Environmental Noxiousness, Racial Inequities & Community Health Project (ENRICH Project)

Lincolnville Water Monitoring Report

ENRICH Water Monitoring Committee Members

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Report Summary

There were two main goals of the water monitoring project in Lincolnville. The first goal was to better understand the drinking water situation in Lincolnville and the associated concerns of the community. There were three objects associated with this first goal; 1) to determine if there is contaminated water flowing in the direction of the community from the landfill site; 2) to build the community's capacity to test their own water; and 3) to provide community members with basic knowledge about contaminants and groundwater sampling. The second goal was to try and develop a framework or model for other communities to follow. This report reflects these two goals. The first part details the pilot study conducted by the Environmental Noxiousness, Racial Inequities & Community Health (ENRICH) Project's Water Monitoring Committee and the second part outlines the steps a community needs to take to embark on a community based water monitoring program.

Four small research/review projects were undertaken to summarize how community concerns arose over time. They include a brief history of Lincolnville with major events in the community; a short background on the evolution of the Lincolnville landfill with notes on provincial legislation; a review of the hydrogeology; and the analytical results of the water sampling project carried out by members of the ENRICH Water Monitoring Committee. The final section summarizes the community capacity building and technical work carried out in Lincolnville by the Water Monitoring Committee and outlines a checklist for well water testing in other communities.

Members of the Water Monitoring Committee met with community members of the Lincolnville Reserve Land Voice Council on two occasions to help the community better understand water quality and the factors that influence water quality. The first meeting had several objectives. These included clarifying some of the background information, explaining the findings of the hydrogeology assessment, and explaining the water sampling project. Committee members also showed community members how to sample wells. Surface site conditions were documented and potential issues associated with wells were explained to residents.

The second meeting was held to explain the results of the water analysis and help the community better understand the overall water quality. Plain language, maps, charts and simplified tables were used to illustrate important points. Members of the community at the meeting provided valuable insights regarding their experiences such as water taste, issues with "slimy feeling water" and smell. These were discussed in terms of water chemistry and health impacts according to Canadian Drinking Water Guidelines.

This project evolved over time through numerous discussions on water quality and the community's intense desire to simply determine if their water was safe to drink. The Water Monitoring Committee could not have carried out sampling nor achieved the

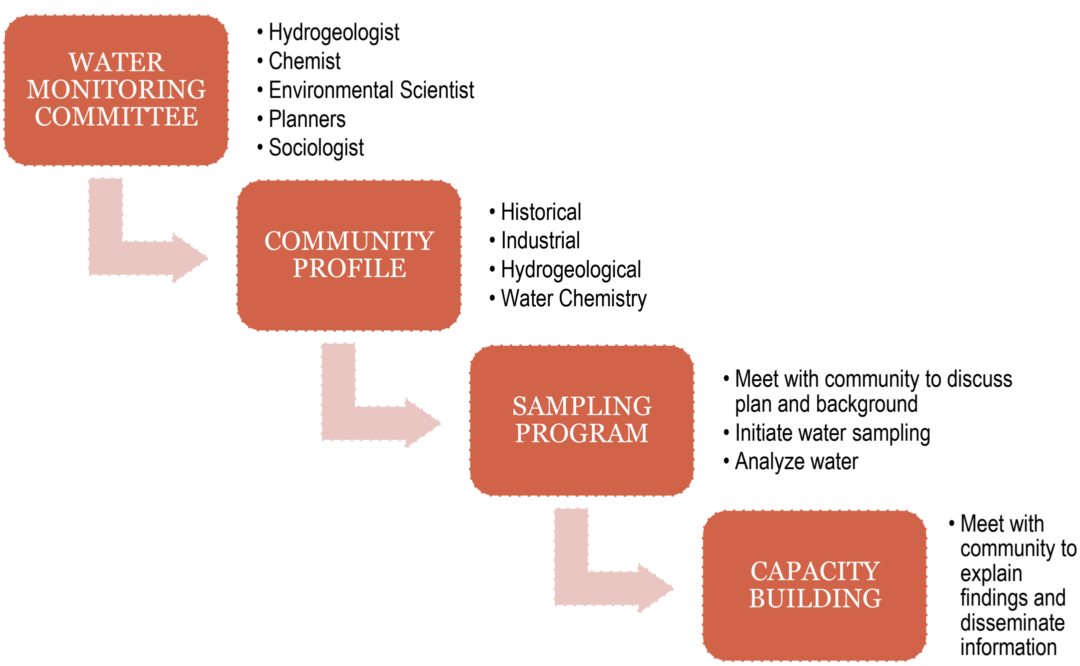
understanding of the struggles Lincolnville has faced without the residents allowing access to their homes and sharing their experiences with us.

Process Summary

The Lincolnville Water Monitoring Committee was fortunate to have a diverse group of professionals and interested community members. Together, we undertook various parts of the community profiling and water sampling program. Community members organized meetings and arranged sampling sites.

The first phase of the project was to compile a community profile to highlight and understand Lincolnville in a historical, industrial, and hydrogeological context. This process included conducting personal interviews with community members, gathering information from published works, articles, and government documents, as well as geological maps and resources.

It was clear during discussions with residents that the community had a certain level of fear associated with drinking ground water from their wells. To determine the basic quality of water, the Water Monitoring Committee developed a simple approach to sample ground water from different wells throughout the community. Water samples were collected and analyzed for bacteria and major ions. Results were interpreted by the Water Monitoring Committee and then explained to the community committee in plain language. Finally, the next steps for community ground water monitoring (sampling) were outlined.



Lincolnville History

Settlement

Lincolnville was founded by the black loyalists in 1784 after the British Government failed to follow through with the promised 3000 acres of land in a different location (Lindsay, 2006; Mason, 2007). The families were driven inland, away from the white population where they were forced to become squatters upon the rocky land that is now Lincolnville (Lindsay, 2006; Mason, 2007).

Lifestyle through the Years

In the early 1900s, the people of Lincolnville maintained their own self-sustaining farms with livestock and crops (Lincolnville History, 2014). In the 1930/1940s the men primarily worked in the forest cutting pulp, as stevedores or on freight ships in Mulgrave and the women primarily worked in homes in Boylston (Lincolnville History, 2014). For such work the people received about 50 cents per day (Lincolnville History, 2014). Up until the 1950s, the locals travelled by foot or by horse and wagon (Lincolnville History, 2014). During the first half of the 20th century, the population was around 200 and currently it is around 50 (Lincolnville History, 2014).

Today, the community is in a state of slow decline due to little economic opportunity, decreasing property values, lack of community infrastructure, poor health and little support from the Guysborough municipality (Lindsay, 2006). The younger community members leave after high school due to lack of jobs and consequently the community consists of mainly elderly people (Lindsay, 2006). The health of the locals is substandard, specifically, the community has exceptionally high cancer rates (Benjamin, 2008). The locals fear they will be driven from the land and lose their community, which is important in maintaining their culture and heritage (Benjamin, 2008).

Major Events in Community

1931 - First school constructed (Guysborough Road Consolidated School), for primary to grade 6, one room (Lincolnville History, 2014).

1942 - First post office opened, located in a local's home (Lincolnville History, 2014).

1960s - Community centre opened, held entertainment and recreation events (Lincolnville History, 2014).

1964 - Mary E Cornish school built for members of Lincolnville and surrounding communities, 5 classrooms, still segregated (Lincolnville History, 2014).

1970s - First dump created, no lining, no community consultation (Benjamin, 2008).

1983 - Students began to attend Guysborough school (no longer segregated), not officially recorded but apparently last school in Canada to officially end segregation (Lincolnville History, 2014).

2006 – Second dump created (Benjamin, 2008).

References

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Lindsay, H. B. (2006). Race and Waste in Nova Scotia. *The Dominion*, *6*.

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Landfill History

Lincolnville Landfill: Background Review

The Guysborough County Waste Management Facility is located at 151 Waste Management Road off Route 16 Meagher's Hill, between the Communities of Boylston and Lincolnville.

In 1974, a first-generation landfill was opened one kilometer away from the community. According to community members, dangerous items and substances were thrown into the landfill at that time, including dead horses and other animals, transformers that leaked PCBs into the ground, and over 15,000 bags of industrial waste associated with beach cleanups. Since there was no daily cover, the landfill emitted the stench of open pit burning. There was little concern at the time about wildlife since the landfill was small and catered to the Guysborough region. That would change when the first-generation landfill was replaced by the second-generation landfill. As Guysborough County struggled to maintain its tax base, the County Council expressed their interest in becoming a site for a second-generation landfill in the community in order to generate needed tax revenues.

In 1995, the province of Nova Scotia adopted a Solid Waste Resource Management Strategy which required all municipalities to have, or have access to, second generation (double liner) landfills by 2006. The Municipality of the District of Guysborough closed the first landfill and opened a second-generation landfill in 2006 that accepted waste from across northern Nova Scotia and Cape Breton. The development of this landfill was based on the provincial government's need to decrease spending. Although Guysborough County determined the suitability of the landfill site and conducted extensive surface and ground water testing, they did not consider the negative social, justice, or cumulative impacts of their decision to site the landfill in the area. Guysborough Council proceeded with approvals and the construction of the landfill because the public did not substantively oppose the project throughout the official Environmental Impact and Assessment (EIA) process.

The Municipality has stated, "*The Municipality of the District of Guysborough has 20-year agreements with 17 municipal units on Cape Breton Island and in the Eastern Mainland of the Province. As a result, the Municipality provides waste management services to 230,000 Nova Scotians. That agreement is in effect until 2026. This leadership initiative reduced the number of landfills in the region from seven to one. The award-winning facility is monitored and maintained to strict environmental standards*" (Municipality of Guysborough County, 2016).

A Community Liaison Committee was established for the second generation landfill. The Community Waste Management Liaison Committee includes community members: Catherine Hartling, Robert Lajoi, Alonzo Reddick and Joan Welsh; council members: Councillor Sheila Pelly (Chair), Councillor Myles MacPherson and Councillor Vernon Pitts; and staff representatives Gary Cleary and Bruce Avery (Recording Secretary)

(Municipality of Guysborough County, 2016). The resident committee members were appointed by Council.

The Waste Management Liaison Committee has a Terms of Reference document the details the committee's purpose, mandate, composition and other guidelines. The purpose of the committee is to provide a line of communication between the Municipality and Waste Management Facility "with specific emphasis on environmental protection concerns" (Municipality of Guysborough County, n.d., 1). There are five actions included in the terms of reference mandate.

(1) "To provide a forum where the Municipal Council may gain a better understanding of the concerns of residents respecting the operation of the Waste Management Facility;

(2) To act in an advisory capacity to Municipal Council on matters pertaining to the monitoring of the operations of the Waste Management Facility with specific emphasis on environmental protection issues;

(3) To provide a forum for residents to express their views and concerns on the environmental protection issues related to the use and operation of the Waste Management Facility;

(4) To provide an opportunity for the Committee or its Members to become aware of the ongoing studies and testing of the site to ensure that the areas of concern being dealt with by the Committee and Council are addressed;

(5) To provide an additional opportunity for communication between citizens and the Waste Management Facility representatives" (Municipality of Guysborough County, n.d., 1).

The Guysborough Waste Management Facility staff also provided tours to the public and schools upon request.

The Municipality of Guysborough landfill is less than five kilometres from the community of Lincolnville, a predominantly African Nova Scotian community. The community thought they only had to bear the burden of being near a landfill for 20 years, but upon development of the second generation landfill this time extended to 45 years (Save Lincolnville Campaign, 2007; Deacon, 2013).

The community feels they were not properly consulted before the first and second generation landfills were developed (Save Lincolnville Campaign, 2007; Deacon & Baxter, 2013). The barriers the community experienced during the siting of the second generation landfill include: avoidance and intimidation tactics by local government and consultants (Deacon, 2013, p. 615), inappropriate jargon and public consultation settings (p. 616) and no funding for community to hire interveners (p. 618).

Now many residents are concerned that leachate from the landfills is affecting their health, and their day to day lives are negatively affected by smell, bird waste, and other issues (Save Lincolnville Campaign, 2007).

Notes

Information from Nova Scotia Environment (NSE) and provincial policies:

- There are no Environmental Assessment approvals for landfills in Nova Scotia
- There is a required landfill 'application for approval' process (Nova Scotia Environment, 2014).
- "No person shall own, construct, manage, operate, alter or modify a landfill without obtaining approval from the Minister"(Province of Nova Scotia, 1994-5, 31.1). The following section lists the information that needs to be submitted to the minister (site plan, monitoring programs, leachate collection description, etc.).
- NSE cannot share the permit because it came from the proponent (County)
- NSE will only share other reports about the landfill if we make an 'Environmental Registry Request': http://www.novascotia.ca/nse/dept/envregistry.asp
- Solid Waste Resource management plans require the inclusion of public awareness programs, descriptions on roles and responsibilities, etc. (Province of Nova Scotia, 1994-5, 41.b).

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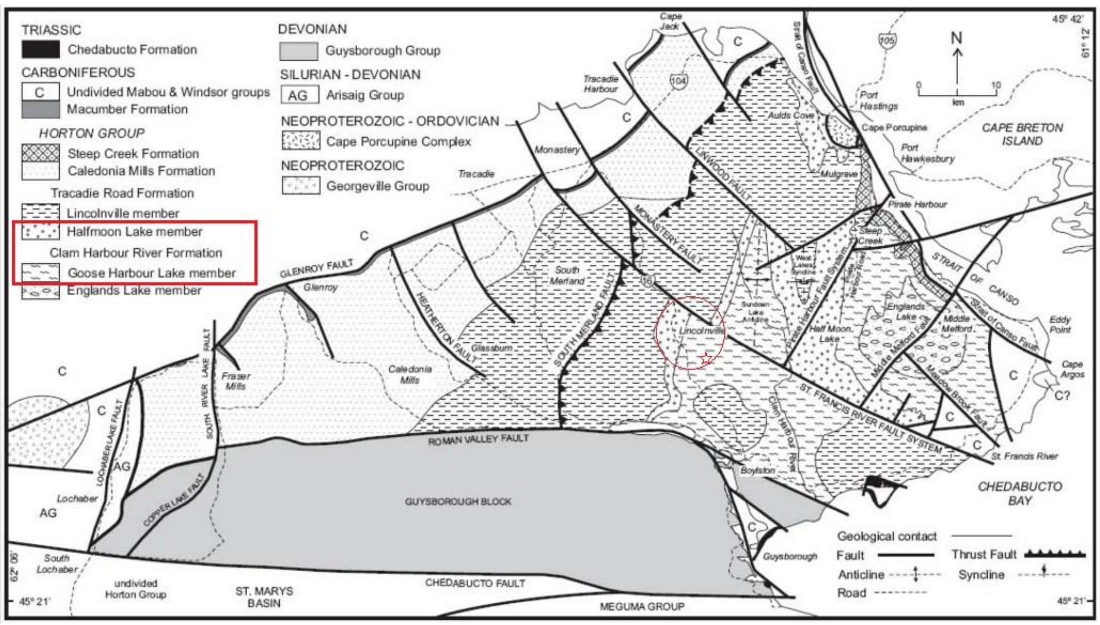
Geology, Hydrology and Hydrogeology

Bedrock Geology

The community of Lincolnville is underlain by two sedimentary rock units (see Geology Map and Rock Sequence Diagram). The lower (older) unit, the Goose Harbour Lake member, mainly consists of green-grey fine grained sedimentary rocks (siltstone and shale) with minor reddish sandstone and mudrock. This unit extends from just north-west (approximately 300m) from the intersection of Highway 16 and the Lincolnville Loop Road, south and east to the landfill (red star ion map) and beyond. The Halfmoon Lake member mainly consists of consists of a variety of sedimentary rock types. These include conglomerates (pebbles and cobbles of older rock types), sandstones and fine grained rocks (shales and mudstones).

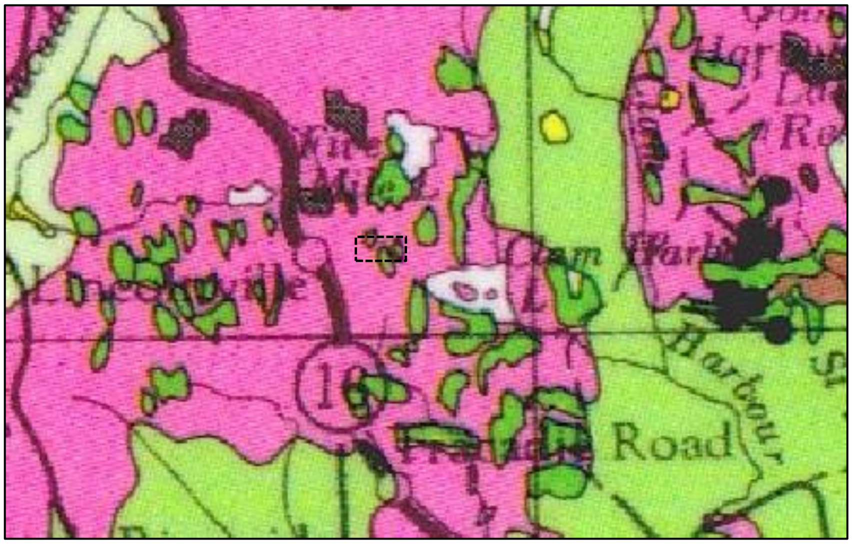


Geology Map (from Teniere 2002)

The Geology Map also shows that the area has been extensively faulted (heavy black lines labeled in map). Rock type and features like faults influence groundwater flow direction and rate of flow. Generally speaking, coarser grained (conglomerate, sandstone) permits water to move faster through the rock than fine grained rock like shale and mudrock. Highly faulted/fractured rock also permits water to flow at greater rates than non-fractured rocks. Geological mapping

shows the area is moderately fractured. The airphoto shows the Lincolnville area with an overlay of the geology.

Surficial Geology



The map clip shows the surficial or glacial geology in the Lincolnville area (from the Surficial Geology Map of Nova Scotia, 1992 1:500,000 scale). This map has very generalized units and the pink colour covering Lincolnville represents a discontinuous, thin cover of glacial till. Till is averages approximately 3 m in thickness. Well water drilling data show depths to bedrock in the range of 1m – 6.3 m. The till is described as a loose, cobbly sand till.

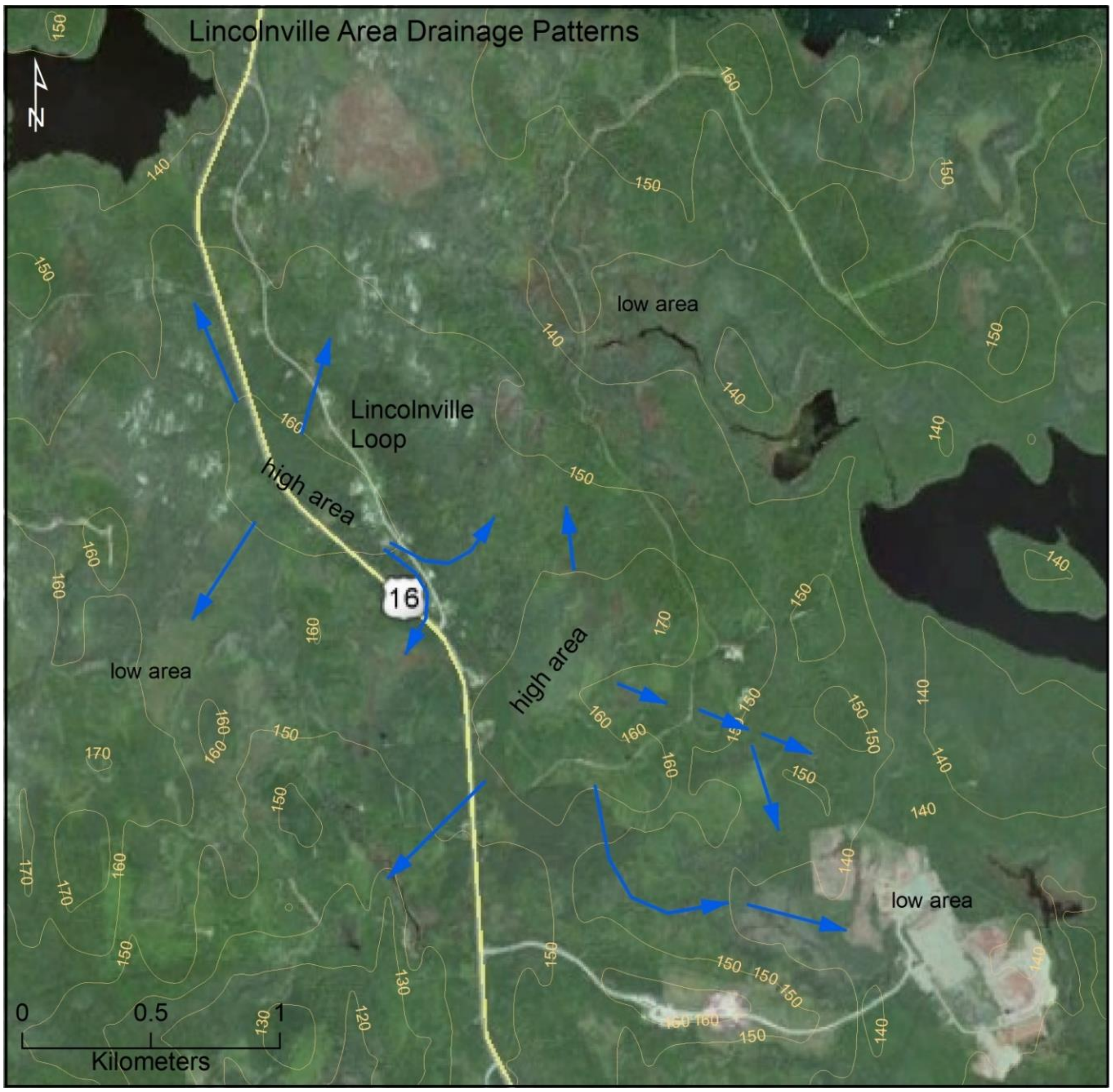
The black box in the map is the approximate area covered in the air photo below. Areas of very thin till or bare rock (outcrop) are seen as whitish-grey patches. The patterns likely indicate glacial erosion and plucking of bedrock to form ridges. The lack of till cover offers little protection to groundwater from potential pollutants at the surface.

Hydrology and Drainage

The airphoto below shows drainage patterns and topography in area from Lincolnville to the landfill site in the lower right hand corner. The light yellow lines are the elevation contours and the yellow numbers are the metres above sea level for the contours.

The blue arrows show the general and approximate direction of water flow over land (drainage). In general terms these arrows point downhill. Actual water flow is controlled by road runoff, ditches and small streams that flow from high areas shown in the map to the low areas in the map.

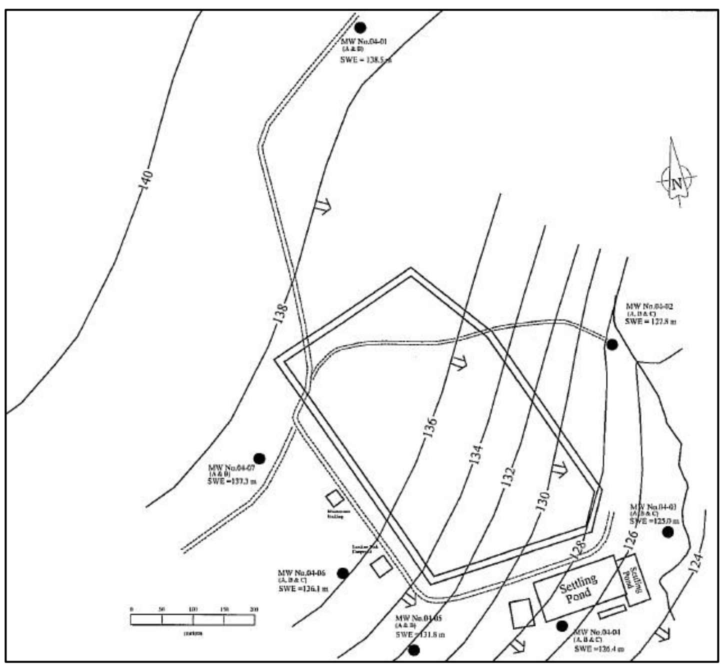
The area is fairly flat with slopes ranging from roughly 1 m – 2 m per 100 m. Brownish areas between the widely spaced contours are wetlands.



Hydrogeology

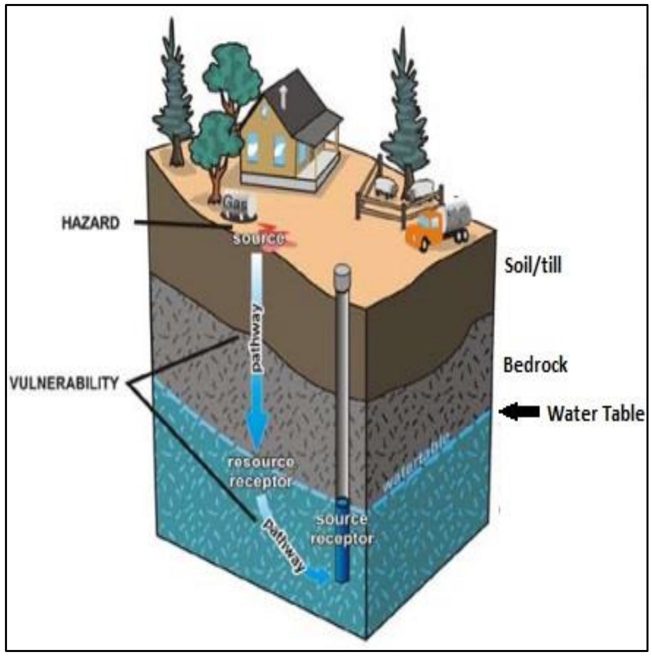
The surficial geology in the Lincolnville area consists of very thin till units. Establishing a dug well water supply in this unit would be difficult. The bedrock underlying consists of granular sedimentary rocks of varying grain sizes. A review of the well water data base shows that wells are drilled to minimum depths of about 30 m and to a maximum of about 100 m in the region. The majority of the wells are for residential use and produce between 5 and 15 litres per minute. The geologic logs of the wells are generally poor records of the actual geology. Depth to the water table in the majority of the reviewed wells is between 5 m – 10 m from the surface. Geologic mapping has identified coarse grained and fine grained units that are faulted and folded. Pervasive fracturing through rock units (cleavage), faults and coarse grained rocks are pathways for groundwater movement and potential contaminant flow.

Surface water flow is generally away from the community. The landfill is located down gradient (downhill) from the community. Groundwater flow in the vicinity of the landfill (see diagram) is to the east which is illustrated by the water table elevations (labelled lines in metres). The Ecology Action Centre presented the following points to NSE in 2008 on behalf of the community:



- There are 14 monitoring wells; sampled 2 times/year
- Leachate plume extends from tens of metres to 170 metres down-gradient of landfill and from water table to depths of 15 metres (as of 1995)
- Three wells showing leachate impacts
- Deeper groundwater flow patterns were not discussed or provided
- Concern for potential for groundwater to move toward Lincolnville at deeper level
- Limited BTEX/TPH data available for review
- No PAHs/PCBs/Dioxin/Pesticides data available for review
- Surface water monitoring exceeds CCME Guidelines for toluene, phenol, ammonia

Groundwater can be contaminated from fertilizers, pesticides, road salt, chemical/fuel spills, leaking septic systems, landfills, transport accidents as well as other human actions. Contaminants make their way down to the water table. If wells are extracting water from the ground the contaminant is drawn horizontally towards the well as water is pumped and may ultimately contaminate the well. Vulnerability to contamination cannot be directly measured. It requires assessment of many factors such as geology, depth to water, soil types, precipitation and physical properties (groundwater flow and storage) of the subsurface geological materials. These properties are determined through well pump tests and observation of groundwater characteristics.



Ground Water Sampling & Analysis

Introduction

On the afternoon of Thursday, June 23rd, members of the Water Monitoring Committee conducted a water quality sampling and monitoring in the community of Lincolnville. We met at the Black Educators Association Office to clarify the goal of our visit and heard from concerned citizens about their situation. We then visited five residences along the community and with the support of the residents we proceeded with the sampling.

Meeting Notes

- We explained the process of water analysis sampling and described different analysis levels (basic analysis of major ions and bacteria vs. a more comprehensive and expensive analysis that would include heavy metals and organic compounds).
- Some of the community members asked about the legality of our testing, and we explained the NSCC lab is not certified.
- We clarified that this testing is a first step – just a baseline study - and if anything comes back that is a red flag there should be certified testing done.
- We explained that individual testing would not provide an overall water quality assessment for the community. The proposed sampling program would provide a baseline of the overall water quality for the community by sharing information from individual wells.
- We suggested that members of the Lincolnville Reserve Land Voice Council contact community members in Shelburne to share knowledge and experiences. The community members present agreed that it could be useful and helpful.
- Has water sampling been done by the government? The municipality might have done testing in the community in 2004 but the question could not be answered at that point.
- We asked if any homeowners had their water tested in the past and if we could have that information to compare data. [Pending response]
- We explained what is included in more comprehensive testing, which is estimated to be $600-$800 per household depending on the parameters being analyzed. The community members agreed that you can't put a price on the health of the community.
- The community members asked how long it will take to get the test results back for our analysis and we answered one week. They asked if we could send individual results as well as community results, and we responded that we would send results as soon as we received them and agreed to travel back to Lincolnville for another meeting to explain the results.
- Community members identified five households to sample.

The sampling program consisted of two parts. Four wells were sampled for bacteria (only four sample containers donated by NSCC were available) and five wells were sampled for major ions and elements (or parameters) that are normally included in a typical water analysis. The need for additional analysis that would test for the presence of lead, cadmium and arsenic as well as organic compounds that could be associated with landfill activities was also discussed.

One site tested positive for both coliforms and E. coli and one site tested positive for coliforms. The community was immediately sent information from the NS Department of Environment that explained steps homeowners could use to try and fix the situation.

Procedure

Two 1-Liter polyethylene bottles of water sample were collected from the taps of the residents. The water was left to run for about 3 minutes to clean possible residues from the pipes and then collected. During sampling on site two water quality parameters were measured: pH (how acid or basic the water is) and conductivity (the ability of the water to carry and electrical current, indication of the presence of ions). Samples were placed in a cooler with ice for transportation to the NSCC- Waterfront Campus Chemistry lab for physicochemical and bacteriological analysis.

The physicochemical analysis consisted of the measurement of a basic standard suit of chemical and physical parameters with the objective to characterize the quality of the water. These measurements included: pH, conductivity, Total Dissolved Solids (TDS), hardness, alkalinity, sodium, potassium, calcium, magnesium, bicarbonate, carbonate, sulfate, chloride, nitrate+nitrite, ammonia, iron, manganese, copper, zinc, and aluminum. These are the most abundant and common species in water samples.

Well Sites & Field Recordings

The following table shows the basic information for each well site.

Site	Temp	PH	Conductivity	Notes
1	10 C	7.00	178.90	
2	9 C	7.11	790.00	-Well head buried in driveway close to road -Wetland adjacent -Salt residue in driveway
3	9 C	7.64	524.00	-140 m well -Casing recently extended -Salt residue in driveway
4	10 C	7.10	238.00	-Wet ground patches (not wetland) -Old well head nearby?
5	12 C	7.16	256.00	-Has well crock but it is buried in backyard -No bacterial sample taken

Basic Water Analysis: Major Ions and Bacteria Analysis

pH

pH is one of the parameters used to measure overall water quality. The recommended aesthetic value is between 6.5 and 8.5. Less than 6.5 leads to corrosive water, more than 8.5 may contribute to scale build-up.

Table 1. Measured pH

Site	1	2	3	4	5
pH	7.06	7.11	7.64	7.10	7.16

All sites have a pH within recommended values.

Total Dissolved Solids (TDS)

Total Dissolved Solids is used to indicate overall water quality. The aesthetic recommended value is less or equal to 500 mg/L.

Table 2. Classification of Water Samples based on TDS

Water Classification Based on Total Dissolved Mineral Solids (TDS)	
Category	Total Dissolved Solids (mg/L or g/m^3)
Fresh Water	0 – 1000
Brackish Water	1000 – 10 000
Saline Water	10 000 – 100 000
Brine Water	More than 100 000

Table 3. TDS Analysis of Samples

Site	1	2	3	4	5
TDS (mg/L)	138.0	562.5	224.5	182.0	193.0

All samples fell into the category of fresh water samples.

Hardness is another parameter used to indicate overall water quality. Hard water causes scale formation in pipes, on plumbing features and in heating systems but it is not a health risk.

Hardness

Table 4. Classification of Water Samples Based on Hardness – Canadian Drinking Water Guidelines

Hardness of Water expressed in mg/L of Calcium Carbonate (mg/L $CaCO_3$)				
Recommended	Soft	Medium	Hard	Very Hard
80 - 100	Less than 60	60 - 120	120 - 180	Greater than 180

Water with hardness greater than 200 mg/L is considered poor but tolerable. Water with hardness greater than 500 mg/L is normally considered unacceptable for domestic purpose.

Table 5. Hardness Analysis of Water Samples

Site	1	2	3	4	5
mg/L $CaCO_3$	102.6	137.0	250.6	140.2	134.2

All water samples are acceptable for domestic purpose. Only site 3 quality is considered poor from the hardness perspective.

Based on a Piper – Trilinear Plot of the samples analyzed, the water on sites 1, 4 and 5 can be classified as calcium bicarbonate type, on site 2 as a sodium chloride type and on-site 3 as a calcium chloride type. These classifications indicate the predominant ions in these water reservoirs.

Stiff diagrams (a graphical representation of water chemical analysis) are used for rapid visual comparison between waters of similar sources. A Stiff diagram of our results indicated that the water from sites 1, 4 and 5 are of similar origin and those from samples 2 and 3 are also of similar origin as the previous but with altered sodium and chloride concentrations. The latest may corroborate a possible run off contamination with road salt on sites 2 and 3.

Both results form a Piper-Trilinear Plot and the Stiff diagram support the hypothesis of all these water samples may be coming from the same reservoir. The table below shows a summary of the concentration of ions analyzed for each site. The last column indicates the Canadian Drinking Water Guidelines (CDWG) maximum or acceptable values, many of them for aesthetic purposes in terms of quality of the water.

None of the sites exceeded the recommended amount for any of the analyzed ions.

Table 6. Lincolnville Water Testing Results in Comparison to Canadian Drinking Water Guidelines (CDWG)

	Concentration (mg/L)					
Constituent	Site 1	Site 2	Site 3	Site 4	Site 5	**CDWG**
Sodium	6.86	130.00	20.70	6.64	18.40	**<200**
Potassium	0.70	0.80	5.80	3.40	1.60	**NL**
Calcium	27.80	37.60	68.90	39.60	38.80	**NL**
Magnesium	8.06	10.40	19.10	10.10	9.10	**NL**
Bicarbonate	111.10	124.00	144.70	162.50	171.00	**NL**
Carbonate	0.00	0.00	0.20	0.10	0.10	**NL**
Sulfate	5.00	21.00	11.00	3.00	8.00	**<500**
Chloride	19.10	238.00	115.00	5.60	8.70	**<250**
Nitrate	2.66	2.66	2.66	1.77	2.66	**<10**
Ammonia	0.04	0.00	0.00	0.00	0.00	**NL**
Iron	0.01	0.01	0.01	0.01	0.01	**<0.3**
Manganese	0.03	0.00	0.04	0.00	0.00	**<0.05**
Copper	0.07	0.04	0.06	0.02	0.11	**<1.0**
Zinc	0.00	0.00	0.00	0.00	0.00	**<5.0**
Aluminum	0.00	0.00	0.01	0.00	0.01	**NL**

Other ions indicators of leachate and possible contamination has not been analyzed for these samples as the technology required is not available at NSCC lab and it was not part of this first base-line analysis of the well water in the community. These other species that should be analyzed in future samplings for a comprehensive study are: Volatile Organic Compounds (VOC), Arsenic, Barium, Boron, Cadmium, Chromium, Lead, and Mercury. The previous are recommended parameters to analyze for monitoring of surface, groundwater and leachate by the Nova Scotia Department of Environment and Labor.

Discussion

As far as the Water Monitoring Committee could determine, a community-wide water sampling/monitoring program has never been completed in Lincolnville.

Analytical results showed that bacteria were present in two wells tested. One tested positive for E. Coli. The community was immediately contacted by phone to inform them of the findings and additionally, provincial government information – brochures regarding control of bacterial contamination was emailed to members of the Lincolnville Reserve Land Voice Council.

The water sampling results showed that the natural water chemistry of the parameters analyzed was of fairly good quality but is being influenced by surface or near (underground) contamination as illustrated by the higher chloride concentrations and bacteria in the same wells.

Two sites appeared to have road salt residue in the driveways. The analytical results show that both of those wells contain slightly elevated levels of chlorine and sodium which together make sodium chloride or common salt. Again, surface water is most likely entering these wells which is consistent with coliform contamination as well. Site 2 had 238 mg/litre of chloride and site 3 had 115 mg/litre. All wells are below the Canadian Drinking water Guideline of 250 mg/litre.

The hardness of water is a measure of minerals in water like calcium and magnesium. There is no drinking water guideline but the optimal range is between 80 and 100 mg/litre of mineral concentration (actually *calcium carbonate equivalent*. In some cases people feel a greasy or soppy feeling when trying to rinse their hands etc. or in other cases minerals can a build-up on plumbing pipes and fixtures which can cause problems. The hardness of water is categorized as follows: Soft below 60 mg/litre; medium between 60-120 mg/litre; hard between 120-180 mg/litre and very hard above 180 mg/litre. The wells tested were site 1 = 102 mg/litre; site 2 = 137 mg/litre; site 3 = 250; site 4 = 140; site 5 = 134. Hard water is not generally a health risk.

Cased on this preliminary basic water chemical analysis the water in the community is in good quality according the Canadian Drinking Water Guidelines.

Conclusions and Recommendations

The Lincolnville Water Monitoring Project had two Goals and several objectives. The first goal was to better understand the drinking water situation in Lincolnville and the associated concerns of the community. There were three objects associated with this first goal; 1) to determine if there is contaminated water flowing in the direction of the community from the landfill site; 2) to build the community's capacity to test their own water; and 3) to provide community members with basic knowledge about contaminants and groundwater sampling. The second goal was to try and develop a framework or model for other communities to follow, which is described in the following section.

1. Research shows that the landfill is down gradient from Lincolnville. Research also shows the first-generation landfill is leaking as it does not have a liner used in modern day landfill construction. Based on the hydrogeological review, there does not appear to be a connection between the landfill and the groundwater aquifer from which the residents of Lincolnville draw their water. However, further water analysis of parameters associated with leachate is necessary to confirm there are no contaminants from the landfill.
2. The Water Monitoring Committee met with members Lincolnville Reserve Land Voice Council on several occasions to explain the results of their research and

sampling through maps, diagrams and tables. A number of Council members participated in the project through meetings and by opening their homes for sampling and by learning how to take water samples. Community capacity building meetings were conducted to encourage the greatest participation from the community as possible. Comments and questions were recorded to help the Water Monitoring Committee develop the project and to better understand the concerns of the community with respect to water quality and the government framework regarding community water monitoring.

3. In order to help the community better understand the importance of sampling and protecting their water from different contaminant sources, the water Monitoring Committee compiled a series of links to important information brochures on many issues associated with protecting ground water quality.

Two of the wells tested had bacterial contamination. One well tested positive for E. Coli which is often a sign of a malfunctioning septic system.

- *It is recommended that the Lincolnville Reserve Land Voice Council encourage residents to test their wells for bacteria.*
- *The Council should distribute information resources to residents regarding testing wells for bacteria, disinfecting wells testing positive for bacteria and protecting wells from bacterial contamination.*

Lincolnville residents are very concerned with pollution from the nearby landfill contaminating their drinking water supplies.

- *It is recommended that additional water analysis of wells across Lincolnville to establish if wells show any evidence of contamination potentially associate with the landfill.*
- *Further testing should include parameters that are associated with landfill leachate such as heavy metals and volatile organic compounds, etc.*

During discussions with the community a number of knowledge gaps were identified regarding ground water and water quality.

- *It is recommended that the Lincolnville Reserve Land Voice Council continue to look for community capacity building opportunities to help residents in Lincolnville to become better informed about protecting well water quality.*
- *Information brochures identified in the following section should be distributed to the community.*

Community-Based Water Monitoring Model

One of the goals of the Lincolnville community-based water monitoring project was to develop a model and checklist for replicating the process in other communities throughout Nova Scotia. These rural communities do not usually have any procedures or plans in-place to monitor water quality compared to communities using public drinking water supplies[1].

In contrast, owners of public drinking water supplies (either surface or ground water) are responsible for testing and delivering safe drinking water to their communities. They accomplish this through a variety of activities such as sampling and source water protection.

Residents not on public water supplies mainly rely on ground water for their drinking water. Individual homeowners are responsible for taking appropriate actions to ensure their water is safe to drink and use. These actions include testing for water quality and protection of their well water supply from contamination.

Individual water analysis tells the homeowner about their well water but will not provide a complete picture of the water quality for the entire community. *Community-based water monitoring,* similar to that carried out in Lincolnville[2], is an approach communities can use to monitor the quality of drinking water across the entire community.

The Online Resource Links section below provides links to government publications that answers frequently asked questions such as how to sample water, where is the closest lab, what does it cost to sample water and how are wells maintained.

Considerations

- Water quality depends on two main factors; the rocks and minerals ground water flows through and around and any other substance ground water comes into contact with – such as a leaking septic system or industrial pollution.
- To develop a picture of a community's overall water quality, it is important to understand the relationship between water analysis and all influences on water chemistry.
- Individual water tests can contribute to the understanding of the community's water quality.
- The two main types of water analysis are bacterial and chemical.

[1] Public water supplies include *municipal drinking water supplies* such as cities and towns and *registered drinking water supplies* (see http://novascotia.ca/nse/water/publicwater.asp.

[2] Only basic water analysis has been carried out to date in Lincolnville.

- Bacterial analysis is extremely important because the presence of bacteria means contaminants are getting into your water supply, either through surface or ground water.
- The presence of bacteria in your water supply is undetectable without lab analysis. Bacterial analysis is crucial for identifying safe drinking water.
- Chemical analysis identifies the presence of various minerals and elements that may be present in your water, either from natural sources or contaminants. Acceptable levels of these parameters are listed in the Canadian Drinking Water Guidelines
- Most common well water analyses do not include parameters associated with polluting industries such as heavy metals and volatile organic compounds (VOCs)

Activities and Resources Checklist

1. Assemble a team to manage the sampling program and build capacity in the community
2. Identify volunteers or persons with experience in water sampling
3. Identify volunteers or persons to research and compile information related to the industry of concern (permits, approvals, etc.)
4. Identify individuals with experience in hydrogeology to explain the natural ground water conditions (including quality) and potential for contamination by nearby industry
5. Identify individuals with experience in water chemistry to identify the parameters to be analyzed and explain the meaning of the analytical results
6. Identify sources of funding for lab analysis
7. Identify a lab to do the analysis
8. Community Capacity Building: Bring the community together to discuss the results of the sampling program and any concerns related to contamination
    a. If bacteria contamination is discovered in an individual well, follow the instructions in the Fact Sheet *Drop on Water - Coliform Bacteria* (see link in the Online Resources section) or contact Nova Scotia Environment
    b. If chemical analysis shows parameters exceeding the Canadian Drinking Water Guidelines, refer to the appropriate Fact Sheet in the *Drop on Water* series (see link in the Online Resources section) or contact Nova Scotia Environment
    c. If chemical analysis shows industrial contaminants contact Nova Scotia Environment
9. If no contaminants are found continue to monitor ground water quality through sampling selected sites as suggested by a hydrogeologist and record analytical results for future reference

10. Investigate funding opportunities to sustain community-based water monitoring into the future
11. Distribute attached online resources

Online Resource Links

Guide for Private Well Owners
https://novascotia.ca/nse/water/docs/wellwaterbookletEnglish.pdf

This is a comprehensive guide that provides information on siting, constructing, protecting, testing, and treating your well.

Tips for Testing Well Water
https://novascotia.ca/nse/water/welltips.asp

Nova Scotia Environment provides tips for testing your well water, including why you should test it, how to test it, and what the results mean.

The Drop on Water – Complete list of Fact Sheets
http://novascotia.ca/nse/water/thedroponwater.Complete.asp

Nova Scotia Environment fact sheets provide on different water quality parameters, such as bacteria and chemicals, that may be present in well water, as well as general information which will help homeowners protect their drinking water supplies and their health.

The Drop on Water - Coliform Bacteria
http://novascotia.ca/nse/water/docs/droponwaterFAQ_ColiformBacteria.pdf

Nova Scotia Environment fact sheets provide information on disinfecting you well and water system as well as protecting it from bacterial contamination.

Private Drinking Water Supplies
https://novascotia.ca/nse/water/privatewatersupplies.asp

Nova Scotia Environment addresses myths and frequently asked questions about private drinking water supplies (aka wells).

Chemistry ‘Interpretation Tool’
https://novascotia.ca/nse/dwit/Form

This site allows you to enter your water test results into a form, and then compare them to Health Canada’s drinking water guidelines. The results indicate if your results meet the national standard and there is also a guide for understanding the results.

Sample Collection Procedures - Chemical Analysis
http://novascotia.ca/nse/water/sample_chemical.asp

Nova Scotia Environment provides instructions and guidelines for collecting water samples for chemical analysis.

Sample Collection Procedures - Bacterial Analysis
https://novascotia.ca/nse/water/sample_micro.asp

Nova Scotia Environment provides instructions and guidelines for collecting water samples for microbiological analysis.

Approved Water Labs
http://novascotia.ca/nse/water/waterlabs.asp

This site provides a list of accredited water labs in Nova Scotia, including their contact information. The list also indicates if the lab provides bacterial analysis, chemical analysis, or both.

Groundwater in Nova Scotia
http://novascotia.ca/nse/groundwater/

Nova Scotia Environment provides an overview of groundwater in Nova Scotia, as well as links to resources including homeowners’ guides for wells, what to know before you construct a well, groundwater data, and maps.