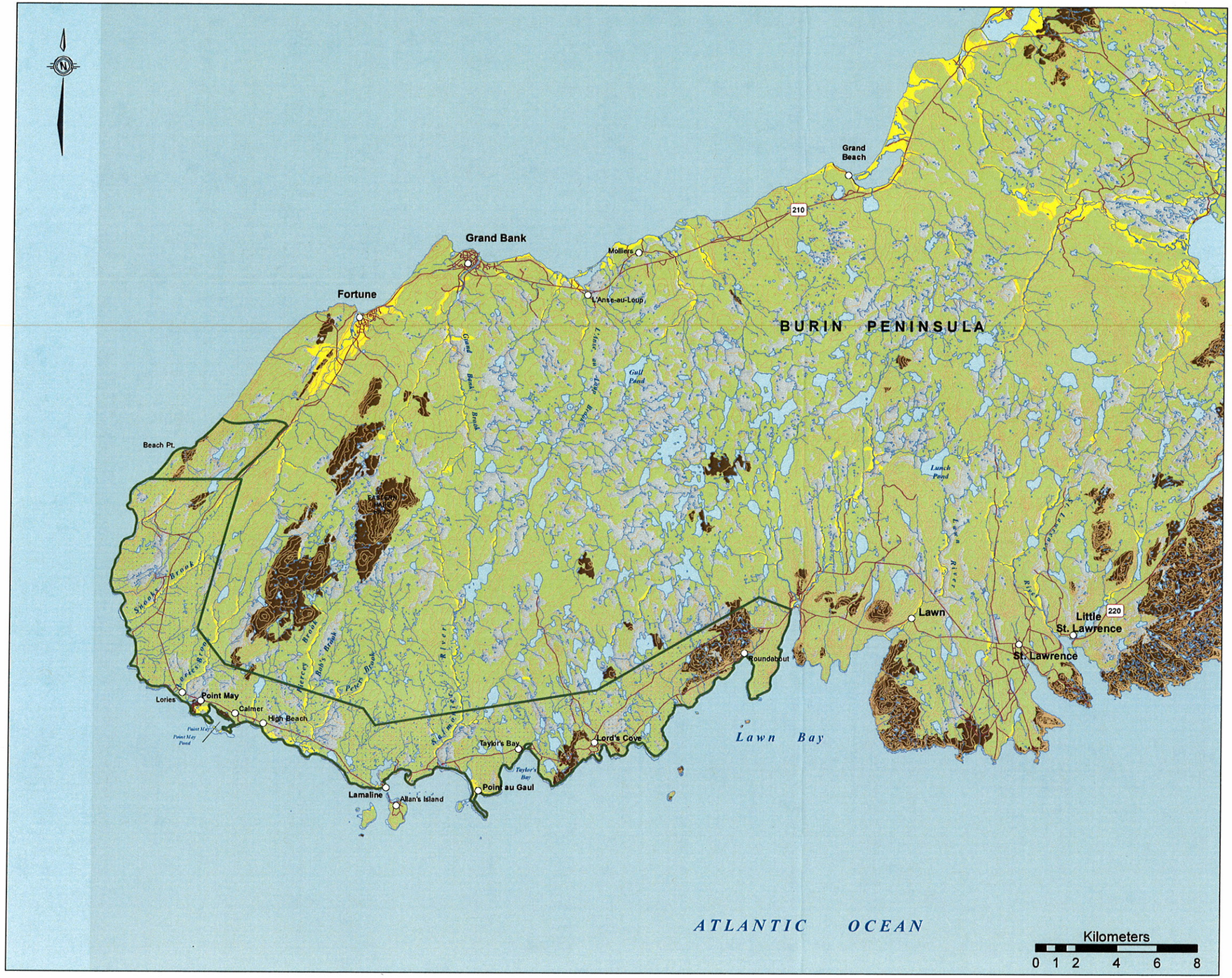
DRAWING TITLE:

LAMALINE ADA LOCATION AND DRAINAGE

Jacques Whitford

Jacques Whitford

SCALE: 1:175,000	DATE: 11/03/2008
DRAWN BY: JLB	CHECKED BY:
EDITED BY: JLB	REV. No. 0
DRAWING No.: 1034406-5-1	
MAP FILE: 1034406-46.MXD	



Surficial Geology Legend

- Bog: Poorly drained accumulations of peat, peat moss and other organic matter; developed in areas of poor drainage
- Sand & Gravel: Sands, gravels and silts of glaciofluvial, fluvial, lacustrine or marine terrace origin
- Glacial Till: Till veneer and moraine deposits of varying thickness overlying bedrock. Composed of diamicton (poorly sorted sediment containing a mixture of grain sizes from clay to boulders)
- Rock: Exposed Bedrock, includes areas concealed by vegetation, till veneer, as well as colluvium

- Stream
- Transportation Route
- Contour Line
- Waterbody
- Agricultural Development Area

PROJECT TITLE:

HYDROGEOLOGY OF AGRICULTURAL DEVELOPMENT AREAS, NEWFOUNDLAND AND LABRADOR

DRAWING TITLE:

LAMALINE ADA SURFICIAL GEOLOGY

Jacques Whitford

SCALE: 1:150,000	DATE: 11/03/2008
DRAWN BY: JLB	CHECKED BY:
EDITED BY: JLB	REV. No: 0
DRAWING No.: 1034406-5-2	
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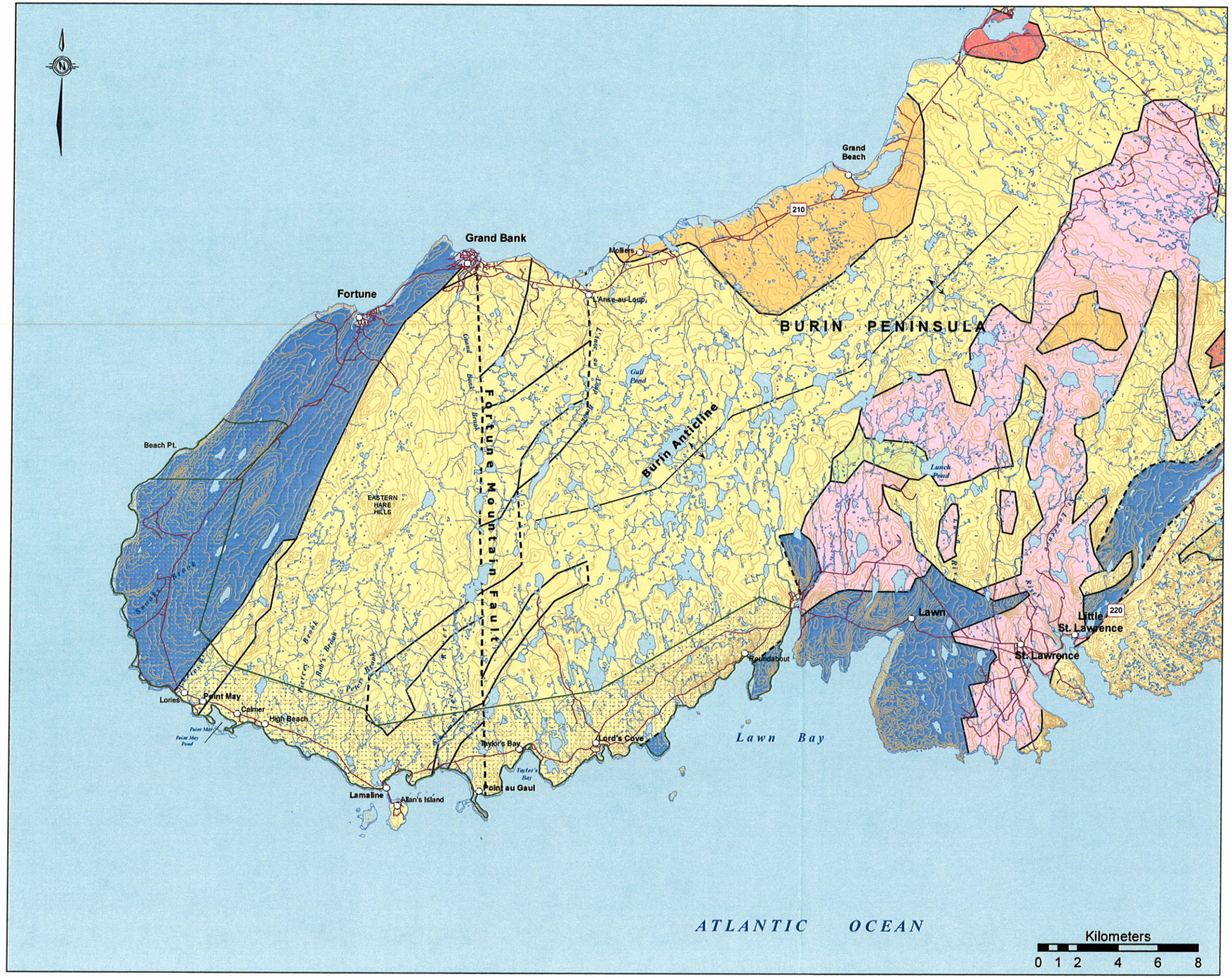
DD/MM/YEAR



Generalized Bedrock Geology Legend

POST-ORDOVICIAN OVERLAP SEQUENCES

Devonian and Carboniferous

Fluviatile and lacustrine, siliciclastic and carbonate rocks; subaerial, bimodal volcanic rocks; may include some Late Silurian rocks

POST-ORDOVICIAN INTRUSIVE SEQUENCES

Devonian and Carboniferous

Granite and high silica granite (sensu stricto), and other granitoid intrusions that are posttectonic relative to mid-Paleozoic orogenies

AVALON ZONE

Stratified Rocks

Precambrian to Early Ordovician

Shallow marine, mainly fine grained, siliciclastic sedimentary rocks, including minor unseparated limestone and volcanic rocks (Adeyton and Harcourt groups)

Precambrian

Bimodal, submarine to subaerial volcanic rocks, including minor siliciclastic sedimentary rocks and unseparated limestone (Marystown and Musgravetown groups).

Intrusive Rocks

Neoproterozoic to Cambrian

Mafic intrusions

- Syncline
- Anticline
- Contact
- Fault, Strike-Slip and High Angle
- Fault, Thrust
- Transportation Route
- Contour Line
- Stream
- Waterbody
- Agricultural Development Area

PROJECT TITLE:

HYDROGEOLOGY OF AGRICULTURAL DEVELOPMENT AREAS, NEWFOUNDLAND AND LABRADOR

DRAWING TITLE:

LAMALINE ADA BEDROCK GEOLOGY

Jacques Whitford

SCALE: 1:150,000	DATE: 11/03/2008
DRAWN BY: JLB	CHECKED BY:
EDITED BY: MCH	REV. No. 0
DRAWING No.: 1034406-5-3	
MAP FILE: 1034406-46.MXD	

DD/MM/YEAR

APPENDIX 5b

Water Chemistry Data

Table 5.3 Surface Water Chemistry, Public Water Supply, Lamaline ADA
Hydrogeology of Agricultural Development Areas, Newfoundland & Labrador

Parameter	Units	CDWQG	CWQG-AWU		Lamaline Upper Hodges Pond (WS-S-0395) 1996-2007[1]		
			Irrigation Water	Livestock Water	Min	Max	Mean
Alkalinity	mg/L $CaC0_3$	na	na	na	0.25	15	5.76
Aluminum	mg/L	na	5	5	0.025	1.06	0.15
Ammonia	mg/L	na	na	na	0	0.05	0.03
Antimony	mg/L	0.006	na	na	0	0.0005	0.0002
Arsenic	mg/L	0.01	0.1	0.025	0	0.001	0.0003
Barium	mg/L	1	na	na	0	0.001	0.003
Beryllium	mg/L	na	0.1	0.1	-	-	-
Bicarbonate	mg/L $CaC0_3$	na	na	na	-	-	-
Boron	mg/L	5	0.5 - 6	5	0	0.03	0.012
Bromide	mg/L	na	na	na	0	0.03	0.015
Cadmium	mg/L	0.005	0.005	0.08	0	0.0005	0.0002
Calcium	mg/L	na	na	na	0	4	2
Carbonate	mg/L $CaC0_3$	na	na	na	-	-	-
Chloride	mg/L	250*	100 - 700	na	5	14	8
Chromium	mg/L	0.05	na	na	0	0.0005	0.0002
Copper	mg/L	1*	0.2 - 1	0.5-5	0	0.019	0.005
Dissolved Organic Carbon	mg/L	na	na	na	4.1	13.4	7.9
Fluoride	mg/L	1.5	1	1 - 2	0	0.12	0.03
Hardness	mg/L $CaC0_3$	na	na	na	0	14	8
Iron	mg/L	0.3*	5	na	0.11	1.26	0.37
Kjeldahl Nitrogen	mg/L	na	na	na	0.03	0.64	0.29
Langelier Index	-	na	na	na	-6.26	-3.2	-4.45
Lead	mg/L	0.01	0.2	0.1	0	0	0
Magnesium	mg/L	na	na	na	0	1	0.63
Manganese	mg/L	0.05*	0.2	na	0.005	**0.78**	0.083
Mercury	mg/L	0.001	na	0.003	0	0.00005	0.00002
Nickel	mg/L	na	0.2	1	0	0.005	0.001
Nitrate	mg/L N	45	na	na	-	-	-
Nitrate + Nitrite	mg/L N	na	na	100	0	0.05	0.012
Nitrite	mg/L	na	na	10	-	-	-
Orthophosphate	mg/L P	na	na	na	-	-	-
pH	Units	6.5-8.5*	na	na	4.7	7.1	6.4
Potassium	mg/L	na	na	na	0	0.83	0.25
Reactive Silica	mg/L SiO2	na	na	na	-	-	-
Selenium	mg/L	0.01	0.02 - 0.05	0.05	0	0.001	0.0003
Silver	mg/L	na	na	na	-	-	-
Sodium	mg/L	200*	na	na	4	7	5
Specific Conductance	uS/cm	na	na	na	33.1	70.6	45.8
Sulphate	mg/L	500*	na	1,000	0	5	3
Sulphide	mg/L H2S	0.05*	na	na	-	-	-
Thallium	mg/L	na	na	na	-	-	-
Tin	mg/L	na	na	na	-	-	-
Total Dissolved Solids	mg/L	500*	500 - 3,500	3,000	20	49	33
Total Organic Carbon	mg/L	na	na	na	-	-	-
Total Phosphorus	mg/L	na	na	na	0	0.02	0.01
Total Suspended Solids	mg/L	na	na	na	1	2	1.25
True Color	TCU	15*	na	na	33	120	76
Turbidity	NTU	0.3/1.0/0.1**	na	na	0.36	12.8	1.88
Uranium	mg/L	0.02	0.01	0.2	0	0	0
Vanadium	mg/L	na	0.1	0.1	-	-	-
Canadian Water	-	-	-	-	81	87	83
Zinc	mg/L	5*	1 - 5	50	0	0.005	0.003

Notes:

CDWQG = Health Canada Canadian Drinking Water Quality Guidelines (March, 2007)

CWQG-AWU = CCME Canadian Water Quaility Guidelines for the Protection of Agricultural Water Uses (Irrigation and Livestock Water) (October, 2005)

1 = Summary statisitics calculated using chemicial data obtained from the NL Department of Environment - Water Resources Management Division Drinking Water Quality Database. Note in the data base, prior to March 31, 2004 analytical results less than the detection limit were reported as half of the detection limit, while after March 31, 2004 analytical results less than the detection limit were reported as zero.

na = No applicable criteria

* = Aesthetic objective

** = Operational guideline value based on conventional treatment/slow sand or diatomaceous earth filtration/membrane filtration.

"-" = Not analyzed

Shaded = Value does not meet applicable criteria

Bolded = Value does not meet CWQG-AWU for irrigation and/or livestock water

Table 5.4 Groundwater Chemistry, Private Drilled Wells, Lamaline ADA
Hydrogeology of Agricultural Development Areas, Newfoundland & Labrador

Parameter	Units	CDWQG	CWQG-AWU		Community[1]	
					Fortune	
			Irrigation Water	Livestock Water	13900	15744
Alkalinity	mg/L $CaC0_3$	na	na	na	275	108
Aluminum	mg/L	na	5	5	-	0.03
Ammonia	mg/L	na	na	na	-	0.029
Antimony	mg/L	0.006	na	na	-	0.0002
Arsenic	mg/L	0.01	0.1	0.025	-	0.001
Barium	mg/L	1	na	na	-	0.15
Beryllium	mg/L	na	0.1	0.1	-	-
Bicarbonate	mg/L $CaC0_3$	na	na	na	-	-
Boron	mg/L	5	0.5 - 6	5	-	0.04
Bromide	mg/L	na	na	na	-	-
Cadmium	mg/L	0.005	0.005	0.08	-	0.00002
Calcium	mg/L	na	na	na	58	13.8
Carbonate	mg/L $CaC0_3$	na	na	na	-	-
Chloride	mg/L	250*	100 - 700	na	55	15.1
Chromium	mg/L	0.05	na	na	-	-
Copper	mg/L	1*	0.2 - 1	0.5-5	-	-
Dissolved Organic Carbon	mg/L	na	na	na	-	0.1
Fluoride	mg/L	1.5	1	1 - 2	0.21	0.08
Hardness	mg/L $CaC0_3$	na	na	na	190	66.6
Iron	mg/L	0.3*	5	na	0.26	0.43
Kjeldahl Nitrogen	mg/L	na	na	na	-	-
Langelier Index	-	na	na	na	-	-
Lead	mg/L	0.01	0.2	0.1	-	0.002
Magnesium	mg/L	na	na	na	11	7.8
Manganese	mg/L	0.05*	0.2	na	**0.51**	0.14
Mercury	mg/L	0.001	na	0.003	-	-
Nickel	mg/L	na	0.2	1	-	0.01
Nitrate	mg/L N	45	na	na	-	-
Nitrate + Nitrite	mg/L N	na	na	100	0.004	-
Nitrite	mg/L	na	na	10	0.001	-
Orthophosphate	mg/L P	na	na	na	-	-
pH	Units	6.5-8.5*	na	na	7.12	8.33
Potassium	mg/L	na	na	na	2.29	1.45
Reactive Silica	mg/L SiO2	na	na	na	-	-
Selenium	mg/L	0.01	0.02 - 0.05	0.05	-	-
Silver	mg/L	na	na	na	-	-
Sodium	mg/L	200*	na	na	79	30.2
Specific Conductance	uS/cm	na	na	na	773	258
Sulphate	mg/L	500*	na	1,000	40	8.4
Sulphide	mg/L H2S	0.05*	na	na	-	-
Thallium	mg/L	na	na	na	-	0.0004
Tin	mg/L	na	na	na	-	-
Total Dissolved Solids	mg/L	500*	500 - 3,500	3,000	397	150
Total Organic Carbon	mg/L	na	na	na	-	-
Total Phosphorus	mg/L	na	na	na	0.01	-
Total Suspended Solids	mg/L	na	na	na	-	1
True Color	TCU	15*	na	na	-	-
Turbidity	NTU	0.3/1.0/0.1**	na	na	-	1.6
Uranium	mg/L	0.02	0.01	0.2	-	-
Vanadium	mg/L	na	0.1	0.1	-	-
Zinc	mg/L	5*	1 - 5	50	**5.7**	-

Notes:

CDWQG = Health Canada Canadian Drinking Water Quality Guidelines (March, 2007)

CWQG-AWU = CCME Canadian Water Quaility Guidelines for the Protection of Agricultural Water Uses (Irrigation and Livestock Water) (October, 2005)

1 = Chemicial data obtained from the NL Department of Environment - Water Resources Management Division Drinking Water Quality Database

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