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An Epidemiological Analysis of Acute Infectious Diarrhea, Water, Sanitation and Housing Infrastructure in a First Nations Reserve in Northern Manitoba

by

Punam Mehta Hayward BA(H), BSc

Defence completed on December 21, 2007

A Thesis submitted to the Faculty of Graduate Studies of

The University of Manitoba

in partial fulfilment of the requirements of the degree of

MASTER OF SCIENCE

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An Epidemiological Analysis of Acute Infectious Diarrhea, Water, Sanitation and Housing Infrastructure in a First Nations Reserve in Northern Manitoba

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Punam Mehta Hayward

A Thesis/Practicum submitted to the Faculty of Graduate Studies of The University of Manitoba in partial fulfillment of the requirement of the degree

MASTER OF SCIENCE

Abstract

Acute infectious diarrhea is defined as increased defecation (the passage of 3 or more loose/liquid stools per 24 hour period) lasting less than fourteen days. The purpose of this study was to describe the epidemiology of acute infectious diarrhea and potential determinants including water, sanitation and housing in a First Nations reserve in northern Manitoba. This prospective study was conducted from May 1, 2006 to April 30, 2007. A total of 142 stool samples were collected from 142 participants and 142 questionnaires regarding water, sanitation and housing were completed by individuals fitting the case definition of acute infectious diarrhea. 138/142 stools were tested for bacteria, 130/142 stools were tested for parasites, 139/142 stools were tested by electron microscopy (EM) and 132/142 by PCR for viral pathogens. Pathogens identified included: *C.jejuni* (5.8%), *B.cereus* (5.8%), Parvolike virus (9.4%) by EM, Calicivirus (2.9%) by EM, Rotavirus (1.4%) by EM, Norovirus Genogroup I (GGI) (19.7%) by PCR, and Norovirus Genogroup (GGII) (19.0%) by PCR. The present study identifies possible risk factors/risk markers for acute infectious diarrhea. Statistically significant association were found between pathogenic stool microorganisms and variables as follows: *Aeromonas spp.* and lack of clean water accessibility ($p=0.01$), *C.jejuni* and drinking lake water ($p=0.01$), *Calicivirus* and drinking lake water ($p=0.01$), *Aeromonas spp.* and no access to an outhouse ($p=0.03$), *B.cereus* and no access to an outhouse ($p=0.01$), GGI and increased home crowding measured by ppr (person-per-room) ($p=0.03$), GGII and high home density ($p=0.01$). Statistical tests showed an association between total microorganisms and drinking lake water ($p=0.01$) and total microorganisms and lack of access to an outhouse ($p=0.04$). Therefore, water characteristics such as lack of clean water accessibility and drinking lake water were associated with potential stool pathogens. Sanitation characteristics such as lack of access to an outhouse were associated with potential stool pathogens. Housing infrastructure such as high home density and increased ppr were associated with potential stool pathogens. The results of this study indicate the significance of water, sanitation and housing infrastructure in the epidemiology of acute infectious diarrhea on a First Nations reserves in Canada.

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I would like to thank my advisor Dr. Pamela Orr for her generosity and patience with her expertise and for her mentorship. Thank you to Dr. Bruce Martin for his unwavering support and commitment throughout this project. Thank you to Dr. Ethan Rubinstein for providing me the opportunity to play a central role in carrying out this study. I would like to also thank Dr. Patricia Kaufert, Dr. Tom Hassard, Dr. Robbie Chase and Ms.Theresa Kennedy for their friendship, over the past three years in the Department of Community Health Sciences.

I would like to thank all the staff at the Garden Hill Nursing Station. Specifically, I would like to thank Grace, Kristine, Sarah, Pam, and Ivan. Thanks to the J.A. Hildes Northern Medical Unit especially, Jacquie, Jean, Sylvia, Kathy and all the nurses from the Renal Dialysis Unit in Garden Hill.

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Dedication

I dedicate this thesis to my mom, Ms. Kokila Mehta –

for always encouraging and supporting me to get an education.

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Abbreviations

[Author] Punam M. Hayward

[CDWQG] Canadian Drinking Water Quality Guidelines

[CHR] Community Health Representative

[CPL] Cadham Provincial Lab

[EM] Electron Microscopy

[EHO] Environmental Health Officer

[FNIH] First Nations Inuit Health

[FN] First Nations

[GH] Garden Hill First Nation

[GGI] Genogroup One

[GGII] Genogroup Two

[INAC] Indian and Northern Affairs Canada

[NML] National Microbiology Lab

[NMU] J.A. Hildes Northern Medical Unit

[PHAC] Public Health Agency of Canada

[WQM] Water Quality Monitor

[WTPO] Water Treatment Plant Operator

List of Definitions

Access to outhouse: was defined as either having an outhouse or not having an outhouse.

Barrel with dipper: was defined as water container which used a cup to distribute water.

Barrel with spigot: was defined as water container which had a valve to distribute water.

Cistern: was defined as water holding storage container often located in crawl spaces within home. A cistern provided a type of running water via household pipes. Cistern water systems were replenished and maintained by community water truck delivery.

Honey bucket: was defined as a pail with garbage/plastic bag inside which is used as a toilet.

No running water: was defined as having no piped pressurized water running into your house and using standpipe water as your water supply.

Outhouse: was defined as a private wall enclosed pit privy, in which resident had to leave the home to access; often outhouse was shared with neighbors.

House density number: was defined by person per house per number of bedrooms.

Household crowding [Person-per-room (ppr)]: was defined as the number of persons by the number of rooms (not including the bathroom).

Piped pressurized water: was defined as water distributed via underground pipes and distributed a type of running water within the home.

Running water: was defined as having either a piped pressurized running water or cistern within the home.

Standpipe: was defined as a large metal water distribution and collection delivery system that were located along the side of roads throughout the

community and used by residents to collect water in large containers for personal usage.

Type of toilet: was defined as having either a honey bucket or flush toilet in the house.

Type of drinking water: was defined as either drinking lake or not drinking lake water.

Type of water distribution system: was defined as either a barrel with spigot or barrel with dipper.

Water accessibility: was defined as having either running water or no running water in the home.

Chapter 1

1. A Introduction

In North America, improvements in healthcare, water, sanitation, and housing have greatly reduced cases of acute infectious diarrhea. Incidence rates of diarrhea vary from 0.8 episodes/person/year in the United States, [1] to 1.3 episodes/person/year in Canada [2], compared to 10 or more episodes/person/year in resource-limited countries [3]. It is estimated that the incidence of acute infectious diarrhea in Canadian First Nations populations is similar to that seen in resource-limited countries and Australian Aboriginal populations [4]. However, there is a scarcity of information on the epidemiology of acute infectious diarrhea in Canadian First Nations communities. It is important to understand the epidemiology of diarrheal disease to identify outbreaks, monitor trends, assess the impact of interventions, and develop appropriate public health policies to prevent disease.

Acute infectious diarrhea is defined as increased defecation (the passage of 3 or more stools per 24 hour period) of loose and liquid stools, lasting less than fourteen days [5]. Acute diarrhea may be accompanied by nausea, vomiting, abdominal cramping and bloody stool. There are non-infectious causes of

diarrhea such as minor dietary disturbances and antibiotic usage; disease states such as inflammatory bowel disease are likely to last longer than the duration included in this definition. Current understanding of the etiology and transmission of infectious diarrheal pathogens may be biased toward microbiological agents that are more easily detected in laboratories. A study to identify the etiology and epidemiology of sporadic (individual, unrelated cases) cases and outbreak (multiple cases with point source or person-to-person transmission of infection) cases will help to better understand acute infectious diarrhea.

1.B REVIEW OF LITERATURE

1. B.1 Global Burden of Disease

In the early nineteen eighties, worldwide estimates of mortality and morbidity from diarrheal disease suggest that there were approximately 4.6 million deaths per year and 1 billion episodes of diarrhea per year [5]. Today, case management has helped reduce global mortality rates but increasing global morbidity rates remain an important public health challenge. Current global burden of disease estimates of mortality and morbidity from diarrheal disease suggest 2.2 million deaths per year and 2 - 4 billion episodes of diarrhea per year [5]. Diarrhea causes 4% of all global deaths and 5% of health loss to disability [5]. Environmental conditions such as poor

sanitation and water quality are risk factors for diarrhea, particularly in developing countries [6]. Paradoxically diarrhea has become a disease increasingly associated with technological progress such as mass food production and distribution which can easily lead to large epidemics. An estimated 15% to 30% of individuals with diarrheal disease in industrialized countries consulted a physician [7]. While, the majority of these cases are mild and self-limiting they pose a significant burden due to lost productivity and health related costs. Other cases are severe and can result in hospitalization, serious chronic conditions, or death.

1. B.2 Burden of Disease in Canada and Comparable Data in Other Countries

In Canada it is estimated that there are 1.3 episodes/person/year [2] and that 20% of individuals with enteric disease consult a physician [7]. It is estimated that in Ontario 1 in 313 cases of diarrheal disease are reported through passive disease notification surveillance [2]. Several Canada-based studies have been conducted to estimate the burden of diarrheal disease. A 2006, cross-sectional telephone survey was conducted to determine the magnitude and distribution of diarrhea among 4,612 randomly selected

British Columbia residents [8]. The survey determined a monthly prevalence* of 9.2% (95% CI 8.4-10.0) and an incidence rate of 1.3 (95% CI 1.1-1.4) episodes/person/year [8]. A 2004, cross-sectional telephone survey estimated the magnitude and distribution of self-reported gastrointestinal illness among 3,500 residents of Hamilton, Ontario [2]. They determined a monthly prevalence* of 10% (95% CI 9.94-10.14) and an incidence rate of 1.3 (95% CI 1.1-1.4) episodes/person/year [2]. Four cross-sectional telephone surveys conducted concurrently to determine the burden of diarrhea, found a monthly prevalence of 7.6% in Canada, 7.6% in United States, 6.4% in Australian, and 3.4% in Ireland [9].

Reliance upon passive surveillance[1] systems based on physician claims data and laboratory test data have resulted in the under-reporting of diarrheal disease in Canada. The Public Health Agency of Canada [PHAC] collects and disseminates data on notifiable infectious diseases from across the country and province/territory by province/territory. Table 1 lists incidence rates per 100,000 per year of reportable cases of acute diarrhea due to enteric

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* Monthly Prevalence was defined as the number of respondents reporting acute gastrointestinal illness in the previous 28 days divided by the total number of respondents.

[1] Passive surveillance system refers to information provided to the health agency without an initiating action by the agency.

pathogens in Canada [10]. These represent the best available national data held in Canada for diarrheal disease.

Table 1: Annual Incidence (per 100,000) of diarrheal disease due to select enteric pathogens in Canada, 2004*

Incidence per 100,000/year	*Campylo-bacter*	*Giardia*	*Hepatitis A*	*Salmonella*	*Shigella*	Verotoxin *E.Coli*
Canada	30.22	13.08	1.47	16.02	2.35	3.36
Newfoundland	11.02	5.61	0.39	6.38	0.39	0.39
Prince Edward Island	18.86	2.90	0.00	12.33	0.00	4.35
Nova Scotia	15.90	9.29	0.85	11.31	0.85	1.28
New Brunswick	19.43	10.51	0.00	18.50	0.93	1.80
Quebec	32.15	12.42	1.45	13.64	2.12	2.04
Ontario	31.83	12.69	1.41	17.01	2.25	2.49
Manitoba	18.20	10.42	1.45	12.13	0.94	4.87
Saskatchewan	No data	No data	No data	No data	No data	No data
Alberta	28.26	14.37	2.06	20.46	3.09	8.96
British Columbia	35.01	17.56	1.81	17.13	3.81	4.60
Yukon	16.02	19.23	0.00	6.41	0.00	0
Northwest Territories	11.68	No data	0.00	7.01	0.00	9.34
Nunavut	No data	No data	No data	No data	No data	No data

* Based on passive surveillance data.

Many of the etiological agents causing diarrheal disease are not identified or reported. In 2004, a mail questionnaire to all provincial labs across Canada found 67% of laboratories conducted on-site testing of stool specimens for enteric bacteria, 31% for parasites and 10% for viruses [11]. However, in the year 2000, these laboratories processed 459,982 stool specimens, of which 5%, 15%, 8% and 19% were positive for enteric bacteria (excluding *C.*

difficile), *C. difficile*, parasites and viruses, respectively [11]. Furthermore, variations in both laboratory testing and public health authority reporting protocols and policies pose challenges on getting reliable data.

Etiological studies from other countries may be compared to those from Canada. A study of acute gastroenteritis amongst 4,637 hospitalized children (ages 0 -14), in Melbourne, Australia (between April 1980 to March 1982) identified: 39.6% of stool samples tested positive for Group A Rotavirus, 6% for Adenovirus types 40 and 41, 5.8% for *Salmonella*, and 3.4% for *C. jejuni* [12]. However, this study failed to test the entire range of potential enteropathogens thus leaving a large percentage (43.5%) of samples with no recognized pathogen [12]. Etiology studies incorporating more sensitive lab tests have increased the ability to identify enteropathogens. A two-year case-controlled prospective study using a broad spectrum of laboratory methods identified enteropathogens amongst Danish children (< 5 years of age); 54% of the 424 cases were positive for a potential pathogen compared with 22% of asymptomatic controls [13]. They found: 14% of stool samples tested positive for Group A Rotavirus, 5.4% for Norovirus, 4.4% for Adenovirus, 3.2% for Sapovirus, 4.7% for *Salmonella*, 3.5% for *C. jejuni*, 2.7% for *Y.enterocolitica* [13] . A one-year prospective case-controlled study amongst adults in Sweden (>15 years age) investigating a wide range of

enteropathogens found 56% of patients and 16% of control subjects positive on stool testing [14]. The most frequent enteropathogens were: 13% *C. jejuni*, 13% *C. difficile*, 8% entertoxigenic *Escherichia coli*, 7% *Salmonella*, 4% *Shigella*, 4% Blastocystis hominis, 3% Calicivirus, 3% Group A Rotavirus, 2% enteroaggregative *E.coli*, 2% *Aeromonas*, 2% Giardia intestinalis, 2% Cryptosporidium, 2% Astrovirus [14].

1. B.3 Aboriginal People's Burden of Disease

In developed countries, diarrheal disease contributes to the ill health of disadvantaged sections of the population that live in conditions described as the *'fourth world'* [15]. The term *'fourth world'* has been used in the context of aboriginal populations located in Australia in which the majority of its citizens enjoy a high standard of living which is not shared by the aboriginal population [15]. This term may also be used to describe the similar situation of First Nation's people living throughout Canada who experience an overall disproportionately lower standard of living compared to the majority of Canadians. Conditions of poverty result in the exposure of aboriginal populations to high levels of microbiological environmental contamination and increased risk of fecally transmitted disease. Aboriginal populations are

at risk from enteric pathogens from human and animal sources, intermediate disease carrying vectors such as contaminated food, water, and air.

There are deficiencies in the scientific literature regarding the true incidence of diarrhea in Canada's First Nations. A prospective study conducted amongst neonates and their siblings comparing 98 Winnipeg non-aboriginal families, 31 First Nations families, and 15 Inuit families in Canada found *Rotavirus* infection was highest in the first six months in the Inuit community (1.07 cases per person) [16]. *Noroviruses* caused 0.15 infections per child per year in the First Nations community of Berens River, Manitoba [16]. Berens River was the only community studied which had no running water supply and inadequate sanitation conditions among, to the majority of the population. A *Hepatitis A* study among residents of First Nations Reserves in British Columbia was conducted between 1991-1996 [17]. The crude incidence of on-reserve was 31 per 100,000 persons per year (95% CI 25-37), twice as high as in the general population of BC (15.1 per 100,000 persons per year) [17]. Higher incidence of *Hepatitis A* was associated with increasing number of people per house and with the presence of no running water in house [24]. A study in Manitoba during the mid-nineties showed that the incidence and hospitalization rates for shigellosis was 29 and 12 times higher, respectively, in First Nations communities than the rest of the

province [18]. The incidence rate of shigellosis varied according to community infrastructure for sanitation and housing; it was 3 to 6 time higher in communities without piped water delivery system; and twice as high in communities without sewage systems [18].

Studies from aboriginal populations in other parts of the world provide useful indicators. For decades, gastroenteritis has been recognized as a serious illness among Australian aboriginals. In 1989, 11% of the western Australian aboriginal birth cohort was admitted to hospital for diarrhea compared with only 1.4% on the non-aboriginal birth cohort [19]. A retrospective analysis of state hospitalization data found that western Australian aboriginal infants were hospitalized for diarrhea eight times more frequently then non-aboriginals infants and were readmitted more frequently and sooner for diarrhea[19]. Furthermore, hospital admission rates for Western Aboriginal infants with diarrhea were significantly associated with other health factors such as undernutrition, anemia, co-existing infections, and intestinal carbohydrate intolerance [19].

Diarrhea remains an important and preventable cause of morbidity among North American Native children. The annual incidence of diarrhea associated hospitalizations has declined by 76%, from 276 per 100,000 in 1980 to 65 per 100,000 in 1995 amongst American Native children (age 1 month-4 years) throughout the United States [20]. Although overall rates were found to be declining, several reserve communities continue to have high hospitalization rates for diarrhea [20]. Overall, American Native children have a higher rate of diarrhea associated hospitalization in their first year of life than non-Native American children [20].

Etiological studies provide evidence of the impact of diarrheal pathogens in aboriginal communities. For example, a year-long prospective study of Australian aboriginal children with diarrhea showed a high rate of isolation of bacteria, parasites, and viruses in stool samples; 39% of children with diarrhea compared with 4.5% of children without diarrhea tested positive for one or more bacterial pathogen including entertoxigenic *E.coli*, *Aeromonas spp., Salmonella spp., Shigella spp., and Campylobacter spp.* [21]. *Rotavirus* was detected in 12% of children with diarrhea and in 8% of controls [21]. *Giardia lamblia* was present in over 25% of children regardless of whether they had diarrhea [21].

During a three week diarrhea epidemic on the White Mountain Apache Indian Reservation rotaviral antigen was detected in 169 (73%) of the 233 collected stool samples [22]. *Rotavirus* was not detected in any of the stool samples taken 6 months before or after the epidemic.

1. B.4 Transmission: Lessons from Canada and Other Countries

The etiologic agents that cause acute infectious diarrhea are spread by several modes. Person-to-person transmission of diarrhea agents is facilitated when persons are housed together in limited space and adequate hygiene cannot be maintained [23]. A study of *Shigellosis* on Manitoba reserves found the rate ratio[2] was 7.7 (CI 2.8 - 17.2) in homes with an average household density [number of per person in house per number of bedrooms] of 6 or 7 people whereas average household densities of 4 or 5 people and 2 or 3 people had rate ratios for *Shigellosis* of 4.0 and 1.0, respectively [18].

Agents may be spread by fecal-oral routes, which can occur directly through person-to-person contact. A randomized controlled prevention trial in Karachi, Pakistan found that children younger than 15 years living in households that received handwashing health promotion and plain soap had a

[2] Rate ratio is defined as the ratio of the rate in the exposed population to the rate of the unexposed population.

53% lower incidence of diarrhea compared with children living in control neighborhoods [23].

Agents can be spread through contaminated food and water. In 2001, in Walkerton, Ontario, seven people died and 2300 became ill after ingesting *E.coli O157:H7* and C.*jejuni* identified in the community water source [24]. In September 2006, a total of 183 persons in the United States were infected with *E. coli O157:H7* after consuming fresh spinach [25]. Transmission of agents can also occur through contaminated surfaces [26]. Rotavirus can be spread from child to child via the contamination of caretaker's hands by infected fomites[3] or surfaces [27]. Evidence for the airborne spread of *Rotavirus* gastroenteritis is primarily circumstantial and includes a short incubation period of 1 to 3 days and the fact that the virus often occurs in explosive outbreaks [27]. *Rotavirus* has also been detected in respiratory secretions in a small number of patients with pneumonia [28]. *Rotavirus* RNA taken from air samples from rooms of hospitalized children with rotaviral infections suggests that airborne spread may be a major route of transmission in hospital settings [28]. *Norovirus* virus can also be transmitted by aerosols generated by vomiting [29].

[3] Fomite: is any inanimate object or substance capable of carrying infectious organisms (such as germs or parasites) and hence transferring them from one individual to another.

Transmission can occur through contact with surfaces such as household water containers used for storage of drinking water. A study examining the surfaces of household water storage containers (where treated water is supplied by community standpipes) in two rural villages (Ncera and Ntselamanzi) in South Africa found household containers supported the growth and survival of total coliform and *E.coli O157:H7* due to poor quality of intake water before and after 48 hour storage [30].

Diarrhea may be caused by contaminated water and wastewater systems. As of the year 2000, 1.1 billion people in the world were without access to safe and clean water supply and 2.5 billion lacked access to adequate wastewater systems [31]. In Canada, First Nations Band Councils, Health Canada, and Indian and Northern Affairs Canada (INAC) are collectively responsible for water and wastewater systems in First Nations across Canada [32]. First Nations Band Councils have primary responsibility for the design, construction, and maintenance of water and wastewater systems [32]. INAC provides funding to assist with the provision of water and wastewater services within the reserve communities while Health Canada works in conjunction with First Nations communities to monitor drinking water

quality [32]. In 2003, INAC evaluated 740 First Nations community[4] water systems and found that 29% (218) posed a potential high risk that could negatively affect water quality [32]. The term "potential high risk," was defined as a system with major deficiencies which pose a high risk to the quality of water quality and/or wastewater quality and which may immediately lead to potential health and safety concerns [32]. Four hundred and sixty-two community wastewater systems were assessed: 16% (74) posed a potential high risk that could negatively influence wastewater sewage quality [32]. Across Canada, reserve water systems were categorized as follows: 60% had a piped pressurized system, 16% an individual well, 14% a truck to cistern system, 3% a community well, 3% a truck to barrel system, 2% other, and 2% no service [33]. More then 50% of First Nations and Inuit homes did not have piped running water in their homes [33]. During water shortage a person might by forced to choose between cleaning and cooking with available potable water. For those communities that have cisterns located in their homes, no data are available on the frequency with which these tanks are replenished, or on the number of water shortages, or on occurrence of water rationing.

[4] This number includes non-reserve and reserve First Nations communities.

1. C Proposed Research

In order to shed light on the epidemiology and community context of acute infectious diarrhea in Canadian First Nations reserve communities, the current research proposal was developed with the following research objectives.

1. To identify the microbiological agents causing acute infectious diarrhea in a remote First Nations reserve community in Manitoba.
2. To describe potential risk factors/risk markers for diarrheal infection and possible associations with specific microorganisms, in recruited cases, including:

    - Type of water supply and sanitation in the homes of each participant
    - Degree of crowding in house - measured by number of person per room (as defined by numbers of person divided by number of rooms [not including bathrooms]) and housing density number (as defined by person per house per number of bedrooms).

The First Nations community of Garden Hill, Manitoba was chosen as the study site. The reasons for choosing this site include the following:

i. Desire expressed by the community (Chief and Council) to understand the causes of diarrheal illness in their community
ii. Presence of infrastructure that supports research in the community (including J.A. Hildes Northern Medical Unit [NMU] director (Dr. Bruce Martin), staff, doctors, nurses, and flights to community.)
iii. Size of the community sufficient to anticipate > 100 stool samples will be collected over 12 months.

The study was devised and implemented with the hope that the results would assist the community to put into practice systems to prevent diarrhea and improve community health.

Chapter 2

2. A. Objectives

The objectives were described in Section 1.C of the Introduction.

2. B. Study Methodology

2. B.1. Ethical Considerations

Ethical approval was obtained from the University of Manitoba Health Research Ethics Board (see Appendix 1). Approval for the study was obtained from the Four Arrows Regional Health Authority and Garden Hill Chief and Council (See Appendix 2). In March 2007, the author met with Chief and Council and obtained verbal permission to collect water samples[5] from the community. Informed consent was translated through a Community Health interpreter or family member accompanying the participant to Oji-Cree for those who did not speak or read English.

2. B.2. Study Time Frame:

This was a prospective 12 month study conducted from May 1st 2006 – April 30th 2007.

2. B.3. Study Site:

Garden Hill is an Oji-Cree First Nations community with a population of 3418[6] [34]. Garden Hill is located 610 kilometers Northeast of Winnipeg, the capital of Manitoba (See Map 1).

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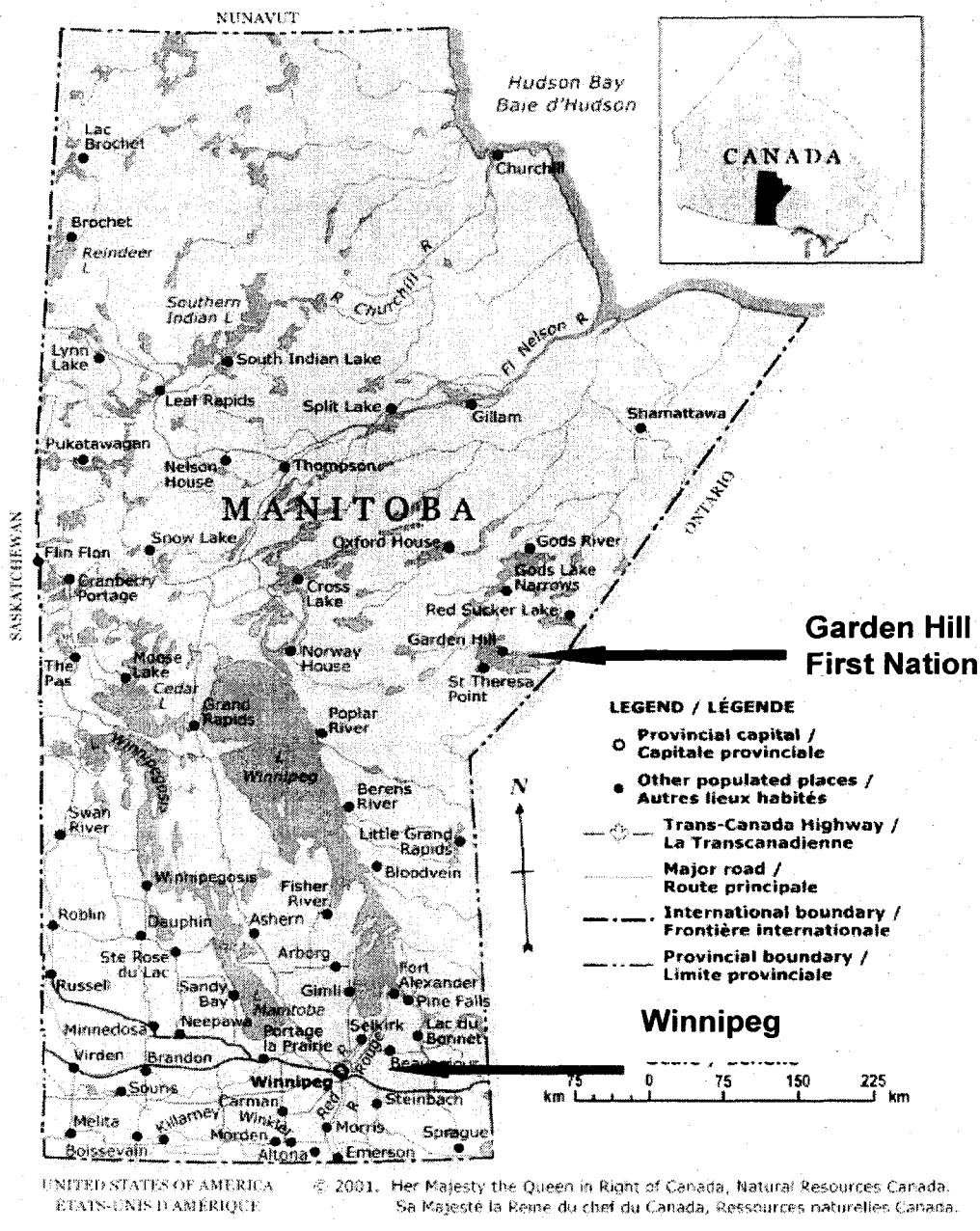
[5] Water Samples were collected because the author wanted to randomly test cisterns and water storage containers in resident's homes in Garden Hill, First Nations.

[6] Statistics Canada 2006 Census found the population of Garden Hill to be 1,898 however through personal communications with public health director, the author learned that this population number to low. [35, 36]



Map 1: Province of Manitoba, showing location of Garden Hill First Nations and its proximity to Winnipeg, Manitoba.

The Garden Hill nursing station is funded and operated by Health and Welfare Canada under First Nations Inuit Health [FNIH][7]. There are three people working as Community Health Representatives [CHR] to provide health promotion and education to the public. The nursing station has two medical drivers and one relief driver. They provide transportation for patients, medical supplies and laboratory specimens. FNIH has established nine to be the total complement of full-time nurses appropriate to fully staff the Garden Hill nursing station [36]. This level of capacity was rarely achieved during the study period. The Garden Hill nursing station currently had four regularly employed FNIH nurses working on-site during most of the study period, with other contracted nurses working intermittently. There are physicians from the NMU who hold clinics in the nursing station approximately four times a month. Usually one physician a week will visit between Monday to Thursday. In addition, NMU coordinates and facilitates monthly visits by specialists such as an Obstetrician who provides specialist pre-natal care for women and an Ophthalmologist who provides eye examinations for the community. NMU coordinates the operation of a renal

[7] FNIH is responsible for ensuring the availability and access to health services for First Nations and Inuit communities, assist First Nations and Inuit communities address health barriers, disease threats, and attain health levels comparable to other Canadians living in similar locations and build strong partnerships with First Nations and Inuit to improve the health system [33]. FNIH was the government term used at the time of the study.

dialysis unit which serves all four Island Lake communities[8], a retinal screening program, and a diabetic foot program [37].

2. B.4 Study Design

Inclusion criteria were as follows:

1. Primary residence in Garden Hill (as defined by participants).
2. Fulfillment of the case definition of acute diarrhea. Acute diarrhea was defined as an increase of defecation (the passage of 3 or more stools per 24 hour period) of loose stools, lasting less than fourteen days which may be accompanied by nausea, vomiting, abdominal cramping, and liquid or bloody stool.
3. Informed consent from participant or guardian.

Stool samples were to be collected from participants over the one-year study period. Nursing station staff estimated that the incidence of acute infectious diarrhea was 5-10 episodes/person/year [38]. A sample size of 360 was selected because this number represented 10% of the population. Age criteria for the study was 5 young pediatric (<3 years of age) and 5 adult (>4 years of age) to be collected on the 5^{th}, 15^{th}, 25^{th} of every month (for a total of n=30 stool samples/month). Collection dates were selected to provide an even flow

[8] Island Lake consists of four communities: Wasagamack, Red Sucker Lake, St. Theresa Point, and Garden Hill.

of samples and to capture the range and distribution of enteric pathogens and avoid sampling bias due to outbreaks. There was concern that if samples were collected only during a selected portion of the month, bias would occur (under sampling or over sampling) in the event of an outbreak or cluster. A local diarrhea study research assistant (see Appendix 3) was hired to work in cooperation with the Garden Hill nursing station staff to recruit participants. Each stool sample was to be shipped to the central laboratory in Winnipeg, within 24-48hours and was to be analyzed, with the appropriate laboratory techniques for bacterial, parasitic, and viral pathogens, to identify the etiology of each case of acute infectious diarrhea (see Appendix 4). In addition, each study participant was to be administered an informed consent (see Appendix 5) and a face-to-face survey (see Appendix 6).

Deviation from the original study design occurred because:

1. Loss of study partners (change in nursing station staff). This resulted in concerns regarding our ability to identify and recruit participants.
2. Difficulties maintaining a research assistant to coordinate and facilitate community involvement in Garden Hill Diarrhea Study.
3. Difficulties overcoming community sensitivities to stool sample collection.
4. Burden of work experienced by local nurses. Their assistance in stool sample collection was considered 'extra' work in a setting of high clinical care.

Due to the above factors the following changes were made in order to meet the objectives of the study (see Appendix 7):

Inclusion criteria were broadened to recruit study participants from several different locations (from community homes directly, not just the Garden Hill nursing station) and pediatric and adult cases were collected without regards to age or date.

2. B.5 Sample Collection:

Study participants were recruited by:

- Door-to-door visitation in the community in order to deliver kits.
- Daily and weekly television presentations encouraging residents to call in with questions regarding the study and to request visits to their homes.
- Recruiting participants in the waiting room of nursing station.
- Inquiring among staff in order to identify names of patients with diarrhea.
- Working with Community Health Representatives (CHRs) to contact families with members that might have diarrhea.
- Working with Garden Hill home care workers to identify and collect samples from those patients with diarrhea.
- Posters (see Appendix 8) and pamphlets (see Appendix 9) were created and distributed throughout the community and nursing station.

2. B.6 Sample Selection

It was not possible to obtain samples from all Garden Hill residents who experienced acute diarrhea. Therefore data was collected from a sample which represents the population. 142 of 3418 approximate on-reserve population were sampled; this represents 4.2% of the Garden Hill population. In this study both voluntary and convenience sampling methods were employed to recruit participants. Voluntary sampled participants consisted of people with diarrhea who decided to take part in the study by responding to general appeals made to the community. For example, researchers made daily TV presentations[9] to recruit participants with diarrhea, after this whoever expressed interest in participating was chosen.

Convenience sampling was used to obtained participation from people experiencing diarrhea who are easiest to reach. For example, researchers appealed to Daycare, which was located across the road from the nursing station, in order to collect stool samples from infants and young children who were identified by workers as having diarrhea. Convenience sampling is

[9] TV presentations: Garden Hill, First Nations has a local TV station in which all community members have access to in their homes. All community announcements, elections, birthdays, bingo, and buying and selling of goods such as clothes and home baking occurs on local TV station. It provides a major and vital communication link throughout the community and was a useful resource in this research study.

biased because it is difficult to know how reflective the sample is of the entire population with diarrhea in Garden Hill.

2. B.7 Stool Kits

Approximately 300 non-coded stool kits were delivered to the Garden Hill nursing station. Each kit consisted of one stool container, one pair latex gloves, one stick, and a small brown paper bag (for private storage in the participant's refrigerator) and if needed, a disposable hat. The name of the participant was written on the stool container. Distribution of stool kits allowed participants to collect their own/or child's/or elder's samples at a time and in a manner convenient to them. Proper methods of stool collection were explained to all participants.

When a participant provided a stool sample, the container (labeled with name) was returned or picked up and brought back to the nursing station. At the nursing station, it was equally divided and transferred by the study research associate, in a sterile manner, from the original container to three case-coded containers. Confidentiality was ensured by using a case-coded kit. Samples for parasitology were aliquoted with 2/3 of SAF (sodium acetate-acetic acid formalin) fixative and all 3 samples were sealed with Parafilm. Case-code numbers, requisition numbers and participant name were recorded

in a confidential logbook that was kept locked in the nursing station. Samples were placed in the refrigerator at 4°C in special lab transport bags along with a requisition form. From Monday to Friday the nurses or [author] packed stool samples for shipment to Winnipeg. When samples arrived at the Cadham Provincial Laboratory [CPL] they were sent to the departments of bacteriology, parasitology and virology for further testing.

2. B.8 Laboratory Methods

In this study, conventional bacterial cultures, microscopic smears for parasites, and electron microscopic[10] examination for viruses were the standard tests applied to each stool sample at CPL. The CPL virology department prepared all original stools for the Garden Hill diarrhea study (CPL study code XS) into suspensions. Every Friday morning between May 1st, 2006 – April 30th, 2007 original stool samples and stool suspensions were picked up by the author[11] and delivered for storage in the laboratory refrigerator in the Department of Medical Microbiology, Basic Medical Sciences Building. The author recorded sample numbers in the specimen receiving logbook, aliquoted and archived stool samples for use in later studies, and maintained the project database for all stool specimens received

[10] Dr. Paul Hazelton performed the EM examination.

in the laboratory. Polymerase Chain Reaction (PCR) was conducted by Dr. Paul Hazelton and sequencing was conducted at National Microbiology Laboratory (NML)[12].

2. B.9. Questionnaire

The questionnaire was initially designed and developed by Dr. Ethan Rubinstein and Dr. Paul Hazelton. Modifications were then made by the author in consultation with key informants (Dr. Pamela Orr and Dr. Nichole Riese, J.A. Hildes Northern Medical Unit). The purpose of the questionnaire was to gather information to establish possible risk factors for diarrheal disease. On a one-day visit to Garden Hill in December 2005 pilot testing of the questionnaire was conducted by the author. After pilot testing, appropriate changes were made to the questionnaire. Final modifications to the questionnaire were approved by entire study team which consisted of: Dr. Ethan Rubinstein, Dr. Pamela Orr, Dr. Bruce Martin, Dr. Nichole Riese, Dr. Paul Hazelton, and the author.

The demographic section of questionnaire provided participant information regarding date of birth, gender, date sample collected, case code number, and

[11] Transport of stool samples from CPL to Basic Medical Sciences Building was the primary responsibility of Dr. Paul Hazelton on dates in which author was in Garden Hill (See Appendix 9)

household ID number. A new case-code number was assigned to each participant from which stool was collected. A household ID number was assigned to the house from which an individual participated in the study. If one or more individuals provided a stool sample from the same house then the same household ID number was assigned to each individual participant. The questionnaire provided participant information regarding personal, environmental, and behavioral characteristics.

2. B.10 Collection of information regarding water, sanitation and housing infrastructure

In order to collect information regarding water and sanitation in community the following methods were used:

1) Conducted informal interviews with the community water plant manager and community water quality monitor.

2) Development of a community map showing the distribution and locations of all participants with diarrhea.

3) Water sample testing results obtained by author.

2. B.11 Statistical Analysis

Chi square analysis was used for categorical data, or Fisher exact test for cells <5.

[12] Sequencing Data was not shown in study results as it remains on-going.

Chapter 3

3. A. Description of the Water, Sanitation and Housing in Garden Hill First Nation Reserve Community

3. A.1 General Description of the Community

Garden Hill is a First Nations community of 3418 people located on an island 650 kilometers northeast of Winnipeg. It has no year-round road access. There are approximately 600 inhabited homes in Garden Hill. Homes are distantly located from each other and the majority of homes are located facing and/or near the lake. Until 1969 Garden Hill First Nation belonged to the Island Lake band, which consisted of four bands: Garden Hill, Wasagamack, St. Theresa Point, and Red Sucker Lake. The First Nations is signatory to the 1909 adhesion Treaty No.5[13]. The main dialect spoken is Oji-Cree; however the use of English is a ubiquitous part everyday life.

The Garden Hill Band Office is centrally located within the community. The Council consists of a Chief and eight Council members who are elected for a two-year term. Political affiliations of Chief and Council are with the Island Lake Tribal Council (ILTC), Manitoba Keewatinohk Ininew Okimahkanak (MKIO) and Assembly of Manitoba Chiefs (AMC).

[13] Treaty 5 was an agreement established from September 1875 between the Canadian government and the Saulx and Swampy Cree First Nations. Much of what is today central Manitoba was covered by the treaty, as were a few small adjoining portions of the present-day provinces of Saskatchewan and Ontario.

The predominant religions consist of traditional and fundamental Christian beliefs; there is one Roman Catholic Church building and one Pentecostal Church building. The head office of the Island Lake Family Services is located in Garden Hill and serves all four Island Lake communities [39]. The Social Assistance program provides funding to unemployed members of the community. Approximately 85-90% of the adult Garden Hill populations use this program [36].

The Garden Hill Education Authority oversees the running of the two schools, one elementary and one high school. The schools offers youth the opportunity to complete education from nursery school through to grade twelve while remaining in their own community. There are currently over eight hundred students enrolled in Garden Hill schools. Recent access to the Internet has allowed some residents of Garden Hill to complete distance education courses offered through University of Manitoba, Brandon University, and Red River Community Collage.

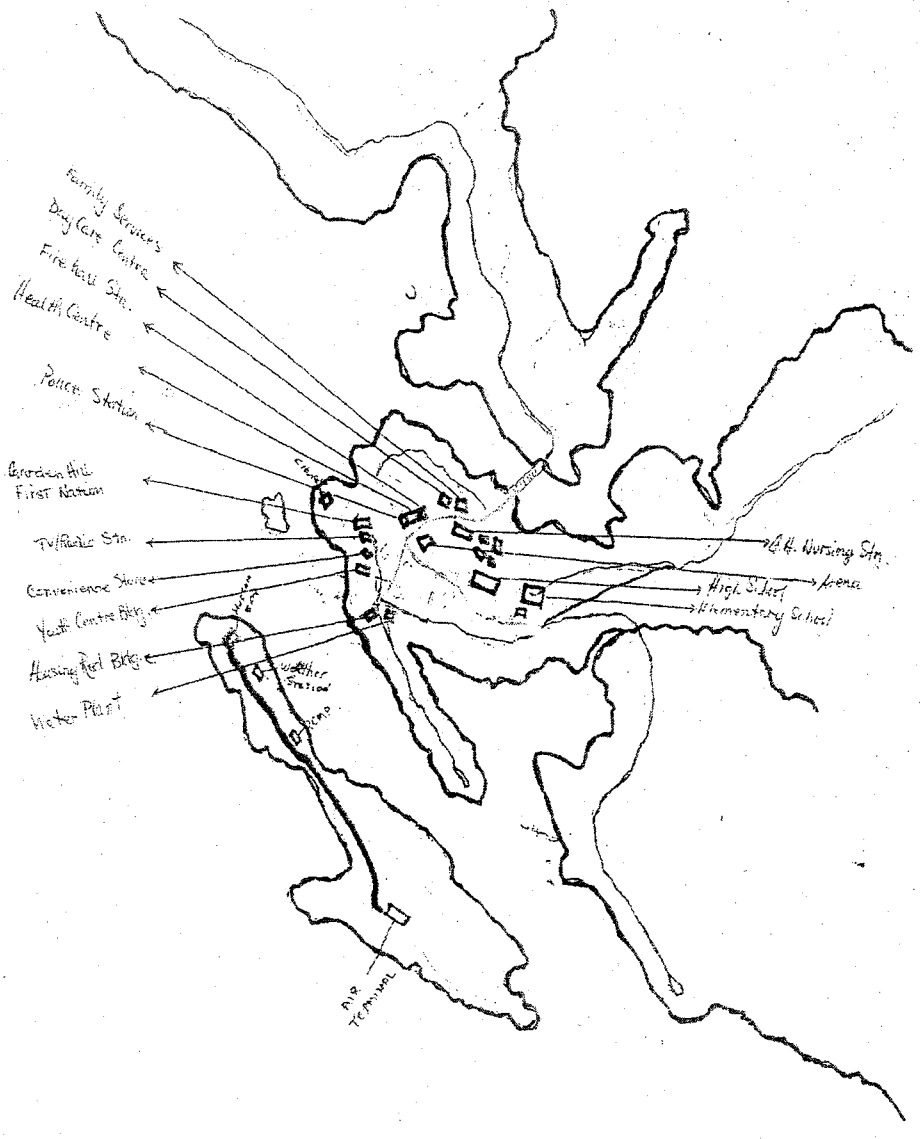
During the summer of July 1999, Garden Hill was linked to the provincial power system through the Manitoba Hydro electrification project. It now supplies 200 - amp service and it replaced the 15 - amp service previously supplied by a diesel generator. The electrification system was funded by the

Federal and Provincial governments and is now managed and maintained by Manitoba Hydro.

3. A.2 Water

3. A.2a Water Treatment Plant

In 1996, a new water treatment plant was built in Garden Hill, First Nation. The water treatment plant provides piped water directly to many centrally located businesses' (approximately 10 -15 homes located in the central area have piped pressurized water delivered into their homes) in the community. Map 2 shows the businesses and institutions that receive piped pressurized water in Garden Hill First Nation.



Map 2: Garden Hill First Nations 'Central Area' Identifying the Businesses and Institutions that Receive Piped Pressurized Water from the Treatment Plant.

The water treatment plant delivers piped pressurized water to the elementary and high school, coffee shop/convenience store, old motel (which is now an overcrowded housing complex for renal dialysis patients and their families), old teacher residence (overcrowded housing complex for residents without a functioning sewage disposal system), public safety building, band office, arena, Manitoba Telephone System [MTS], nursing station, Awasis (family services and daycare), new teacher residences, and bus shelter. Currently an estimated 5% of homes in Garden Hill have access to piped pressurized water. INAC categorized Garden Hill First Nations water and waste water system as a 'medium risk[14]' to water quality in their 2006 First Nations Drinking Water Action Plan [32].

The water treatment plant is located a few meters away from the North Shore of Island Lake. The water treatment plant operator mentioned to the author that an oil spill may have contaminated the ground surrounding the plant, in 1998 [39]. In 2001 a team of environmental engineers along with water treatment plant operator conducted tests to determine if there was indeed soil

[14] Medium risk: These are systems pose a medium risk to the quality of water. These systems would not generally require immediate action, but the deficiencies could be more easily corrected to avoid future problems. The absence of backup equipment, the lack of operating manuals and insufficient operator training, are some examples of deficiencies under this category.

contamination [39]. Ground tests of the surrounding area revealed no contaminants but environmental engineers stressed the importance of regular monitoring over the next few years [39]. The water treatment plant operator discussed his concerns about this potential problem with the author and stated that he continues to inform Chief and Council [39].

There is a laboratory within the community (the water treatment plant) used to monitor bacteriological quality of treated water (ie. water delivered through the piped distribution system). Between 2001 - August 2006, the water was regularly tested by a water treatment plant operator or an assistant. Table 2 presents water testing results from between 2001-2003. This information was provided by Mr. Eric Wood, the director of Community Health in Garden Hill. The author had requested results from 2003-2007 from the Garden Hill Chief and Council but had not obtained them to date. Table 2 provides monthly summary of water testing results at Garden Hill water treatment plant from records, April 2001 – December 2003. Table 2 showed that in July 2001 1% of water samples collected tested positive for *E.Coli* and in November 2003 showed contamination of a cistern placed under boil water advisory.

Table 2: Monthly summary of water testing results at Garden Hill water treatment plant from April 2001- December 2003[15]

Date	Results
April 2001	- 53 samples collected. - 13% were positive for Total Coliforms. No *E.Coli*
May 2001	- 41 samples collected. - 7% were positive for Total Coliforms. No *E.Coli*
June 2001	- 52 samples collected, - 8% were positive for Total Coliforms. No *E.Coli*
July 2001	- 75 samples collected. -- 1 % were positive for Total Coliforms and 1 % were positive for *E.coli*
August 2001	- 63 samples collected. - 1 % were positive for Total Coliforms. No *E.Coli*
September 2001	- 62 samples collected. - 10% were positive for Total Coliforms. On September 19th there were some complications due to high levels of chlorine. There were 15 water fountains in the community. 8 of 15 community standpipes are functioning and some have garbage around them. No *E.Coli*
October 2001	- 108 samples collected. - 7% were positive for Total Coliforms. No *E.Coli*
November 2001	- 64 samples collected. - --- 13% positive for *E.Coli*. The plant operator flushed the system. High number of *E.coli* due to shortage of chemicals which were later delivered by plane.
December 2001	- 42 samples collected. - 1% were positive for Total coliforms. Most of the standpipes are frozen and malfunctioning.
Jan 2002	- 53 samples collected. No *E.Coli*. Most of the standpipes are not in use because they are frozen.
February 2002	- 72 samples collected. Most samples taken from central area (business centre) for this month because these are only two standpipes in use by community. Only raw water tested and no *E.Coli* was detected.
March 2002	- 72 samples collected, Standpipes still frozen. Only one is operating and one more water outlet is available which is across from the nursing station. These two have been negative for coliform and *E.Coli*. We were informed of a shortage of chlorine but it is being ordered before the winter road closes.
October 2003	- 107 samples collected. - 6% were positive for Total Coliforms and 5 % tested positive for *E.Coli*.
November 2003	- 80 samples collected. - 4% were positive for Total coliforms. 1 tested from a dirty 1000 gal tank home owner was given Boil Water Advisory until tank is cleaned other 2 samples were from raw water. No *E.Coli*
December 2003	- 85 samples were collected. - 2% were positive for Total Coliforms.

[15] Some months missing data due to inconsistency in data obtained by the author.

Table 3 provides testing results obtained from the water treatment plant during the month of October 2003. 5 different types of water supplies were tested: Tap, standpipe, hose, water truck, and treated water from treatment plant. The responsibility of community water quality monitoring was that of the water treatment plant operator and water treatment plant technicians. To the author's knowledge, there is no established protocol within the water treatment plant regarding which businesses, institutions, and houses are tested [38].

Table 3: Garden Hill Water Treatment Testing Record for Total Coliform and *E.coli* for October 2003[16]*

Date	Location	Water Supply Type	Total Coliform[17]	E.coli[18]
Oct. 1/03	Business #1	Tap	Negative	Negative
Oct. 1/03	***Private Residence #1***	***Tap***	***Positive***	***Negative***
Oct. 1/03	Business #2	Tap	Negative	Negative
Oct. 1/03	Business #3	Tap	Negative	Negative
Oct. 1/03	Business #4	Tap	Negative	Negative
Oct. 2/03	*Private Residence #2*	Standpipe	Negative	Negative
Oct. 2/03	*Private Residence #3*	Standpipe	Negative	Negative
Oct. 2/03	*Private Residence #4*	Standpipe	Negative	Negative
Oct. 2/03	Business #5	Tap	Negative	Negative
Oct. 2/03	Business #6	Tap	Negative	Negative
Oct. 2/03	Business #7	Tap	Negative	Negative
Oct. 2/03	Business #4	Hose	Negative	Negative
Oct. 3/03	**Business #8**	***Hose***	***Positive***	***Positive***
Oct. 3/03	**Business #8**	***Tap***	***Positive***	***Positive***
Oct.3/03	***Sewage Plant***	***Tap***	***Positive***	***Positive***
Oct.3/03	Business #9	Water Truck	Negative	Negative
Oct. 6/03	**Business #10**	***Tap***	***Positive***	***Negative***
Oct. 6/03	Business #11	Tap	Negative	Negative
Oct. 6/03	Business #12	Tap	Negative	Negative
Oct.6 /03	***Arena***	***Tap***	***Positive***	***Positive***
Oct.6/03	Business #13	Tap	Negative	Negative
Oct.6/03	Business #14	Tap	Negative	Negative
Oct.15/03	Business #15	Tap	Negative	Negative
Oct. 15/03	Business #16	Tap	Negative	Negative
Oct.15/03	Business #17	Tap	Negative	Negative
Oct. 15/03	Business #18	Tap	Negative	Negative
Oct.16/03	Business #19	Tap	Negative	Negative
Oct.16/03	***Private Residence #5***	***Standpipe***	***Positive***	***Positive***
Oct.16/03	***Business #20***	***Treated***	***Positive***	***Positive***

[16]Water treatment plant operators and assistants failed to note whether homes that were tested contained a cistern.

[17] Total Coliforms are commonly found in the environment (e.g., soil or vegetation) and are generally harmless. If only total coliform bacteria are detected in drinking water, the source is probably environmental. Fecal contamination is not likely. However, if environmental contamination can enter the system, there may be a way for pathogens to enter the system. Therefore, it is important to determine the source and to resolve the problem.

[18] *E. coli* is a sub-group of the fecal coliform group. Most *E. coli* are harmless and are found in great quantities in the intestines of people and warm-blooded animals. Some strains, however, may cause illness. The presence of *E. coli* in a drinking water sample almost always indicates recent fecal contamination – meaning that there is a greater risk that pathogens are present.

		Water		
Oct. 18/03	*Private Residence #6*	Standpipe	Negative	Negative
Oct.18/03	*Private Residence #7*	Standpipe	Negative	Negative
Oct.18/03	*Private Residence #8*	Standpipe	Negative	Negative
Oct.20/03	*Private Residence #9*	Tap	Negative	Negative
Oct.20/03	*Private Residence #10*	Tap	Negative	Negative
Oct.20/03	*Private Residence #11*	Tap	Negative	Negative
Oct.20/03	Business #21	Tap	Negative	Negative
Oct.20/03	Business #22	Tap	Negative	Negative
Oct.20/03	***Business #23***	***Tap***	***Positive***	***Negative***
Oct.21/03	Business #24	Tap	Negative	Negative
Oct.21/03	*Private Residence #12*	Tap	Negative	Negative
Oct.21/03	*Private Residence #13*	Tap	Negative	Negative
Oct.21/03	Business #25	Tap	Negative	Negative
Oct.22/03	Business #26	Tap	Negative	Negative
Oct.22/03	Business #27	Tap	Negative	Negative
Oct.22/03	Business #28	Tank	Negative	Negative
Oct.22/03	Business #29	Tank	Negative	Negative
Oct. 23/03	*Private Residence #14*	***Tank***	***Positive***	***Negative***
Oct. 23/03	***Private Residence #15***	Standpipe	Negative	Negative
Oct.23/03	*Private Residence #16*	Standpipe	Negative	Negative
Oct.23/03	*Private Residence #17*	Tap	Negative	Negative
Oct.23/03	Business #30	Tap	Negative	Negative
Oct.27/03	***Private Residence #18***	***Tap***	***Positive***	***Negative***
Oct.27/03	Business #31	Tap	Negative	Negative
Oct.27/03	Business #32	Tap	Negative	Negative
Oct.27/03	Business #33	Tap	Negative	Negative
Oct.27/03	Business #34	Tap	Negative	Negative
Oct.27/03	Business #35	Tap	Negative	Negative
Oct.28/03	***Private Resident #19***	***Standpipe***	***Positive***	***Negative***
Oct. 28/03	*Private Resident #20*	Standpipe	Negative	Negative
Oct.28/03	***Private Residence #21***	***Standpipe***	***Positive***	***Negative***
Oct.28/03	***Private Residence #22***	***Standpipe***	***Positive***	***Negative***
Oct.28/03	Business #36	Tap	Negative	Negative

* Identification of residences and businesses were coded for confidentiality.

In the month of October 2003, 23% of water supplies tested were positive for Total Coliforms and 10% of *E.coli O157:H7.*

In August 2006, the Garden Hill Health Directorate[19] hired its first Community Based Water Quality Monitor (WQM). This position was created by the Health Directorate to fill a need in the community to prevent disease caused by contaminated drinking water throughout the community. The primary role of the water quality monitor was to randomly collect, test, and monitor drinking water quality in homes throughout Garden Hill. Other roles are to monitor wells, water tracks, standpipes, and cisterns. Table 4 lists water testing results in homes, businesses, and institutions between August 2006 – December 2006 by the WQM. These tests were conducted at homes, businesses, and institutions throughout the community by the WQM. To the author's knowledge, there is no established protocol directing the time and location of testing. In a discussion with the WQM, the author was unable to elicit a protocol for which water sources would be tested, at which intervals. The WQM stated that testing of specific sites was interrupted by community events such as funerals and holidays and was limited because his position was part-time [39].

[19] Garden Hill Health Directorate governs and manages the Garden Hill Nursing Station, Public Health, and Community Health Representatives.

Table 4: Results of random water testing by Garden Hill First Nations Water Quality Monitor (WQM), (August 2006 - December 2006) *

Date	**Location**	**Results (For Total Coliform and *E.coli*)**
August 28, 2006	Business #1(Tap)	Negative
August 28, 2006	*Private Residence #1* (Standpipe)	Negative
August 28, 2006	Business #2(Tap)	Negative
August 28, 2006	Business #3 (Tap)	Negative
August 29, 2006	*Private Residence #2*, Standpipe	Negative
August 29, 2006	Business #4 (Tap)	Negative
August 29, 2006	Business #5 (Tap)	Negative
August 30, 2006	*Private Residence #3* (cistern)	Negative
August 30, 2006	Business #6	Negative
August 31, 2006	Business #7 (Hose)	Negative
August 31, 2006	*Private Residence #4* (Tap)	Negative
August 31, 2006	*Private Residence #5* (Tap)	Negative
September 12, 2006	*Private Residence #6* (Cistern)	Negative
September 12, 2006	Business #8(Tap)	Negative
September 12, 2006	*Private Residence #7* (Tap)	Negative
September 12, 2006	Business #9	Negative
September 14, 2006	*Private Residence # 8* (Cistern)	Negative
September 14, 2006	*Private Residence #9* (Tap)	Negative
September 14, 2006	*Private Residence #10* (Cistern)	Negative
September 14, 2006	*Private Residence #11* (Tap)	Negative
September 14, 2006	*Private Residence #12* (Tap)	Negative
September 15, 2006	*Private Residence #13* (Cistern)	Negative
September 15, 2006	*Private Residence #14* (cistern)	Positive Total Coliform
September 22, 2006	*Private Residence #15* (Cistern)	Negative
September 22, 2006	*Private Residence #16* (Cistern)	Negative
September 22, 2006	Business #9(Tap)	Negative
Oct.11 & 13, 2006	Lake Water (Raw)	Positive Total Coliform
October 16, 2006	Water Treatment Plant (Tap)	Positive Total Coliform
October 16, 2006	Lake Water (Raw)	Positive E.coli and Total Coliform
October 16, 2006	Standpipe	Negative
October 23, 2006	*Private Residence #17* (Cistern)	Positive Total Coliform
October 23, 2006	*Private Residence #18* (Cistern)	Positive Total Coliform
November 7, 2006	*Private Residence #19* (Cistern)	Negative
November 7, 2006	Water treatment plant (standpipes)	Positive Total

		Coliform
November 7, 2006	Water Treatment plant Raw	Positive Total Coliform
November 7, 2006	*Private Residence #20* (Cistern)	Negative
November 8, 2006	*Private Residence #21* (Cistern)	Positive Total Coliform
November 8, 2006	*Private Residence #22* (Cistern)	Positive Total Coliform
November 8, 2006	*Private Residence #23* (Cistern)	Positive Total Coliform
November 8, 2006	*Private Residence #24* (Cistern)	Positive Total Coliform
November 8, 2006	*Private Residence #25* (Cistern)	Positive Total Coliform
November 8, 2006	*Private Residence #26* (Cistern)	Positive Total Coliform
November 14, 2006	Business #10 (Tap)	Negative
November 14, 2006	Business #11 (Tap)	Negative
November 14, 2006	Business #12 (Tap)	Negative
November 15, 2006	Bus Shelter (Tap)	Negative
November 15, 2006	*Private Residence #27* (Cistern)	Negative
November 15, 2006	*Private Residence #28* (Cistern)	Negative
November 15, 2006	*Private Residence #29* (Cistern)	Negative
November 23, 2006	Water Treatment Plant (Hose)	Positive Total Coliforms
November 23, 2006	Business #13 (Tap)	Negative
November 23 , 2006	Business #14 (Tap)	Negative
November 24, 2006	*Private Residence #30* (Tap)	Negative
November 24, 2006	*Private Residence #31* (Tap)	Negative
November 24, 2006	*Private Residence #32*(Tap)	Negative
December 7 , 2006	Business #15 (Tap)	Negative
December 7, 2006	Business #16 (Tap)	Negative

*Names coded for confidentiality of individuals and private businesses.

On March 15, 2007, 12 homes were visited and water samples to test for Total Coliforms and *E.coli* were collected by the author along with WQM. The homes from which samples were obtained were selected by WQM. All samples were collected under the supervision and assistance of the WQM to ensure proper collection technique. The samples were transported by the author to Winnipeg and delivered to ASL Laboratory Group[20] (Manitoba Technology Centre of Winnipeg) for detection of Total Coliform and *E.coli.* Results are listed in Table 5.

Table 5: Results from water samples collected (March 15, 2007) by author, tested for Total Coliforms and *E.coli* at ASL Laboratory, Winnipeg Manitoba.

ID Number	Location in Home of Point Source Water Collected	Results
1	Cistern taken from Kitchen Tap	No Total Coliform, no *E.Coli*
2	Cistern taken from Kitchen Tap	> 200 Total Coliform, no *E.Coli*
3	Cistern taken from Kitchen Tap	No Total Coliform, no *E.Coli*
4	Cistern taken from Kitchen Tap	2
5	Cistern taken from Kitchen Tap	> 200 Total Coliform, no *E.coli*
6	Honey Bucket/Pail	> 200 total Coliform, no *E.coli*
7	Cistern taken from Kitchen Tap	2 Total Coliform, no *E.coli*
8	Honey Bucket/Pail	> 200 Total Coliform, no *E.coli*
9	Cistern taken from Kitchen Tap	> 200 Total Coliform, no *E.coli*
10	Honey Bucket/Pail	18 Total Coliform, no *E.coli*
11	Honey Bucket/Pail	No Total Coliform, no *E.Coli*
12	Honey Bucket/Pail	12 Total Coliform/ no. *E.coli*

Nine of twelve (75%) homes tested were positive for Total Coliforms (see Appendix 11). This indicates that 75% of homes failed to meet the Canadian

Drinking Water Quality Guidelines[21] (CDWQG) for bacteria in drinking water. In December 2006, a contract was signed to install a new pressurized piped water system to homes throughout Garden Hill over the next five years. In January 2007, building supplies were delivered via winter road to begin construction of a piped pressurized water system for approximately 50 houses located in the central area of the community over the summer of 2007.

3.A.2b Standpipes

The majority of residents (approximately 85%) living in Garden Hill do not receive piped pressurized water from the water treatment plant directly to their homes. Instead many of these homes obtain water from standpipes located throughout the community (15 in total throughout the community). Map 3 provides the location and distribution of standpipes throughout Garden Hill First Nations.

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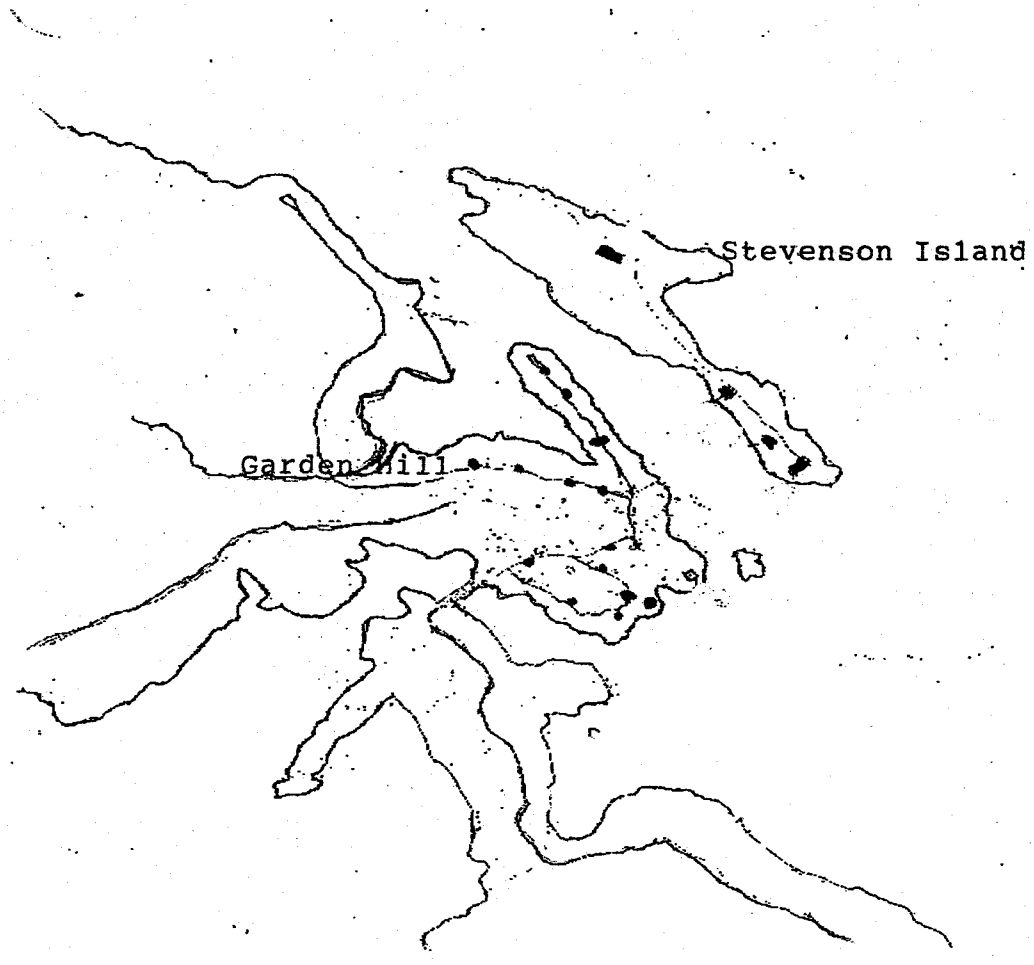
[20] ASL Environmental is a full-service environmental laboratory company providing physical, inorganic, organic, bacteriological and toxicological analyses of random water testing.

[21] Canadian Drinking Water Quality Guidelines (CDWQG) helps to protect the health of Canadians by establishing maximum acceptable concentrations for substances found in water used for drinking.



Map 3 shows the location and distribution of community standpipes in Garden Hill, First Nations.

Standpipes supply water to the community directly from the treatment plant. Residents collect water from standpipes in plastic pails (usually old laundry detergent containers) or large water jugs. Residents use this water in their home by dipping a cup (either a coffee mug with handle or glass cup without a handle) into 'large mouthed' containers. Often hands touch the water when using a dipper, thereby potentially spreading enteric pathogens. Other residents have containers that have a spigot allowing water to come out of a controllable nozzle. Both types of containers are susceptible to the accumulation of biofilms[22] if they are not regularly washed with bleach. Unwashed water storage containers that are not thoroughly cleaned could result in transmission of enteric pathogens.

Water in standpipes may freeze during the winter. Water testing records from Winter 2001, 2002 and 2003 indicate that 13 out of 15 standpipes froze, rendering them unusable. In a letter dated November 25, 2004 to Garden Hill Chief and Council the Environmental Health Officer [EHO] Tom Smithson wrote, "...in regards to the standpipes that freeze up during the winter, I was informed that no action has been taken to prevent this problem from occurring again this winter. These standpipes need to function properly to

[22] Biofilms: A complex aggregation of microorganisms imbedded in slime usually found on a solid substrate submerged in or exposed to some aqueous solution, in a biofilms the organism lives in a nonmovable colony unlike plankton free living organisms.

avoid residents from obtaining their water from other possibly unsafe sources"[23] [39].

The freezing of water in standpipes during winter months has been a continual problem which is openly discussed among community leaders and with the EHO. However, the problem still persists. In September 2006 all the community standpipes were removed in preparation for replacement with new ones. This has had consequences for the residents of the community, as the only subsequent place to collect water is directly from the water treatment plant or the one operational standpipe located across the road from the water treatment plant. The one operational standpipe is located in the central area which makes it difficult for residents of the north and south side of the community to obtain water. In addition, water is difficult to access because the standpipe is located on a 3 foot slope and water run-off from the standpipe creates a large amount of ice surrounding it which makes it extremely slippery and dangerous.

In February 2007, 15 new standpipes arrived via the winter road to Garden Hill. These new standpipes are less likely to freeze during the winter months and will provide year round access to residents throughout the community to

[23] Author unable to obtain a photocopy of letter but recorded information provided by WTPO.

collect water closer to their homes [39]. Beginning in the spring of 2007, the new standpipes will be installed. However, the water treatment plant operator informed the author that he was unsure whether the new community standpipes were going to pose the sample problem as previous standpipes, in terms of winter freezing [39].

3.A.2c Cisterns/Water holding tanks[24]

Approximately 70 homes in Garden Hill contain cisterns/water holding tanks [39]. Approximately 10 of these are not being used either because they have not been cleaned or have malfunctioned [36, 39]. For example, in one of the homes visited the cistern was broken and water had leaked throughout the home. In addition, many of the cisterns were placed in small crawl spaces which make them difficult to access for cleaning, maintenance, and repair. The EHO stated in a letter to Chief and Council dated January 17, 2007, "We are very concerned regarding contaminated water cisterns as the homes we have tested. Due to this contaminated water they [the residents of Garden Hill First Nations] should not be drinking it but they have no choice. We tested the water in their homes and results have come back positive for contamination" [see Appendix 11].

[24] Cisterns and water holding tanks are the same thing. The EHO and WTPO use the term cistern while residents of Garden Hill use the term water holding tank.

One community water delivery truck distributes treated water from the water treatment plant directly to cisterns located within homes. However, water delivery is often slow and sporadic as the water delivery driver does not have time to do regular and routine maintenance of cisterns [39]. The CHR and water plant operator have advised the Chief and Council that cisterns should no longer be placed in homes as they are difficult to access and clean [39,40]. For example, in homes where cistern water is stagnant, enteric pathogens that cause diarrhea are more likely to flourish. Residents reported to the author that having a cistern means that you have access to the same quality water as provided by the piped pressurized water system. This raised concerns that the community may not understand that cisterns do not necessarily provide 'good' quality water, without proper cleaning. Throughout the summer 2006 the Chief and Council provided job opportunities for high school students to clean these tanks throughout the community but only 10 of 70 cisterns were cleaned [41].

Both the Water Treatment Plant Operator [WTPO] and the Water Quality Monitor [WQM] reported to the author that they have asked the Chief and Council for funds to establish a community-based cistern cleaning program

[39, 40]. The author was informed that the Chief and Council have allocated funds to this program but they have not yet provided the money to the water treatment plant operator [39, 40]. The WTPO and the WQM stated to the author that a community cistern cleaning program should include the following:

1. A complete list of all homes in Garden Hill that have a cistern, including specific information on how frequently cisterns are replenished, how frequently cisterns water levels are low, how often is the water from the cistern under boil water advisories and how often residents with cisterns have to ration water.
2. Regular and routine surveillance and monitoring of Total Coliform and *E.coli* levels in cisterns and taps.
3. Distribution of bleach to homes for proper cleaning of cisterns and prevention education efforts to teach residents how to do basic cleaning of cistern tanks.
4. A full-time WQM responsible for the daily operations of the community cistern cleaning program.

In February 2007, the EHO wrote in a letter to Garden Hill Chief and Council, "...a cistern cleaning program is vital to ensuring that community residents are provided with a clean potable water supply" (see Appendix 11). In March 2007, more cisterns were delivered via the winter road to Garden Hill. These cisterns are going to be placed in homes located on the outskirts of the community. Homes in this area are up to 10km away from the water treatment plant and it is difficult to build a piped water system to these homes. In a discussion with the WQM, he stated that due to the addition of

more cisterns in homes, there is a greater need for a community wide cistern cleaning program [40].

3. A.2d Lake Water

Many residents obtain water directly from the lake, as this was a traditional custom. Most residents reported using/collecting water from multiple sources for daily use in their homes. For example, many residents collect water from the lake during the summer (due to warmer weather and proximity to the lake) and from standpipes throughout the year. However, in the winter it is more likely that residents collect water from standpipes only. This variation in water sources makes it challenging to identify specific routes of transmission for enteric pathogens.

Over the past several years, along the shores of Island Lake surrounding the community, water samples have consistently tested positive for Total Coliforms and *E.coli* [39]. This is especially true for the shoreline in the Central Area, starting from the water treatment plant, past the old teacher's residence to the Central Area church [39]. As the community is located on an island, during the Spring, Summer, and Fall this area has a high volume of

traffic with many boat water taxis providing transportation to and from the Northern store and adjacent communities.

3.A.2e. Distribution of Houses with Cases of Diarrhea

Areas of the community are named: Keno Town, the causeway, Taylor's Point, Central area, Northend, Southend, Monias Point, Toffey's Point, and Knottsville. Maps 5, 6, 7, 8, and 9 provides the specific location of each house within Garden Hill showing cases with diarrhea. The houses with one or more cases of diarrhea are circled and the study number assigned to the house where the case lives is labeled.

3. A.2f. Location of Homes with Cases of Diarrhea

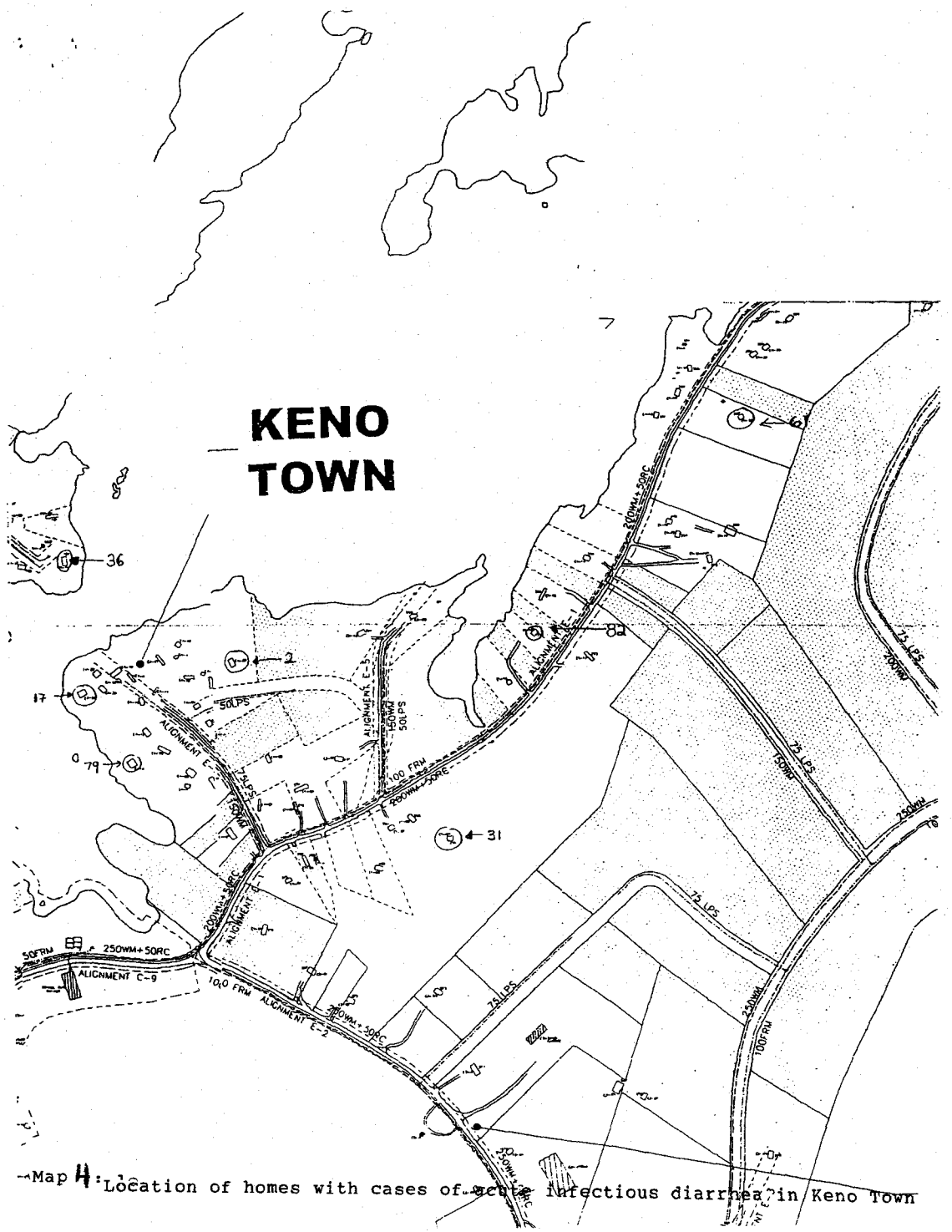
Table 6: Location of Homes with Cases of Acute Infectious Diarrhea by Household ID numbers*.

Household ID Number	Area of Home in Community	Number of People with Diarrhea
36	Keno Town (Map 4)	1
2	Keno Town (Map 4)	1
17	Keno Town (Map 4)	1
79	Keno Town (Map 4)	1
82	Keno Town (Map 4)	1
61	Keno Town (Map 4)	2
31	Keno Town (Map 4)	2
20	Causeway (Map 5)	4
52	Causeway (Map 5)	2
15	Causeway (Map 5)	1
27	Central Area (Map 5)	1
26	Central Area (Map 5)	1
51	Central Area (Map 5)	1
3	Central Area (Map 5)	1
84	Central Area (Map 5)	1
42	Central Area (Map 5)	1
34	Central Area (Map 5)	1
69	Central Area (Map 5)	3
67	Central Area (Map 5)	9
86	Central Area (Map 5)	1
12	Central Area (Map 5)	1
32	Central Area (Map 5)	1
33	Central Area (Map 5)	1
81	Central Area (Map 5)	1
46	Central Area (Map 5)	1
45	Central Area (Map 5)	3
7	Central Area (Map 5)	1
21	Central Area (Map 5)	1
39	Central Area (Map 5)	2
63	Central Area (Map 5)	1
30	Central Area (Map 5)	1
29	Central Area (Map 5)	1
6	Central Area (Map 5)	1
18	Monias Point (Map 5)	1
40	Southend (Map 5)	2
71	Southend (Map 5)	1
19	Southend (Map 5)	1
8	Southend (Map 5)	1
1	Southend (Map 5)	3

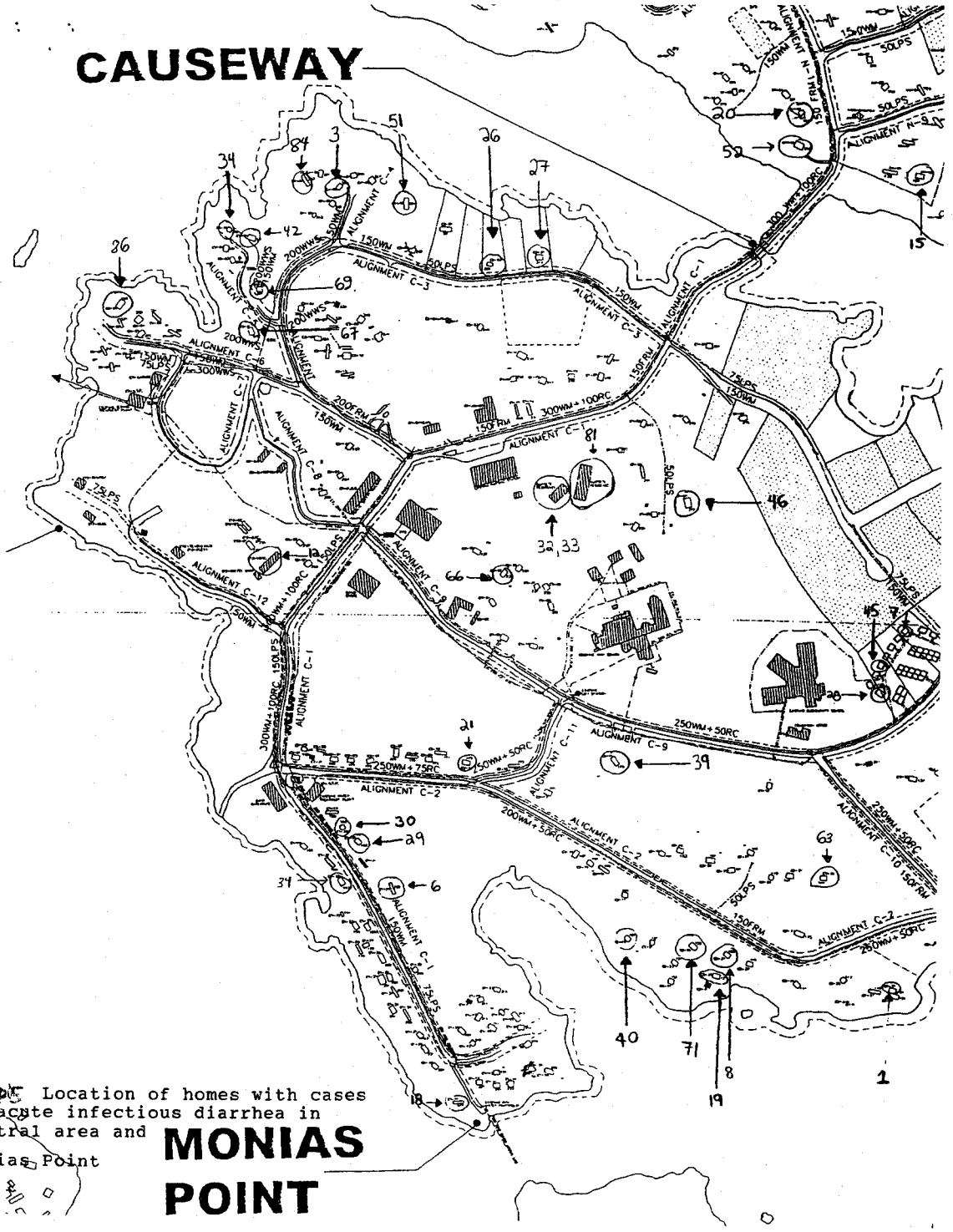
56	Southend (Map 6)	2
41	Southend (Map 6)	1
37	Southend (Map 6)	1
23	Southend (Map 6)	1
65	Southend (Map 6)	1
4	Southend (Map 6)	1
59	Southend (Map 6)	2
11	Toffey's Point (Map 6)	1
13	Toffey's Point (Map 6)	2
48	Northend (Map 7)	1
5	Northend (Map 7)	3
60	Northend (Map 7)	2
50	Northend (Map 7)	2
24	Northend (Map 7)	1
9	Northend (Map 7)	1
35	Knottsville (Map 8)	1
82	Knottsville (Map 8)	1
25	Knottsville (Map 8)	2
68	Knottsville (Map 8)	2
53	Knottsville (Map 8)	2
58	Knottsville (Map 8)	2
81	Knottsville (Map 8)	1
84	Knottsville (Map 8)	1
16	Knottsville (Map 8)	1
57	Knottsville (Map 8)	1
72	Knottsville (Map 8)	1
47	Taylor's Point (Map 8)	2
22	Taylor's Point (Map 8)	8
10	Taylor's Point (Map 8)	1
85	Taylor's Point (Map 8)	4

*Total number of houses 69, missing from maps are household ID numbers: 38, 43, 44, 48, 49, 55, 62, 64, 68, 70, 72, 73, 74, 75, 76, 78, 80, 83, 87,88,89 (missing 21 houses)[25].

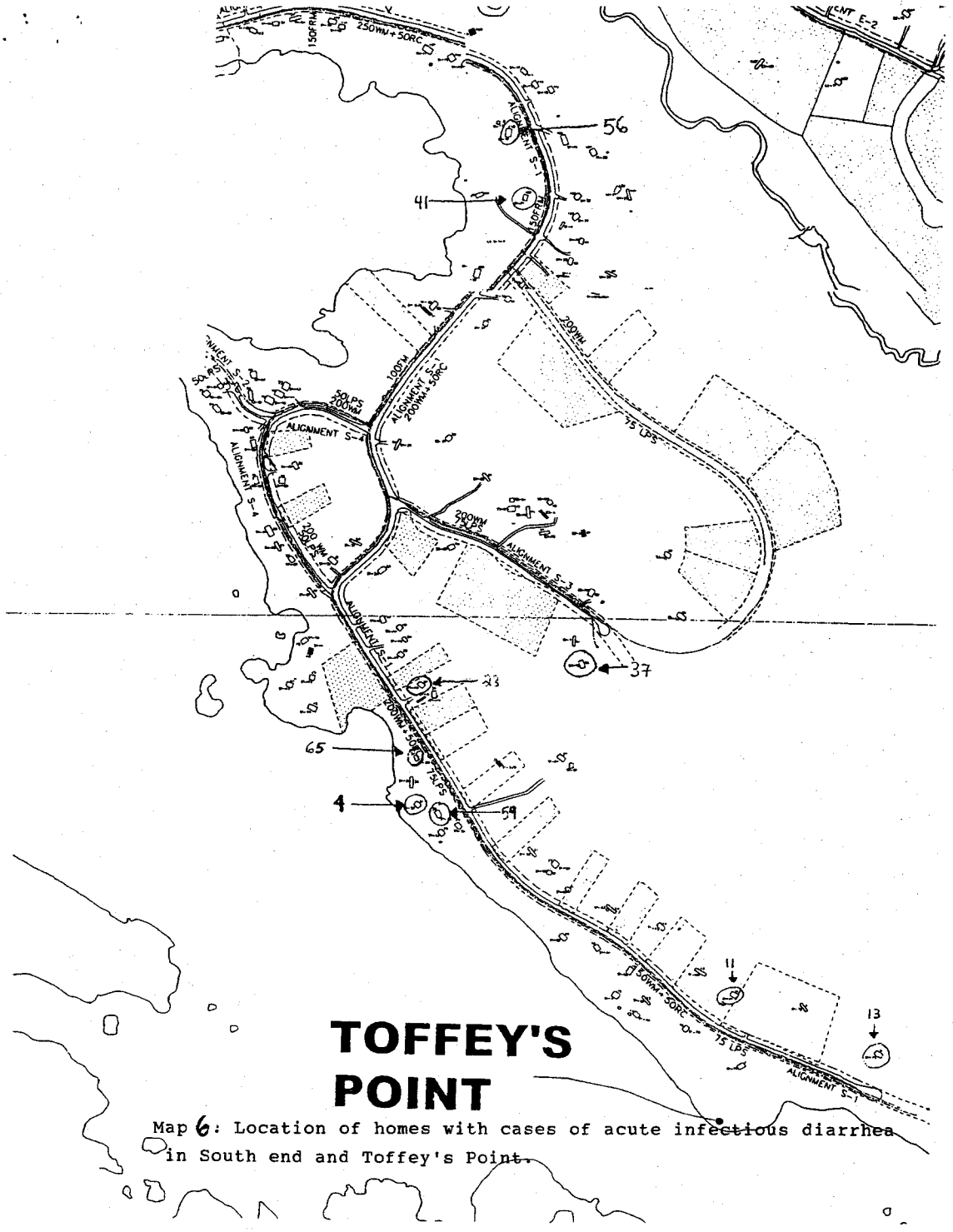
[25] Unable to obtain this information. The author made several requests to CHR to obtain the location of these homes with cases of diarrhea buy has not been provided to date.



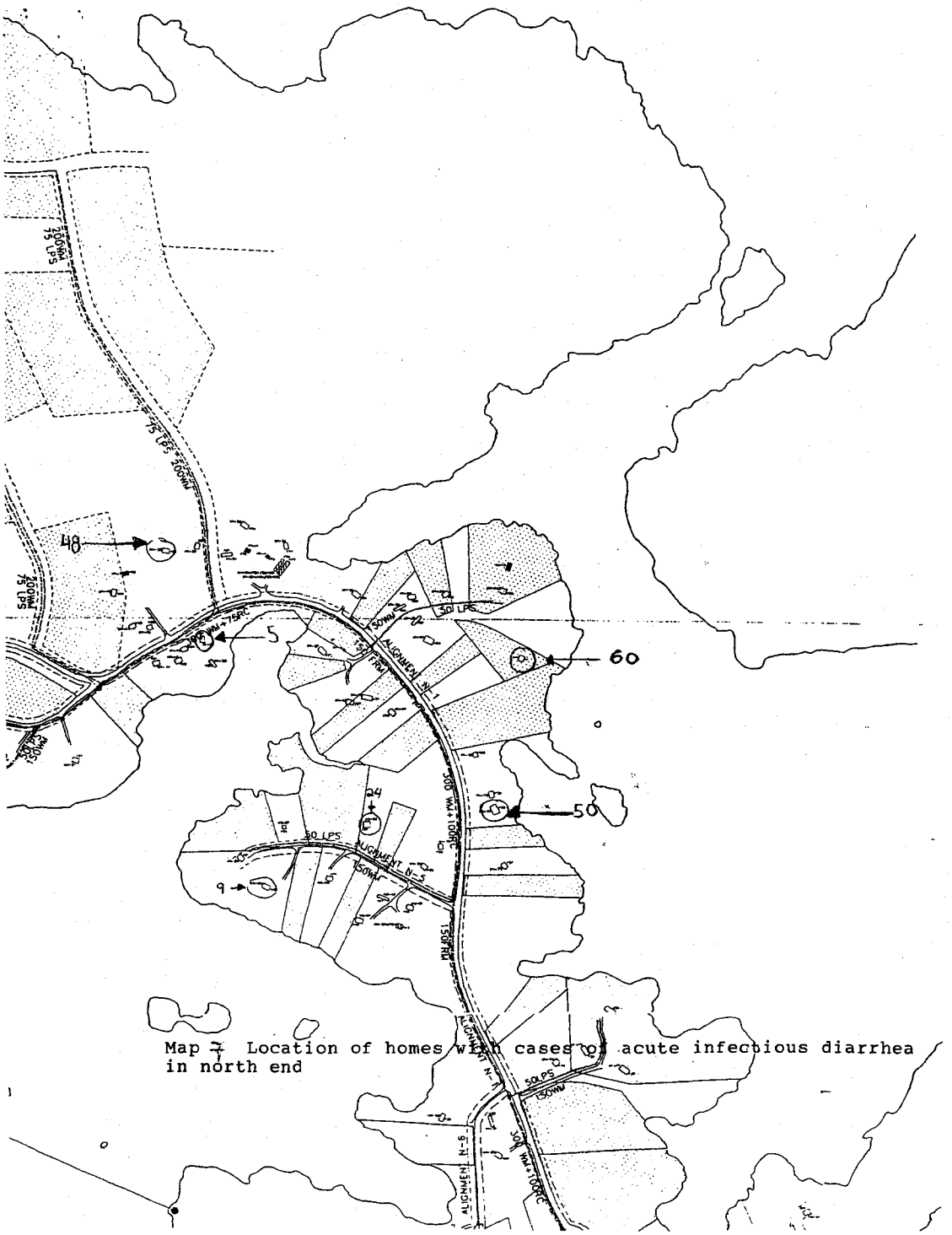
Map 4: Location of homes with cases of acute infectious diarrhea in Keno Town



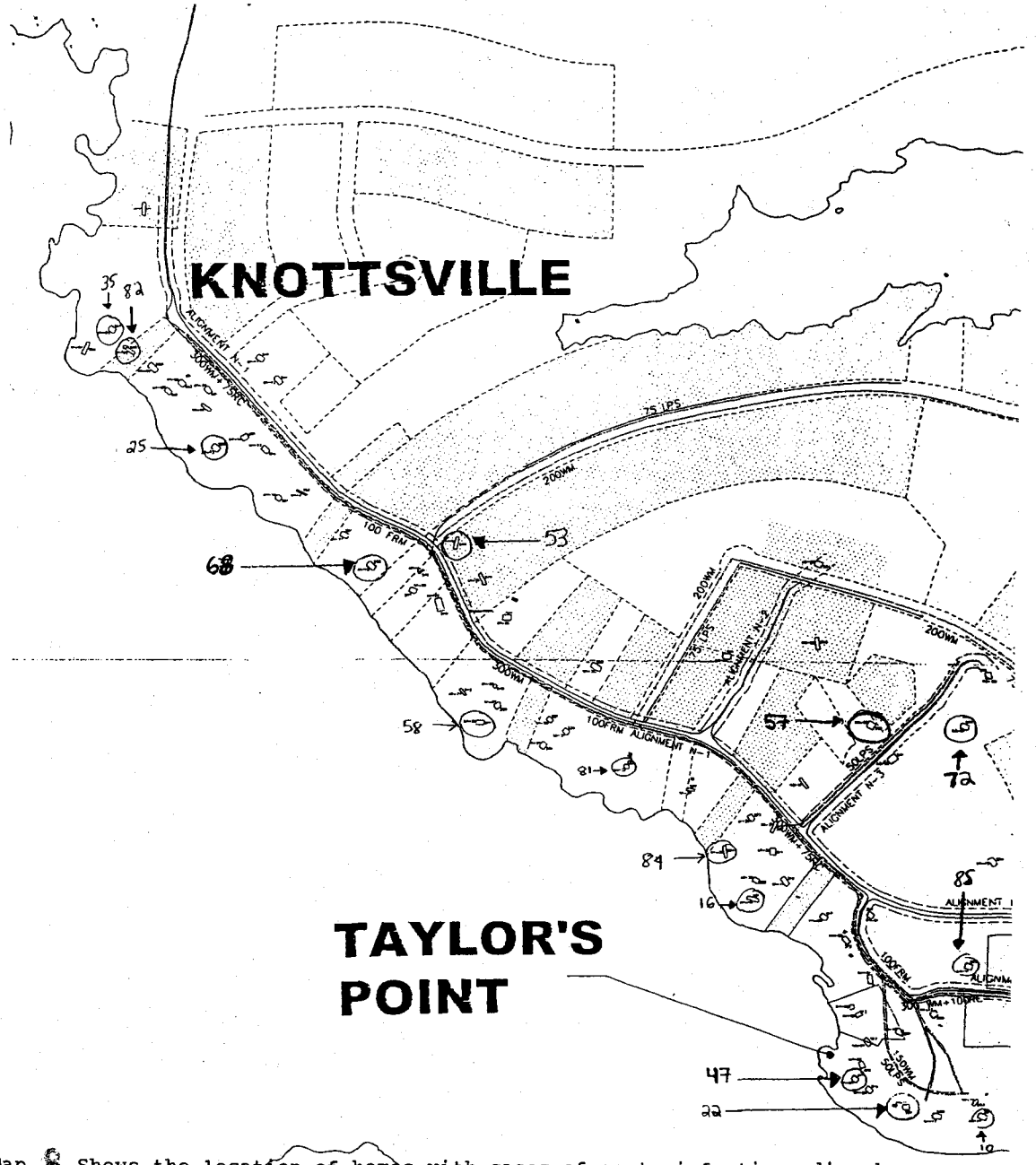
MAP Location of homes with cases acute infectious diarrhea in ntral area and nias Point



Map 6: Location of homes with cases of acute infectious diarrhea in South end and Toffey's Point.



Map 7 Location of homes with cases of acute infectious diarrhea in north end



Map 8 Shows the location of homes with cases of acute infectious diarrhea in Knottsville and Taylor's Point.

3. B. Description of Data

3. B.1 Microorganisms and PCR Results

Between May 1, 2006 and April 31, 2007, a total of 142 stool samples were collected from 142 individuals. One hundred and thirty-eight stools out of 142 stools were tested for bacteria (4 samples were not tested[26]). One hundred and thirty eight stools out of 142 stools were tested for parasites (12 samples were not tested[27]). One hundred and thirty-nine stools out of 142 stools were tested by electron microscopy (3 samples were not tested[28]) and 132 stools out of 142 by PCR for viral pathogens (10 samples were not tested[29]). The 142 participants represent 4.1% (142/3418) of the population of Garden Hill.

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[26] Two samples were not tested because of insufficient quantity and two were not tested because of laboratory error.

[27] Three samples were not tested because of insufficient quantity of stool sample and nine samples were not tested because the containers leaked in transport.

[28] One sample was not tested because insufficient quantity of stool sample and two samples were not tested because of laboratory error.

[29] Four samples were not tested because of laboratory error, six samples were not tested because insufficient quantity of stool sample.

Graph 1: Number of stool samples collected per month (May 1st, 2006 - April 31, 2007), n=142

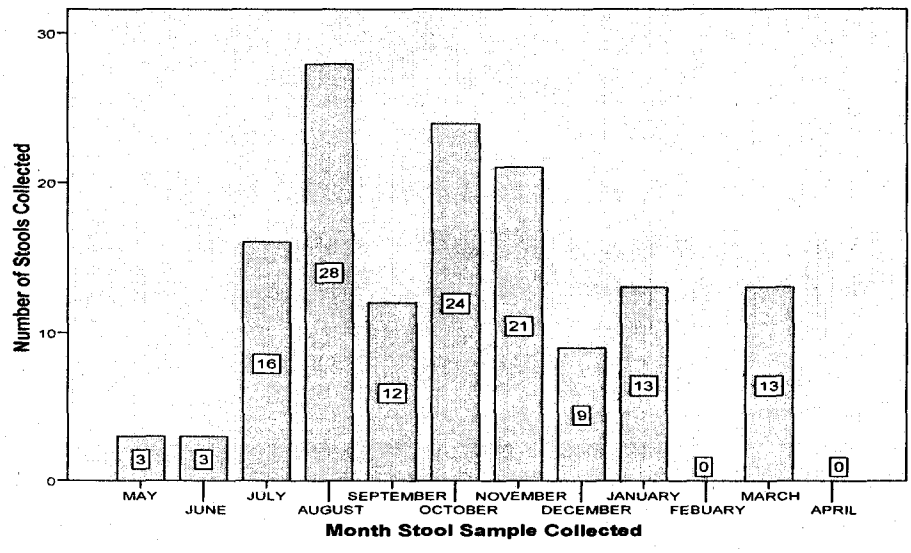


Table 7: Distribution of microorganisms identified in stool samples by standard methods and PCR between May 1, 2006 to April 30, 2007+

Group[30]	Microorganisms Name	Number of Stool Tested	Number of Stool Positive (%)
Bacteria		138	
	*Bacillus cereus**		8/138 (5.8)
	*Campylobacter jejuni**		8/138 (5.8)
	*Aeromonas spp.**		2/138 (1.5)
	*Enteropathogenic E.coli 055**		1/138 (0.7)
	*Salmonella oranienburg**		1/138 (0.7)
	Negative		118/138 (85.5)
Parasites		130	
	*Blastocystis hominis***		8/130 (6.1)
	*Entamoeba coli***		8/130 (6.1)
	*Dientamoeba fragilis **		5/130 (3.8)
	*Endolimax nana***		3/130 (2.3)
	Negative		112/130 (86.2)
Virus – EM		139	
	*Parvolike Virus***		13/139 (9.4)
	*Picornalike Virus***		6/139 (4.3)
	*Calicivirus**		4/139 (2.9)
	*Coronavirus***		2/139 (1.4)
	*Rotavirus**		2/139 (1.4)
	*Small Round Structured Virus***		2/139 (1.4)
	Negative		110/130 (79.2)
Virus – PCR		132	
	Enterovirus*		41/132 (31.1)
	Calicivirus – Norovirus – GGI**		26/132 (19.7)
	Calicivirus – Norovirus – GGII**		25/132 (19.0)
	Astrovirus**		6/132 (4.5)
	Negative		34/132 (25.7)

* Pathogenic Organisms

** Nonpathogenic Organisms

[30]Groups were characterized by either Bacteria, Parasite, Virus identified either by EM or PCR. It is important to note only 1 bacteria was identified in each stool samples from the bacteria group, 1 or more parasite was identified in stool samples from parasite group, 1 virus was identified in stools samples from virus – EM group and 1 or more virus was identified in stool samples from virus – PCR group. In Table 7 - parasites and virus-PCR group with multiple organisms identified in respective groups are included in number of positive stools column.

+ Note: 1 individual tested positive with *Aeromonas spp.* and *Parvolike virus*, 1 individual tested positive with *Enterovirus* and *Parvolike virus*, 2 individuals tested positive with *Parvolike virus* and GGII, 1 individual tested positive with *C.jejuni* and GGII, 1 individual tested positive with *Dientamoeba fragilis* and GGII, 1 individual tested positive with *Calicivirus* and *Enterovirus*, 3 individuals tested positive with *Enterovirus* and GGII, 1 individual tested positive with *Parvolike virus* and *Astrovirus*, 1 individual tested positive with *Dientamoeba fragilis* and *Blastocystis hominis*, 1 individual tested positive with *Entamoeba coli* and *Endolimax nana*, 1 individual tested positive with *C.jejuni* and *Enterovirus*, 1 individual tested positive with *Blastocystis hominis* and GGII, 5 individuals tested positive with GGI and GGII, 1 individual tested positive with *B.cereus* and *Enterovirus*, 1 individual tested positive with *Calicivirus* and *Enterovirus*, 1 individual tested positive with *Astrovirus* and *Enterovirus*, 1 individual tested positive with *Calicivirus* and *Enterovirus*, 1 individual tested positive with *Dientamoeba fragilis* and *Enteropathogenic E.coli 055*, 1 individual tested positive with *Aeromonas spp.* and GGII, 1 individual tested positive with GGII and *Enterovirus*, 1 individual tested positive with *S.oranienberg* and GGI, *SRSV* and GGI, 1 individual tested positive with GGI and *Enterovirus*, 1 individual tested positive with *B.cereus*, *Parvolike virus* and *Enterovirus*, 1 individual tested positive with *C.jejuni*, *Entamoeba coli* and *Astrovirus*, 1 individual tested positive with *Entamoeba coli*, GG1 and *Enterovirus*, 1 individual tested positive with GG1, GG2 and *Enterovirus*, 1 individual tested positive with *Blastocystis hominis*, *Picornalike Virus* and *Enterovirus*, 1 individual tested positive with *B.cereus*, *Blastocystis hominis* and *Picornalike virus*, 1 individual tested positive with *Entamoeba coli*, *Rotavirus*, and GGII, 1 individual tested positive with *B.cereus*, GGI, GGII, and *Enterovirus*, 1 individual tested positive with *B.cereus*, *Coronavirus*, GGI, and *Enterovirus*, 1 individual tested positive with *C.jejuni*, *Entamoeba coli*, *Astrovirus*, GGII, 1 individual tested positive with *C.jejuni*, *Blastocystis Hominis*, *Coronavirus* and *Enterovirus*, 1 individual tested positive with *Blastocystis hominis*, GGI, GGII, and *Enterovirus*, and 1 individual tested positive with *Dientamoeba fragilis*, *Calicivirus*, GGI, GGII and *Enterovirus*.

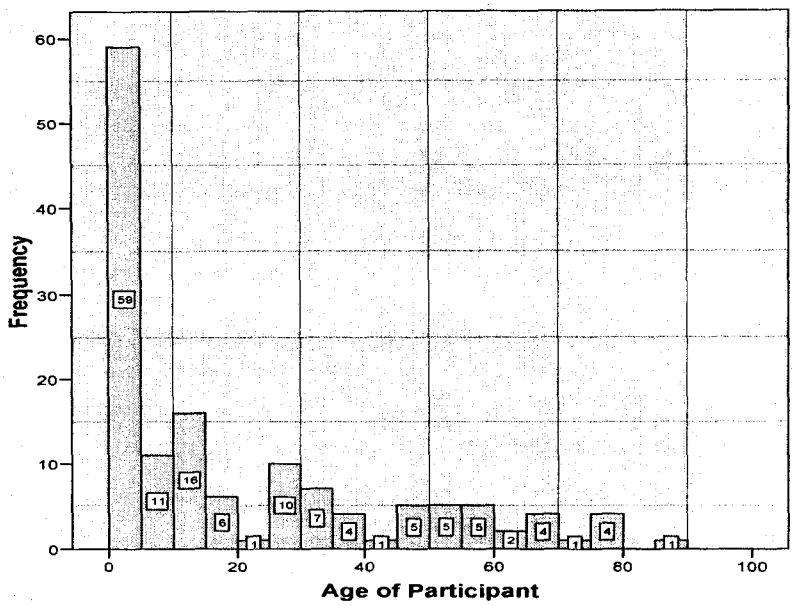
3B.2 Questionnaire Data

3.B.2a. Demographics based on Questionnaire Data

Table 8: Sex distribution of participants, n=142

Sex	Count	Percent
Female	76	53.5 %
Male	66	46.5 %

Graph 2: Frequency by age of participants, n=142



3. B.2b Symptom Data

Table 9: Presence of blood in stool among participants, according to self-reporting, n=142

Presence/absence of blood in stool	Count	Percentage
Presence of blood in stool	21	14.7%
Absence of blood in stool	107	75.3%
Didn't say	14	9.8%

107 of 142 (75.3%) participants reported the presence or absence of blood in stool. 14 of 142 (9.8%) of participants didn't say possibly because they didn't look at their stool or were unable to tell because they used an outhouse or possible because they had other reasons for not responding.

3.B.2c Environmental data: water, housing, and sanitation among participants in the Garden Hill diarrhea study based on questionnaire data

Table 10: Water accessibility in homes of participants, n=142

Water accessibility in homes	Count	Percent
Running water in homes	26	18.3%
No running water in homes	116	81.7%
Total	142	100%

Table 11: Water accessibility in homes by either cistern, piped pressurized water or standpipe water, n = 142

Water accessibility in homes	Count	Percentage
Running water - cistern	16	11.2%
Running water – piped pressurized water	10	5.6%
No running water - standpipe water	116	81.7%
Total	142	100%

Table 11 shows the specific type of running water (could be piped pressurized system or cistern system) or no running water in homes.

Table 12: Type of water storage container in homes, among participants, n=142

Type of water storage container	Count	Percentage
Barrel with dipper	109	76.8%
Barrel with spigot	14	9.9%
Cistern or piped water	19	13.4%
Total	142	100.00

Table 12 indicates that water storage containers in homes of participants involved either a barrel with dipper or barrel with spigot. One-hundred and twenty-three of 142 (86.6%) participants stated that they used a water storage container in their homes; this is a higher number than the total number of participants who stated they did not have running water in the house (116). This was because some homes were put under a boil water advisory by a WQM and/or WTPO, or residents had decided for themselves that the water was not fit for drinking at the time survey was administered [40].

Table 13: Type of drinking water: drink lake water or do not drink lake water, among participants, n=142

Type of drinking water	Count	Percent
Drink lake water	58	40.8%
Do not drink lake water	84	59.2%
Total	142	100.00%

Table 14: Other members of household experiencing diarrhea within past 10 days, n=142

Others with diarrhea	Count	Percent
Yes	73	51.4%
No	69	48.6%
Total	142	100.00

Table 15: Outhouse access among participants, n=142

Outhouse	Count	Percent
Outhouse	82	57.7%
No Outhouse	60	41.5%
Total	142	100.00

Table 16: Type of toilet in homes of participant, n = 142

Type of toilet in home	Count	Percent
Honey bucket	119	83.8%
Flush toilet	23	16.2%
Total	142	100.00

Graph 3: Number of cases by person-per-room (ppr) in homes of participants in the Garden Hill Diarrhea Study, n=142

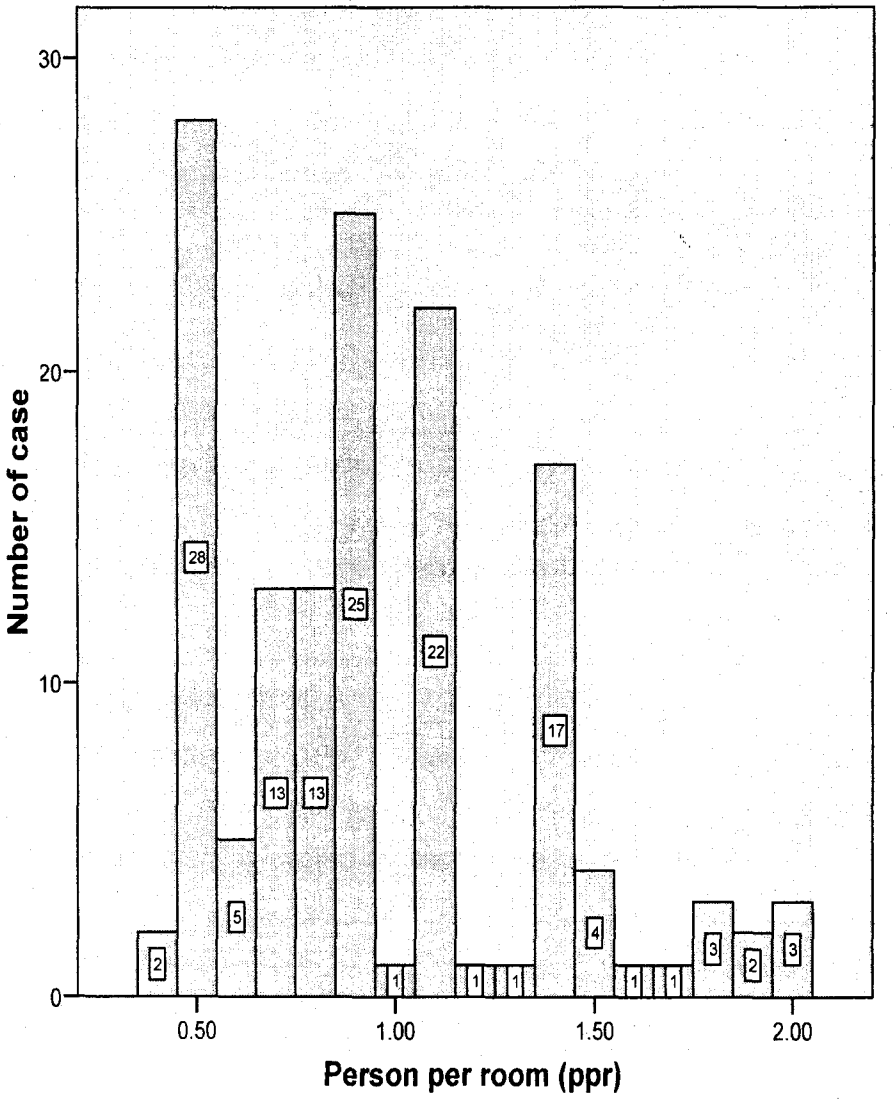


Table 17: Household density number of participants, n=142

Household density	Count (%)
1.00 -1.99	12/142 (8.4)
2.00 – 2.99	56/142 (39.4)
3.00 – 3.99	42/142 (29.5)
4.00 – 4.99	25/142 (17.6)
5.00 – 5.99	6/142 (4.3)
6.00 – 6.99	1/142 (0.8)
Total	142 (100)

There were positive stools identified in clusters from 1 household suggesting possible transmission through household sources. Four of 8 (50%) *B.cereus* positive samples were from one household. Four of 8 (50%) *C.jejuni* positive samples were from one household and 2 of 8 (25%) *C.jejuni* positive stools were from another household. Two of 4 (50%) of *Calicivirus* positive stools identified through EM, were from the one household. Three of 26 (11.5%) of GG1 positive stools identified by PCR were, from one household and 2 of 26 (7.7%) of GGI positive stools identified by PCR were from one household. Three of 25 (12%) of GGII positive stools identified by PCR were identified in one household and 2 of 25 (7.7%) of GGII positive stools identified by PCR were from one household. Two of 41 (4.9%) of *Enterovirus* positive stools identified by PCR were identified in five different households.

3. B.2d Comparison of stool analysis with water, sanitation, and housing characteristics

All stools which tested positive for 2 or more of 1 specific microorganisms were compared with variables which were: running water/no running water (water accessibility), flush/honey bucket(type of toilet), spigot/dipper/running water(water distribution system), drink lake water/no drinking of lake water(type of drinking water), outhouse/no outhouse (access to outhouse), household crowding (defined as > 1.00 ppr, household density (high defined as >2.56).

Table 18: Pathogenic/non-pathogenic microorganisms and variables, significance by p-values.

Pathogens	Water Accessibility	Type of Toilet	Water Distribution System	Type of Drinking Water	Access to an Outhouse	Household Density	Person-Per Room (ppr)
*C. jejuni**	NS	NS	NS	**p=0.01**	NS	NS	NS
*B.cereus**	NS	NS	NS	NS	**p=0.01**	NS	NS
*Aeromonas spp. **	**p=0.01**	NS	NS	NS	**p=0.03**	NS	NS
*S.Oranienberg**	NS	NS	NS	NS	NS	NS	NS
*Enteropathogenic E.coli 055**	NS	NS	NS	NS	NS	NS	NS
*Calicivirus**	NS	NS	NS	**p=0.01**	NS	NS	NS
*Rotavirus**	NS	NS	NS	NS	NS	NS	NS
*GG1***	NS	NS	NS	NS	NS	**p=0.01**	NS
*GG2***	NS	NS	NS	NS	NS	NS	**p=0.03**
Non-pathogens							
*Blastocystis hominis***	NS	NS	NS	**p=0.04**	NS	NS	NS
*Entamoeba coli***	NS	**p=0.03**	NS	NS	NS	NS	NS
*Dientamoeba coli**	NS	NS	NS	NS	NS	NS	NS
*Endolimax nana**	NS	NS	NS	NS	NS	NS	NS
*Coronavirus **	NS	NS	NS	**p=0.02**	**p=0.03**	NS	NS
*Parvolike virus**	NS	NS	NS	NS	NS	NS	NS
*Picornalike virus**	NS	NS	NS	NS	NS	NS	NS
*Small Round Structured Virus (SRSV) **	NS	NS	NS	NS	NS	NS	NS
*Astrovirus**	NS	NS	NS	NS	NS	NS	NS
*Enterovirus **	NS	NS	NS	NS	NS	NS	NS

**Fisher Exact Test*
***Chi-Squared Test*

Table 18 outlines the statistically significant association between organisms in the stool and infrastructure variables: *Aeromonas spp.* and lack of clean water accessibility (water accessibility) (p=0.01), *C.jejuni* and drinking lake water (type of drinking water) (p=0.01), *Calicivirus* and drinking lake water (type of drinking water) (p=0.01), *Aeromonas spp.* and no access to an outhouse (access to an outhouse) (p=0.03), *B.cereus* and no access to an outhouse (access to an outhouse) (p=0.01), GGI and increased home crowding measured by ppr (person-per-room) (p=0.03), GGII and high home density (p=0.01).

The above initial analysis promoted several research questions, as follows:

1. Is there an association between water accessibility (running water vs. no running water) and incidence of microorganisms in stools?

2. Is there an association between type of toilet (flush toilet vs. honey bucket) in homes and incidence of microorganisms in stools?

3. Is there an association between type of drinking water (drinking lake water vs. not drinking lake water) and incidence of microorganisms in stools?

4. Is there an association between water distribution system (barrel with spigot vs. barrel with dipper) in homes and incidence of microorganisms?

5. Is there an association between access to outhouse (having an outhouse vs. not having an outhouse) and incidence of microorganisms in stools?

6. Is there an association between household crowding (above vs. below average Garden Hill ppr of 1.00) and incidence of microorganisms in stools?

7. Is there an association between household density (above vs. below Canadian average housing density number of 2.56) and incidence of microorganisms in stools?

For all research questions (except question 4) a sample size of 122 was used as this was the total number of stools tested for all microorganisms by all methods utilized in this study. For question 4 a sample size of 107 was used as this who the total number of homes which used a water storage container that required the use of either a spigot or dipper.

1) Is there an association between water accessibility and incidence of microorganisms in stools?

Background

- Water accessibility was coded as *0 if there is no running water* and *1 if there is running water* in homes.
- *Presence of microorganisms was coded as 1 if there is one or more microorganism present in stool* and *0 if there is no microorganism in stool.* A microorganism was defined as the presence of one or more microorganism identified through standard methods and the presence of one or more microorganism identified by PCR (see appendix 4 for complete list of microorganisms tested).

Hypothesis

Ho: There is no relationship between water accessibility and microorganisms in stools (independent).
Ha: There is a relationship between water accessibility and microorganism in stools (dependent).

Table 19: Water accessibility and microorganisms, n =122

Microorganisms	**Water accessibility**		Total
	Running water	No running water	
Yes	7	24	31
No	14	77	91
Total	21	101	122

Calculated chi-squared critical value = .840, df = 1
Table chi-squared value = 3.95, .05, with 95% confidence, df=1
p-value = .359 > .05, with 95% confidence, df=1

Conclusion: We fail to reject Ho. There is no detected association between water accessibility and microorganisms.

2) Is there an association between type of toilet in homes and incidence of microorganisms in stools?

Background

- Type of toilet in house was coded as *0 if there was a flush toilet* in the house and *1 is there was a honey bucket* in the homes.
- *Presence of microorganisms was coded as 1 if there is one or more microorganism present in stool* and *0 if there is no microorganism in stool.* A microorganism was defined as the presence of one or more microorganism identified through standard methods and the presence of one or more microorganism identified by PCR (see appendix 4 for complete list of microorganisms tested).

Hypothesis

Ho: There is no relationship between type of toilet in house and microorganisms and/or viral pathogens in stools (independent).
Ha: There is a homogeneous relationship between water type of toilet in the house and microorganisms and/or viral pathogens in stools (are dependent).

Table 20: Type of toilet and microorganisms n=122

Microorganisms	Type of Toilet		Total
	Flush toilet	Honey bucket	
Yes	7	24	31
No	12	79	91
Total	19	103	122

Calculated chi-squared critical value = .1.552, .05, with 95% confidence, df = 1,
Table chi-squared value = 3.95, .05, with 95% confidence, df=1
p-value = .213 > .05, with 95% confidence, df=1

Conclusion: We fail to reject Ho. There is no detected association between type of toilet in the house and microorganisms identified in stool samples.

3) Is there an association between type of drinking water and incidence of microorganisms in stools?

Background:

- Drinking lake water was coded as *0 and not drinking lake water was coded as 1.*
- *Presence of microorganisms was coded as 1 if there is one or more microorganism present in stool* and *0 if there is no microorganism in stool.* A microorganism was defined as the presence of one or more microorganism identified through standard methods and the presence of one or more microorganism identified by PCR (see appendix 4 for complete list of microorganisms tested).

Hypothesis

Ho: There is no relationship between type of drinking water and microorganisms in stools (independent).
Ha: There is a relationship between water type of drinking water and microorganisms in stools (dependent).

Table 21: Type of drinking water and microorganisms, n=122

Microorganisms	Type of drinking water		Total
	Drinks lake water	Does not drink lake water	
Yes	28	3	31
No	44	47	91
Total	72	50	122

Calculated chi-squared critical value = 16.841, .05, with 95% confidence, df = 1,
Table chi-squared value = 3.84, .05, with 95% confidence, df=1
Table chi-squared value = 10.83, .001, with 99% confidence, df=1
Therefore, 16.841 > 3.84, significant relationship with 95% confidence, df =1
Therefore, 16.841 > 10.83 significant relationship with 99% confidence, df = 1
p-value = .001 < .05, with 95% confidence, df=1

Conclusion: We reject Ho and accept Ha. There is an association between drinking lake water and potential pathogens identified in stool samples.

4) Is there an association between water distribution system within the home and incidence of microorganisms?

Background:

- *Water storage container with spigot was coded as 0* and *water storage container with dipper was coded as 1.*
- *Presence of microorganisms was coded as 1 if there is one or more microorganism present in stool* and *0 if there is no microorganism in stool.* A microorganism was defined as the presence of one or more microorganism identified through standard methods and the presence of one or more microorganism identified by PCR (see appendix 4 for complete list of microorganisms tested).

Hypothesis

Ho: There is no relationship between type of water distribution system in the home and microorganisms in stools (independent).
Ha: There is a relationship between water distribution system in the home and microorganisms in stools (are dependent).

Table 22: Water distribution system and microorganisms, n=107

Microorganisms	Water distribution system		Total
	Dipper	Spigot	
Yes	71	11	82
No	22	3	25
Total	93	14	107

Calculated chi-squared critical value = 0.034, .05, with 95% confidence, df = 1,
Table chi-squared value = 3.84, .05, with 95% confidence, df=1
p-value = 0.854 > .05, with 95% confidence, df=1

Conclusion: We fail to reject Ho. There is no detected association between water distribution system and microorganisms identified in stool samples.

5) Is there an association between access to outhouse and incidence of microorganisms in stools?

Background:

- *Use of outhouse near home was coded as 0 and* no outhouse *was coded as 1.*
- *Presence of microorganisms was coded as 1 if there is one or more microorganism present in stool* and *0 if there is no microorganism in stool.* A microorganism was defined as the presence of one or more microorganism identified through standard methods and the presence of one or more microorganism identified by PCR (see appendix 4 for complete list of microorganisms tested).

Hypothesis

Ho: There is no relationship between access to outhouse and microorganisms in stools (independent).
Ha: There is a relationship between access to outhouse and microorganisms in stools (are dependent).

Table 23: Outhouse and microorganisms, n=122

Microorganisms	Outhouse or no outhouse		Total
	Outhouse	No outhouse	
Yes	31	60	91
No	17	14	31
Total	48	74	122

Calculated chi-squared critical value = 4.181, .05, with 95% confidence, df = 1
Table chi-squared value = 3.84, .05, with 95% confidence, df=1
Therefore 4.181 > 3.84, significant relationship with 95% confidence, df = 1
p-value = 0.041 < .05, with 95% confidence, df=1

Conclusion: We reject Ho and accept Ha. There is an association between lack of access to an outhouse and microorganisms identified in stool samples.

6) Is there an association between average ppr and incidence of microorganisms in stools?

Background:

- *Above avg. ppr was coded as 0 and below avg. ppr was coded as 1.* Above average ppr was defined as 1.01 ppr or higher and below average ppr was defined as 1.00 or lower.
- *Presence of microorganisms was coded as 1 if there is one or more microorganism present in stool* and *0 if there is no microorganism in stool.* A microorganism was defined as the presence of one or more microorganism identified through standard methods and the presence of one or more microorganism identified by PCR (see appendix 4 for complete list of microorganisms tested).

Hypothesis

Ho: There is no relationship between average ppr in the home and microorganisms in stools (independent).
Ha: There is a relationship between average ppr in the home and microorganisms in stools (dependent).

Table 24: Below and above average Garden Hill 1.00 ppr and microorganism, n=122

Microorganisms	Below and above average Garden Hill 1.00 ppr		Total
	Above average 1.00 ppr	Below average 1.00 ppr	
Yes	34	57	91
No	13	18	31
Total	47	75	122

Calculated chi-squared critical value = 0.240, .05, with 95% confidence, df = 1,
Table chi-squared value = 3.84, .05, with 95% confidence, df=1
p-value = 0.651 > .05, with 95% confidence, df=1

Conclusion: We fail to reject Ho. There is no detected association between average ppr and microorganisms in stool samples.

7) Is there an association between average housing density number and incidence of microorganisms in stools?

Background:

- *Average housing density above Canadian average was 0* and *Average housing density below Canadian average was coded as 1.*
- *Presence of microorganisms was coded as 1 if there is one or more microorganism present in stool* and *0 if there is no microorganism in stool.* A microorganism was defined as the presence of one or more microorganism identified through standard methods and the presence of one or more microorganism identified by PCR (see appendix 4 for complete list of microorganisms tested).

Hypothesis

Ho: There is no relationship between housing density in the home and microorganisms in stools (independent).
Ha: There is a relationship between housing density in the home and microorganisms in stools (dependent).

Table 25: Above and below 2.56 Canadian average home density and microorganisms, n=122

Microorganisms	Above and below 2.56 Canadian average home density		Total
	Above	Below	
Yes	48	43	91
No	16	15	31
Total	64	58	122

Calculated chi-squared critical value = 0.120, .05, with 95% confidence, df = 1,
Table chi-squared value = 3.84, .05, with 95% confidence, df=1
p-value = 0.913 > .05, with 95% confidence, df=1

Conclusion: We fail to reject Ho. There is no detected association between housing density and microorganisms in stool samples.

From the above 7 research questions it was identified that type of drinking water and lack of access to an outhouse had a statistically significant relationship with microorganisms. Therefore, drinking lake water and microorganisms and having lack of access to an outhouse and microorganisms were both identified at possible risk factors/risk markers for acute infectious diarrhea. However some participants identified (in Table 21, type of toilet and microorganisms) as having a flush toilet were found not to have the toilet's connected to the piped pressurized water system. Residents with flush toilets could have their toilets connected to either the piped pressurized water system or cistern system. However, the author did not discover until near the end of the study, through discussions with community members, that participants from the community had new bathrooms (consisting of bathtub, flush toilet, and sink) installed in homes but some not connected to water systems. This could be a possible reason why no association was identified between type of toilet and microorganisms.

4. 1 Discussion and conclusions

An epidemiological study of the health of Native Americans must be considered within the context of all three points of the epidemiological triangle which include environment, agent and host factors. These study results provide an epidemiological understanding of acute infectious diarrhea within the context of one First Nations community in Canada. Many historical and social factors have influenced the health status of First Nations people in Canada and have promoted a unique environment in which select diseases, such as acute infectious diarrhea, are endemic. The epidemiological transition of many First Nations communities in Canada have resulted in the long-term changes in the health of populations which may be characterized as 3 ages: the age of infectious diseases, age of chronic diseases, and the age of psychological/social ill-health [42]. First Nations people having lived through the epidemiological transition experienced and developed a unique epidemiology with infectious diseases, such as acute infectious diarrhea. After contact with the Europeans, First Nations people transitioned from "...small band epidemiology to large herd epidemiology, often with devastating results" [42].

Traditionally the peoples of Garden Hill were nomadic and traveled, in small group, from one hunting and fishing place to another in pursuit of food [43]. Diseases such as acute infectious diarrhea would likely have been limited to a small group that traveled. An increase in enteropathogens within a small nomadic band may have originated from a point source, without large spread of disease to the entire population. With the establishment of community reserves, the epidemiology of acute infectious diarrhea has been influenced by several key factors: rising on-reserve population, less then adequate infrastructure to support public health through water, sanitation, and housing, and the introduction of new food and food preparation techniques.

There are over 40 microorganisms associated with acute infectious diarrhea. In this study presented here, 142 stool samples were collected from participants who fit the case definition of acute infectious diarrhea. One of the original intents for this study was to determine the incidence of etiological agents associated with cases acute infectious diarrhea. However, early on in the study it was ascertained that it would not be possible to determine the incidence. The reasons for this were: 1) Challenges in recruiting a research assistant to recruit and retain study participants and stool samples, and demanding workload preventing local healthcare staff from

recruiting participants. 2) Patients with acute infectious diarrhea did not self-report. However, it was possible to achieve the second goal of describing potential risk factors with possible associations with specific etiologic microorganisms in recruited cases.

The results of this study confirm that there is a broad range and variety of microorganisms associated with cases of acute infectious diarrhea in a remote First Nations reserve community in Northern Manitoba. *B.cereus*[31] (5.8%) and *C.jejuni*[32] (5.8%) were the most commonly identified bacteria, while others included: *Aeromonas spp.*(1.5%), Enteropathogenic *E.coli* 055 (0.7%), *S. oranienburg* (0.7%). *B.cereus* is a reportable pathogen in Canada that is commonly transmitted through food [44]. *C.jejuni* is a reportable pathogen in Canada that is commonly transmitted through poultry [45]. The predominance of these two pathogenic bacteria infers that transmission through food may play an important role in causation of acute infections diarrhea in this community. It is important to note that the purpose of this study was not to study the potential relationship of dietary intake and diarrhea. Therefore we did not collect data regarding this potential relationship.

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[31] 50% of B.cereus positive stools were obtained from one household over a period of 72 hours.
[32] 50% of C.jejuni positive stools were obtained from one household over a period of 24 hours.

There are limited data to support the etiological role of *Aeromonas spp.* in acute infectious diarrhea. A case-controlled study identified 397 patients with acute diarrhea and 121 patients without acute diarrhea in Mérida, Venezuela between June 1993 to December 1994. The genus *Aeromonas* was identified in 11.83% of case patients and in 5.78% of the control patients, suggesting that the Aeromonas species are potential enteric pathogens in this population [46]. A cohort study in Bangalore, India isolated the genus Aeromonas as the sole bacterial enteric pathogen from 45 (1.8%) of 2,480 patients (age > 5 years) with acute gastroenteritis. Of the 45 Aeromonas isolates, 35 (77.8%) strains were *Aeromonas hydrophila*, 7 (15.5%) strains were *Aeromonas sobria*, and 3 (6.7%) strains were *Aeromonas caviae* [47]. These results highlight the significance of *Aeromonas spp.* in acute infectious diarrhea. *Enteropathogenic E.coli 055* (0.7%) was identified pathogen. A prospective cohort study (amongst infant's ages 0-3 years) to determine prevalence of different strains of enteropathogenic *E.coli* in 56 stools in Chandigarh, India. They found 4/56 stools positive for enteropathogenic *E.coli* (including one strain of 055) and 21 untypable strains of *E.coli*. This study indicates the importance of enteropathogenic *E.coli* in causing diarrhea and the need for characterization of all significant *E.coli* isolated in stools [48].

The common identified non-pathogenic parasites were *Entamoeba coli* (6%), and *Blastocystis hominis* (6%). *Entamoeba coli* and *Blastocystis hominis* cause no known disease in humans: these parasites are considered nonpathogenic [5]. A prospective cohort study conducted in Ilesa, Nigeria to determine the prevalence of parasitic agents among children (age 0-5 years) presenting with acute diarrhea found that out of 300 children, 70 (23.3%) had parasites in their stool and 1.4% were positive for *Entamoeba co*li [49]. A prospective study conducted in Vancouver, British Columbia detected *Blastocystis hominis* in 3.2% of fecal samples from an outpatient (non-hospitalized) population [50]. This study detected *Blastocystis hominis* isolates in 1.1% asymptomatic carriers, 0.8% with acute gastroenteritis and 1.3% with chronic gastroenteritis [50].

Pathogenic viruses identified by EM in our investigation were *Calicivirus* (2.9%) and *Rotavirus* (1.4%). There were a higher number of stool specimens positive for *Calicivirus* compared with *Rotavirus* in our sampled population. This indicates that *Calicivirus* may play a more significant role than rotavirus in this First Nations community. However, the low number of stool samples collected during the spring season could have influenced the low number of *Rotaviruses* identified in this study. This is an important finding when we consider that a new *Rotavirus* vaccine has been developed but not yet

implemented as part of the routine childhood vaccination program in Canada [51].

It is important to note the high number of non-pathogenic *Parvolike viruses* (9.4%) identified in stool samples by EM. *Parvovirus B19* is the only known human strain of *Parvovirus*; however, this strain was not identified by PCR in any of the study stool samples. We may speculate that the organisms seen by EM in our study may be a new strain of *Parvovirus* not previously identified in humans. The origin of the *Parvolike virus* found in this study is unknown. It is possible that infection may occur through transmission from dogs or other animals to humans. Currently the stool samples in which the *Parvolike virus* was detected are being tested at National Microbiology Lab (NML) in an effort to more specifically characterize the strain.

Pathogenic viruses identified by PCR included *Enteroviruses* (31.1%) and *Norovirus* - GGI (19.7%) and *Norovirus* - *GGII* (19%). No *Rotavirus* was detected by PCR. The high number of *Enteroviruses* identified through PCR suggests possible transmission through the fecal-oral route from stools of infected person via water, food or through respiratory secretions [3]. *Norovirus* (a member of the *Calicivaridae* family) is often classified as the

Norovirus (a member of the *Calicivaridae* family) is often classified as the second leading cause of viral diarrhea in the world [52]. *Norovirus* is transmitted primarily through the fecal-oral route or by direct person-to-person spread. Genogroup II is the most prevalent human *Norovirus* genogroup in the world [53]. A review of 55 outbreak investigations of gastroenteritis in the United States between 1987 – 1997 found predominant *Noroviruses* strains sequenced to be: 8 GGII, 2 GGI, 3 belonging to a novel genogroups [54]. A prospective study in Finland followed children (ages 2 months - 2 years) with acute gastroenteritis for rotaviruses, enteric *Adenoviruses*, *Astroviruses*, and human *Caliciviruses*, including both Norwalk-like viruses and Sapporo-like viruses, using PCR [54]. In this study human *Caliciviruses* were as common as *Rotaviruses*, both being detected in 29% of the cases [55].

The present study identifies possible risk factors/markers for acute infectious diarrhea. Chi-squared test and Fisher exact test showed significant association between pathogenic microorganisms isolated from stool specimen and variables as follows: *Aeromonas spp.* and lack of clean water accessibility (p=0.01), *C.jejuni* and drinking lake water (p=0.01), *Calicivirus* and drinking lake water (p=0.01), *Aeromonas spp.* and lack of access to an outhouse (p=0.03), *B.cereus* and lack of access to an outhouse (p=0.01), GGI

and increased home crowding measured by ppr (person-per-room) (p=0.03), GGII and high home density (p=0.01). Chi-squared test showed an association between total microorganisms[33] (n=122) and type drinking water (drinking lake water) (p=0.01) and total microorganisms[34] (n=122) and access to an outhouse (p=0.04).

Methodological issues arose including:

1. Collection of stool samples at varying intervals, from all those presenting themselves (without age stratification) and from convenience sampling resulted in a sample of people recruited that may not represent all those with diarrhea in the community. This raises concerns about the internal validity of the results.

2. An uneven number of stool samples collected each month limits the ability to interpret the temporal data, as it does not capture the true incidence of enteric pathogens. The collection of samples was uneven because there was a loss of local research assistant(s), requiring the author to fly in and out of the community to recruit participants and collect stool samples. Therefore

[33] Total microorganisms refer to stool sample tested by all study methods which included bacteria, parasites, and viruses (by both EM and PCR).
[34] Total microorganisms refer to stool sample tested by all study methods which included bacteria, parasites, and viruses (by both EM and PCR).

it was not possible to collect samples that truly reflect the temporal pattern and distribution of microorganisms associated with acute infectious diarrhea (i.e. days, months, and seasons).

3. The absence of controls limits the interpretation of the data. The absence of controls fails to allow for a comparison group to see if there are characteristics of these patients that differ from those who don't have the disease (controls). It is possible that some microorganisms are present in asymptomatic persons as well as in those with diarrhea. It is also possible that even if controls had been used in this study, true associations between environmental factors (eg. particular types of water supply or sanitation) and diarrhea in the community may not have been statistically apparent if these factors are ubiquitous among cases and controls.

4. As the study was not validated in another year/another population/different geographical site, its results can not be generalized (external validity) to other aboriginal communities. It is unknown whether the sick individuals included in the study reflect the population at large in Garden Hill or in the Island Lake district. Island Lake district is composed of 4 reserve communities and

to the author's knowledge there have been no other epidemiological studies regarding acute infectious diarrhea in this area. Interpretations of these study results must be carefully assessed regarding the possibility of the "ecological fallacy". This fallacy assumes that all members of a group exhibit characteristics of the group at large.

5. Diagnostic bias or misclassification bias – there may have been participants in the study who had non-infectious causes of their diarrhea. For example, some cases of diarrhea may be caused by inflammatory bowel disease (Crohn's disease, or Ulcerative colitis), irritable bowel, dietary causes (eg. lactose intolerance), or antibiotic use. However it should be noted that a population based ecologic study in Manitoba showed that inflammatory bowel disease is rare among Aboriginal people [56].

6. In this study statistically significant associations may identify either risk factors or risk markers for acute infectious diarrhea. A risk factor is causal, whereas a risk marker is associated with an increased probability of the health condition but this association is not necessarily causal. This study did not take into account behavioral (eg. frequency of handwashing) or dietary factors (eg. eating uncooked meat) that might be causative for diarrhea and

which might also be associated with markers which we studied, such as crowded housing.

7. With regard to the question, "Do you have a flush toilet in your home?", it was discovered at the end of the study that some[35] participants who stated they had a flush toilet did not have the toilet connected to the piped pressurized water system. Therefore the data regarding the presence or absence of a flush toilet in homes and potential associations are not reliable.

One of the major strengths of this study is that it provides epidemiological information about diarrhea at the community level. Few studies exist in the medical literature regarding water, sanitation and housing and acute infectious diarrhea in a First Nations reserve community. This is useful for the people of Garden Hill First Nations who experienced an epidemiological transition in their health statues and health determinants. The results of this study are useful for creating awareness within the community and contributing to a dialogue among its residents, particularly regarding the impact of water, sanitation and housing infrastructure in Garden Hill. The author had engaged in discussions with the Health Director and Director of

[35] It was not clear to the author whether some or all participants who stated they had a flush toilet had them connected to the water system.

Public Health in Garden Hill First Nations in which they stated that they perceived water, sanitation and housing infrastructure to be factors in the causation of acute infectious diarrhea. It is hoped that the results of this study will be useful for decision-makers who want to implement health and infrastructure projects.

It is essential to recognize the importance for First Nations communities to have the capacity to engage in research in order to answer questions of importance to them. In some instances this may involve working with universities, governments, and other organizations. This study strengthens the research partnership between the University of Manitoba and a First Nations community. It is vital to note the importance of cultural sensitivity and awareness when conducting research in a First Nations Community. In this study the author frequently flew in and out of the community for various lengths of time. During these visits the author spent time getting to know community members, visiting homes, and attending community events. These factors were important for the success of this study and should not be undervalued in carrying out research in First Nations communities.

The majority of the homes of recruited participants did not have running water. Of the homes with no running water, more used a container with a dipper than a container with spigot for water storage. Of the homes with running water, more used a cistern than piped pressurized water. Within the community there was a perception that the cisterns were dirty and an unhealthy source of drinking water. Seventy-five percent of homes with cisterns randomly tested by author with the assistance of WQM tested positive for total coliforms count of >200 during the Garden Hill diarrhea study. Statistical tests found that an association (p=0.01) between *Aeromonas spp.* and lack of running water to be a risk factor/risk marker for acute infectious diarrhea. Drinking water was defined as running water from a piped water system and has been identified as a causative agent in diarrheal disease. A review of 288 outbreaks (1974-2001) of diarrhea linked to drinking water[36] in Canada found the main causative agents to be, in descending order of frequency: *Giardia, Camplyobacter, Cryptosporidium, Norwalk-like virus, Salmonella and Hepatitis A virus* [55]. *Calicivirus* and drinking lake water was associated (p=0.01) and *C.jejuni* and drinking lake water was associated (p=0.01) as risk marker for acute infectious diarrhea. However, there is no literature documenting an association between these

[36] None of these included First Nations Reserve communities.

microorganisms identified through lake water consumption as causing acute infectious diarrhea.

Overcrowding housing conditions can enhance exposure of susceptible people to infectious enteric pathogens and increase the likelihood of transmission . The average household density in Garden Hill was found to be 2.98 which is slightly higher than the average household density for the general Canadian population which is 2.6 [33]. The average ppr among recruited participants was found to be 0.98 ppr which is higher than the general Canadian population which is 0.4 ppr, but consistent with the average ppr of 1.0 in Garden Hill [33]. GGI and increased home crowding measured by ppr (person-per-room) ($p=0.03$), GGII and high home density ($p=0.01$) were identified as risk factors. This indicated the widespread nature of crowded housing in the community, not just among those with diarrhea but in the community as a whole.

Sanitation refers to the management of human feces at the household level. Fifty-eight percent of participants had access to an outhouse while 42% had no access to an outhouse. *Aeromonas spp.* showed a significant relationship between access to an outhouse and all microorganisms in stool ($p=0.04$). In this study it was found that having access to an outhouse could be protective

against microorganisms that cause acute infectious diarrhea. It is also possible that having access to an outhouse provided better protection against microorganisms than having a honey bucket. The explanation for these findings is not completely clear. Given the need to package and dispose of bagged feces from honey-buckets, the opportunities for contamination of hands and the surrounding indoor and outdoor environments are likely greater with that form of sanitation device than with outhouses. However, because of methodological issues, it is not clear whether using an outhouse is "protective" against diarrhea compare to use of an indoor flush toilet. In Salvador, Brazil, two longitudinal studies (841 children in the 1997 pre-sewage system installation intervention study and 1007 children in the 2003 post-sewage system installation intervention study; age 0-36 months) found that diarrhea prevalence fell by 21% (95% CI 18-25%) - from 9.2 (9.0-9.5) days per child-year before the intervention to 7.3 (7.0-7.5) days per child-year afterwards. They found an overall prevalence reduction of 22% (19-26%) [57]. There were no epidemiological studies identified that showed the relationship between specific etiological microorganisms in stools from cases with acute infectious diarrhea and sanitation.

Conclusions

The results of this study broaden the understanding of the epidemiology of acute infectious diarrhea in a First Nations reserve community in Canada. It was not possible to identify the true incidence of acute infectious diarrhea and its causative enteric pathogens but associations between microorganisms and water, sanitation and housing were identified. These results have implications for First Nations communities in Canada with regard to the importance of improvements of infrastructure within First Nations reserve communities in reducing acute infectious diarrhea. Further research is needed to identify the relationship between specific microorganisms and water, sanitation and housing infrastructure and dietary practices amongst cases of acute infectious diarrhea in First Nations reserve communities in Canada.

Appendix 1 Human Research Ethics Board Approval

UNIVERSITY of MANITOBA

BANNATYNE CAMPUS
Research Ethics Boards

P126-770 Bannatyne Avenue
Winnipeg, Manitoba
Canada R3E 0W3
Tel: (204) 789-3255
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APPROVAL FORM

Principal Investigator: Punam Mehta
Supervisor: Dr. Pam Orr

Protocol Reference Number: H2005:189A
Date of Approval: January 30, 2006
Date of Expiry: January 30, 2007

Protocol Title: "The Epidemiology of Acute Infectious Diarrhea in Garden Hill, First Nations"

The following is/are approved for use:

- **Protocol submitted January 15, 2006**
- **Research Participant Information and Consent Form dated November 1, 2005(approved under H2005:189)**
- **Revised Questionnaire submitted January 15, 2006**

The above underwent expedited review and was **approved as submitted** on January 30, 2006 by Dr. Laine Torgrud, Ph.D., C. Psych., Health Research Ethics Board, Bannatyne Campus, University of Manitoba on behalf of the committee per your letter dated January 15, 2005. The Research Ethics Board is organized and operates according to Health Canada/ICH Good Clinical Practices, Tri-Council Policy Statement, and the applicable laws and regulations of Manitoba. The membership of this Research Ethics Board complies with the membership requirements for Research Ethics Boards defined in Division 5 of the *Food and Drug Regulations*.

This approval is valid for one year only. A study status report must be submitted annually and must accompany your request for re-approval. Any significant changes of the protocol and informed consent form should be reported to the Chair for consideration in advance of implementation of such changes. The REB must be notified regarding discontinuation or study closure.

This approval is for the ethics of human use only. For the logistics of performing the study, approval should be sought form the relevant institution, if required.

Sincerely yours,

Laine Torgrud

Laine Torgrud, Ph.D., C. Psych.
Acting Chair, Health Research Ethics Board
Bannatyne Campus

Please quote the above protocol reference number on all correspondence.
Inquiries should be directed to REB Secretary
Telephone: (204) 789-3883 / Fax: (204) 789-3414

Appendix 2: Garden Hill Chief and Council and Four Arrows Regional Health Health Authority Ethical Approval Letter

Punam Mehta
98 Walnut Street
Winnipeg, Manitoba
R3G 1N8

Re: Letter of Permission: "The Epidemiology of Acute Infectious Diarrhea in Garden Hill, First Nations."

Dear Punam February 15,2006

Thank-you for informing us of your research interests in the Acute Infectious Diarrhea study in Garden Hill, First Nations. We are aware of your student status at the University of Manitoba, Department of Community Health Sciences . We understand that you need ethical approval to engage in your research project. We support your project entitled 'The Epidemiology of Acute Infectious Diarrhea in Garden Hill, First Nations."

We also have been made aware that Punam Mehta will provide the Garden Hill Chief and Council with a report that highlights all significant findings from this project..

From,

Chief Garden Hill, First Nations

Appendix 3: Diarrhea Study Research Assistant Job Description

JOB DESCRIPTION

Guidelines and Responsibilities of Local Assistant for Stool Collection in Garden Hill

The local assistant will be responsible for the collection of each stool sample for the acute infectious diarrhea project in Garden Hill, First Nations. The project will be conducted over one-year commencing May 2006 to April 2007. Each month the local assistant will be responsible for collecting 30 stool samples, which will be transported to a Cadham lab Winnipeg. It is the primary responsibility of the local assistant to ensure that stool samples are collected, labeled, and packaged appropriately for transport to Winnipeg.

Requirements for position: speak local languages, be familiar with the distribution of household throughout the community, know where and who lives in each household, be available throughout the year and able to wait at the Garden Hill Nursing Station until samples are collected on the 5th, 15th, 25th of every month.

GUIDELINES FOR COLLECTING STOOL IN NURSING STATION

1. On the 5th, 15th, 25th of every month stool samples will be collected from the first 5 pediatric and first 5 adult cases of diarrhea from the Garden Hill Nursing Station.
2. Record the patient's household number and case number in master file.
3. Administer a questionnaire to the patient, after the patient has been refereed from the nurse.
4. Ensure entire 2-page questionnaire is completed before collecting stool samples.
5. Give the patient a stool sample container and one wooden stick. Instruct them to use a "HAT" to collect the stool sample. Tell them to use the wooden stick to scoop their stool from the hat and place the stool sample in the container. Instruct the patient, to fill the container with stool to the bottom line of the label.
6. Stool sample will be equally divided into three different containers. Keeping the original container place 1/3 of the sample into second container and 1/3 of the sample into third container.
7. Correctly label all three samples (as shown below). Record on label the date samples were collected, age, and correct case number.
8. Complete the requisition form that accompanies the collected stool sample.
9. Place all confidential written materials locked in filing cabinet in the Garden Hill Nursing Station.
10. Store the stool samples in a safe, temperature appropriate *(4 degrees C)* place in the Garden Hill Nursing Station until they transported back to Winnipeg.

GUIDELINES FOR COLLECTING STOOL FROM PATIENTS IN COMMUNITY

In the event that a patient with diarrhea cannot provide a stool sample while at the nursing station then you must collect sample from patients home.

1. On the 5th, 15th, 25th of every month you will collect stool samples from the first 5 pediatric and first 5 adult cases of diarrhea from the Garden Hill Nursing Station.
2. Record the patient's household number and case number in master file.
3. Administer a questionnaire to the patient, after referral from the nurse.
4. Ensure entire 2-page questionnaire is completed before collecting stool samples.
5. Provide the patient with one stool container – be sure to explain how much stool is needed in container – **tell them DO NOT FREEZE stool.** Provide them with a temperature appropriate stool storage container. Tell them to keep the stool in this special container until pick up.
6. Give the patient a stool sample container with a wooden stick. Instruct and give them a "HAT" to collect the stool sample at home. Tell the patient to place the stool sample in the container. Instruct the patient to fill the container with stool to the top of the black line. Ensure you collect "HAT" from patient's house and return it to the Garden Hill Nursing Station.
7. You will be responsible for collecting stool from patients home and storing it in a safe place in the Garden Hill Nursing Station.
8. Stool sample will be equally divided into three different containers. Keeping the original container, place 1/3 of the sample into a second container and 1/3 of the sample into a third container.
9. Correctly label all three samples (as shown below). Record on label the date samples were collected, age, and correct case number.
10. Complete the requisition form that accompanies the collected stool sample.
11. Place all confidential written materials locked in filing cabinet in the Garden Hill Nursing Station.
12. Store the stool samples in a safe, temperature appropriate *(4 degrees C)* place in the Garden Hill Nursing Station until they transported back to Winnipeg.

Payment

The local assistant will be paid for each stool sample collected and sent to Winnipeg, the local assistant will be given $ _____. In addition, the local assistant will be paid a monthly fee of $_____.

Exceptions

When the 5th, 10th, 25th fall on a weekend, you will begin collecting the samples on the following Monday. For example, April 5, 2006 is a Saturday; you will commence collecting stool samples on Monday, April 3, 2006. You would still follow routine procedures and collect 5 pediatric stool samples and 5 adult stool samples.

Important

ENSURE THAT WHEN STOOL SAMPLE IS TOO SMALL THAT YOU GET MORE STOOL FROM THE PATIENT. DO NOT FREEZE STOOL.

Special Procedures for Infants

All stool samples from infants and children wearing diapers can be collected from diapers by parent/guardian.

Appendix 4: Microorganisms Tested in Stools in the Garden Hill Diarrhea Study

Bacteria : Bacteriologic testing was done for Aeromonas app., *B.cereus*., *C.jejuni, C.difficile*., verotoxins-producing E.coli (E.coli O157:H7 and other verotoxin producing E.coli serotypes, *Pleisomonas spp., Salmonella spp., Shigella spp., S.aureus, Vibrio spp.,* and *Yersinia spp* by standard culture in the microbiology section of CPL.

Parasites: Smears of stools were stained and examined at CPL for Cryptosporidium parvum, Cyclospora, Dientamoeba fragilis, Diphyllobothrium, Entamoeba histolytica, Giardia lamblia, Isospora beli and Microsporidia.

Viruses: Virology testing was conducted at the EM unit, Department of Medical Microbiology, University of Manitoba in conjunction with the Virus detection unit of CPL. . Suspensions of fresh stools were examined for viral pathogens by routine negative stain electron microscopy (NS-TEM)[1]. Viral pathogen suspensions of fresh stools were examined for Picornalike virus, Adenovirus, Astrovirus, Calicivirus, Sapovirus, Enterovirus, Hepatitis A, Poliovirus, and Rotavirus, Small Round Structured Viruses (SRSV), Coronavirus and Parvolike virus. All PCR was conducted in the Department of Medical Microbiology under the supervision of Dr. Paul Hazelton. Stools were tested for Adenovirus, Astrovirus, Norovirus - GGI and GGII, Poliovirus, Rotavirus, Hepatitis A, Sapovirus, Parvovirus b-19[2], and Bocavirus[3].

[1] Dr. Paul Hazelton in the Department of Medical Microbiology, University of Manitoba can be contacted for further information regarding methods.
[2] Tested at NML
[3] Tested at NML

Table 1: Microorganisms tested for but not identified in stool samples from the Garden Hill Diarrhea study

Microorganisms	Lab Method
C.difficile	Culture
Pleisomonas spp	Culture
Salmonella spp	Direct isolation the placement of the fecal material straight onto the agar. 48 hrs incubation, the plates are examined for the presence of Salmonella organisms.
Shigella spp	2 selective media used - a general - purpose plating medium of low selectivity (e.g., MacConkey-MAC) and a more selective agar medium (e.g. xylose lysine desoxycholate agar-XLD).
S.aureus	Culture
Vibrio spp	Culture
Yersinia spp	Culture
Giardia lamblia	Microscopy
Entamoeba histolytica	Microscopy
Microsporidia	Microscopy
Isospora beli	Microscopy
Diphyllobothrium spp	Microscopy
Cyclospora	Microscopy
Cryptosporidium parvum	Microscopy
Reovirus	Internal lab assay directed to S3 gene segment. (PCR)
Parvovirus B-19	Lab internal VP1 specific assay. (PCR)
Hepatitis A virus	Lab Internal assay (PCR)
Reovirus	Internal lab assay directed to S3 gene segment. (PCR)
Poliovirus	5'UTR assay reported by Puig, 1994, based on universal primers from Rotbart. (PCR)

Table 2: Describes the methods used for pathogenic microorganisms identified by standard methods and viral pathogens identified by PCR.

Pathogenic Microorganisms	Lab Methods
Enteropathogenic E.coli 055	Culture. Stool specimen tested on sorbitol-MacConkey (SMAC) agar. 24 hours.
Bacillus Cereus	Culture. [A presumptive test for *Bacillus cereus*.] Uses prepared traditional media. 24 hours
S.Oranienberg	Culture.
Campylobacter jejuni	Cultured and pooled in a tube with 3 ml sterile water and left for approximately 2 min to suspend bacteria.
Enterovirus	5'UTR assay reported by Puig, 1994, based on universal primers from Rotbart.
Hepatitis A virus	Lab Internal assay
Calicivirus – Norovirus – GG1 and GG2	GG1/2 multiplex set - SR33:SR46 & SR33:48/50/52 — Confirmation by Region B amplification using Mon 431/432/433/434.
Rotavirus	VP 6 target assay reported by Gomara in 2002.

Table 3: Describes the methods used for non-pathogenic microorganisms identified by standard methods and viral pathogens identified by PCR.

Non-pathogenic Microorganisms	Lab Methods
Dientamoeba fragilis	Microscopy. Infection is diagnosed through detection of trophozoites in permanently stained fecal smears (e.g., trichrome).
Blastocystis Hominis	Microscopy. Diagnosis is based on finding the cyst-like stage in feces.
Endolimax Coli	Microscopy
Endolimax Nana	Microscopy
Adenovirus	Hexon specific assay reported by Puig – 1994
Astrovirus	Mon 340-348, reported by Beliot – 1997
Hepatitis A virus	Lab Internal assay
Calicivirus – Norovirus –GG1 and GG2	GG1/2 multiplex set - SR33:SR46 & SR33:48/50/52 --- Confirmation by Region B amplification using Mon 431/432/433/434.
Poliovirus	5'UTR assay reported by Puig, 1994, based on universal primers from Rotbart.
Rotavirus	VP 6 target assay reported by Gomara in 2002.
Parvolike virus	Tested at the National Microbiology Laboratories, Winnipeg, MB
Picornalike virus	EM

Appendix 5: Garden Hill diarrhea study informed consent

UNIVERSITY OF MANITOBA

RESEARCH PARTICIPANT INFORMATION AND CONSENT FORM

Title of Study: "Spectrum and Burden of Acute Infectious Diarrhea in a Remote Northern Manitoba Reserve"

Principal Investigator: **Dr. Ethan Rubinstein**
Departments of Medical Microbiology and Medicine
University of Manitoba
501 Basic Medical Sciences
730 William Avenue
Winnipeg, Manitoba, R3E 0W3
204-977-5680

Co-Investigator: **Dr. Paul R. Hazelton**
Department of Medical Microbiology
University of Manitoba
531 Basic Medical Sciences
730 William Avenue
Winnipeg, Manitoba, R3E 0W3
204-789-3313

Dr. John L. Wylie
Cadham Provincial Laboratory
750 William Avenue
Winnipeg, Manitoba, R3C 3Y1
204-945-7473

You are being asked to participate in a research study. Please take your time to review this consent form and discuss any questions you may have with the examining physician or nursing staff. You may take your time to make your decision about participating in this study and you may discuss it with your friends, family or (if applicable) your doctor before you make your decision. This consent form may contain words that you do not understand. Please ask the study staff to explain any words or information that you do not clearly understand.

Purpose of Study

This study is being conducted to determine the different types of bacteria, parasites and viruses causing acute infectious diarrhea (AcID) at the Garden Hill Reserve.

A total of 360 individuals will participate in this study.

Study procedures

If you take part in this study, you will have the following procedures:

You will be asked to provide a fecal sample during your visit to the clinic for treatment of AcID. Your sample will be identified by code number, and your name will not be associated with the sample. We will test the sample for bacteria, parasite and viruses associated with AcID to determine the cause of your diarrhea. If the test results are positive we will compare the results with those for other cases in your community. The results of these tests will also be provided to the clinic. The clinic will be able to link the results to your case to ensure that you receive the best treatment. You will also be asked to provide limited information regarding your age, contact with cases of AcID (that is, whether you have been in contact with someone with AcID), and the type of water and sewage disposal you have in your home.

Participation in the study will only involve the collection of this one stool specimen.

The medical care you receive will be the same whether you participate in the study or not.

The overall results of this study will be available to you as a participant, the Chief and Council, the staff of the Garden Hill Nursing Station, academic institutions and relevant health care providers. No individual will be able to identify you because your name will not be included in the report of results.

Risks and Discomforts

There are no risks in participating in this study.

Benefits

While there may be no direct foreseeable benefit to you from participating in this study, the results of the study may result in improvements in water and waste disposal in your community. In the future, we hope the information learned from this study will benefit other people with AcID.

Costs

All the procedures that are performed as part of this study are provided at no cost to you.

You will receive no payment for participating in this study.

Alternatives

You do not have to participate in this study to receive treatment for your condition.

Confidentiality

Test results for your stool sample will be sent to your physician.

Information gathered in this research study may be published or presented in public forums, however your name and other identifying information will not be used or revealed. Despite efforts to keep your personal information confidential, absolute confidentiality cannot be guaranteed. Your personal information may be disclosed if required by law.

The University of Manitoba Health Research Ethics Board may review records related to the study for quality assurance purposes.

All records will be kept in a locked secure area and only those persons identified will have access to these records. If any of your medical/research records need to be copied to any of the above, your name and all identifying information will be removed. No information revealing any personal information such as your name, address or telephone number will be collected.

Voluntary Participation/Withdrawal from the Study

Your decision to take part in this study is voluntary. You may refuse to participate in the study. Your decision not to participate will not affect your care at this centre.

We will inform you through the Chief and Council about any new information that may affect your health or welfare.

You are not waiving any of your legal rights by signing this consent form nor releasing the investigator(s) or the sponsor(s) from their legal and professional responsibilities.

Questions

You are free to ask any questions that you may have about your treatment and your rights as a research participant. If any questions come up during or after the study or if you have a research-related injury, contact:

Dr. Ethan Rubinstein
Departments of Medical Microbiology and Medicine, University of Manitoba
Work: 204-977-5680
e-mail: rubinste@cc.umanitoba.ca

Dr. Paul Hazelton
Medical Microbiology, University of Manitoba
Work: 204-789-3313
Pager: 204-931-9345
e-mail: paul_hazelton@umanitoba.ca

Dr. John Wylie
Cadham Provincial Laboratory
Work: 204-945-7473
e-mail: jwylie@gov.mb.ca

Title: Spectrum and Burden of Acute Infectious Diarrhea in Remote Northern Manitoba Reserves

For questions about your rights as a research participant, you may contact The University of Manitoba, Bannatyne Campus Research Ethics Board Office at (204) 789-3389

Do not sign this consent form unless you have had a chance to ask questions and have received satisfactory answers to all of your questions.

Statement of Consent

I have read this consent form. I have had the opportunity to discuss this study with Dr. Cristo Baben or his/her study staff. I have had my questions answered by them in language I understand. The risks and benefits have been explained to me. I believe that I have not been unduly influenced by any study team member to participate in the study by any statements or implied statements. Any relationship (such as employer, supervisor or family member) I may have with the study team has not affected my decision to participate. I understand that I will be given a copy of this consent form after signing it. I understand that my participation in this study is voluntary and that I may choose to withdraw at any time. I freely agree to participate in this study.

I understand that information regarding my personal identity will be kept confidential, but that confidentiality is not guaranteed. I authorize the inspection of any of my records that relate to this study by The University of Manitoba Research Ethics Board, for quality assurance purposes.

By signing this consent form, I have not waived any of the legal rights that I have as a participant in a research study.

I agree to be contacted for future follow-up in relation to this study, Yes _ No _

Participant signature: _____ Date _____
(day/month/year)

Participant printed name: _____

Legal Guardian consent for child or person incapable of providing consent

Parent/legal guardian's signature: _____ Date _____
(day/month/year)

Parent/legal guardian's printed name: _____

Child's signature: _____ Date _____
(day/month/year)

Child's printed name: _____

Title: Spectrum and Burden of Acute Infectious Diarrhea in Remote Northern Manitoba Reserves

Third Party Signature

I, the undersigned, attest that the information in the Participant Information and Consent Form was accurately explained to and apparently understood by the participant or the participant's legally acceptable representative and that consent to participate in this study was freely given by the participant or the participant's legally acceptable representative.

Witness signature: _____ **Date** _____
(day/month/year)

Witness printed name: _____

I, the undersigned, have fully explained the relevant details of this research study to the participant named above and believe that the participant has understood and has knowingly given their consent

Printed Name: _____ **Date** _____
(day/month/year)

Signature: _____

Role in the study: ☐ **Clinician**
☐ **Nurse**

Appendix A. List of gastroenteric pathogens for which results may be obtained.

Bacterial:	***(B. cereus,* Campylobacter spp., *C. difficile, E. coli 0157:H7,* verotoxic *E. coli*, Pleisomonas spp., Salmonella spp., Shigella spp., Vibrio spp. and Yersinia spp;**
Parasitic:	**Cryptosporidium parvum, Cyclospora, Dientamoeba fragilis, *Diphyllobothrium spp.*, Entamoeba histolytica, Giardia lamblia, Isospora beli, and Microsporidia; and**
Viral:	**Adenovirus, Astrovirus, Norovirus, Enterovirus, Hepatitis A virus, human Rotavirus, and Poliovirus.**

Appendix 13 Garden Hill diarrhea study questionnaire

Acute Infectious Diarrhea Study – Garden Hill, First Nations

Date Collected ☐☐ ☐☐ ☐☐ **Case Code Number** ☐☐☐☐

Year *Month* *Day*

Household Code Number ☐☐☐☐

Demographics

Date of Birth: ☐☐ ☐☐ **Gender:** Male ☐ Female ☐

Year *Month*

Symptoms

1. How many diarrhea movements (poops) did you have in the last 24 hours? ☐☐

1a. What was your longest duration of diarrhea (poop) in hours? ☐☐

2. Is there any blood in your stool (poop)? ☐ ☐ ☐ ☐

YES *NO* *DON'T KNOW* *DON'T WANT TO SAY*

Contacts

3. How many people sleep and spend the day in your house? ☐☐

4. Have other members of your household had diarrhea within the past 10 days? ☐ ☐ ☐

YES *NO* *DON'T WANT TO SAY*

5. Do you have any children who sleep and spend the day in your house that attend pre-school? ☐ ☐

YES *NO*

5a. If yes, to #5, how many children? ☐☐

6. Do you have any children who sleep and spend the day in your house that go to school (elementary or high school)? ☐ ☐

YES *NO*

6a. If yes, to #6, how many children? ☐☐

7. Do you wash your baby after diarrhea? ☐ ☐ ☐

YES *NO* *DON'T WANT TO SAY*

7a. Do you wash your hands after handling your baby with diarrhea? ☐ ☐ ☐

YES *NO* *DON'T WANT TO SAY*

Water Supply

8. Do you have running water in your house? If no, go to number 9. ☐ ☐ ☐

YES *NO* *DON'T WANT TO SAY*

8a. If yes, to #8, do you use the running water in your house as drinking water? ☐ ☐ ☐

YES *NO* *DON'T WANT TO SAY*

9. Do you get water for your house from the outside taps (standpipes)? ☐ YES ☐ NO ☐ DON'T WANT TO SAY

9a. If yes, to #9, do you drink the outside taps (standpipes) water? ☐ YES ☐ NO ☐ DON'T WANT TO SAY

9b. If yes, to #9, do you boil it for drinking? ☐ YES ☐ NO ☐ DON'T WANT TO SAY

9c. If yes, to #9, do you use the outside taps (standpipes) water during food preparation? ☐ YES ☐ NO ☐ DON'T WANT TO SAY

9d. Do you boil it for food preparation? ☐ YES ☐ NO ☐ DON'T WANT TO SAY

10. Do you drink unboiled lake water? ☐ YES ☐ NO ☐ DON'T WANT TO SAY

11. What kind of receptacle (container) do you put the water in for your house? ☐ BARREL WITH DIPPER ☐ BARREL WITH SPIGOT (SPOUT) ☐ OTHER

11a. Do you regularly wash the receptacle? ☐ YES ☐ NO

12. Do you have a toilet inside your house? ☐ YES ☐ NO ☐ DON'T WANT TO SAY

12a. What kind of toilet? ☐ FLUSH ☐ HONEY BUCKET ☐ OTHER

13. Do you use an outhouse behind your house? ☐ YES ☐ NO ☐ DON'T WANT TO SAY

14. Do you wash regularly wash you hands after using the toilet, either inside or outside your house? ☐ YES ☐ NO ☐ DON'T WANT TO SAY

15. Do you think the quality of water in your community is good? ☐ YES ☐ NO ☐ DON'T WANT TO SAY

15a. If no, to # 15, then please explain why? _____

16. Do you think food has caused your diarrhea? ☐ YES ☐ NO ☐ DON'T WANT TO SAY

17. What do you think caused your diarrhea? _____

Appendix 7: Changes to Study Design

1) Research assistants and research activities

Table 1: Employment dates of research assistants (May 1, 2006 – April 30, 2007)

Research assistant	Employment dates
Research assistant # 1	May 1 - July 31
Research assistant # 2	September 1 – Oct.1
Research assistant # 3	Oct .12 – April 30, 2007

Table 2: Details of activities

Visit dates of researcher	Details of activities	Number of stool samples collected each visit
1) December 27, 2005	One day visit, drive through community, visit schools and daycare, pilot tested survey	Studies had not begun
2) February 8 – 13, 2006	Establishment of project, meeting with nurses/nurse-in-charge and CHR, office set up with study supplies.	0
3) May 15 – May 19, 2006	Collection of samples, TV presentations, meeting with CHR, accompany CHR on home visits.	3
4) June 5 – June 10, 2006	Collection of samples, TV presentations	2
5) July 24 – August 1, 2006	Collection of samples, TV presentations, door-to-door visits.	13
6) August 7 – September 5, 2006	Collection of samples, TV presentations, met with daycare staff, door-to-door visits to delivery kits, recruitment of patients throughout out nursing stations and community.	29
7) September 20, 2006	One day visit – meet with research assistant to discuss progress of project.	0
8) October 10 – 27, 2006	Collection of samples, TV presentations, recruited patients in nursing stations and community	22
9) November 20 – November 29, 2006	Collection of samples , TV presentations, met with chief and council.	14
10) December 4 – December 8, 2006	Collection of samples, TV presentations	8
11) January 15 – January 19, 2007	Collection of samples, TV presentations	6
12) March 7 – March 20, 2007	Collection of samples, water samples collection, TV presentations	13
13) April 24, 2007	Final Report to CHR and clean-up of project.	0

2) Challenges with stool collection: All research assistants experienced tremendous personal/family problems while working on this project.

3) It was difficult to overcome collective community sensitivities to stool sample collection.

A great deal of time was taken by community leaders especially CHR and church elders to support the Garden Hill diarrhea project. Through daily public health TV announcements, monthly TV presentations, poster and pamphlet distribution, people became more open about participating in the study. People in the community began to understand the importance of this study.

4) It was difficult to get nurses to assist in stool sample collection as this was considered 'extra' work in a setting where nurses already are overworked. During a regular week (9-5pm) there are on average 4-6 nurses working at the Garden Hill nursing station. FNIH specifies that to run the Garden Hill nursing station effectively there must be at minimum 8 nurses working full-time. Therefore the nursing station was consistently understaffed.

Appendix 8 : Garden Hill Diarrhea study poster template

EVERYONE IS AT RISK FOR DIARRHEA

THE COMMMUNITY NEEDS YOUR HELP!

Diarrhea is something nobody likes to talk about but everybody gets it....

Do you suffer from any of these?

-Frequent or loose,
Watery or bloody poop

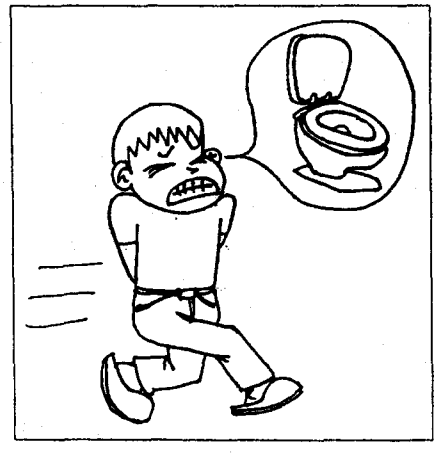
- Cramps or pain

- Fever

- Bleeding

- Nausea

- Vomiting



PROVIDE A STOOL SAMPLE

RECRUITING BOTH CHILDREN AND ADULTS

TELL NURSING STATION STAFF OR DOCTOR YOU WOULD LIKE TO BE PART OF THIS IMPORTANT STUDY

RESULTS WILL BE USED TO IMPROVE TREATMENT AND PREVENTION

STUDY DATES: May 2006 - May 2007

THE COMMUNITY NEEDS YOUR HELP

rden Hill, First Nations

Diarrhea Study:

of the Garden Hill, First Nations
dy is to find out what is causing
arden Hill, First Nations.

Hill Chief and Council, the Univer-
ba's Northern Medical Unit, and
nt of Medical Microbiology are
is study.

e needed over the next year (May
08) for this study.

Garden Hill Nursing Station
Garden Hill, First Nations
204-456-2343

J.A. Hildes Northern Medical Unit
Department of Community Health Sciences
University of Manitoba
T-162 770 Bannatyne Ave.,
Winnipeg, MB, R3E 0W3
204.789.3711

J.A. Hildes Northern Medical Unit

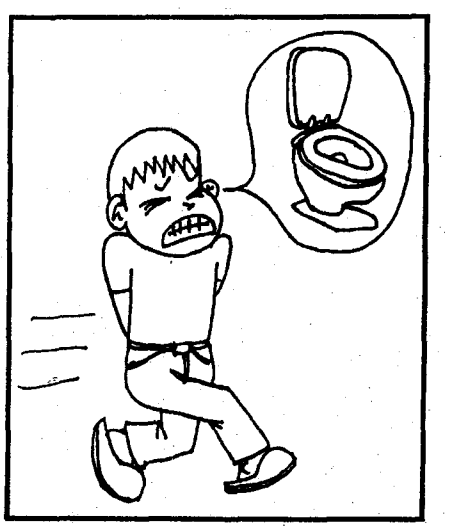
University of Manitoba

REDUCING DIARRHEAL DISEASE

The Garden Hill, First Nations Diarrhea Study

Please telephone the Garden Hill, First Nations Diarrhea Study at:

456-2343



EVERYBODY GETS THE POOPS

3 or more loose poops in a 24 hour period.

ɜease that can affect males and

ɪtter what age.

:hild have ONE or more of these ptoms:

t of loose or bloody or watery poop

ɪmps or pain

en you poop

ı or feeling like you have to throw up

ase provide a poop for the Diarrhea study.

ı (18 years or less) and adults with needed.

a resident of Garden Hill, First Na- :ipate

ɔking for 40 different bugs in poop arr!ea.

ɔple about the study and ask them

If you or your child have Diarrhea please call the Garden Hill, Nursing Station at 456-2343

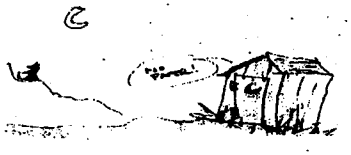
After you call the Garden Hill, First Nations Diarrhea Study.

- Your name will be put on a list and someone from the nursing station will visit your home.
- Don't worry! Your name will not be associated with the poop sample - it will be kept secret.

During the visit:

1. You or your child will be asked to provide a poop sample
2. Sign Informed Consent form.
3. Fill in a short form.

- The form will ask you to provide limited information regarding your age, contact with other cases of diarrhea, and type of water supply in your home.
- Your stool sample will be sent to Cadham Provincial lab in Winnipeg, for testing.



- Lab results will be sent to the Garden Hill Nursing Station for follow -up treatment.
- Each participant will receive follow-up treatment at Garden Hill, Nursing Station.
- We hope the information learned from this study will benefit other people in your community with diarrhea.
- It will take up to 4 weeks for follow-up treatment because of lab analysis and shipping of samples from Garden Hill to Winnipeg.

The results from this study will hopefully result in Diarrhea prevention in the community.

- The overall results of this study will be available to the Garden Hill Chief and Council, the staff of the Garden Hill Nursing Station, and relevant health care providers.
- A talk will be made on the Garden Hill local TV station and to the Garden Hill Chief and Council.

ALS Laboratory Group Analysis Report

Date Received: 16-MAR-07
Date Reported: 19-MAR-07

Appendix 10: ASL laboratory testing results from random water samples collected in Garden Hill

Lab SampleNum: **L487230-1**
Job Description: GARDEN HILL FIRST NATION
Sample ID: #1 (CISTERN)
Sample Source: WATER - MUNICIPAL TREATED (CISTERN)
Date Sampled: 15-MAR-07
Submitted By: Punam Mehta

MB WATER STEWARDSHIP SUBSIDY PROGRAM
ATTN: PUNAM MEHTA
98 WALNUT STREET

WINNIPEG MB R3G 1N8

Test Description		Result	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli						
Total Coliform	PASSED	0	MPN/100mL	0		17-MAR-07
Escherichia Coli	PASSED	0	MPN/100mL	0		17-MAR-07

This water sample has PASSED and therefore meets the Canadian Drinking Water Quality Guidelines (CDWQG) for bacteria in drinking water.
For further information on wells and water testing contact your local Manitoba Conservation Office or Health Links at 204-788-8200 Toll Free 1-888-315-925

QT-MPN/MPNU- a colour reaction (positive) is produced to indicate the presence of Total coliform and E.coli.
The number of positive cells is converted to a statistical number Most Probable Number units or MPN/MPNU.

Approved by Robert S. Kitlar
ROBERT S. KITLAR
Project Manager

ALS Laboratory Group Analysis Report

Date Received: 16-MAR-07
Date Reported: 19-MAR-07

Lab SampleNum: **L487230-2**
Job Description: GARDEN HILL FIRST NATION
Sample ID: #2 (CISTERN)
Sample Source: WATER - MUNICIPAL TREATED (CISTERN)
Date Sampled: 15-MAR-07
Submitted By: Punam Mehta

MB WATER STEWARDSHIP SUBSIDY PROGRAM
ATTN: PUNAM MEHTA
98 WALNUT STREET

WINNIPEG MB R3G 1N8

Test Description		Result	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli						
Total Coliform	** FAILED	>200	MPN/100mL	0		17-MAR-07
Escherichia Coli	PASSED	0	MPN/100mL	0		17-MAR-07

** This water sample has FAILED to meet the Canadian Drinking Water Quality Guidelines (CDWQG) for bacteria in drinking water.

Until the bacterial safety of your water supply can be confirmed, water for drinking purposes should be brought to a rolling boil for one minute. This applies to water used for making infant formula and juices, making ice, washing fruits and vegetables, and brushing teeth.

Discard all ice made and disinfect ice cube trays. Small children who may drink bath water should receive sponge baths instead of baths or showers. Alternate safe supplies of water, such as bottled water, can also be used. The water can be used for other household purposes such as bathing, showering, dishwashing, and laundry. See the attached fact sheet: "What do I do when a boil water advisory is issued ?". Read the section: "How do I use water when the boil water advisory has been issued for drinking water only ?". If you have received this report by e-mail please see http://www.gov.mb.ca/health/publichealth/cmoh/water.html for the fact sheets.
For further information on wells and water testing contact your local Manitoba Conservation Office or Health Links at 204-788-8200 Toll Free 1-888-315-9257.

QT-MPN/MPNU- a colour reaction (positive) is produced to indicate the presence of Total coliform and E.coli.
The number of positive cells is converted to a statistical number Most Probable Number units or MPN/MPNU.

Please remit this coupon for a
FREE
Resample of Sample Number L487230-2

PUNAM MEHTA
98 WALNUT STREET

Only Original Will Be Accepted

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Approved by Robert S. Kitlar
ROBERT S. KITLAR
Project Manager

ALS Laboratory Group 1329 Niakwa Road East, Unit 12, Winnipeg, MB R2J 3T4 Phone: (204) 255-9720 Fax: (204) 255-9721

ALS Laboratory Group Analysis Report

Date Received: 16-MAR-07
Date Reported: 19-MAR-07

Lab SampleNum: L487230-3
Job Description: GARDEN HILL FIRST NATION
Sample ID: #3 (CISTERN)
Sample Source: WATER - MUNICIPAL TREATED (CISTERN)
Date Sampled: 15-MAR-07
Submitted By: Punam Mehta

MB WATER STEWARDSHIP SUBSIDY PROGRAM
ATTN: PUNAM MEHTA
98 WALNUT STREET

WINNIPEG MB R3G 1N8

Test Description		Result	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli						
Total Coliform	PASSED	0	MPN/100mL	0		17-MAR-07
Escherichia Coli	PASSED	0	MPN/100mL	0		17-MAR-07

This water sample has PASSED and therefore meets the Canadian Drinking Water Quality Guidelines (CDWQG) for bacteria in drinking water.
For further information on wells and water testing contact your local Manitoba Conservation Office or Health Links at 204-788-8200 Toll Free 1-888-315-9257.

QT-MPN/MPNU- a colour reaction (positive) is produced to indicate the presence of Total coliform and E.coli.
The number of positive cells is converted to a statistical number Most Probable Number units or MPN/MPNU.

Approved by _____
ROBERT S. KITLAR
Project Manager

23A

Job Description: GARDEN HILL FIRST NATION
Sample ID: #5 (CISTERN)
Sample Source: WATER - MUNICIPAL TREATED (CISTERN)
Date Sampled: 15-MAR-07
Submitted By: Punam Mehta

MB WATER STEWARDSHIP SUBSIDY PROGRAM
ATTN: PUNAM MEHTA
98 WALNUT STREET

WINNIPEG MB R3G 1N8

Test Description		Result	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli						
Total Coliform	** FAILED	>200	MPN/100mL	0		17-MAR-07
Escherichia Coli	PASSED	0	MPN/100mL	0		17-MAR-07

** This water sample has FAILED to meet the Canadian Drinking Water Quality Guidelines (CDWQG) for bacteria in drinking water.

Until the bacterial safety of your water supply can be confirmed, water for drinking purposes should be brought to a rolling boil for one minute. This applies to water used for making infant formula and juices, making ice, washing fruits and vegetables, and brushing teeth.

Discard all ice made and disinfect ice cube trays. Small children who may drink bath water should receive sponge baths instead of baths or showers. Alternate safe supplies of water, such as bottled water, can also be used. The water can be used for other household purposes such as bathing, showering, dishwashing, and laundry. See the attached fact sheet: "What do I do when a boil water advisory is issued ?". Read the section: "How do I use water when the boil water advisory has been issued for drinking water only ?". If you have received this report by e-mail please see http://www.gov.mb.ca/health/publichealth/cmoh/water.html for the fact sheets.
For further information on wells and water testing contact your local Manitoba Conservation Office or Health Links at 204-788-8200 Toll Free 1-888-315-9257.

QT-MPN/MPNU- a colour reaction (positive) is produced to indicate the presence of Total coliform and E.coli.
The number of positive cells is converted to a statistical number Most Probable Number units or MPN/MPNU.

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Approved by Robert S. Kitlar
ROBERT S KITLAR
Project Manager

24A

ALS Laboratory Group Analysis Report

Date Received: 16-MAR-07
Date Reported: 19-MAR-07

Lab SampleNum: **L487230-6**
Job Description: GARDEN HILL FIRST NATION
Sample ID: #6 (CISTERN)
Sample Source: WATER - MUNICIPAL TREATED (CISTERN)
Date Sampled: 15-MAR-07
Submitted By: Punam Mehta

MB WATER STEWARDSHIP SUBSIDY PROGRAM
ATTN: PUNAM MEHTA
98 WALNUT STREET

WINNIPEG MB R3G 1N8

Test Description		Result	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli						
Total Coliform	** FAILED	>200	MPN/100mL	0		17-MAR-07
Escherichia Coli	PASSED	0	MPN/100mL	0		17-MAR-07

** This water sample has FAILED to meet the Canadian Drinking Water Quality Guidelines (CDWQG) for bacteria in drinking water.

Until the bacterial safety of your water supply can be confirmed, water for drinking purposes should be brought to a rolling boil for one minute. This applies to water used for making infant formula and juices, making ice, washing fruits and vegetables, and brushing teeth.

Discard all ice made and disinfect ice cube trays. Small children who may drink bath water should receive sponge baths instead of baths or showers. Alternate safe supplies of water, such as bottled water, can also be used. The water can be used for other household purposes such as bathing, showering, dishwashing, and laundry. See the attached fact sheet: "What do I do when a boil water advisory is issued ?". Read the section: "How do I use water when the boil water advisory has been issued for drinking water only ?". If you have received this report by e-mail please see http://www.gov.mb.ca/health/publichealth/cmoh/water.html for the fact sheets.
For further information on wells and water testing contact your local Manitoba Conservation Office or Health Links at 204-788-8200 Toll Free 1-888-315-9257.

QT-MPN/MPNU- a colour reaction (positive) is produced to indicate the presence of Total coliform and E.coli.
The number of positive cells is converted to a statistical number Most Probable Number units or MPN/MPNU.

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Date Sampled: 15-MAR-07

Expires March 31, 2007

Approved by Robert S. Kitlar
ROBERT S. KITLAR
Project Manager

26A

ALS Laboratory Group Analysis Report

Date Received: 16-MAR-07
Date Reported: 19-MAR-07

Lab SampleNum: **L487230-7**
Job Description: GARDEN HILL FIRST NATION
Sample ID: #7 (CISTERN)
Sample Source: WATER - MUNICIPAL TREATED (CISTERN)
Date Sampled: 15-MAR-07
Submitted By: Punam Mehta

MB WATER STEWARDSHIP SUBSIDY PROGRAM
ATTN: PUNAM MEHTA
98 WALNUT STREET

WINNIPEG MB R3G 1N8

Test Description		Result	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli						
Total Coliform	** FAILED	2	MPN/100mL	0		17-MAR-07
Escherichia Coli	PASSED	0	MPN/100mL	0		17-MAR-07

** This water sample has FAILED to meet the Canadian Drinking Water Quality Guidelines (CDWQG) for bacteria in drinking water.

Until the bacterial safety of your water supply can be confirmed, water for drinking purposes should be brought to a rolling boil for one minute. This applies to water used for making infant formula and juices, making ice, washing fruits and vegetables, and brushing teeth.

Discard all ice made and disinfect ice cube trays. Small children who may drink bath water should receive sponge baths instead of baths or showers. Alternate safe supplies of water, such as bottled water, can also be used. The water can be used for other household purposes such as bathing, showering, dishwashing, and laundry. See the attached fact sheet: "What do I do when a boil water advisory is issued ?". Read the section: "How do I use water when the boil water advisory has been issued for drinking water only ?". If you have received this report by e-mail please see http://www.gov.mb.ca/health/publichealth/cmoh/water.html for the fact sheets.
For further information on wells and water testing contact your local Manitoba Conservation Office or Health Links at 204-788-8200 Toll Free 1-888-315-9257.

QT-MPN/MPNU- a colour reaction (positive) is produced to indicate the presence of Total coliform and E.coli.
The number of positive cells is converted to a statistical number Most Probable Number units or MPN/MPNU.

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Date Sampled: 15-MAR-07

Expires March 31, 2007

Approved by _____
ROBERT S. KITLAR
Project Manager

27A

ALS Laboratory Group Analysis Report

Date Received: 16-MAR-07
Date Reported: 19-MAR-07

Lab SampleNum: **L487230-8**
Job Description: GARDEN HILL FIRST NATION
Sample ID: #8 (CISTERN)
Sample Source: WATER - MUNICIPAL TREATED (CISTERN)
Date Sampled: 15-MAR-07
Submitted By: Punam Mehta

MB WATER STEWARDSHIP SUBSIDY PROGRAM
ATTN: PUNAM MEHTA
98 WALNUT STREET

WINNIPEG MB R3G 1N8

Test Description		Result	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli						
Total Coliform	** FAILED	>200	MPN/100mL	0		17-MAR-07
Escherichia Coli	PASSED	0	MPN/100mL	0		17-MAR-07

** This water sample has FAILED to meet the Canadian Drinking Water Quality Guidelines (CDWQG) for bacteria in drinking water.

Until the bacterial safety of your water supply can be confirmed, water for drinking purposes should be brought to a rolling boil for one minute. This applies to water used for making infant formula and juices, making ice, washing fruits and vegetables, and brushing teeth.

Discard all ice made and disinfect ice cube trays. Small children who may drink bath water should receive sponge baths instead of baths or showers. Alternate safe supplies of water, such as bottled water, can also be used. The water can be used for other household purposes such as bathing, showering, dishwashing, and laundry. See the attached fact sheet: "What do I do when a boil water advisory is issued ?". Read the section: "How do I use water when the boil water advisory has been issued for drinking water only ?". If you have received this report by e-mail please see http://www.gov.mb.ca/health/publichealth/cmoh/water.html for the fact sheets.
For further information on wells and water testing contact your local Manitoba Conservation Office or Health Links at 204-788-8200 Toll Free 1-888-315-9257.

QT-MPN/MPNU- a colour reaction (positive) is produced to indicate the presence of Total coliform and E.coli.
The number of positive cells is converted to a statistical number Most Probable Number units or MPN/MPNU.

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Date Sampled: 15-MAR-07

Expires March 31, 2007

Approved by Robert S. Kitlar
ROBERT S. KITLAR
Project Manager

28A

ALS Laboratory Group Analysis Report

Date Received: 16-MAR-07
Date Reported: 19-MAR-07

Lab SampleNum: **L487230-9**
Job Description: GARDEN HILL FIRST NATION
Sample ID: #9 (CISTERN)
Sample Source: WATER - MUNICIPAL TREATED (CISTERN)
Date Sampled: 15-MAR-07
Submitted By: Punam Mehta

MB WATER STEWARDSHIP SUBSIDY PROGRAM
ATTN: PUNAM MEHTA
98 WALNUT STREET

WINNIPEG MB R3G 1N8

Test Description		Result	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli						
Total Coliform	** FAILED	>200	MPN/100mL	0		17-MAR-07
Escherichia Coli	PASSED	0	MPN/100mL	0		17-MAR-07

** This water sample has FAILED to meet the Canadian Drinking Water Quality Guidelines (CDWQG) for bacteria in drinking water.

Until the bacterial safety of your water supply can be confirmed, water for drinking purposes should be brought to a rolling boil for one minute. This applies to water used for making infant formula and juices, making ice, washing fruits and vegetables, and brushing teeth.

Discard all ice made and disinfect ice cube trays. Small children who may drink bath water should receive sponge baths instead of baths or showers. Alternate safe supplies of water, such as bottled water, can also be used. The water can be used for other household purposes such as bathing; showering, dishwashing, and laundry. See the attached fact sheet: "What do I do when a boil water advisory is issued ?". Read the section: "How do I use water when the boil water advisory has been issued for drinking water only ?". If you have received this report by e-mail please see http://www.gov.mb.ca/health/publichealth/cmoh/water.html for the fact sheets.
For further information on wells and water testing contact your local Manitoba Conservation Office or Health Links at 204-788-8200 Toll Free 1-888-315-9257.

QT-MPN/MPNU- a colour reaction (positive) is produced to indicate the presence of Total coliform and E.coli. The number of positive cells is converted to a statistical number Most Probable Number units or MPN/MPNU.

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Date Sampled: 15-MAR-07

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Expires March 31, 2007

Approved by Robert S. Kitlar
ROBERT S. KITLAR
Project Manager

ALS Laboratory Group 1329 Niakwa Road East, Unit 12, Winnipeg, MB R2J 3T4 Phone: (204) 255-9720 Fax: (204) 255-9721

ALS Laboratory Group Analysis Repor

Date Received: 16-MAR-0
Date Reported: 19-MAR-0

Lab SampleNum: **L487230-10**
Job Description: GARDEN HILL FIRST NATION
Sample ID: #10 (CISTERN)
Sample Source: WATER - MUNICIPAL TREATED (CISTERI
Date Sampled: 15-MAR-07
Submitted By: Punam Mehta

MB WATER STEWARDSHIP SUBSIDY PROGRAM
ATTN: PUNAM MEHTA
98 WALNUT STREET

WINNIPEG MB R3G 1N8

Test Description		Result	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli						
Total Coliform	** FAILED	18	MPN/100mL	0		17-MAR-0
Escherichia Coli	PASSED	0	MPN/100mL	0		17-MAR-0

** This water sample has FAILED to meet the Canadian Drinking Water Quality Guidelines (CDWQG) for bacteria in drinking water.

Until the bacterial safety of your water supply can be confirmed, water for drinking purposes should be brought to a rolling boil for one minute. This applies to water used for making infant formula and juices, making ice, washing fruits and vegetables, and brushing teeth.

Discard all ice made and disinfect ice cube trays. Small children who may drink bath water should receive sponge baths instead of baths or showers. Alternate safe supplies of water, such as bottled water, can also be used. The water can be used for other household purposes such as bathing, showering, dishwashing, and laundry. See the attached fact sheet: "What do I do when a boil water advisory is issued ?". Read the section: "How do I use water when the boil water advisory has been issued for drinking water only ?". If you have received this report by e-mail please see http://www.gov.mb.ca/health/publichealth/cmoh/water.html for the fact sheets.
For further information on wells and water testing contact your local Manitoba Conservation Office or Health Links at 204-788-8200 Toll Free 1-888-315-9257.

QT-MPN/MPNU- a colour reaction (positive) is produced to indicate the presence of Total coliform and E.coli. The number of positive cells is converted to a statistical number Most Probable Number units or MPN/MPNU.

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Date Sampled: 15-MAR-07

Expires March 31, 2007

Approved by Robert S. Kitlar
ROBERT S. KITLAR

ALS Laboratory Group Analysis Report

Date Received: 16-MAR-07
Date Reported: 19-MAR-07

Lab SampleNum: L487230-11
Job Description: GARDEN HILL FIRST NATION
Sample ID: #11 (PAIL)
Sample Source: WATER - MUNICIPAL TREATED (CISTERN
Date Sampled: 15-MAR-07
Submitted By: Punam Mehta

MB WATER STEWARDSHIP SUBSIDY PROGRAM
ATTN: PUNAM MEHTA
98 WALNUT STREET

WINNIPEG MB R3G 1N8

Test Description		Result	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli						
Total Coliform	PASSED	0	MPN/100mL	0		17-MAR-07
Escherichia Coli	PASSED	0	MPN/100mL	0		17-MAR-07

This water sample has PASSED and therefore meets the Canadian Drinking Water Quality Guidelines (CDWQG) for bacteria in drinking water.
For further information on wells and water testing contact your local Manitoba Conservation Office or Health Links at 204-788-8200 Toll Free 1-888-315-9

QT-MPN/MPNU- a colour reaction (positive) is produced to indicate the presence of Total coliform and E.coli.
The number of positive cells is converted to a statistical number Most Probable Number units or MPN/MPNU.

Approved by Robert S. Kitlar
ROBERT S. KITLAR
Project Manager

Appendix 11: Letters from Environmental Health Officer

PUBLIC HEALTH PROGRAM
Box 272 Garden Hill, Manitoba ROB-OTO
Phone: (204) 456-2926 Fax:(204) 456-2645

January 17, 2007

Mr. Norman Wood
Band Administrator
Garden Hill First Nation
Garden Hill, Manitoba
ROB-OTO

Dear Sir;

Re: Contaminated Cisterns

We are very concerned regarding contaminated water cisterns at the homes we have tested. Due to this contaminated water they should not be drinking it but they have no choice. We tested the water at their homes and results came back positive for contamination. This means if they keep on drinking this water they will get a serious stomach flu which will last maybe 4 – 6 weeks and especially dangerous for an infant and elders or Chronic people.

You must have been made aware of this problem before. The water cisterns involved are very dirty and needs to be cleaned properly. This is the reason whey we have been getting a lot of bacteria showing up on our water testing.

Our recommendation is to have these cisterns cleaned by trained personnel as soon as possible. We will be retesting contaminated cisterns every week until we are satisfied the water result are good.

We will also be sending results and information to Environmental Health at Winnipeg Medical Services.

For your information the water supply at Water Treatment Plant is clean and no bacteriological contamination evident. The water delivery truck is also tested for bacteria at all times and no contamination whatsoever.

As you can see it is the homes that have contamination is their water supply.

I hope we have made it clear to you that this is an emergency situation and needs to be acted upon right away on this very serious matter. To make it simple this is like drinking water out of your toilet, that is how bad their water supply is.

List of homes with cisterns that need cleaning is attached.

Thank you for your time.

Mr. Clint E. Wood
Community Based Water Monitor
Public Health Program
GARDEN HILL HEALTH DIRECTORATE

c.c. **Oberon Munroe**, Health Director-GHHD
Eric Wood, Public Health Program Coordinator-GHHD
Tom Smithson, Environmental Health Officer-Winnipeg
Bruce McDougall, Water Plant Operator-GHFN
Chief & Council, Garden Hill First Nation-GHFN

Health Canada / Santé Canada

First Nations and Inuit Health Branch
Manitoba Region
300 - 391 York Ave.
Winnipeg, Manitoba
R3C 4W1

February 16, 2007 OF6-29-5-297

Chief and Council
Garden Hill First Nation
Garden Hill, Manitoba
R0B 0T0

Dear Chief Flett

RE: Water Holding Tanks, 1000 gallons

During a recent trip to your community from Feb. 5 - 8, 2007, I had inspected a two 1000 gallon water holding tanks with your ~~community based water monitor, Clint Wood.~~

During this inspection, the following locations were visited: Josh Harper - Hse 11S1, and Oliver Beardy.

Josh Harper - Hse 11S1; As indicated in picture one, this unit is visibly dirty, and the support piping had come off and was floating around. A bacterial sample taken from this unit indicated that the water was contaminated.

Another problem with this unit is that garbage is strewn about the yard, as shown in picture two. I was informed that, although there is a garbage collection service, it is not picked up from this location. Please ensure that garbage is picked up from all areas.

Oliver Beardy; As shown in picture three, this cistern is extremely filthy. A bacterial sample taken from this unit also indicated that the water was contaminated.

During a conversation with your Band Manager, Norman Wood, in Feb. 2006, I was informed that there was currently no program in place, at that time, to clean water holding tanks. There still is no program in place to clean water holding tanks. There are some tanks which have not been cleaned since they were installed approx. 10 years ago. Some tanks are extremely dirty, and some are contaminated with coliform bacteria. Some tanks may also not be properly covered. When tanks are not properly covered, dirt and debris can enter.

A cistern cleaning program is vital to ensuring that community residents are provided with a clean, potable water supply. Please ensure that such a program is developed as soon as possible.

In addition to cleaning the cisterns following a regular maintenance program, they will also need to be cleaned following a positive bacterial result when identified by the community-based water monitor. Cisterns should be sampled 1 - 2 times per year.

If you have any questions regarding the above please do not hesitate to contact this office.

Yours truly

T. Smithson
Environmental Health Officer

cc Norman Wood, Band Manager, Garden Hill First Nation
Oberon Monroe, Director of Health, Garden Hill Health Directorate
Bruce McDougall, Garden Hill Water Treatment Plant
Eric Wood, Community Health Program Manager
Clint E. Wood, Community-based Water Monitor
Ken Mattes, Sr. Instructor, Mb. Water and Wastewater Treatment

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